Huawei Technologies

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12/2014 > ISSUE 73

Beyond Technology

Top 10 E2E VoLTE deployment considerations

MTN Nigeria upgrading to Telco 2.0

CloudIMS kicks off NFV for carrier networks

4G Communications Evolution

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Changing communications, creating value

Ma Haixu,

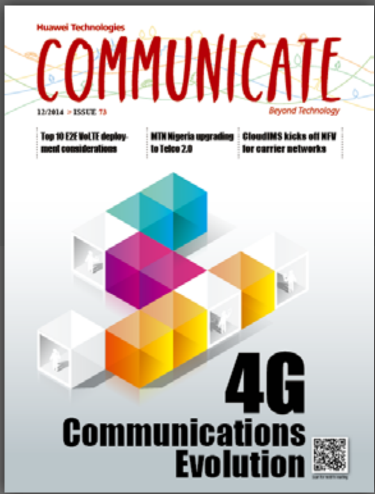
President of Huawei Core Network Product Line

Today, broad application of smart devices has greatly enhanced the communication experience. Users are no longer merely satisfied with voice and SMS. They are increasingly concentrating on media services such as instant messaging, photo and video sharing, and HD conferencing. OTT players have had the advantage of late, as technological stagnation has made carriers slow to adapt to rapid changes in communication habits. LTE commercialization gives telcos a chance to revolutionize how we communicate and create value once more.

Evolution to 4G will drive network transformation from circuit-switched (CS) to all-IP VoLTE architecture and ultimately to network function virtualization (NFV) to facilitate ICT transformation. This evolutionary process will enhance the user communication experience and enable provision of services such as crystal-clear voice and real-time HD video communication services, as well as sharing- and coordination-based communications. These services will revolutionize communication, help carriers reconnect with users, and create new value. And what's more, with the evolution of 4G, carriers' network architecture and high-quality capabilities can be integrated easily with third-party applications in a wide range of devices and other machines. As a result, carriers can expand services and grow users by opening their network capabilities and building a cross-industry ecosystem, making for innovation of their business models.

Telcos are focused on two 4G evolutionary elements. First, faced with a lengthy and complex evolutionary process, carriers need an E2E solution that includes equipment and network integration services to simplify deployment, facilitate evolution, and make operations more efficient. Second, as carriers already cannot create much of a premium in the basic telco market, how can they profit from 4G evolution? They must open their communication capabilities to third parties so that new services can be developed by partners that serve new markets in the enterprise and vertical arenas. Together with third-party developers, carriers can jointly set up new business models that mesh with the cooperative ecosystem, which is inherently innovative and creative of value.

Huawei is the only ICT vendor that offers a complete set of solutions, from network technology to service integration. In 2014, Huawei won "Best VoLTE Product" and "Most Innovative Virtualized IMS Solution" at the IMS World Forum, and we have been chosen by 25 carriers worldwide for VoLTE deployment. We helped PCCW-HKT commercialize enhanced single-radio voice call continuity (eSRVCC) for the first time anywhere. We also helped Fujian Telecom break into the enterprise and vertical realms through an open communication platform, and we will certainly continue to collaborate with global carriers to change communications and create value through LTE.



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CONTENTS

Cover Story

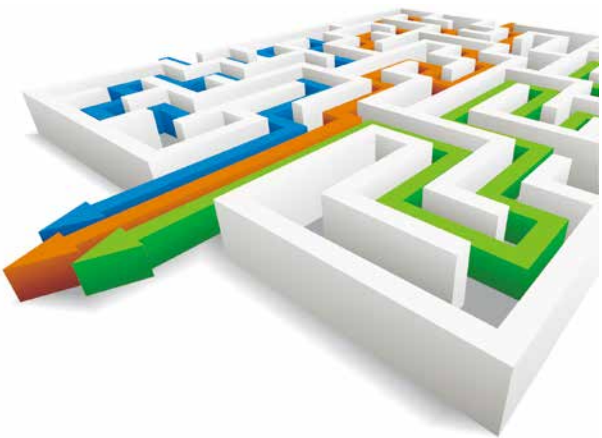
Expert's Forum

Focus

Let's COMMUNICATE beyond technology and share understandings of the latest industry trends, successful operational cases, leading technologies and more. Based on in-depth analysis of the matters that lie close to your heart, we will help you stay on top of the telecom game.

Industry Perspectives

How to Operate



Solutions

Cutting Edge

Achievements >>

Best Global Brands

Shanghai, China, Nov 14, 2014, Leading global brand consultancy Interbrand released its Top 100 Best China Brands list, and at the press conference presented Huawei with a Best Global Brands award. Huawei's debut on the Best Global Brands list marks the first time a mainland Chinese brand has earned a place on it, 15 years after the list's inception.

Cyber Security

Ipoh, Malaysia, Nov 13, 2014, Huawei announced that it has won the "Cyber Security Organization of the Year" Award from CyberSecurity Malaysia, the national cyber security specialist agency under the Ministry of Science, Technology and Innovation (MOSTI), Malaysia. The award is a recognition of Huawei's best practice in building an end-to-end comprehensive and reliable global cyber security assurance system in the industry.

NFV

Amsterdam, Netherlands, Oct 21, 2014, Huawei introduced its latest NFV progress and showcased how its unified ICT orchestration management system could help improve the whole network efficiency including multiple tenant, network design, network deployment, dynamic scaling, service and capacity forecast, and unified troubleshooting. The showcase took place at the 14th Annual Broadband World Forum 2014.

Huawei has a full range of NFV solutions including infrastructure, a cloud operating system and cloud-aware applications. The solution is open to multiple partners as demonstrated in successful Proofs of Concept (PoC) and joint innovation projects with leading operators across the globe. Huawei is the main contributor in the ETSI ISG NFV standardization with ranking the first contributions and co-chairperson position of Architecture of the Virtualization Infrastructure Working Group. Huawei was also chosen as the preferred NFV vendor according to the Current Analysis survey report.

<< Statistics

100G-PON

Shenzhen, China, Oct 27, 2014, Huawei announced that their optical access innovation lab has made a breakthrough in 100G-PON optical access. This new 100G-PON technology uses a hybrid time-division and wavelength-division architecture to support a 4×25Gbps downstream rate and a 4×10Gbps upstream rate, verified by way of the lab prototype and enables 100Gbps access rate per port on existing optical distribution networks (ODNs). The technology also establishes compatibility between 100G PON and GPON/10G PON/40G TWDM PON, allowing carriers to execute seamless upgrades to future-proof access networks.

Smart OLT

Amsterdam, Netherlands, Oct 23, 2014, Huawei launched the industry's first smart optical line terminal (OLT) with distributed architecture, the SmartAX MA5800, at Broadband World Forum 2014. As the first OLT to integrate distributed architecture, the MA5800 is the industry's most advanced OLT for next generation passive optical networks (NG-PON), catering to the demand of carriers for ultra-broadband networks with faster broadband, wider coverage, and smarter connection for an optimal service experience.

AfricaCom 2014

Cape Town, South Africa, Nov 12, 2014, Huawei demonstrated its latest solutions at AfricaCom 2014 in Cape Town in hall D3 of the CTICC, in line with the conference's theme – "Building a Better Connected Africa." In particular, the company highlighted its ultra-fast broadband solutions available to the African market, leadership in experience centric operations, and strategic investments to help operators in Africa develop agile digital business models.

UPS Innovation Days

Nuremberg, Germany, Nov 11, 2014, Huawei recently hosted the 2014 European UPS Innovation Day. Nearly 50 partners from 10 European countries attended this event.

Huawei has always implemented green strategy - "Green Pipe, Green Operations, Green Communications, Green World," by providing green ICT solutions to help customers reduce the impact on the environment, but also continues to improve energy and resource efficiency, while promoting and leading the ICT industry's green and sustainable development. UPS, as a key component of ICT pipeline, makes a big impact on data center efficiency and reliability. Huawei has developed modular UPS system (UPS5000-E series) with high efficiency (up to 97%) and the characteristics of high density and high availability. Huawei UPS system is applied in more than 100 data centers in Europe as of 2014

Optical T-SDN

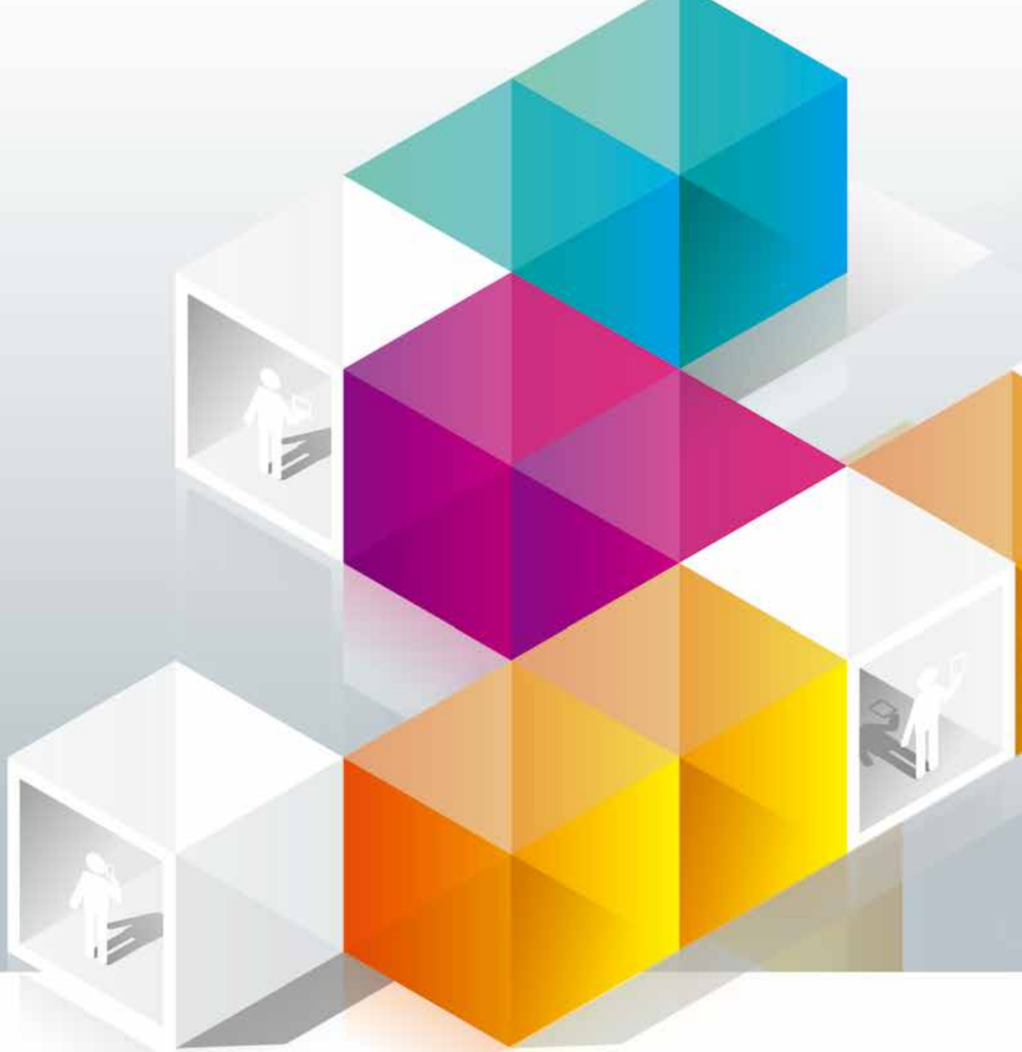
Xiamen, China, Nov 3, 2014, Huawei, together with China Telecom Fujian (Fujian Telecom) and China Telecom Beijing Research Institute announced recently the successful deployment of the world's first innovative transport software-defined network (T-SDN). The T-SDN implements an intelligent private line bandwidth on demand (BoD) app for VIP customers over a transport network, and IP + optical synergy for data centers, leading transport networks into the SDN era.

APEC Summit 2014

Beijing, China, Oct 31, 2014, Huawei announced its role as the official telecom sponsor of the Asia-Pacific Economic Cooperation (APEC) Summit 2014, with Huawei's 4G LTE-enabled MediaPad M1 used by all guests attending the meetings as official digital meeting brochure. Mr. Zhu Ping, President, China, Huawei Consumer Business Group (BG), was Huawei's official representative at the APEC Meetings Sponsorship Signing Ceremony on October 24.

Open Stack

Paris, France, Nov 5, 2014, Huawei participated in the 5-day OpenStack Paris Summit 2014. As a gold member of OpenStack Foundation, Huawei shared its latest contributions, accomplishments, and experience in promoting OpenStack for telecom infrastructure transformation, enhancing OpenStack-based NFV technology, developing Compass (a deployment system), and OpenStack cascading. In addition, Huawei showcased its OpenStack-based cloud offerings including the latest FusionSphere 5.0 cloud operating system from November 3 to 7, 2014. Huawei's UPS system is applied in more than 100 data centers in Europe as of 2014



4G communications evolution

By Wang Yongde

Carriers usually develop VoLTE in four distinct stages – a complex process, one that requires a great deal of engineering and re-engineering, and yet worthwhile, as VoLTE represents a path to the future, not just a fancier way of delivering voice.

Fast-changing behavior

Never before have people been able to communicate with one another so freely and conveniently. With the increasing penetration of broadband, maturing social media, and the proliferation of powerful yet cheap multimedia devices, the Internet has become a major medium for both consumer and business communications. In addition, advertisers, vendors of fast-moving

consumer goods (FMCGs), and social networks use the Internet to connect with consumers. Enterprises can use the Internet to cultivate user loyalty, allocate and supervise work, and coordinate with suppliers and partners based in different areas.

This represents two major changes to the ICT industry. First, the model of communication has changed. One-to-one bidirectional voice and messaging communications are being replaced by many-to-many coordinated, multimedia communications. Second, the dominant power in the ICT industry is shifting, from carriers to open Internet platform vendors, due to the opening of standards and various technological advancements.

Despite currently dominating one-to-one communications, carriers are now increasingly challenged by newcomers who use open platforms to meet fast-changing and varied customer needs. According to Juniper, voice revenue will drop 2% annually for the foreseeable future. Carriers must find ways to secure their position in an ever-changing industry if new growth opportunities are to be seized.

New value through LTE

LTE can greatly improve the mobile service experience, create new value, and even enable new business models and ecosystems. In the LTE era, traditional voice and messaging services will transform into rich media services that feature half-second connection times, crystal clear A/V performance, and instant messaging/sharing/transfer. Carriers can now provide enterprise customers with fixed-mobile convergence (FMC) and multi-terminal coordination services. In the future, an all-IP Internet will integrate third-party applications with ease. Carriers will be able to open their network capabilities to third-party developers to launch innovative services jointly (and share the profit) through communication as a service (CaaS).

Evolution of carrier communications strategy

Carriers worldwide face the challenge of simplifying VoLTE deployment. Therefore, ICT vendors must provide just E2E technical solutions, but also corresponding integration services and support to help carriers tackle this challenge.

Evolution of mobile voice

LTE deployment and a maturing terminal ecosystem have prompted global carriers to evolve their mobile voice services in the following steps.

- **Step 1: LTE hotspots give rise to pre-VoLTE**

Initial LTE deployments are usually for hotspot offload; circuit-switched fallback (CSFB) is a must for such scenarios. However, CSFB typically has a call delay of seven to twelve seconds, and sometimes longer. It also requires legacy upgrade, which most carriers are no longer willing to do on a large scale. Flash CSFB and CSFB proxy solutions can help.

- **Step 2: Widespread LTE coverage leads to VoLTE**

When LTE is deployed throughout a large and/or highly-populated area, commercial VoLTE becomes viable. VoLTE provides a superior user experience, and improves spectrum utilization as well. Compared with mobile softswitch (MSX) architecture, which has only two network elements (NEs), VoLTE architecture, based on the IP-multimedia subsystem (IMS), is much more complex, with over 40 NEs and 60+ interfaces. Its deployment requires not just an IMS network, but reconstruction or building of a CS network and evolved packet core (EPC), along with LTE, IMS, and PCC.

LTE and 3G networks must be transformed to support enhanced single-radio voice call continuity (eSRVCC) and robust header compression (ROHC), which reduce the handover delay and improve the network performance. With the EPC and CS network upgraded and transformed to coordinate with IMS (so that call continuity is ensured), user data management is integrated, and service experience is consistent on multiple networks. A Diameter-based signaling network must be introduced, with the unified policy and charging controller (UPCC) upgraded to support QoS control. The IP bearer network must also be transformed to support IPv6, with the charging and BSS/OSS upgraded along with it to support VoLTE service provisioning. Legacy service inheritance and terminal interoperability testing must also be accounted for during VoLTE deployment. Carriers around the world seek to simplify this process. Therefore, ICT vendors need to provide not just E2E technical solutions, but also corresponding integration services and support to help carriers tackle this challenge.

- **Step 3: NFV-based VoLTE**

During this stage, LTE and other wireless broadband technologies such as high-speed packet access (HSPA) form a seamless wireless network. VoLTE is on its way to being a major voice service, and traditional CS networks will eventually be replaced, but the latter will not happen for quite some time, time enough for all network infrastructures to move to the cloud. With hardware decoupled from software, resources can be scheduled on demand, with service expansion and contraction automated. With their open, automated nature, these networks will be more dynamic, efficient, and scalable. Service provisioning times will be shortened and innovation will be accelerated. As LTE goes mainstream, DT, Vodafone, and Telefónica are all deploying virtual IMS-based VoLTE as the first step towards cloudification.

By opening communications capabilities to third parties through communications as a service (CaaS), carriers can achieve the ultimate goal – monetizing their communications capabilities.

Rich communications experiences

In an all-IP LTE era, carriers must offer amazing services to attract end users. There is an initiative in the industry to integrate VoLTE, rich communications suite (RCS), and RCS-e features into all LTE chips so that innovative multimedia services can be offered through phone address books, without the need to install related apps; these include instant message/picture/video sharing, file transfer, and SNS integration. Users will also be able to use phone numbers for new communication services, without applying new IDs and rebuilding their communication context, and enjoy all relevant communications services, and be reached by all manner of terminal or soft client.

The enterprise market offers carriers a great opportunity to increase revenues. Gartner shows that communications expenditure accounted for nearly 40% (USD1.5 trillion) of all enterprise IT expenditures worldwide, and carriers such as BT, AT&T, Vodafone, and TATA are all trying to provide hosted UC solutions.

Hosted UC is a cloud-based synergy solution for SOHOs and enterprises of all sizes. To enhance work coordination and cut cost, enterprises need a unified UC platform that provides a single interface for coordinated work, while supporting instant messaging, voice and video call, and convergent conferencing. As a whole, this solution enhances an enterprise's cross-regional communications, information collection & switching, and overall work efficiency.

Communication monetization

By opening communications capabilities to third parties as a service (CaaS), telcos can achieve their ultimate goal – communication monetization. The key is to allow third parties to explore carriers' rich communications capabilities at both the network and terminal sides, in a simple and intuitive manner.

On the network (upstream) side, open application platform interfaces (APIs) can empower third-party applications with carrier-level capabilities relating to voice, video, instant messaging, and file sharing. These capabilities will improve partners' application and service quality, creating value for both partners.

For the terminal (downstream) side, open software development kits (SDKs) can endow terminal devices, and even items like glasses and shoes, with communications capabilities, turning machines and things into network nodes. Communications will expand from people-to-people to include people-to-thing and thing-to-thing communications.

Commercialization of VoLTE is on the way

During their 2012 and 2013 LTE deployments, carriers started or completed their CS network upgrades to support CSFB. In South Korea and the U.S., VoLTE commercialization began in earnest. In May 2014, the process went global. On May 15, HKT launched seamless VoLTE service, with Hutchison Global Communications announcing the commercial use of VoLTE on the same day. On May 21, Singtel launched full VoLTE. The next day, T-Mobile in the U.S. also launched VoLTE. On May 23, AT&T did the same.

According to GSMA estimates, in the next 12 months, over 20 carriers will deploy VoLTE, including China Mobile, the world's largest mobile operator. Accordingly, handset support is rapidly accelerating as all major players scramble to launch VoLTE-enabled phones like the VoLTE-ready Huawei Ascend P7, already released in the third quarter of this year.

Top 10 E2E VoLTE deployment considerations

By Wang Yachen

Wang Yachen

Director of Multimedia Network Lab, China Mobile Research Institute, and Reporter of SG13 Q10 Work Team, ITU.

VoLTE deployment is unprecedented in its complexity and a great challenge to carrier networks and telco business transformation. This article details the ten most important deployment considerations.

VoLTE is the mainstream solution for voice and voice-roaming services in the LTE era. VoLTE provides high-quality voice and video services and supports single-radio voice-call continuity (SRVCC) and enhanced SRVCC (eSRVCC). Through its provision of rich service experiences to end users, VoLTE is crucial to next-generation convergent communications. With the coordinated development of frequency division duplexing (FDD) and time division duplexing (TDD), more and more carriers are investing in VoLTE. They are also jointly promoting the construction of VoLTE roaming networks that will offer seamless roaming on a global scale.

IMS core network deployment

IP multimedia subsystem (IMS) supports a

variety of access types and multimedia services. It has been acknowledged by the 3GPP and GSMA as the standard architecture for all-IP mobile voice services. Deployment of an IMS core network is a key to VoLTE deployment. It contains many network elements (NEs), such as the interrogating-call session control function (I-CSCF), serving-call session control function (S-CSCF), domain name server (DNS), E.164 number to URI mapping (ENUM) server, multimedia resource function controller (MRFC), multimedia resource function processor (MRFP), interconnection border control function (I-BCF), breakout gateway control function (BGCF), media gateway control function (MGCF), IP multimedia media gateway (IM-MGW), and session border controller (SBC). The IMS core network is responsible for access control, call routing, and service triggering.

The SBC is a key NE on a VoLTE network, usually co-located with the proxy-call session control function (P-CSCF), which acts as the first contact point for mobile users within IMS networks. Generally, the SBC transmits both VoLTE signals and media streams. Its location on the VoLTE network has a great impact on user experience, so deployment efficiency and engineering efficiency must be considered during centralized SBC deployment, with the traffic switching efficiency warranting consideration during distributed SBC deployment. As the proxy node and access point for VoLTE media streams, the SBC also acts as both the access transfer control function (ATCF) and access transfer gateway (ATGW), with these functionalities reducing the media channel reestablishment time for handover from LTE to 2G/3G, allowing for smooth inter-system call roaming.

EPC core network deployment

The evolved packet core (EPC) core network includes the mobility management entity (MME), serving gateway (S-GW), and PDN gateway (P-GW). It supports the following VoLTE-related functions; assignment of IPv4 or IPv6 addresses to IMS access point names (APNs); P-CSCF discovery deployment; service request routing to the IMS core network; enforcement of policy and charging rules function (PCRF) policies over the Gx interface to establish EPC and air interface bearers that meet QoS requirements; and handover request initiation for CS networks over the Sv interface between the MME and single-radio voice call continuity interworking function (SRVCC IWF).

APN configuration, which must be performed on the user equipment (UE), MME, and P-GW, is a key element of EPC core network deployment. Call and data services can share an APN or use independent APNs, and different IP addresses are required for different APNs. If they share an APN, deployment is easy, but voice could be impacted by data services. When the sharing APN solution is used, voice call-related traffic must be separated from data traffic by the IMS charging identifier (ICID) as voice calls are charged by call duration while data services are charged by traffic volume, and this separation involves complex adaptation of the billing system. This problem will not occur, however, when an independent APN solution is in use.

CS core network reconstruction

The circuit-switched (CS) and VoLTE networks will coexist for a long time to come, and coordination between the two is crucial to seamless user experience. This requires CS network support of the Sv interface for SRVCC/eSRVCC handover, which ensures voice call continuity when users roam from LTE to 2G/3G. A CS network must also support enhanced SRVCC/eSRVCC for common supplementary services after handover, such as call waiting (CW), call hold (CH), and multiparty (MPTY). An international standard solution is prescribed for evolution from CS to IMS networking – CS network upgrade to support IMS centralized services (ICS). This solution calls for the mobile switching center (MSC) server to be transformed into an enhanced MSC (eMSC) in order to support the I2 interface, migrating the service switching

01

IMS core network deployment

Deployment of an IMS core network is a key to VoLTE deployment. It contains many NEs, such as I-CSCF, S-CSCF, etc. The IMS core network is responsible for access control, call routing, and service triggering.

02

EPC core network deployment

The EPC core network includes the MME, S-GW, and P-GW, supports many VoLTE-related functions. APN configuration, which must be performed on the UE, MME, and P-GW, is a key element of EPC core network deployment.

03

CS core network reconstruction

The CS and VoLTE networks will coexist for a long time to come. In the future, the CS network will be upgraded to support IMS centralized services, then a unified core network can be built to improve user experience and operational efficiency.

04

LTE PCC deployment

PCC architecture provides E2E policy control on PS networks. In PCC architecture, the SBC/P-CSCF applies for VoLTE voice and video bearer resources from the PCRF, the PCRF instructs the EPC and wireless network to reserve dedicated service resources in order to ensure QoS.

05

Service platform and IN reconstruction

In terms of service deployment, there are two challenges. The first is service experience consistency for voice and supplementary services on 2G/3G and LTE networks. The second is service migration from 2G/3G to LTE.

and call switching functions to the IMS network. A unified core network can then be built to improve user experience and operational efficiency.

However, CS network reconstruction must be minimal during the initial phase of VoLTE deployment. To implement eSRVCC, carriers need only deploy one or two eMSCs to function as the SRVCC IWF to bridge the CS and EPC/IMS networks, as inter-system handovers are relatively few and eSRVCC deployment is an interim solution for evolution to LTE.

An international standard solution is prescribed for network evolution from CS to IMS – CS network upgrade to support ICS so that the service switching and call switching functions can be migrated to the IMS network. A unified core network can then be built to improve user experience and operational efficiency.

LTE PCC deployment

Policy and charging control (PCC) architecture, proposed in 3GPP R7, provides end-to-end (E2E) policy control on packet-switched (PS) networks. In PCC architecture, the SBC/P-CSCF applies for VoLTE voice and video bearer resources from the PCRF over the Rx interface. The PCRF generates dynamic rules for the voice and video services, based on the configured policies; then, over the Gx interface, the PCRF instructs the EPC and wireless network to reserve dedicated service resources in order to ensure QoS.

E2E QoS depends on QoS parameter configuration and mapping on each NE. The configuration and mapping include provisioning of key parameters, such as QCI, ARP, APN-AMBR, and UE-AMBR, in the system architecture evolution home subscriber server (SAE-HSS) based on subscribed services; the QoS mechanism and parameter mapping of service-layer NEs (e.g. base station, MME, S-GW, P-GW, and PCRF), and differentiated control mapping between the QCI and differentiated services code point (DSCP) for IP bearer-layer NEs (e.g. router). E2E QoS deployment involves multiple fields and numerous

06

Convergent HLR/HSS deployment

Convergent HLR/HSS (co-located HLR, SAE-HSS, and IMS-HSS) avoids large-scale synchronization of authentication or eSRVCC data between the HLR/SAE-HSS and IMS-HSS. It also simplifies BSS/OSS reconstruction.

07

Diameter signaling network deployment

Diameter is the basic protocol for EPC, PCC, and IMS network communication. If the STP on a live network can be directly upgraded to support Diameter, it can be reused, with convergent Diameter/SS7 relay equipment deployed otherwise.

08

BSS/OSS and NMS deployment

VoLTE service provisioning involves many NEs. The BSS/OSS must be rebuilt to support various service provisioning interfaces, such as VoLTE service provisioning and billing. VoLTE's all-IP architecture and complex service processes pose great challenges to network management.

09

Wireless network reconstruction

The LTE network must be upgraded to support VoLTE. Real-time telecom services, such as voice and video, are sensitive to delay, imposing strict requirements on E2E QoS, including QoS on the wireless side.

10

IP bearer network reconstruction

IPv6 address deployment is an important task for large carriers; the UE, IP bearer network, EPC core network, IMS core network, and SBC are all involved. QoS improvement is important to the reconstruction of bearer networks.

NEs, posing a great challenge to carrier and vendor integration capabilities.

Service platform and intelligent network reconstruction

In terms of service deployment, there are two challenges. The first is service experience consistency for voice and supplementary services on 2G/3G and LTE networks. The second is intelligent network (IN) service migration from 2G/3G to LTE so that VoLTE users can use value-added services such as virtual private mobile network (VPMN) and 400.

There are three ways to resolve the first challenge.

Solution 1: Deploy an ICS architecture-based target network so that users can use IMS services even when roaming in CS networks. This solution is not mature and requires tremendous CS network reconstruction.

Solution 2: Users subscribe to originating CAMEL subscription information (O-CSI) and terminating CAMEL subscription information (T-CSI). When they make or receive calls on a CS network, it triggers the O-CSI or T-CSI to route the call requests to the anchor application server (AS), which then provides an IMS routing number (IMRN). Based on the IMRN, the CS network anchors the calls in the IMS network for service processing. This process is known as anchoring. It is easy to deploy but reduces service processing efficiency, so most carriers currently use mobile terminated (MT) anchoring only.

Solution 3: Parallel CS/IMS service processing: neither mobile originated (MO) calls nor MT calls are anchored in IMS networks. This solution requires service data synchronization between the home location register (HLR)/SAE-HSS and IMS-HSS.

Considering the availability of solutions and time to market, carriers should select solution 2 or 3, based on their network conditions.

There are several ways to help carriers migrate IN services. Carriers can deploy the IP multimedia service switching function (IM-SSF) which, similar to the service switching point (SSP) on the CS network, implements IN service control by routing CAMEL or INAP signaling to the service control point (SCP) and online charging system (OCS). In this case, it is recommended that the IM-SSF be co-located with the multimedia telephony application server (MMTel AS). Carriers could also opt to transform an IN service platform that already supports or can be upgraded to support SIP as a SIP AS. This would allow the S-CSCF to contact the SIP AS

As users migrate from 2G/3G to 4G LTE, the required capacity of Diameter signaling networks will increase while the capacity of SS7 signaling networks will decrease. Carriers are advised to deploy Diameter/SS7 convergent signaling networks. The SS7 networks will be completely replaced as their lifecycles end.

through initial filter criteria (iFC) to implement service control. Another solution would be to configure the MGCF to route interactive voice services to the MSC/SSP, on a CS network, to complete intelligent interaction. Carriers can choose a suitable solution based on their network conditions and specific services.

Convergent HLR/HSS deployment

Convergent HLR/HSS (co-located HLR, SAE-HSS, and IMS-HSS) avoids large-scale synchronization of authentication or eSRVCC data between the HLR/SAE-HSS and IMS-HSS. It also simplifies BSS/OSS reconstruction because it doesn't require VoLTE subscription data provisioning to two sets of equipment. The unified service subscription data ensures supplementary service consistency on CS and VoLTE networks, enabling the same service experience whether users are on CS or VoLTE networks.

The optimal solution for convergent HLR/HSS deployment is HLR upgrade on the live network so that it functions as both the SAE-HSS and IMS-HSS. If the HLR on a live network does not support such an upgrade, a convergent HLR/HSS must be deployed, with the legacy HLR either coexisting with the convergent HLR/HSS indefinitely or being replaced directly. Coexistence allows for smooth deployment, but it requires flexible number routing (FNR), as most users are migrated to LTE without a change to their phone numbers. FNR distinguishes routes to the existing HLR and the newly deployed convergent HLR/HSS. HLR replacement does not require FNR deployment, but it is still risky and requires comprehensive verification of every service scenario. Carriers can determine a database deployment solution and process based on their network conditions.

Diameter signaling network deployment

Diameter is the basic protocol for EPC, PCC, and IMS network communication and is used by interfaces connecting to the PCRF, OCS, and HSS. As stipulated in 3GPP, the Diameter routing agent (DRA) is used for Diameter signal routing aggregation and applies to core network routing scenarios. As defined by the GSMA, the DRA is used for security isolation in 3G/LTE inter-network roaming and interworking with legacy SS7 signaling networks; it applies to inter-network roaming interwork scenarios. The DRA is deployed between the EPC, PCC, and IMS networks and binds sessions from the same user over different NE interfaces to the same PCRF. DRA deployment helps simplify deployment and maintenance of Diameter signaling networks and accelerates service rollout.

As users migrate to LTE, the required capacity of Diameter signaling networks will increase while the capacity of SS7 signaling networks will decrease. If the STP on a live network can be directly upgraded to support Diameter, it can be reused, with convergent Diameter/SS7 relay equipment deployed otherwise. With user migration and IP-based reconstruction of SS7, convergent Diameter/SS7 networks will gradually replace legacy SS7.

BSS/OSS and NMS deployment

VoLTE service provisioning involves many NEs, including the convergent HLR/HSS, MMTel AS, IM-SSF, DNS, ENUM server, SCP, and other AS. The BSS/OSS must be rebuilt to support various service provisioning interfaces, with the call detail record (CDR) processing and online charging interfaces of the MMTel AS and P-GW rebuilt to support VoLTE service provisioning and billing.

VoLTE's all-IP architecture and complex service processes pose great challenges to network management. Less than five NEs exist on the CS core network, while VoLTE will have more than twelve core NEs. With VoLTE, far more NEs and interfaces are involved in basic service processes, increasing their complexity. Carriers must consider improving E2E troubleshooting and service provisioning efficiencies, building a service quality KPI system for LTE, and managing E2E voice quality in the all-IP architecture.

Wireless network reconstruction

The LTE network must be upgraded to support VoLTE. Real-time telecom services, such as voice and video, are sensitive to delay, imposing strict requirements on E2E QoS, including QoS on the wireless side. According to test results, wireless-related features, such as robust header compression (ROHC), transmission time interval (TTI) bundling, and semi-persistent scheduling (SPS), can improve the VoLTE coverage and system capacity. The E-UTRAN NodeB (eNodeB) must be correctly configured with neighboring GSM or UMTS location areas and eSRVCC measurement control parameters. The configurations must be adjusted correspondingly as the network changes. In addition, the base station controller (BSC) or radio network controller (RNC) must be configured to support reselection from a 2G/3G network back to a 4G network when the 4G network is available.

IP bearer network reconstruction

Generally, virtual private networks (VPNs) are used to distinguish signaling, media, and maintenance management data from telco networks to improve service security. IMS signaling VPNs and IMS media VPNs are used to distinguish IMS signaling from media, for example. Unlike 2G/3G PS users, whose IP addresses are automatically

VoLTE deployment involves many issues related to operation and network optimization; all require persistent effort, and rich experience to overcome. We hope that carriers, network equipment vendors, and device and chip manufacturers all cooperate to promote the development of the VoLTE industry.

recycled when they do not consume data traffic for a period of time, VoLTE users are always online. Therefore, IPv6 address deployment is an important task for large carriers; the UE, IP bearer network, EPC core network, IMS core network, and SBC are all involved.

QoS improvement is important to the reconstruction of bearer networks, as they must be enabled with DiffServ queue scheduling in order to differentiate QoS. Priority parameter mapping between the QCI and DSCP must be configured to prioritize VoLTE services over other packet services so that QoS for VoLTE signaling, voice, and video services is assured.

VoLTE deployment involves many issues related to operation and network optimization; all require persistent effort and rich experience to overcome. We hope that carriers, network equipment vendors, and device and chip manufacturers all cooperate to promote the development of the VoLTE industry.

MTN Nigeria upgrading to Telco 2.0

By Joyce Fan

Charles Molapisi, CIO of MTN Nigeria, spoke with *Communicate* about how the largest operator in Africa's largest market is upgrading to Telco 2.0 in order to unleash endless possibilities through ICT transformation.

Charles Molapisi,
CIO of MTN Nigeria

IT in the front

Communicate: How has the strategic positioning of a telco's IT infrastructure changed over the past five years?

Charles Molapisi: In the past five years there has been a lot of discussion about IT transforming from a cost center into a business driver. I think that the time has finally arrived for IT to be much more prominent than it used to be.

It is very evident now if you look at the telco space. I think IT is no longer supposed to play a background role as a supporting function. Instead, it must move forward to take a very critical role in creating a whole value chain across the business. IT is now almost at the forefront in terms of driving new solutions, new products, digital services, and the whole transformation of the business today. Even in other vertical industries, such as banking and logistics, etc., you can't ignore IT alone.

Let me give you an example from the MTN perspective in terms of the role we play in customer experience. We are responsible for enabling all the touch points of the business, such as call centers, service delivery platforms, payment channels, and retail channels, to make sure the customers can get the products they need; we are responsible for customer engagement, the cloud platform, the data center, as well as the digital solutions that deliver all the value-added services. Those are the key business drivers for us going forward. Our role is not just supportive, actually we have to be revolutionary. For example, we are now hosting businesses into our own environment and that demonstrates that IT is in the front.

Telco 2.0: A two-sided business model

Communicate: How would you define MTN's ICT transformation?

Molapisi: My definition is very simple; I see Telco 1.0 and Telco 2.0. The way I see it, Telco

1.0 is for basic services like traditional voice. Telco 1.0 is focused only on the customer, at the consumer and enterprise levels. Now in the new space of Telco 2.0 there's a two-sided business model. One side includes enterprises and consumer customers, and the other side includes banks, developers, and retailers, etc. The whole ecosystem has changed and Telco 2.0 is at the core of that, enabling all of these elements and creating this massive ecosystem of developers, partners, verticals, and consumers who are enjoying all of those services. So it is the creation of a whole new ecosystem and that is what Telco 2.0 transformation is all about.

Communicate: What are the business and technology drivers behind this transformation?

Molapisi: First of all, there is the pressure on revenue. The prices are falling, which pressures operators to bring the cost down. Second, customers want you to know them and to personalize the services. The days of broad campaigns and marketing tactics are over.

The only way you can understand all your customers' needs and offer targeted services is to dive very deeply into data analytics and match relevant products and services with your customers; that is where IT comes in. We provide analytics and the capabilities to conduct marketing campaigns to our customers. We can orchestrate cost-effective and precise analysis. We also have to save the data center cost. Now we can turn the data center into a cloud data center to enable data analytics in a much more efficient way.

New businesses are all about third-party integration, ecosystem creation, and time-to-market. The quicker you launch, the quicker you can make money before your competitors are able to copy you. The service delivery platform (SDP) provides us the ability to integrate partners and bring them on board very quickly.

Communicate: What can we expect from MTN Nigeria's Telco 2.0 phase?

Molapisi: If we go to the Telco 2.0, the possibilities are endless. Once we implement Telco 2.0, our customers will have a plethora of content and services from different partners, because we are the orchestrator who brings everything from different partners and ensures customer take-up.

We can talk about location-based services for example, because that's an area where telcos of our size can really offer value. It means that we will be able to tag our customers, and understand their preferences and location. We will be able to deliver advertisements and services that are much more relevant to them.

Today we are the biggest music distributor in Nigeria. In 2008 we launched our music service, Callertunez, and provided ring-back tone (RBT) services. We reached the 17-million-subscriber mark last October, a record yet to be beaten by any of the other networks. The service currently offers Nigerians a library of over 12,000 sound files, offering subscribers the ability to personalize their RBT. Nigerian artists are provided with a new means to monetize their content. Working with our partners, we made the music distribution transparent. The artists and other parties involved can monitor the subscriptions and download count.

Mobile payment is another example. Infrastructure and transportation are two of Nigeria's challenges. We are going to shrink the gap by collaborating with partners to provide online payment. When we finish the transformation, individuals in Nigeria will be able to make a payment or transfer from the comfort of their home. We've already launched a finance service in cooperation with a local bank. Now, having a mobile phone means you can enjoy banking services anywhere.

All information in one pile

Communicate: How are you getting your IT infrastructure ready for the transformation?

Molapisi: First of all is the integration with content, services, and partners. We have deployed our SDP with Huawei. It's a very powerful and strategic platform for us. With it, we can integrate all third parties with any of their content and value-added services and launch them very quickly. Also, partner onboarding, management, and payment are easy to conduct and monitor.

We are in a business that is definitely driven by analytics. We tag to our customers, develop our solutions, and conduct online campaigns based on that. Our customer management platform and data center help us see the customers. In the past, one of our challenges was that we had separate piles of customer information. We are trying to create a comprehensive view of the customer by collaborating and unifying all information into one pile. We are now moving into big data and will have a very strong analytic platform. At the same time, a transformation in the data center is underway; it's becoming software-defined and everything is moving into the cloud.

MTN is the biggest in the local market with about 58 million subscribers. We've got very strong network coverage and capacity, as well as a solid distribution network. Remember, this transformation is about maintaining the strength of our core business while unlocking many elements around the core – data analytics, music distribution, and payment channels. All those capabilities arise around the core and depend on IT. We are leveraging all the technologies that enable all those elements.

VoLTE can deliver real value

By Yang Qin

Voice is still the bread & butter of mobile telco, but revenues have been stagnant in the OTT era. VoLTE, through its superior user experience and spectrum utilization, presents the opportunity for more bread and more butter through reduced spectrum CAPEX, increased voice revenue, more customers, and more enterprise services.

Value of voice in the LTE era

Long-term evolution (LTE) is a data-oriented technology, but it still offers a chance to breathe new life into the voice revenue stream, which has declined to 58% of the mobile carrier total globally – a significant drop. Korean carriers KT, SKT, and LG+ offer a certain amount of voice in bundled service packages, while Japan's NTT DOCOMO offers separate voice and data service packages for users to combine freely, with unlimited on-net calls. In the U.S., Verizon offers a bundle of limitless voice service and a certain amount of data, but the price is high. And in Britain, EE also offers a bundle of limitless voice service and a certain amount of data; but compared to its data-only package, the voice package contributes a significant portion of revenue; its loss would be devastating.

Four business benefits of VoLTE

LTE voice was once a diverse field, with voice over LTE (VoLTE), simultaneous voice and LTE (SVLTE), circuit-switched fallback (CSFB), and voice over long-gain antenna (VoLGA) all vying for supremacy, but IP-multimedia subsystem-based (IMS-based) VoLTE has now emerged as the long-term solution of choice, with the others only proving temporary.

VoLTE has distinct advantages in terms of user experience and spectrum utilization. Calls connect ten times faster, while four times as many users can occupy a given area without compromise of their call experience, and MOS score averages remain above 4.0. However, VoLTE isn't just about technology. Telco CFOs will consider how it influences consumption behavior, its effects on operational efficiency, and how business value can be created.

Reduced spectrum CAPEX

LTE competition in any country starts with the spectrum auction. Spectrum is precious, and will remain so as LTE data traffic continues to surge. According to the GSMA, 62MHz of LTE700 spectrum was auctioned in the U.S. for USD19 billion, while 2×30MHz bands of LTE800 frequency sold in Germany for EUR4 billion.

The use and reuse of current spectrum is far more economical than buying more. By utilizing what was once 2G/3G spectrum for LTE, data and voice services can be migrated gradually, saving billions in telco CAPEX. This can also free up certain spectra for LTE, such as 800MHz or 1800MHz, that are widely used for LTE roaming.

Keeping telcos relevant

OTT players are eroding telco revenue, but VoLTE and rich communication suite (RCS) services are opportunities to regain lost

ground. They provide similar services to those offered by OTTs, including chat, group chat, and picture/video/address sharing, enhanced by carrier-grade service quality & security and differentiated services such as global connection and QoS guarantee. In a market featuring fierce horizontal and OTT competition, and telco service commoditization, VoLTE and RCS give carriers a chance to stand out.

For example, China Mobile recently announced an RCS-based unified communication plan that aims to integrate VoLTE and SNS functions to create a brand new experience for users. This solution will include what is called "new voice," "new SMS," and "new contacts." RCS-based "new SMS" will integrate multiple media and messaging formats and work seamlessly with traditional SMS/MMS, while "new contacts" will present brand new SNS and public service portals based on real phone numbers. China Mobile is currently reconstructing networks for unified communication. By the end of 2014, they will have implemented nationwide commercial VoLTE and pre-commercial RCS, with the latter to be commercialized in the first half of 2015.

Accelerating 4G adoption

LTE is no longer a niche technology, but VoLTE can be. Verizon and AT&T are in heated competition in the U.S. to promote their LTE services. AT&T focuses on the disadvantages of fallback. When Verizon highlighted its superior coverage, AT&T mocked, "With Verizon Wireless, you can't talk and surf the web at the same time."

Stimulating service consumption

VoLTE enables many services that can influence user decisions and change their behavior. It encourages subscribers to use more voice and data, creating "out-of-bundle" revenue for telcos. Even for telcos that offer packages with unlimited voice, consumption of more services and features can still raise their ARPU.

VoLTE makes voice more relevant; the average VoLTE call duration is 20% longer than the average 2G/3G call. It can also prompt subscribers to call their contacts. For instance, depending on configuration settings, subscribers can receive a prompt to make a call if one of their contacts updates their status on social media to "I feel terrible." HD video calling is another service that VoLTE can do much better than 3G. Many other derivative video services are also supported, such as video email, video call center, telemedicine, replay of voice calls, and viewing of other video during a call. The benefits of VoLTE far outweigh the deployment costs. Return on investment (ROI) is guaranteed.

2014 – The year VoLTE goes mainstream

The superiority of VoLTE is certain; what is uncertain is when you might be able to use it. According to Infonetics, there have been twelve VoLTE commercial deployments to date, attracting eight million users. By 2017, global VoLTE subscriptions will have increased seventeen-fold, reaching 138 million.

According to a 2013 survey by the Global Mobile Broadband Forum in London, 59% of carriers planned to launch commercial VoLTE in 2014. AT&T and Verizon planned to do it at the beginning of 2014 while China Mobile planned to launch it by the end of 2014. DOCOMO, KDDI, T-Mobile, Sprint, and Etisalat also had their eye on VoLTE. Now they are all turning their attention to the bottleneck of VoLTE commercialization – chip and terminal availability. Smartphones that support VoLTE are now reaching the market, with VoLTE-compatible chips now available from Qualcomm, Samsung, and HiSilicon.

Optimize EPC to ensure VoLTE success

By Yang Hong

OTTs are now providing voice services; to compete, carriers must secure user loyalty by providing a better voice service experience. Fortunately, carriers have network resources at hand. Optimization of the EPC network can turn VoLTE commercialization into a historic success.

OTT challenge and VoLTE opportunity

Mobile voice services have evolved from 2G to 3G to LTE. With the development of mobile broadband, over-the-top (OTT) voice services keep emerging, causing a huge impact on carrier voice revenue. In the LTE era, all carrier services will be IP-based. The circuit switched (CS) network will gradually die out and the CS voice service will be ultimately replaced by voice over LTE (VoLTE).

This means that the evolved packet core (EPC) network of LTE has to bear not only traditional data services such as web browsing, video and apps, but also the most important service to carriers – voice. OTT voice services will also be supported on the EPC network. It is critical that carriers prioritize their VoLTE services over OTT voice services.

Leveraging network advantages and focusing on user experience

User experience is the key factor of competitiveness. Carriers must deliver better user experience to maintain user loyalty. With the proper network optimization, carriers' VoLTE service experience cannot be matched by OTTs.

Adjust EPC architecture to improve VoLTE experience

The EPC network has evolved from the packet switched (PS) core network, which was designed only for data services. The PS networks of most carriers are centralized. The serving GPRS support node (SGSN) and the gateway GPRS support node (GGSN) are deployed in the centralized room. For example, most Chinese carriers' provincial PS devices are deployed in the primary provincial equipment room to provide province-wide services. After evolution to LTE, the mobility management entity (MME) and system architecture evolution gateway (SAE-GW), which are upgraded from the SGSN and GGSN, are still deployed in a centralized equipment room.

According to CS voice statistics, 80% of calls are initiated and ended locally. Based on the current network structure, 80% of VoLTE traffic needs to be transmitted by the SAE-GW deployed in the centralized equipment room, causing two problems: First, 80% of these transmission network resources are wasted. Second, longer transmission distance causes longer latency. Unlike data services, voice service depends heavily on low transmission latency; if end-to-end latency exceeds 300ms, user experience is substantially degraded. By adjusting the current EPC network architecture and deploying gateways locally, 80% of VoLTE traffic will be transmitted locally, saving bandwidth resources and latency.

Deploy special voice gateways to improve VoLTE service processing efficiency

According to 3GPP, all VoLTE and data service traffic goes through the SAE-GW. However, the sharing of the gateway leads to poor network efficiency due to the inherent differences between voice and data services.

Carriers can deploy special VoLTE gateways locally to process local users' VoLTE services. Since the VoLTE gateway does not need service awareness (SA) functionality to distinguish VoLTE from data services, the user capacity and signaling processing capability of each card would be in full play. VoLTE services do not require high throughput; few cards are needed for a gateway, so cost is minimal. VoLTE is also less demanding on the policy and charging rules function (PCRF), which can be conveniently integrated on the VoLTE gateway. As a result, networking cost is reduced. Since signaling interaction between network elements (NEs) is performed by the VoLTE voice gateway, signaling processing is efficient. In addition, voice packets are small and stable compared with other data service packets. The special VoLTE voice gateway can provide transmission and scheduling efficiency optimization for small packets, while improving VoLTE service processing efficiency.

Prioritize VoLTE signal processing for E2E QoS

Compared with OTT players, carriers have a big advantage in network resources. Leveraging the EPC network, they can realize guaranteed bitrate (GBR) and thereby ensure E2E QoS for VoLTE services. A bitrate of 23.85kbps with less than 100ms transmission delay ensures HD voice experience for VoLTE users. In comparison, OTT voice services are supported by whatever is available, so they cannot guarantee QoS absolutely.

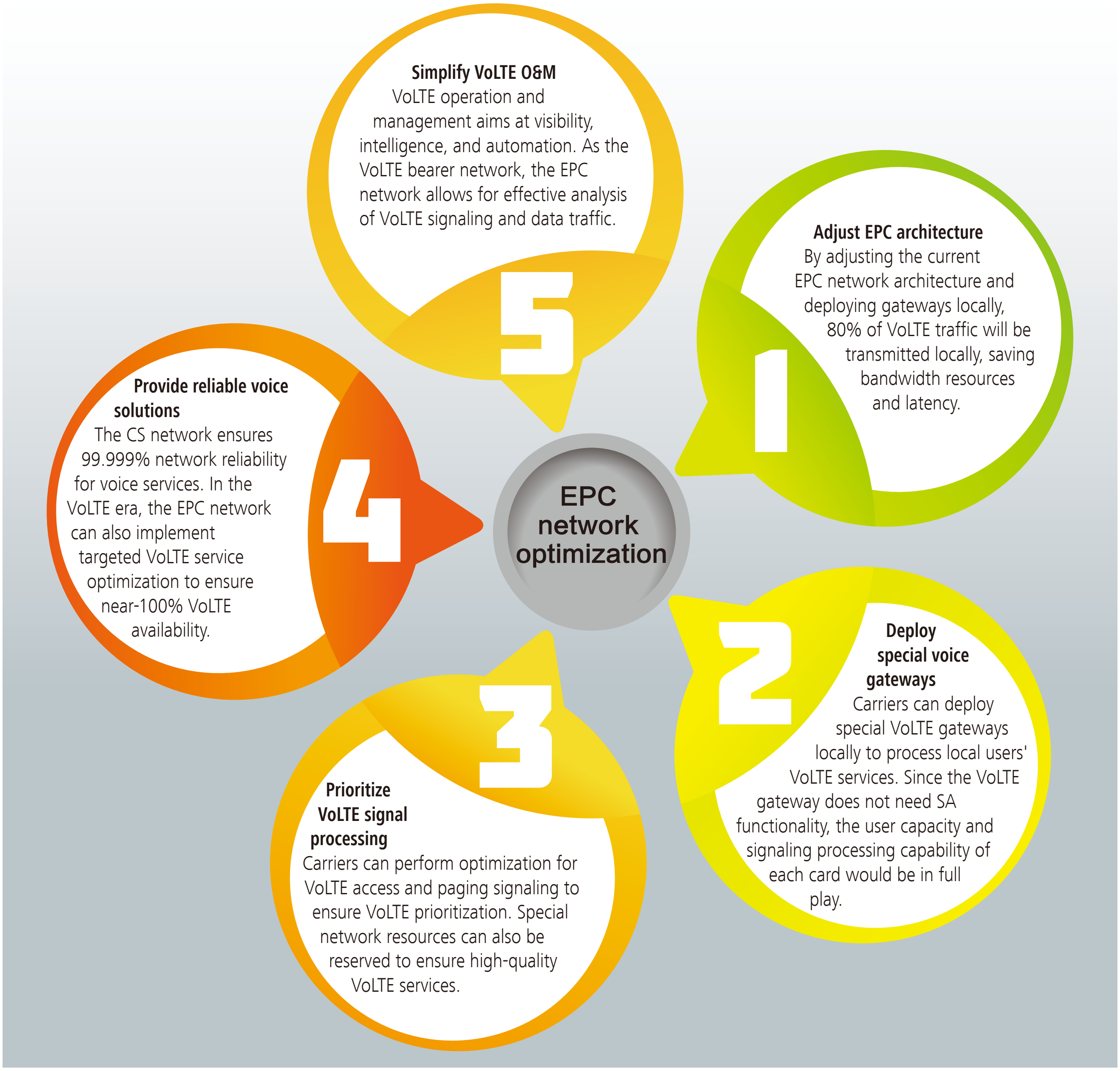
The EPC network can prioritize scheduling of VoLTE packets by configuring the differentiated service code point (DSCP) of the packets. In addition, carriers can perform optimization for VoLTE access and paging signaling to ensure VoLTE prioritization. Special network resources can also be reserved to ensure high-quality VoLTE services.

Provide reliable voice solutions to ensure 100% VoLTE availability

The CS network ensures 99.999% network reliability for voice services. Carriers can ensure availability for voice services in almost all scenarios. In the VoLTE era, the EPC network can also implement targeted VoLTE service optimization to ensure near-100% VoLTE availability.

The biggest difference between VoLTE and OTT voice services is that VoLTE service availability can be guaranteed in any scenario. In the VoLTE era, the EPC network conducts targeted optimization of VoLTE services to keep them available at all times.

While users can tolerate some data service delay, they are much less tolerant when it comes to voice service. Most data services are initiated by users themselves while voice calls are typically between a caller and a receiver (who could be anywhere). Therefore, reliable storage of user location information must be guaranteed to ensure call availability, even when faults occur in the mobility management entity (MME) and the gateway. By backing up user location information between MMEs deployed with the MME Pool mechanism, carriers



can ensure 100% call availability even when user location information on one MME is lost; 1+1 hot backup is also implemented for the special voice gateway.

First-time call success rate and drop rate are KPIs unique to voice. The EPC network can be optimized in a variety of scenarios to guarantee smooth VoLTE services. For example, in case of a handover scenario, EPC can be optimized to avoid call initiation during handover. If the network is congested, EPC should reserve special resources and prioritize scheduling of VoLTE services. Even some of the network resources for data services can be used for VoLTE to ensure first-time call success.

Simplify VoLTE O&M through E2E KPI visualization

Carriers accumulated a lot of valuable experience in voice service operation and maintenance (O&M) during the 2G/3G era. The entire KPI system was designed for voice services. These KPIs must be adapted for VoLTE O&M. VoLTE operation and management aims at visibility, intelligence, and automation. As the VoLTE bearer network, the EPC network allows for effective analysis of VoLTE signaling and data traffic. Service visualization is required for effective VoLTE O&M. The EPC network provides visualized KPI reports that indicate VoLTE service status. The KPIs include call success and drop rates as well as packet latency and jitter.

Intelligent VoLTE O&M helps O&M personnel identify and locate service faults quickly. The EPC is the best element to locate the faults involving specific NEs based on abnormal KPIs and to locate faults involving specific modules through fault replay. Quick fault location ensures timely problem solving.

Automated VoLTE O&M significantly boosts the work efficiency of O&M personnel. For example, the EPC analyzes the call success and drop rates in different areas to direct the O&M personnel to conduct targeted network optimization, ensuring consistent service experience in all areas. The EPC can also provide voice quality analysis reports based on different types of terminals, which is useful for terminal device marketing.

The VoLTE operation and management aim at visibility, intelligence, and automation. As the VoLTE bearer network, the EPC network allows for effective analysis of VoLTE signaling and data traffic.

EPC: Key to VoLTE success

In summary, the EPC network is not only a VoLTE bearer network. For carriers, it is the key to differentiating VoLTE services from OTT voice services. To enhance user loyalty, carriers must provide a service experience that OTTs cannot match.

Voice services are the key to carriers' survival. If carriers optimize EPC to establish absolute advantages over OTT, they can succeed once again in the VoLTE era as they did in the 2G/3G eras.

HKT: VoLTE Pioneer

By Jiang Kun

VoLTE can fully leverage the superior spectrum utilization of LTE to provide a superior voice experience. In fact, it's universally acknowledged as the ultimate voice solution for the LTE era. Compelled by fierce competition, HKT decided to act on VoLTE while most carriers were still talking.

A new era with VoLTE

Hong Kong is home to seven million people and even more smart devices, with a user penetration rate exceeding 220%. Average data consumption is a whopping 716MB per month. With five mobile operators and ten LTE networks in play, mobile competition is fierce. To stand out, carriers must ensure a superior user experience through the most comprehensive and highest-quality LTE service available.

In May 2014, HKT kicked off a new era of voice communication in Hong Kong with Voice over LTE (VoLTE), and became the first operator in the world to support enhanced single-radio voice-call continuity (eSRVCC), thus creating a complete ecosystem from network device to terminal to chip.

With VoLTE, HKT user experience is noticeably superior, a clear competitive advantage. A marketing campaign was also launched, centered on the theme "Not even a second more." HKT highlighted the advantages of VoLTE on its website, specifically its rapid and crystal clear connection. They also offered free switching between voice and video, and provided a detailed mobile phone upgrade guide.

To help subscribers switch to VoLTE seamlessly, HKT offered its "Ultimate Mobility 4G" bundle, which integrates voice and SMS service. The bundle provides unlimited voice and SMS service at a fixed price and does not charge additional fees for VoLTE. With the same price yet better services, HKT has encouraged many subscribers to migrate to VoLTE. Since May 15 of this year, there has been an average of 1000+ upgrades per day.

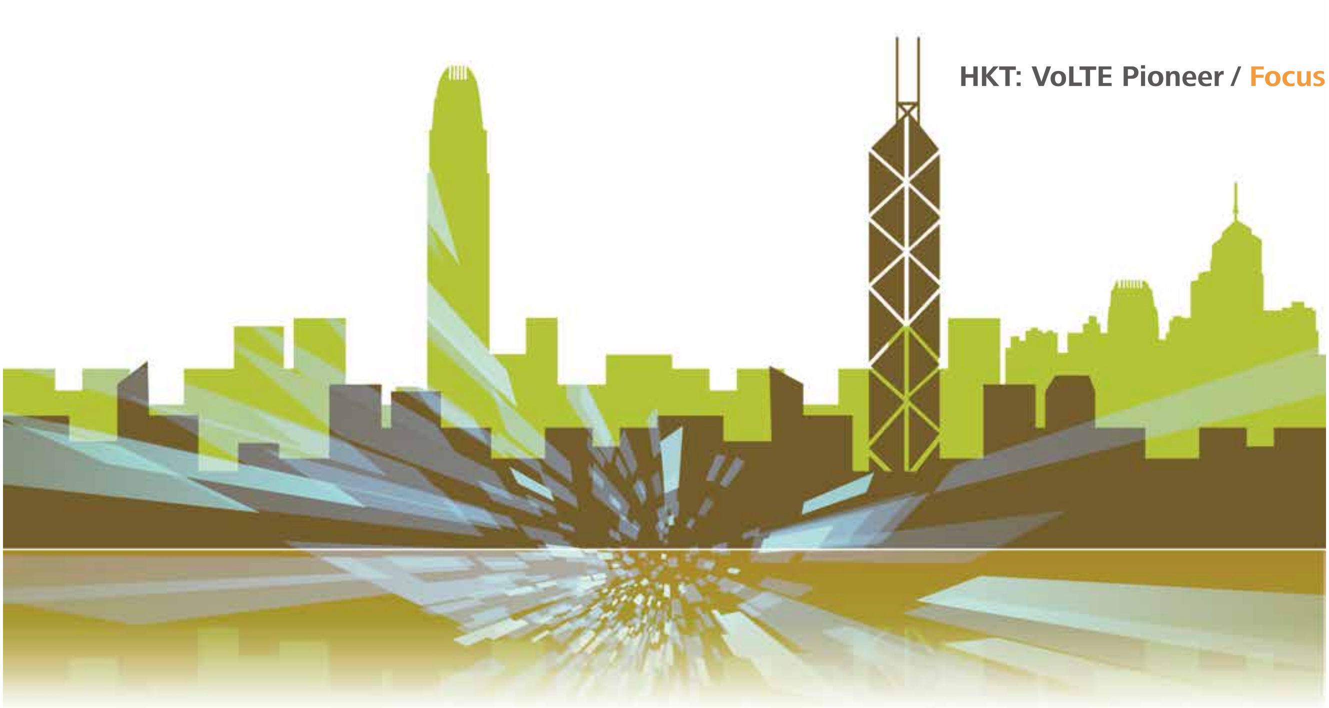
Despite the quickly increasing traffic, the VoLTE network has performed exceptionally. With a call connection rate of 99.3%, it's more reliable than the typical circuit-switched (CS) network.

Overall VoLTE deployment in 12 months

To assure that it was first-to-market with VoLTE, HKT turned to Huawei. It took a mere 12 months of joint effort for HKT to complete its overall VoLTE deployment, which was announced on November 11, 2013. Over the next six months, HKT finished interoperability testing of its network with devices, including a VoLTE/eSRVCC-enabled smartphone. Many E2E deployment challenges were met during this year-long process, but with considerable expertise in user database integration and minimization of legacy network impact, HKT and Huawei were able to resolve every issue.

Minimizing legacy operation

To achieve quick VoLTE deployment, impacts upon the current CS network had to be minimized. HKT adopted a single-radio voice-call continuity (SRVCC) interworking function (IWF) proxy solution, which allows SRVCC function deployment on one or more MSCs that act as SRVCC-IWF proxies, avoiding the need for large-scale MSC upgrade or transformation of the current CS network, which would be laborious, costly, time-consuming, and potentially disruptive.



With SRVCC-IWF proxy, HKT was able to concentrate its resources and energy solely on the construction process for VoLTE.

Integration of user data

To help 2G/3G users migrate smoothly to LTE without changing their SIM or phone number, and to simplify the provisioning and management of user data, telcos must integrate the home location register (HLR) and system architecture evolution-home subscriber server (SAE-HSS) with the IMS-HSS. HKT planned to complete its user database integration in three steps. During LTE deployment, it completed the HLR/SAE-HSS integration. During VoLTE deployment, HLR/IMS-HSS service data was synchronized automatically to ensure the consistency of LTE and 2G/3G services. During the last stage, HKT finished integrating the three front-ends (FEs) – the HLR, SAE-HSS, and IMS-HSS, with all public data stored and shared, and a single profile for each user.

Seamless service experience

All-LTE coverage cannot be achieved overnight. To ensure continuity for voice and other services during switching between 2G/3G and 4G, eSRVCC was leveraged.

Seamless voice through eSRVCC

HKT uses 1800MHz for LTE coverage and 2600MHz for capacity. In Hong Kong's central business district, the high concentration of skyscrapers means that 3G networks still have advantages over LTE. To guarantee a seamless user experience, Huawei's eSRVCC technology was leveraged to ensure seamless switching between 3G and LTE. In fact, HKT's eSRVCC test results now show an E2E call latency of less than 230ms, which users can hardly perceive.

Complete inheritance of traditional services

HKT's CS network currently serves over 1.6 million subscribers. Local users subscribe to many mobile VAS's such as ring-back tone (RBT) or voice mail, so HKT must ensure that the user experience of these services is not degraded after LTE migration. Detailed network planning and design were carried out before VoLTE deployment, with 20 service priorities, 300 service announcement scenarios, and 1,000 billing policies analyzed. After this comprehensive and systematic process, HKT elected to migrate 29 traditional services, including 12 supplementary services and 17 exclusive Hong Kong VAS's. These measures enabled users enjoy their familiar services with a high-level experience.

Forging a better future

HKT regards its recent VoLTE deployment as merely the first step in a continuing journey. In the future, its VoLTE network will interconnect with local and global telcos, and enable roaming services of global telcos. HKT also plans to migrate one of its rich communication suite (RCS) services from its private platform to the IMS, and carry out RCS standardization.

HKT intends to monetize its IMS. Through communication as a service (CaaS) and web real-time communication (WebRTC), HKT can open its communications capabilities to third-party applications and devices. By leveraging the innovation of these third parties, HKT can better meet the growing demands for mobile VAS's in Hong Kong.

CloudIMS kicks off NFV for carrier networks

By Deng Ao

> With the proliferation of LTE, basing VoLTE on the IMS has become a carrier priority. IMS features high performance, high integration, and high-capacity computing. It proves the value of telecommunications network virtualization and is required for NFV.

At MWC 2014, network function virtualization (NFV) was one of the cutting-edge technologies that drew the most attention. It promises a beautiful blueprint for carriers, but NFV realization is no easy task. Carriers have to find more NFV application scenarios based on network situations and propose practical evolution solutions.

NFV: Revolutionizing network architecture

In January 2013, 13 top companies in the

ICT industry jointly established the ETSI NFV ISG work group to define NFV requirements, architecture, and application scenarios. So far, nearly 200 carriers and venders have joined the work group.

NFV aims to decouple software from hardware and virtualizes network functions so that they do not have to depend on special hardware, and new functions and services can be deployed through software installation and upgrade. Hardware can also be upgraded at the pace of Moore's Law, enhancing network performance and cutting cost. NFV helps carriers increase network flexibility, realize highly efficient network construction and operation, expedite service provisioning, and reduce total cost of ownership (TCO).

NFV is an important breakthrough for carriers. It also represents the next network architecture revolution, following the transformation to all-IP.

IMS: Ideal breakthrough for NFV

During the early stages of research into NFV, a universal platform is required that can adapt to all network functions. However, this revolution in network architecture cannot be achieved overnight, due to numerous difficulties related to power consumption, efficiency, virtualization of real-time services, and reliability. If we divide the network into service, control, and user planes, we can find the breakthrough points for NFV by analyzing the difficulties and benefits of their virtualization.

Service plane

The service plane provides value-added services (VAS), and some of them run on a standard hardware platform, similar to an IT server. The service plane is easy to virtualize and the benefits are obvious. However, its virtualization does not touch upon the key problems of telecommunication network virtualization, such as maintaining the SLA after cloudification. Virtualizing the service plane could be a first step even if it contributes little to the overall network virtualization process.

Control plane

The control plane is responsible for the scheduling of network resources. It requires real-time signal processing capability and high reliability. High computing capacity is the major need of control plane virtualization, which can be satisfied by a universal IT hardware platform. Thanks to mature hardware, control plane virtualization can address many deep-rooted problems such as carrier-level SLA guarantee on a universal hardware-based network topology, and NFV network management & maintenance. Therefore, virtualization of the control plane would pave the way for overall network cloudification.

User plane

To meet requirement of high-throughput packet forwarding capability, high reliability, and low latency, traditional platform adopted many private hardware such as NP processors, speed-up ASICs, and hard codecs. The current universal IT platform has yet to meet the demands of network IO, and transcoding. For example, the signal processing of the wireless carrier system consumes too many CPU resources, causing high latency and low throughput. What's more, the aggregation of various user-plane functions is also challenging. In summary, the virtualization of the user plane still has a long way to go.

Our analysis shows that virtualizing the control plane first is the most feasible choice. The current universal hardware meets the demands of control plane virtualization with regard to service reliability, platform virtualization, and centralized resource management, while the control plane itself is the network brain and key to transformation from network-based to service-based networking. LTE proliferation makes commercialization of IMS-based VoLTE a priority. VoLTE and NFV began to show promise at nearly the same time, giving IMS virtualization a higher priority in control plane virtualization. According to Infonetics' *SDN and NFV Strategies: Global Service Provider Survey* released in July 2013 and ABI's *The SDN and NFV Business Case* released in September 2013, IMS will be among the first elements of the telecommunications network to be virtualized. Leading carriers such as Deutsche Telecom (DT), Vodafone and Telefónica are already conducting POC and testing NFV in VoLTE deployment. Huawei is their preferred partner in this journey.

vIMS Realization: Key problems facing

Global carriers are sparing no effort to promote NFV maturation and deploy VoLTE based on virtual IMS (vIMS) during core network evolution to LTE. So what are the challenges of vIMS implementation?

Immature standards

The NFV ISG is responsible for formulating the framework for NFV, and is developing NFV-requirement whitepapers for standardization organizations such as 3GPP, IETF, and ITU-T. In May 2014, the sixth NFV meeting started to review group specifications developed by work groups, and discussed the target & plans of NFV Phase 2 (which will be started in the first quarter of 2015). Therefore, NFV now has a stable framework, but it will take time for it to mature.

Virtualizing the control plane first is a wise choice. The current universal hardware can meet the requirements of control plane virtualization, and the control plane is the brain of the network. Virtualization of the control plane provides the blueprint for the virtualization of the entire network.

SLA and flexibility

In the IT field, services are HTTP-based and not real-time. Carrier services are SIP-based, real-time and reliable. Therefore, it might degrade the SLA when directly migrating real-time carrier services to IT platforms. To guarantee the accessibility and real-time feature of carrier services on a distributed Internet-based framework, designs and optimizations must be in accordance with the requirements of carrier service models and every single network function.

E2E integration and network O&M

Using special devices for VoLTE deployment is complex and involves over 40 NEs and 60 interfaces. IMS-based VoLTE deployment requires multiple layers of entity systems (hardware, virtual software, and application software) to be reintegrated, so as to ensure highly reliable operation of IMS on the virtual platform. Then integrations and IOTs of NEs with standard interfaces are needed. This is called vertical integration and it poses many challenges. The clarification of interfaces between multiple layers of entity systems, compatibility, and unified & effective network fault allocation methods must be addressed. What's more, different service venders have different SLAs for carriers, leading to variation in response time and unclear responsibility between vendors.

NFV friendly O&M

Carriers have developed mature network management and operations & maintenance (O&M) systems in the past decades. When the network is revolutionized by NFV, the existing management and O&M must be upgraded at the same time. Carriers' organizational structure, for instance, needs to transform from vertical to layered. A synergized management and maintenance for both traditional and NFV networks is needed. Associating alarms with virtualized network functions and virtualized hardware position and type is also an issue. Another challenge lies in establishing a unified network fault location method and an end-to-end (E2E) fault detection & recovering mechanism between multiple heterogeneous network layers.

In the future, the evolution target of maintenance systems will be to realize unified dashboard-based management, automated service scheduling, application installation, service provisioning and self-healing of network faults over distributed data centers, heterogeneous virtualized services, and interoperation between different cloud platforms.

CloudIMS: Forging IT-based carrier networks

Based on advanced research and a profound understanding of the ICT industry, Huawei has proposed its future-oriented SoftCOM strategy. Based on NFV and SDN, future network architecture will be cloudified, making it more dynamic, efficient, scalable, automated, and open. A cloudified network supports cloud management, cloud services, cloud control, and a cloud edge.

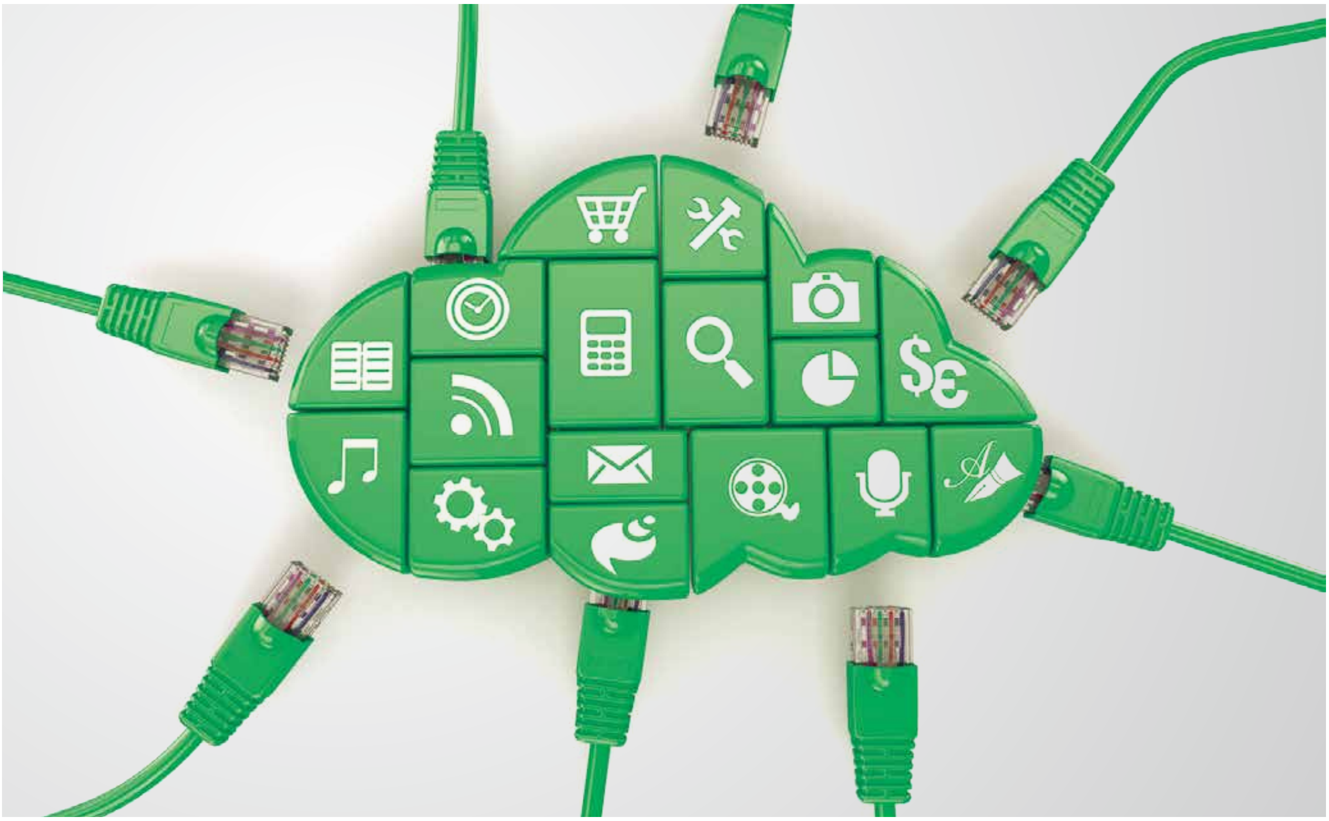
To realize the virtualization of the control plane for SoftCOM, Huawei announced its core network virtualization plan, which aims to virtualize all core network devices, including IMS, PCRF, CS, and USC. Huawei commercially launched its virtualized IMS solution, Huawei CloudIMS, at MWC 2014, which supports large scale automated deployment, elastic expansion, and virtualized network resources. In addition, vIMS guarantees the SLA of carrier services after cloudification.

Open architecture

Huawei actively contributes to the development of NFV. Huawei is a co-chair of INF WG and plays an important role in NFV development. Huawei hosted the second NFV conference. By the second quarter of 2014, Huawei submitted 207 proposals, more than any other member. Huawei is a gold member of OpenStack and is devoted to open source development of NFV.

Under the guidance of NFV visions and objectives, Huawei CloudIMS will be opened and decoupled step by step. FusionEngine is ICT convergent off-the-shelf (COTS) hardware. It can be managed by third parties through SNMP and IMPI and passed IT-standard certification and testing, including VMware authentication and SPECvirt testing. It can be powered by AC and deployed in the IT equipment room. FusionEngine meets various strict telecommunications requirements, including ETSI and NEBS Level 2 certification, eight-degree shock strength, and has a working temperature range of -5 to 55°C.

Huawei offers an OpenStack-based



open cloud platform – FusionSphere, which supports over 200 types of hardware (computing, storage, and switching), major virtualization technologies and guest OS. It can carry both IT and CT applications and provide improved performance that is both reliable and real-time.

In terms of virtual network functions (VNF), all IMS functions including SBC are virtualized. Huawei CloudIMS is an open solution that is compatible with Huawei NFV infrastructure (NFVI) and other forms of NFVI, such as VMware and HP COTS.

Realizing IT flexibility and high SLA for telecommunication services

FusionEngine is a carrier-enhanced COTS platform that effectively reduces the impact of virtualization on real time performance. FusionEngine uses a variety of advanced technologies in the chip layer, including the VT-X-supporting CPU, SR-IOV-supporting network interface chip, and 100G switching chip that realizes microsecond-level latency. In system architecture, FusionEngine realizes unified computing, storage, and switching. The computing and storage capacity are one of the most powerful in the IT industry. 400G per slot high bandwidth is also supported. Built-in eFabric supports flat Layer-1 network topology, which isolates north-south traffic from east-west traffic and minimizes external latency caused by multi-level forwarding and switching.

FusionSphere is specifically optimized to support real-time telecommunication services. Advanced DPDK technology is used and powerful switching capacity is aligned with single root I/O virtualization (SR-IOV). What's more, telecommunication affinity scheduling, large memory pages, interruption aggregation, the embedded operations interruption (EOI), along with the advanced programmable interrupt

The challenges of vIMS implementation include immature standards, the need to guarantee carrier-grade SLA and IT flexibility at the same time, evolution to full automatic maintenance, and difficulties in the vertical integration.

The standard and open virtual platform provides carrier-level reliability and supports both NFV and OpenStack. In addition, it enhances carrier capabilities, improving efficiency and security while implementing carrier-level network maintenance.

controller (APIC) all help reduce latency for service processing. In service assurance and a reliability, live migration of VM and a fault tolerance (FT) mechanism ensure quick fault recovery.

NEs for vIMS use cloud-aware architecture, realizing statelessness and decentralization and maximizing perception-based service flexibility by the isolation of applications and data. More importantly, process-level N+M redundancy, in combination with the inter-DC pooling of VNFs, ensures quick service recovery and high service availability.

High-efficiency automated network deployment and service scheduling

Based on NFV ISG's recommended architecture, management of NFV networks is accomplished by the management and orchestration (MANO) system.

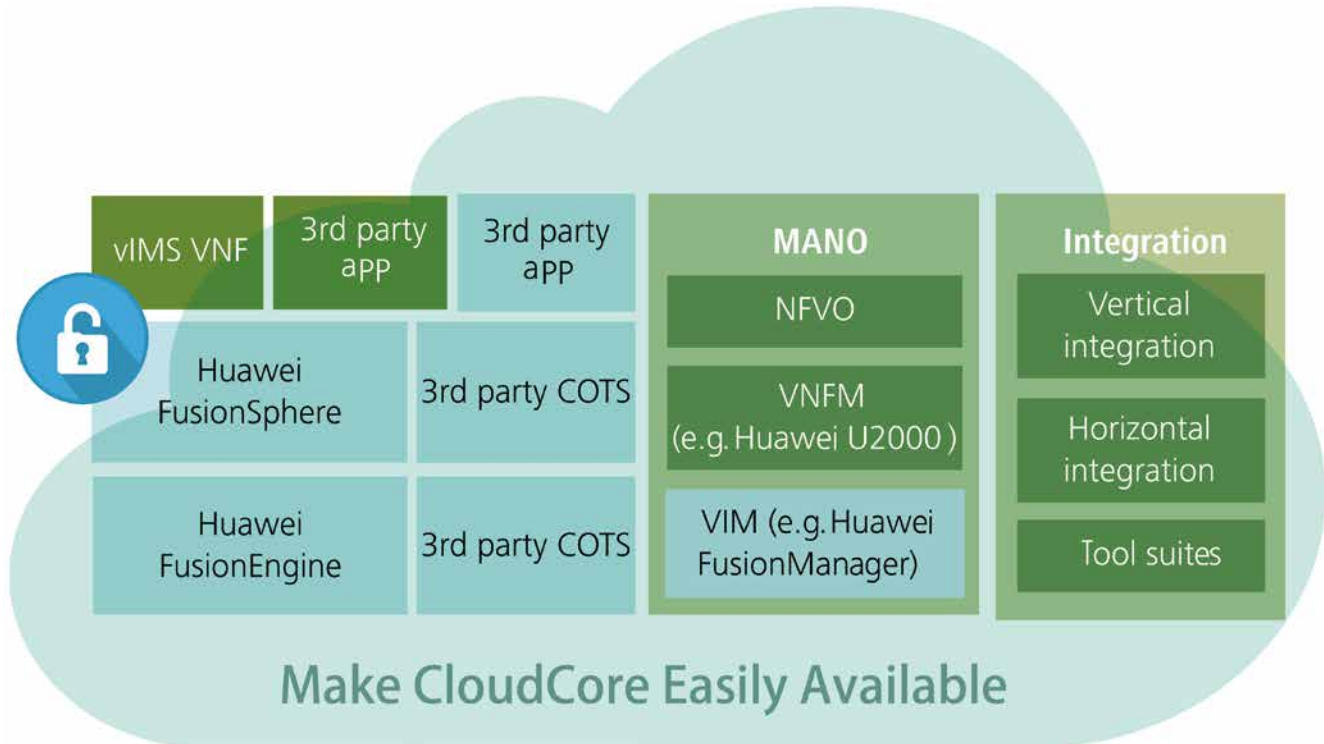
MANO consists of three layers. Each MANO layer is responsible for resource management and scheduling on one of the three network layers. The first layer is the virtualized infrastructure manager (VIM). The second layer is the virtualized network function manager (VNFM), which manages the lifecycle of virtualized network functions (VNFs). Huawei's VNFM can be independently deployed or deployed as an expansion module of U2000 (EMS) to minimize impacts on the BSS and OSS on existing networks. The third layer is the network function virtualization orchestrator (NFVO) that manages the lifecycle of network services and conducts service scheduling. The southbound interfaces of Huawei's NFVO can be used for managing third-party VNFM. Its northbound interfaces work with a large data analytics system to implement accurate lifecycle management of network services. All three layers can interoperate and coordinate with external modules through the REST interface. The coordination and association of the three layers make vIMS-based network deployment as easy as installing computer software. What's more, by coordinating with existing EMS/OSS, MANO can inherit functions such as KPI, alarm association, hardware management, and application alarm, realizing E2E network O&M monitoring.

Easy to deploy

vIMS applications can run on Huawei's open-cloud platform or third-party platforms. Carriers can customize their networks to suit their specific situations.

Networks built on Huawei's NFVI components (FusionEngine and FusionSphere) and vIMS have the following advantages:

Simplified integration: Standards are currently incomplete, but through E2E pre-integration, pre-verification, and unified service, the problem of vertical integration is solved, avoiding



the potential risks of multi-layer NE integration. This will also shorten TTM and quickly meet service requirements.

Future-orientation: Networks built on Huawei's NFVI components (FusionEngine and FusionSphere) and vIMS are a foundation for TOC and ICT transformation. As the industry standards and NFV mature, any third-party COTS can be added to the current hardware layer to provide computing and storage capabilities. Third-party applications can also be deployed on the current platform to enable sharing of NFVI by multiple services.

Another option is to deploy networks using Huawei's vIMS and third-party NFVI (VMware + HP COTS). In 2013, Vodafone conducted POC verification of Huawei's VMware-based vIMS solution. Huawei's solution leads the industry in terms of deployment time and testing cases. Huawei also established a comprehensive integration service framework and supporting teams to help carriers tackle challenges by providing primary integration service. Through comprehensive network design of the application, network, and system layers, Huawei can guarantee high SLA standards for telecommunication services on platforms of low reliability. By constructing the capability of unified maintenance of heterogeneous components from different vendors, Huawei can help carriers realize easy IMS deployment, high availability/reliability, and simple network O&M in multi-vendor scenarios.

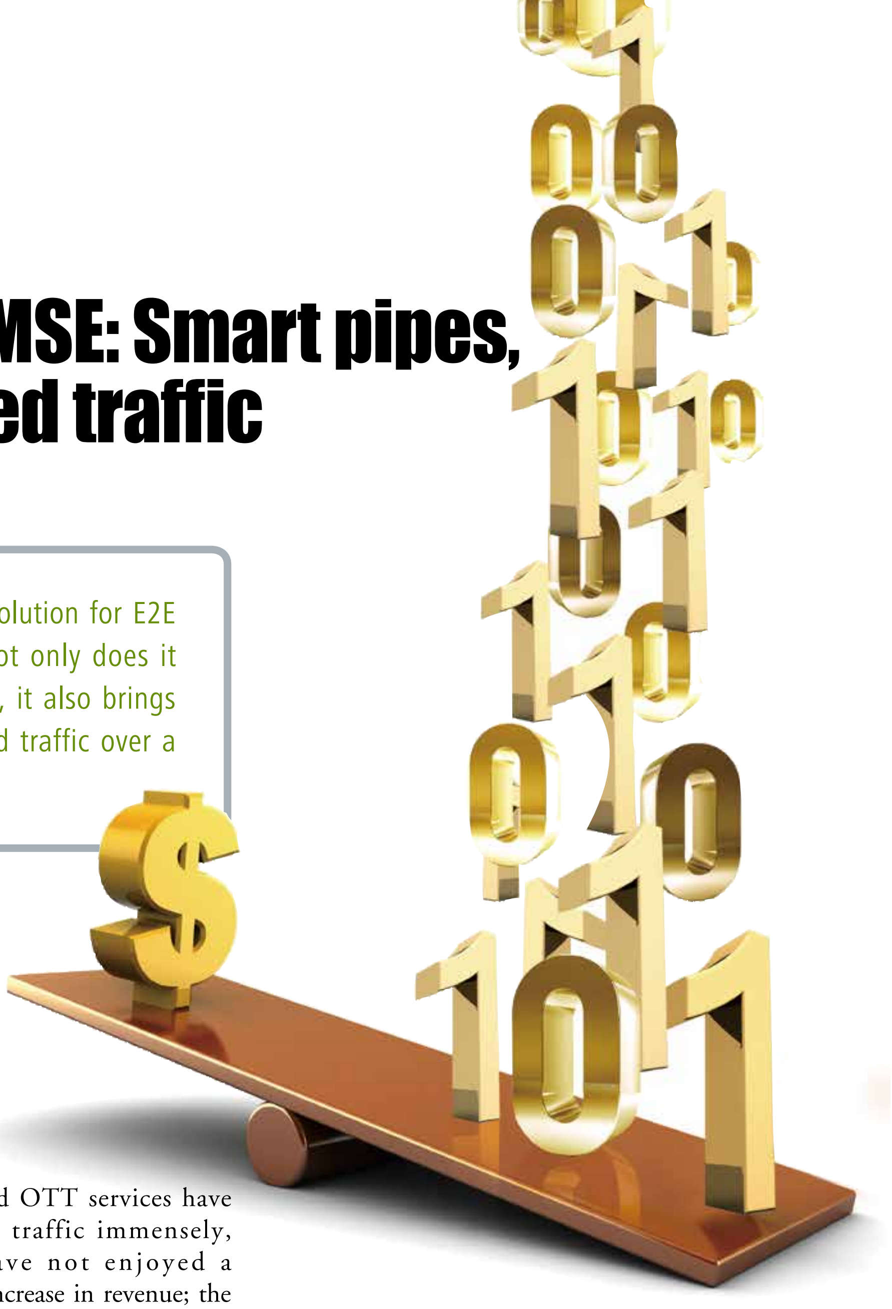
Huawei is actively promoting the development of virtualization for the telecommunications industry and hopes to cooperate with carriers to explore integration, unified O&M capability construction, deployment of NFV-based high-reliability services, and reconstruction and replacement of traditional devices.

Huawei is actively promoting the development of virtualization for the telecommunications industry and hopes to cooperate with carriers to explore integration, unified O&M capability construction in multi-vendor scenarios, SLA guarantee for telecommunication services on NFV networks, and virtual network management. Ultimately, IT-based telecommunication networks can be constructed. That is the ultimate goal of NFV.

Huawei MSE: Smart pipes, monetized traffic

By Gao Yonghua

Huawei's MSE is the first of its kind, a solution for E2E QoE assurance of a mobile network. Not only does it improve the experience for the end user, it also brings that long sought-after goal of monetized traffic over a smart pipe within reach.



Popular apps and OTT services have increased data traffic immensely, but telcos have not enjoyed a corresponding increase in revenue; the answer is monetization.

How to monetize MBB traffic

Traffic monetization requires the maximized consumption of high-value data. To increase revenue and achieve sustainable mobile broadband (MBB), customer requirements must be explored, with business models transformed soon after, so that network efficiency improvements won't be in vain.

Improve user experience

User data analysis can illustrate general tendencies and recent demands, enabling telco provision of a complete set of premium applications and services, in collaboration with upstream and downstream industry partners who optimize user experience; this is fundamental to both big data operation and MBB traffic monetization.

Carriers can also optimize the service experience for new subscribers through exhibitions that demonstrate new services and attract more subscribers. After analyzing initial traffic consumption patterns, telcos can target their marketing efforts and send out representatives if necessary to stimulate consumption.

By analyzing customers' favorite LTE products and services, telcos can determine what users might respond to, and deliver the appropriate products in a turn. If a customer is sipping data, telcos can send out prompts that indicate just how much is left under his/her data cap.

Increase revenue

In the MBB era, telcos are increasingly looking to boost revenue through business model innovation. Voice demand is satiated; the potential of MBB services is in data. Operational refinement/differentiation is the key to boosting revenue, especially revenue per bit.

Understanding and meeting the demands of upstream and downstream users is a challenge all telcos face. Unlike voice users, MBB users have quite differentiated and personalized demands. They can be grouped as social users, business users, or entertainment users based on their preferences; high-end, mid-level and low-end based on their ability to pay; and high-, average-, and low-traffic based on their consumption. They can also be grouped by terminal or location.

Quantified pricing (voice or traffic bundles) is still the industry's primary tariff model, but it turns the operator into a mere bit vendor, and doesn't seem to play well with subscribers either; it is an unsustainable model. Something new is needed – backwards charging, where the OTT hubs that generate the vast majority of network traffic pay for what they generate, but what can telcos offer in return for OTT cooperation? The answer is smart pipes, which can offer flexibility, scalability, context awareness, and robust policy control.

Improve network efficiency

In the MBB era, network structure is in constant flux, making simplified topology a must. Many telcos have attempted to monetize their traffic by deploying value-added servers, and even load-balancing devices on the Gi interface side, where network complexity is an issue. However, vendor diversity in this area makes interconnection, operation, and maintenance work complicated.

Huawei MSE: Smart competitive pipes

Business model redesign requires strong support capabilities, while traffic monetization relies on smart pipes. Huawei proposes a multi-service engine (MSE) solution with a first-of-its-kind, all-in-one architecture that eases deployment, improves user experience through automated closed-loop management, and enables pricing based on value.

Closed-loop management

As a standard-setter and core algorithm designer for ITU-T P.NAMS/P.NBAMS, Huawei is a leader in objective user experience evaluation. Huawei MSE offers a service awareness system that can identify over 95% of over 1,300 protocols. This enables accurate analysis and creation of statistics at the network, terminal, user, and service level, all presented through a user-friendly interface, illustrating network status, service hotspots, and customer requirements.

Under MSE, Huawei has designed the industry's first differentiated flow priority indicator (FPI) solution, where coordination between the radio access network (RAN) and the packet-switched (PS) network is realized, with end-to-end (E2E) QoE for the wireless and PS sides assured. This guarantees top-quality service for high-value users and experience-sensitive services – a rare luxury over a mobile network.

Value-based pricing

Huawei MSE can implement customized billing for any desired Internet hub, whether it be an SNS, video provider, or game service. It also supports binding of QoE and billing policies. Bandwidth and premium can be assured for VIP users, with ordinary customers who pay for bandwidth expansion enjoying their privilege without compromise. What's more, lower fees and quality services can also be combined for first-time users.

Huawei's MSE solution has been deployed on over 200 networks in over 120 countries. After its adoption, O2 (Germany), EE, and DT all saw increases in total revenue and ARPU. It is a proven MBB revenue solution, both mature and reliable.

Pioneering all-in-one architecture

Huawei was the first to propose the "ONE Box/ONE Management/ONE Interface" architecture for its MSE solution, where smart pipe services are deployed over a single device with value-added services built in by third parties. A unified operation and maintenance interface is provided, with traffic optimization services over the Gi interface aggregated. In other words, MSE makes smart pipe deployment quick and easy for carriers, with monetized traffic now within reach.

Monetize communication capabilities through CaaS

By Li Haifeng

CaaS is about opening carrier network capabilities to third parties so that the user base can be expanded with applications enhanced to meet the needs of enterprise and vertical clients through the integration of communication services into business processes. In such an ecosystem, carriers, enterprises and third parties will create and share value together.

Third-party partnership

Mobile business revenues for global carriers have finally exceeded one trillion U.S. dollars, but the market is far from stable; anything can happen.

Mobile operators have three revenue sources – voice & messaging, data traffic, and value-added services (VAS). Voice revenues are stagnant in developed countries. Data traffic revenues are growing, but so are costs and often faster. VAS has the most potential, but telcos face numerous competitors in the enterprise sphere, including Internet companies, vertical market players, and other telcos. Telcos have three roles to play in the VAS application market – pipe provider, E2E solution provider, or communication as a service (CaaS)-based enabler.

Unlike the consumer market, enterprise and vertical markets require professional development and business models that integrate communication services into business processes so that they are more efficient and automated. If telcos provide the pipe only (simple access service), not enough value is added. E2E provision is one option, but an individual telco can only focus on one or two industries at most, making the opening of network communication capabilities through CaaS preferable.

Innovation of software development and business models

CaaS requires that telcos open their network and terminal capabilities. At the network level, open application programming interfaces (APIs) must be implemented, through which developers can leverage a telco's video, voice, conferencing, QoS, and billing capabilities, among others, and integrate them into their applications. APIs should be easy to use and presented in a mainstream web language such as RESTful or JavaScript so that corresponding applications can be developed quickly, without the need to learn the intricacies of a telco network. Through carrier-grade integrated communication tools, developers and other third parties can significantly improve the quality of what they offer, while operators can cut costs and share in the value of the industry chain.

At the terminal level, telcos can issue software development kits (SDKs) via CaaS. SDKs can be viewed as a group of communication construction modules, such as a codec or user authentication module, for a non-communication device. Through SDKs, carrier-grade communication capabilities can be embedded into various "terminals," converting various machines into network "users." This enables telcos to expand their subscriber base and penetrate the enterprise and industry spheres. SDKs should easily run on the mainstream operating systems such as Android, iOS, Windows, and Linux. They should also feature robust codec capabilities to suit different situations and latencies, along with HD audio or video communication.

CaaS drives innovation in traditional business and development models; meaning that telcos

can bring their advantages into full play and make their outdated organizational structures and rigid business processes more flexible. CaaS also enables third-party developers to develop applications together with carriers, making for a collaborative cross-industry ecosystem, leading to better applications and more users. What's more, telcos will be able to adopt numerous business model innovations, including revenue sharing, commissioned development, and joint operation.

First-mover success

Successful CaaS depends on selecting the appropriate market. For telcos, enterprise and vertical markets are the best choices initially, as quick wins will boost the confidence of the management team so that long-term cooperation projects can go ahead. Instead of charging third parties for Internet utilization fees, carriers can cultivate partners with real potential, share value with them, and later leverage their channels and customer resources to make headway in different industries.

China Telecom Fujian (Fujian Telecom) is a CaaS pioneer. Since 2012, they planned to collaborate with upstream and downstream players in the mobile Internet industry that complement each other's advantages so that a profitable ecosystem can be built for the ultra-broadband era. Fujian Telecom and Huawei have worked together to build intelligent pipes and a complementary platform, monetizing Fujian Telecom's core assets through open communication and information service capabilities. By the end of 2013, 175 partners were brought to Fujian Telecom's open platform, producing over 110 collaborative products, with many industries involved.

Fujian Telecom and Grandstream Networks cooperated on developing new IP cameras, where the built-in SDK allows the camera, a device that can normally be connected but cannot communicate, to do both with other network devices, with the communication process itself as easy as a voice call. This service has been successfully deployed in home security and localized surveillance scenarios, with the number of users surpassing 300,000 in 2013.

Fujian Telecom also cooperated with a local car insurance company to launch a video-based service where information is collected remotely concerning accidents, without the need for insurance personnel on site, saving a lot of time & expense for all involved.

Third-party developers have also created other services that utilize Fujian Telecom's voice, multimedia, and cloud capabilities in the areas of messaging, assistance, and e-health, among others. Partners are very optimistic about them. "Jiaying Information (a Fujian Telecom partner) is very confident that in the next year, our application (conferencing software) will be used for over 120 million minutes, and involve over 30,000 enterprises." Another company, Cloud Computing Technologies, anticipates that its Tianyiqun UC&C service will attract over one million conference users in 2014.

In the LTE era, E2E all-IP-based VoLTE not only enriches telcos' communication capabilities, it also minimizes the difficulty in opening them. Mass VoLTE commercialization will pave the way for CaaS, which will monetize VoLTE capabilities in turn.

Telco communication capabilities will soon be integrated into enterprise business processes, making operations more efficient. By building a new ecosystem, carriers can achieve business success in new industries and secure new revenue sources, while partners can boost their competitive advantages through their newfound carrier-grade capabilities.

Solving the riddle of RCS

By Chen Songlin

By combining RCS and VoLTE, China Mobile and SKT upgraded their voice and SMS services and leveraged network advantages to differentiate their services from OTT services. They adopted the "entrance + platform" policy to open RCS platform capabilities to achieve win-win outcomes with partners.

Carriers have long been criticized for being unable to upgrade SMS, MMS, or video calls, and for monotonous functions and relatively poor user experience. The Rich Communication Suite (RCS) industry initiative was developed to change just that.

Problems facing RCS

According to GSMA statistics, so far, 17 carriers in 11 countries have deployed RCS and 5 of the top 10 global carriers have realized commercial RCS use. By 2015, RCS will be deployed by 85 carriers around the world. However, no apparent success has been achieved so far. RCS-e (IP messaging + video sharing) services offered by the G5 (Deutsche Telekom, Orange, Telecom Italia, Telefonica, and Vodafone) did not attract as many users as OTT services did. Basic communication experience has yet to be upgraded. The failure is mostly due to the business model. G5 RCS provides only free IP messaging services. There is a plan to develop G5 RCS terminals, but currently there is only an app, which attracts few loyal users and does not differentiate itself from OTT apps. The progress of developing G5 RCS terminals is slow and a RCS-based ecosystem is yet to be established. The business model is still a carrier-dominated one with no efforts or framework dedicated to attracting OTT players and industry app developers.

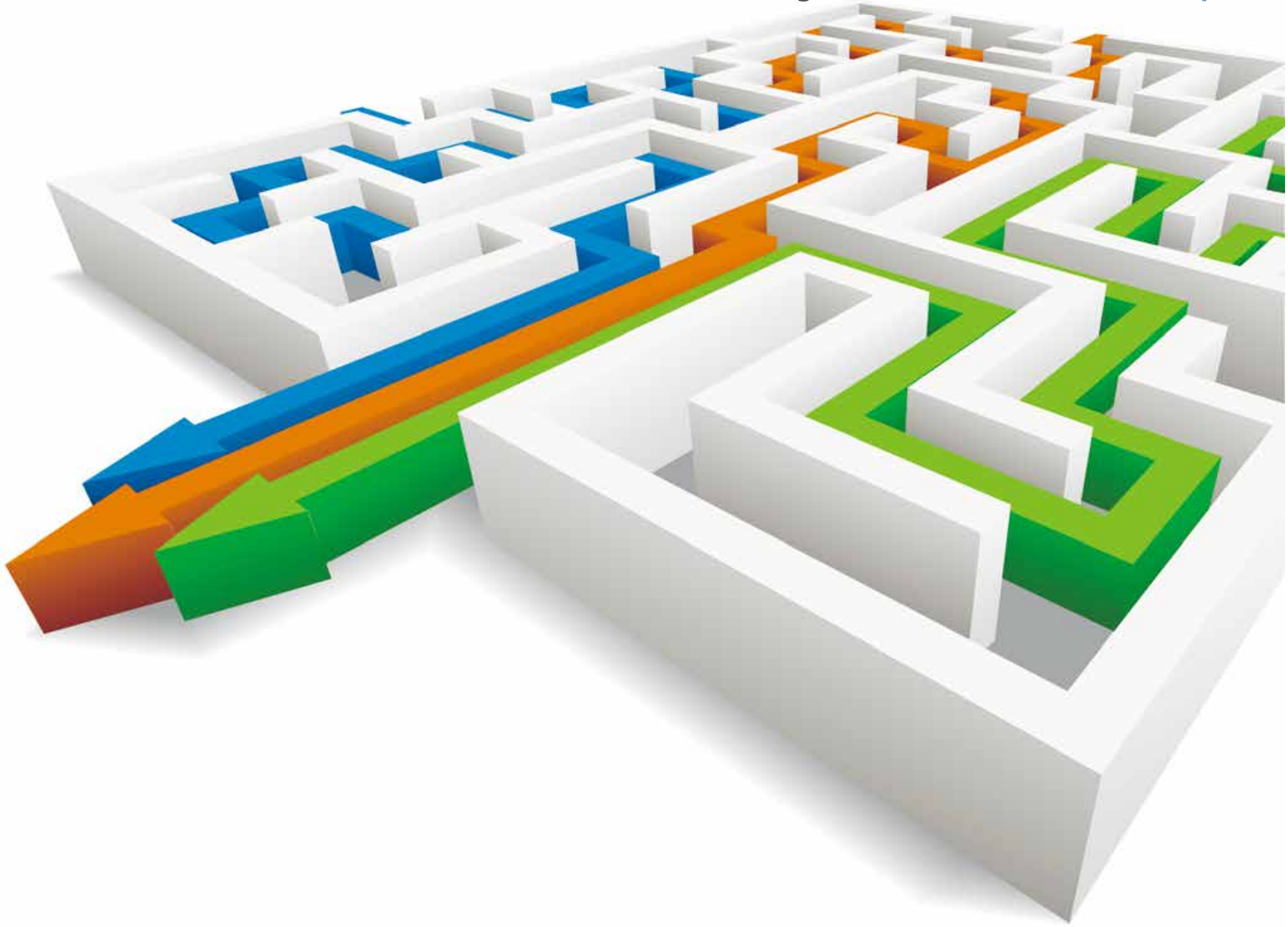
Unleash RCS potential

In the past two years, China Mobile and SK Telecom (SKT) have both taken measures to solve the problems facing RCS. For starters, VoLTE and RCS have been combined to upgrade voice and SMS services with RCS positioned as a basic communication capability rather that a value-added service (VAS). Carrier advantages such as full interconnection, high quality, and 100% availability have also been leveraged to establish clear superiority over OTT services. Both carriers have adopted the strategy of "entrance + platform." For example, China Mobile upgraded its communication entrance through the "New Voice Calls, New SMS, and New Contacts" policy and opened its RCS platform capabilities to partners. There are three keys to unlock RCS excellence.

Business model innovation

China Mobile's "New Voice Calls, New SMS, and New Contacts" policy features smooth evolution. It allows users to enjoy HD MMS and HD video conversations with the same service stability and availability as SMS and telephone calls. Carriers can increase revenues by taking the following measures:

They can put MMS of RCS and traditional SMS/MMS in a bundle that allows a finite number of messages. If subscribers use up all messages, they can buy top-up bundles. This way, users can enjoy far better services while paying a bit more if they use more. At the same time, carriers can increase the average revenue per user (ARPU) of the message service. The amazing



experience of RCS MMS services will stimulate more subscribers to change their 2G/3G bundles for 4G bundles, cutting TCO on 2G/3G networks.

Globalization is driving more and more people to study, travel, and do business abroad, yet the expense of international roaming remains prohibitively high for many users. Many people simply buy disposable local SIM cards or use VoIP services such as Skype while they travel overseas. China Mobile's "New Voice Call" offers another option. Users can initiate international Wi-Fi calls on a local RCS phone or app. The price is comparable to that of domestic calls. This creates a new revenue source for China Mobile. The service experience is better than Skype because users can retain original phone numbers and the ring tone ensures no phone calls or SMS are missed. Besides, there are no fees for receiving a roaming call and voice mail notifications are also provided. According to statistics of the China National Tourism Administration, the number of outbound Chinese travelers reached 97 million in 2013. There are also a huge number of overseas students, business people, enterprise branches, and overseas workers – all have strong demands for communication. This market has great potential.

In addition, RCS capabilities can be opened."New SMS" capabilities can be opened to the application-to-person (A2P) market. For example, carriers can interconnect with business/government processes through the RCS open gateway and apply the new SMS capabilities to businesses' and government's customer relationship management (CRM), marketing, media subscription, and mini-SNS. "New Voice Call" capabilities can be opened to upstream and downstream partners. Carriers can open HD voice and video call capabilities to upstream third-party developers or integrators through the easy-to-use application programming interface (API). The developer and integrators will integrate the capabilities into CRM, office automation (OA), and enterprise resource planning (ERP). Alternately, carriers can develop video-call software development kits (SDKs), which will be integrated into a wide range of smart terminals such as IP cameras and doorbells by downstream third parties.

Carriers and third-party developers should share the revenues. That would motivate developers to develop even better apps and the RCS-capability opening community would be very attractive. Capability opening would also help carriers to break into the new M2M market.

User experience improvement

Network capabilities determine

As one of the pioneers of GSMA RCS standards formulation and product development, and with valuable experience in network deployment, business model design, user experience improvement, and partner league construction, Huawei can offer E2E RCS solutions.

user experience. IP multimedia subsystem-based (IMS-based) IT infrastructure ensures ubiquitous and seamless service experience with 100% reliability (retaining of original phone numbers, multi-terminal, push notifications, and firewall traversal). Policy and charging rules function-based (PCRF-based) accurate control of network bandwidth and quality levels guarantees HD video call experience. Control over traditional telecom networks leverages to enhance integrated interconnection experience. For example, automatic switch between IM and SMS, VoLTE fallback to CS network, and video conferencing through fixed and mobile convergence (FMC). These capabilities will differentiate carriers from OTT companies. Service stability, continuity, and simplicity are essential to customer loyalty and are decided by network capabilities as well as terminals.

Terminal interface experience also has a huge impact on overall user experience. The friendliness of the user interface, including the color, style, interaction, and even reminders, requires a special design team. Many large carriers have their own user interface design teams that follow the latest user demands and technologies and apply them in RCS interface design. This requires separation of bottom-layer communication capabilities and interface design to ensure constant interface upgrade does not affect service quality.

Industry chain innovation

Building the RCS industry chain will be challenging. The capability-opening ecosystem and the terminal devices are not mature, especially local terminal devices. GSMA launched a RCS product called joyn, which was developed for local terminal design. Its product development documents (PDDs) define in detail the terminal service experience and the interface between terminals and the network. GSMA also provides regular authentication service, which draws participation from 9 of the top 10 mobile phone manufacturers. So far, over 50 types of mainstream flagship smartphones have passed the authentication. Top carriers such as AT&T and Verizon also require terminals to support local RCS. Naturally, as China Mobile and other carriers start RCS commercialization in the 2014 Q4, terminals in China will become more mature.

An ecosystem of capability opening and sharing is also crucial to the execution of the aforementioned business model. A carrier-dominated ecosystem cannot flourish. Capability opening and sharing should be taken into consideration during the primary stage of RCS planning and construction, including the construction of the capability opening platform and the partner league, and the reservation of uplink and downlink interfaces. In RCS network planning, carriers must bear in mind what devices must be stable (such as IMS core and RCS AS), what devices must support dynamic upgrade in the future (such as RCS opening interface gateway and big data interface gateway), and specify the revenue sharing rules ahead of time. Carriers should learn from successful industry cases to attract more developers to join the ecosystem.

As one of the pioneers of GSMA RCS standards formulation and product development, Huawei can offer E2E RCS solutions. So far, Huawei has served more than 10 carriers in over 20 countries with RCS solutions and consultancy service. The company has accumulated valuable experience in network deployment, business model design, user experience improvement, and partner league construction. To help customers achieve ultimate RCS success, Huawei is willing to cooperate with more carriers working in integrated MMS communication.

Next-generation SBC for VoLTE

By Sun Hongwei

> The SBC is a strategic network element (NE) for VoLTE. It is essential to network security, reliability, and multimedia interconnection as well as future network evolution.

Voice over LTE (VoLTE) is gradually replacing the traditional 2G/3G networks and the voice over broadband (VoBB) network. The all-IP VoLTE network can provide voice, fax, video, and multimedia services at lower prices. Compared to the traditional network, the VoLTE network is greatly enhanced in terms of security, capacity, QoS, and ICT convergence.

As the border gateway of the VoLTE network, the session border controller (SBC) is located on the signaling and the media planes of VoIP networks. It is usually deployed at the network edge as an independent device. The SBC supports VoIP communication between end users as well as between carrier networks. It is also a security shield protecting networks against a range of potential security threats.

According to a cost structure analysis conducted by T-Mobile, investment in SBCs accounts for almost 30% of the total VoIP network investment by telcos. In the coming era, SBCs must adapt to the following changes to meet service requirements.

Multi-level joint network protection

The VoLTE network is based on all-IP architecture and supports various access types, including LTE wireless broadband, fixed broadband, Web/Wi-Fi, and enterprise network access. The openness of the all-IP network, the scalability of session initiation protocol (SIP), and the flattening of the LTE access network bring three security challenges to

New security risks require the next-generation SBC to be more innovative and powerful. The SBC must have independent security analysis modules and multi-level joint protection capability, have intrusion detection and prevention systems, and support sophisticated encryption/ decryption and intelligent traffic control.

VoLTE networks as compared to traditional broadband networks.

More attack sources: With the proliferation of smart devices and mobile apps, if users install cracked applications with malicious plug-ins, their smart terminals can be infected with viruses that attack the VoLTE network or enable attacks against it. Consequently, attack sources increase exponentially.

More attack types: In addition to traditional TCP/IP packet attacks, traffic attacks, malformed packet attacks, and service logic attacks, the VoLTE network will face more types of potential security attacks as the network architecture and services evolve. In the early stage of 4G network deployment, there are many coverage holes. Users have to constantly switch between 2G/3G and 4G networks, resulting in registration storms. Rich media services such as instant messaging and telepresence are burst services that transmit very little information, but cause frequent SIP signaling interaction, resulting in network signaling storms. Hackers may even steal user information to initiate short-time and incomplete calls, filter out short messages, or use third-party applications (such as spam interception apps that provide white-list or black-list functions) to interfere with users' calling activity.

More frequent attacks: Attack traffic is surging. According to Huawei Cloud Security Center, since 2013, peak attack traffic has exceeded 100G and is increasing at a rate of 50% every year.

The new security risks require the next-generation SBC, the guard dog of VoLTE networks, to be more innovative and powerful. Traditional SBCs protect only when an attack is underway. The VoLTE SBC must have independent security analysis modules and multi-level joint protection capability. It should be able to conduct in-depth analysis based on user behavior and characteristics, and combine with different services to conduct independent security analysis and processing if necessary. For example, the SBC must identify malicious ultra-short and incomplete calls based on user behavior and develop different security policies. It can then deliver the security policies to the IP/ transmission layers to prevent attacks from the IP source, realizing joint protection across the IP layer, the signaling layer, and the media layer.

The SBC also must support ACL, CAC, and DoS/DDoS attack prevention, have intrusion detection and prevention systems, and support sophisticated encryption/decryption such as IPSec AKA, and SIP over TLS, so that legitimate users can safely use VoLTE services. In addition, the SBC must also support intelligent traffic control to defend against increasingly frequent registration storms.

Enhancing QoS, connectivity and service continuity

In the LTE era, users are no longer content with simple voice and messaging services. They demand high definition voice and video experiences, instant messaging, picture and video sharing, and richer service experience, with all these things available anytime and anywhere. As the "VoLTE user access board," a next-generation SBC must guarantee QoS, service continuity, and global connectivity.

To enable high-quality multimedia communication, SBCs should have built-in proxy-call session control functionality (P-CSCF) to interact with the policy and charging rules function (PCRF) in order to ensure E2E QoS. In addition, in the case of limited resources, VIP service experience must be prioritized, so an SBC must support differentiated bandwidth management to prevent low-value services from consuming excessive resources.

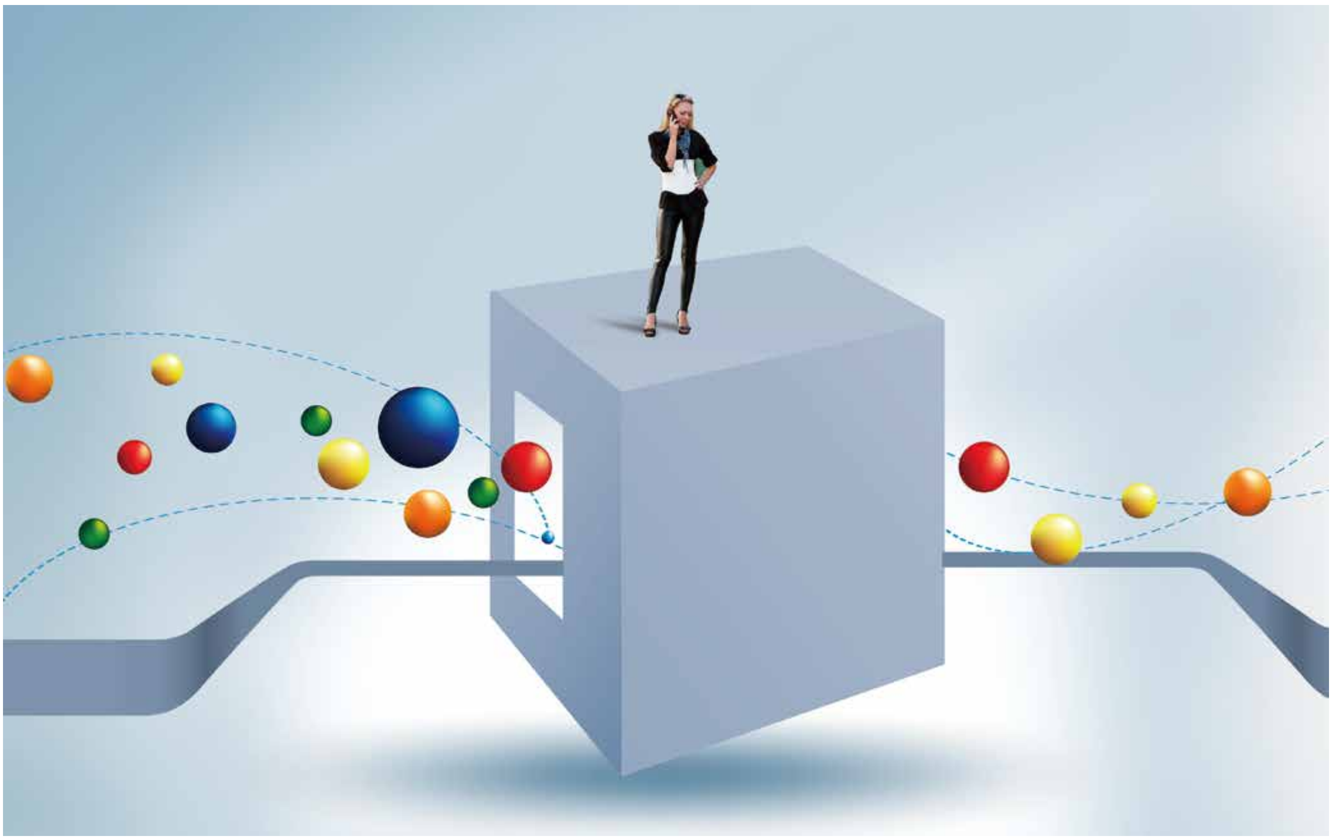
In terms of service continuity, since full LTE coverage cannot be achieved from the start, there may be handovers between 2G/3G and LTE networks; if not handled properly, long handover time or call drop will occur. To minimize handover time and prevent call drop, the SBC must be equipped with built-in ATCF/ATGW to ensure that only media information is updated on the local side when a handover occurs, this minimizes handover time, ensuring uninterrupted VoLTE service.

After VoLTE commercialization, the network has to interconnect with associated 2G/3G networks as well as those of other telcos and must also interconnect with fixed and IMS-based networks. The next-generation SBC should have rich audio and video codecs (including G.711, G.729, GSM codecs, AMR, WB-AMR, and H.264) and codec translation capabilities to realize codec translation for interconnection between different networks. According to IR.88 and IR.65 technical specifications formulated by GSMA and 3GPP, for international roaming, the SBC must also support IBCF/TrGW evolution, OMR and TRF functions of the RAVEL architecture, and optimize the roundabout path, and provide diversified billing methods such as time- and traffic-based billing and billing based on the number of messages for voice, video, and RCS VoLTE services.

High performance and flexible resource management

In the VoLTE era, the number of users is growing faster than ever before, and communication is increasingly expanding from people-to-people, people-to-machine, and machine-to-machine. Infonetics forecasts that from 2012 to 2017, VoLTE subscriptions will increase 145% year-on-year, every year. This breathtaking user increase requires large-capacity SBCs. The next-generation SBC

As the "VoLTE user access board," the next-generation SBC must guarantee QoS, service continuity, and global connectivity.



Next-generation SBC must be capable of evolving into a WebRTC GW so that signaling protocols, media streams, and codecs can be converted. It must also function as a firewall for signaling and media streams to ensure access security.

should be capable of flexibly expanding its capacity by adding boards or other hardware. It should evolve smoothly to support millions of users and support IPSec and AKA authentication of all users.

China Mobile provides a good example; the telco planned two stages for its SBC deployment. Getting started in 2014, they focus SBC deployment in the provincial capitals. Each SBC supports hundreds of thousands of users. Next, SBCs will be deployed in smaller cities. The capacity of each SBC will be similar to that of a traditional media gateway (MGW), supporting about one million users.

The surge of users and the popularization of multimedia services will boost traffic. For example, SD video call of VGA format generates more than 1MB of data every second, 40 times higher than an HD voice call. According to Infonetics, in the next couple of years, data generated by all services will grow ten fold. The VoLTE core network will be inundated by torrents of data that will make today's traffic look like a trickle. The SBC must have a throughput of as much as 100G and support intelligent traffic control to ensure VoLTE network reliability.

Different services have different resource demands. For example, IM and telepresence services are burst services. They consume huge signaling resources yet generate little traffic. Video calls consume more media resources. Therefore, the next-generation SBC should be capable of flexibly managing signaling and media resources based on different service models.

Evolving to a WebRTC GW

Web real time communication (WebRTC) allows users to directly communicate with one another through video calls on browsers without installing any software or apps. The emergence of WebRTC transforms the vast number of web users into new telecom users.

By late 2014 or 2015, Internet Explorer and Safari will support WebRTC. After that, the number of WebRTC terminals will exceed one billion. WebRTC's browser-based communication allows web users and mobile users to interact, and this "click to talk" web functionality can be embedded in enterprise applications as well, transforming how businesses interact.

When web users communicate with mobile users or access telco VASs such as agent or conferencing services, they will have certain impacts on the telco network.

First, WebRTC causes security problems. WebRTC users are everywhere, using different types of terminals to access mobile networks through different access modes. As a result, user privacy data is vulnerable to sniffing tools. Second, WebRTC is bandwidth-intensive, as users can engage in browser-based audio and video calls on any platform, leading to congested networks. Third, WebRTC requires interwork between web protocols and other protocols such as SIP.

To satisfy web users' communication needs, and to reduce security risks during communication, a new device responsible for web users' seamless and secure network access, as well as signaling, media conversion between web browsers and telco networks, must be deployed at the network edge. 3GPP R12 developed an enhanced P-CSCF-based architecture suited to this purpose. The next-generation SBC must be capable of evolving to a WebRTC gateway (GW) to convert web signaling (HTTP, JSON over WebSocket, etc.) to SIP, SRTP/DTLS to RTP, and web codec OPUS/VP8 to mobile codec G.7XX/H.264. The SBC will also function as a firewall for signaling and media streams to ensure access security.

Huawei SE2900 is oriented toward 4G core networks and, based on the telco cloud platform, adopting a distributed architecture. It provides differentiation advantages, such as optimal audio/video, professional-grade security, intelligent interoperability, and powerful performance, thereby helping carriers construct highly secure Voice and Video over IP (V^2oIP) networks with exceptional QoS, simplify SIP interworking, and reduce total cost of ownership (TCO).

Evolution towards convergent signaling networks

By Hu Di, Sun Hongwei, and Yang Qin

The SS7 signaling network is growing increasingly outdated compared to the emerging Diameter signaling network. Carriers need a convergent signaling network that supports both SS7 and Diameter signaling to extend signaling networks' service life, enhance network performance, and enable smooth network evolution in the future.

Telco signaling networks are constantly evolving. Carriers around the globe need a solution to smoothly upgrade their mature and stable SS7 signaling networks to advanced Diameter networks.

Network development drivers

SS7 is reaching the end of its lifecycle

Carriers across the world use public switched telephone networks (PSTN) and public land mobile networks (PLMN) to bear most of their voice calls and short messaging services (SMS). After two decades of development, the STP-based signaling system is now reaching the end of its lifecycle.

Service transformation boosts Diameter development

In the LTE era, carriers adopt policy and charging control (PCC) architectures to realize refined traffic operation. The IP multimedia subsystem (IMS) over LTE allows carriers to provide integrated multimedia communications services, improving user experience. In the future, the number of NEs, network scale, network complexity will keep growing. The connection and management of NEs and routing capability will be crucial to fast network development. The Diameter signaling network has over 85 network elements and interfaces, and utilizes the latest Diameter technologies for policy control, charging, and authentication. The increase in mobile Internet users has resulted in explosive growth of signaling traffic. Exact Ventures, an independent market intelligence firm, estimates that global Diameter signaling traffic has been growing at an average annual rate of 77% since 2012. By the end of 2017, traffic will exceed 42 million transactions per second.

Diameter Agent (DA) has been defined as the new signaling device to provide efficient routing and secure interconnection for Diameter signaling. DA supports a number of industry standards, including the Diameter Routing Agent (DRA) defined by 3GPP R8, Diameter Edge Agent (DEA) defined by GSMA IR.88, and DA defined by IETF RFC 3588.

Carriers need smooth evolution from SS7 to Diameter

As LTE replaces time division multiplexing (TDM), Diameter replaces SS7. Traditional SS7 signaling networks use call control protocols, such as integrated services digital network user part (ISUP) and bearer independent call control (BICC), as well as protocols that are not relevant to call control, such as intelligent network application protocol (INAP), CAMEL Application Part (CAP, CAMEL refers to customized applications for mobile network enhanced logic), and mobile application protocol (MAP). However, on LTE, PCC, and IMS networks, ISUP and BICC are replaced by SIP and INAP, while CAP and MAP are replaced by Diameter.

The replacement will be a slow process, so STP-based SS7 and Diameter will coexist for a long time. Carriers must maintain legacy SS7.

Convergent signaling networks

To minimize operating expense, carriers need a convergent signaling network that supports both SS7 and Diameter, and a signaling service processing system (SPS) that functions as both the STP and DRA/DEA.

With the rapid development of LTE, quick realization of LTE roaming capability and mass deployment of LTE networks have become competitive advantages. Carriers who have urgent need for LTE deployment, yet face little pressure from old SS7 equipment, can build DRA signal networks quickly. They can use the SPS as the DEA to enable international Diameter interconnection and LTE data roaming. Alternatively, they can use the SPS as the DRA to enable efficient Diameter routing in LTE networks and cut over the existing SS7 links to the SPS based on the STP's lifecycle plan. For carriers whose STP is reaching the end of its lifecycle, the SPS can be used to upgrade the legacy SS7 signaling networks, with the SPS configured to support Diameter signaling traffic interconnection and routing upon LTE deployment.

The integrated signaling network lowers network deployment costs, reduces the number of network devices by half, simplifies signal bearing, and enables dynamic hardware resource sharing between the SS7 and Diameter signaling networks, maximizing the return on investment (ROI). Additionally, signal integration minimizes OPEX for carriers, and improves network evolution flexibility, allowing functional NEs to change their protocols and interfaces from SS7 to Diameter. For example, integration allows evolution from the MAP-compatible home location register (HLR) to the home subscriber server (HSS), and from the INAP- and CAMEL-compatible intelligent platforms to the online charging system (OCS).

Key capability requirements

To develop such an integrated signaling network, the SPS must fully support SS7 and Diameter protocols and have the following capabilities.

High reliability

The signaling network is the central nervous system of a telecommunications network. A reliable signaling network is requisite of quality network services. The rapid expansion of mobile services, such as data and multimedia services, brings massive signaling traffic and may lead to signaling storms. A fully-meshed network architecture has no unified control point. Consequently, when such storms happen, network outages and massive economic losses are common. Infonetics reports that Diameter signaling traffic is growing at an annual rate of 50%. Therefore, carriers need an integrated signaling network that features a carrier-grade platform, multi-level (link-, router-, and network-level) disaster recovery and intelligent, large-capacity flow control to support signaling expansion in the future.

Enhanced security

Telecommunications networks are changing from enclosed, TDM-based switching systems to open and IP-based data service systems. Carriers must ensure network security and prevent user data disclosure. Network assets and user data can help carriers develop a favorable industry ecosystem that can give them a competitive edge in the market. To achieve these objectives, the integrated signaling network must support multi-level disaster recovery and multi-level security protection (embedded IP firewalls and Diameter signaling firewalls). These mechanisms allow telcos to send user and policy data to partners in a secure and reliable manner.

Flexible and efficient routing

Carriers are providing an increasing number of services, even providing them wholesale, in a constantly expanding scope. Governments are mandating new services, such as number portability, at all levels. To meet service requirements in the future, carriers need an integrated signaling solution that can work as an efficient and flexible routing engine to provide rich routing functions and support mobile number portability (MNP), flexible number routing (FNR), and subscription locator function (SLF).

Visual and intuitive management

Effective management plays a key role in efficient operation. An integrated signaling solution must support management of both SS7 and Diameter signaling networks and display all signaling data related to service control, such as end-to-end message tracing, on carriers' core networks. This simplifies network maintenance, fault location, and new service deployment significantly.

Intelligent terminal applications bring uncertainty to signaling generated from the core network. Therefore, such applications must have complete signaling statistics indexes to analyze the signaling traffic trend, offering data support for signaling network expansion design.

Convergent user data for VoLTE

By Fu Xiaoyang

The vast majority of mobile networks involve numerous technologies and forms of access, making integration of user data a must to ensure its consistency, improve user experience, simplify network structure, reduce OPEX, and boost operational efficiency, especially in the LTE/VoLTE era.

Convergence is best

On a legacy network, user data is scattered across various network elements (NEs). The home location register (HLR) will store 2G/3G data, the system architecture evolution home subscriber server (SAE-HSS) will store LTE data, and the IP multimedia subsystem home subscriber server (IMS-HSS) will store voice over LTE (VoLTE) data. This division of labor causes numerous problems, including authentication synchronization failures for LTE users, inconsistencies in PS and evolved packet core (EPC) data, and difficulties with the VoLTE handover process. What's more, maintaining separate user databases increases OPEX and prolongs service deployment times. Erasure of garbage data is also difficult.

Re-synchronization of user authentication data

Authentication data for 2G/3G users is stored in the HLR while that for LTE is stored in the SAE-HSS; when users switch between 2G/3G and LTE, terminals must obtain data independently generated from each. To avoid discrepancies, constant synchronization of the HLR and the SAE-HSS is required. Unfortunately, this is a bandwidth- and signaling-intensive process that impacts user experience. A converged HLR/SAE-HSS database avoids this.

Consistent PS & EPC user data

According to 3GPP protocols, about 70% of user data in the HLR and SAE-HSS is the same, leading to redundancy, cost and potential inconsistencies. Discrepancies in access point name (APN) data can lead to service interruption when users switch between 2G/3G and LTE, but problems caused by data inconsistency are very hard to locate. Telcos must expend a lot of resources to ensure HLR-HSS integrity. A convergent database that encompasses HLR and SAE-HSS user data would simplify service provisioning and facilitate network maintenance, while ensuring data consistency.

Voice service consistency for CS and VoLTE

For circuit-switched (CS) networks, supplementary user service data is stored in the HLR. For VoLTE, it's stored transparently in the IMS-HSS. This leads to an impaired service experience because these databases are independent of each other and cannot be synchronized. CS forward numbers are stored in the HLR; when they roam to a VoLTE network, these numbers become invalid. Users can only change supplementary services (forwarding/blocking etc.) on one network domain on their mobile terminal, so comparable data on 2G/3G and VoLTE networks may be inconsistent. With an integrated HLR/HSS database, telcos can ensure service data consistency. If users change supplementary services through the service delivery system or through their terminal, data changes are universal, guaranteeing voice consistency.

Costly network complexity

Coexistence of independently-built 2G/3G/LTE/VoLTE networks is a complex situation. VoLTE requires eight NEs to manage user data and 36 interfaces for integration and interwork, with at least four interfaces in the upper-layer service provisioning system adapted, making network structure simplification a real challenge. Integration of user data management NEs for unified data storage and processing not only reduces their interworking complexities, it also simplifies the service provisioning system interfaces.

Network simplification will ultimately boost operating efficiency, making a convergent database the best choice for VoLTE. 3GPP R6 introduced user data convergence (UDC) architecture, which logically separates user data and application services, providing a solution for unified user data storage and management. It's no surprise that major vendors are now adopting it.

Converged user data network build scenarios

Most telcos have heavily invested in their legacy HLRs. They can apply one of these two methods for deployment of a converged user data network, based on the status of the legacy HLRs.

Method 1: Retaining live HLR while deploying a convergent HLR/HSS database

Telcos can retain the current HLR and build a new convergent HLR/HSS database to manage all VoLTE user data from the IMS, CS, PS, and EPC domains, with HLR data migrated gradually to the convergent database, and the HLR itself eventually retired at the end of its lifecycle. However, this requires allocation of new international mobile subscriber identity (IMSI) and mobile station international ISDN (MSISDN) numbers to LTE/VoLTE users.

The new independent convergent database will be responsible for unified management of 2G/3G/4G/VoLTE user data. The challenging part will be the coexistence of the HLR and convergent HLR/HSS database. Some users will migrate from the HLR to the convergent HLR/HSS, so flexible number routing (FNR) is needed for correct routing to the convergent database for processing. What's more, the provisioning system has to interoperate with the original HLR and the new convergent database. If the user is an LTE/VoLTE subscriber, the BOSS delivers 2G/3G/LTE services to the convergent HLR/HSS. Otherwise, 2G/3G service is delivered to the HLR.

Method 2: Live network HLR replacement with a convergent HLR/HSS database

If an aging network HLR is proving too costly to maintain, a new HLR/HSS database can replace the HLR completely and be responsible for storage of 2G/3G/LTE/VoLTE user data and support services for the IMS, CS, PS, and EPC domains. However, a cutover can be challenging; network security and a quick fallback must be ensured if problems emerge.

Major industry vendors have cutover experience, with some having developed special tools to secure and facilitate user data cutover/migration. Huawei's Smart Cutover tool can migrate data of various types while ensuring the consistency and completeness of authentication data before cutover, greatly boosting the efficiency of the overall process. Smart Cutover has successfully cutover/migrated over one billion lines involving non-Huawei devices, with no cooperation required with original device vendors.

Future-oriented user data monetization

When they provide customer services, telcos gather a large amount of user data, including subscription data, location information, behavior patterns, and content information. If properly refined, this data is valuable to customer service and marketing efforts. It can also be shared with third parties, if user privacy can be guaranteed, with potential benefit to urban planning and shop location selection. A convergent user data solution aggregates user data for systematic analysis, and allows telcos to share the data internally or externally through secure interfaces, maximizing its value.

Can WebRTC revolutionize real-time communication?

By Yang Xiaohua

The impact of WebRTC technology is being felt throughout the entire ICT industry, but its future is hard to predict, given the immature standards in place and the mad scramble taking place between vendors.

WebRTC: A game-changer?

What is web real-time communication (WebRTC)? To put it simply, WebRTC allows browser-based video chat over any compatible terminal. With WebRTC, a browser is equipped with A/V codec capabilities, and with the RTC service control logic moved to the cloud, a standard server-client communication model is created.

WebRTC was created by Internet service providers (Google primarily). It is open and free and provides real-time communication through simple Javascript APIs, without the need for plug-ins or apps. With its basis in developer-friendly HTML5, WebRTC can evolve smoothly to support tomorrow's web-based applications.

WebRTC has been a hot topic since its inception, with some analysts considering it a game-changer. However, its impact on the ICT sector, especially web conferencing and enterprise, is hard to predict. WebRTC supports video chat and data sharing, which will certainly revolutionize web conferencing, and its browser origins will make audio and video communication on enterprise websites much easier.

Is the industry ready?

WebRTC is a hot topic, it still has a long way to go.

Standards set by different organizations

The IETF is formulating WebRTC's overall architecture, which is scheduled for release by the end of 2014. The W3C is responsible for WebRTC terminal-side API definition, with API 1.0 already defined, and a baseline version scheduled for release in February 2015 (after numerous delays). The 3GPP has defined the enhanced P-CSCF-based WebRTC gateway architecture, which means that WebRTC users can access an IP multimedia subsystem (IMS)-based network to use corresponding communication services.

Competition between browsers

The three browser giants are not equally geared for WebRTC; in fact, only one is presently ready. Google is the pioneer & champion of WebRTC, and has support from both Firefox and Opera. Microsoft tried and failed to come up with its own CU-RTC-Web standards through W3C, and has seemingly given up on WebRTC-IE integration. Apple seems equally disinterested, apparently quite content with its own Facetime

service. Thus far it has sat on the sidelines of WebRTC development. All-in-all, this lack of mainstream acceptance will indeed slow down the WebRTC revolution, as will prolonged conflict between video codecs. Mass deployment is not expected until at least 2015.

Opportunity or challenge?

For traditional telcos, WebRTC is both a challenge and an opportunity. It further fragments real-time communication services, with anyone who installs a dedicated server able to provide web-based real-time communication (in theory). WebRTC also helps OTT companies further penetrate both the Internet itself and telco revenues, but it also transforms real-time communication from a standalone service into an embedded function, which means that it can actually help telcos open their capabilities to expand service channels and user groups. If all web-based applications, such as online games, telemedicine, and distance education, could use telcos' real-time communication capabilities, all web terminal users could potentially be telco subscribers.

The future of WebRTC is bright, but during implementation, telcos must consider the relationship between WebRTC and existing VoLTE and rich communication suite (RCS) services.

Complementary WebRTC and VoLTE

Some see WebRTC as a threat to VoLTE, but in truth the two are more complementary, with VoLTE more suited to the individual consumer market and WebRTC more vertical-oriented.

WebRTC and RCS can help each other

Telcos have had a hard time promoting their RCS services because they have largely been presented thus far in app form, thus requiring promotion, download, and compatibility with the user's terminal, but WebRTC-enabled browsers have fewer issues.

WebRTC and Huawei CaaS: Open capabilities

WebRTC may be revolutionary, but it cannot revolutionize the ICT industry on its own. In fact, WebRTC and Huawei's CaaS solution have overlap. WebRTC opens communication capabilities to the terminal side. As WebRTC only defines the processing of the media plane, while the signaling plane is de-standardized, IMS telcos can provide SIP- and IMS-based WebRTC solutions to develop their IMS users in the field. Thus, telcos can further open real-time communication capabilities to third-party web apps (online games, telemedicine, and distance education, etc.), allowing themselves to break into the Internet and enterprise/vertical fields and create more flexible business models (such as revenue sharing and pay-as-you-use).

Future CaaS solutions will be entirely open in terms of architecture, with upstream capabilities opened to expand telco business channels and downstream capabilities that include software development kits (SDKs) and WebRTC (which can increase the user base). SDKs focus on H2M and M2M while WebRTC enables development of web-based applications for the Internet industry, especially enterprise/verticals.

How can telcos prevail over OTT players in the WebRTC race? Huawei's Telco-WebRTC solution enables carrier-grade network communication and global interconnection, while differentiating service control through QoS control on demand. It also enables inheritance of traditional telecom subscriber identifiers and supplementary services.

Other benefits include session border controller-based (SBC-based) WebRTC gateway support of all forms of telco and Internet access, enabling carrier-grade network reliability. This gateway can be easily deployed by adding or upgrading a single network element, minimizing the impact on current network reconstruction. Cloud-based deployment also makes this solution flexible and scalable. Pre-integrated industry application cases can greatly shorten the service time-to-market.

As a founding member of the IETF RTCWeb work team and as a member of W3C, Huawei has led industry development of WebRTC since 2011. At GSMA's Mobile Asia Expo held in June 2013, Huawei worked with GSMA to promote RCS capability opening through WebRTC. At MWC2014, Huawei and China Mobile jointly demonstrated for the first time the sharing of audio/video/files between WebRTC users and LTE users, with Huawei also demonstrating how telco-WebRTC enables hospitals to improve service quality and user experience for telemedicine through HD video chat, on-demand QoS, one-number-link-you (ONLY) service, and global interconnection, enabling in-home patient monitoring and care. At the IMS Forum held in April 2014, Huawei proposed the WebRTC-based RCS capability opening gateway and demonstrated an application involving car insurance. Since then, many other manufacturers have launched similar solutions, making web-based RCS capability opening an industry consensus.

WebRTC can satisfy communication needs in the time of ICT integration. However, the neutrality of its technology puts telcos and IT/OTT players at the same starting line. Telcos have to come up with strategic plans and execute those plans if WebRTC is to be successfully embraced. At the service level, telcos must focus on capability opening and the enterprise/vertical markets. At the operational level, they must select typical use cases for promotion and design the proper business models.

METIS: Striding towards 5G

By Huawei's METIS Project Team

Future mobile and wireless communication systems will have to be highly versatile and scalable to provide high capacity with greatly enhanced efficiency in power consumption, cost, and spectrum usage. The METIS project will develop a brand new 5G system concept and lay the foundation for future mobile and wireless communication systems.

Challenges after 2020

In recent years, mobile and wireless communication has been developing rapidly. It has gone way beyond traditional voice, messaging, and data services and expanded into many new sectors such as e-banking, e-learning, e-health, and on-demand video/audio services. The emergence of the Internet of Things (IoT) also signifies that in addition to human-centric communication, machine-centric communication will be an important part of future wireless systems and will greatly improve people's life quality, working efficiency, and security.

Mobile and wireless communication is evolving at such an unprecedented speed that many challenges will arise accordingly. It is estimated that by 2020, the mobile data traffic will be boosted by 1000 times. Moreover, due to massive machine communication (MMC), 50 billion devices will be connected. The coexistence of human-centric communication and machine-centric communication will demand more diverse services from the mobile communication

5G must consume less energy and capital while providing much higher capacity and resource utilization efficiency. Moreover, it should be versatile to support different requirements such as availability, mobility, and QoS, and new application scenarios. The 5G system must also be highly scalable to support a wide range of requirements and large traffic dynamics.

system. Such service diversification requires the mobile system to be more powerful and versatile in a lot of aspects, including throughput, delay, link density, as shown the figure on the following page, as well as cost, complexity, power consumption, and Quality of Service (QoS).

To tackle the above challenges, Huawei and its 28 European partners initiated the Mobile and Wireless Communications Enablers for the Twenty-twenty Information Society (METIS) project. Launched in November 2012, the METIS project aims to develop a brand new 5G system concept and the related key technologies in three years to support future explosive mobile data increase with very high cost- and power efficiency as well as spectrum usage efficiency. Huawei is a core member of the METIS project and is responsible for leading the wireless air interface research and development. Wireless air interface is a core technology component of the METIS project and is crucial to the success of 5G.

The vision of METIS

METIS envisions a future world where all people can access and share information and connect to anything at anytime, anywhere. This "all-connected world" with no boundaries for information flow will greatly promote socio-economic development. Compared to the traditional mobile and wireless communication systems, 5G must consume less energy and capital while providing much higher capacity and resource utilization efficiency. Moreover, the 5G system should be versatile to support different requirements such as availability, mobility, and QoS, and new application scenarios such as MMC. The 5G system must also be highly scalable to support a wide range of requirements and large traffic dynamics.

Compared to the traditional network, the 5G system designed by METIS will support 1000 times the mobile data traffic volume per area and 10 to 100 times the connected devices and user data rate. It will provide 10 times longer battery life for low power MMC than current networks. Its end-to-end (E2E) latency will be one fifth that of LTE Release 8.

Key technologies for 5G

To construct the 5G system concept, METIS will look into four technology components: radio link concepts, multi-mode and multi-antenna transmission, multi-radio access technology (RAT) and multi-layer network, and spectrum usage techniques.

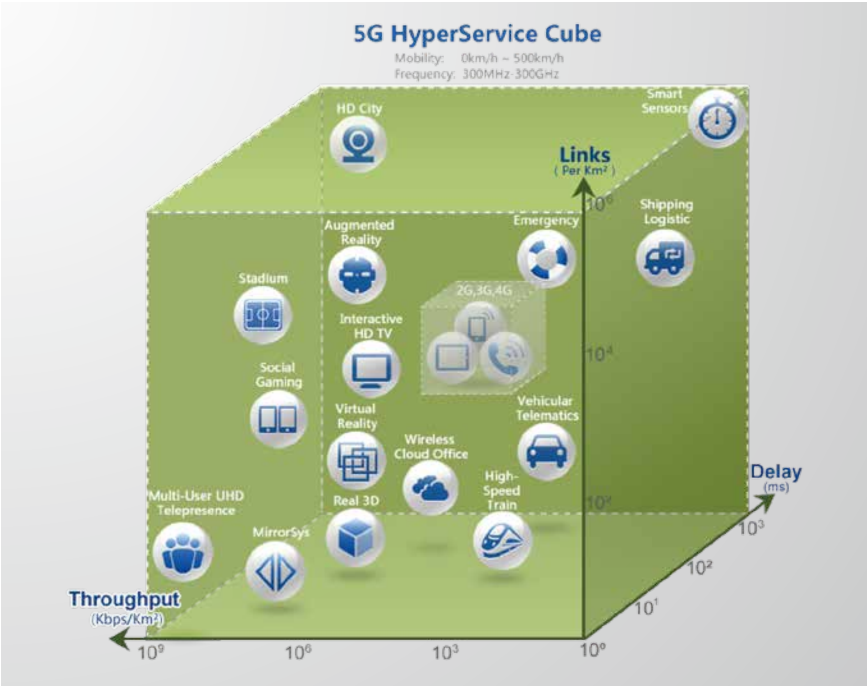
Radio link concepts

To meet new requirements of future mobile applications, METIS will design a new air interface. The most challenging part for the air interface is to support various application scenarios from low power consumption sensors that demand low data rates to multimedia services that demand high-speed data rates. Therefore, new technologies related to transmission waveform, coding, modulation, and transceiver structures must be developed to improve the spectral efficiency in the physical layer, reduce power consumption, and enhance anti-interference capability and robustness of the wireless network. In addition, multiple access, media control, and wireless resource management will also be re-designed to increase the system efficiency.

Huawei Europe Research Center (ERC) is actively leading the research on this new air interface design, focusing on the coexistence between broadband applications (such as multimedia services) and narrowband applications (such as sensors) in the same frequency band. To achieve the most efficient use of the available frequency bandwidth in this heterogeneous multi-service scenario, the new air interface will be able to adaptively adjust the waveform according to transmission environments and conditions. Furthermore, a waveform with ultra-low out-of-band emission is used, allowing the development of flexible spectrum usage concepts. Such concepts will allow mobile operators to share the spectrum dynamically and adaptively with other non-communication/communication systems or with each other.

Multi-node and multi-antenna transmission

Multi-node and multi-antenna transmission technology will greatly boost the performance and capacity of the future wireless communications system. METIS will address the performance limits, architectural impact and development of algorithms and key



5G service requirements and scenarios beyond 2020

technologies. New application scenarios like ultra dense networking (UDN) and MMC will also be targeted.

First, massive multi-antenna configuration will be addressed, based on beamforming, space division multiple access, and spatial multiplexing. The goal is to provide higher data rates and spectral efficiency, or to increase link reliability, coverage rate, and to reduce power consumption. Second, advanced multi-node coordination technology will be developed to significantly increase spectral efficiency and user throughput, and to improve link quality in unfavorable radio conditions. The novel air interfaces and new multi-node coordination methods will be integrated into practical systems. Third, multi-hop communications and wireless network coding will be studied, which use one or multiple relay nodes between the information source and the information destination. Such technologies should provide efficient means for backhauling, to extend coverage and reliability, or to transfer the processing/energy burden from the MMC devices to the network.

Multiple RAT and multi-layer network

The research on multi-RAT and multi-layer network involves many aspects and is crucial to efficient network deployment, operation and optimization, especially the deployment of heterogeneous multi-layer and multi-RAT networks. The first focus is on network coexistence, collaboration, and interference management. Providing solutions for UDN is challenging since interference dependencies between communicating entities in a UDN are especially complex. Another challenge is the increased degrees of freedom for interference management due to direct device-to-device (D2D) communications and MMC.

The second focus is the management of demand, traffic, and mobility. Mobile operators need to predict and utilize the information about users and devices, including users' location and environment information. Such information can help optimize the selection of the RAT and the network layers. Furthermore, novel mobility management concept will be proposed, especially for UDN, to decrease signaling overhead.

The third focus is on the functional network enablers, including defining new management interfaces, automatic integration and management of multiple types of network nodes, and efficient integration of nomadic cells in heterogeneous networks.

Spectrum usage techniques

METIS will propose new concepts for spectrum sharing to ensure sufficient spectrum beyond 2020. First, frequency bands up to 275GHz will be analyzed to identify new spectrum resources and to understand their characteristics. Additionally, future mobile and wireless communications scenarios will be studied to predict spectrum requirements beyond 2020. Ultimately, novel flexible spectrum sharing and management techniques will be developed to realize UDN operation at high frequency bands and network-

> *To solidify the 5G system concept, METIS will apply four technology components: radio link concepts, multi-mode and multi-antenna transmission, multi-radio access technology (multi-RAT) and multi-layer network, and spectrum usage techniques.*

assisted D2D communication that supports high mobility.

METIS's horizontal topics

The METIS project has outlined a series of "Horizontal Topics (HT)" to construct the 5G system concept. Each HT will integrate a series of new technology components to provide effective solutions for one or several application scenarios. So far, METIS has identified six such HTs.

Direct D2D communication

Direct D2D means direct communication between two or more wireless devices without resorting to network infrastructure. D2D is different from other E2E transmission technology such as Bluetooth in that the wireless link between devices is still subject to network management, including wireless resource management and interference management. Therefore, D2D can increase network coverage, boost network availability and reliability, and offload backhaul to reduce cost. D2D can also improve spectrum utilization and increase network capacity per area.

With D2D enabled, the network can reduce unnecessary wireless links and optimize network resource allocation according to actual situations. Furthermore, D2D can improve service quality in densely populated networks. Finally, by developing novel resource and interference management techniques, D2D will be integrated to multi-dimensional networks including multi-RAT and multi-layer networks.

Massive Machine Communication (MMC)

MMC is an important part of the future mobile and wireless communication systems. MMC advancements will lead to connectivity solutions for the connection of tens of billions of devices, realizing flexible network up- and down-scaling. The major challenge is that machine-centric communication has a wide range of unique characteristics and requirements on traffic rates, latency, cost, network availability, and reliability, which are quite different from those of human-centric communication. Within METIS, new technologies will be developed to support MMC and create an "all-connected world".

Moving Networks (MN)

An MN consists of one or more nodes, each of which can be an automobile, bus, or any other moving entities. In such a network, a node can communicate with surrounding nodes including fixed or mobile nodes on or off the mobile subnet. The MN involves all technologies mentioned above, especially backhauling, mobility, and interference management, as well as models and technologies for spectrum and network sharing.

Ultra Dense Networks (UDN)

UDN is the main solution for high traffic rates. It increases network capacity, improves link efficiency and spectrum utilization while reducing power consumption. In fact, densification of infrastructure has already been used in current cellular networks, where the minimum distance between base stations is about 200 meters. In comparison, METIS plans to further increase the network density by several times.

UDN faces many technical challenges, including difficulties on mobility management and backhauling (including self-backhaul). METIS will develop advanced interference and mobility management concepts at the physical and network layers to support UDN. METIS will also assess the UDN in terms of cost, power consumption, and spectrum utilization.

Ultra Reliable Communication (URC)

URC aims to improve network availability. METIS will provide scalable and cost-effective solutions to support services that have extremely high demand on network availability and reliability such as telemetric services and automation. Currently, some purpose-built networks such as public security networks have been set up. These networks boast high reliability and security. METIS's new ideas and solutions will support the evolution and migration of such networks and allow their markets to benefit from the economy-of-scale advantages of the public mobile and wireless communications market.

Overall architecture

METIS will investigate key concepts and enablers of network architecture, and design the whole system taking into account the features related to functionality, topology, and interfaces. In other words, a brand new 5G network architecture will be created, which integrates all above technology components and HTs.

Huawei's METIS Project Team

Huawei's METIS project team, also known as the Future Radio Network (FRN) team, is located at Munich, Germany. The team belongs to the CT Lab (2012 Lab) and is headed by Dr. Egon Schulz, with the research focused on 5G air interface, signaling, spectrum usage, and network architecture. The FRN team participates in the EU project METIS on behalf of Huawei.