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Innovative ICT Building a Better Connected World

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Open ROADS to a Better Connected World

William Xu
Executive Director, President of Strategy Marketing Dept., Huawei

A Better Connected World is now at hand. Countries are enhancing connectivity between the physical and the digital worlds in pursuit of mutual growth. Industries are using ICT to break down barriers and engage in joint innovation. Enterprises are using ICT to reconstruct end-to-end R&D, production, sales, and service processes.

Huawei is a key player and driver of the ICT industry. We will tap into our innovative technologies, pool global resources, and collaborate with customers and partners to assist carriers' and enterprises' ICT transformations. With keen insights into the ICT industry, strong ICT planning capabilities, and global experience, we can help every country achieve digital transformation.

Now that ICT is increasingly significant to life and work, how can we evaluate ICT development in countries and industries? At last year's Huawei Cloud Congress, we published the Global Connectivity Index (GCI) for the first time. The GCI provides a comprehensive system for evaluating ICT development from four dimensions: supply, demand, experience, and potential. It was the first comprehensive and objective evaluation of connectivity in 25 countries and 10 industries.

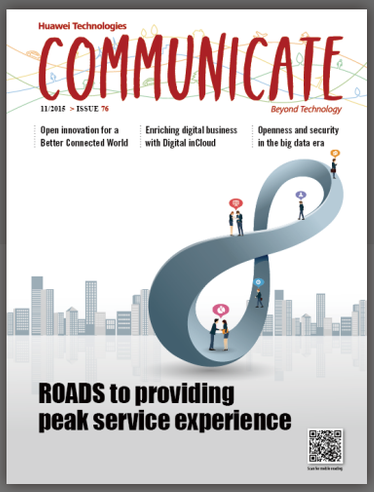
This year, we conducted more extensive research. We increased the number of evaluated countries to 50, which account for 78% of the world's population and 90% of global GDP. We also increased the number of indicators from 16 to 38, which relate to four dimensions. In our research we looked at ICT connections rather than just CT connections. With these indicators, the GCI is able to fully reflect the benefits that ICT brings to digital economies.

GCI findings show that a 20% increase in ICT investment will directly increase a country's GDP by approximately 1%. And this calculation does not include the indirect contributions of ICT to GDP. We estimate that by 2025 there will be 100 billion connections, of which 55% will be business-related. ICT has great potential to transform traditional industries and create immense opportunities.

What kind of experience do end users want most? At Huawei we believe a superior user experience can be summarized by several words. First, "Real-time" – users will enjoy zero-wait time enabled by sufficient bandwidth. Second, "On-demand" – users will be able to freely use whatever services they want. Third, "All-online" – devices will be online all the time. Fourth, "DIY" – users will be able to tailor their services, apps, and network requirements. Fifth, "Social" – social networks are part of life. Together, these words spell "ROADS". This is our vision for the future, and also a strategy to guide our actions. The ROADS concept represents "open roads" and is the direction that industries will take during their Internet transformations.

A Better Connected World is waiting. No single company will be able to meet the needs of diverse scenarios in a world of 100 billion connections. Open cooperation and joint innovation will be our way forward.

Let's remain open and work together to build a Better Connected World!



Sponsor:
Digital Marketing Dept,
Huawei Technologies Co., Ltd.

Editor-in-Chief:
Sally Gao (sally@huawei.com)

Editors:
Linda Xu, Julia Yao, Kyra Mi, Pan Tao, Xue Hua
Chen Yuhong, Cao Zhihui, Zhou Shumin

Contributors:
Ryan Ding, Zheng Chunhua, Liu Haofei
Liu Yu, Cao Ping, Hong Cheng, Cai Meng
Chen Yi, Liu Qiao

E-mail: HWtech@huawei.com

Tel: +86 755 28786665, 28787643
Fax: +86 755 28788811
Address: B1, Huawei Industrial Base,
Bantian, Longgang, Shenzhen 518129, China

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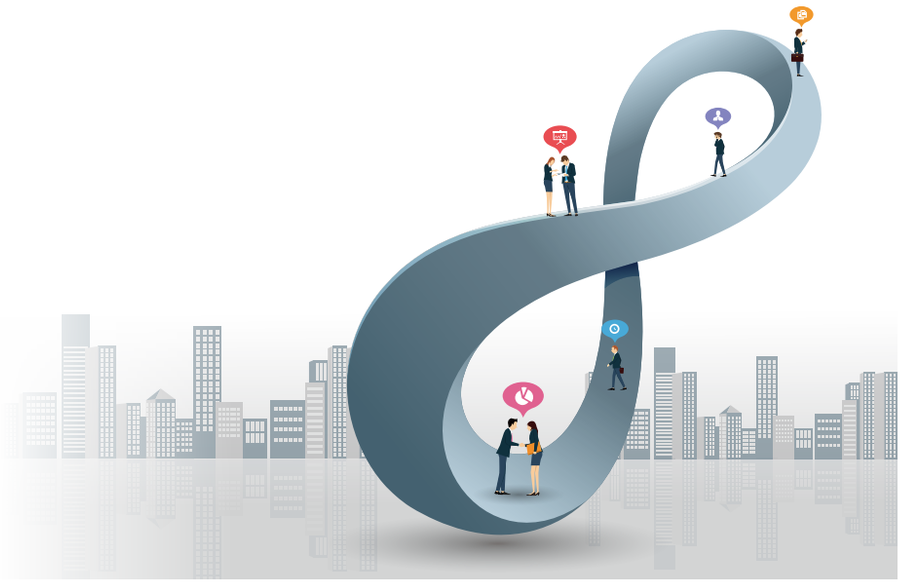


Expert's Forum

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.

Focus

How to Operate

Solutions

Cutting Edge

Achievements >>

4.5G 1Gbps

Hong Kong, Nov. 3, 2015, HKT and Huawei successfully demonstrated the world's first 4.5G 1Gbps mobile network at the Global Mobile Broadband Forum 2015 in Hong Kong. The partners continue to lead the evolution of the 4G LTE standard.

Challenger

Shenzhen, China, Nov. 10, 2015, Gartner, the world's foremost authority on IT research, released the *Magic Quadrant Report* for *General-purpose Disk Arrays* in October 2015. Huawei continues to gain market share, and is positioned as the lead organization in terms of execution and vision in the Challengers Quadrant, which the company believes is due to its future oriented innovated products.

Storage

<< Events

Hong Kong, China, Nov. 3, 2015, Huawei announced its MBB 2020 Strategy on the opening day of the 2015 Global Mobile Broadband Forum, outlining a new mobile broadband blueprint for the next five years. "From now until 2020, we have three main targets: support 6.7 billion mobile broadband users, achieve a 1Gbps access rate, and enable one billion connections for the cellular Internet of Things," said Ken Hu, Huawei Deputy Chairman and Rotating CEO.

MBB 2020 Strategy

Shenzhen, China, Nov. 4, 2015, Storage Summit 2015, themed Transformation, was held in Shenzhen, the hardware capital of the world, from November 3-4. Huawei and the Storage Networking Industry Association (SNIA) co-hosted the event, which gathered the top authorities in the storage field together, including Nobel Prize laureate Prof. Albert Fert; IEEE Fellow Prof. David Hung-Chang Du; and other experts from Huazhong University of Science and Technology, Intel, Baidu, Micron, and SanDisk.

Ecosystem >>

Innovation Ecosystem

Singapore, Nov. 12, 2015, Huawei co-hosted the inaugural Huawei Innovation Day Asia in partnership with the National University of Singapore today. The theme of the event was Building Innovation Ecosystems for a Better Connected Asia. The forum attracted over 150 regional government officials, as well as experts from universities and research institutions.

NB-IoT

Hong Kong, Nov. 6, 2015, top telecom industry members China Mobile, China Unicom, Ericsson, Etisalat, the GSMA, GTI, Huawei, Intel, LG Uplus, Nokia, Qualcomm Incorporated, Telecom Italia, Telefonica and Vodafone have held a preparatory event, chaired by Vodafone, to lay the foundations for a new industry forum aimed at accelerating the ecosystem around Narrow Band Internet of Things (NB-IoT) technology.

Cutting Edge Technology >>

5G

Shenzhen, China, Nov. 17, 2015, Huawei and Telefónica signed a strategic Memorandum of Understanding to work together on the next generation of mobile networks known as 5G (the 5th generation). Based on the MoU, the two companies will jointly evaluate and research the requirements of a 5G network environment, and investigate the 5G network architecture needed to deliver the ambition of superior data connection speeds with low latency.

10 times

Nagoya, Japan, Nov. 13, 2015, Watt Lab, which is part of the Central Research Institute under Huawei Technology, unveiled their new quick charging lithium-ion batteries at the 56th Battery Symposium in Japan. Using next generation technology, these new batteries have achieved a charging speed that's 10 times faster than normal, reaching about 50% capacity in minutes.

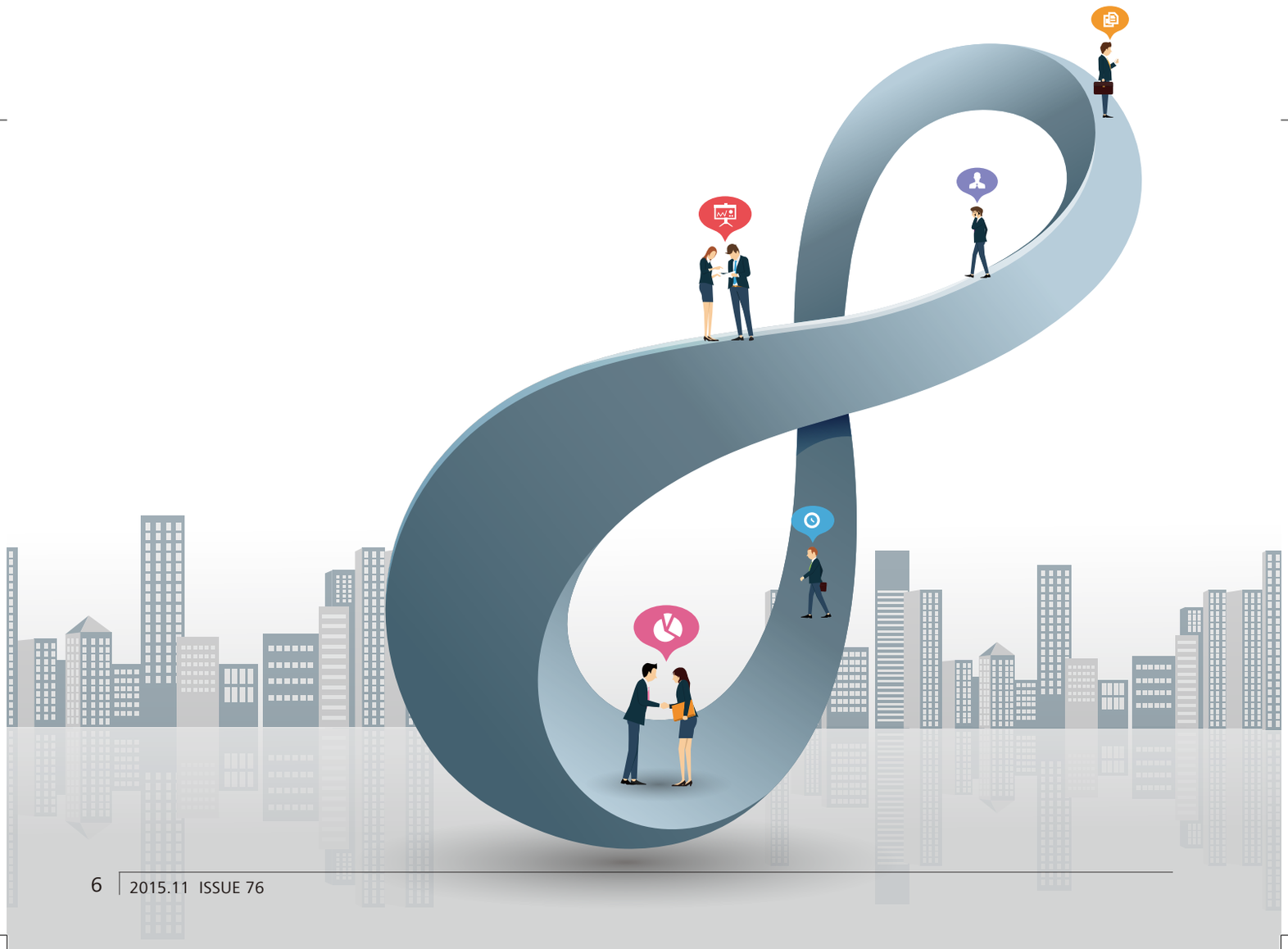
FDD+TDD

Hong Kong, Nov.3, 2015, 3 Hong Kong, the mobile communications division of Hutchison Telecommunications Hong Kong Holdings, and Huawei successfully demonstrated an innovative FDD+TDD and 4.5G (TDD+) network at the Global Mobile Broadband (MBB) Forum 2015 in Hong Kong.

ROADS to providing peak service experience

Zheng Chunhua
President of Carrier Marketing Dept., Huawei

A satisfactory user experience in the information age must be real-time, on-demand, all-online, DIY, and social (ROADS). To survive and thrive, telcos must create a ROADS-capable experience that allows users to enjoy real-time customized services on demand that are accessible anywhere.



Each day, the physical and digital worlds grow more intertwined, blurring the lines between online and off. A tremendous portion of our daily lives is being sent, transferred, received, and stored in binary format thanks to anywhere-anytime online access. The digital economy is disrupting traditional markets, creating new business opportunities such as Industry 4.0, the Internet of Things (IoT), big data, e-commerce, telemedicine, and distance education.

The telecom industry — which has enjoyed the benefits of a growing population, mobile Internet and smartphones — has faced developmental barriers due to surging bandwidth requirements and consumer service expectations. Carriers' traditional voice and messaging services are being eroded by OTT applications. In addition, increasing consumer demand requires greater network coverage, bandwidth, and quality, which leads to an increase in OPEX due to network expansion, upgrades, and maintenance. For the telecom industry to remain competitive, the combined efforts of the entire industry are required.

ROADS to the optimal telecom experience

Central to the information age is the concept of data-based intelligence, as are all-connection and zero-distance, which remove the limitations of time and space. To achieve this, enterprises must adopt a consumer mindset, and pay close attention to user perception and interests. A satisfactory user experience in the information age must be real-time, on-demand, all-online, DIY, and social (ROADS).

Real-time

Real-time, zero-distance, one-click capabilities allow users to enjoy a new service in just seconds, including ordering, payment and configuring. In the past, the process might have taken hours, days or even weeks. Real-time capabilities greatly improve customer satisfaction.

On-demand

On-demand capabilities allow users to customize services based on their actual needs. Current telecom service packages are limited, and customers want free package customization in terms of bandwidth, capacity, time, and quality of service (QoS).

All-online

Users are accustomed to online services and entertainment. Cloud technologies will enable even more services, including telecom services, to be accessed online, improving efficiency and reducing costs.

DIY

DIY-capability allows users to participate in service development and optimization, which accelerates innovation and makes users feel more connected to services.

Social

Social networking platforms allow

users to share experiences, insights, and views about online services. These platforms help create fan bases, enhance user loyalty, and give users a sense of belonging.

ROADS is the external goal of a carrier's user-centric operations in the information age. To live up to its requirements, carriers must consider changing their business, R&D, service, and operation models, as well as restructuring their telecom networks.

SoftCOM builds open ROADS

To deliver a ROADS experience to users, networks need a new technology system. Huawei has proposed a system called SoftCOM, a network development strategy that seeks to build fully open ICT architecture to enable an industry shift from single-vertical innovation to all-encompassing innovation across the industry.

SoftCOM will reshape the telecom industry in four key ways:

Architecture reconstruction: In the information age, service provision, data exchange, and business activities will all be digitized. Storage, processing, and switching information will happen in data centers alongside business processing and transactions. DC-centered ICT architecture will be indispensable, and data centers will become the telephone exchanges of the digital era.

Network reconstruction: After the control and forwarding planes are separated and network resources are virtualized, networks can be managed in a more unified and global way to ensure better resource scheduling, higher efficiency, and simpler software upgrades. With the decoupling of hardware from software and NFV, the functions of network devices will depend on more than a certain piece of hardware. Network elements can share the same hardware platform (a hardware resource pool) to realize flexible resource sharing. In this way, networks can realize service automation and scalability based on service scale, and implement fault isolation and self-healing based on system autonomy. This improves network utilization, deployment, and maintenance efficiency, and accelerates service provision.

Service reconstruction: As cloud computing technologies mature, cloud services will become more widespread, creating an enormous market. Different businesses require different cloud services, which opens up countless strategic opportunities. The ICT infrastructure needed by enterprise cloud services is fundamental to carriers. Leveraging cloud computing for business model transformation, carriers will seize the opportunity created as enterprises shift ICT infrastructure onto the public cloud. A new telecom market worth trillions of dollars will come into being.

Operational reconstruction: ROADS-oriented operations allow users to enjoy on-demand, real-time, and customized services in an all-online way. These features also help carriers offer more intelligent customer services based on big data analysis, understand customer requirements, and carry out precision marketing. Social networking platforms aggregate industry innovations to offer a wide range of services.

The information age is a time of abundant change, with success becoming increasingly tied to user experience. Telcos will survive and thrive in this fiercely competitive market by creating a ROADS experience. Huawei will work with carriers and industry partners to build future-oriented telecom networks and operations so that customers can carry out business transformations and build a Better Connected World.

Open innovation for a Better Connected World

Innovation is the key to improving our capabilities and tackling the challenges in a diverse world. To build a Better Connected World, Huawei has defined three levels of innovation: fundamental, allied, and ecosystem.

Ryan Ding
President of Products & Solutions, Huawei

Challenges in a diverse world

Over the past two decades, people-to-people voice communications has been a hot topic. As the Internet became more popular, and as IP-based networks and social media became more common, we saw technologies evolve from TDM to IP, 2G to 3G and 4G, among others. However, our networks have always been built around people.

Looking ahead, we need to address three important requirements: a latency of one millisecond, 100 billion connections, and 10Gpbs of bandwidth. If we consider their implications, we will see that future network requirements no longer only relate to people.

Let's take one-millisecond latency as an example: 100 millisecond latency over 3G networks and 50 millisecond latency over 4G networks have both worked for people-to-people communications. However, for time-

critical industrial applications, latency presents a huge obstacle. For example, with a latency of 50 milliseconds, a self-driving car travelling at 100km/h will continue to move 1.4 meters from detecting a failure to applying the brakes. This is unacceptable for self-driving. That's why we are striving to achieve an end-to-end latency of one millisecond in the 5G era.

Future virtual reality (VR) applications will require 10Gpbs of bandwidth, far surpassing previous requirements of only 100Mbps. And the 100 billion connections will connect far more than the seven billion people on this planet. In the future era of 5G, we will be connecting things, not just people.

These requirements present a challenge. Over the past century, people-to-people communications have not had many diverse requirements on networks. But in the future, diversity will become the new norm. Against this backdrop, how can we better develop our network application architecture to satisfy diverse requirements? At Huawei, we believe that for infrastructure, we can only achieve high efficiency and low cost through economies of scale. To this end, we will need to create a uniform physical network and apply virtualization technologies to satisfy the diverse requirements of different industries.

Applications will become increasingly diverse in the future. At the MWC 2015 in Barcelona, we launched an energy-efficient IoT module. It's a very small chip, but it can run for 10 years without recharging on just two or three button cells. Some of our carrier customers were very excited to see this solution, and proposed many new ideas. Some said they wanted to embed this chip in a pet's collar, so they would always know where their pets are. Some customers from the manufacturing sector wanted to install the chip in their bicycles, so that they would never lose them. Logistics customers said they could install this chip in their containers, and track them anywhere in the world.

We currently offer E2E solutions to carriers, including BSS, infrastructure architecture, and devices. However, we are unable to provide pet or tap water management systems. Therefore, in the future, we will need to openly collaborate with industry partners. We will jointly innovate with our partners to provide diverse vertical applications to users. This will no doubt become a common practice in the diverse world of the future.

We will not be able to do everything ourselves. Instead, we need to focus on areas where we can excel and create value for industries. After analyzing our own capabilities, we have come up with three basic areas to focus on over the next 10 years.

First is network infrastructure, a traditional area of focus for Huawei. We will continue to invest and maintain our leadership in this sector. Second is IT infrastructure. This includes computing, storage, networks, and operating systems. We will keep investing in innovating cloud data centers. Third is digital infrastructure. Right now we are focusing our efforts on carriers, for example, providing them with cloud platforms and big data analytics systems.

Three-level innovation

To improve our capabilities to address future challenges, we believe innovation is the key. Huawei has always relied on innovation to achieve success. But in the future we will require an expanded definition of innovation. That means Huawei will innovate on three levels: fundamental innovation, allied innovation, and

ecosystem innovation.

Fundamental innovation

Fundamental innovation is the foundation of all other innovation activities. In this area, we will continue to invest in chips, including ultra-broadband chips, 5G chips, silicon photonics chips, and all-optical chips. In the IoT era, we will sustain our investment in LTE-M, including chips, infrastructure, and core networks. In software, our investments will focus on helping customers, including the customers of our carrier customers, to achieve Internetized operations. Our purpose is to bring Internetized operations to the traditional communications sector.

Fundamental innovation is very important. However, it is also very challenging, as it requires longer payback periods. As a key player in the ICT industry, Huawei has made longterm investments in basic research to drive the industry forward. This is our unshakable commitment to the industry. Over the past 26 years, we have invested at least 10% of our annual sales revenues in R&D every year. Just last year, Huawei spent 14% of its annual sales revenue on R&D. We also allocate 10% of our total R&D investment to research future technologies. Over the past 10 years, we have invested over CNY190 billion in R&D, and are committed to maintaining this level of investment in the future.

Fundamental innovation is the foundation of all other innovation activities. In this area, we will continue to invest in chips, including ultra broadband chips, 5G chips, silicon photonics chips, and all-optical chips.

Allied innovation

We have been heavily involved in innovation, mainly in cooperation with carriers, such as Vodafone, China Unicom, and China Mobile. However, this is not enough. Diversity will be a key part of future development. To address diverse requirements, we must adopt a new innovation mindset. Let me give you an example on how

Huawei innovates and integrates this new concept of innovation with vertical industry innovation. For 5G, Huawei set up a 5G Vertical Industry Accelerator (VIA) and two testbeds. One testbed is near London and the other is in Munich. We are not simply concerned about carriers. The VIA also includes members from several other sectors, including standards organizations such as 3GPP, IERC, and PPI. All policy makers and standards setters in these sectors are now cooperating with us. We believe that it is also essential to introduce players from vertical industries, including SAP, Siemens, BMW, and Volkswagen. We have conducted E2E system integration and verification with these players to promote 5G-based innovative applications.

We also work with industry partners to conduct research in other new areas. We are currently cooperating with SAP and Intel on IoT. We are integrating our infrastructure with SAP's HANA big data platform to enter the IoT and Industry 4.0 domains. We are also working with Sony and Harmonic to promote the E2E commercialization of 4K videos. In terms of SDN, we play a leading role in the SDN alliance, which comprises over 30 companies. As a founding member, we are working with Stanford University and AT&T to jointly establish ONOS, the industry's first open-source SDN organization.

Ecosystem-based innovation

In the future, hundreds of millions of applications will exist. This will require us to create an ecosystem-based innovation mechanism. Compared with Apple and Google, Huawei is still a new player in this arena. However, we are willing to work with more industry partners to promote this kind of innovation. We are striving to develop uniform standards and conduct compatibility tests to increase platform capacity. In doing so, we aim to cooperate with more partners and contribute more to open-source organizations. In addition, we are working hard to create an industry ecosystem, and hope to attract more developers to open-source communities and labs to develop applications.

Take cloud computing as an example. We have launched an OpenStack-based cloud OS and made many efforts in this area. First, we completed compatibility testing on the OS with over 50 major vendors. Second, we have collaborated with the OpenStack open-source community, and are now one of the top 10 community contributors. We aim to increase our ranking to the top five this year. Third, we have actively cultivated independent software vendors (ISVs) to develop more software on our platform.

Make dreams come true

To satisfy the diverse needs in the Better Connected World, Huawei will remain focused on fundamental innovation and continue to invest heavily in basic research. This is the foundation for our future sustainable growth. We are also committed to joint innovation. We will jointly innovate with upstream and downstream partners to create a healthy value chain. Our efforts will of course include ecosystem-based innovation. We aim to aggregate more applications developed by our business partners, which will enable us to serve more sectors and scenarios. Through this we can grow together with the whole ecosystem and push the entire industry forward.

We believe that these three levels of innovation will allow us to realize our vision of a Better Connected World.

ONOS: SDN gets real

The future of telco is software-defined; it's also open-source. Open Network Operating System (ONOS) is the first carrier-grade operating system that combines both. ONOS is the brainchild of ON.Lab, and its Executive Director, Guru Parulkar, recently sat down with *Communicate* to discuss the platform itself, the state of SDN in the industry, and the shifting role of telcos.

Guru Parulkar
Executive Director of ON. Lab

It's no longer academic

Communicate: Tell us a bit about the background of ON.Lab and ONOS.

Guru Parulkar: SDN started originally at Stanford University and UC Berkeley. We did a number of things with SDN, including building SDN controllers and OpenFlow-based switches. Three years ago, we started to see that SDN was taking off and the industry was becoming serious about SDN. So at that time, we realized that the industry would need open-source SDN platforms, the use of which can build real products and solutions. To accelerate SDN, we started Open Networking Lab (ON.Lab) as an independent, non-profit organization to create open-source SDN platforms and tools for the industry to use and build on.

As for ONOS, it is, in some way, our first significant open-source SDN platform. It is an open-source network operating system that is primarily designed for service provider networks. What that means is that ONOS is designed to be scalable, high-performance, highly available, and has the right kind of abstractions, so network DevOps personnel can write applications and services on top of ONOS very easily.

When we started ON.Lab, SDN was already starting to happen in data centers. So we decided

We are delighted to have all these partners working with us and supporting ONOS, especially the leading service providers, because they are the ones that show us which use cases matter and how they plan to deploy SDN and ONOS in their real networks.

to focus on the service provider networks as the next frontier for SDN. We realized that unless we build open source platforms and demonstrate use cases, service providers will not adopt SDN as quickly. That was the origin of ON.Lab and ONOS.

ONOS: A team effort

Communicate: Who are the major backers of ONOS?

Parulkar: The major backers include a number of leading service providers such as AT&T, NTT Communication, and SK Telecom. We have a commitment from China Unicom to join as well. In addition to the leading service providers, we have a number of vendors that are partners in backing ONOS, which include Huawei and companies like Ciena, Cisco, Ericsson, Fujitsu, Intel and NEC.

We are delighted to have all these partners working with us and supporting ONOS, especially the leading service providers, because they are the ones that show us which use cases matter and how they plan to deploy SDN and ONOS in their real networks. It is very important for us to have service providers supporting it as well, because at the end of the day, it is for their benefit that we are doing all this work on software-defined networking and use cases.

Communicate: How many engineers do you have working on ONOS?

Parulkar: Building a core platform like an SDN operating system requires a small group of experts that can work like a team. That is exactly what we have. We have a group of 20 people. Four are architects, who have experience both in the industry and delivering major products, as well as people who have a research background. Then we have a developer team and a QA team. Together, they have a very unique expertise in networking, distributor systems, and software systems for the development of advanced platforms. That is what is needed to create an SDN operating system of the type I mentioned before.

In addition to the ON.Lab team, we have engineers from our partners, like AT&T, Huawei, and others who are also part of the team. So the ON.Lab team forms the core; then we have engineers from our partners, and then there's the larger developer community.

One fast Blackbird

Communicate: What's the significance of the Blackbird release of ONOS?

Parulkar: In the Blackbird release, we experimentally demonstrated the key attributes of ONOS. As I mentioned, ONOS is designed to be scalable, high-performance and highly available. For example, we demonstrated that ONOS can sustain up to two million flow operations per second and performance scales with the number of ONOS instances or servers. We also demonstrated that ONOS can react to networking events in less than 100 milliseconds, where ONOS does most of its processing in less than 10 milliseconds. These are the important

performance metrics that service providers care about; and these are the performance metrics that an open source SDN control plane has demonstrated for the first time.

We hope going forward that the networking industry and the SDN industry will standardize these performance metrics and expect everyone to report or ask for them, whether you are a designer or the user of the SDN control plane. In software development, many organizations try to get the functionality right, and then worry about performance, scale and high availability. But architecture absolutely affects performance, scalability and availability, especially for an operating system. That is why we thought getting the architecture right is very important, because that is the only way you can get these performance and scalability numbers. We are very happy that our team got this right.

Communicate: Where does ONOS fit in this wide-open SDN and NFV environment?

Parulkar: ONOS is focusing primarily on two types of use cases or solution proofs-of-concept (POCs). One type has to do with the reduction of CAPEX and OPEX on the infrastructure side. For example, if you look at the backbone networks where service providers operate packet optical networks, they operate them independently. We are doing a use case to demonstrate that we can use a single SDN control plane to control packet optical networks. The second type of use case has to do with creating revenue-generating services that are enabled by something like NFV. We are focused on those cases as well to demonstrate how service providers can create new services very quickly on top of ONOS.

As I mentioned earlier, ONOS is the network operating system designed for service provider networks for scalability, high performance and high availability. So I think in that space, ONOS is unique, and we believe that is the only platform that is designed with these attributes.

What's ahead?

Communicate: The industry has developed a lot of software. What do you see ahead in terms of commercial deployment?

Parulkar: Huawei is one of the vendors that has already announced a plan to build commercial products and commercial solutions based on ONOS. I know that there are other vendors planning to do it as well. But I would let them speak for themselves. Also I told you about some of the solution POCs that we are doing with AT&T, NTT Communications, and so on. You can imagine they will not be doing these solution POCs unless they have some serious plan of actual deployment and monetization.

Communicate: Telcos are worried about OTT competition. How can operators compete against or maybe align with OTTs?

Parulkar: There's going to be a combination of competition and some cooperation. So in the case of service providers, they do have the benefits of central offices. They do come very close to the subscribers. In the central offices, if they deploy the right kind of computing, storage, and networking technology, then they are able to create some value-added services that maybe the OTT providers cannot offer. So they have some advantages and they can find a way to monetize it. At the same time, they can open up their infrastructure to OTT providers and, as a result, offer some interesting services and share revenue. So there may be opportunities for some innovative business models. I'm sure service providers are exploring those.

Telco OS: A next-gen operations system to enable telecom transformation

To transform traditional business models through digitization and internetization, the new agile digital operations model is the key to synergize business operations (e.g. agile business process) with infrastructure operations (e.g. automated cross data center resource allocation through SDN and NFV) to enable new open digital ecosystems and real time, open, all online, DIY, and social (ROADS) service experiences. This is Huawei's value proposition, and Telco OS is Huawei's concrete solution to achieve it.

Dr. Sun Dong
Chief Architect of Digital Transformation Solutions, Huawei

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

A vision for the future of ICT operators

Huawei's solutions allow SMEs to quickly and effectively establish their business by DIY method, run the business, and manage ICT resources through automated digital operations. Take the example of a small gaming startup that wants to quickly set up e-commerce and roll out a new game to the market. Traditional CSPs are impossible to achieve this in a timely and efficient manner. But by using the DIY method, the gaming company can quickly get their business online, setting up business and operations supporting systems, customer interaction and care systems (portal, mobile app etc), and release new services in an hourly timeframe. In addition, it can provide big data analytics capabilities for business operations and real-time decisions to help the company achieve rapid growth, and it can also help the timely automatic scaling of ICT resources including network bandwidth, IT computing and storage to meet business growth.

This is ROADS operations. Digital operators are now able to support large enterprises, and help SMEs launch new business and services more quickly, enabling them to provide these kind of ROADS capabilities to their customers.

How can ROADS capabilities benefit

individual users? Take the example of a user who wants to watch a 4K HD video only to find the OTT cannot provide a good experience due to bandwidth constraints. When this happens, the digital operator can proactively offer a bundle with 4K plus 50Mbps bandwidth, and allow this user to carry it around for a premium experience. Moreover, users could also subscribe the bundle through DIY, share this kind of good experience with friends via social networks, and give their friends the opportunity to enjoy a similar service.

To provide a ROADS user experience, the network must first be able to support ROADS capabilities, and this can be realized across the entire infrastructure by virtualization.

Numerous studies have shown that ROADS will be a major developmental driving force for networks of the future. In the future, operators will need to carry out infrastructure virtualization to provide better ROADS capabilities, and leverage a series of technologies including Cloud, SDN and NFV to achieve this.

However this is not enough. Operators also need new open digital business models, which are enabled by transforming traditional business models through digitization and internetization. In terms of services, new business models enable traditional businesses to provide digital services and cloud services, as well as various kinds of industrial Internet applications, thus maximizing the value of user experience. In order to build new business models, new operations models are essential to synergize agile business process with infrastructure operations (e.g. data centers through technologies such as SDN and NFV), so that new ecosystems can be built and ROADS experience can be supported. This is Huawei's value proposition, and Telco OS is Huawei's concrete solution to achieve it.

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

The three key components

Just as an orchestra has some lead players, Telco OS has several key components. These components provide key capabilities for business, operations, and intelligence support. Just as every orchestra has a conductor, Telco OS also possesses the orchestration capability to orchestrate services, business, and infrastructure operations based on user needs and ROADS requirements, so as to achieve better collaboration across the entire business process.

There are three sub-systems in Telco OS. In fact, they are not just three specific products, but three different kinds of capability sets.

Business Enabling System (BES): Enabling business agility

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

So, what is the strategy of BES deployment?

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

Big data: Enabling intelligent operations

Operational intelligence depends on big data, which is the brain of the entire system, and big data analytics can be used to guarantee user experience and achieve perfect operations.

Fully leveraging big data not only helps companies capture operations status, such as data monitoring and analysis, but it can also help them offer more innovative services. Big data can provide useful insights for business decisions, and perform better adaptive orchestration to enable personalized automated business processes based on real-time status. This means per process per user journey, since user demand is changing all the time and business operations have to adapt to that change for the best user experience and best business benefits.

Infrastructure Enabling System (IES): Enabling ICT infrastructure automation

IES enables infrastructure operation automation, which includes entire infrastructure management from cloud management to SDN and NFV.

Infrastructure operation automation is very complicated, and includes the multiple levels of lifecycle management such as ICT infrastructure, service and customer experience lifecycles at various customer levels and different SLAs. Each lifecycle consists of multiple phases such as ICT infrastructure planning/design, deployment and assurance, service innovation, and fulfilment and assurance. Moreover, ICT infrastructure operations should leverage and streamline different levels of lifecycles from the user perspective for a timely and on-demand experience – in other words ROADS capabilities.

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

Huawei has allocated significant resources to drive the business success of Telco OS. Huawei has conducted commercial trials with operators, including a very comprehensive pilot project with China Unicom. In this project, Huawei has provided a range of products including big data analytics and monetization. At present, the project has achieved initial positive results. In addition, Huawei works with China Mobile to transform its traditional customer relationship management (CRM) system into a digital customer service center to support O2O, DIY and open digital stores.

In summary, Telco transformation is driven by the change of end user behaviours brought by the Internet and digitalization. ROADS becomes the new benchmark of user demand, which opens up new business opportunities. A new agile digital operation model is the key to realizing ROADS capabilities and delivering business benefits.

FusionInsight: Innovation creates more value

In big data analytics, Huawei focuses on three key sectors: telecommunications, enterprises and consumers. With FusionInsight, Huawei has built a hugely powerful collection of big data solutions that can create greater value for our customers and significantly enhance the efficiency of work and life.

Li Hang
Director of Noah's Ark Lab, Huawei

Big data is a hot topic. In fact, Huawei's founder Ren Zhengfei realized the importance it would have in the future. A number of years ago, he indicated that the future of ICT would be decided by big data, and proposed the Noah's Ark Lab for innovations in machine learning, data mining, and artificial intelligence. Ren did not use the term "big data" at the time of course; the expression he used was "information flood". He once discussed with us how Huawei could meet the challenges of this information flood, as well as the future of these technologies. Today, these are the challenges and topics that the whole industry is tackling. This article is about Huawei's achievements in

During FusionInsight's development, two key terms continually cropped up, reflecting Huawei's strategy and capabilities in big data analytics. They were "application-driven" and "algorithm-centric".

big data analytics.

FusionInsight: Integrating Huawei's leading achievements in big data

In 2014, on the back of many years of research and development in big data analytics, Huawei launched its big data product– FusionInsight, a platform that contains a range of big data solutions for different scenarios. Huawei's R&D teams and product teams jointly developed the core technologies and algorithms to support the product. With the launch of FusionInsight, Huawei will be able to provide better products and services for its customers.

During FusionInsight's development, two key terms continually cropped up, reflecting Huawei's strategy and capabilities in big data analytics. They were "application-driven" and "algorithm-centric". As a leading ICT solutions provider, Huawei has an excellent understanding of the needs of different types of customers and the characteristics of applications from various sectors. Huawei also possesses a very strong capability at developing algorithms for big data analytics. In addition, it has many outstanding ICT platforms. These are all Huawei's strengths in the field of big data.

Huawei's big data analytics focuses on three key sectors: telecommunications, enterprises and consumers. After analyzing the key applications in these three areas, Huawei divides the data from all these applications into six types: tabular, stream, graph, text, temporaspatial, and multimedia. Targeting the characteristics of these key applications and data types, Huawei has developed a large number of advanced algorithms and tools in numerous important areas, including deep learning, stream data mining, graph data mining, and large-scale machine learning. Huawei has fully leveraged its existing platforms and solutions to bring these together to build the exceptionally powerful platform and solutions for big data analytics – FusionInsight.

Structurally, FusionInsight has three layers: a system layer at the bottom, a tool/algorithm layer in the middle, and at the top an application layer which contains a variety of applications.

Different types of data analytics require different tools, and FusionInsight offers a large number of powerful tools and algorithms at the tool layer, consisting of two main types – machine learning and data mining. These tools include a search engine, a recommendation engine, a graph data mining toolkit, and a stream data mining toolkit.

At the application layer, Huawei focuses on carriers, enterprise and consumer applications. In the carrier sector, Huawei offers five key applications of particular importance for telcos: intelligent customer relationship management (CRM), big data services, future network architecture, intelligent network maintenance, and intelligent network planning and

optimization.

In the consumer sector, the key applications are the intelligent applications store and intelligent information management; while in the enterprise sector, the key applications are intelligent banking and intelligent management.

Success in industry applications

2014 was a very fruitful year for Huawei in the field of big data analytics. It marked the official release of FusionInsight, a product of many years of collaborative effort on the part of numerous departments in the company. In addition, a range of powerful big data analytics technology and products were successfully implemented for different customers and in various scenarios. The following examples demonstrate how FusionInsight has been utilized to help customers solve problems in their businesses.

The first example pertains to applications for the telecom industry. Operators have accumulated a huge amount of data during their operation, including the so-called OSS and BSS data. In the past, it was very difficult for operators to make churn predictions using big data. With FusionInsight, Huawei helps operators build big data platforms that leverage Huawei's technical expertise to produce effective customer loss forecasts that help increase customer retention from 15% to 35%. The main technology used is automatic user modeling, which effectively captures key customer attributes. These are then employed to forecast how likely a user will be to terminate service contracts, thus helping operators retain customers.

The second example relates to applications for the financial sector. Commercial banks usually rely on transaction data to build customer models to provide personalized services. Such models are critical for boosting the effectiveness of promotional activities. Huawei FusionInsight's intelligent banking applications leverage big data to help banks create more accurate user models with thousands, even millions, of features. With this solution, Huawei helped a commercial bank in China increase the success rate of their target promotion sixfold.

In the consumer market, FusionInsight also offers an extensive range of in-depth applications. For example, all Huawei phones released since September 2014 offer the intelligent help feature. With this feature, users can ask questions through voice input or key touch input about how to use Huawei smartphones. The accuracy of the answers provided is as high as 90%.

This new function is powered by Huawei's big data analytics technology. The biggest challenge for the intelligent help function is that the answers provided by the phone do not match users' questions. To address this, Huawei is continuing to make advances in machine matching technology to provide matches for answers based on semantics (sentence meaning), and to increase the accuracy of answers and help users better solve problems. More Huawei smartphone users are now using this function, with over 100,000 questions collected on the cloud every day.

FusionInsight is a very large product portfolio, as is demonstrated from these examples. It includes many technologies that will only continue to improve and feature more new functions, creating greater value for customers and enhancing their efficiency in work and daily life.

Mobile video: The new frontier

To help mobile operators conquer the mobile video market and monetize the service, Huawei Business and Network Consultancy services offer the knowledge and experience on what it takes to build a full end-to-end video ecosystem.

Dr. Jose L Gil
Huawei Mobile Broadband Consultant

Mobile video ecosystem components

A profitable mobile video business requires an understanding of the complex end-to-end video ecosystem, from content producers to content providers. Mobile operators must establish key deals with content producers and content providers as a prerequisite, followed by a good selection of video transport technologies, such as unicast and broadcast (eMBMS) systems. But deployment of eMBMS, without a proper business case, will not drive mobile video by itself. Huawei Business and Network Consultancy services offer mobile operators the knowledge and experience to build a full end-to-end video ecosystem, from business development to network implementation.

The race for the conquest of mobile video started long ago, but very few in the

mobile communications industry have an understanding of the intricacies involved in developing a successful proposition. There is no doubt that the experience accumulated over the past years will shape the future mobile video business, but mobile operators already looking beyond traditional video streaming traffic will have a higher likelihood of setting the basis for success.

Video has become a major part of mobile network traffic – 50% on average. However, is this video traffic being monetized? In general, the answer is no. Whether video traffic is 5%, 50% or 90% of a monthly data allowance, the mobile operator gets the same revenue from the user.

E2E ecosystem for mobile video

Three domains can be distinguished in the end-to-end mobile video ecosystem: content provider, network provider, and service provider.

Content provider domain

The content provider domain is owned by the producers of the media content. The producers of films, national news or documentaries are examples of content producers.

Network provider domain

The network provider domain corresponds to the last-mile telco that provides the media content to the end user. These networks can be any type, but in this article we consider mobile.

Service provider domain

The service provider domain is also known as the distribution or aggregation domain, because it is the point at which multiple media channels are aggregated and distributed to the edge/last-mile networks responsible for delivering the media content to the end user. The service provider domain usually includes three functions: broadcast, head-end and data center.

Broadcast domain: Once the media content is produced, the next step is to broadcast it over a national or regional territory. Satellite systems are commonly used to broadcast the media content over a large geographical area. Cable TV operators typically receive the content via satellite. Other systems, such as terrestrial radio frequency systems or fiber systems, are also used. Even a mixture of all these systems can be found in many cases. The broadcast domain can distribute the content to last-mile networks or directly to the end user. Nowadays it is also pertinent to mention the importance of the Internet to make media content available to the end user directly from the media producer.

Head-end domain: The head-end function is necessary to convert the media content into IP-based streams. Powerful hardware units transcode the media content into different IP-based formats.

Data center domain: The data center (DC) domain is an important component of the end-to-end mobile video system that contains, among other elements, the security systems, which ensure that only authorized paying subscribers access the broadcast content. Security solutions are divided broadly into two categories – conditional access systems (CA) and digital rights management systems (DRM). The CA system ensures that only authorized subscribers access the media content. The DRM system ensures that the content owner's business model and rights are implemented. Encryption and security keys are typical functions implemented as part of

the security solution. Other functions found in the DC are related to network management and billing.

In today's mobile networks, video content is delivered to the end user through unicast transport. Unicast means that the network establishes a one-to-one dedicated connection to the end user. If the same video content is downloaded by another user at the same time, the network establishes another separate dedicated connection to the second user. From a transport efficiency standpoint, the new solution multicast/broadcast (eMBMS) is being trialed by certain major mobile network operators. This solution is a one-to-many network connection where the same video content is transmitted just once and received by multiple users, therefore saving scarce network resources. While the multicast/broadcast is still not widely deployed, it is gaining momentum. Unicast and multicast/broadcast transport mechanisms do not compete, but complement each other, and will always co-exist on a mobile network. This is because of the differing natures of different video applications. Video applications such as video on demand (VOD) imply a unicast transport method, because the user downloads video content at any time.

From an architectural perspective, the introduction of eMBMS does not require major new network elements on top of existing LTE. Only three new entities are required:

Broadcast Multicast Service Center (BM-SC): authenticates and authorizes the content provider and forwards video content to the eMBMS gateway inside the mobile core network. Manages the broadcast/multicast sessions.

eMBMS GW: forwards the video content and session control information to the eNodeB.

Multi-cell Entity (MCE): manages eNodeB radio resources and schedules eMBMS transmission.

An eNodeB only requires a software upgrade to support eMBMS. However, one important requirement for eMBMS is that the entire LTE network (eNodeB's + EPC) must be synchronized in time and phase. This requirement is already satisfied in TDD networks, as TDD operation requires eNodeB synchronization. However, FDD networks are typically unsynchronized, and the introduction of eMBMS requires the deployment of a synchronization solution for the entire network. The most typical synchronization solution is GPS-based, but other alternatives exist such as IEEE-1588 or Ethernet Synch. One additional requirement is the enablement of IP multicast within the core and radio network. This can typically be achieved by a software upgrade, or activation of the IP multicast protocol within routers, and some possible additional IP planning.

The basic network architecture for eMBMS can be complemented with a connection to an IPTV system and/or a CDN network.

A vision for mobile video

In today's mobile networks, up to 50% of total data traffic (and even more in some networks) is video. For a mobile operator to monetize mobile video content, it would be necessary to define tariff plans where video is charged separately, currently a big challenge due to tariff competitiveness among operators and other issues such as net neutrality.

The increasing volume of traffic generated by mobile video pushes the mobile operator to increase network CAPEX and OPEX. But will this result in more revenue? It might increase revenue

Business use cases and content deals are the most important factors that drive mobile video monetization. Such business cases must drive the next step – network implementation. However, it is the type of video content to be delivered that determines the network video solution, and not the other way around.

indirectly by creating more expensive flat tariffs with larger data quotas. This is probably the most straightforward and established method for mobile operators to monetize mobile video. However, it is indirect, and offers little control. To establish a direct cause-effect relationship, mobile operators should establish solid relationships with video content producers and providers to offer premium content and targeted video applications to end users. Such video content must be attractive and valuable to mobile users, suited to smaller screen sizes, and different from what fixed operators or terrestrial broadcasters can offer.

Premium or differentiated mobile video content is the way to monetize mobile video. Huawei's Business and Network Consultancy (BNC) team houses experts from different backgrounds in video/OTT, capable of helping mobile operators establish key deals with content producers and content providers. Mobile operators must pay close attention to establishing these deals because they are the route to revenue. However, these deals might be costly and therefore risky. To reduce this risk, mobile operators must create new in-house teams with video expertise, as illustrated in the previous end-to-end video ecosystem section, or rely on external consultancies such as Huawei BNC. Some possible use cases where mobile video can offer singular value and open successful revenue streams are:

Football stadiums: goal replays, souvenir advertising, and food offers.

Tennis matches: replays key shots (it is difficult to see all shots from all court angles).

Formula One: The whole circuit cannot be watched from a single seat but, with the help of an in-situ eMBMS mobile network, the race can be viewed from a subscriber's mobile device.

Smart cities: display restaurants, information points, banks, traffic levels, etc.

Other events: broadcast live interviews, event information, paid ads, live advertising, and live remote auctions.

Business use cases and content deals are the most important factors that drive mobile video monetization. Such business cases must drive the next step – network implementation. However, it is the type of video content to be delivered that determines the network video solution, and not the other way around. Delivering video content in a Formula 1 circuit to enable all spectators to watch the race requires a broadcast system (eMBMS) installed in the F1 circuit. The delivery of interviews or marketing information at the Mobile World Congress requires a mobile broadcast system (eMBMS). VOD requires a unicast solution.

Mobile operators already trialing or deploying eMBMS systems without a solid business case with established video content deals run the risk of not getting a return on their investment. There are some in the industry who believe that a lot of the current video traffic transported over unicast connections can be transferred to broadcast systems, such as eMBMS, for a more efficient and cost-effective transport method. However, the majority of the current video traffic is VOD, which is unicast, and therefore not suitable for a broadcast system. To send unicast traffic efficiently over a broadcast network, it would be necessary that a large number of users concentrated in the same geographical area decided to view the same content at the same precise time, which is highly unlikely for VOD applications. Huawei Network Consultancy services have already been working for some time on technical solutions to help operators design, deploy and manage video network solutions such as eMBMS.

Focus

Huawei's open cloud strategy

OpenStack, the mainstream open source cloud OS, enables mainstream IT vendors to build an open ecosystem. Based on OpenStack architecture, Huawei has officially rolled out FusionSphere, and published its strategy for promoting the development of an open cloud platform.

Xie Yubin
Senior Marketing Manager, Cloud Computing, Huawei

Open-source cloud is the future

Openness is an inevitable trend in IT development. Since specialized, closed platforms came into being, the industry has worked to open up and standardize various IT resources, including computing, storage, and network resources.

Since the birth of x86 processors in the 1970s, the industry has constantly improved the open architecture of x86 to meet user requirements. Almost all aspects of the industry are based on this open computing architecture, including personal computing systems, massive data processing on the Internet, and even public cloud services.

Internet development is also open-sourced. The open-source implementation mechanism of the TCP/IP protocol stack is embedded into Unix systems, which drives Internet development. Today's Internet is based on openness, and almost all Internet technologies employ open-source implementation.

If openness embodies the essence of the Internet, then it is sure to characterize cloud platforms. In the current era, existing closed IT architecture, modes, and software platforms fail to address the requirements of forward-thinking industries. For a long time, enterprise virtualization resource pools and cloud systems were built by proprietary technology vendors, creating silos, increasing OPEX, and complicating management.

Significance of cloud openness

OpenStack has brought an opportunity to converge multiple virtualization pools and clouds. It is currently the mainstream open-source cloud operating system (OS). Open source has many benefits: The industry can share software, the open-source community can optimize functions and features, and participants can contribute to completing OpenStack. Open source can accelerate software development and product time-to-market (TTM), and products based on it can lower purchase costs for customers.

OpenStack enables independent software vendors (ISVs) to establish open architecture. Huawei's OpenStack cascading solution converges multiple clouds so customers can manage resource pools and cloud data centers to improve operating efficiency and significantly reduce OPEX. Equally, open architecture can avoid vendor lock-in while reducing purchase costs.

The mainstream IT vendors for OpenStack have collaborated on building an open ecosystem, completing the entire cloud blueprint based on it. This has made the cloud industry a success, and laid a solid foundation for customers' business transformation.

Huawei's open cloud strategy

Huawei's open cloud strategy involves open source, open architecture, and an open ecosystem.

Open source

Committed to promoting the development of open cloud platforms, Huawei is an active contributor in the global open-source community that participates in numerous groups and projects.

Specifically, Huawei became a Silver Sponsor of the Apache Foundation in 2011,

Huawei's FusionSphere, featuring automated: installation and deployment coupled with high availability (HA), upholds OpenStack's value of openness thanks to completely open architecture.

a Gold Member of the Linux Foundation in 2012, a Silver Member of the OpenDaylight Project, a Gold Member of the open cloud computing organization OpenStack Foundation in 2013, and a Silver Member of the Open Compute Project in 2014. Moreover, Huawei is the sole Asian representative in the OpenStack Foundation.

Huawei has contributed considerable resources to open-source projects. In the OpenStack Juno release, Huawei operated two framework incubator projects, Compass (management automation) and OpenStack cascading, for cloud data centers and network functions virtualization (NFV). Huawei collated over 150 IT/ICT features, and incorporated dozens of carrier-grade NFV features, including NUMA affinity, VM NIC bandwidth scheduling, and CPU affinity, into the Juno version in collaboration with Red Hat.

By December 1, 2014, Huawei has submitted 116 blueprints (ranking second) to the OpenStack community. Of these, 25 were accepted (ranking sixth). In addition, Huawei resolved 91 bugs (ranking ninth), committed 133 times (ranking tenth), and submitted 1,068 reviews (ranking tenth) and 12,424 lines of code (ranking sixteenth).

The huge contributions made by Huawei to the open-source community have seen substantial returns. Huawei has officially rolled out FusionSphere, the industry-leading cloud-OS based on OpenStack architecture.

Open architecture

Huawei's FusionSphere, featuring automated installation and deployment coupled with high availability (HA), upholds OpenStack's value of openness thanks to completely open architecture.

The following figure shows the southbound and northbound interfaces of FusionSphere.

FusionSphere uses standard OpenStack plug-ins for southbound integration. When installed with these plug-ins, computing, storage, and network devices can be integrated easily. FusionSphere also supports mainstream hypervisors, such as VMware, KVM, XenServer, and Hyper-V. In addition, FusionSphere is compatible with SMI-S, enabling superior interworking with heterogeneous storage devices.

FusionSphere provides standard application programming interfaces (APIs) for northbound communication. Upper-layer applications can flexibly schedule computing, storage, and network resources based on service requirements. In addition to APIs, FusionSphere also provides interfaces for interworking with CloudStack, OpenStack-integrated eSDK interfaces for developers to invoke, and SNMP interfaces for network management.

FusionSphere also supports hybrid cloud services, and is compatible with OpenStack private and public clouds and Amazon public clouds.

In other words, Huawei FusionSphere has a fully open architecture, laying a firm technical

foundation for customers to build a cloud computing ecosystem.

Open ecosystem: Huawei has launched the Yunfan plan to build a comprehensive cloud ecosystem. This plan consists of carrier, enterprise, and technology partnerships, as well as training.

Carrier partnerships: Backed by its leading position among global carriers, Huawei has initiated the inTouch Partnership Program, which offers marketing and technical support and helps Huawei partners enter the carrier market using the following three business models – revenue sharing, recommendation, and resale. For carriers, Huawei provides matchmaking and quality assurance services for applications.

Huawei has also proposed an NFV development plan, and FusionSphere is a core NFV product. Based on its open architecture, Huawei performs compatibility tests, ensuring that FusionSphere is interoperable with products from mainstream NFV solution providers. This also helps prevent vendor lock-in.

Enterprise partnerships: Huawei has strengthened its collaboration with ISVs, channel sellers, service integrators (SIs), and service providers across the industry.

In 2014, Huawei focused on a wide range of industries, including government, utilities, transportation, safety, energy, media, and finance. Huawei has developed a strategic relationship with at least one ISV from each industry to promote the application of cloud computing in these industries.

Huawei will further improve the regulations on channel partnerships to build an equal, trustworthy, and open channel. When expanding the scale of its partnerships, Huawei also helps partners boost sales and improve after-sales service capabilities.

Huawei's service providers offer various professional cloud computing services for customers, such as consultation, service operation, basic virtualization, key service virtualization, management, and technical account manager services. Huawei also employs green solutions to bring profits to its partners and achieve win-win scenarios by sharing risks and rewards.

Technology partnerships: Huawei's cloud computing technology partnership comprises three levels of technology partners – professional, elite, and global. It also includes one set of standard APIs – open FusionSphere APIs – based on a central software development kit (SDK). We also have access to an open remote laboratory, giving Huawei's partners remote access for development and commissioning. General certifications fall into three types: HCNA-Cloud, HCNP-Cloud, and HCIE-Cloud. Huawei-ready certifications cover application software, virtual appliances, server storage, management, networking, and security.

Educational development: Huawei's education partnerships consist of personnel training alliances with partners for cultivating cloud computing technicians and recommending posts for them, with standards for cloud computing technicians that outline career path and professional certification systems included. Teaching resources for cloud computing, including training and certification for instructors to jointly develop training classes and certify partners, and a complete ICT laboratory and e-learning platform are also included. Finally, Huawei also runs the Dandelion Empowerment Program, offers certification exams, and hosts ICT skills competitions and regular summits to help develop talent.

Enriching digital business with Digital inCloud

Digital transformation is deepening as increasing numbers of telcos strive for growth through digital services. Huawei has launched its Digital inCloud strategy and solution to help telcos accelerate digitization, aggregate partners, build digital ecosystems and infrastructure, and gradually expand into other industries.


Li Xin
Director of Business Support Dept, Digital Business, Huawei


Chen Jiuzhao
Marketing Expert, Digital Business, Huawei


Su Rui
Marketing Manager, Digital Business, Huawei

Global telco experiences in the digital wave

Telcos are currently exploring possible ways to harness the third growth wave in the telecom industry (digital services) and benefit from its rise.

Some telcos are opening up their own capabilities or integrating third-party capability resources to monetize their network and user assets and expand into new markets. America Movil has built its AM hub to integrate and open its operational capabilities in 17 countries to its global partners. Orange and AT&T, both multi-national telecom groups, have launched

the capability openness platforms Orange Partner and AT&T Developer to extend sales from services to capabilities. MTN Group has evolved its existing services and enabled its open platform to launch over 3,000 digital services, greatly enriching MTN's content offerings. China Unicom launched the WO+ platform, opening its capabilities and resources to individual and enterprise developers and third-party capability providers, for which 15 types of APIs were launched by mid-2014, making for new service revenue streams.

Others are using their own businesses to aggregate partners and build an industry service marketplace that offers applications in areas such as digital media, video, smart home, finance, and healthcare. AT&T Digital Life offers personalized home security and automation packages that allow users to manage door locks, monitor their homes, and control their household utilities.

China Mobile has established Migu, an entertainment and technology service platform, to improve its content business by integrating music, video, reading, gaming, and comics. Moreover, China Mobile aggregates industry partners on one platform and achieves profitability through revenue sharing. DOCOMO rolled out D-market, where users can find content and applications in 14 categories; to date it has attracted over seven million users. The proportion of revenues it generates from digital services increased from 14.2% in 2013 to a forecasted 18% in 2014.

Digital inCloud: Enriching digital business

Huawei Software is strategically positioned as the best partner for managing and monetizing user assets, aiming to help telcos achieve business success in digital transformation and enrich the digital business conducted by operators. To achieve this goal, Huawei has launched its Digital inCloud strategy and solution.

Digital inCloud provides an open service platform coupled with operation support services to help telcos achieve digital transformation. The solution features an open platform, a partnership alliance, and operation support services.

Digital inCloud provides an open service platform coupled with operation support services to help telcos achieve digital transformation. The solution features an open platform, a partnership alliance, and operation support services.

The open platform allows telcos to design business scenarios for network assets and user assets, making these assets available in digital marketplaces so that industry partners can easily shop for telco capabilities. Examples include:

Big data openness service: Open information is analyzed based on big data analytics, including location tags, interest tags, and credit tags to partners. Advertisers are interested in this data because it can help them target individuals with ads and monitor ad efficacy. This type of application is now widely used by Internet advertisers and finance product vendors.

Business support service: Customer relationship management, billing capabilities, and user authentication and charging capabilities are offered by telcos to third-party partners. Charging capabilities are popular with gaming vendors and online retailers because they require a quick payment function. What's more, telcos

Huawei's Digital inCloud, winner of the 2015 TM Forum Excellence Award in the Open Digital Ecosystem, has proved to be effective at helping telcos explore and create new business models, ecosystems, and organizational structures.

have high credibility and provide reliable network facilities.

IoT service: Telcos can open SIM card capabilities for Internet of Vehicles (IoV) vendors such as VW and BMW.

The Global Partnership Alliance bridges telcos and partners to facilitate telco business development in the digital business ecosystem. The program provides various services ranging from partner recruitment and service launch to service promotion and operational support. These can drive telco business development in the areas of digital music, traffic monetization, TV and video, open APIs, enterprises, and vertical industries. To date, the inTouch® partnership program has aggregated over 2,000 partners and 146,000 applications, including over 9,000 games, 200,000 songs, and 100 enterprise applications. This program helps telcos build a solid foundation for additional content and partners.

Tailored solutions target different markets. In mature markets where telcos have built their own ecosystems, Huawei provides an end-to-end technical platform and operations consulting services. Moreover, Huawei's partnership program can supplement telcos' digital ecosystems.

In emerging markets where the digital ecosystem is not yet formed, Huawei provides a one-stop solution that includes a technical platform, partner aggregation program, and operations services.

Benefits of Digital inCloud

Thanks to its openness, bridging capability, and efficiency, the Huawei Digital inCloud provides an open platform to help telcos transform into digital service providers. A unified and open platform makes telco assets available to partners, leading them from a closed business environment to an open digital ecosystem. This in turn expands the market landscape and creates more value.

Digital inCloud also bridges telcos and partners to enrich service offerings. The Global Partnership Alliance connects more partners and resources, and has so far bridged over 2,000 partners with 250,000 content items.

This solution also helps telcos improve operating efficiency by streamlining digital business processes, which generates more revenue streams from digital business operations. To respond to changing customer requirements in the digital ecosystem, Huawei helps telcos to streamline digital business operation processes, external integration processes, and new business launch processes to reduce time-to-market and quicken market response.

Huawei's Digital inCloud, winner of the 2015 TM Forum Excellence Award in the Open Digital Ecosystem, has proved to be effective at helping telcos explore and create new business models, ecosystems, and organizational structures. Then telcos can apply their core advantages in networking and customers, aggregate partners, build ecosystems and digital infrastructures, and gradually expand their scope of business.

Universe: Enabling telcos' digital transformation

Big data is now the core driver behind the digital transformation among telcos. When it comes to building big data analytics platforms, operators are frequently asking the following three questions: How can big data analytics platforms be built? How can big data analytics platforms be used to tackle business problems? How can we build digital collaborative ecosystems to realize the monetization of data assets?

Meng Qingguang
Senior Marketing Manager, Carrier Software BU, Huawei

The era of business-driven big data has arrived

Big data, which was first used by Internet companies, is now seeing widespread application in all kinds of industries. There are three key factors behind the growth of big data:

Business: Big data can be used to mine business value, and an increasing number of telcos are now focusing on its commercial applications. With the customer as a core focus, they are looking to leverage big data for customer value innovation, business optimization, and business model innovation. 2015 marked the start of a new era of business-driven big data.

Data science: The traditional analytical tool has become intelligent, with new theories and techniques in data science (such as machine learning, cognitive computing, deep learning and knowledge discovery) being applied and becoming the driving force behind the development of data analysis.

Technology: Open-source technologies such as Hadoop have played a significant role in driving the development of big data. Hadoop has even become the de facto industry standard. However, the diversity and complexity of these technologies present quite significant challenges to operators' IT departments. The issue now facing the industry is how to further consolidate and standardize big data technologies.

Operators face numerous new challenges in big data application

The use of big data in the telecom sector can be divided into four classes based on technology maturity:

Class 1: Technology Enhancement, using big data technologies to enhance computing elasticity and lower data processing costs.

Class 2: Vertical Solutions, like precision marketing, customer retention, and service quality management. But these are also silo systems and cause data silos.

Class 3: Data-driven Operations, building enterprise big data analytics centers to support digital transformation. All data, including third party data, is ingested, stored, and processed. Applications and data are decoupled completely. Therefore a large number of long-tail analytics applications emerges.

Class 4: Operating Data as a Biz, monetizing data by providing data services for various industries, thus creating new business models and value streams.

However, unlike Internet companies, carriers lack sufficient big data technology and data scientists, and thus face a large number of challenges in leveraging big data such as:

Data asset integration: Most telcos use many kinds of service systems and analytics systems across their networks, such as BI, NI, customer services and marketing. This "silo-ization" of data has become a critical obstacle to big data analysis. The primary issue carriers face with big data is how to efficiently integrate all the data from BSS, OSS, network equipment and financial systems – as well as a growing amount of Internet data – and ensure the quality of this data.

Severe shortage of data scientists: In 2014, there was a shortage of almost 200,000 big data scientists in the US alone. Big data scientists are in even stronger demand in other regions. Operators are struggling to find enough big data scientists in their regions to support refined operations analysis.

Serious lack of successful big data business

cases: Carriers are attempting various ways to leverage big data to solve their business problems. The average operator drafts dozens of big data business cases per year, but less than 20% succeed.

Difficulty in finding innovative business models for data asset monetization: In addition to helping operators refine their internal operations, big data can also be opened to businesses, thereby helping operators build digital ecosystems. While many operators have made attempts in this respect, the incomes generated have been small. There are two main reasons for this: firstly, the lack of external data sources; and secondly, the inability to find suitable business models.

An overview of Huawei's Universe big data solution

Big data is now the core driver behind telcos' digital transformation; its importance is evident. The three questions telcos ask the most when building big data analytics platforms are: 1) How can big data analytics platforms be built? 2) How can big data analytics platforms be leveraged to solve business problems? 3) How can big data be used to build digital collaborative ecosystems for the monetization of data assets?

These three questions are the consistent focus of Universe, Huawei's big data solution. Universe takes advantage of Huawei's significant strengths in industry experience, technology and services to provide the best big data analytics platform in the industry. At the same time, Huawei's Universe solution combines two types of collaborative ecosystems (the big data application development ecosystem and the big data operations ecosystem), and leverages the standard BDRA service delivery process and Analytics App Market to create a business-driven and artificial-centric big data solution. The solution helps telcos build the core capabilities to carry out digital transformation (including refining their internal operations and expanding their industry value chain).

Huawei's Universe big data solution includes the Universe big data analytics platform (Data Factory, Wisdom Center and Data Operation Platform) and end-to-end value-driven big data services (consulting, business operations, data analytics, data governance, and integration services).

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A closer look at the Universe big data platform

Data Factory

It has been estimated that during the implementation of big data projects, nearly 70% of the time is spent on data ingestion and integration. In the future, the amount and complexity of data will only increase. Today, data conversion must be carried out in near real time. It will become impossible to manually complete the labor-intensive work of data conversion with the scale of data that we will see in the future.

The core features of the Data Factory are unified data ingestion and integration, unified data asset management, converged data models, and unified data access services. The unified

data ingestion and integration function is pre-configured to support 190 BSS, OSS and MSS data sources – as well as providing adapters for the collection of new media data sources such as the Internet and social networks. This gives operators the ability to carry out digital analysis. The Data Factory offers automated data cleaning and conversion, dramatically improving the efficiency of data integration. The unified data asset management component supports telecom converged data models and data quality standards, helping operators to rapidly implement information architecture governance. The unified data access service creates a unified interface for the data storage layers (EDW, MPP DB and Hadoop), and provides a unified access point for upper-layer applications. More importantly, it enables data access control, ensuring data security.

Using the Data Factory, one operator in China has been able to achieve integration and governance of real-time event data from over 190 data sources (BSS, OSS and MSS) in only two months, a significant time saving compared to conventional methods.

Wisdom Center

Big data business analytics has in the past been heavily dependent on highly skilled data scientists. Now, the Wisdom Center provides intelligent and real-time data analysis capabilities using its two core analytics engines: the knowledge discovery engine and the real-time analytics engine. Huawei's knowledge discovery engine is targeted at business problems and is based on Huawei's in-depth research on data science techniques, including automated modeling, incremental learning, feature engine and high-dimensional feature extraction. The engine includes the Persona engine and the Product Portrait engine. It is capable of automated knowledge discovery and reduces the time needed for business analysis from several weeks to a few hours. The real-time analytics engine is based on automated pattern-matching technology and can process

millions of events and decisions per second, helping operators to quickly seize business opportunities.

The Wisdom Center is also preset with more than 300 out-of-the-box business templates. These cover nine areas under three main headings – "innovation and growth", "customer and market", and "operations and support". The solution is already being put to use by operators as an on-demand virtual data scientist team.

Using the Wisdom Center, one carrier in China has been able to boost its 4G user marketing success rate from 5% to 12%, and its rate of attracting subscribers defected from rival networks from 5% to 10%, greatly increasing its 4G business revenue and subscriber growth.

Data Operation Platform

The Data Operation Platform offers four key solutions: partner management, data product development, data exchange and trading, and a digital product store. In addition, it has over 500 kinds of data products built in. It provides a one-stop solution to help operators build data operations capabilities to achieve rapid data monetization and business model innovation.

The Data Operation Platform is based on Huawei's inTouch Partnership Program platform. The solution helps operators build a digitized data operations ecosystem, create differentiated and innovative business models, and monetize data assets.

In one successful case, Huawei helped a Chinese operator join forces with partners to launch data monetization products targeting the finance, tourism, credit checking, government, retail, and advertising sectors. The products included customer preference analysis, crowd flow analysis, advertising effectiveness assessment, industry indexing, and credit checking. Not only did this help the carrier generate a substantial new revenue stream within two months, but it also helped it establish a leading position in the market.

Universe's end-to-end big data services

Huawei's Universe big data solution provides the following end-to-end big data services:

Consultancy: Huawei has partnered with globally leading consultancies to provide operators with business and technical consultancy, covering precision marketing, customer experience management and data operations, as well as technical planning consultancy for big data analytics platforms.

Business Operations: brings together partners from sectors, such as advertising, banking, credit checking, government and enterprise, and retail, to provide operators with a one-stop data operation service, helping them to create new revenue sources.

Data Analysis: Data mining, machine learning and knowledge discovery technologies provide analysis targeting business problems, including innovation and growth, customer and marketing, operations and support analysis.

Data Governance: leverages Huawei's deep understanding of telecom data to provide end-to-end data governance services, including maturity assessment, roadmap planning, rule design, and implementation.

Integration and Delivery: provides end-to-end big data integration based on Huawei's service platform that provides a comprehensive solution to complexities caused by fragmented technologies to streamline delivery and shorten delivery periods.

Openness and security in the big data era

Gartner analysis shows that more than 60% of the world's carriers have started to invest in big data. And as technology advances, carriers are also shifting their focus from network assets to data assets. However, making data openly available raises issues of security and privacy, ones that must be addressed.

Data openness is a big data trend

Carriers develop big data capabilities in three phases – endogenous problem solving, commercialization, and sharing & trading. Most carriers are in the data commercialization phase, where data openness is critical.

Carriers have two primary bases for opening their data – group-based or individual. For the former, carriers provide statistical reports on regional users' characteristics, such as geography, and such reports can be used for government planning or market research purposes. For example, carriers might suggest store locations based on crowd traffic data and work with consultants to output reports for customers. For individual data, carriers profile users based on user behaviors and preferences and then use these profiles to improve their services and develop targeted marketing campaigns. For example, carriers might work with advertisers to launch precision marketing campaigns based on user preferences in vertical industries such as tourism, automotive, and aviation.

Data security and privacy challenge

Carriers must deal with emerging privacy issues at the same time as they begin to profit from data openness. Privacy issues are more serious than problems with mobile Internet advertising because when data is exposed to and reused by third parties, its security and privacy may be compromised.

To protect user privacy, general national laws must be enacted to ensure that user permission is obtained before the data is made open. This measure must be supplemented with a data usage, management, and authorization mechanism. For users

to benefit from data openness, the protection of sensitive information is critical.

As data service providers, carriers must improve data service transparency to maintain the profitability of data openness. Carriers must notify consumers of what data has been made open plus where and how long it will be used. They must guarantee the security of the open data, and grant users full control to view and cancel the data and corresponding processes at any time.

Various organizations, countries, and regions, including the EU and the U.S., are beginning to regulate data security and privacy. The security and privacy of open data must be protected in accordance with international laws, the design principles of general privacy protection for the industry, and individual data privacy protection principles. In this context, technology must be used to protect sensitive information. Data openness is only feasible with controlled access, encrypted storage, and the secure transmission of individual data.

Huawei Open Data Bus solution

Technically, a safe channel should be in place to ensure that the big data capability of carriers and data transactions of users are secure, reliable, and compliant with standards.

Huawei has a wealth of experience in reliability and security design in the telecom industry, and understands the laws and regulations of more than 100 countries. It has developed a solution that incorporates measures such as real-time authorization, anonymity, encryption, and adaptation to various security and privacy protection policies. The Open Data Bus solution is Huawei's answer to total data protection and user privacy.

Managing data openness: Huawei believes that data openness must be preauthorized by users. Users can easily revoke authorization or determine which data is off-limits. In addition, Huawei advocates a transparent process of data openness so users can easily find out where their data is coming from and going to. This management policy enables users to monitor data flow. Moreover, carriers can obtain valuable data and simultaneously improve user awareness about information security. The Huawei Open Data Bus solution features a user data openness management module, which is a convenient user data openness management tool for carriers. It includes a user-friendly interface for end users to manage the data being opened.

Privacy reference model: The privacy reference model represents complex laws and regulations as simple and configurable metadata labels. It provides a basis for determining whether to open each piece of data, and incorporates end-to-end privacy policies to prevent privacy invasion. As a service provider for more than 100 carriers worldwide, Huawei ensures that its Open Data Bus privacy reference model is universally applicable. By analyzing regional and national laws and regulations, and then grading common carrier data, Huawei defines data in each grade, and provides references for privacy laws and regulations for graded data implementation. The privacy reference model also has the flexibility to adapt to customer requirements or regional policies.

Data usage security: Data openness brings carriers out of the closed telecom network and into the open Internet. Without reliable security mechanisms, data openness cannot survive Internet attacks. Threats can be neutralized using end-to-end data security and privacy protection measures such as authentication and authorization, secure transmission, data encryption, anonymity including generalization and randomization, pseudonyms, data usage audits, and secure data deletion. The Huawei Open Data Bus solution supports all these security features, making it applicable to the entire IT industry.

Future prospects

Current data openness involves existing carrier data assets. To better utilize these assets in the future, carriers will use their credibility, and huge data assets, to incorporate third-party data into a data-mart ecosystem. Implementing multi-source data sharing and trading with privacy protection in a data-mart ecosystem will pose a challenge for big data security and privacy solutions.

As the data openness business model matures, each country will further standardize data security and privacy protection. Another challenge for big data security and privacy solutions is how to rapidly respond to business requirements in compliance with the laws and regulations of different countries. This is an increasingly necessary capability given the various forms of big data openness.

eLTE and TETRA collaboration: for smarter cities

New developments are bringing about a gradual shift towards wide coverage and multimedia in the field of public safety informatization. With its eLTE and TETRA integration solution, Huawei is helping customers to set up comprehensive, multi-dimensional command and dispatch systems for Public Protection and Disaster Relief (PPDR).

Mao Feixiang
Marketing Manager, Enterprise Wireless, Huawei

Wide coverage and multimedia: New requirements for smart cities

Terrestrial Trunked Radio (TETRA) is a professional trunking standard used in the public safety sector for smart cities. The mature technology provides an array of functions and mature, stable systems; supports flexible networking; and has powerful error correction and anti-interference capabilities. It also possesses the advantages of a complete industry chain and wide coverage. TETRA is now the most widely deployed emergency communication system, providing a highly reliable communications system, with wide coverage and rapid deployability for command

and dispatch for customers in public safety and other sectors.

However, the emergence of new services is precipitating the need for bearer technologies with higher bandwidth and lower latency that support multimedia transmission. One reason for this is the growth of the Internet and the increasing popularization of mobile Internet, which has caused access to information to become increasingly flattened, boosting demand in the public safety sector for multimedia services such as visualized command, real-time information transmission, and high-frequency database queries. In addition, developments in ICT (in particular cloud computing, big data, and mobile Internet) are having a far-reaching impact on emergency communication networks. In order to bear pictures, video and high-speed data, dedicated wireless networks face new challenges, including multi-dimensional visual command and dispatch, large-capacity HD video backhaul, and multimedia service deployment. Now, the informatization of the public safety sector features wide coverage and multimedia.

An emergency communication network that can support comprehensive, multi-dimensional PPDR command and dispatch systems that meet the requirements of government and public safety sector clients will need to encompass the following: 1) A basic emergency network consisting of a wide-coverage, interconnected wireless digital voice trunking network. 2) Dedicated wireless multimedia broadband networks built in key areas and hotspots that can meet the needs of public safety departments for multi-dimensional control and management on key areas, mobile offices, and geographic information system (GIS) coordination, and can develop multimedia services during actual application.

In the domain of urban railway systems in smart cities, current wireless train-ground communication systems are prone to interference and service discontinuity due to multiple co-existing networks. In such cases, TETRA networks can be used for train dispatch and emergency dispatch, and LTE networks can also be built to support broadband requirements such as passenger information systems (PIS) and interior closed-circuit television (CCTV). In the future, LTE will also support communication-based train control (CBTC) by implementing a unified communication platform for the two networks.

eLTE and TETRA: A perfect coordination solution

Huawei's enterprise LTE (eLTE) is a wireless broadband solution that supports interconnection with the TETRA system. It was developed based on 4G LTE standards to meet industry demands, with a focus on multimedia applications. At present, the eLTE solution can be connected to the narrowband digital trunking system – TETRA, in two ways – through a gateway interconnection model or a system interconnection model. These two models allow for the hybrid grouping of eLTE and TETRA users. They support professional trunking functions, including group and point-to-point (P2P) voice calls, and floor pre-emption and release.

The gateway interconnection model uses a back-to-back method that leverages the trunk gateway and TETRA Vehicle-Mounted Radio to achieve service interworking of eLTE and TETRA at the terminal side. This model simplifies network logic and facilitates interconnection, allowing for effective coordination and cooperation between both systems, and ensuring the service, signal, and

process independence of both systems. This greatly enhances the service provisioning capability and deployment flexibility of the communication network. As a consequence, the gateway interconnection model has seen widespread application in the industry.

The system interconnection model makes use of a customizable software development kit (SDK). The application SDK is built using specific software packages/frameworks, hardware platforms, and operating systems, and provides standardized open interfaces and pre-integration service suites for the easy integration of LTE networks with upper-layer applications. This enables system-level interconnection of eLTE and TETRA. The advantages of this model are service reliability and the capability to provide more professional trunking services, making it suitable for scenarios such as large networks, large-scale service capacity, and the unified bearing of multiple services.

Successful case studies

Huawei successfully developed an eLTE and TETRA interconnectivity solution for the Nanjing Municipal Government, creating the world's first LTE-based eGovernment broadband trunking network. The network was also the first to support interconnection with the TETRA system, allowing for hybrid grouping of eLTE and TETRA users and professional trunking functions between them (such as group and P2P voice calls and floor pre-emption and release), and helping to protect existing investments. The Nanjing Municipal Government was able to leverage the Huawei eLTE solution to deploy an emergency communication network spanning the whole municipal area, establishing a unified information platform for all its departments. The system enabled various operational functions, including voice trunking services, visual command and dispatch, real-time data monitoring (such as electrical power and hydrological data), video surveillance of transportation and key locations, and mobile government offices. The emergency communication network and unified information platform significantly enhanced efficiency and collaboration between Nanjing Municipal Government's departments, and helped to successfully ensure the smooth running of large scale public events in Nanjing, such as the 2013 Asian Youth Games and 2014 Youth Olympic Games, by putting into place a high-efficiency command system for critical situations.

Zhengzhou is a major city and transportation hub in central China. Line 1 of the Zhengzhou Metro uses TETRA products for voice command and vehicle dispatch, and has also deployed Huawei's eLTE urban rail solution. The eLTE solution provides a passenger information system (PIS) and dedicated broadband data and video services such as vehicle-interior mobile video surveillance (CCTV). The two solutions are used alongside each other to provide different functions in a successful mutually complementary fashion. The two systems have been in stable operation since November 2013, not only meeting Zhengzhou Metro's various service requirements, but also significantly boosting the operational efficiency of the metro and optimizing the passenger experience. As a consequence, the system has been highly praised by the customer. Of note, Huawei is currently testing LTE-based communications-based train control (CBTC) with Alstom and other partners in the transport sector. In the future, eLTE will support CBTC services, which will usher in a new era of wireless broadband communication in the railway sector.

Next-generation broadband policy control systems – where are they heading?

Existing broadband policy control systems are already unable to meet the requirements currently placed on them by LTE and its future development. The next generation of policy control systems will need critical features such as 200,000 TPS performance, 99.9999% reliability, rapid policy TTM, open access, fixed and mobile policy convergence, and NFV support.

Wang Minghu
Senior Marketing Manager,
Core Network, Huawei

With the rapid deployment and popularization of LTE networks, the amount of data traffic handled by these networks has seen breakneck growth of over 400% year-on-year, due to the high-bandwidth, "zero" wait and always-on nature of the technology. Carriers have implemented refined traffic solutions in order to boost their revenue from data services. Such developments have placed much higher requirements on broadband policy control systems. Existing policy control systems are already unable to meet the requirements currently placed on them by LTE, and will be unable to meet the requirements that future developments bring.

What the next generation of policy control systems need

High performance

Rapid increases in the number of concurrent subscribers: The fast growth of LTE subscribers has caused the overall number of broadband subscribers to rise rapidly. According to a report by Informa, the number of broadband subscribers is expanding by nearly 18% year on year. Added to this, the growth in the average Internet usage time per subscriber will mean a year-on-year increase in the number of concurrent subscribers by 25%.

More refined policy controls: When it comes to broadband deployment, operators' current main focus is data traffic, with fair use policies (FUP) and packages for specific applications (such as unlimited Facebook plans) being common. In the future, operators will implement more policies that support more refined mobile broadband services. These will include policies based on factors such as time, location, subscriber level, network congestion status, and subscriber terminal type. In 2013, operators adopted on average 12 policy use cases. According to a report by Heavy Reading, this figure will rise to 35 in 2015 and continue to increase rapidly as time goes on.

Broader policy control scope: At present, policy control systems typically only control data gateways and DPI equipment for the management of user traffic and QoS. In the future, they will control more user traffic processing devices to strengthen user experience management. Such equipment will include video optimization servers to compress video during times of network congestion; URL filtering servers to prevent children from accessing inappropriate content; and in the future SDN gateway equipment for the management of user traffic QoS on SDN networks.

There needs to be a substantial enhancement in the performance of the next-generation of policy control systems to meet the requirements of more refined traffic operations in the future. According to estimates from Huawei's Core Network MI department, performance needs will increase 20-fold on 2013 levels by 2020, from 10,000 to 200,000 Transactions per Second (TPS).

High reliability

Using policy controls to guarantee user experience is a key measure for boosting subscriber loyalty and reducing churn rates.

The user experience of LTE data services will suffer greatly if policy control systems are unavailable. Take the example of subscribers participating in an important teleconference or watching the live feed of an important football match. If user experience could not be guaranteed due to the policy control system being unavailable, subscribers would be unable to take part in the conference or watch the match; this would significantly impact subscriber satisfaction.

If policy control systems are unavailable, VoLTE services will be unusable. VoLTE services will continue to be an essential service of LTE networks. Policy control systems need to coordinate with wireless systems to notify the latter what traffic is that of VoLTE services so that VoLTE quality can be guaranteed and to implement voice handover between base stations. If policy control systems are unavailable, VoLTE calls cannot be established at the outset.

Policy control systems play a crucial role in LTE data and voice operations. For this reason, the requirements for reliability placed on them should be higher than that of IT and general telecommunications equipment. The aim should be for 99.9999% reliability.

Rapid policy time-to-market (TTM)

With the rapid spread of LTE, mobile

Internet has become an essential part of our everyday lives. We watch video, listen to music, shop and socialize on mobile devices. In order to increase revenue, operators need to respond to the rapidly changing, diverse needs of users by releasing targeted packages or policies in time frames as short as one month or less, encompassing all steps from design to release-to-market. According to Heavy Reading's 2012 report, 65% of operators had to adjust policies every month. The telecom industry's typical six months' time-to-market can no longer meet the operational requirements of LTE.

Take the case of one particular West African carrier. In 2014, this carrier began to plan the release of a YouTube video data package one month before the FIFA World Cup to encourage subscribers to watch the competition on their mobile network. The carrier completed a ROI analysis, designed and deployed the YouTube package/policy within a month. Thanks to the data package it successfully created an additional source of income during the World Cup.

Open

For Internet OTT applications, user experience is a crucial factor for their success. For example, every increase in latency of 100 milliseconds leads to an 8% drop in page views for Google. This is why many OTT content providers are willing to pay operators to enhance the user experience of their content. In terms of LTE networks, when end-to-end QoS policy controls were implemented, policy control systems began to have a true impact on the user experience of various OTT applications.

If operators want to work with OTT providers, they need to start opening up their policy control capabilities. Take the example of a user watching a YouTube video. When the subscriber starts to watch the video, if the operator has provided an open interface to its policy control capabilities, YouTube will be able to send a request to the operator via the interface to guarantee the service experience for this particular instance.

Fixed and mobile policy convergence

The vast majority of operators have already deployed policy control systems across their mobile networks. As fixed networks, like mobile networks, also have limited bandwidth, an increasing number of operators will start to implement policy control systems across their fixed networks in the future to prevent heavy subscribers from excessive use.

The policy control systems of fixed and mobile networks will ultimately converge. This will not only reduce set-up and maintenance costs, but will also allow operators to offer combined packages across fixed and mobile networks, for example unified data management (e.g., data caps, URL filtering) and QoS management.

NFV support

Network functions virtualization (NFV) has been gaining momentum throughout the telecom industry, and is hailed as the latest innovation in network architecture since All IP. The technology offers hardware and software decoupling, standardized hardware platforms, resource sharing, and dynamic resource scheduling – benefits that can reduce operators' procurement and maintenance costs and decrease time-to-market, offering maximum investment protection. In Europe, the majority of tier-1 operators have already tested NFV on the network control plane (core networks such as IMS and EPC) and began commercially deploying the technology in 2015. As important components of IMS and EPC, policy control systems therefore also need to

support NFV.

A comparison of two policy control decision-making center solutions

As defined by the 3GPP, Policy and Charging Rules Function (PCRF) is the decision center of the entire policy control system. It controls the bandwidth policy of every individual user based on their individual usage. It instructs the policy and charging enforcement function (PCEF) to execute policy control, and the online charging system (OCS) to complete the charging function.

The two main PCRF solutions currently in use in the industry are standalone PCRF and OCS-embedded PCRF. The former is a standalone product, while the latter is integrated into the OCS product – a PCRF software module added to the OCS.

Standalone PCRF will be better able to meet the requirements of policy control systems in the future. As a standalone product, it will offer greater flexibility for technological upgrades, which will give it a significant advantage.

In contrast, it will be difficult for OCS-embedded PCRF to meet future requirements because it will be limited by developments in OCS architecture and the OCS product itself. This will make it difficult for technologies that are best suited to PCRF to be adopted. For this reason, OCS-embedded PCRF can only act as a temporary solution.

Standalone PCRF to dominate in future

Developments in LTE are placing new demands on the next generation of policy control systems. The PCRF solution – the decision-making center of the policy control system – must meet these demands. The standalone PCRF solution has a significant advantage due to its greater flexibility for technology upgrades. Standalone PCRF has already been deployed on the majority of 3G networks, with 90% of operators using the solution, according to figures from the MI department of Huawei Core Networks. In the future, standalone PCRF will continue to occupy a dominant market position.

Table 1: A comparison of two policy control decision-making center solutions

Requirements on Next-generation Policy Control System	Standalone PCRF	OCS-embedded PCRF
High performance	Uses the latest distributed architecture; performs at up to 100,000 TPS, with future increases to come	Performance is limited by the performance of the OCS, often less than 10,000 TPS
High reliability	No single point of failure within the product, high reliability thanks to seamless disaster recovery technology	Reliability is untested, limited by the reliability and product maturity of the OCS itself
	For example, among over 200 Huawei UPCCs deployed globally, there have been no reliability incidents in two years	
Rapid policy TTM	Rapid version release program, typically taking one month for a new version supporting new policies to be released	Offers advantages due to the unified policy data configuration with the OCS
	Policy configuration wizards/templates and simulation testing technology can accelerate TTM	
	Some vendors including Huawei have implemented unified policy data configuration for PCRF and PS, which further accelerates TTM	However, it is significantly disadvantaged in terms of new version release speed and PS unified policy data configuration
Open	Standalone PCRF acts as a junction for IT systems and network equipment, providing a convenient interface for OTT providers	The OCS is typically not open
Convergence of fixed and mobile policy control systems	Standalone PCRF can be easily deployed on fixed and mobile networks	Many operators have separate fixed and mobile billing and charging systems, making integration difficult
NFV support	Some standalone PCRF already support NFV, including Huawei's UPCC products	Advances are slow, limited by developments in NFV support in OCS technology

Microwave In-band Full-duplex doubles microwave capacity

Microwave In-band Full-duplex technology improves microwave link capacity, optimizes spectrum resources, and boosts network capacity. It is expected to greatly reduce network OPEX, improve network service capabilities, and become a mainstream solution for microwave network deployment.

Huawei UHSR Project Team

At present, mobile broadband networks are rapidly developing, LTE technology has been commercially applied on a large scale, and the industry is widely researching 5G technology. Specifically, mobile networks are expected to experience massive growth in capacity over the next five years. The already-commercialized LTE-A Cat 6 enables a peak rate of 300Mbps, while LTE-A Cat 10 will provide a peak rate of 1Gbps according to the 3GPP standard, and 5G technology is expected to provide a rate of 10Gbps.

The huge rise in mobile data traffic heaps great pressure on backhaul networks. Microwave backhaul, a major backhaul solution for macro

base stations, will remain a key measure for connecting macro base stations and small cells. Therefore, microwave transmission capacity must be improved to satisfy the rapid growth in mobile traffic.

100% capacity improvement

Microwave In-band Full-duplex (M-IFD) enables microwave transmission in full-duplex mode over a single frequency. It can be applied to the common frequency bands (6–42GHz), V-band (60GHz), and E-band (80GHz). Compared with existing duplex technologies under the same conditions, M-IFD doubles the air interface rate.

If the transmitter and receiver at the same end transmit and receive signals concurrently at the same frequency in microwave communication, the transmitter causes severe co-channel interference. This is much greater than the received signal strength on the receiver, which fails to receive signals properly as a result. In time division duplex (TDD) mode, signals are transmitted and received at the same frequency; however, the transmitter and receiver work alternately to avoid co-channel interference. In frequency division duplex (FDD) mode, signals are transmitted and received concurrently, but at different frequencies. To prevent co-channel interference, traditional TDD or FDD technology must either transmit and receive signals alternately or use different frequencies.

M-IFD cancels co-channel interference, and enables the transmitter and receiver to work concurrently at the same frequency. Compared with TDD and FDD technologies, M-IFD doubles the air interface rate under the same spectrum bandwidth, or saves 50% in spectrum resources while achieving the same rate as TDD and FDD. To double microwave capacity, M-IFD can work with existing microwave capacity improvement technologies such as higher order modulation, multiple-input multiple-output (MIMO), frame header compression, cross-polarization interference cancellation (XPIC), and link aggregation.

Key technologies of M-IFD

Microwave equipment features high transmit power, high-order modulation, and long-distance transmission. These features pose great challenges to M-IFD; for example, signals with high transmit power cause great near-end self-interference on the receiver. In the case of long-distance transmission, far-end self-interference may be caused by obstacles in the transmission path, surface scattering, and reflection at the peer site. Moreover, the increase in frequency bands and bandwidth may cause performance indicators to deteriorate, such as phase noise, which adds to the difficulties of implementing M-IFD. M-IFD adopts the following technologies to overcome these challenges and improve system performance: isolation enhancement, near-end self-interference cancellation (near-SIC), far-end self-interference cancellation (far-SIC), phase noise suppression, and synchronization precision improvement.

Isolation enhancement: On the same equipment where the transmitter and receiver work at the same frequency, co-channel self-interference occurs between the transmitter and receiver as well as between antennas. In the RF front-end circuit design, isolation between the transmitter and receiver can be improved by adding ground holes around signal wires,

Microwave In-band Full-duplex (M-IFD) enables microwave transmission in full-duplex mode over a single frequency. It can be applied to the common frequency bands (6–42GHz), V-band (60GHz), and E-band (80GHz).

increasing the distance between the transmit and receive channels, or optimizing the shielding cavity structure. The transmitter and receiver circuits can also be separated from each other if necessary. In the antenna design, isolation between antennas can be improved by adding near-field interference suppression structures or absorbing materials, optimizing the layout of transmit and receive antennas, or improving circulator isolation.

Near-SIC: Because the isolation achieved by the antenna and circuit design is limited, near-SIC is required to further reduce the near-end self-interference. Near-SIC provides the following functions:

RF interference cancellation: A few transmit signals are coupled from the transmitter to the receiver front end. Based on the amplitude, phase, and delay of the coupled signals, cancellation signals are generated. Their amplitude and delay are the same as those of the interference signals, but the phase differs by 180 degrees. In this way, the near-end self-interface can be canceled. Generally, multi-level interference cancellation circuits can be used to improve the cancellation capability. In addition, the integer nonlinear optimization algorithm that controls the adjustment of the amplitude, phase, and delay enables fast, automatic near-end self-interference cancellation.

IF interference cancellation: ensures that the quantification accuracy is not affected by strong interference when an analog-to-digital converter (ADC) converts received signals into digital signals. IF interference cancellation is similar to RF interference cancellation, except that cancellation signals and adjustment of their amplitude, phase, and delay are completed on the baseband. Interference cancellation signals are converted into analog signals by a digital-to-analog converter (DAC), and interference signals in received signals are canceled at the front end of the ADC.

Baseband interference cancellation: cancels residual near-end self-interference in digital baseband signals. The digital baseband algorithm estimates the interference signals and reconstructs interference cancellation signals to cancel residual interference.

Far-SIC: Far-end self-interference can be generated in any place over the signal transmission path. Therefore, far-end self-interference generally contains multiple multi-path signals with different delays. Far-end self-interference signals can be processed only in the digital baseband. Multiple parallel interference cancellation algorithms can be used to process multiple multi-path signals, improving the processing speed and saving logical resources. In addition, the cancellation algorithms must support a wide range of delays.

Phase noise suppression: Microwave phase noise increases as the frequency increases, and affects the performance of the baseband interference cancellation algorithms and demodulation algorithms. Phase noise in received signals can be reduced using the phase noise suppression algorithm. System noise can be reduced by optimizing hardware circuit design, using high-performance frequency source components, and also by optimizing the loop filter design and transmitter/receiver design. In

M-IFD improves microwave link capacity, optimizes spectrum resources, and boosts network capacity. It is expected to greatly reduce network OPEX, improve network service capabilities, and become a mainstream solution for microwave network deployment.

addition, phase noise in self-interference signals can be effectively reduced by configuring the same local oscillator for the transmitter and receiver.

Synchronization precision improvement: When microwave equipment demodulates received signals, it restores the symbol synchronization clocks from the signals to ensure the sampling performance of the signals. However, in M-IFD, the power of the interference signals and useful signals is similar, making it hard for microwave equipment to identify the useful signals. Adaptive equalization is performed at the beginning of processing digital signals to cancel interference before synchronization, which improves synchronization precision and reduces noise.

Future evolution of microwave backhaul

The rapid growth of wireless network bandwidth requires improved microwave transmission capacity and more spectrum resources. Some operators and equipment vendors propose wireless network solutions that use microwave frequency bands, such as 11GHz, 28GHz, or even millimetric wave bands. These further cut the frequency resources available for microwave backhaul. M-IFD increases microwave link transmission capacity, simplifies O&M, improves frequency utilization, enables flexible network configuration, and enhances other aspects of network performance.

Flexible microwave networking: Densely deployed microwave backhaul sites no longer need spectrum resources in pairs. Uplink and downlink transmission channels can be established in a single frequency band. In this way, more subsidiary bandwidth can be divided from a microwave frequency band division for networking.

Co-site dense deployment: When multiple microwave devices are deployed in the same site, crosstalk between devices working in adjacent frequency bands can be canceled using interference cancellation technology. In this way, the deployment density of microwave devices in the same site can be improved.

Intra-frequency relay: Microwave relays can use M-IFD to cancel crosstalk generated by the transmit antenna on the receive antenna. In this way, the number of frequencies used on a network can be reduced.

Microwave equipment normalization: The integrated transceiver with self-interference cancellation technology features high transmit-receive isolation, and achieves the same effect as the broadband duplexer used in FDD communication. With the transceiver, no duplexer is required for equipment working in each sub-band, simplifying product supply and maintenance.

In conclusion, M-IFD improves microwave link capacity, optimizes spectrum resources, and boosts network capacity. It is expected to greatly reduce network OPEX, improve network service capabilities, and become a mainstream solution for microwave network deployment.

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