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Tackling uncertainties with All-Cloud Network

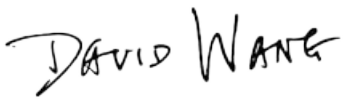
The intelligent world is driving the digital transformation of every industry, triggering an industrial revolution that's bringing great business opportunities. This new world is based on networks, which are now becoming as necessary as water and air, with ever-increasing requirements on coverage and depth of services.

Telcos, however, face challenges with uncertain services, business models, and technical standards. Services based on the deep convergence of IT and CT, IoT, and emerging tech like 4K, VR, 5G, and AI are all possible avenues for telcos to explore. But, they need innovative business models in a collaborative ecosystem that considers declining demographic dividends and traffic dividends. New technologies such as SDN and NFV and new standards have uncertain value for carrier networks, delaying the standardization and commercialization of new technologies.

Telcos tend to deploy networks with an eye on long-term technological development and evolution roadmaps that support value creation in a given business. Now, business direction is less certain and first-mover advantages are the most effective way to create business value.

All-Cloud Network is designed to drive business success. It uses cloud to build agile, intelligent, efficient and open, future-orientated networks. The centralized scheduling of network capabilities enables services to be deployed automatically and new service TTM to be cut from several months to a few days or even minutes. Open network capabilities will allow telcos and their partners to flexibly integrate resources, rapidly innovate, and embrace business opportunities for digital transformation in IoT, smart cities, and Industry 4.0, and other domains. All-Cloud Network will change network construction and maintenance from traditional silos to end-to-end automatic network planning, deployment, optimization, and O&M, thus maximizing network efficiency and reducing OPEX.

Digital dividends based on All-Cloud Network are limitless. Huawei helps operators and the enterprise industry to achieve business success through All-Cloud Network with an open and collaborative approach that seeks to build a Better Connected World.



David Wang, President of Products and Solutions, Huawei

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Moving towards a business-driven All-Cloud Network

David Wang, President of Products and Solutions, Huawei

Redefining business roadmaps

In the past, operators were tech-led, first building networks and then deploying services. Now, in the ultra-broadband era, simply improving services doesn't fully demonstrate network value, especially with the decline in traditional business models.

Broadband, video, and B2B are operators' main businesses, but trends in video, cloud, Internet+, and BYOD are seeing network traffic soar. They're facing issues with Gigabit fixed broadband acceleration, long construction periods, and low ROI. The long-term coexistence of diverse wireless standards, different types of services, and differentiated business models are increasing requirements on mobile broadband

With enterprises implementing digital transformation, the telecom industry is rich with opportunity. Operators are the enablers of digital transformation in a market with vast potential for development. But, they must switch from traditional tech-driven investment models to models driven by business value.

networks. Video has become a basic service for operators, but they aren't more competitive than wired cable operators or OTT providers. B2B is also an important revenue source for operators; however the enterprise and industry markets require that private line services should have many on-demand service capabilities, such as on-demand customization and immediate service provisioning, which greatly challenges existing networks.

Operators need to actively explore emerging business models. New technologies, such as cloud computing and IoT, enable them to enter the trillion-dollar market for digitally transforming vertical industries, but they need flexible and open networks that bear diverse services.

Agile, intelligent, efficient, open

More than 400 global operators have created US$10 trillion in network assets over the past two decades. Their biggest problems now are how to maximize network value, transition into a smart world, and enable networks to create a new trillion-dollar commercial roadmap. Huawei believes that future networks should be:

Agile: includes rapid new service integration and provisioning, plus Internet-based operations that slash new service TTM.

Intelligent: provides flexible scheduling for tens of thousands of services with automated business planning, provisioning, resource scheduling, and O&M.

Efficient: pools resources without independent networks for each service and industry, ending silos and maximizing resource sharing.

Open: creates a cross-industry, deeply integrated, and collaborative society where networks are fully open so partners can quickly innovate together.

Networks with high-speed broadband and low latency are vital for operators to explore business roadmaps and core assets to distinguish them from OTT providers.

Future networks won't just mean new technologies such as cloud computing, SDN, and NFV; they'll also bring in new business models and operating models. This is a core facet of Huawei's All-Cloud networks. Centering on application scenarios, Huawei dynamically integrates new tech and business requirements into a business-model driven approach that enables digital transformation.

The strategy

Huawei's strategy focuses on pipelines, with new opportunities from ICT convergence framed in an open, interconnected, and innovative ecosystem through Huawei All-Cloud products and solutions. Huawei hopes to be an active promoter and leader in the All-Cloud process, based on the following aims:

- Enabling operators to flexibly expand their business. With stronger network business and operation platforms, operators can meet traditional broadband, video, and enterprise campus private line requirements and business requirements for emerging vertical industries such

Transforming operations is more than just providing online customer services and online sales – it also needs to support process transformation with a focus on customer requirements.

as smart homes, IoT, smart cities, and Industry 4.0. New services can be rolled out in days instead of months.

- Enabling operators to have agile, efficient networks. Operators need to fully coordinate network resources for diverse business in the future, maximizing network resource use and reducing OPEX.

- Providing consumers with a Real-time, On-demand, All-online, DIY and Social (ROADS) digital experience, including service experience and an E2E purchase and usage experience.

When implementing business-driven transformation, operators focus on end user experience and services. Huawei can help operators maximize network value, improve revenues and efficiency, and boost business opportunties. Huawei uses the pipeline advantage to enter new fields for reshaping B2B business through cloud services.

Huawei believes All-Cloud transformation is the most effective technology for itself and vertical industries to go digital.

E2E solution suite

After five years of development, Huawei released its cloud solutions in 2017:

Wide Area Network (WAN): To upgrade traditional radio access, fixed access, metro, backbone, and optical networks to All-Cloud, Huawei's agile solutions include CloudRAN, CloudFAN, CloudMetro, CloudBackbone, and CloudOptiX. In July 2016, Huawei CloudRAN helped Telecom Italia build future-oriented agile networks, delivering an optimized mobile broadband network experience and slashing maintenance and site acquisition costs. In October 2016, Huawei and China Unicom Shanghai deployed network slicing technology for broadband access to provide multi-functional networks through CloudFAN, improving network usage. In January 2017, Huawei and China Unicom Guangdong released SD-UTN smart leased line services that provide flexible, customizable cloud-based leased line services by reconstructing existing IP RAN networks with cloud.

Enterprise B2B: Huawei released the CloudEPN solution to satisfy agile, interconnected, and one-stop ICT integrated service requirements for SMEs. The CloudEPN solution supports two deployment models: SD-WAN and CloudVPN. This can help operators reshape the E2E service experience and provide new enterprise private lines for enterprise customers. In September 2016, Telefonica announced that it would deploy the Huawei E2E CloudEPN solution for its global procurement framework, with a lab in Argentina dedicated to piloting commercial deployment. For the enterprise campus market, operators need to change the original box resale model to the cloud service model. To help operators enter this emerging trillion-dollar market, Huawei has rolled out its innovative CloudCampus solution, which provides cloud-based enterprise campus network planning and OAM services.

Digitizing verticals: Huawei provides the industrial IoT solution Edge Computing IoT

(EC-IoT) based on cloud architecture NB-IoT solution (Cellular IoT). The EC-IoT solution is based on SDN architecture and implements unified management and operations on numerous IoT gateways, enabling operators to enter the IoT domain. The solution has edge intelligence and processes IoT data in real time at network boundaries, achieving rapid response and local survival. In September 2016, Huawei collaborated with Schindler Elevators on a flexible and expandable EC-IoT Internet of Elevators solution for managing millions of elevators. The NB-IoT solution includes a smart device solution, eNodeB, IoT Packet Core, and an IoT connection management platform. The NB-IoT solution helps operators rapidly implement NB-IoT full network coverage, supports smart NB-IoT devices, and enables industrial openness. In December 2016, Huawei and Sweden Telia released the first commercial NB-IoT network. Telia completed cellular network upgrades and reconstruction, enabling it to access more vertical industry applications, integrate and improve its existing businesses, and create more cellular IoT connections.

Data center-centric network architecture: Huawei's CloudFabric solution helps operators build open, agile, and efficient cloud data centers with two core components: the CloudEngine data center switch and Agile Controller. In February 2017, Huawei CloudFabric helped China Unicom Henan deploy a commercial, distributed cloud data center that delivers localized cloud services with low latency, secure data isolation, and a unified management platform. The solution meets demands for cloud services from local governments, medical and educational institutions, and SMEs.

Core networks: Huawei's CloudCore and CloudEdge implement fully distributed and automated network software based on NFV, in a shift towards network functions cloudification (NFC). In February 2017, Telecom Argentina and Huawei released the first All-Cloud core networks in Latin America based on Huawei CloudCore and CloudEdge. In February 2017, China Mobile Hong Kong and Huawei commercialized an All-Cloud core network, which is more agile, flexible, and stronger, and thus better for operators to develop B2B, IoT, and 5G in the future. Huawei CloudCore and CloudEdge solutions won the Best Technology Enabler award at MWC 2017 for features like NFV architecture, commercial use, and cloud evolution.

By 2016, Huawei had collaborated with global customers to innovate and commercially develop All-Cloud networks, and conducted more than 500 commercial or trial applications of cloud-based networks in many scenarios, including operator WAN, data center networks, enterprise campus, and IoT.

Cloud needs openness

Collaboration is necessary for the maturity of cloud-based networks, and Huawei is a committed to building an open ecosystem, developing standards, and guiding trends. It's a platinum member and main contributor to the OPNFV community, a platinum member of OpenStack, a gold member of CloudFoundry, and a member of ONOS. It's one of the main contributors to technical standards for SDN/NFV.

Huawei supports the Edge Computing Consortium and, in December 2016, initiated the NFV-ITI alliance to help operators minimize integration and deployment costs, simplify multi-vendor collaboration processes, and implement rapid service rollout.

Huawei has established four OpenLabs, each with a different focus. The areas of focus are network evolution, NFV, SDN, and data centers. We are dedicated to constructing cloud infrastructure and developing and deploying cloud technology.

Constructing an All-Cloud Network

Industry transformation is shaping an intelligent world that, for telcos, also means disruptive changes in services, business models, and technical standards. ICT convergence and the rise of IoT, 4K, VR, 5G, and AI are redefining the concept of what a basic service is. Declining revenues from traditional services are driving telcos towards business models that work under a collaborative ecosystem. But, the value SDN and NFV will create for telecom networks is unclear, slowing the development of technical standards and commercialization.

By Wei Feng, Zhang Lei, and Cai Yanghai

A new layer of cloud

Cloud services demand a level of flexibility from the application layer that wasn't required when telcos knew what future services they would be providing and could easily develop technology to meet predictable needs. Moreover, OTT players are compounding this uncertainty, threatening telco dominance of the application layer.

The gap between existing network infrastructure and applications is already huge, with two major problems: One, the passive adaptation

of networks to each new service is either poor or extremely costly; and two, existing networks can't be adapted to business models capable of competing with OTT players.

But, network cloudification can build an intelligent adaptation layer between the network connection layer, with its defined functions, and uncertain service applications. Cloudification delivers a fast-response network infrastructure that can quickly enable applications that have commercial value.

Standardized connection layer

Regardless of network evolution, networks must ensure high bandwidth, low latency, and ubiquitous connectivity for telcos to expand their business.

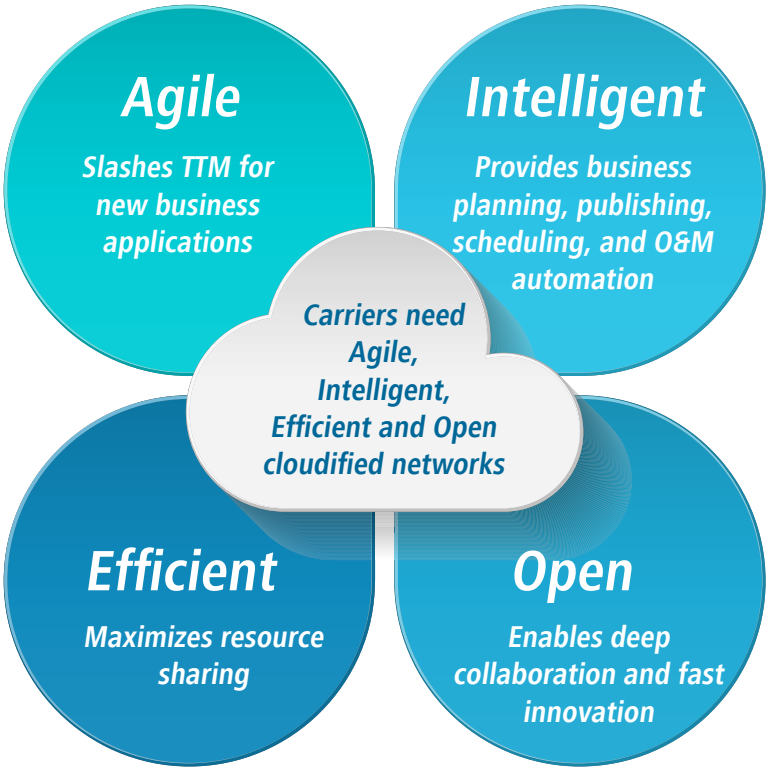
Intelligent adaptation layer

This crucial layer is responsible for:

Opening network capabilities: Facing the flexible application layer in the northbound direction, the adaptation layer centralizes resource scheduling and abstraction. Application developers can then schedule and assemble open network capabilities to quickly innovate services and applications.

Stabilizing architecture: Facing the standardized connection layer in the southbound direction, the adaptation layer masks the instability of various technical standards by using deterministic architecture to manage uncertain technologies.

Enabling agile innovation: This layer provides rapid and low-cost iteration capabilities, minimizing the costs associated with errors to combat business uncertainty.



Flexible application layer

This layer is designed to support a digital service and application ecosystem whose services and applications can belong to either telcos or third parties. It supports telco business scenarios and provides a ROADS (Real-time, On-demand, All-Online, DIY, Social) experience for end users through Internetized operations.

After cloud migration, networks are agile, efficient, intelligent, and open. They help operators build commercially driven networks for the future and maximize the value of their network assets.

Network Cloud Engine (NCE): The brain of the cloud network system

Service deployment requirements determine cross-domain distributed deployment and scheduling, improving network resource utilization by as much as 100 percent.

Huawei developed All-Cloud to resolve a range of business issues with a series of scenario-specific solutions.

The new NCE serves as the adaptation layer in the shape of a cloud-based platform and system. By enabling and opening network capabilities, it provides customers with network connectivity that delivers a ROADS experience and other VAS.

The NCE has the following characteristics:

Cloud Native

The NCE is based on a cloud infrastructure and platform service. Network functions for different service scenarios, such as home, enterprise, and operator WANs, are deconstructed into independent, autonomous, and neutral micro-services. Each micro-service supports gray upgrades, which enables elastic scaling based on service requirements. Service deployment requirements determine cross-domain distributed deployment and scheduling, improving network resource utilization by as much as 100 percent. The architecture is user-oriented, providing multi-tenant resource isolation and management. The reliable design complies with design-for-failure principles, enabling automated monitoring, fault location, isolation, and self-healing on the NCE.

Lifecycle automation

The NCE provides the following functions: planning and simulation, network service deployment and provisioning, network monitoring, assurance, and optimization of the entire process.

Based on a unified software orchestration and workflow engine, different service packages can be quickly and flexibly built for different service and commercial scenarios. This implements full-lifecycle automation of physical and virtual network functions, with the aim of reducing network connectivity service time from months to days via a friendly, real-time online consumer service portal or application, which provides minute-level provisioning and services. Intelligent operations, such as planning, deployment, control, maintenance, and assurance, are implemented through a unified, simple, and clear administrator's workbench, improving O&M efficiency tenfold while greatly reducing OPEX.

SaaS, NaaS, and DevOps

In addition to providing traditional CT network devices and a software transaction model, the NCE supports new SaaS and NaaS transaction and delivery models on the public cloud. Examples include one-stop e-commerce service transaction models such as online product and service subscriptions, provisioning, and adjustment. These help operators reduce consumer-oriented transaction costs and slash transaction costs between solution providers and operators.

NCE provides DevOps tools so operators or third-party partners can flexibly integrate, reuse, and combine existing micro-service and third-party capabilities. This enables rapid development and low-cost testing when customers' business scenarios and network tech change. For example, Huawei's CloudEPN enables operators and third party integrators to use the NCE-based DevOps tool platform to quickly create new third-

party firewalls, accelerate WANs, and introduce a wide range of VAS. It also integrates secondary software and capabilities, providing the end consumer with more flexible and richer integrated services.

The NCE is the brain of the entire cloud network solution architecture. It integrates the SDN agile controller and can combine and assemble different software function modules for micro-services to adapt to various CloudX network scenarios.

The NCE simplifies business monetization and ramps up efficiency by accelerating service and application development and innovation.

Another important part of Huawei's comprehensive cloud network architecture is the infrastructure connection layer. People, things, data, and applications are all interconnected, with data centers (DC) at the core in a range of scenarios, including home, base station, enterprise, campus, branch, and IoT.

Making All-Cloud reality

Taking cloud networks from concept to implementation is long, slow, and difficult. The entire industry chain must form a consensus on the following three ideas, and then fully promote them:

Business-driven: Develop a network evolution roadmap to start the shift from tech-driven to business-driven networks.

Network evolution technologies are continually emerging in the CT, IT, and OTT space. But, telcos must first consider commercial value, starting with ROI, before selecting technologies and applications. They need to look at increasing B2B revenues and optimizing the B2C service experience.

Systematic evolution: Decide on network-wide cloudification strategies, focus on service continuity and connecting old and new services, and ensure steady and systematic network evolution.

Operators have more than 30 years of accumulated network infrastructure, so it's unwise to rush cloud migration. Evolution must progress together with business planning, and so a policy of gradual evolution is advisable.

Typical evolution policies include overlay-to-underlay and evolving locally before expanding the whole network. During the replacement window in the network lifecycle, new technologies are used for network reconstruction. When expansion to support new types of services is required, new technologies are used to construct new networks.

Unified architecture: Define a unified cloud network architecture that's agreed industry-wide.

Cloud networks are still in their initial development stage, and still need to be defined by the industry to implement a stable and unified architecture. A priority when selecting technologies is the ability of the service layer to carry over the flexibility and agility of OTT/IT, while masking the uncertainty of technologies and protocols and supporting flexible service innovation.

It's also important that the network layer doesn't lose the strengths of CT, and that its architecture is standardized so interconnections can happen without increasing complexity. Therefore, standards organizations, such as IETF, BBF, and ITU-T, are vital to defining cloud network architecture.

For decades, global operators have deployed networks based on technology. However, as the direction of future service development leads us into uncertainties, traditional network deployment logic is already showing cracks. Future opportunities will only open up by making business value the core of future network planning.

Get strong, fast and agile with Cloud Native

In a world where the only certainty is change, telcos are threatened by dwindling revenues but empowered by the promise of 5G and the rapid migration of enterprise services to cloud. For those who can find the right solutions to navigate into the blue ocean, a trillion-dollar market awaits.

By Deng Ao

The silo problem

Traditional siloed network architecture impedes telcos' development given that business success today hinges on maximizing network efficiency, offering a diverse service range, and quickly responding to the highly varied demands of long-tail markets. That's why more telcos are using integrated NFV and SDN solutions to cloudify their networks and benefit from the following features: greater agility and efficiency, global resource sharing, easy capacity expansion, adjustable architecture, capability openness, agile service creation, and automated closed-loop O&M.

Network cloudification needs to marry the CT industry's reliability with the agility and flexibility of the IT industry. While NFV standardizes and virtualizes network infrastructure hardware, the traditional box development approach to software architecture, service innovation, operations, and O&M is inflexible and inefficient.

Cloud Native is a large-scale, IT-based software design for distributed network architecture that's a step closer to NFC. Harnessing Cloud Native concepts to reconstruct virtual network functions software enables the full distribution and full automation of this software and the construction of truly efficient and agile telecoms cloud networks.

Service and experience

The Cloud Native concept focuses on services and experience rather than infrastructure. Decoupling from hardware infrastructure enhances network resource efficiency and yields a series of advantages:

Flexibility places network-level distributed architecture at the core. The key technologies are stateless design, control and user plane separation, and cross-data center deployment. These enable flexible networks with service awareness. Resources can be provided on-demand, service capacity isn't constrained by single pieces of physical hardware, and network functions can be dynamically generated and deployed on-demand. This ensures that the different experience requirements of applications are met.

Robustness positions redundant and smart O&M capabilities at the core. The key technologies are stateless design, N-way redundancy and cross-DC deployment, active fault detection, and automatic closed-loop control. These enable decentralized multi-point fault tolerance and self-healing systems for high reliability independent of infrastructure.

Agility deploys network slicing, service orchestration, and grey release at the core. The key technologies are service-based decomposition, data modeling, and application orchestration. They flexibly assemble new network functions, launch new network services, and enable network functions and features to be customized online for rapid response to different industry demands.

Cloud Native networks can give operators unparalleled flexibility, efficiency, speed, and elasticity. Second-level network capacity expansion, minute-level service release, experience assurance, and optimal efficiency are all easily achievable.

Going native

Cloud Native combines different ideas like key IT and best practices such as DevOps, continuous delivery, and agile infrastructure. However, it isn't possible to fully replicate IT practices in architectural setup and key tech selection in a Cloud Native network. Telcos need to consider business features and the differentiated service requirements of application scenarios, quality requirements, and DevOps models. They should focus on flexibility, robustness, and agility, and introduce key Cloud Native technologies in a layered, on-demand and step-by-step manner.

Micro-service decomposition of virtualized software: Data and control plane separation should first be completed before micro-service decomposition. Service status and session data are separated from service processing units and stored in a separate distributed database, creating a stateless design for service processing units, allowing on-demand elastic scalability, and enabling single or multiple service processing units to fail without affecting services. This greatly enhances the flexibility and robustness of virtual software. Micro-service decomposition of virtualized software can then be implemented according to the service application scenario and network model.

When it comes to decomposition granularity, smaller is not necessarily better. Instead, the focus should be on independent upgradability, independent scalability, and reusability. The size of post-decomposition micro-services will differ markedly between applications that change rapidly and have a high number of customized requirements, such as IoT and enterprise communications, and those where functions are comparatively stable, like IMS and EPC.

Building a telco DevOps platform: After service-based decomposition is carried out, the smallest service unit can be independently developed, scaled, operated, isolated, and repaired. Introducing a DevOps platform and a collaborative development and O&M culture enables fully automated, continuous service iteration, and release from the development to operations stage. Telcos can then quickly respond to differentiated requirements, achieve agile development, and release new services.

Telcos need to build a telco DevOps platform and processes that fit the particular

Cloud Native combines different ideas like key IT and best practices such as DevOps, continuous delivery, and agile infrastructure.

When building a Cloud Native telco cloud network, it's necessary to implement a fully automated, closed-loop, smart O&M system based on big data and artificial intelligence.

characteristics of their services. But, most lack software development capabilities and tend to use a B2B delivery model where the vendor is responsible for development and the telco operates the service, unlike in IT where companies develop and operate services themselves.

Unlike in IT, a telco DevOps platform requires more complete automated O&M, reliability, and security capabilities, as well as the ability for rapid integration with current network O&M systems. However, telcos shouldn't be aiming to build an end-to-end DevOps team for processes, and should instead consider how to best leverage their service expertise – a better method is where the vendor provides a basic platform and basic micro-service units, and the telco carries out on-demand orchestration and the secondary development of micro-service units based on service scenarios.

Big data-based smart O&M system: While flexible and agile, software and hardware decoupling and decomposition based on virtualized software services increases system complexity and O&M; for example, hierarchical decoupling leads to complex fault demarcation and location. With hundreds of thousands of virtual machines (VM) and service nodes, the number of failed nodes increases. As the size of the cloudified network increases, the cost of O&M also grows exponentially under a traditional manual model.

When building a Cloud Native telco cloud network, it's necessary to implement a fully automated, closed-loop, smart O&M system based on big data and artificial intelligence. Such a system can automatically collect a variety of service instances and hardware and software statuses, and analyze them based on policies. The system can then suggest and action network error corrections, configuration adjustments, and the self-healing of network functions. Alongside system-wide automated service orchestration, these features enhance O&M efficiency and ensure efficient and stable service operations 24/7.

Introducing container technology: Containers are a lightweight virtualization technology that greatly benefits resource efficiency, performance, deployment, start-up speed, and mobility; however, they also have security issues. VMs are a heavyweight virtualization technology that have clear advantages in terms of security and resource isolation, but are worse at resource efficiency and performance. The two types of virtualization technology will coexist in the future, and operators can select which type to use based on the characteristics of the particular application.

Decomposition based on services enables "Lego-type" agile service assembly and creation. Telco DevOps platforms enable rapid service development under an Internet model by streamlining development and operations. And application-based multi-node fault tolerance and self-healing under stateless design and smart O&M allow carrier-grade reliability independent of infrastructure. By harnessing Cloud Native concepts, telcos can build agile and efficient telecom cloud networks, enhance E2E efficiency, and achieve business success.

Why you should become a CloudFAN

As the ICT industry steps into the cloud era, broadband infrastructure needs to keep pace with rapid service innovation. But, broadband access infrastructure is asset-heavy and investment-hungry, with a lengthy engineering lead time. Operators need to assess the ROI timeframe and choose the right architecture for maximizing network utilization and boosting competiveness.

By Wu Huazhong, Zhou Bo, and Zhu Hong

Enter CloudFAN

The cloud architecture in Huawei's CloudFAN solution optimizes resource sharing, flexibly configures resources, and simplifies service development. It aligns with changes in home and enterprise services, and builds in core competitiveness for operators in home broadband and enterprise access scenarios.

Moreover, it uses one network to carry multiple services, maximizing the resource utilization of access devices.

The cause of complaints

A good user experience sits at the heart of home broadband, with 100 Mbps gradually removing the QoS bottleneck associated with bandwidth. Now, though, home users are accessing more Internet services on more devices through Wi-Fi, creating a new bottleneck that negates the benefits of high bandwidth and makes ultra-broadband services meaningless. According to Shanghai Telecom, 34 percent of its home user complaints relate to home Wi-Fi.

As a result, many operators are hesitant to provide Wi-Fi services. However, Ovum observed in its latest report that, "Whether operators admit it or not, users regard providing home Wi-Fi services as a responsibility of operators." Thus operators require a home network solution that manages internal home connections, meets user requirements, and minimizes service risks.

Home Wi-Fi networks differ from broadband access networks in that each home network is a mini Wi-Fi network accessed by different wireless devices that interfere with each other. Additionally, service types

are diverse and home environments vary, with family activities greatly impacting Wi-Fi use.

Time for a cloudy home

Cloud architecture that supports central management and optimizes synergy for thousands of home networks can ensure a consistent broadband experience.

The architecture must also monitor performance, simplify O&M, optimize user experience, and support remote troubleshooting.

Smart homes are the next home service blue ocean for operators. Traditionally, solutions are based on integrating universal services such as broadband, video, and home networks. However, there are more smart home services than traditional services, they have obvious regional characteristics plus different service combinations, and different users can use them in different ways. Smart homes also require smart device integration and continuous service development, which traditional construction models cannot achieve.

Instead, an architecture that supports terminal-cloud synergy can rapidly introduce third-party services, integrate smart services, and develop iterations of service applications to realize quasi-Internet service operations.

Thus, operators need to switch from traditional broadband network architectures to open, cloud-based architectures.

Best choice for SMEs

SME services are evolving towards cloud. SMEs have higher requirements on leased line deployment efficiency than before, as previously it took up to a month to prepare and configure a leased line. But, the cloudification of enterprise applications means that operators face competition from Internet companies. For example, Amazon Web Services (AWS) Direct Connect offers dedicated networks that rapidly and easily connect local facilities to AWS. To compete, operators must provide SMEs with leased line services that support DIY configuration in real time.

Operators plan to provide network hosting services for vertical industries. Part of the new economic paradigm is sharing, integral to which is maximizing efficiency across the ecosystem. Operators can play an important role in this new era by applying their expertise in building and maintaining infrastructure networks in enterprise campuses.

Enterprise campuses often serve hundreds of SMEs, most of which aren't telcos or IT enterprises. Previously, enterprises had to waste resources by hiring specialist personnel to construct and maintain their networks. Traditional enterprise campus networks are now evolving from switch networks to all-optical networks, which benefits operators because of their strong capabilities in all-optical network construction and O&M. They can also build multi-tenant hosted networks for enterprise campuses. SMEs can create applications based on demand and receive network services, while operators can maximize network utilization.

All SME access services require cloud network architecture to centralize resource management and sharing, eliminate redundant and complex service configurations, and support business transformation for operators.

FTTx

The core of traditional broadband network operations is to improve installation rates, ensuring assets are efficiently utilized and infrastructure ROI is improved.

There are two methods for improving network utilization: one, using a network for multiple services, and two, wholesaling services. In the first, FTTH networks can bear home, enterprise, and mobile bearer services. However, traditional FTTH networks are oriented to homes and don't support differentiated SLA quality assurance for enterprise and mobile bearer services. Moreover, for service planning, VLAN resources need to be isolated for different services. However, a traditional

FTTH network supports 4,096 VLANs, but not service expansion. When operators lease idle network resources to other operators, they have similar demands on network capabilities.

To put multi-service networks into commercial use, FTTx networks must support slicing and resource isolation, including MAC addresses, VLANs, and IP addresses. One physical network needs to be virtualized into multiple networks, with each supporting the same SLA attributes for different services as the physical network. Inefficient network resources, especially VLANs, are expandable and independent.

Technical close up

CloudFAN's networking structure comprises the physical component and cloud platform, and they communicate using management control protocols. General servers use cloud computing technologies to implement network cloud engines (NCEs) on the cloud. These servers are deployed in operators' CO equipment rooms or edge data centers, and include the FAN manager, VPN enabler, and home enhancer modules. They respectively implement service management, E2E connection management, and VAS processing for physical devices on access networks.

Huawei's CloudFAN solution uses three key technologies – cloud management, one-stop cloud access, and network slicing – to manage home Wi-Fi on the cloud, provision new services quickly for home users, and provide cloud access and fast provision of leased line services for SMEs. It improves FTTx network utilization, optimizes Wi-Fi capabilities, and enables operators to improve network utilization and deploy network wholesale services.

The three technologies in focus

Cloud management: Cloud architecture automates plug-and-play for home terminals and enterprise access devices. It automates service provision and subscriptions, and provides easy-to-customize interfaces, so operators can provide third-party applications through upper-layer adaptation. For example, they can provide wholesale services and analyze network quality and operating data.

NCEs execute cloud O&M on access networks, with system management possible in hosting or sharing mode. Self-installation, self-reliant procurement and installation, and auto-provision and auto-maintenance reduce network construction complexity and cut O&M costs.

One-stop cloud access: To provide leased lines for enterprises, operators previously had to configure devices individually, leading to slow service provision and overly complex O&M. However, CloudFAN connects FTTx networks to the cloud with one pipe, so only the start and end points need to be configured while the intermediate network supports transparent transmission.

Cloud authorization lets enterprises implement self-reliant network management, define service attributes, and freely adjust bandwidths and policies.

Network slicing: CloudFAN uses virtual access network (vAN), virtual extensible LAN (VXLAN), and hierarchical QoS (HQoS) to implement network slicing on physical devices. User- or port-level vAN division and definition can segment and isolate devices' logical resources, so operators can isolate user resources and prevent services from overlapping. When upper-layer services are transmitted over a uniform bearer network, the CloudFAN solution establishes tunnels using VXLAN technology. Packets can be transparently transmitted through the intermediate network. HQoS technology provides SLA assurance for every user and service, and bandwidth can be dynamically adjusted.

These technologies can plan service identifier decoupling and isolate and transmit various types of services from different content providers over the same access network, creating networks that can support multiple services and tenants.

Mobilize your spectrum boundaries with All-Cloud

Although mobile subscriber growth is slowing, broadband connections will hit 6.2 billion by 2020 and 8.5 billion by 2025, 2.5 billion of which will be at gigabit speed in 2025. Moreover, the prevalence of mobile ultra-broadband, smart devices and homes, AR, VR, and wearables will see each user generating 30 GB per day by 2025, up from less than 1 GB now.

By Wang Yufeng

Two major trends

Mobile technology has quickly spread from the consumer sector to manufacturing, where it's enabling digital transformation across verticals. Smart manufacturing, for example, is riding on the back of tech like wireless voice, multimedia communications, wireless video surveillance, data collection from mass sensors, real-time scheduling, and remote robotics.

At the same time, the Internet of Vehicles (IoV) will emerge as the next major mobile market, with all new vehicles networked by 2025. Drivers and passengers will be able to access a wide variety of cloud services online, including V2X services, infotainment, and fleet

management services.

Fast reactions

As business boundaries expand, operators will move deeper into verticals, adapting and integrating network capabilities. This will introduce new requirements for mobile networks and force operators to reconfigure their models for managing network resources.

Low latency is critical for certain applications in both smart manufacturing and IoV. For example, critical control in a smart factory requires 1-ms latency – Huawei's X Labs and Kuka jointly developed a 5G industrial robot where the master and slave arms need to exchange information every 4 ms for precise coordination, requiring stable latency under 1 ms. Conversely, interaction between sensor data has much lower requirements. In an IoV scenario, a column of networked cars driving at high speed to reduce fuel consumption requires less than 3 ms latency, while in most V2X scenarios, 20 ms latency can meet requirements.

The spectrum problem

Spectrum is mobile operators' most precious asset. And it's scarce, especially the 900 MHz golden spectrum band. An estimated 74 percent of telcos have less than a 10 MHz block of the 900 MHz band. They spend huge amounts of bidding for spectrum, with 10 MHz costing around US$40 million and 10 MHz of 900 MHz commanding up to US$98 million. One Thai operator bid a staggering US$2 billion for a block of 900 MHz.

Because operators' spectrum consumption will grow to meet consumer and industry demand, they must maximize spectrum resource efficiency as a matter of priority. Over the past 10 years, telcos have substantially increased spectrum efficiency by using SingleRAN base stations for refarming. Spectrum refarming allows the static allocation of 5 MHz of a 10 MHZ block to UMTS and 5 MHz to GSM, but it doesn't allow spectrum resources between different standards to be dynamically re-shared.

Standards and spectrum decoupling is therefore required to reuse spectrum and maximize spectrum efficiency, enabling operators to go from refarming to sharing.

Taking it to the clouds

Cloud allocation and scheduling of different mobile network resources, such as OM, RRC and PDCP, must be based on service scenarios. In the future, a greater need for local computing will arise from services with high bandwidth and latency requirements, such as mobile VR/AR and machine vision, to guarantee user experience.

Wireless

When an operator develops new services, very different requirements from different applications and scenarios can emerge with data speeds (from Kbps to Gbps) and latency (from seconds to milliseconds). Network complexity might increase due to the jump in frequency bands, standards,

Cloud allocation and scheduling of different mobile network resources, such as OM, RRC and PDCP, must be based on service scenarios.

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SingleRAN to CloudRAN

Oriented towards 5G evolution, CloudRAN is a unified wireless cloud architecture based on SingleRAN. Its three main features are as follows:

Pools hardware resources: In traditional architecture, resources are centralized in a single site, preventing dynamic resource adjustment within a region. CloudRAN changes this by meeting the diverse hardware resource requirements of different services during the implementation process and carrying out overall scheduling to efficiently allocate resources.

Flexible architecture: CloudRAN uses real-time and non-real-time scheduling layers. The real-time layer is closer to the user, enabling accurate and efficient air interface resource management. The non-real-time layer is centrally deployed and can coordinate multiple technologies and perform cross-site scheduling. CloudRAN network functions can be deployed based on demand to different nodes, including wireless, backbone aggregation, and even core aggregation nodes, maximizing network efficiency and capabilities.

Automates service deployment: Flexibly defined new service processes and interfaces can automate resource scheduling and fault handling. Voice, video, and IoT will become the main service types of mobile networks, and increase requirements. CloudRAN supports network slicing for network functions customization and orchestration. It automates the deployment of different services on the same network, enabling new technologies to be rapidly deployed.

CloudRAN's advantages will make it the next deployment standard for wireless network architecture. By reconfiguring the most critical access network architecture with cloud technology, operators can meet the diverse requirements of the future.

Conceptualized in April 2016, the first field POC for Huawei CloudRAN will be completed in 2017, with small-scale commercial adoption predicted for Q2 2018. The technology will help operators develop new services with greater agility to gain a head start in the market.

CloudRAN's benefits

CloudAIR shatters air interface bottlenecks: A key resource for MBB networks, CloudAIR uses cloud technology to centrally schedule and efficiently utilize air interface resources, that is, spectrum, power, and channels. Operators can then focus on improving efficiency and flexibly deploy various services to enhance user experience.

Spectrum cloudification eliminates limits: mainly includes sharing solutions for GU and GL spectrums, LTE, and 5G NR new air interface spectrums. Huawei has

completed the first commercial deployment of the GU spectrum sharing solution with Vodafone India and verified the GL spectrum in Thailand. Huawei will optimize its GU and GL spectrum sharing solutions to boost spectrum efficiency. It has proposed sharing standards for LTE and 5G NR new air interface spectrum, which have already gained widespread industry acceptance. Standardization work is currently taking place under the 3GPP framework.

Power cloudification maximizes power utilization: mainly includes power sharing within and between standards. Huawei has developed sharing solutions for carriers between GSM and UMTS and between GU and GL standards, commercially deploying the solutions on a global scale. In 2018, Huawei will also launch LTE and UL and GUL power sharing solutions between multiple bands to further boost power efficiency.

Channel cloudification builds user-centric networks: mainly includes D-MIMO and UC-MIMO. TDD D-MIMO has been tested and verified on Japan's SoftBank and China Mobile's networks, and is set for commercial launch in Japan. FDD D-MIMO will be available in 2018 and, in the future, UC-MIMO will enable user-based network resource scheduling.

CloudAIR's benefits

Better utilizes air interface resources: Spectrum cloudification enables rapid deployment of new standards; power cloudification enhances cell capacity; and channel cloudification improves service continuity at the cell edge. Spectrum, power, and channel cloudification all enhance air interface utilization for better user experiences.

Fast coverage for new standards: The most important requirement when introducing a new standard is fast network coverage. This requires deployment of the new standard on the existing frequency band, so new and old standards can share the same frequency band. The new standard quickly reaches the same coverage as the old standard and uses spectrum resources based on demand according to changes in penetration and traffic.

The long-tail problem of old standards: 2G and 3G networks will exist over the long-term in many regions; for example, the US carrier AT&T started to retire its 2G network in 2011 but has yet to complete the process. Today, old standards only constitute a small amount of traffic but they continue to occupy golden spectrum and will do so over the long term, resulting in wasted resources. Through dynamic spectrum sharing of new and old standards, CloudAIR prevents waste by allocating the vast majority of spectrum resources to new standards based on traffic demands.

All-Cloud network innovations will allow operators to overcome various limitations affecting mobile networks and create all kinds of new possibilities. Fully cloudified networks will become the infrastructure for digital transformation in all sectors, opening up new business opportunities for the mobile industry.

Securing NFV the smart way

In October 2012, ETSI proposed the concept of NFV, established the NFV-ISG group, and set out the following action plan, which was accepted industry-wide: construct decoupled, efficient, and open next-gen networks using NFV. But, since then, the severity and frequency of network attacks increased, compromising the potential of NFV.

By Liu Maojun

More NFV-related technologies have been developed, verified, and passed integration testing. Operators are attracted by the efficiency and agility that NFV brings, especially in cutting OPEX and promoting rapid innovation and breakthrough services.

But, cloud security issues have cast a shadow over NFV, representing an ever-present threat to telcos and users. A security incident in a telecoms network can have immediate and disastrous effects, interrupting services, compromising user privacy, enabling telecoms fraud, and damaging operators' brand equity.

A changing security landscape

Traditional telecoms network functions run on dedicated hardware using dedicated software. Although the closed nature of these network functions is a disadvantage that NFV remedies, it is in fact an advantage for network security due to mutually independent hardware platforms, closed dedicated software, and a trusted internal network.

NFV changes the network security environment, however, due to resource pools based on cloud computing and open network architecture. Cloud computing and virtualization technology decouple software, so NFV networks face the same security challenges as cloud computing and virtualization. Thanks to the agility and O&M efficiency of NFV networks, attacked networks can potentially be abandoned and resources recycled, enabling disasters to be quickly isolated, a response that's impossible in traditional networks. Network functions, network links, and even entire networks can be rapidly redeployed, enabling fast disaster

recovery. At the same time, though, security threats have become more diverse.

The major threats

A new high-risk area – the virtual layer: Resource virtualization is the foundation of cloud computing and the main feature that differentiates NFV networks from traditional networks. The virtual layer provides unified computing resources based on generalized hardware to the layers above, and is the basis of all VMs and service software. If the virtual layer is breached, all VMs come under direct attack with disastrous consequences.

Resource sharing breaks physical boundaries: Resource sharing is vital for the agility and efficiency of NFV networks, but it means the user no longer has complete control over resources. A single physical server may run several different tenants' VMs, and a single tenant's VM might be distributed across different physical servers. Multi-tenancy resource sharing and breaking physical boundaries introduce the risks of data leaks, data residue, and attacks.

Traditional security policy failures: Virtualized networks have no physical network boundaries, rendering traditional security measures based on physical divisions ineffective. Thus, VMs are vulnerable to attacks between VMs on the same host. Moreover, the static policies of traditional security solutions cannot be automatically adjusted or respond to migrations, expansion, and other scenarios that lead to security policy failures.

Layered architecture and multi-vendor integration: After NFV introduces the virtual layer, a trusted link is needed between the infrastructure, platform, and service layers to secure each layer from the bottom up. Multi-vendor integration makes it difficult to coordinate security policies and determine responsibility for security problems, and requires more effective network security monitoring capabilities.

Open source and third party software: Because NFV extensively uses open source and third-party software, it faces the same security vulnerabilities as both, threats which most companies aren't equipped to respond to.

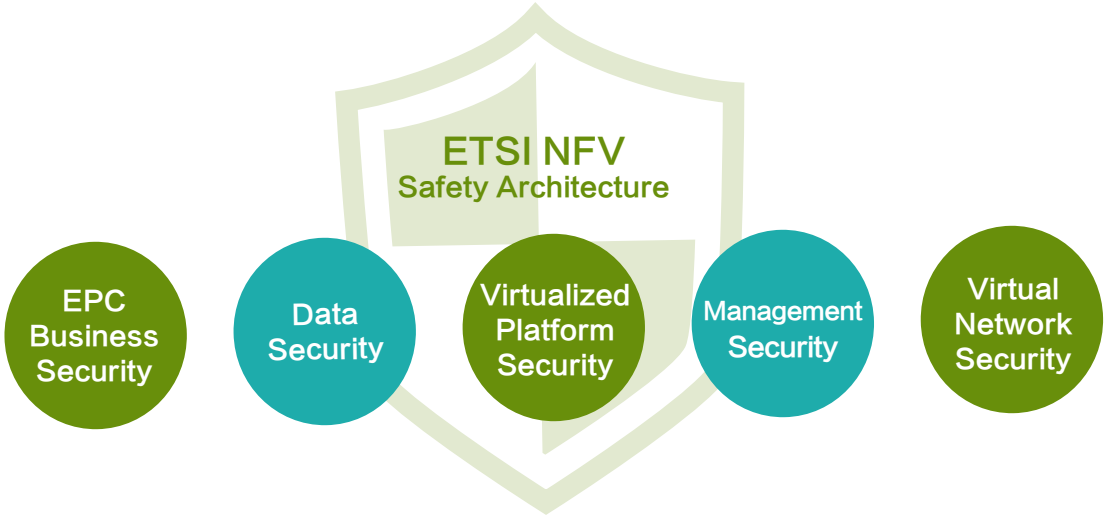
The solution

The security architecture for NFV must be multi-layered and include the following features:

Enhanced virtual layer: Hardening and patching virtual platform security can counteract software vulnerabilities. System tailoring minimizes the service system by deleting unnecessary software packages, which reduces system-wide security risks. Supplementary methods include security codes, open port scanning, minimized authority control, and anti-virus software.

Resource sharing: Isolating resources between different VMs on the same physical machine on the virtual layer can prevent data theft and malicious attacks between VMs because resource use by a given VM isn't impacted by the surrounding VMs. Users can only access their own VM resources, including hardware, software, and data, thus ensuring VM isolation and security.

Isolating resources between different VMs on the same physical machine on the virtual layer can prevent data theft and malicious attacks between VMs because resource use by a given VM isn't impacted by the surrounding VMs.



New security policies: Service orchestration via NFV has given rise to dynamic new forms of security policies. To deal with initialization, capacity adjustment, upgrades, migration, and security termination of network services (NS) and virtualized network functions (VNF), a security management and orchestration center is necessary to coordinate security protection across layers. This involves collecting information about each layer and tenant, analyzing system security status, developing security policies and measures, and deciding how to deploy them.

Three layers of firewalls: A physical firewall on the physical infrastructure sub-layer, a virtual firewall on the virtual infrastructure sub-layer, and a firewall deployed as a VNF on the service layer can mitigate the lack of physical boundaries in the network and protect all layers.

A security ecosystem: Given that the openness and flexibility of NFV is attracting more users and encouraging more services, a security ecosystem is necessary with multi-layer collaboration. Standardization, an alliance of developers, open source communities, and industry alliances can achieve this, but it will be a long and complicated process that requires the concerted effort of all.

An industry first

Cloud security threats in the NFV era present a long-term challenge. As NFV security technology continues to develop, automated and virtualized protection systems with robust security models will enable NFV networks to flourish.

As a leader in the field of NFV, Huawei has released the industry's first security solution for NFV. Its bottom-up, outside-in, and multi-layered architecture rapidly adjusts security policies based on network status, with centralized security monitoring enabling operators to visualize security status.

In January 2017, Huawei became an executive member of the Cloud Security Alliance. As part of the group, Huawei works with the other nine members to ensure the security of cloud services. Huawei's years of experience in cloud and telecoms security will help operators complete NFV cloud transformation efficiently, quickly, and securely.

Drilling down to the core of 5G evolution

5G marks the era of hyper-connectivity. An increasing variety of smart terminals will be connected in different ways, with new services like autonomous driving, smart homes, smart cities, AR, and VR increasing in prevalence. In turn, these services will need ultra-low latency, a vast number of concurrent connections, ultra-high bandwidth, and multiple access scenarios – features that today's core networks can't deliver.

By Zhou Zhiyong

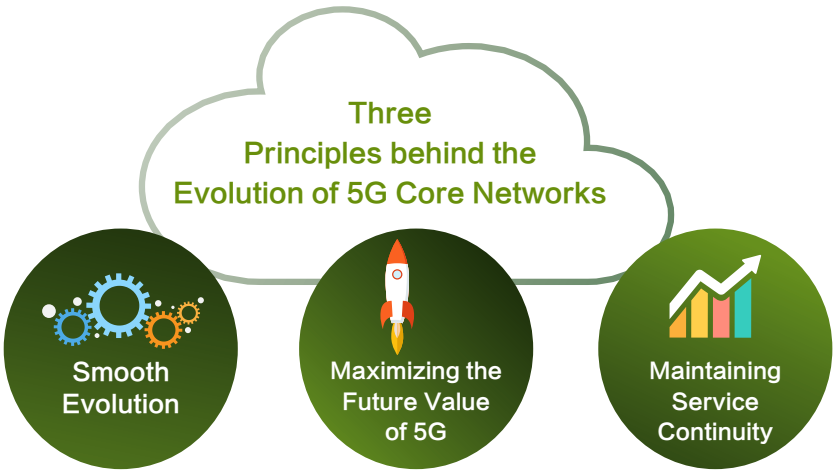
Two phases of standards

3GPP defined 5G network architecture at the end of 2016, with the core network divided into the control plane (CP) and user plane (UP). With the integrated CP comprising function models, the CP uses a service-based architecture. The UP is unified from UP functions and Gi-Lan functions. Cloud Native software architecture will underpin 5G core networks to meet key future service requirements through agility, flexibility, and robustness.

5G standards will be released in two phases – the first phase standards will be fixed in June 2018 and the second in November 2019.

4 keys to 5G

Service-based architecture (SBA):
In a 5G core network, CP functions are decoupled, integrated, and service-based. They combine with UGW control functions



to form an integrated CP. Service-based architecture enables plug-and-play network functions (NFs), ensuring extreme agility and the rapid deployment of functions.

Control and user plane separation (CUPS): CP and UP (C/U) are completely separate in a 5G core network, which simplifies network structure. Core network NFs can be flexibly deployed in data centers (DCs) on different levels based on service requirements; for example, the UP can be deployed on an edge DC near the end user and application server to meet extreme service experience demands like low latency.

Slicing: The 5G core network provides on-demand NF and resource deployment capabilities to meet the diverse service demands of future vertical industries. Building logically isolated network slices in cloud infrastructure enables services to be tailored to different vertical industries.

Fixed mobile convergence (FMC): The 5G core network unifies access and authentication to support multiple access types. FMC ensures a seamless service experience in any scenario.

From 4G to 5G

To meet operator demand for early 5G network deployment, 3GPP will first fix non-standalone (NSA) standards in the Phase 1 release to support mobile ultra-wideband services such as WTTx. A number of operators in the US, South Korea, and Japan will launch commercial 5G networks in 2018, with major players from other nations releasing timetables. Fixing 5G standards in phases will let operators gradually evolve 5G networks to reflect service demands.

As networks evolve, service continuity is needed to protect existing investment and develop future services. Operators should consider the following three principles when developing evolution strategies of 5G core networks:

Smooth evolution: Architecture is the first stepping stone to 5G evolution. 5G core networks will be completely deployed on cloudified architecture. Thus, operators must first cloudify legacy core networks to ensure smooth evolution.

Reconstructing infrastructure, including DCs and transmission networks, will lay the foundation for 5G network construction during the cloudification process. Operators will also be able to build IT O&M capabilities, accumulate DC O&M experience, and transform the O&M structure from vertical to horizontal.

As new services develop, it will be necessary to gradually deploy 5G architecture on to 4G core networks. Introducing Cloud Native architecture to core networks will support special capabilities such as cross-DC and gray upgrades, making software architecture ready for 5G evolution. Separated C/U architecture will allow the gateway forwarding plane to be moved down to the MAN, so mobile video services can be quickly rolled out. Introducing MEC architecture can move the gateway further down to the network edge to help develop

new services for applications like autonomous driving, smart buildings, and smart offices.

Once core network cloudification and architecture evolution are completed, 4G and 5G can be deployed on core networks on the same physical infrastructure and software architecture, enabling smooth evolution of the current network to 5G.

Maximizing the future value of 5G: 3GPP has suggested several ways to evolve to 5G, with two options available for core networks. One is to upgrade current networks to EPC+ when NSA standards are fixed, and then upgrade to NGC (Next Generation Core) when standalone (SA) standards are fixed. The second is to wait until SA standards are fixed before building NGC. EPC+ standards will first be fixed to meet the requirements of mobile ultra-wideband services; however, EPC+ terminals are incompatible with 5G standards, and it won't be possible to later upgrade them to 5G terminals. NGC standards will be fixed in six months – they'll support more functions and NGC terminals will be compatible with 5G standards.

Operators will need to choose a network evolution strategy based on the development of their services. From the perspective of maximizing 5G's, NGC is better suited for developing future services.

Maintaining service continuity: During early 5G network development, the coexistence of 2/3/4G and 5G core networks is unavoidable. Users will switch between two core networks when they interoperate between 4G and 5G, a scenario that makes maintaining service continuity difficult. To ensure continuity, 5G core network solutions must support integrated access for 2/3/4/5G to simplify network structure and O&M and to ensure interoperability.

In terms of core network evolution, a two-phase implementation is the general recommendation: evolve architecture then evolve functions. In the first phase, traditional core networks can be cloudified by region. Then, Cloud Native, C/U separation, MEC, and FMC architecture can be gradually adopted, with the infrastructure and architecture ready for constructing the 5G core network.

Functions evolution can be carried out as soon as the standards are fixed. Either the core can be upgraded to EPC+ first to support mobile ultra-wideband services before building the 5G core network, or the 5G core network can be built straight away. Ultimately the method operators choose will depend on how their services develop.

Once core network cloudification and architecture evolution are completed, 4G and 5G can be deployed on core networks on the same physical infrastructure and software architecture.

Henan Unicom gets enterprising with distributed cloud data centers

In February 2017, China Unicom subsidiary Henan Unicom rolled out its distributed cloud data center (DC). Deployed with Huawei, the DC solution meets the growing demand for cloud services from government departments, SMEs, and healthcare and education organizations.

By Qian Guifeng, Yu Li

New challenges

With the traditional telecoms market well and truly saturated, big data, IoT, and artificial intelligence have created new sources of growth for operators. These new services also mean that operators need to transform – a process that is fraught with challenges.

For Henan Unicom, the construction of all-optical networks left more than 100 of its PSTN equipment rooms idle. However, fully using resources in its widely distributed equipment rooms is the key to reducing CAPEX.

Henan Unicom has launched its 4K HD video service. This will allow it to expand their video business to hundreds of thousands of IPTV users in each county across the province. But, to support a 30 Mbps data rate and average user concurrency of 30 percent, the operator needs a scalable network with ultra-high bandwidth. It also requires a content delivery network (CDN) that supports cloud video services and can be opened to third parties to drive B2B revenues. A large-scale SDN was the right tool for forging new business opportunities.

Local government, healthcare, education, and SME customers require diverse cloud services, including active-active hot standby, desktop cloud, cloud gaming, and machine-to-machine (M2M), all of which require low latency to guarantee a good user experience. Moreover, some government and enterprise customers need resources from nearby data center sites due to policy requirements or preference, with each customer's services isolated.

Network operators require open devices on all network layers so as to adapt to current development trends and reduce equipment costs. As increasing numbers of customers have differentiated service requirements, operators need to provide open interfaces to support customized development and thereby attract new customers with a one-

stop self-service model. With the growth in data center services, new security risks arise from multi-tenancy, dynamic virtual machine (VM) migration, and disappearing network borders. Guaranteeing the reliability and security of cloud data center networks that run complex services has become a new issue for operators when it comes to cloud transformation.

CloudFabric

Aiming to drive cloud transformation, Henan Unicom teamed up with Huawei and the Network Technology Research Institute under China Unicom Group to deploy a secure and reliable cloud data center network solution for localized cloud services.

The solution uses the following innovative 1+4+N distributed architecture: **one** provincial management platform for cloud data centers, **four** areas (North, East, South, and West), and **N** municipal data centers. The management platform interconnects various cloud platforms by leveraging CloudFabric's network-and-network synergy capabilities, centralizing management, operations, and resource scheduling for municipal data centers.

CloudFabric uses Virtual Extensible LAN (VXLAN) technology to connect networks within or across the four areas. The municipal data centers offer localized cloud services and rack/bandwidth leasing services. The solution provides scalability, openness, and security guarantees, helping to support Henan Unicom's cloud business.

Localized service

Henan Unicom has transformed some of its equipment rooms – those with robust

transmission, power and air conditioning capabilities and key resources – into Virtual Data Centers (VDCs) to offer reliable and secure localized cloud services that maximally reuse resources and extend the CDN network to customer premises. The solution guarantees latency-sensitive services, such as active-active hot standby, desktop cloud, cloud gaming, and M2M, and lets government and enterprise customers obtain resources from nearby equipment rooms.

Government operations are kept secure on a more reliable network environment, and Henan Unicom can maintain infrastructure as a Service (IaaS) applications more easily. The localized cloud service model significantly improves service experience, improving the competitiveness of Henan Unicom against OTT service providers.

Scalable network = scalable business

Henan Unicom's large-scale cloud DC network uses spine-leaf architecture from the Huawei CloudFabric solution, with CloudEngine 12800 switches at the core layer and CloudEngine series top-of-rack (ToR) switches at the access layer.

The CloudEngine switches provide high port densities, high bandwidth without oversubscription, and large buffer sizes capable of supporting more than 20,000 servers in each DC. Controlled by the Huawei Agile Controller, CloudEngine switches automate network configuration to quickly provision bandwidth-hungry services such as HD IPTV and virtual reality (VR). The network resource pooling function creates a scalable network environment for flexible VM migration.

In the future, the network will need to accommodate multiple access media such as physical machines, VMs, and Docker containers. The CloudFabric solution can adapt to these access scenarios and reuse existing resources to create flexible and scalable networks that maximize resource utilization.

Open and secure

Huawei CloudFabric provides open architecture and interoperability with third-party cloud platforms, controllers, VAS devices, and virtualization platforms. Moreover, Huawei works with more than 20 ICT vendors and standardization organizations, including VMware, OpenStack, Brocade, Puppet, and F5. The open network architecture is compatible with heterogeneous network devices on different layers, and supports interoperation with customers' cloud platforms, offering more options for customers to build their networks.

The solution isolates services through domain- and rights-based user management, and employs security technologies like anti-DDoS, IPS/IDS, and an antivirus engine (AVE).

The partnership between Henan Unicom and Huawei has established a cloud DC solution that delivers high-quality localized cloud services for government and enterprise customers, making Henan Unicom more competitive in the blue-ocean cloud service market.

A cloudy view from the fragrant harbor

China Mobile Hong Kong pioneers cloud solutions

In February 2017, China Mobile Hong Kong (CMHK) commercially launched its NFV-based cloud core network. CMHK is the first operator in the Hong Kong market to cloudify its core network, with successful switchover marking the dawn of the cloud era in the financial hub.

By Wang Yurong

Three drivers

Services

Hong Kong is one of the world's most developed and fiercely competitive telecom markets. At the end of 2016, the number of mobile subscriptions in the territory had grown to over 17 million, achieving a subscriber rate of 230 percent based on its population of 7.3 million.

To stand out in this highly-saturated market, CMHK has been developing new services to retain old customers and attract new ones. In the future, operators' main services will be cloud services, video, AR, VR, IoT, and new 5G applications. As such, CMHK's future network will need to simultaneously meet the different network demands that each of these services has, for example, low latency, high bandwidth, reliability, huge numbers of concurrent connections, and seamless connectivity. It must also satisfy requirements such as fast service provisioning and rapid customization.

User experience

In today's world where experience is king,

Cloudifying networks can better utilize resources since the network elements installed on the infrastructure can share computing, network, and storage resources.

customers expect operators to be able to provide ROADS (real-time, on-demand, all-online, DIY, and social) services in the same way that Internet companies do; however, this is impossible with legacy network architecture. They need agile networks to build open and collaborative ecosystems.

TCO

The city-wide explosion in data traffic means that carriers have to constantly increase infrastructure investment, driving up TCO. Moreover, the use of primary-standby disaster recovery for network elements in legacy networks lowers resource utilization, but the cost of expansion is high. Cloudifying networks can better utilize resources since the network elements installed on the infrastructure can share computing, network, and storage resources.

All-Cloud in 3 phases

NFV is a disruptive network reconstruction technology that telcos need to assess in terms of whether it can retain carrier-class reliability, smoothly evolve services, and overcome possible challenges.

As a result, CMHK chose Huawei to deploy China Mobile Group's first ever All-Cloud core network for commercial use in 2016. Underpinned by decades of IT and CT experience, Huawei launched its All-Cloud software-defined network architecture – SoftCOM – back in 2012. The solution is designed to help operators cloudify hardware, networks, services, and operations with unified and open ICT infrastructure.

The All-Cloud project kicked off in June 2016, prioritizing the operator's goal of being first past the post in Hong Kong to bring cloudified services to market.

Phase 1 of the project saw cloud deployment of Evolved Packet Core (EPC), Diameter Routing Agent (DRA), and Policy and Charging Rules Function (PCRF). **Phase 2** deployed cloud-based user database (HSS/HLP), VoLTE, VoWiFi, and RCS (Rich Communication Suite). And **Phase 3** finished off the scheme by deploying the Circuit Switched domain (CS) on the cloud.

Preparations for full network cloudification were completed in six months, including research on requirements, network planning, and network deployment. CMHK also gained experience in co-deploying network elements (NEs), ensuring the smooth cutover of existing network services, and constructing NFV O&M systems, all of which can provide a useful reference point for future projects.

A global first for hardware

The project involved cloudifying the CS, PS, and IMS (IP Multimedia Subsystem), covering more than 20 NEs for the signaling and data planes. Deploying so many NEs on the same IT infrastructure had never been done before – anywhere.

During deployment, CMHK opted for the cloudified NEs to share management nodes, so all NE resources could be shared. Not using a separate management node for each NE cut hardware usage, slashed the space needed for cabinets, and provided unified

O&M access.

Smooth cutover

CMHK's existing platform used equipment from several different vendors. To ensure smooth service cutover from the legacy platform to the new cloud platform, the operator leveraged a hybrid pool solution. A hybrid pool is built from the same NEs on different platforms or NEs from different vendors. All resources are shared and can be flexibly allocated by percentage without the end user being aware. The solution minimizes impact on the current network and protects the operator's investment by reusing existing network equipment.

By the end of 2016, the partners had deployed a heterogeneous pool comprising Huawei's cloudified Mobile Management Entity (MME) and other vendors' legacy platform MMEs on CMHK's commercial network, with the same approach soon adopted for the Mobile Switching Center (MSC).

The team

CMHK faced a series of O&M challenges after network cloudification, including changing organizational management from vertical to layered; coordinating management and maintenance on the legacy and cloud network; correlating physical hardware warnings; implementing cloudified software; constructing unified demarcation and location methods; and implementing end-to-end fault detection and healing mechanisms that work between multi-layer heterogeneous entities.

At the start of the cloudification project, CMHK formed a virtual NFV team comprising personnel with different technical backgrounds and differnt business lines, and adjusted the structure in accordance with project progress.

Comprehensive system assessments were conducted based on the information gathered during maintenance, including diagnoses for services, software, and infrastructure. The network would be optimized and adjusted based on the outcome of the assessment.

Repeating this process helps to ensure service continuity, stability, and user experience, and enables an NFV network with high availability.

Cloud leads the way

CMHK completed the first phase of EPC and DRA cloud deployment in June 2017. Once full cloudification was completed, CMHK will be able to deliver quality services to its subscribers. This cloud project represents China Mobile's first successful commercial deployment of an NFV network, and will provide invaluable experience for the group going forward.

The All-Cloud platform also provides CMHK with better network infrastructure for developing enterprise services, IoT, and future 5G services. In the future, CMHK will be able to create more value from the network infrastructure through continued innovation in new tech areas such as network slicing and edge computing.

CloudMetro brings certainty to an uncertain future

Future-oriented metro networks are necessary to respond to continuous service innovation, maximize network value over the next two to three years, and enable operators to take the driving seat in the cloud era.

By Liu Kai, Gao Bo

Metro networks for a new age

The past 15 years has seen two major stages in metro network evolution. In the first, multiple protocols and modes like SDH, ATM, and ETH coexisted, with each corresponding to one network and requiring a dedicated maintenance team. The OPEX of managing multiple networks wiped out any cost savings from new tech, and so a new construction roadmap was needed.

The rapid development of broadband services like video required unified ultra-broadband networks, leading to the second stage of metro network development. Huawei's SingleMetro solution integrated multiple vertical networks into one horizontal network and combined multiple boxes into a single device on a unified platform, minimizing costs in technology evolution and traffic growth, while boosting profits and efficiency.

But, digital transformation has resulted in an uncertain future for metro networks. New industries and services need more from

metro networks, including high bandwidth, high reliability, and low latency. Flexible architecture, flexible resource scheduling, simple transactions, and faster service provisioning are all crucial features of a better customer experience. Metro networks' transformation must adapt to the complexity of integrating future tech, service diversity, and the fragmentation of commercial models.

Monetizing the pipe

Huawei CloudMetro reconstructs metro networks with cloud technology and includes resource management, smart connectivity, and flexible architecture as native capabilities. The solution's five main tools are resource pooling, modular services, intelligent O&M, automated management, and an open platform.

Resource pooling decouples resources through IT and network technologies, thus enabling on-demand flexible adjustment, improving the utilization of network resources, and making it possible to manage and control tens of millions of users.

Modular services: provides "Lego-style" modular service capabilities that can be flexibly deployed on demand, reducing service deployment costs and slashing new service rollout times.

Intelligent O&M automates online planning and simulation capabilities to rapidly locate and correct faults.

Automated management delivers one-click service deployment across domains, cities, and vendors, and enables offline-to-online flexible service scheduling.

Open platform provides an abundance of network services by rapidly integrating third-party applications.

CloudMetro makes networks function-centric instead of NE-based. It forms a multi-service edge (MSE) real-time forwarding layer, network cloud engine (NCE) service, and resource management layer based on different function attributes like service forwarding, resource management, user management, and connection management. Each function can be configured as required, achieving network functions atomization and better adaptation to different network environments. The IP-based MSE unifies the flexible forwarding and scheduling of multiple services, calculates services in real time, and guarantees ultra-high bandwidth and ultra-low latency. The NCE centrally manages and distributes multiple users, services, and connections. Because of their flexible

A single rack can manage tens of millions of users and dynamically expand resources based on loads.

architectures, the MSE and NCE collaborate to transform network-centric deployment into service-centric.

Fixed Broadband: Years to months

CloudMetro extracts and centralizes user management functions on MSE devices, and separates the forwarding plane from the user plane, facilitating flexible expansion. In the new architecture, centralized cloud deployment in the control plane fully utilizes the cloud's strong computing capabilities. A single rack can manage tens of millions of users and dynamically expand resources based on loads. The forwarding plane features high-performance hardware, with each rack providing Tbps of forwarding capability and the ability to process high-bandwidth services with low latency.

Integrating fixed broadband services involves adjusting service modes and frequent changes to service policies, which results in a heavy workload and makes integration difficult. The cloud NCE handles the management and service functions of CloudMetro, achieving "Lego-style" on-demand deployment capabilities for service modules. Orchestration enables network functions chaining, so fixed broadband service functions can be autonomously selected and flexibly deployed, and resources can be dynamically expanded or reduced according to service requirements.

The software module implements dedicated service functions to improve VAS capabilities, reducing integration costs by 70 percent, cutting service development from months to days, and enabling greater innovation. Standardized northbound interfaces (NBIs) eliminate previous application limits by opening up capabilities for third-parties. This is supported by Huawei's remote online verification lab, which now focuses on joint development with industry partners for industry-wide gains.

CloudMetro unifies the allocation of IP addresses based on the whole BNG network and also the automated application, renewal, and release of services. It configures session and bandwidth thresholds based on the bandwidth and session consumption of each board in the resource pool, and scientifically schedules BNG board resources, so resources are effectively utilized. The NCE's multi-VM architecture flexibly scales in or out based on traffic changes by adding or releasing occupied VM resources, enabling second-level service-automated migration without interrupting service traffic. Various technologies ensure carrier-class reliability, such as active/standby protection on the control plane, dynamic healing by VMs when component faults occur, and network-level fault protection.

In 2017, Huawei and China Mobile rolled out a cloud BRAS pilot program based on CloudMetro architecture, jointly issuing the industry's first technical whitepaper on cloud BRAS based on separated control and forwarding planes. The two parties thus contributed metro network evolution by enhancing system theory and basic practices for innovating cloud architecture.

5G slicing

CloudMetro uses network slicing to support differentiated services. All network resources, including ports and services, are sliced E2E, achieving the isolated bearing of multiple services such as MBB, FBB, and B2B. The network can then meet differentiated SLA requirements on bandwidth and latency while maximizing the network's bearing capabilities. The forwarding plane is completely isolated, guaranteeing bandwidth and latency SLAs between different slices. Network analysis automates the management of the E2E lifecycle, including each network slice, service deployment, resource scheduling, and troubleshooting. Based on different stages of service development, new slices can be added or deleted without affecting other slices and the bandwidth of each slice can be adjusted on demand and in real time based on each service's bandwidth requirements.

Marking a solution first in the industry, Huawei's network slicing router (NSR) slices network resources as according to control and management, protocols, and forwarding. It creates E2E network slices according to specific scenarios, with each network slice acting as a logical, self-sufficient network. An independent network slice can be generated for a single service such as a video, IoT, or key communication. Different service slices have independent O&M views on which resource scheduling and management can be performed, enabling on-demand network SLA, bandwidth assurance for slices in any scenario, and rapid fault location. The NSR can thus meet the service bearing requirements of differentiated SLAs in multiple 5G scenarios.

At MWC 2017, Huawei and Deutsche Telekom jointly presented their E2E 5G slice network, demonstrating how robots can improve production efficiency and reliability in the 5G network era. The bearer network used Huawei's 5G slice router to divide the network into three isolated slices, ensuring different latency requirements were met for each service. Network congestion due to heavy traffic in one slice was shown not to affect the bandwidth and latency of another slice responsible for precise robot tasks, thus verifying the Huawei slice router can meet SLAs for different slices.

B2B leased lines

Enterprise leased line requirements have increased, in part because the offline subscription and provisioning of traditional leased line services are slow and inefficient.

SDN technology enables CloudMetro to implement online application and rapidly deploy services on leased lines, increasing service provisioning efficiency tenfold, with one-click cross-region deployment cutting service provisioning time to minutes. The service application information sent from the program allows the standard interface on the controller to interact with the OSS system and automatically calculate routes based on configured policies, realizing the one-click deployment and adjustment of E2E services. Moreover, multi-layer service protection achieves 50 ms hitless switching. Enterprise customers can obtain leased service SLA information from a smartphone app for total service performance control anytime, anywhere.

In January 2017, China Unicom Guangdong and Huawei jointly launched the SD-UTN on-demand leased line range for enterprises based on CloudMetro architecture. These products provide government and enterprise customers with on-demand adaptability, security, reliability, and minute-level automatic provisioning, helping China Unicom Guangdong's 100 Building Plan to take root commercially.

For CloudMetro to mature and develop, joint promotion from partners across the industry is necessary. Huawei is active in this area, and is working with industry partners to rapidly roll out optimized solutions. CloudMetro is destined to become a key driving force for operators to digitize and innovate services.

CloudBackbone does the heavy lifting

By 2020, 85 percent of applications will be deployed on the cloud. Serving as network traffic hubs, data centers (DCs) will bear cloud services and backbone networks will create large-scale DC interconnections (DCI) by connecting WAN. But, are traditional backbone networks up to the task?

By Zhang Liqiang, Zhou Fei, and Gao Bo

Cloud services have three major requirements that networks need to deal with: fast TTM; hard-to-predict, randomly changing traffic; and different bearing requirements for different services.

As an agile solution for the ultra-broadband age, CloudBackbone comprises two parts: one, the network physical layer, which includes backbone network routers and transport devices, and two, the network control layer – the layer's brain, which is implemented by Network Cloud Engine (NCE).

Two industry wins

Increases in DCI information access and data backup have caused inter-DC traffic to increase, boosting CAGR to more than 30 percent. To meet future bandwidth requirements for cloud services, Huawei has launched NE9000, the industry's most fully integrated backbone router. It's also rolled out the industry's first 4T routing line cards, yielding a total system capacity of up to 80 Tbps – four times higher than competitors' devices.

Huawei's transport devices provide a 320–640 Tbps all-optical switching platform that matches large-capacity OTNs with OXC all-optical cross-connections, specs that can keep up with the next 5 to 10 years of service development.

With its 4T line cards, one NE9000 backbone router can provide 800 x 100GE ports, meeting the required quantity of interconnections between 100GE ports for connecting DCs into a full-mesh, flat backbone network. The NE9000 provides industry-leading 400GE ports that work with the transport devices to support E2E 400 Gbps transmission links. The router improves port efficiency fourfold, simplifies network topology, and requires fewer optical fiber links. The Solar 5.0 network processing chip cuts energy use to 0.4 W/G, half the industry average, which slashes OPEX and solves equipment room issues.

Service packages can increase new subscribers to more than 10,000 per month, but also drive up service bandwidth requirements, with single-node capacity likely to reach 25.6 Tbps over the next five years. Due to the space and power supply limitations of equipment rooms, operators prefer a single product to multiple devices. Due to the new 4T line cards, a single NE9000 can deliver 80 Tbps in capacity, equivalent to the capacity of three competitor 2+4 clusters.

The NE9000 meets five-year service requirements, uses far less space in equipment rooms, and saves 1 million kWh over five years.

DCI and DCN

Different departments usually manage DC network (DCN) service deployment and DCI deployment, manually transferring and coordinating tenant requirements. Weeks or months can elapse between issuing requirements and provisioning services, which is far too long for fast-moving cloud services. Through the NCE, CloudBackbone can coordinate DCN and DCI deployment and automatically transfer intra- and inter-DC tenant and service requirements. It takes just minutes to deploy services after user requirements are issued, massively shortening TTM and service innovation.

A large-scale DC generally bears tens of thousands of users with a wide array of requirements on network delays. For example, financial transactions have strict latency requirements, while data backup is hard on bandwidth. Traditional models use the same link to bear different users' services, so they compete for bandwidth and can't ensure service quality. The NCE automatically maps user requirements and services in a DC to VPN tunnels with different capabilities. One VPN tunnel is mapped to each tenant, so E2E tenant-level SLAs can be flexibly set. Operators can then charge subscribers according to network capabilities, adding value to pipes.

Keeping it real-time

The random, unpredictable nature of cloud services like inter-DC VM migration and network hotspot events can result in traffic bursts, congested links, and low traffic utilization. Because traditional traffic engineering (TE) is based on predicted network conditions, it cannot solve this issue. These conditions are where NCE proves its worth.

Like an urban transport control center, NCE has a global network view. It can collect network-wide usage data on link bandwidth and recalculate routes based on bandwidth balancing policies. It can then redistribute specified traffic in real time from a congested link to one with a lighter traffic load, improving link bandwidth utilization by up to 50 percent.

To ensure user QoE, CloudBackbone can adjust traffic based on factors such as delay, using lower-latency links for VIP services and diverting common services. China Telecom and Tencent have already deployed Huawei's traffic optimization technology, with great success.

CloudBackbone calendars bandwidth so operators can customize bandwidth assurance on-demand, based on service characteristics, for example, setting a period where 200 Mbps

CloudBackbone's innovative award-winning IP+Optical solution for collaborative planning uses a Super Controller for planning, protection, and management.

of bandwidth is assured and another where only 100 Mbps is assured.

InfoVision 2016 award winner IP+Optical

The IP and optical layers are independently planned and maintained on traditional backbone networks and links are manually deployed. Provisioning a single link not only takes weeks, but backup link planning is done separately, which wastes resources on re-planning redundancy.

CloudBackbone's innovative award-winning IP+Optical solution for collaborative planning uses a Super Controller for planning, protection, and management. It also coordinated the IP-layer and optical-layer controllers, improving network resource utilization and maintenance efficiency. For example, planning inter-layer links can simplify changing a redundant link configuration from N:N to N:1, thus reducing construction costs. Additionally, collaborative protection enables the IP layer to reach peers through optical-layer links to improve network reliability, preventing a multipoint link failure from interrupting services if the IP layer can't find or restore the failed links.

The Super Controller automatically sets up IP-layer and optical-layer links, reducing provisioning time from weeks to minutes, greatly simplifying O&M and minimizing maintenance costs. Huawei's IP+Optical solution has cut TCO by 40 percent for the Latin American operator America Movil, and slashed automated service provisioning and deployment to minutes.

Multi-service integration

Due to increasing requirements, backbone networks need to shift from bearing single services to multiple services. This is necessary to maximize network resource utilization and avoid overlapping investment.

CloudBackbone can virtualize a single physical backbone router into multiple independent virtual systems (VS). Each VS is allocated an independent slicing unit for its exclusive use, enabling hardware resources such as backplane and power supply to be shared while isolating the control and forwarding planes. Control and forwarding resources can be flexibly configured according to service requirements and each VS is isolated, preventing interference between them.

The VS technology in CloudBackbone executes network slicing so that different network planes virtualized from one physical network can bear different services. Slicing helps operators improve resource utilization, use fewer physical nodes, and cut network construction costs. Control, management, and the physical planes used by different services are isolated, enabling each plane to be independently managed and upgraded – using a dedicated network for each service guarantees network security, reliability, and user experience.

Adapting backbone networks to the requirements of cloud services is vital for operators to digitize. The Huawei CloudBackbone solution helps them build ultra-broadband, agile, reliable, and competitive next-gen backbone networks.

A clear transport vision with CloudOptiX

According to Ovum's Optical Networks Forecast Report: 2016–21, carriers and OTT service providers will continue increasing investment in optical networks based on continued traffic growth, with the optical network market set to be worth US$19 billion by 2021.

By Nie Yi, Wang Jinhui

As network functions and service applications shift to the cloud, east-west traffic between data centers will skyrocket. Pipe bandwidth requirements for data center interconnections will increase at least sixfold in the next five years, and bandwidth-intensive services such as 4K/8K video and VR/AR services will drive up traffic between users and data centers.

A first with CloudOptiX

To deploy OTN devices in lower network layers, Huawei launched its future-oriented CloudOptiX solution at MWC 2017. For the first time ever, the solution applies cloud concepts to restructuring transport networks.

The traditional siloed O&M model is OPEX-heavy and delivers low per-capita O&M efficiency. In Google data centers, for example, each engineer can maintain and manage thousands of servers. In carrier networks, each engineer can maintain and manage

just 20 to 50 devices. The network O&M costs of carriers are two to three times higher than device investment. Carriers are in urgent need of a full-lifecycle management tool that improves management efficiency and slashes O&M costs.

During evolution from OptiX to CloudOptiX, Huawei uses cloud concepts to restructure traditional pipes and applies OXC+OTN and OTN to CO to simplify basic network architecture. In addition, Huawei uses the full-lifecycle cloud management platform, Network Cloud Engine (NCE), to optimize O&M and build a simpler, future-oriented transport network.

DC-centric simplified architecture

On a backbone network, the rapid growth of DC interconnection services dramatically increases the switching capacity of backbone network nodes. In the next three to five years, the switching capacity of a super core node is expected to exceed 100T. The OTN switching capacity of a single device ranges from several Terabits to tens of Terabits. Due to power consumption and footprint constraints, the electrical cross-connect capacity of a single subrack is close to hitting its upper limit and cannot meet Terabit switching requirements.

Huawei has launched the industry's first all-optical cross-connect equipment, the OXC. Based on wavelength-level switching, OXC uses LCOS silicon photonics technologies to achieve a cross-connect capacity of 320T to 640T. To do so, it uses just 100W of power, resolving the conflict between switching capacity and power consumption.

OXC's optical backplane eliminates the complex fiber connections of ROADM, reduces connection losses, and improves system reliability. OXC+OTN constructs full-mesh simplified transport networks and interconnects DCs at the lowest latency based on wavelength grooming of up to 32 optical directions from the OXC, and the access and grooming of small-granularity services from the OTN. Like an airline network, OXC implements one-hop direct transmission from any source node to any target node.

To cope with the north-south traffic increase from video services on metro networks, the Huawei OTN to CO concept deploys OTN at network edges. It constructs a large-capacity, one-hop transmission, and multi-service bearer network between COs and DCs, satisfying the bandwidth and experience requirements of video services and leased lines.

OTN to CO also provides a simplified transport platform that can carry all services, thereby unifying the bearing of fixed, mobile, and leased line services and reducing carriers' investment in equipment.

More than 200 carriers worldwide have deployed an OTN to CO network – as of Q1 2017, over 50 European tier-1 carriers had commercialized OTN to CO networks, including Vodafone, Telefonica, Orange, and Belgacom. Estimates hold that OTN to CO will cover 50 percent of CO sites in Europe by the end of 2017. Over the next three years,

China Mobile aims to achieve over 90 percent CO site coverage, building on its current position of 20,000 CO sites.

Full lifecycle management

In a traditional network management system, the planning tool, NMS, and controller are independent of each other. Moreover, user interfaces are not unified, internal data cannot be shared, and O&M efficiency is low.

To evolve from OptiX to CloudOptiX, Huawei provides the NCE, a unified management and control platform comprising planning, management, control, and analysis units. The NCE includes all the management functions needed for the entire network lifecycle, helping carriers improve O&M efficiency with a one-stop solution.

The planning unit migrates network design from offline to online. It connects to the management unit and controller and obtains live-network data automatically and regularly, rather than manually. The simulation module implements network simulation and verification based on the planning result, achieving design as delivery. This directly delivers data to the management unit and controller to enable online service configuration.

The management unit uses algorithms to abstract hardware architecture as logical network resource models, and implements visualized management over networks, services, wavelengths, and optical fibers at all layers.

The control unit is an app based on the controller's open architecture. It provides functions like applying for self-service bandwidth, adjusting bandwidth in real time, and reserving bandwidth. Moreover, it shortens service provisioning from weeks to minutes, making services far more agile.

The analysis unit analyzes survivability, rapidly locates service and hardware faults, and provides ASON service protection and ECOS hardware protection, greatly improving service survivability and automating O&M.

The analysis unit uses advanced big data analysis algorithms and artificial intelligence to dynamically predict network quality deterioration and faults, further improving network survivability and self-healing capabilities. It transmits data to the planning unit for guidance on network upgrades and reconstruction, forming a closed-loop system and automating O&M.

As a full-lifecycle management platform, the NCE streamlines

The NCE includes all the management functions needed for the entire network lifecycle, helping carriers improve O&M efficiency with a one-stop solution.

Optical networks boast the lowest and most stable latency and are the best choice for leased lines.

planning, management, control, and analysis to form a closed-loop system. It implements design as delivery, network visualization, service agility, and O&M automation to simplify O&M processes and improve O&M efficiency.

Increasing leased line revenue

Leased lines account for over 40 percent of fixed network carriers' total revenues. China's leased line market, for example, will exceed US$7.5 billion in 2017, with year-on-year growth of 10 percent. By constructing fixed networks, mobile carriers are also developing leased line services – in 2016, China's Mobile's leased line service grew by 96 percent, and competition to win high-value subscribers is intensifying accordingly.

Optical networks boast the lowest and most stable latency and are the best choice for leased lines. The CloudOptiX leased line solution deploys MS-OTN devices on the physical layer and uses physical hard pipes to guarantee low latency. On the management and control plane, the NCE uses the controller to centrally manage network-wide resources, eliminating isolated network management by region and guaranteeing quick provisioning of E2E leased lines. The controller obtains network information, such as link latency, in real time and uses a centralized algorithm to provide high-quality leased lines with low latency for enterprise customers.

Leased lines are also a profit growth source for China Unicom. But, homogeneous competition for VIP leased lines is fierce in China, and customer requirements are increasing for features such as guaranteed low latency for paths and faster service provisioning.

To better serve finance and government customers, China Unicom chose Huawei as its partner for deploying MS-OTN on its national backbone network and expanding MS-OTN to major cities, including Beijing, Shanghai, and Shenzhen, to build a dedicated nationwide network for large financial centers. China Unicom also uses Huawei controllers to offer leased line service packages with guaranteed low latency for finance customers. It provides optimal and suboptimal paths with different latency levels to meet different customer requirements. China Unicom has shortened service provisioning from weeks to minutes, boosted the competitiveness of its leased line services, and attracted more high-value finance and government customers.

Huawei's OXC+OTN and OTN to CO solutions restructure basic network architecture into future-oriented, one-hop transmission networks with simplified architecture, and the NCE streamlines planning, management, control, and analysis into a full-lifecycle system. By implementing design as delivery, network visualization, service agility, and O&M automation, Huawei helps carriers increase revenues by improving efficiency, resolving service challenges, and offering competitive and high-quality leased line services. Huawei is committed to promoting optical networks and driving cloudified network transformation.

Achieve new growth with CloudCampus

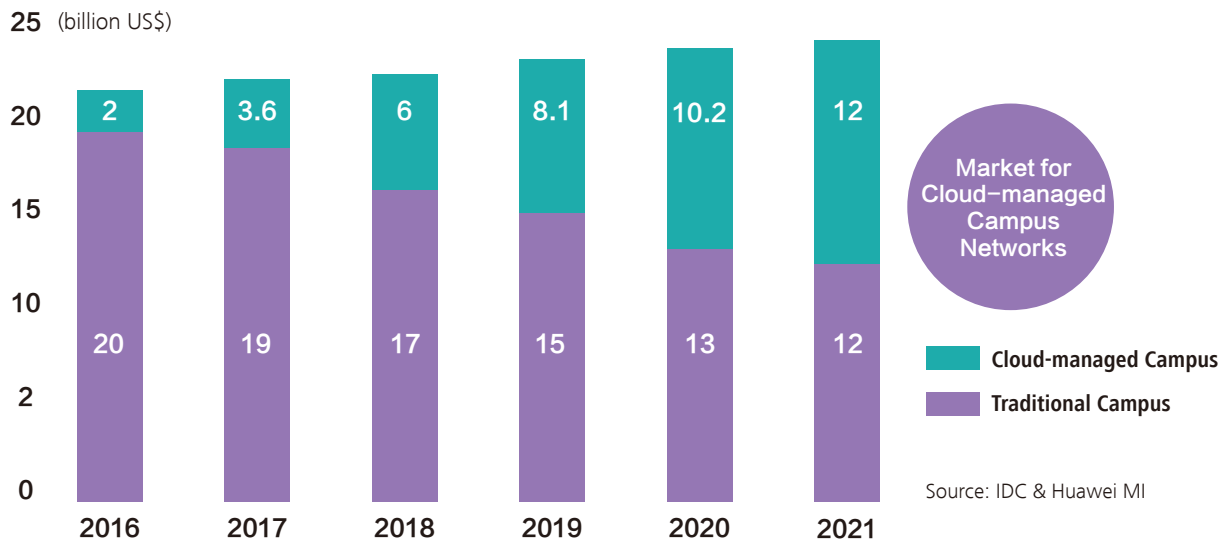
The rise of technologies like cloud computing, big data, and artificial intelligence are forcing enterprises and industries to adapt to a new economic paradigm. Business and verticals like education, government, manufacturing, finance, and transportation are going digital, with IT greatly boosting enterprise productivity. In this scenario, network efficiency determines operating efficiency and competitiveness.

By Wang Bo, Xu Dehui, and Zhang Li

Traditional campus networks no longer meet enterprise requirements for fast network deployment and efficient operations and maintenance (O&M), with the OPEX of large-scale campus networks accounting for as much as 73 percent of TCO.

Changes to networks and provisioning new services are the two biggest problems for enterprises.

IDC and Huawei estimate that over the next five years, the number of enterprises purchasing cloud network management services will continue to grow. Enterprises can shift focus from operating network assets or deploying and maintaining campus networks themselves. The CAGR of the market for cloud managed campus networks will increase by more than 45 percent to be worth US$12 billion by 2021, representing a field where telcos can cultivate B2B services.



Huawei's CloudCampus solution is designed to reduce the high O&M costs of campus networks, provide open network capacities, and enable campus networks to offer diverse VAS, creating service value for telcos.

A question of management

Huawei's CloudCampus adopts a cloud management platform to centrally manage all campus networks and enable remote O&M, marking a shift away from distributed management and on-site O&M. Telcos can thus provide efficient campus management and maintenance solutions.

Huawei CloudCampus applies cloud management technology to implement centralized multi-tenant management and support millions of network elements, so telcos can take full advantage of their high-performance network platforms to expand campus network services.

Efficiency and cost are also key factors that telcos consider when they provide campus network services for enterprises. Huawei's CloudCampus solution enables cloud-based campus network planning, deployment, optimization, and preventive maintenance inspection (PMI), helping carriers reduce TCO by over 80 percent.

The Huawei CloudCampus solution adopts all-cloud architecture to support template-based network planning and design, and provides an application orchestration wizard. IT personnel don't need extensive training, thanks to the simplified service and network design. Automated deployment tools on the cloud deliver fast Wi-Fi network deployment in enterprise campuses, and implement plug-and-play of all-cloud managed devices including WLAN APs, switches, and firewalls. Services can be provisioned quickly after onsite personnel install hardware devices and power them on.

A cloud management platform manages servers in widely dispersed campuses, pools network device resources, enables elastic resource scalability to improve resource utilization, and automatically optimizes networks. Service orchestration in resource pools are drag and drop, lowering skill requirements for IT personnel and ensuring fast service provisioning. The cloud management platform supports geographical information system (GIS) maps and floor plans to enable live networks anytime, anywhere, greatly reducing response time and improving quality of service. The cloud-based PMI tool allows for remote one-click network inspections, cutting onsite workloads and improving routine inspection efficiency.

Huawei's CloudCampus solution introduces the first management model in which one set of products supports and can switch between both local and cloud management, protecting customer investment in live networks.

All Wi-Fi access

Currently, enterprise networks are moving towards all Wi-Fi access, requiring at least five years of network transformation, a golden period for telcos to provide cloud network

services. The Huawei CloudCampus solution offers Wi-Fi coverage solutions for scenarios with high room densities, high user densities, or IoT appliances.

Huawei's Distributed Wi-Fi Solution provides ubiquitous coverage, while its APs have small-angle directional antennas, improving Wi-Fi coverage performance by 30 percent in high-density coverage scenarios such as stadiums. Huawei's industry-leading IoT-converged APs combine Wi-Fi coverage with other types of wireless technologies such as RFID, ZigBee, and Bluetooth, greatly reducing the TCO of wireless network construction.

New business models

Self-operated cloud management platforms help telcos maximize service revenues. In the traditional enterprise market, carriers mainly sell broadband leased lines. To avoid purely acting as pipe providers and create more value, telcos can deploy Huawei's CloudCampus to transform to selling VAS as the solution supports various business models and offers both leasable and sellable cloud management platforms.

The open cloud management platform provides big data VAS, letting telcos extract value by responding to enterprise business requirements and improving user experience. Analyzing data like user behavior and locations enables the cloud management platform to provide quality awareness, free mobility, and network optimization, further improving user experience and increasing customer loyalty.

Telcos' digital transformation goals lie in developing diverse, new services and building new partnerships. Huawei's CloudCampus solution provides a platform with open network capacities and APIs for interconnecting with third-party apps, providing enterprises with self-operated SaaS such as customer flow analysis, e-schoolbags, and precision marketing. The solution also helps carriers build a business ecosystem of enterprise services.

Based on cloud architecture, Huawei's CloudCampus solution realizes intelligence and helps enterprises accelerate digital transformation. In the cloud era, enterprises will embrace the cloud to create new business models and improve user experience and efficiency.

The CloudCampus solution builds a cloud-based, integrated and open network management platform and provides user-centric Wi-Fi coverage to offer an ultra-simple B2B platform for telcos to achieve success in the enterprise market.

Huawei's CloudCampus solution provides a platform with open network capacities and APIs for interconnecting with third-party apps, providing enterprises with self-operated SaaS such as customer flow analysis, e-schoolbags, and precision marketing.

Why your leased line service needs CloudEPN

As more enterprise IT systems use cloud architecture, requirements on cloud-based applications such as office and manufacturing systems are increasing. IDC believes that 50 percent of ICT infrastructure will be cloud-based by 2020. Traditional network traffic design follows the Pareto principle in that 80 percent of network traffic is local traffic (LAN) and 20 percent needs to be transmitted over the backbone network (WAN).

By Zhu Huaqi, Li Xianyin

Because services are migrating to the cloud, enterprises need to frequently interact with cloud centers. This reverses network traffic, with 80 percent transmitted on the WAN and 20 on the LAN, which requires higher WAN bandwidth. In the financial industry, for example, more than 50 financial services are expected to migrate to the cloud, and an increasing number of new digital financial services such as Virtual Teller Machines and digital billing are provided online, which requires 50 percent higher leased line bandwidth each year.

On-demand services

Each technical wave of leased line development has given rise to a new leased line solution. TDM resulted in SDH/PDH leased lines, while IP/MPLS led to Layer 2/3 VPN. Based on cloud technology, Huawei's Cloud Enterprise Private Network (CloudEPN) solution lets carriers provide enterprises with on-demand, cost-effective leased line services that support visualized O&M, boosting competitiveness and allowing them to more effectively explore the burgeoning B2B market.

CloudEPN architecture

Huawei CloudEPN comprises the network connection layer, cloud management platform, and upper-layer application layer. The network connection layer includes virtual and physical customer-premises equipment (CPE) and firewalls, which bear the physical NEs that connect tenant networks to data centers. The cloud management platform controls and manages CPEs and data center devices, configuring services for them. The orchestration layer enables cross-overlay and WAN controller orchestration so tenant resources can collaborate between the enterprise side and the cloud and between CPEs and virtual network function (VNF) NEs. The upper-layer application layer provides a unified GUI that allows tenant and carrier administrators to customize CloudEPN services. Open protocols, such as RESTful and NETCONF, are used between all layers to interconnect southbound and northbound interfaces, guaranteeing an open network.

Interconnection services

Subscriptions: changes traditional offline in-store service to online self-service, allowing customers to enjoy a convenient, simple, and easy-to-use service experience.

Service provisioning: supports plug-and-play and rapid deployment, cutting service provisioning time from 30 days or more to 20 minutes.

O&M: supports cloud management of multiple branches, improves O&M efficiency, and utilizes carriers' platform advantages.

Service adjustments: identifies applications and precisely detects performance to deliver intelligent service awareness and routing, preferentially forward key services, and dynamically adjusts paths.

Optimization: optimizes bandwidth online in real time by performing intelligent analysis based on applications, links, and traffic. Traditionally, fixed bandwidth is configured for leased lines based on service peaks, which is less cost-effective.

Business benefits

Huawei CloudEPN solution provides enterprises with application-aware, cost-effective, easy O&M and on-demand cloud-managed leased lines. It helps reduce the costs and accelerate service provisioning, empowering enterprises to quickly respond to market demands and changes in the cloud era.

Binds links to cut bandwidth costs by 50 percent

According to TeleGeography, the price of an MPLS leased line is several times higher than Internet links. The Huawei CloudEPN supports the widest range of CPE interface types in the industry, including LTE, 3G, G.fast, PON, and hybrid access, covering all enterprise access scenarios. The solution helps enterprises combine links, such as 3G/LTE links, MPLS leased lines, and xDSL links, using widely deployed and cost-effective Internet links, increasing WAN bandwidth and reducing bandwidth costs.

The Huawei CloudEPN helps carriers provide agile interconnection services on demand, meeting enterprises' requirements for innovative services and flexible service changes.

Cuts service provisioning time from months to days

Setting up traditional enterprise leased lines often involves many stages, such as in-store application, service commissioning, and onsite configuration. The entire process usually takes from one to three months, and requires skilled O&M personnel. Huawei CloudEPN provides carriers with one-stop services that are available on-demand, such as enterprise interconnection and value-added services (VAS). Enterprises can order or subscribe to enterprise interconnection services and VAS in real time on an e-commerce service platform, for example, applying for a new branch to have a network connection, create bandwidth adjustment policies, or order resources for cloud multimedia communication and audio and video conference calls. After subscribing, the customer's service requirements will be automatically divided and delivered.

In the past it took 30 days to deploy multiple services; now, online one-time package subscriptions and orders take 5 minutes and another 15 minutes to approve the order and pack the devices for delivery. All the customer needs to do is to connect Ethernet cables and power on the devices. These plug-and-play devices then automatically go online and obtain VPN service configurations from the cloud management platform, so carriers can quickly respond to enterprise service changes.

Application-driven link selection improves service experience

Traditional enterprise leased lines encounter burst traffic, especially entertainment-related content such as videos and social media. This often congests key services, such as video conferencing and enterprise applications, worsening user experience. But, application-based smart traffic scheduling on the Huawei CloudEPN provides differentiated network services. For example, services requiring high link quality use leased lines, and other services use Internet links. When a link fails or is unstable, services using the link can flexibly switch to other links to improve user experience.

Cloud-based visualized O&M reduces OPEX by 90 percent

Traditional leased line services are usually provisioned and maintained onsite, but enterprise branches may be widely distributed. As the number of branches surge, maintenance becomes more difficult and expensive. The Huawei CloudEPN provides visual management for applications and links. Information about network-wide devices and applications is displayed on a GIS map, accelerating fault location and simplifying O&M. Carriers' network operations centers (NOCs) can remotely and automatically manage and maintain networks, reducing onsite maintenance costs by 90 percent.

The Huawei CloudEPN helps carriers provide agile interconnection services on demand, meeting enterprises' requirements for innovative services and flexible service changes. By leveraging the solution, carriers can sail on the blue ocean of B2B as enterprises digitally transform, quickly attract new enterprise users, retain high-value customers, and continuously increase revenue from the B2B market.

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