Huawei Technologies

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Beyond Technology

Carriers enhance network value through Wi-Fi operation

Well-leveraged policies accelerate broadband evelopment

D-CCAP is MSOs' competitive edge in the Gigabit era

IBA: Wenzhou Mobile's 4K trump card

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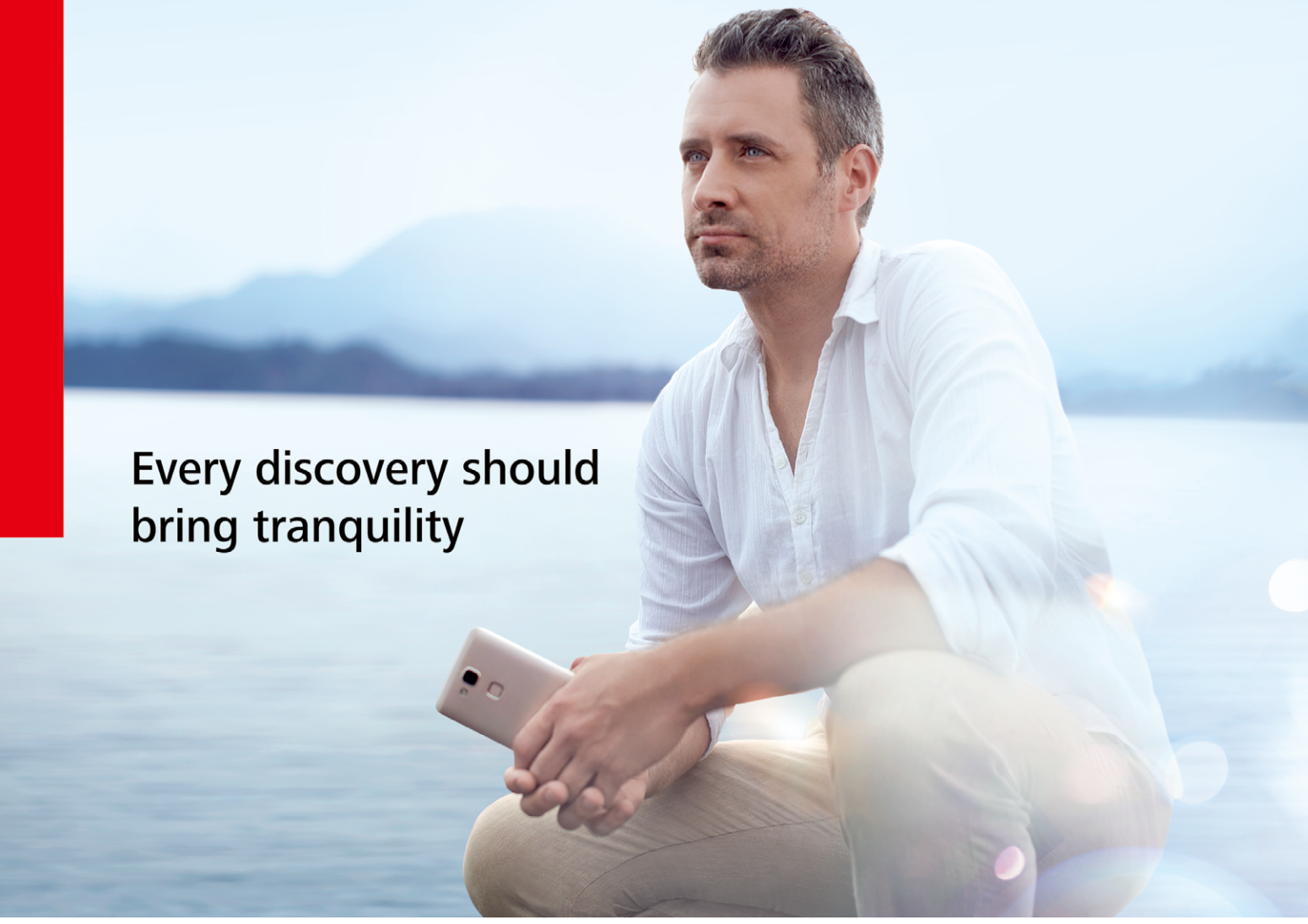

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HUAWEI Ascend Mate7

Big yet small

- Large 6" screen with borderless design
- Sleek 7.9mm metallic body

Fast yet slow

- Ultra fast Cat 6 4G LTE
- 8+1 core processor combined with large 4100mAh batte

Safe yet open

- Convenient and personal fingerprint sensor
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Please refer to the real product for color, shape and material.
Demonstration is created by visual effect.

Access redefined, experience enhanced

Consumers are no longer content with mere broadband; it's the services that must dazzle. With 4K video, smart homes, and the IoT emerging, ultra- broadband ubiquity is a must. To recover the investment this will take, telcos are accelerating service experience-oriented business transformation. Unlike network-centered transformation, user experience and innovative services are the driving force of experience-oriented business transformation.

In the future, networks will be "broader, faster, and smarter." Telcos will take full advantage of existing infrastructure and innovative access technologies to provide users with 100Mbps-to-1Gbps ultra-broadband access. In addition to experience-based business operation for existing customers, telcos should expand sites and terminal resources to home users and business users.

To enhance the service experience, telcos must use more efficient systems and more intelligent networks to perceive and analyze customer experiences. Then they can leverage their network capabilities to improve service experience. In this way, telcos can monetize network capabilities and boost network value. As the near-end for users and the main revenue source for telcos, the access network will be redefined in a whole new way. The "last mile" of the access network is being transformed into "the first meter" of an intelligent network portal for users. With Wi-Fi and smartphone apps, the access network is extending further towards the user.

A new era is upon us. Operators will redefine access, and offer users a superior connection experience that enables and inspires.

Zha Jun

President of Huawei Fixed Network Business Unit

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CONTENTS

Cover Story

Focus

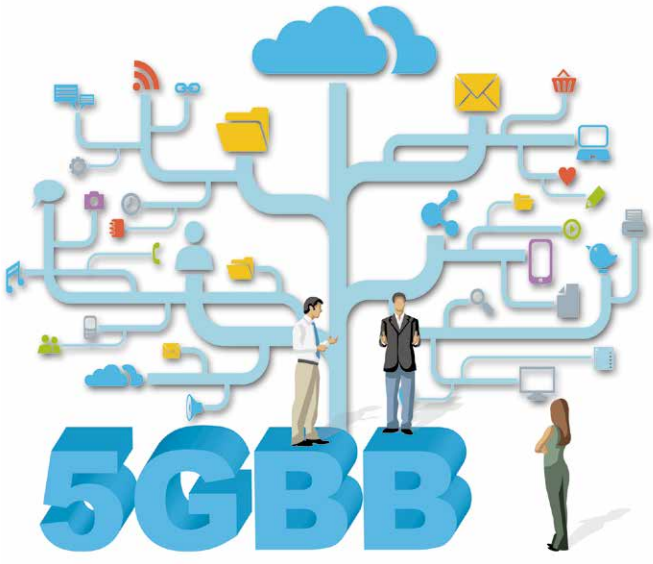
Let's COMMUNICATE beyond technology and share understandings of the latest industry trends, successful operational cases, leading technologies and more. Based on in-depth analysis of the matters that lie close to your heart, we will help you stay on top of the telecom game.

Industry Perspectives

How to Operate

Solutions

Cutting Edge



Achievements >>

Smartphone Best New Arrival

Shanghai, China, Jan 30, 2015, Huawei's large screen flagship smartphone, Mate7, was presented with the "Smartphone Best New Arrival" award at the Eleventh Hurun Best of the Best Awards ceremony in Shanghai. At the event, which sees awards presented to over 100 luxury brands, from car to watches, fashion brands, jewelers, jets, yachts, luxury properties, and private banking. Huawei Mate7 was recognized for its increasing importance as Huawei's "most rapid-growing, popular, and fast selling smartphone."

Supplier Awards

London, U.K., Jan 26, 2015, Huawei has been awarded 'Extraordinary Contribution to Project Spring' at Vodafone's 2014 Supplier Awards. The award recognizes Huawei's outstanding contribution to Vodafone's Project Spring in terms of commitment and dedication, speedy rollout across all target countries, guaranteed high network performance and effective management of delivery. This is the fifth award Huawei has received from Vodafone Group. In 2008 Huawei was named 'Outstanding Performance Supplier'. In 2009 and 2012, Vodafone Group named Huawei as their 'Global Supplier of the Year'. Huawei was also named 'Responsible Supplier of the Year' in 2013.

<< Statistics

507Mbps

Helsinki, Finland, Jan 9, 2015, Ukko Networks, a mobile data operator in Finland, announced the successful completion of a TDD LTE-A demonstration in their Helsinki lab based on a 2.6GHz band. The demonstration showed a peak throughput of over 507Mbps, which is currently the fastest in Europe. The event included a demonstration of throughput of 507Mbps with a 2*20Mhz carrier aggregation, as well as several application services such as a video surveillance solution, which will develop the enterprise market using the TDD spectrum.

Open Social Ecosystem

Las Vegas, U.S.A., Jan 8, 2015, Huawei and Omlet, a spinoff from Stanford University to create an open social ecosystem, jointly announced their partnership at CES 2015. Coming pre-installed on upcoming Huawei Android devices, Omlet's open social platform will unlock the unique attributes of the devices, providing a way for people chat and share photos with friends without losing ownership of the data they choose to share. The integration of Omlet's open social platform in Huawei devices will make it easy to quickly create and share collaborative photo albums. The Social Gallery feature built on the Omlet platform will allow users to build, share and comment on a photo album with friends without the use of any central data storage.

CES2015

Las Vegas, U.S.A., Jan 6, 2015, Huawei Consumer Business Group (BG) showcased more than one hundred products at CES 2015 including its latest flagship smartphones, wearable devices, tablets, mobile access devices, home access devices, smart home devices, OTT and vehicle-mounted modules. The company also introduced the start of the Hilink era – its strategy to offer fully integrated mobile internet solutions to consumers all around the world – as part of its commitment to bringing the latest technology to consumers and creating extraordinary connected experiences for people everywhere.

4K

Chengdu, China, Dec 31, 2014, Huawei and China Telecom Sichuan announced the successful launching of the first commercial 4K ultra-HD iTV network service in China. They have also jointly released a 4K ultra-HD intelligent smart set top box (STB), making China Telecom Sichuan the first telecommunications company in China to use 4K STBs for carrying video services. Huawei and China Telecom Sichuan specially adopted the H.265 video coding standard for a better user experience, and also deployed leading technologies to optimize the code stream, coding quality, delay, and algorithm complexity.

Agile Stadium

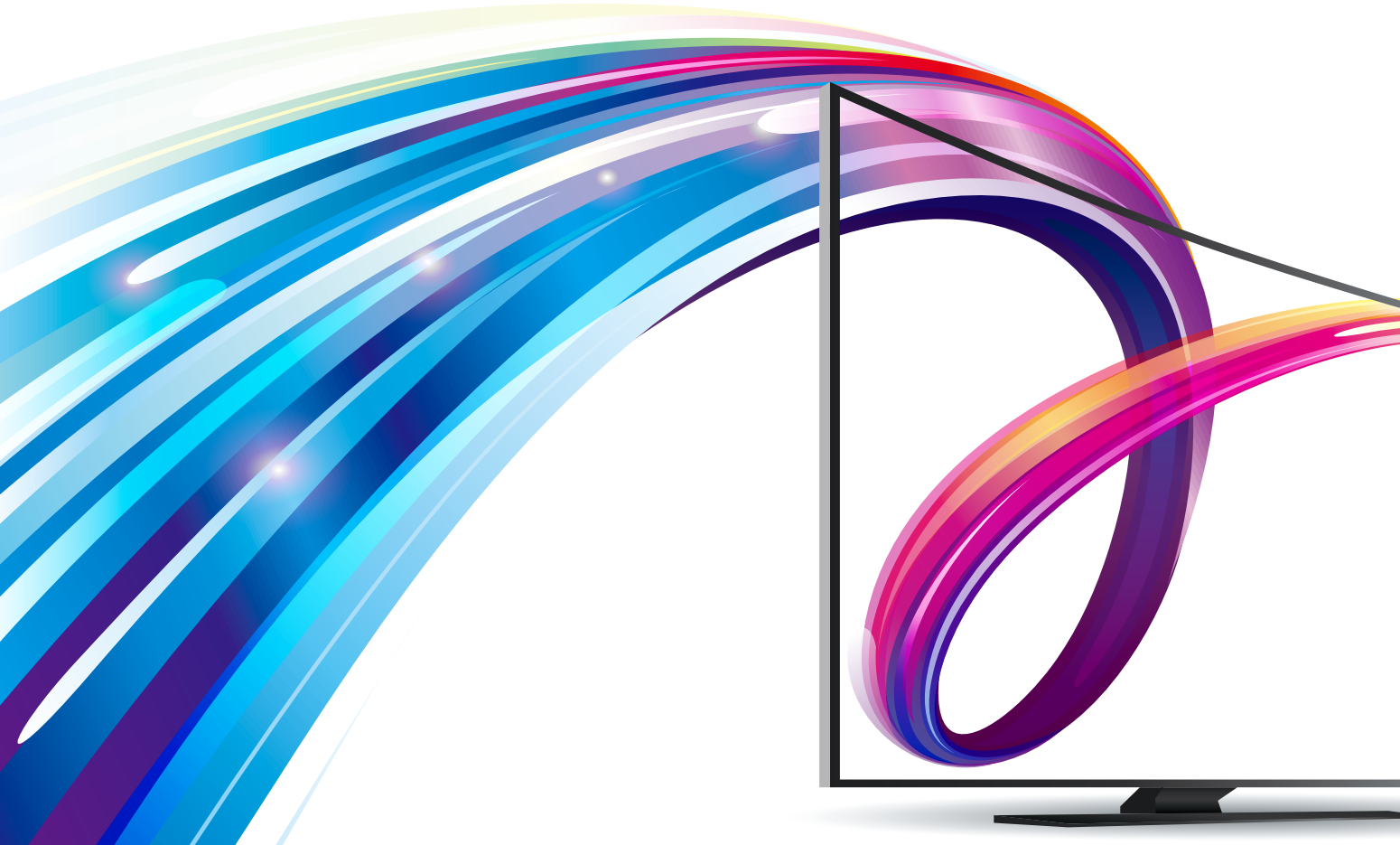
Moscow, Russia, Jan 9, 2015, Huawei successfully deployed its Agile Stadium Solution in Spartak Stadium in Moscow. With the solution, the stadium has been modernized to efficiently deliver high-density, high-security wireless broadband Internet access to fans, and also ensure a direct link between stadium operators/sports clubs and fans for enhanced services such as direct ordering of food and drinks to fan seats, sales of tickets and goods, seat and parking navigation, and so forth.

NFV Open Lab

Xi'an, China, Jan 20, 2015, Huawei announced the launch of its new, state-of-the-art Network Functions Virtualization (NFV) open lab in Xi'an, China, dedicated to developing multi-vendor integration verification capabilities, expanding joint service innovations with customers, partners, industrial organizations and open source organizations and accelerating development of the open eco-system for NFV infrastructure, platforms and services. These efforts mark a key step to realizing Huawei's future-oriented open SoftCOM architecture.

Dual-beam Antenna

Shenzhen, China, Jan 8, 2015, Huawei has released an innovative dual-beam antenna solution which allows simple and efficient deployment of 6-sector networks for operators. The solution has already been deployed by AIS Thailand and improved capacity by 70%. Huawei's innovative dual-beam antenna solution improves on the shortcomings of the traditional 6-sector solution. As the sole provider of both RAN and antenna solutions, Huawei's antenna adopted a synergistic design which was developed at the conception stage.



IBA: Wenzhou Mobile's 4K trump card

Intelligent broadband acceleration ensures an optimal user experience through bandwidth on demand. One of the areas that can benefit from this is 4K (ultra-high-definition) video. As broadband acceleration becomes more intelligent, fixed broadband becomes more valuable.

4K on the rise

4K resolution (3840 × 2048) boasts four times as many pixels as Full HD (1920 ×1080) and nine times as many as HD (1280 × 720). With 4K live broadcasting taking place at the 2014 FIFA World Cup, and the world's first ultra broadband 4K TV channel launching this past April in South Korea, 4K is on the rise.

Implementation challenges

4K is still little known or enjoyed by general consumers outside of a few select countries. In the development and promotion of 4K products, content providers, terminal vendors, and carriers all face a number of obstacles.

Lack of 4K content support

Compared with HD media content, 4K poses greater requirements on cameras, storage and editing equipment, shooting, and even props and makeup. Thus, 4K programs are much more difficult and expensive to produce. What's more, network bandwidth hinders 4K consumption. With current H.264 and H.265 technologies, 4K streaming can consume 30 to 100Mbps, forcing content providers to pay carriers much higher fees, fees that may not seem worthwhile, given that most consumers aren't receiving nearly this much bandwidth in their homes (the Chinese average is 3.5Mbps).

Products (TV/STB chips) that adopt H.265 technology, which supports a higher compression ratio and improved bitstream, have captured the attention of industry players, who regard them as a

Li Hui
Huawei Fixed Network Business Unit Expert

In the development and promotion of 4K products, content providers, terminal vendors, and carriers all face a number of obstacles such as insufficient content, low penetration rate of ultra broadband, and modest terminal sales.

transitional terminal optimization solution that enhances the 4K experience.

Bandwidth limitations

According to China's Ministry of Industry and Information Technology, China's broadband users numbered 198 million in June 2014, of which 53.9 million (27.3%) were optical fiber users. Although 100Mbps optical connection is commonplace, average bandwidth access speed is only 3.5Mbps, and a lack of valuable high-bandwidth applications is discouraging consumers from upgrading. Despite the fact that many carriers offer "free broadband acceleration" services, most consumers still don't consider high bandwidth a necessity.

Unsatisfactory picture

Many consumers complain that 4K TV sets don't perform as well in the home as they do in the showroom. Those aforementioned content and bandwidth limitations are at work here, as is a lack of calibration expertise (an optimized image is rarely delivered with a TV's factory settings) outside of the advanced markets. With 4K televisions commanding premiums of over 100% over a comparably-sized HD set, that's a steep price to pay for something that doesn't seem to deliver on its promise.

IBA will expedite industry cooperation

The development of the 4K industry will definitely unleash great market potential at every point in the industry, and shift the competition focus of the TV industry from price to technology. This process cannot be achieved alone by media content providers, carriers, or terminal manufacturers. End-to-end (E2E) industry chain cooperation is a must.

Compared with content providers and terminal vendors, carriers have been slow to promote 4K development. For consumers, a 100Mbps bandwidth subscription used exclusively for 4K programming is costly and unwise. Intelligent broadband acceleration (IBA) technology can address this problem, and speed up the cooperation of the 4K industry.

With IBA, audiences watching a 4K program can have their broadband accelerated to the range of 30 to 80Mbps (based on current H.264 or H.265 technology), with the bandwidth automatically returning to normal after the program concludes, at an expense far less than a 100Mbps subscription would command. What's more, other services and applications can be accelerated during 4K viewing, making IBA a hit with consumers.

IBA should stimulate both 4K sales and consumption. Terminal manufacturers have the most to gain, and this had made them willing to pay for certain pipeline upgrade costs. Content providers can charge for value-added services such as 4K theater or bind their content to manufacturers' 4K products to share in the profits, which should be considerable. Carriers can charge less from upstream content providers for bandwidth, but the resulting surge of 4K traffic consumption should more than compensate. Consumers at first can utilize IBA through short-term monthly packages or pay-per-view

services, but they'll become ultra-broadband subscribers eventually, making for a net boost to carrier revenue.

IBA streamlines E2E network capabilities to ensure an optimal user experience. Huawei's intelligent network control platform streamlines E2E network functions that include the BRAS, OLT, and ONT, enabling timely broadband acceleration, without changing the existing network structure.

Online "4K theater" in Wenzhou

China Mobile Wenzhou (Wenzhou Mobile) serves the affluent trading hub of Wenzhou, a city with over 700,000 fixed broadband subscribers (all FTTH), most of which subscribe to 4 or 6Mbps packages. Consumers have the lacked the incentive to upgrade beyond this range, while market forces have driven down the price of a 6Mbps broadband package to a very modest price per year. Meanwhile, most of Wenzhou Mobile's FTTH networks have reached a network load over 90%.

Through active exploration and innovation and close cooperation with Huawei, Skyworth, Hisense (both are Chinese TV vendors), and Union Voole (a major Chinese Internet content provider), Wenzhou Mobile launched its "Happy Family, Happy 4K" online 4K theater on August 15, 2014. Consumers who buy Skyworth's 4K TVs pre-installed with UnionVoole's IBA client can enjoy online 4K movies, with bandwidth accelerated to 100Mbps as needed.

Industry chain cooperation has been the key to Wenzhou Mobile's rapid launch of online 4K. High cost in 4K content production

The development of the 4K industry will definitely unleash great market potential at every point in the industry, but this process cannot be achieved alone by either media content providers, carriers, or terminal manufacturers. End-to-end (E2E) industry chain cooperation is a must.

Consumers get a package with an intelligent bandwidth-boost and rich 4K content when they buy a 4K TV set. This has stimulated the sale of 4K sets in Wenzhou.

is a shared challenge for content providers and operators. Wenzhou Mobile encourages content providers by offering IDC at a preferential price, thus reducing traffic cost. Union Voole content is also subsidized by TV vendors. Consumers get a package with an intelligent bandwidth-boost and rich 4K content when they buy a 4K TV set. This has stimulated the sale of its 4K sets in Wenzhou. Although the operator reduced traffic fees for the content provider, 4K consumption still managed to drive the rapid growth of CDN traffic, meaning boosted revenue for the carrier. What's more, 4K TVs bundled with broadband and SMS and telephone marketing targeted at Skyworth's customers has driven the sales of mobile broadband. After three months of free trial use, IBA will be charged, with users able to pay per month or pay per view.

Both Wenzhou Mobile and Skyworth boast a vast system of sales channels, the sharing of which is another highlight of their partnership. Skyworth's 200+ direct-sales outlets in Wenzhou are open to Wenzhou Mobile for mobile broadband service, while the latter's business halls showcase "Happy Family, Happy 4K" services. In addition to selling "4K + broadband," the business halls also promote the idea of 4K theatres and help build a brand image of "real 4K" for Skyworth.

Technical architecture of IBA

Wenzhou Mobile's current IBA solution comprises of four parts – a content system, IBA platform, network access system, and 4K TV terminals. There is also the external interoperating system of Zhejiang Mobile's business and operation support system (BOSS) platform.

Content system

Wenzhou Mobile's 4K video-on-demand (VoD) content system is provided by UnionVoole. The content is stored locally, as IBA is a targeted solution for the network side, with only content stored locally or within a WAN capable of broadband acceleration. If the EPG server was deployed in a single country-level node, user experience might be negatively impacted. In order to shorten the latency and improve the service stability, after negotiations with Wenzhou Mobile, Union Voole plans to mirror the EPG server in the provincial node.

IBA platform

The IBA platform itself, known as NETOPEN, is deployed in Wenzhou Mobile's equipment room, and is provided by Huawei. NETOPEN connects the Broadband Remote Access Server (BRAS) and service applications, or content platforms. It accelerates the pipeline bandwidth between users and content/application servers to a required level to optimize E2E user-side service experience based on acceleration requests sent by content server platforms, such as UnionVoole's EPG server or platforms of other content providers (in the future) and Internet service platforms.

BRAS system

The BRAS system is a carrier-side system

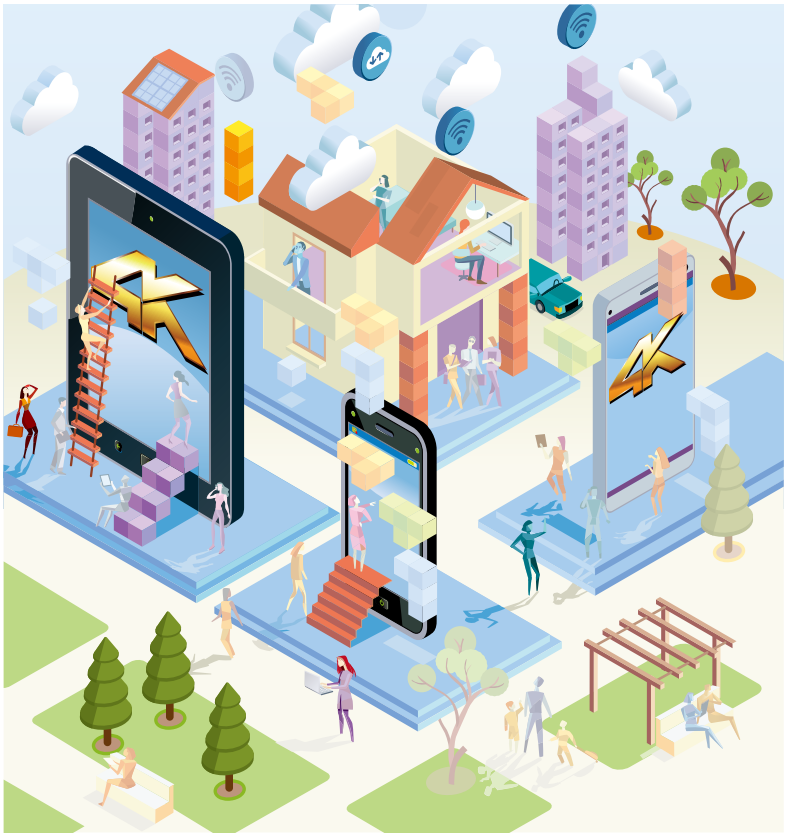
that connects to the optical line terminals (OLT). It implements user broadband acceleration based on "acceleration requests" sent by the IBA platform. BRAS integrates user pipelines with the content providers' service systems so that the pipelines and the cloud system can coordinate to optimize service experience.

4K TV terminals

Currently, Skyworth is the only manufacturer to have deployed the IBA platform in China, but other brands with H.265 codec capabilities will soon be introduced, as will additional content providers. The ultimate goal is to popularize Wenzhou Mobile's "Happy Family, Happy 4K" service and make the solution a model for the industry.

To expand the system across all of Zhejiang province, Wenzhou Mobile and Zhejiang Mobile have cooperated to achieve commercial interoperation between the IBA platform and the BOSS. Consumers can subscribe easily via Zhejiang Mobile's business halls or the content provider's client. Both pre-paid and post-paid models are supported.

To further optimize user experience, help carriers create business value, attract more content providers, and seize the last-mile pipe market, Huawei will provide more solutions and technologies relating to intelligent optical network terminal (ONT: fiber optical transceiver + smart router with service content plug-in), which can strengthen carriers' indispensable position in the industry chain. In the end, carriers can deliver to customers a more diverse and cost-effective indoor access experience and offer content providers more friendly and consumer-centric pipeline service integration, making for enhanced business value.



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The value of IBA is that it ensures the best on-demand service experience for end users. In addition to 4K, it can be applied to cloud storage, download, and gaming. As exploration and innovation go on, IBA will further unleash the potential and value of fixed broadband.

Carriers enhance network value through Wi-Fi operation

Carriers and Internet companies should cooperate to bring their advantages into full play. Carriers can focus on optimizing and guaranteeing Wi-Fi access experience while Internet companies can concentrate on user resource monetization. Together the two can build a healthy and sustainable business ecosystem.

Gu Xiaofeng
Marketing Manager of Huawei Fixed Access Network Business Unit

With the popularity of smart devices and mobile Internet, wireless access is becoming mainstream. From the point of view of end users, mobile and fixed broadband will eventually converge to provide ubiquitous ultra broadband for wireless connection. The Wi-Fi industry chain is very mature and supports a variety of types of smart devices including tablets, video game consoles, ebook readers, and digital cameras. According to Mobidia statistics, around 70% of smartphone data traffic is consumed via Wi-Fi. In indoor scenarios, the percentage is as high as 80% or more. Wi-Fi technology is developing steadily. The latest 802.11ac can boost Wi-Fi transmission throughput to over 1Gbps. The ultra-high-speed surfing experience breaks the bottleneck of home Internet. Therefore, as the major access mode for smart devices, Wi-Fi is the key to ubiquitous ultra broadband coverage in homes, office buildings, public places, and even vehicles.

Wi-Fi: An underestimated market

Currently, except for some public hotspots, carriers do not provide Wi-Fi for homes, office buildings, or shopping malls. Traditionally, carriers offer in these places voice, broadband, or leased line services. Deploying Wi-Fi in these places can hardly create any new revenues and the maintenance costs are high. Especially in shopping malls, Wi-Fi may offload traffic of higher-value cellular networks, so it is understandable that carriers lack the initiative to deploy Wi-Fi. As a result, most carriers only deploy pipelines to customers' houses or malls where end user experience cannot be perceived.

For many Internet companies though, the potential market space of Wi-Fi service in homes, shopping malls, and public hotspots is greatly underestimated. While carriers stick to fiber-to-the-home (FTTH), Internet companies are vying for the user access portal. Chinese Internet companies represented by HiWiFi

and Xiaomi have already broken into the home market using smart routers, thereby seizing the portal of future smart home services. Smart routers have become another typical OTT service. As to restaurants and shopping malls where foot traffic is huge, competition for Wi-Fi service by Internet companies is even fiercer. Through business model innovation, Internet companies provide free Wi-Fi for users to channel commerce towards online to offline (O2O) shop portals. There are over 300 companies engaging in commercial Wi-Fi service in China. TreeBear, a company invested by Alibaba Group, is a typical example. The company provides shops with customized portal service. While offering free Wi-Fi within their shops, shop owners can obtain users' WeChat numbers, phone numbers, QQ numbers, and email addresses for advertisement delivery and secondary marketing. They can also turn customers into fans of their online shops. Internet companies then gain revenues through platform big data analytics and developing customized value-added applications for vendors.

Google is also deploying Wi-Fi hotspots in America. Google has its own cloud platform and allows users to access Google's Wi-Fi hotspots for free after being authenticated by Google's Wi-Fi app. After the first authentication, users' smart devices can access any Google hotspots without user perception. This boosts the usage of Google search engine, bringing more advertisement revenue.

Internet companies' entry into the Wi-Fi market is a huge threat to carriers. They offer OTT-style free Wi-Fi based on carriers' fixed networks. Free Wi-Fi offloads the traffic of carriers' mobile cellular networks but does not produce any revenue for them. How should carriers transform their business model to cope with the challenge?

Improved network value through Wi-Fi extension

Faced with intense competition from OTT Wi-Fi, carriers are also paying increasing attention to Wi-Fi's role as the Internet access portal. Many of them are trying to extend fixed networks to users' smart devices by deploying Wi-Fi.

Home Wi-Fi operation and business model

PCCW of Hong Kong provides customers with home and enterprise Wi-Fi networking. For large residential buildings and office buildings, the carrier offers Wi-Fi devices and conducts professional Wi-Fi network deployment. This expands PCCW's business range. It can charge HKD9800 from high-end home customers for the Wi-Fi networking. Thousands of home users have subscribed to the service.

After carriers extend Wi-Fi to home users, they can conduct business innovation based on the information obtained. Liaoning Unicom collects information on users' network visit, terminal type, and even mobile number through Wi-Fi. By analyzing the data, the carrier can formulate accurate

Wi-Fi will become an important access portal for mobile users and a new competition field for Internet players. Internet companies face the great challenge of providing superior Wi-Fi coverage and experience and conducting network operation and maintenance (O&M).

marketing plans, develop new preferential packages, and give subsidies to attract users of other carriers.

In-shop Wi-Fi operation

In the commercial Wi-Fi domain, China Telecom and China Mobile are considering to cooperate with OTT companies. Guangdong Telecom's third-party partner eShore is operating a portal platform, providing customized Wi-Fi marketing service to shops. Using the carriers's brand and marketing platform, eShore provides commercial Wi-Fi service (bundled with communication services) to shop owners. The third-party company conducts post-paid business operation and shares profits with Guangdong Telecom, which anticipates over 700,000 Wi-Fi shop users in a single year.

Hangzhou Mobile also works with the famous Zhejiang-based OTT company – Shuxiong to bundle the company's Wi-Fi marketing service with its own broadband service and provide them to shop owners. Shuxiong earns profits with the post-paid model, while Hangzhou Mobile enhances the competitiveness of its broadband service among shop customers. Shop vendors, on the other hand, can use Wi-Fi for secondary marketing in order to attract online fans.

In some countries where Internet innovation is insufficient, carriers can play an even more important role in Wi-Fi service. An operator in Mexico targets small office/home offices (SOHOs) as well as street convenience stores and restaurants. They plan to provide broadband access and Wi-Fi to over 20,000 convenience stores in Mexico City, and use the additional four to eight Service Set Identifiers (SSIDs) in the access device for Wi-Fi sharing. Through this initiative, they will obtain tens of thousands of Wi-Fi hotspots for free while gaining many small business broadband subscribers. These SSIDs can be used for marketing, leased to other carriers for traffic offloading, or leased to OTT companies for user access portal monetization. This business model has already been proven by Japan's NTT Broadband Platform (NTTBP).

Win-win cooperation

The industry trend shows that Wi-Fi will become the most critical technology in the last 10 meters to users. Wi-Fi will become an important access portal for mobile users and a new competition field for Internet players. Internet companies face the great challenge of providing superior Wi-Fi coverage and experience and conducting network operation and maintenance (O&M). Carriers, however, have E2E network control, comprehensive O&M teams, rich network operation experience, and unique advantages in sales channels and brand image. As to the Wi-Fi operation model, carriers and Internet companies should work hand in hand to bring their own advantages into full play. Carriers are dedicated to assuring Wi-Fi experience while Internet companies focus on the operation and monetization of user resources. Together they can build a healthy and sustainable business ecosystem.

Joint iODN innovation drives FTTH development

FTTH deployment has a long history of cost and efficiency problems. To seize market opportunities, telcos need to speed up return on investment (ROI) and improve FTTH deployment efficiency. Huawei is dedicated to optical distribution network (ODN) innovation to cope with FTTH construction challenges, having developed floor distribution box (FDB) and pre-connection solutions that have seen action on Rostelecom and Telefónica networks, respectively.

Ma Hongyan
Marketing Manager of Huawei Fixed Access Network Business Unit

FTTH is still a story of high cost, low efficiency, and slow ROI. ODN construction costs account for over 60% of FTTH investment, with the network planning and product selection involved complicated. Different ODN construction models (centralized/distributed splitting, level-1/level-2 splitting, fiber fusion/mechanical splicing) can lead to different costs overall. Therefore, flexibility in ODN networking and product standardization are key to FTTH construction in the early periods as they can improve FTTH deployment efficiency and reduce CAPEX.

Huawei focuses on the challenges telcos face and engages in a variety of joint innovation projects. It worked with Rostelecom to develop an FDB to facilitate the latter's FTTH development. It also worked with Telefónica to jointly design a pre-connection solution to help improve the telco's FTTH deployment efficiency.

Joint FDB design

Huge investments and low installation rates

Rostelecom is the largest fixed network operator in Russia, offering telecom and long-distance transmission services in eight of the country's nine federal districts. The Russian government has demanded that Rostelecom develop 13 million FTTH users by 2015. With the exception of a few major cities, Russia is sparsely populated, leading to extremely low actual installation rates. Thirteen million users in two years is a daunting task in such an environment, especially given the huge investments and low actual installation rates involved. Rostelecom needed a partner to help it increase actual installation rates and accelerate ROI.

Huawei and Rostelecom in tandem

In the early deployment stages of Rostelecom's network, construction is done to user access points and floor distribution boxes (FDBs) are deployed

as the interface between the outside plant (OSP) and the inside plant (ISP). In future network expansion situations, pre-made drop cables can be used for plug-and-play and quick service provisioning. Backed by this model, Huawei and Rostelecom customized an innovative FDB to meet this requirement. The FDB was designed in a step-by-step manner to meet different requirements during the different stages of FTTH construction, ensuring that only appropriate investments are made. In the initial stage, Rostelecom can deploy FDBs that provide access to only a single user. As the numbers of subscribers increase, the FDB can smoothly evolve to support four and even eight users, ensuring timely access. This method of expansion is innovative and flexible, requiring no splicing. Engineers can complete the expansion in just one minute, without the need for a single tool. This FDB solution is particularly applicable to sparsely populated areas where the actual installation rates are low and construction seasons are short. This solution will help Rostelecom build a flexible and scalable optical distribution network (ODN), improve deployment efficiency, maximize ROI, and reduce the total cost of ownership (TCO).

Huawei and Telefónica develop FastConnect solution

As a global leader in full-service operations, Telefónica has drawn up a grand plan for FTTH development, adopting Huawei's customized ODN solution to facilitate it. This innovative solution employs pre-connection, making for greatly improved outdoor FTTH deployment efficiency.

This solution uses aeronautic connector technology, with plug-and play pre-connection drop cables, saving the trouble of manual welding and enhancing engineering efficiency. The solution also supports IP68-level protection, allowing optical fibers to work at a temperature range from +70°C to -40°C, as well as environments of high humidity.

Daniel Paul, Telefónica's access network director, said, "ODN is the infrastructure for FTTH and is highly adaptive to tough environments. The plug-and-play ODN solution can effectively improve FTTH deployment efficiency through pre-connection to realize large-scale FTTH deployment."

You Yiyong, director of Huawei's access network product line, also remarked, "Global fixed ultra-broadband construction is in full swing. We focus on customers' challenges and conduct innovation accordingly. Huawei's patented pre-connection solution helps customers build ultra-broadband networks by improving FTTH deployment efficiency."

Huawei is committed to ODN innovation

Committed to technical innovation, Huawei provides customers with the FastConnect ODN solution to allow for fast deployment and intelligent management. In October 2010, Huawei announced the industry's first intelligent ODN (iODN) solution, which received the InfoVision Award at the Broadband World Forum (BBWF). In November 2012, iODN standards primarily developed by Huawei were also released by ITU-T. In July 2014, Huawei and Rostelecom cooperated to develop the innovative FDB and signed a framework procurement contract. In 2014, Huawei and Telefónica signed a two-year framework procurement contract for pre-connectorized products (FastConnect). Zha Jun, Director of Huawei's Fixed Network Product Line, and Javier Gutiérrez, Telefónica's Vice CTO, signed an agreement on joint ODN innovation. So far, Huawei has deployed over 60 intelligent ODNs around the world. Huawei will continue to work with global carriers to conduct innovative ODN research. It will apply the iODN architecture in product solutions and upgrade passive ODN to intelligent ODN to realize simplified and intelligent management of optical fiber resources.

Transforming billing to revenue generation

The billing system is a vital element in any telecom network and the best place to start the transformation process. Since the billing system links two core carrier assets (networks and customers) together, its transformation is in fact the most important transformation of all.

Wang Lin
Market Representative of Huawei Revenue Management

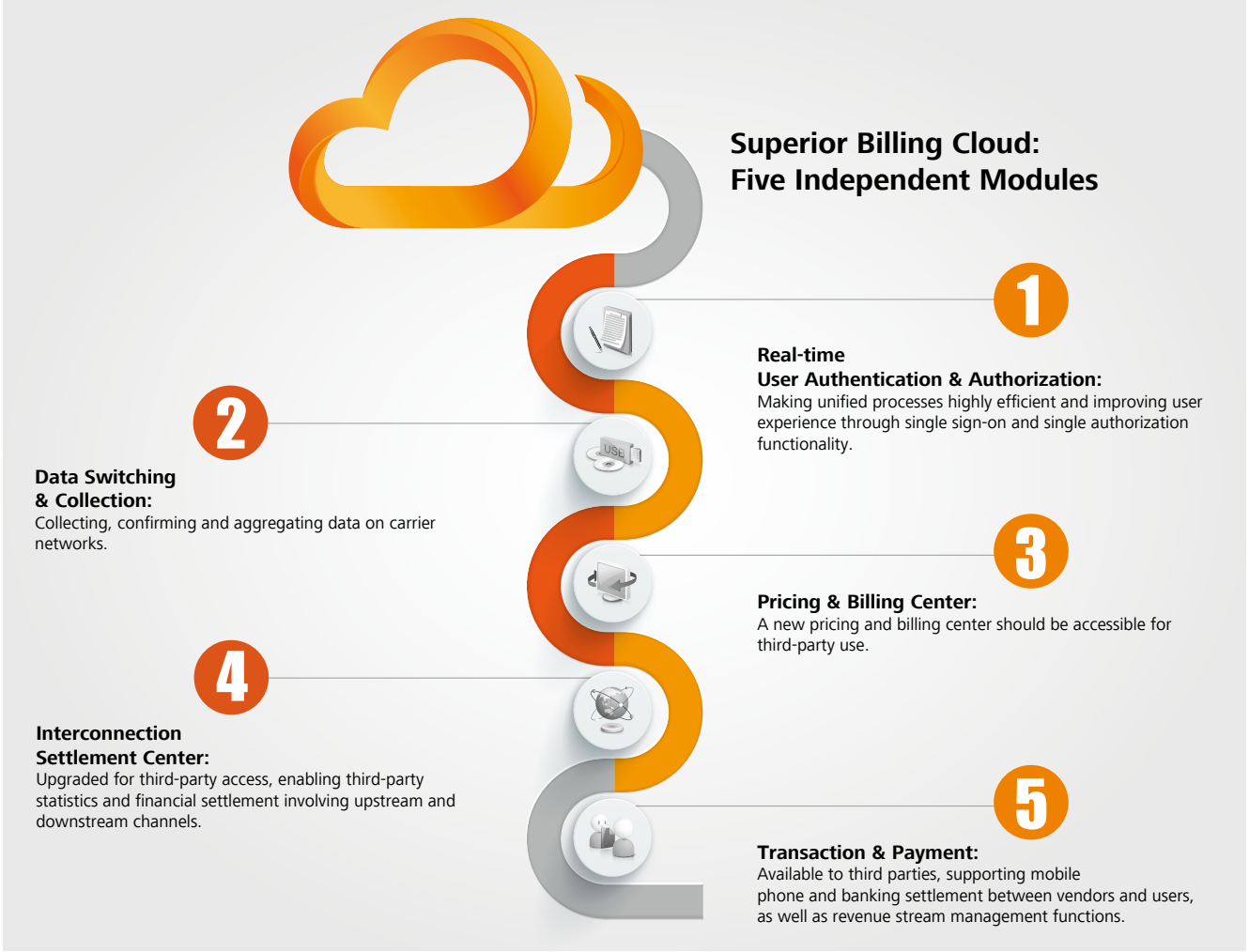
Telcos are becoming increasingly restless as they watch Internet companies benefit most from the digital economy. Many have proposed the "de-telecom" concept or "injection of Internet genes" in an effort to transform themselves along ISP lines, but telco transformation is not about abandoning existing advantages to engage Internet companies in an increasingly homogenized market. It should be about business model transformation through digital operation, with Internet innovation complementing existing strengths. Telcos' billing systems, which give feedback to customers regarding their Internet consumption behavior, are the best places to start. In fact, since they associate telecom networks with Internet IT innovation, they are the very key to business transformation.

From networks to experiences

A traditional billing system is network-derived, a tool that calculates the fees users should pay for network usage. However, the current digital economy emphasizes "experience first, service foremost," and an ordinary billing system does not inspire loyalty. Carriers must redesign their billing systems around customer experience-orientation, with the goal of making customers feel valued and thus willing to pay higher premiums.

A reformed billing system should have the following features:

Integration: Traditional billing systems are network-dependent, with network and service limitations directly perceptible to users. If an intelligent network (IN) billing system only supports GSM voice billing, subscribers cannot use data services. The coexistence of multi-standard networks, coupled with the isolation of pre-paid and post-paid billing systems, leads to multiple billing systems, thus aggravating this problem. A new-generation billing engine should support all standards, physical interfaces, and value-added services, while shielding the differences in CT network elements (NEs). It



should also provide unified online billing and control capabilities for the IT layer, including those for actual services and different user types (pre-paid/post-paid/hybrid). Finally, a new billing engine should support all network services, making it the very foundation of customer-centric billing.

Real-time functionality: Traditional billing systems do not operate in real time, and carriers have long dismissed this notion. However, IN billing systems do, but only with the aim of collecting fees more quickly. The digital economy has revolutionized service usage behavior, with users now growing more and more accustomed to real-time experience. They need real-time updates about how much data is left, as no one wants to exceed their data cap while watching a movie. A next-gen billing engine should feature real-time monitoring, billing, alarm, and service recommendation, so users can have a real-time understanding of their data and voice consumption.

Agility: The digital economy is accelerating consumption. Traditional billing systems can no longer keep up due to a lack of customization or on-demand design. Next-gen billing should be agile in terms of products and services through a flexible business rule engine and business script, thus reducing time-to-market (TTM) from months to hours. A flexible engine makes product design inter-disciplinary work, as opposed to telco-only. Carriers can cooperate with ISPs to provide targeted and differentiated service packages, or with terminal manufacturers to provide tariff packages bundled with certain phones.

Billing as a service

Not long ago, people were using cellphones that offered voice and SMS only. Today they revel in their smartphones. Smartphone makers themselves have received the lion's share of the credit, but the real facilitators have been a variety of invisible service support systems, or more accurately, application clouds for support platforms.

As the owners of a vast amount of device-related user information, and with a monopoly in terms of network pipes, telcos have also tried to build cloud services, but with little success. This is because they have largely offered "me-too" cloud service models already perfected by OTTs. Telcos would do better to leverage their networks and the

enormous amount of accurate user information they hold to carry out IT restructuring, starting with the building of an agile IT-enabled billing system. This is how telcos can break their closed operating model and create a trump card for cloud operations.

To build a superior billing cloud that helps industries achieve digital billing, telcos must cloud their billing architecture so that independent service clouds can be packaged and offered to third parties. The cloud components include five modules: real-time user authentication & authorization, data switching & collection, pricing & billing, interconnection settlement, and transaction & payment.

The traditional online charging gateway should be upgraded to a user authentication/authorization center. A modular authentication/authorization center makes unified processes highly efficient and improves user experience through single sign-on (SSO) and single authorization functionality, thus minimizing the inconvenience of logging in many times to various Internet services.

Traditional mediation should be upgraded into a data switching & collection center, which can collect, confirm, and aggregate data on carrier networks.

A new pricing and billing center should be accessible for third-party use. For example, a power company might install SIM cards in electric meters for interconnected pricing, enabling automated meter reading, billing, and bill delivery.

The traditional partner settlement system should be upgraded for third-party access. Such a system should support flexible multi-service, multi-partner settlement, enabling third-party statistics and financial settlement involving upstream and downstream channels.

The traditional fee collection, user charging, and revenue stream management system should be upgraded to a new transaction & payment center, once again available to any third party. It should support mobile phone and banking settlement between vendors and users, as well as revenue stream management functions such as circulation and exchange of product resources, discount coupons, and virtual currency. This new center could also be deployed in other capacities such as railway coverage, enabling customers to buy tickets by sending a short message on their handset.

Case study: Telenor Pakistan

The billing system swap for Telenor Pakistan (TP) has been the first step in Telenor Group's strategic transformation in Asia. The Group's leaders have attached great importance to this swap, dubbed "Trango" (a Pakistani peak notoriously hard to conquer). TP planned to build a brand new IT architecture-based billing engine to realize transformation from traditional billing to a market-oriented revenue-generating operating model. The new billing engine would greatly optimize customer experience and shorten service TTM.

With the help of Huawei, the project results were extraordinary, even in the face of what seemed endless difficulties. The new system supports all user categories (pre- and post-paid) and delivers online real-time billing for all services (voice, SMS, MMS, and data services), while preventing large-scale bad debts from the source. The system's agility ensures that most requirements do not need customized development, shortening service TTM from half a year to one to three days. With the successful transformation of its billing system, the foundation is laid for TP's other transformations.

According to Irfan Wahab Khan, TP's CMO, "I am very excited and proud to witness the success of such a big and important swapping project. More surprising is that the upgrade leads to successful business transformation of Telenor through perfect integration of technical and business processes. I must say the painstaking work of the Trango project team, consisting of Telenor and Huawei members, proved a great success. "

Well-leveraged policies accelerate broadband development

A 10% increase in broadband penetration generates 1% GDP growth. Broadband construction has become one of the driving forces of economic recovery and growth for countries around the world. National-level ICT policies provide macro-regulation and control of broadband development. Well-leveraged policies can iron out market wrinkles and ensure optimal resource allocation and distribution.

Xie Weiqiang
Senior Marketing Manager of Huawei Fixed Access Network Business Unit

Statistics show a correlation between broadband penetration and socio-economic growth. Every 10% of penetration generates 1% GDP growth. Broadband construction has become one of the driving forces of economic recovery and growth for countries around the world. Progressive policies ensure national-level macro-regulation and control. Well-leveraged industry policies can iron out market wrinkles and achieve optimal resource allocation and distribution.

Broadband development bottleneck and government support

In the 21st century, "broadband" has become a buzzword. Countries around the world have invested heavily into next-generation broadband deployment. The ICT industry is now the engine of economic innovation and growth and credited with improving productivity. In 2013, China officially announced the "Broadband China" strategy. Other countries and telecoms also proposed their own broadband development strategies and construction plans, leading to booming broadband deployment across the world. At the same time, Internet services are developing rapidly and enriching their offerings. Services such as fixed and mobile convergence (FMC) and multiscreen are also growing. There is now a global broadband development trend aimed at ultra-broadband coverage.

The driving forces of network evolution and the building of new networks are customers' constant demand for high-quality service experience and continuous ICT development. New access media based on optical fiber, integrated optical & copper access, and the

exploitation of traditional copper wires provide the foundation for ultra-broadband services. However, network bandwidth cannot be the sole measure of Internet service development and service experience. Telecoms need to address three challenges in the construction and sustainable development of ultra-broadband – investment, terminals, and content.

To promote the development of the telecom industry and ultra-broadband and to guide third parties to help telecoms solve these three problems, governments should provide strategic guidance and support through industry policies to ensure that broadband construction is included in national strategic development strategies, just like expressways and railways.

Investment: Shift from encouraging competition to encouraging investments that support rapid fixed broadband (FBB) development.

Cost: Coordinate infrastructure construction to reduce network costs.

Operation: Promote industry chain integration & bandwidth monetization.

Development: Execute the national broadband network (NBN) strategy.

Shifting from encouraging competition to encouraging investments

Although the number of Internet users is rising, a significant number of people still cannot access the Internet – even in emerging and developed countries. At the same time, those who are already connected demand higher speed and better service experience. A robust broadband network is the prerequisite for spreading new Internet services. Developing countries are increasing broadband penetration while developed countries are moving on to ultra-broadband; both require enormous investments.

The best way to judge whether the current industry policies are successful or not is to look at the broadband development level. If FBB is developing well and its penetration is increasing, the related industry policies and regulations are beneficial to broadband development. Then the government should continue the implementation of the policies. If FBB development is slow, the government should consider adjusting or changing policies and regulations to attract investment and broadband users.

We can classify the broadband development process of a country or an operator into three phases based on the broadband penetration rate: exploration (<10%), developing (10% to 25%), and developed (>25%). In the exploration phase, services offered are extremely insufficient, users have to wait for service provisioning, and technologies are few. Governments should encourage operators

to quickly deploy more networks to expedite service time-to-market.

In the developing phase, broadband coverage is sufficient, but the service prices are high and service choices are few. Governments can issue new licenses to increase the competition somewhat so that operators will accelerate broadband deployment and increase network speed. Benign competition is conducive to broadband promotion. Considering telecoms' large investments and in order to promote widespread coverage, governments should not charge too much for new licenses, and can even give subsidies to telecoms, who will then have to shoulder some social responsibilities such as providing ubiquitous coverage.

In the developed phase, broadband coverage is widespread. Governments should pay attention to the requirements of high-end and low-end users and encourage telecoms to carry out continuous innovation and sustainable development. Low-end users are distributed in remote mountainous regions and less developed regions. Like all other businesses, telecoms seek profit and lack the incentive to deploy networks for low-end users. Governments should give more policy and fund support to telecoms to reduce their investment risks. The focus of high-end users has shifted from broadband connection to service experience. Telecoms must offer more innovative services of superb quality, which will promote the healthy development of broadband networks.

Competition aimed at stimulating telecoms to pay more attention to broadband users is good for market development in the exploration and development phases and should be encouraged to ensure quick broadband coverage and the provisioning of cost-effective services. However, during the developed phase, governments should shift from encouraging competition to encouraging investments. They should focus on helping telecoms to achieve technological innovation and reduce investment risks. This will create more investments in the market, helping telecoms realize leapfrog development and grow to become broadband leaders in a region.

Coordinated city infrastructure construction reduces deployment costs

Strategic measures to reduce broadband deployment costs

FTTx-based ultra-broadband development requires huge investment because a lot of stations and pipes need to be constructed or reconstructed. In both developing and developed countries, optical distribution network (ODN) construction costs make up a large part of network deployment expenses. For example, ODN projects account for over 70% of FTTH costs in Germany. ODN deployment costs account for 60% of total network FTTx construction costs in China, where the prices of land and labor are rising.

Coordination of city infrastructures can reduce network deployment costs by 20% to 40%. For example, Nigerian operator Phase3 Telecom minimized total network costs through coordinated construction. They deployed optical lines on high-voltage cables and leased optical lines from Nigerian Power Company, transforming themselves into the largest fiber-optic telecom in the country. Other telecoms, enterprises, and even the government are now leasing optical fiber from Phase3 Telecom to reduce costs.

In most countries, different government departments regulate the construction of various types of infrastructure. Power grids, oil pipelines, highways and railways, and municipal power lines

are in the care of different departments and companies with no coordination at all. The aim of coordinated construction is to reduce project scale and difficulty. If the construction of telecommunication infrastructure can be coordinated with that of transportation, power, water and sewer, and buildings, the network deployment costs are greatly reduced. According to the Federal Communications Commission (FCC), it takes USD144,000 to build independent optical fiber networks every mile. The cost will be reduced to only USD101,000, if network construction is coordinated with other infrastructure deployment like highway construction thanks to a reduction in material costs, and especially engineering costs.

Measures of coordinated city infrastructure construction

There are three scenarios that involve coordinated infrastructure construction. First, different companies and telecoms conduct simultaneous pipeline and optical fiber deployment and municipal infrastructure construction. Second, governments share existing municipal infrastructures with broadband telecoms to facilitate broadband deployment. Third, for fiber-to-the-building (FTTB) and fiber-to-the-home (FTTH) scenarios, copper wire can be reused and cross-connection boxes can be shared.

Infrastructure coordination is especially important to developing countries since they need to build a lot of it. If optical cables are deployed while work is done on roads, the power grid, or buildings, then costs are reduced. Coordinated construction eases the deployment of facilities such as pipes and towers. This strategy is also significant in developed countries. Governments around the world are recommended to promote coordinated infrastructure planning during annual city construction review. For example, in the U.S., the "dig once" act stipulates that digging for infrastructure construction can only be performed once in a certain period of time. Different companies are required to coordinate their construction projects to meet potential customer requirements when it comes to cable and pipe deployment. In Boston, the "shadow conduit" policy demands that the first company to dig should ask other companies of their potential needs so that shadow conduits can be reserved for future users.

Fully sharing new infrastructure construction and opening existing infrastructures could accelerate broadband development. Governments can formulate policies and laws to promote the opening of city infrastructure such as municipal pipelines, highways, subways, and telephone poles to telecoms for free or at low prices. For example, Altibox, the largest optical fiber telecom in Norway, pioneered the franchised outlet model, attracting 42 local companies for cooperation to reduce the investments and risks of network construction. Altibox provided unified device models while local companies provided pipelines, optical fiber resources, and marketing resources to develop customers. In just 10 years, Altibox accumulated 80% of all optical fiber users in Norway. The Swedish government also issued licenses to electricity, gas, and telecommunication companies, allowing them to lease optical fibers to others. The measure accelerated the usage of existing infrastructure to expedite optical network deployment. In Spain, ultra-

Different companies companies and telecoms conduct simultaneous pipeline and optical fiber deployment and municipal infrastructure construction. Governments share existing municipal infrastructure with broadband telecoms to facilitate broadband deployment. For fiber-to-the-building (FTTB) and fiber-to-the-home (FTTH) scenarios, copper wire can be reused and cross-connection boxes can be shared.

broadband construction can be based on existing pipelines. For example, Telefónica's pipelines can be leased to other telecoms for further network deployment. The re-use of existing infrastructure has greatly accelerated network construction in countries around the world.

The most challenging part of broadband deployment is FTTH. Governments should formulate a number of regulations and standards and strictly implement them in infrastructure planning. Strict adherence to regulations and standards in building construction can greatly simplify the task.

For buildings with copper wires, the re-use of these resources and sharing them among telecoms can greatly accelerate broadband deployment and enhance broadband coverage. For example, both the U.K. and Hong Kong have explored good ways to realize coordinated infrastructure construction.

Regulations must be even more comprehensive for the construction of new buildings. In April, 2014, the Ministry of Housing and Urban-Rural Development of China released the Regulations for FTTH Infrastructure Construction for Residential Areas and Buildings and FTTH Infrastructure Project Implementation and Acceptance Standards. The two documents provided detailed pipeline and cable connection specifications for the project preparation and implementation process, greatly facilitating optical fiber deployment.

Building a healthy industry chain to achieve sustainable development

Informatization is the greatest technological revolution in the last 30 years. Over the next 20 years, we will enter an age of connectivity. Fixed and mobile convergence (FMC) and ubiquitous connections will be fundamental to our work and life. The development of the Internet and mobile applications will further promote the emergence of the experience-based economy. Focus has shifted from connection to service experience. It is now imperative that ultra-broadband network operators integrate their fixed and mobile broadband networks and increase network content.

In order to quickly attract users and activate network resources, telecoms, network content providers must engage users to cooperatively build a win-win ecosystem that focuses on improving user experience. This ecosystem is beneficial to continuous business model innovation and can activate user interest. It promotes ultra-broadband development through optimal service experience.

By issuing more licenses, especially comprehensive licenses to top telecoms, governments could encourage and promote network development and the creation of more innovative services. Broadband development alliances should be fostered as they have had great success in streamlining and aligning the operation of content providers, telecoms, vendors, and regulatory institutions leading to innovation and an optimized customer experience.

Execution of NBN strategies

National Broadband Network (NBN) is a broadband development model that relies on government encouragement and support through regulations and laws. NBN controls network construction and maintenance costs and lowers the price of services. NBN can help recover an economy in recession. It is a source of innovation and digitization, and also the key to building a knowledge-based economy and society.

The public-private partnership (PPP) model where the government cooperates with telecoms is the key to the successful execution of NBN

strategy. Top telecoms have rich experience in network O&M and own widespread pipeline resources. The government can select the best telecoms to quickly realize their NBN goal.

While executing NBN strategy, governments should take into consideration the requirements of remote regions and provide policy support accordingly. For example, the U.K. government launched its NBN strategy in 2010 and executed it with two projects. BT was responsible for the NGA project that completed the coverage of two-thirds of the population in cities and other densely populated areas.

The Broadband Delivery U.K. (BDUK) project completed the coverage for the remaining third of the population in remote corners of the country. This project was jointly funded by the British government (25%), local governments (25%), and the bidding telecoms (50%). The total costs for the two projects amounts to GBP2.5 billion and GBP2 billion, respectively. The projects aim to boost U.K.'s ultra-broadband penetration to over 90%. BT is responsible for project implementation.

In addition to NBN, governments should also support broadband development by making preferential policies and offering terminal subsidies and IT training to ensure broadband application and network content creation.

The Malaysian government funded the establishment of 246 community broadband service centers with MYR60 million (USD18 million) and the deployment of digital counters in 105 aboriginal areas across the country with MYR40 million (USD12 million), spreading e-government service in remote regions. South Korea launched the Korea Information Initiative (KII) in three phases and passed laws dictating that all educational, governmental, and medical institutions should connect to the broadband network. During the KII phase of South Korea's broadband development, the government invested in the deployment of backbone networks. In the KII-P phase, private investments poured in and home and enterprises users were connected. The KII-T phase was one of joint public and private investments.

Governments should shift from encouraging competition to encouraging investments, ensure coordinated city infrastructure construction, facilitate industry chain cooperation, and execute NBN strategies.

The South Korean government made great efforts to develop potential broadband users. From 2000 to 2002, the government carried out tens of thousands of trainings for 14 million people from all walks of life. The training programs played a very important role in promoting broadband development.

In summary, national social and economical growth requires broadband support and broadband initiatives need government support. Government can guide network investments and promote sustainable broadband development.

During the process, governments can achieve shift from encouraging competition to encouraging investments, thereby boosting telecoms' investment enthusiasm; facilitate coordinated city infrastructure construction to reduce costs and risks; facilitate industry chain cooperation to stimulate broadband consumption; and execute NBN strategies that provide nationwide coverage.

Smart next-gen OLT: Redefining network access

As access aggregation devices, smart next-generation optical line terminals (smart NG-OLTs) must support ultra-broadband, fixed-mobile converged services, and smart capabilities to build broader, faster, and smarter access networks that satisfy the access requirements of any bandwidth, service, or location, and deliver better service experience.

Wang Bing
Marketing Manager of Huawei Fixed Access Network Business Unit

Broader, faster, smarter access networks

As broadband prices drop, 4KTV is proliferating, with the content getting richer. Certain FIFA World Cup matches were broadcast in 4K this year. Vodafone has launched a 4K IPTV service with network speeds of up to 200Mbps in Germany. Meanwhile, major broadband access terminals have shifted from PCs to tablets and smartphones (fixed and mobile multi-terminal access). Broadband services have also shifted from home services to those that integrate enterprise service, Wi-Fi hotspot backhaul, and video surveillance. More and more carriers are

shifting from providing basic broadband access to user experience-centered operation. They are trying to improve network operation capabilities by optimizing service experience and will offer integrated ICT services such as smart home/community/enterprise services in the future.

As access aggregation devices, OLTs must enable ultra-broadband, fixed-mobile convergence, and smart capabilities so that broader, faster, and smarter access networks come into being that satisfy access requirements for any bandwidth, service, or location, and deliver better service experience. Smart NG-OLTis developed to meet these demands.

Smart NG-OLT features

Ultra-broadband

Smart NG-OLT features distributed architecture that is scalable and flexible, with 400G switching capacity per slot. In order to guarantee 100M access in the 4K era, smart NG-OLT must support ultra-broadband, high-capacity 4K video access and aggregation. The switching capacity per slot must reach 400Gbps, so each slot supports 16x10G passive optical network (PON), 4x40G PON, and 2x100G PON non-blocking access. Overall, an entire OLT system can deliver 100M 4KTV service free of congestion to 32,000 families.

The switching architecture decides the actual performance of network devices. High-performance switching architecture is critical to core network devices. As broadband services have grown, centralized switching architecture and distributed switching architecture have emerged. The former relies on the central forwarding engine on the main processing unit (MPU) to provide high-performance access with all ports, with said engine checking every packet before forwarding it on a certain route. The centralized switching architecture will experience forwarding delay, struggle with issues related to bottleneck from limited switching capacity. Costs and power consumption for the system will also surge as its capacity expands. Most legacy networks and last-generation OLTs adopted centralized forwarding architecture, leading to those aforementioned bottlenecks. The switching capacity is only dozens or hundreds of Gbps, which can hardly satisfy future development needs for broadband service.

Smart NG-OLT adopts distributed switching architecture, supporting ultra-broadband services such as 4K video, online education, and e-health. Distributed architecture is applied to both the forwarding and control planes. In the forwarding plane, the smart NG-OLT does not rely on the central forwarding engine on the MPU, as each service card has its own independent forwarding engine for distributed routing and data packet forwarding, thus reducing the MPU workload and boosting the switching capacity and performance of the entire system. In the control plane, the CPU is also distributed, with the CPU on the MPU responsible for the control and scheduling of the entire system, the learning and delivery of the forwarding table in Layer 2/3. The CPU of the service card is responsible for checking the local forwarding table and status maintenance of service cards. This enables distributed computing, routing and forwarding, increasing the forwarding efficiency of OLTs.

Distributed switching architecture can help to build a large-capacity non-blocking system. A single smart NG-OLT slot can support bidirectional 400G switching, with the OLT itself highly scalable. Carriers can expand the switching capacity of their OLT systems gradually, which means they can meet their growing demands for data traffic and new services. This is one of the main reasons why mainstream core switches and routers have all adopted distributed switching architecture.

Fixed-mobile convergence

Smart NG-OLT also features full-service (family/enterprise/mobile) access, unified access/aggregation, and high reliability. Global carriers are using FTTx for high-value business customer access and mobile bearing. By reusing existing access resources, a single optical network can support full-scenario application, including home and enterprise access and base station bearing.

Smart NG-OLT is capable of full-service PON/P2P access, including gigabit PON (GPON), 10G PON, 40G PON, WDM-PON, and P2P GE/10GE access, supporting SOHO and high-speed leased-line access for government and business customers. SOHO customers have similar QoS requirements as home users, GPON/10G PON can be deployed in a way similar to FTTH to support them. Smart NG-OLT also supports WDM-PON and P2P access, enabling leased-line service for government and business customers. WDM-PON provides 32 wavelengths on a single optical fiber, saving as much as 87.5% of fiber resources. Each wavelength provides exclusive symmetrical uplink and downlink rates of 1.25G, 2.5G, and even 10G, meeting stringent demands for bandwidth, security, and QoS. Meanwhile, WDM-PON allows for maximal reuse of existing ODN network resources, adding value to the PON network.

To realize network de-layering and increase capacity while decreasing site number for CO equipment rooms, smart NG-OLT has integrated access and aggregation capabilities in order to realize one fiber for all services and a unified access layer. Smart NG-OLT integrates the functions of aggregation switches and edge routers, reducing the type and quantity of devices while reducing CO room space and power consumption. Since no independent Layer-2 aggregation network is needed, the network architecture is simpler, which reduces network fault points and improves the network quality and management efficiency.

As the unified aggregation platform for full-service optical fiber access networks, smart NG-OLT must have very reliable networking capabilities to support high-reliability design at the device/line/network side. At the device layer, all OLT components should adopt a dual-backup mechanism to prevent single-point faults. The forwarding layer is also decoupled, so faults in the control layer do not affect it, enabling online software upgrade and resetting without service interruption. Meanwhile, OLTs should support multiple cores and processes. Faults in one CPU or process cannot interfere with service. At the PON/P2P line layer, OLTs should support type-B/type-C single-homing and dual-homing protection, as well as inter-board link aggregation grouping (LAG). At the network layer, OLTs should support dual-homing protection (LAG, VRRP, and BFD) and G.8032 ring protection.

Smart capability

And finally, smart NG-OLT supports software-defined networking (SDN)-based smart service capability and N:1/1:N virtualization, while being generally open and programmable. More and more carriers are transforming from simple bandwidth operation to experience and digitized operation. The boundaries between IT and CT are blurring and ICT integration is underway. Against this backdrop, how can network construction be transformed to help carriers seize business opportunities?

As the aggregation headend of FTTx networking, smart NG-OLT conforms to the trend of ICT integration. At the data forwarding layer, the smart NG-OLT hardware platform uses programmable network processor (NP) chips, enabling programmable packet forwarding. New service requirements can be supported through microcode upgrade, without the need to replace hardware. At the control layer, the control and management planes of remote access nodes are moved to the OLT, enabling centralized control and management of the access network, simplified network planning & deployment, and reduced OPEX. With a unified control and management plane, smart NG-OLT offers open application programming interfaces (APIs), opening the network access capabilities to the application layer. Upper-layer applications, including carriers' own applications and OTT applications, can easily use network capabilities through the APIs, including dynamic bandwidth adjustment, low-latency routing, and customized QoS, realizing quick service innovation/deployment and improved service experience.

Smart NG-OLT can also be virtualized so that device and network resources can be partitioned logically. Multiple instances (virtual OLTs) can be virtualized for allocation to different services (home/business/mobile services) or retail service providers (RSPs).

Smart NG-OLT can also be virtualized so that device and network resources can be partitioned logically. Multiple instances (virtual OLTs) can be virtualized for allocation to different services (home/business/mobile services) or retail service providers (RSPs). All virtual OLTs have independent forwarding and control planes and can be managed by different teams or customers. Differentiated service policies can also be made. Virtual OLTs also support multiple different services without additional devices or separate sub-racks, saving equipment room space, reducing power consumption, and improving operational efficiency.

Huawei SmartAX MA5800: Smart NG-OLT platform

At the Broadband World Forum 2014, Huawei launched the industry's first smart NG-OLT platform with distributed-architecture – the SmartAX MA5800. As a smart NG-OLT, MA5800 supports ultra-broadband, converged fixed-mobile services, and smart capabilities, it is the industry's most advanced OLT for NG-PON. MA5800 is designed to help carriers to build broader, faster, and smarter access networks, delivering a better service experience.

The fifth-generation optical network – flexibility, orchestration, and openness

With the rapid development of new services like cloud computing, streaming media, and mobile broadband, the optical network's bandwidth and efficiency must be improved. Smarter networks of higher bandwidth must be built. The fifth-generation optical network will be software-defined, and feature flexibility, orchestration, and openness.

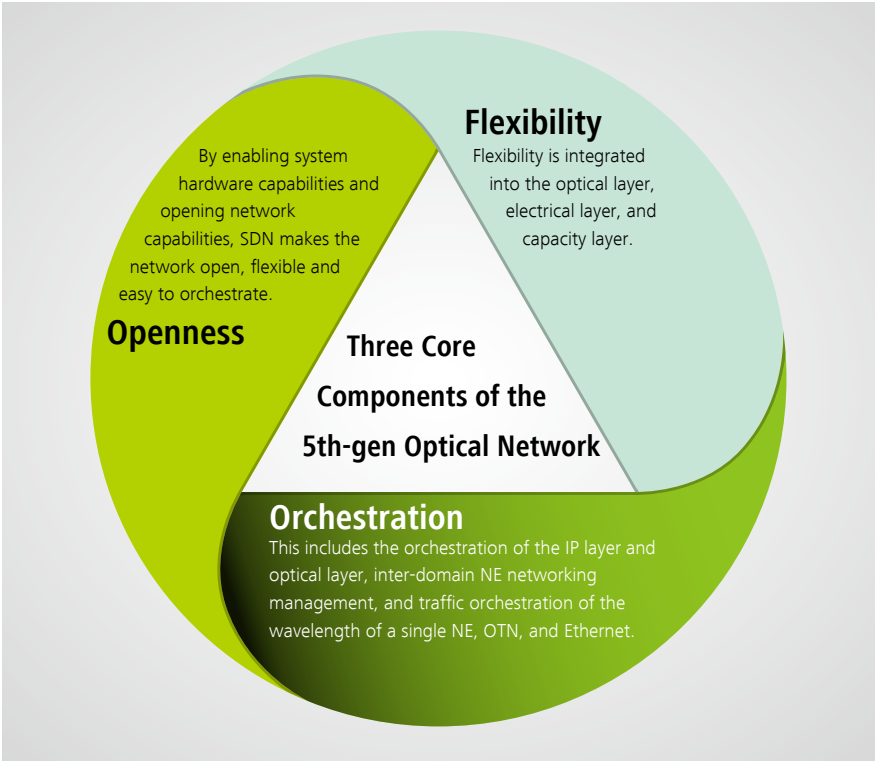
Pan Feng
Senior Marketing Manager of Huawei Fixed Access Network Business Unit

The telecom industry is facing ever-growing demand for higher bandwidth. It is estimated that by 2018, global data traffic consumption will reach 5ZB – that's more than 100 million DVDs per hour. Optical networks are the fundamental architecture of the telecom network. The relentless development of the telecom industry drives the evolution of optical networks. Although the 100G optical transport network (OTN) has just arrived, the industry is already anticipating what comes next. As the latest evolutionary step, the fifth-generation optical network architecture will reshape the software and hardware of optical networks.

From the start, the two main factors driving the development of the optical network industry have been bandwidth and cost. Optical networks of higher bandwidth yet lower costs are constantly being developed. In less than 50 years, the optical network has witnessed four important phases of development: Plesiochronous Digital Hierarchy (PDH), Synchronous Digital Hierarchy (SDH), Wavelength Division Multiplexing (WDM), and OTN-based coherent 100G WDM.

Advancements in hardware and software have graduated optical fiber capacity from Mbps to Tbps. System efficiency has also improved, reducing cost per bit. Further, manual control has been automated in many ways.

With the rapid development of new services like cloud computing, streaming media, and mobile broadband, the 100G OTN must be improved. Smarter networks of higher bandwidth must be built. Tbps-level networks must be exponentially enhanced. The fifth-generation optical network will be software-defined networks that feature flexibility, orchestration, and openness.



Key flexibility

The first key component is flexibility. Flexible super pipes boost network capacity. The extreme transmission capacity of a pair of optical fibers can be increased to support the huge amount of data traffic of the entire telecom network. Network flexibility includes the flexibility of the optical layer, electrical layer, and capacity. Hardware flexibility of the optical network means the hardware can be upgraded just like the upgrade of smartphones to support LTE/LTE-A. Technological upgrade of hardware can boost system speeds.

Optical layer flexibility refers mainly to a flexible grid. According to the current ITU-T DWDM standards, multiplexers (MUX) and demultiplexers (DEMUX), wavelength selective switching (WSS), and reconfigurable optical add/drop multiplexer (ROADM) are all defined based on fixed bandwidth grids such as 50GHz and 100GHz spectrum gaps. Flexible grids minimize grid gaps to 12.5GHz. The system can conduct dynamic bandwidth allocation based on service requirements. Different spectrums (37.5GHz, 50GHz, 75GHz, 100GHz, 125GHz) can be allocated and adjusted based on dynamic data transmission requirements. Flexible grids redefine the accuracy capability of optical signal scheduling, increasing spectrum utilization by 50%.

Electrical layer flexibility refers mainly to Flex OTN based on Nx100G flexible frame architecture. The evolution of traditional OTN follows a fixed pattern. For example, the rate of optical transport unit 5 (OTU 5) is four to ten times faster than that of OTU 4. If this pattern persists in the 100G era, different OTUs would support different rates, making for stark gaps. The lack of medium rates will make actual bandwidth utilization low. Flex OTN supports cross-connection and multiplexing of high-speed pipes. The baseline rate can be set as 100G and the dynamic interface OTUCn can be used to provide n x 100G rates. Flex OTN is like a flyover, achieving flexible service scheduling. After 100G became a reality, the era of flexible OTN frame architecture dawned.

Capacity flexibility: Thanks to the rapidly developing Optical Digital Signal Processing (ODSP) technology, online real-time signal modulation now supports switching of different CODEC for high-speed signals, realizing flexible switching between capacity and distance. For example, 16 quadrature amplitude modulation (16QAM) supports large capacity. Now the system can transform 16QAM into QPSK so that both large capacity and long distance can be achieved.

So far, leading operators including Vodafone, DT, Türk Telekom, BT, and MTN have all tested future-oriented flexible super-large capacity technologies, breaking many world records relating to capacity of the optical network system.

Key orchestration

The second key component

Through network resources and capability abstraction and providing standard interfaces, telcos can provide innovative service such as bandwidth on demand (BoD) and virtual transport network service (VTS). BoD is a refined intelligent leased line service. Customers can flexibly adjust network features based on demand.

is orchestration, which means the efficient collaboration between different channels of multiple layers. Multi-layer orchestration unleashes the full potentials of a system, maximizing system efficiency. The orchestration optimizes traffic usage and minimizes costs. Network orchestration includes the orchestration of the IP layer and optical layer, inter-domain NE networking management, and traffic orchestration of the wavelength of a single NE, OTN, and Ethernet (L0/L1/L2).

The value of orchestration is obvious. The costs per bit for each pipe are different. Policy-based pipe orchestration minimizes traffic cost and improves pipe efficiency and utilization.

At the beginning of 2014, Telefónica tested the orchestration between the IP layer and optical layer on commercial devices, which showed that network-level orchestration effectively improves network capacity. The lessons learned are expected to be put into commercial use within the year.

Key openness

The third key component is software-defined network openness. On the one hand, software-defined networking (SDN) enables the system's hardware capabilities; pipes become flexible and high-efficiency orchestration is achieved, unleashing hardware potentials. On the other hand, SDN opens network capabilities. The network system can be empowered through SDN technologies to meet a wide variety of customer needs, realizing system availability and scalability.

Through network resources, capability abstraction, and standard interfaces, telcos can provide innovative service such as bandwidth on demand (BoD) and virtual transport network service (VTS). BoD is a refined intelligent leased line service. Customers can flexibly adjust network features such as bandwidth and latency of leased lines based on demand, which maximizes the value of leased lines.

VTS provides virtual leased lines to customers so that they can conduct effective and visualized network management. SDN changes the operation model of optical networks to realize bandwidth monetization. SDN also enables abstraction and unification of network resources, which simplifies network operation and maintenance and reduces cost per bit.

Telefónica, SingTel, and China Telecom have conducted in-depth testing and trial use of SDN in the transport network field in preparation of commercial SDN deployment.

At the end of June 2014, Huawei shared fifth-generation optical network concepts at the Next Generation Optical Networking Forum in Nice, France. Dedicated to the research and promotion of next-generation optical networks, Huawei leads the development of global optical networks and continues to make strategic investments in the area. Working with industry partners, Huawei drives the formulation of industry standards and promotes the sustainable development of the optical network industry.

The fifth-generation optical network architecture will lead the industry into a bright new future.

Swisscom: Creating possibilities

Swisscom's fixed services have faced mounting pressure from MSO's in recent years. Couple this with a doubling of data volumes over local fixed lines every 16 months, and the operator has a tremendous need to take its services to the next level; Huawei figures prominently in those plans.

Zhu Hong
Expert of Huawei Fixed Access Network Business Unit

Mounting pressure from cable

Swisscom is the largest integrated telecommunications service provider in Switzerland, offering public switched telephone network (PSTN), fixed broadband, and wireless services. However, fixed competition has been fierce in recent years, with Swisscom facing mounting pressure from Switzerland's largest cable operator and its 250Mbps broadband service, enabled by DOCSIS 3.0.

Swisscom has been eager to get its broadband back up to par, and make its IPTV bundles more competitive. This has prompted the buildout of a new-generation ultra-wideband (UWB) network that will consolidate its leadership position as an integrated telecom service provider on the horizon.

Accelerating buildout with copper

After meticulously analyzing user bandwidth needs, return on investment (ROI), and future network development, Swisscom chose copper-based Vectoring technology for provision of 50-to-100Mbps bandwidth in the first phase of its UWB rollout, followed up with G.fast technology that will increase the bandwidth by a factor of ten in the second.

Given its widespread copper resources, Swisscom utilized fiber to the curb (FTTC), fiber to the street (FTTS), and fiber to the building (FTTB) as its fiber supplements. For its FTTC deployments, the copper is typically 750 meters in length and covering roughly 300 households via medium-capacity digital subscriber line access multiplexers (DSLAM's). For FTTS, the design goal is to have 90% of the copper lines within a distance of 250 meters, with a maximum of 48 households covered using small-capacity all-in-one waterproof devices. And with FTTB, copper is typically less than 100 meters with roughly a dozen households covered using small-capacity wall-mountable devices.

In December 2012, Swisscom initiated a tender, eventually settling on Huawei as an exclusive provider for its new-generation copper UWB network, which will accommodate more than two million households and enterprise users

in Switzerland, with Huawei's outdoor deployment experiences, timely customization capability, robust Vectoring technology, G.fast evolution capability, and broad influence in the industry chain the deciding factors.

Swisscom CTO Heinz Herren and Huawei Carrier Network BG CEO Ryan Ding attended the contract signing ceremony, at which Herren said, "We are delighted to expand cooperation with Huawei in the FTTx field. We find that Huawei is an excellent and trustworthy partner with accrued experience and high security awareness. Their solution offers technical possibilities for our network to stay most competitive in Switzerland." Ding added, "We are very pleased that Swisscom has decided to expand the existing cooperation in the fibre network and select Huawei for the roll-out of the FTTS. Our leading solutions in this area will build ultra-broadband and enable Swisscom customers to enjoy much more with connected possibilities. We will engage all resources necessary to ensure a successful win-win cooperation of the project. "

Project delivery challenges

Strict quality requirements are par for the course with Swiss technology, with Swisscom proving no exception. The operator had nearly 70 types of VDSL2 terminals in use, many of which did not support Vectoring, Huawei responded with our innovative Auto Sense solution that implements automatic VDSL2 terminal detection and policy matching to accommodate the broad diversity of terminals in use during Vectoring deployment.

Huawei's Vectoring solution is capable of a forced friendly mode (FFM) that enables VDSL2 terminal operation in Vectoring-based multiline coexistence scenarios, without compromising terminal connectivity or performance. With FFM, Swisscom doesn't need to replace its legacy terminals, making for a dramatic reduction in both service deployment time and cost. To ensure smooth terminal operation, Huawei has established a lab and allocated the necessary resources at Swisscom headquarters to test operability between dozens of live-network VDSL2 and Vectoring terminals. Interoperability issues have been resolved smoothly, making for a quality delivery process.

Another delivery challenge stemmed from the need to balance water resistance with ease of upgrade to G.fast in FTTS, which sees devices deployed under roadways. Huawei employed high-quality waterproof, aerospace-quality connectors as external interfaces for FTTS devices, and engineers can replace the devices quickly by switching these connectors. Housings were made of a waterproof and dustproof plastic that could keep sewage out during disassembly and assembly, and withstand long periods of immersion in snow runoff.

What's more, power is supplied by the exchange office for these all-in-one waterproof FTTS devices. Multiple telephone line pairs transmit boosted power to remote FTTS devices which integrate

the adaptor, lightning protection, and personal safety protection modules. This remote power supply model can eliminate the need to dig ditches or lay power cables. It has also simplified engineering operations and accelerated device installation substantially.

Gbps access via G.fast

Swisscom's 100Mbps UWB network has brought the operator back up to speed with its MSO competitors, but DOCSIS 3.1 promises greater bandwidth speeds over cable, and Swisscom is already making moves toward 1Gbps to get ahead and stay ahead. Swisscom has helped formulate G.fast standards for distance and interference resistance, and collaborated with Huawei for testing and trial use. But there are major obstacles to overcome.

The FTTS scenario requires G.fast to run up to a maximum street-to-household distance of about 400 meters, but the distance specified in the G.fast standard does not exceed 250 meters. Thus, Swisscom and Huawei have begun research on G.fast extension. What's more, a large number of the copper wires currently in use on Swisscom's network are paper-insulated, leading to severe interference and compromised performance. Interference resistance technology is a must, and the research has already begun.

On August 7, 2014, Swisscom and Huawei signed the industry's first G.fast contract. According to Oliver Lamparter, G.fast Technical Director at Swisscom, said, "On short loops, G.fast technology can dramatically increase the existing DSL access speed, which will undoubtedly make Swisscom's broadband network very competitive. We are willing to contribute our efforts to accelerate the technology maturity and the solution deployment." Felix Kamer, Managing Director of Huawei's Switzerland office, said, "We are honored that Swisscom recognized Huawei's continuous innovations in the access field and chose Huawei as their new-generation UWB network provider. Huawei will continue to accelerate G.fast standardization and translate standards into products, enabling more users to enjoy UWB services."

According to Oliver Lamparter, G.fast Technical Director at Swisscom, "On short loops, G.fast technology can dramatically increase the existing DSL access speed, which will undoubtedly make Swisscom's broadband network very competitive."

Advantage through integration

According to Swisscom's UWB network plan, the new network is set to serve 2.3 million households and commercial premises by the end of 2015 and 85% of all households and commercial premises by the end of 2020. Swisscom has already started large-scale deployment of Vectoring technology. By July 2014, the new network covered about 200,000 new households and commercial premises with Vectoring and FTTS, a number that will soon increase tenfold.

Swisscom also provides UWB-based IPTV services, enabling users to watch up to 250 video programs, playback video feeds within seven days, and perform cloud-based video recording. Swisscom incorporates fixed-line telephone, broadband, and IPTV services into an integrated, cost-effective service package dubbed Vivo, which is both attracting users and reducing churn.

In the future, Swisscom plans to introduce G.fast technology to improve the access rate up to 500Mbps to 1Gbps. This project is setting an exemplary precedent, enhancing operator confidence in copper and enabling more users to truly experience ultra-broadband.

FMC 2.0: The road to fixed broadband monetization

Over-the-top (OTT) players are encroaching on operators' return on investment (ROI), thus pressuring them to upgrade their infrastructure, despite the fact that they gain very little revenue from the bandwidth-hungry applications they carry. Operators are striving hard to invent new business or cooperation models. This is where FMC 2.0 comes into play.

Sameer Ashfaq Malik
Deputy CTO, Huawei Fixed Network Business Unit

What is FMC 2.0?

Fixed-mobile convergence (FMC) has been redefined, with Huawei adding content into the mix for FMC 2.0 (FBB + MBB + Content) – a long-gestating concept and imperative that defines full/unified service operations for fast-moving operators and OTT players. It entails a partnership-driven, user-centric model, comprised of business monetization, robust network construction, and unified network transformation. FMC 2.0 is composed of four elements:

Broadband + Content: Operators must start acquiring or owning content, if they haven't already, and shift their business model away from broadband to content.

MBB → MBB + FBB: Mobile operators must add fixed services to the mix to reduce churn.

Content → Broadband: Content providers and other OTTs are already wading into the infrastructure game, a trend that could and should continue.

FBB → FBB + MBB: MSOs are adding Wi-Fi and other forms of offload to their robust fixed holdings to stay competitive with OTTs.

With always-on connected ecosystems now the norm, fixed and mobile networks are becoming indistinguishable, at least from the user's point of view. Unified service operation with an FBB focus, coupled with a better quality of experience and application-driven architecture, is a must if telcos hope to retain market leadership at a reasonable TCO. Monetizing user QoE that differentiates, beyond simple connectivity, gives operators a strong argument to establish new business-to-business-to-consumer (B2B2C) relationships, and share revenues with content providers and other OTTs.

Improved business environment

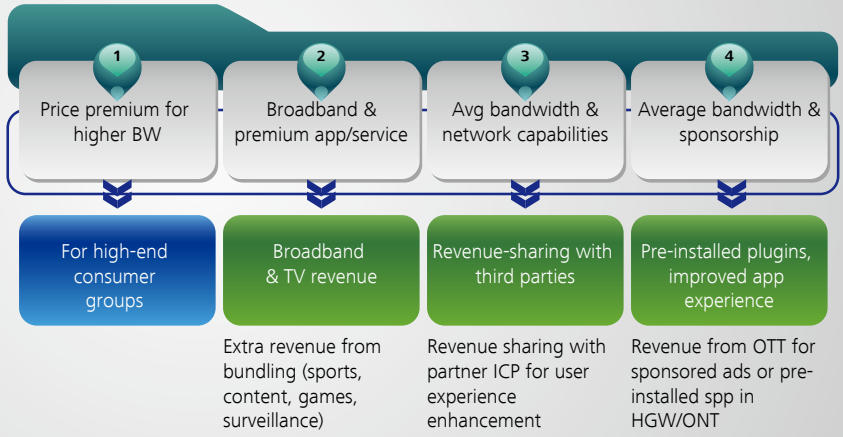
Huawei's FMC 2.0 business modeling framework question improves the ROI while

holding the "I" part of the equation in check. In North America, a certain operator found that it's bundled MBB-FBB subscribers are 10% more satisfied than it's unbundled subscribers, while its ultra-broadband market share is growing steadily. Another operator in Western Europe is offering a quadruple-play package of Internet, television, mobile, and fixed-line services, helping attract roughly 1.5 million subscribers in a single quarter, including 40% from competitors.

B2B2C engages industry while monetizing broadband

By acquiring exclusive content to provide through dedicated channels. Others cooperate with OTTs for better traffic monetization and user experience. No matter which path operators choose, B2B2C will play a vital role where value-based pricing is of paramount importance as compared to price-based modeling, where tariffs or simple packages alone are insufficient. Value-based pricing is based on improved open-network capabilities, bringing maximum differentiation and impact to businesses and consumers. Value-based monetization is based on tailored subscription packages that can improve QoE as opposed to bandwidth. With mutual collaboration between telcos and OTTs, a new level of service granularity is possible with service providers (as pipe owners) providing improved end-to-end QoS architecture for OTT service flow.

Broadband Monetization: Business Models for FBB



Note: For reference only. These models are flexible and evolving.

There are four different value-based monetization models for broadband that achieve three key strategic goals for telcos – preservation of legacy voice & text services, expansion of the broadband access market, and tapping of the enterprise potential of broadband.

Price for bandwidth: This is fairly straightforward. For non-price-sensitive consumers, speed does matter, and they will pay to upgrade.

Broadband + premium services: In this scenario, operators add something special to the bundle, like BT does with its sports offerings, and this can make a real difference in terms of subscription adds and profit.

Average bandwidth + network capabilities: This is where telcos open their networks to third parties, and share in the resulting revenue.

Average bandwidth + sponsorship: In this arrangement, the third-party's contribution is pre-installed.

The latter two models represent the essence of value-based pricing; through engagement, platform partnership and revenue sharing, the best user experience is delivered through an open network. Neither broadband service providers nor OTT players can be in complete control of the Internet ecosystem. China Telecom Fujian has partnered with Thunder, China's largest P2P client, offering temporary high-speed download services to VIP telecom users via bandwidth on demand, reducing download times from hours to minutes.

A combined Telco-OTT strategy results in lower bandwidth costs for OTTs and lessens bandwidth scalability pressures for operators. Experts are sticking with their predictions that this will come to pass, as it has with Netflix, and its placement of content delivery network (CDN) edge servers into operator data centers (DCs). As 4K starts becoming the norm for video content, other providers will surely have to follow their example.

Huawei's smart FTTC sites accelerate ultra-broadband deployment

Since innovative copper technologies such as Vectoring and G.fast continuously evolve and legacy copper usage accelerates both network deployment and service provisioning, more and more carriers are deploying the copper-based fiber to the cabinet (FTTC) outdoor cabinet solution for ultra-broadband network.

Zhu Hong
Expert of Huawei Fixed Access Network Business Unit

Installation and maintenance requirements of outdoor cabinets

As innovative copper technologies such as Vectoring and G.fast mature and legacy copper accelerates network deployment and service provisioning, more and more carriers are applying the copper-based fiber to the cabinet (FTTC) solution. The installation and maintenance of outdoor cabinets differs significantly from the exchange-based operation model. Additionally, outdoor cabinets are subject to extreme temperatures, dusts, floods, and external damage. Sealed design and environment surveillance are required so that abnormalities will be detected and corrected, ensuring stable and reliable operation. The system should have smart automatic main distributing frame (AMDF) jumpers and be scalable so that no manual work is needed in service cutover. When the number of users increases and expansion is required, modular expansion can quickly boost the capacity of outdoor cabinets so there is no need to migrate or replace the entire cabinet or components.

Huawei's FTTC solution offers one-stop E2E products and solutions to simplify site deployment, including network devices, cabinets, power supplies, batteries, cable distributors, as well as remote surveillance management. Huawei's outdoor FTTC cabinet solution has seen large scale deployment by BT, eircom, and Telkom South Africa. The solution helped carriers reuse existing copper wire resources and deliver ultra-broadband coverage.

Design and environment testing

Many carriers place strict requirements on outdoor cabinets to ensure the products can survive harsh open environments. With powerful R&D teams and high-reliability design, Huawei can deliver highly resilient cabinets. For example, some outdoor cabinets have stainless shells in order to withstand hurricane winds and other

external threats. No riveting points can be detected from outside, which means they cannot be drilled open. The cabinet can survive 80mph automobile impacts with barely a scratch. The shell components of the cabinet can be replaced onsite without service interruption. The cabinet is rated IP55 for water and dust protection. A variety of temperature, humidity, smoke, and entrance guard sensors are installed in the cabinet, allowing engineers to remotely monitor the cabinet interior. Batteries can also be charged or discharged remotely. In case of power failure, the cabinet system switches to the backup battery and issues an alarm to ensure operation stability.

Huawei ensures the robust character of cabinets through E2E environmental conditions testing. Huawei has a number of internationally certified environment testing labs that expose cabinets to hellish conditions including temperature extremes, dust, smoke, radiation, electromagnetism, noise, as well as earthquake and security simulations that test cabinets' ability to withstand physical assault. Testing discovers any weaknesses in a system, which is then improved and optimized to ensure reliable operation of the cabinet and protection of the devices inside.

Cabinet innovation

As user demand for bandwidth increases, more and more users are shifting to FTTC ultra-broadband services. Increasingly, outdoor FTTC sites are being deployed and the number of device ports is increasing as well. Outdoor cabinets need to be flexible and scalable. Therefore, Huawei developed modular cabinets, which are designed to be expanded whenever needed by simply attaching additional device compartments, cable distribution compartments, or power and battery compartments. The

Huawei's outdoor cabinets can be found in every extreme environment the earth has to offer, from rural frontiers to densely populated urban centers. Huawei is dedicated to helping carriers deploy networks that are faster and smarter.

cabinets also support the upgrade of the heat dissipation system and smooth cabinet expansion and upgrade through the flexible combination of modules.

Ultra-broadband deployment is reaching many remote and rural regions. There is a strong demand for cabinets of higher capacity and lower cost. Huawei designed two new cabinet types based on traditional main distribution frame (MDF) cabinets. One type is the "re-shell cabinet," By removing the shell of an MDF cabinet (the original MDF and cables remain) and adding new active devices into it, you have a re-shell cabinet. The main benefit of the re-shell cabinet is that customers can reuse the original MDF cabinet site, saving construction costs. However, re-shell cabinets require that the original MDF cabinets are of the same specifications and low capacity. Additionally, the original MDF and cables must be good enough to be reused. Britain is one place that Huawei's re-shell cabinets are seeing large scale deployment for rural broadband construction.

Huawei has also introduced the "top-box cabinet," which replaces the cap of an original MDF cabinet with an active device compartment. Active devices are placed in the compartment to support ultra-broadband networks. Top-box cabinets have strict requirements on the uniformity of the original MDF cabinets. The cap of the MDF cabinet should be removable so that hardware merger can be done. For example, eircom deployed top-box cabinets in its ultra-broadband construction in remote areas.

Many cabinets are installed on city streets, where they become part of the city scenery. Therefore, Huawei has developed special outdoor cabinets to which LCD screens can be attached for advertising. Carriers can remotely update or turn off the screens. Carriers can further use the outdoor cabinets to expand into new services. For example, they can transform the cabinets into automobile charging centers or Wi-Fi hotspots.

The advantage of outdoor FTTC sites

With legacy copper ultra-broadband construction in full swing, network devices are being moved from exchanges to outdoor FTTC sites. Sites are playing an increasingly important role in networks. They act as ultra-broadband acceleration centers, remote power supply and backhaul centers, as well as comprehensive management centers.

Broadband acceleration center: Copper wires in the outdoor FTTC sites are very close to users. Using VDSL2 and Vectoring, 50M to 100M access rates can be achieved. Since the sites reuse original MDF cabinets and cables, the ports are concentrated and the system capacity is large. Compared with other ultra-broadband construction models such as FTTH, fiber to the building (FTTB), or fiber to the door (FTTD), outdoor cabinets prove more economical and efficient, minimizing construction cost per user. As innovative copper access technologies continue to emerge, network speed can be further accelerated by replacing service cards while the site

and cabinets remain unchanged. If there are multiple pairs of cables on the users' side, multi-pair bonding can also be used to improve the access rate.

Power supply center: An FTTC site has an AC power supply and batteries for backup. In addition to the cabinet itself, the power supply system can power Wi-Fi hotspots, remote FTTB and FTTD devices, and devices in LTE small-cell base stations. The site can provide various types of power supply through multiple pairs of telephone lines. FTTC sites also support E2E power supply management.

Backhaul center: In addition to power supply, FTTC sites can provide uplink backhaul for surrounding Wi-Fi hotspots, FTTB/FTTD devices, and LTE small-cell base stations. Optical fiber can be used to achieve uplink aggregation and multi-pair bonding of copper wires can be used to provide uplink interfaces to remote devices, which is very suitable for broadband coverage in remote rural areas.

Management center: FTTC sites achieve sound management of site devices, power supplies, batteries, cabinet temperature/humidity, and security. Remote battery charging/de-charging is also supported. FTTC sites also help to manage aggregation channels for surrounding Wi-Fi hotspots, FTTB/FTTD devices, and LTE small-cell base stations. Smart FTTC sites can also be integrated with automatic MDF (AMDF) to facilitate automatic management of service cutover, such as cross-connection of external ports and internal devices. Automatic jumper operation can be performed remotely, which eliminates operation errors and minimizes connection management errors as well as maintenance costs.

One-stop delivery

Huawei's one-stop delivery solution successfully integrates all cabinets, devices, power supplies, batteries and MDFs while they are still at headquarters. The service functions of all ports are also tested to ensure successful integration. Going forward, the one-stop delivery solution will become a popular option for carriers utilizing legacy copper in their ultra-broadband deployments.

Building copper-based ultra-broadband networks will inevitably involve outdoor sites and devices. If integration is conducted at sites, conditions such as bad weather and challenging environments can complicate and delay delivery progress, compromising project quality. Huawei's one-stop delivery solution successfully integrates all cabinets, devices, power supplies, batteries and MDFs while they are still at headquarters.

The service functions of all ports are also tested to ensure successful integration. In this way, integrated equipment arrives on site ready for rapid and high-quality delivery. Going forward, the one-stop delivery solution will undoubtedly become a popular option for carriers utilizing legacy copper in their ultra-broadband deployments.

As a leader in the access network industry, Huawei's broadband network devices have served over one-third of the world's population. Huawei's outdoor cabinets can be found in every extreme environment the earth has to offer, from rural frontiers to densely populated urban centers. Huawei is dedicated to helping carriers deploy networks that are faster and smarter.

Telecoms capitalize on SME information platform

FTTO (Fast-to-the-Office) is a Huawei product designed to bring together a customized collection of proprietary and third-party services. As rapid development of the commercial market has led to enterprises' continuously increasing requirements for comprehensive information service, this Android-based product makes intelligent enterprise access easy and effective while providing differentiated services for different commercial customers.

Qiao Ruole
Marketing Representative of Huawei Fixed Access Network Business Unit

SME comprises a key market segment

Advancements in e-commerce have fostered the proliferation small and medium-sized enterprises (SMEs). It must be pointed out that small enterprise also includes a significant "micro" segment that cannot be overlooked. By the end of 2013, the number of new SMEs in rural China alone exceeded 400,000 while the total number of new SMEs in China overall exceeded an astounding 45 million. At present, the number of registered SMEs in China has exceeded 60 million, which accounts for 95% of the total number of enterprises in China. These enterprises create final products and added value amounting to 50% of GDP. According to international telecom operation experience, SMEs are high-value customers because the revenue generated by this market segment is the largest part of total operating revenue. To attract SMEs, telecoms offer flexible charging packages, value-added services, and high-end service levels based on their using habits.

SMEs require access products that are low cost and which provide good user experience, flexibility, customization, and high-level services. Despite the fact that SMEs are commercial customers, telecoms are missing an opportunity by offering them only the same services they offer to common household customers – basic communication service and few customized information services that can be widely adopted by SMEs.

Differentiation is the only way to win in SME

As SMEs are developing rapidly, Internet companies have been gradually entering the enterprise leased-line market. They have been

trying to change their service targets from individual users towards enterprise users mainly through service development, and in ways such as branding, service platforms, and even customized devices. For example, WeChat has developed WeEnterprise for enterprise staff management, CRM, and punching in/out; Tree Bear in Hangzhou has developed its store-owner customers through dealers and telecoms, and provided Wi-Fi routers and a Wi-Fi marketing platform. The Tree Bear Wi-Fi marketing platform enables stores to customize portals, O2O customer flow acquisition (for example, to follow official accounts), ordering systems, and other functions; 2Dfire has focused on the catering industry and provides an Android-based package solution for cashiers, ordering, and customer management; and Baidu's Direct Number uses a customized platform to display traditional companies to the public. Continuous search and exploration for high-end customers has triggered more fierce competition in the SME market, putting telecoms at risk of being further channelized and marginalized.

From 2011, national broadband and optical networks in China have developed rapidly. Because they own the basic network coverage, telecoms have an extraordinary advantage in developing services for SMEs. Telecoms can meet the requirements of SMEs from different fields by leveraging existing access resources and providing service platforms and differentiated services.

Differentiated solutions for various scenarios

SMEs can be categorized by scale, location, and service type. Through research and analysis of typical scenarios, solutions can be customized to precisely meet a range of varied SME requirements.

Shops along streets are usually owned by individuals or families. A computer is necessary in the shop mainly for entertainment, ordering inventory, or maybe accounting, with simple software installed. Apart from basic broadband

Telecoms can meet the requirements of SMEs from different fields by leveraging existing access resources and providing service platforms and differentiated services. The Android-based intelligent FTTO solution released by Huawei can help.

access requirements, low-cost devices for security protection and video surveillance as well as the storage of surveillance files are in urgent demand, considering the possibility of nobody being on guard during the night. Other devices needed include one or two telephones, a POS machine, a fax machine, and so on.

Chain-supermarkets often need professional cashiers, video surveillance systems, and security protection devices, while catering chain stores need ordering systems, customer management systems, and payment systems. As for express delivery companies, professional warehousing, mail delivery and receipt are required.

Shopping malls require seamless Wi-Fi coverage to ensure that users do not need to switch between networks at every corner of the grounds. Several service set identifiers (SSID) can be configured in the Wi-Fi and ad push services can be embedded so that users can enjoy free Internet access for a limited time after they have watched obligatory advertisements. Users can also log-in using their VIP accounts or telecom accounts. Users can receive preference or sales information when they enter each shopping area. The shopping malls can be equipped with LCDs to show preference information periodically.

Small-sized enterprises need seamless coverage of Wi-Fi in their office areas, considering for personnel that move around and for convenient communication with customers. Firewalls should be embedded in the Wi-Fi and the enterprise-level confidentiality should be protected against hacking, such as freeloading, phishing, and Trojan horses, so that the security of employees and customers can be ensured and convenient online communication can be achieved. The bandwidth can be increased in real time whenever there is a need for higher levels of big data transmission in the company, such as during account reconciliation with the headquarters and when video conferences are being held. When bandwidth needs are low, bandwidth can be reduced, and then it can be turned back to normal status to save enterprise operational costs when high bandwidth is not necessary. Besides, devices for security protection and including video surveillance in the night are essential. Requirements for time recorders, office device interconnection, data backup, and energy conservation are also of great importance.

As for small hotels, cost and user experience are two fundamental factors that determine survival in the highly competitive hotel business. Therefore, they should prefer low-cost construction that meets customer requirements and provides convenient services which make customers feel comfortable while charging them low prices. Business hotels generally already have catetogry-5 cables that enable basic coverage of broadband, voice, and Wi-Fi for customers. They can also provide value-added services for customers, such as point-to-point video on demand services, dinner reservation, ordering, and high-definition videos inside the hotel rooms. Due to poor IT technical maintenance capabilities in small hotels, it takes a long time to repair network problems, which greatly affects customer experience. Simplified network

O&M and troubleshooting will significantly improve the ability of small hotels to respond to customer needs.

According to the above requirement survey, traditional solutions focus on pipe functions, which tend to require a long time for customization and costly equipment to meet the differentiated requirements of customers, resulting in poor customer satisfaction.

A new hardware platform is needed to provide various interfaces including traditional multiple broadband and voice interfaces, and support multiple Wi-Fi hotspot coverage and access of multimedia peripherals, such as infrared interfaces and HDMI. It should also support flexible expansion of USB interfaces, which enable future hardware expansion. The related software should support open platforms, flexible customization capability, and third-party extended plug-in capability.

Android-based intelligent enterprise leased-line system

The Android OS has the greatest openness and the most applications of all. There are a plethora of Android applications used in office, video entertainment, social activities, consulting, and other areas.

The Android-based intelligent FTTO solution released by Huawei is comprised of four functions. The network center includes network interconnection function modules, such as the GE, POTS, HDMI, infrared, Bluetooth, Wi-Fi enhancement, USB, and enterprise cloud backup. The control center controls intelligent enterprise energy conservation, security protection, video surveillance, and one-click bandwidth acceleration through USB dongle interfaces. The maintenance center conducts automatic fault locating, service emulation, and automatic detection for intelligent FTTO devices through smartphone applications and 3G/4G/WIFI. And the data center, with the media service unit installed, will achieve Android-based intelligent control of, for example, various OTT video services, office software, integration of various industry software, video surveillance, corporate directory and other self-service software.

From the service application perspective, the solution can be divided into three parts. The first part is basic telecommunication services, such as the enterprise broadband, voice, and enhanced Wi-Fi access, as well as prioritization, traffic classification, and security, which can well satisfy basic communication needs of stores along streets.

The second part includes Huawei -developed intelligent modules, for example, the interworking between video surveillance, security protection, and cloud storage. For small shops, when the door or window of a store is forcibly opened, an alarm is generated. Upon receiving the alarm, the intelligent FTTO device will report the alarm to a user by sending an SMS message to his/her phone or triggering a special ring in his/her phone. Then, the surveillance video will be pushed to the user's phone so that the user can watch the video to check whether it is a false alarm. It is a low-cost and easy to customize guarding solution to small stores. With the commercial multiple Wi-Fi SSID function, several independent subnets can be created under a Wi-Fi network. By leveraging this function, telecoms are able to deploy their networks with flexibility and generate more revenue for themselves and stores in shopping mall. As the subnets can operate independently, one can be used by the store owner, one can be leased to telecoms as a supplement to 3G/4G, and another one can be used for commercial purposes, such as leasing ad slots to other companies. For instance, customers can be offered Internet access for free for a certain time-period after they have watched ads. The ads can be loaded through a local USB, or loaded to the intelligent devices in a centralized way through OLT. With the automatic O&M function, easy and simple local management, maintenance, and troubleshooting of devices is conducted with maintenance software that can be installed in smartphones. The time of locating a network failure reduced from several days to several is minutes. Hotels would welcome the reduced maintenance cost and shortened responses involved.

Thanks to the openness of Android

Based on the intelligent Android platform, telecoms can cooperate with software companies to develop customized softwares for hotels, restaurants, and office buildings and charge according to function packages.

OS, the third part is comprised of services that should be integrated with third-party applications and plug-ins to achieve profit sharing. As for the catering industry, the introduction of third-party developed software such as integrated ordering, customer management, and cashiers will accelerate service provisioning. The integration of Xunlei Accelerator will meet the instantaneous bulk bandwidth requirements of high-definition video and video conferencing. Vendors may integrate their products with telecom platforms so that their product sales will be promoted with the selling of telecom platforms. Telecoms can maintain and manage their platforms integrated with enterprise products and then finally provide a full series of customized solutions for SMEs.

Opportunity for business transformation

Intelligent FTTO devices have innovatively extended the traditional business and profit-making models for telecoms. In the traditional model, telecoms sell products to customers in a one-off manner and charge the customers a fixed amount of money for network access. However, with the basic network development of telecoms, the competition for high-value customers, especially SMEs, has become increasingly fierce, which has brought great challenge to the traditional sales model.

After adopting the intelligent platform, customers and telecoms will become close partners, not simply dealing with each other for device sales. For example, with the multiple Wi-Fi SSID function and the ad embedding function of FTTO, SMEs become not only traffic consumers, but also traffic telecoms. They can lease their ads slots to other companies, embed the ads into the Wi-Fi, and then push the ads to customers. In this way, the enterprises have a new revenue stream.

For customers from different industries, telecoms can cooperate with software companies based on the intelligent Android platform to develop customized software that can be used in hotels, restaurants, and office buildings and charge fees according to function packages. Telecoms can also cooperate with Internet companies instead of competing with them. For example, they can cooperate in the function of e one-click bandwidth acceleration services. Through cooperation with Internet companies, telecoms can evolve their services from simple bandwidth leasing to service operation, and build a close relationship with end users. Furthermore, by providing value-added services, telecoms can continuously gain service fees.

The above services are only basic services that FTTO provides in the initial stage. With the expansion of the service platform, the growing of third-party partners, and the accumulation of operational experience, more intelligent services will be developed in the future, and the intelligent FTTO will become the network and service center of enterprises. Broadband and voice services will become basic service packages and function as supplementary services to intelligent service packages, as telecoms will change their focus from pure broadband operation to comprehensive information services with content and service as the core. The intelligent FTTO is the perfect starting point for telecom service transformation.

D-CCAP is MSOs' competitive edge in the Gigabit era

Data Over Cable Services Interface Specification (DOCSIS) has proven to be one of the most successful broadband access technologies. Since 2008, DOCSIS 3.0 solutions have been widely deployed to meet the even-increasing bandwidth demand of tens of millions of subscribers. To date, the scalability and consistently improving performance of DOCSIS solutions has given the cable industry a competitive edge. As a result, cable broadband subscriptions outweigh telco broadband subscriptions by 40%.

Allen Wang
Director of Huawei Broadband Access

As is often the case, success breeds competition. In the case of DOCSIS, the ongoing transition toward gigabit access is providing a golden opportunity to telcos and other competing operators. This is the dawn of the age of the Internet of Things. Broadband access will be an integral part of general household utilities, and the Gbps access network needed to acquire and retain subscribers is destined to be one the most valuable assets. The current trend of Gbps service offerings isn't just a way to counter the increasing number of Google Fiberhoods; rather, it is the new baseline requirement for service delivery in the coming decade.

The Gigabit era is reshaping the competitive landscape

For competing operators without access to legacy copper, the focus has been on lowering the cost of FTTH buildout. Through a mix of lower component costs, construction/design innovations and public/private partnerships, per-home FTTH connection cost in the U.S. now averages below USD1,300, compared to USD4,000 for Verizon FiOS just a few short years ago. Moving forward, the FTTH home connection cost is expected to decrease by 7% CAGR. With a slew of recent Gbps projects announced by the telcos, cable is in jeopardy of being outbuilt in the area of fiber. G.fast fiber-to-the-distribution-point (FTTdp) is rapidly becoming a top Gigabit solution, especially for high-density deployment scenarios such as MDU. From a distance of 50 meters, G.fast can now deliver 1Gbps bandwidth on a single twisted pair. A typical G.fast FTTdp node can support up to 16 subscribers with a single drop fiber. With the advent of TWDM-PON, 10G access pipes over GPON can readily provide the uplink capacity required to deliver Gbps services to every

subscriber connected to these FTTdp nodes.

With increasingly affordable FTTH and FTTdp with G.fast, the bar is set quite high for the next phase of broadband access competition. While the MSOs can also deploy FTTH for head-to-head competition, which will likely be the case for greenfield projects, the real question is whether hybrid fibre-coaxial (HFC) solutions will be competitive enough in the Gigabit era

Do CCAP and DOCSIS 3.1 give MSOs a competitive edge?

Until recently, most people in the cable industry had a lot of faith in HFC. After all, CableLabs standards specify DOCSIS 3.1 will provide a minimum of 5Gbps of downstream bandwidth by bonding two D3.1 channels together with 24 D3.0 channels. Fully integrated converged cable access platforms (CCAPs) will deliver these high bandwidth pipes to thousands of fiber deep nodes, just like it was envisioned; sounds straight forward enough.

Indeed, after ramping up rapidly in 2013, CCAP has achieved phenomenal growth, essentially replacing the traditional cable modem termination system (CMTS) as the mainstream cable access solution. In Q1 2014, CCAP/CMTS channel shipments were up more than 100% as MSOs continue to build capacity to meet sharply rising data consumption, which increases 40-to-50% annually. However, much of the CCAP being deployed today is nothing more than denser CMTS modules and edge quadrature amplitude modulation (EQAM) platforms. In other words, growing bandwidth demand is being addressed, while space shortage is not. Hub space shortage was identified as one of the key driving factors for CCAP, and the severity of this issue cannot be overstated. By some estimates, most hubs in North America will run out of space if only 10% of the HFC plant is converted to fiber deep nodes, which occurs after about 150 homes passed. Conversion to fiber deep nodes is a critical HFC migration step anticipated to be widely implemented by 2017 in conjunction with the introduction of DOCSIS 3.1.

So, why is there so little progress made in saving hub space after more than one year of CCAP ramp-up? There is no simple answer, but industry sources provided many clues. One of the most basic problems is the sheer complexity of migrating from a modular platform to an integrated platform in a tightly confined space while maintaining normal operation – something said to be as difficult as swapping out a plane's engine mid-flight.

In most hubs, installing a fully integrated I-CCAP means the existing CMTS must be swapped out and reallocated to another hub, which is typically located in a less populated part of the network where space is available. That way, the CMTS can be expanded to meet bandwidth consumption growth. This swapping-out and relocating exercise also requires warehouse space for temporary storage of equipment en route, making it both a logistic challenge and a time-consuming process.

Perhaps more importantly, the impact of CCAP migration on both MSOs' and vendors' business cases also plays a key role in the pace of the migration. After investing tens of billions upgrading the HFC network during the past decade, MSOs will likely stick to a pay-as-you-grow strategy in order to maintain a sound business case. With this strategy in place, it is unlikely we will see any large-scale replacements of existing CMTS with full-spec CCAP chasses. Instead, CCAP migration will be gradually carried out with a variable mix of adding high-density line cards in the existing M-CMTS platform and installing full-spec I-CCAP chasses over several years, in much the

same fashion as previous HFC migration efforts. From CCAP vendors' perspective, the explosive growth in demand coupled with the dynamic platform migration creates many opportunities. Market data suggests that vendors with full-spec I-CCAP solutions are gaining market shares from less progressive incumbents. The number of CCAP channels being deployed worldwide seems to indicate future growth in bandwidth consumption is being adequately addressed. However, the coming crunch in hub space, driven by the massive number of node splits, will require a new migration option that can effectively address the space issues in the hub and headend.

Time to consider distributed access architecture

The HFC outside plant is a highly scalable broadband access facility. Much of DOCSIS technology's success can be attributed to the superior performance of the tree-and-branch shared coax plant, compared to the point-to-point twisted-pair copper plant. In the age of Gbps broadband access, a properly scaled HFC fiber node stands as one of a few remaining options that are comparable to the bandwidth capacity of FTTH.

The traditional fiber node is a physical layer O/E media converter. For Gbps service delivery with a hub-based CCAP, each fiber node is connected via analog fibers to a pair of upstream and downstream CCAP ports. A number of service groups, including a dedicated DOCSIS service group, are transmitted to a group of subscribers connected to the coax plant.

With a distributed access architecture (DAA) platform, an Ethernet node replaces the fiber node. Instead of analog fibers, digital fibers are used to connect a number of Ethernet nodes to a centralized aggregation point such as an OLT, located in the hub. The Ethernet node is a layer-2 element containing a complete DOCSIS media access control (MAC) and physical layer (PHY) and other components needed to deliver a full suite of service groups. Functionally, the Ethernet node is equivalent to a pair of upstream and downstream ports in the hub-based CCAP modules. The Ethernet nodes are centrally controlled by the OLT and managed as a single network element. Collectively, the OLT and its subordinate Ethernet nodes function as a distributed CCAP (D-CCAP) by combining the functionality of a CMTS with an EQAM, similar to a hub-based CCAP. More significantly, D-CCAP solves the hub space issue and advances the HFC network further down the migration path to reach a higher level of competitiveness, a level that is essential for the MSOs to lead the broadband access race in the Gigabit era.

Key benefits of DAA

The space savings realized by replacing CCAP with the OLT is significant. A next-generation OLT is designed to support a minimum of 32K subscribers connected though a minimum of 450 Ethernet nodes from a single 11 rack unit chassis. To cover 30,000 homes passed from a single hub, assuming a highly dense 13RU large I-CCAP chassis capable of supporting 64 fiber nodes, it would take four I-CCAP chasses.

With D-CCAP, all 200 Ethernet nodes can be covered with 7 GPON line cards, about half of the available slots in the OLT, with the remaining slots available for FTTH. Given the severity of space shortage in many hubs and headends, it is expected that many of these hubs will need to switch to the D-CCAP platform in order to support the coming conversion to fiber deep nodes.

For migration to DOCSIS 3.1, it is well-understood that replacing the analog optical

transmission system with a digital optical system such as PON, between the hub and the node, provides a 3-7dB improvement in end-to-end SNR, increasing bandwidth by up to 25%. In the near-term, for many HFC networks, the top-end of the downstream spectrum is expected to be 1 GHz. Before a transition is made to full IP video, the availability of downstream RF spectrum for DOCSIS will be extremely limited. Consequently, the bandwidth gained by converting to a digital optical system adds significant value to DOCSIS 3.1, making it more competitive against FTTH.

D-CCAP is the mainstream DAA solution

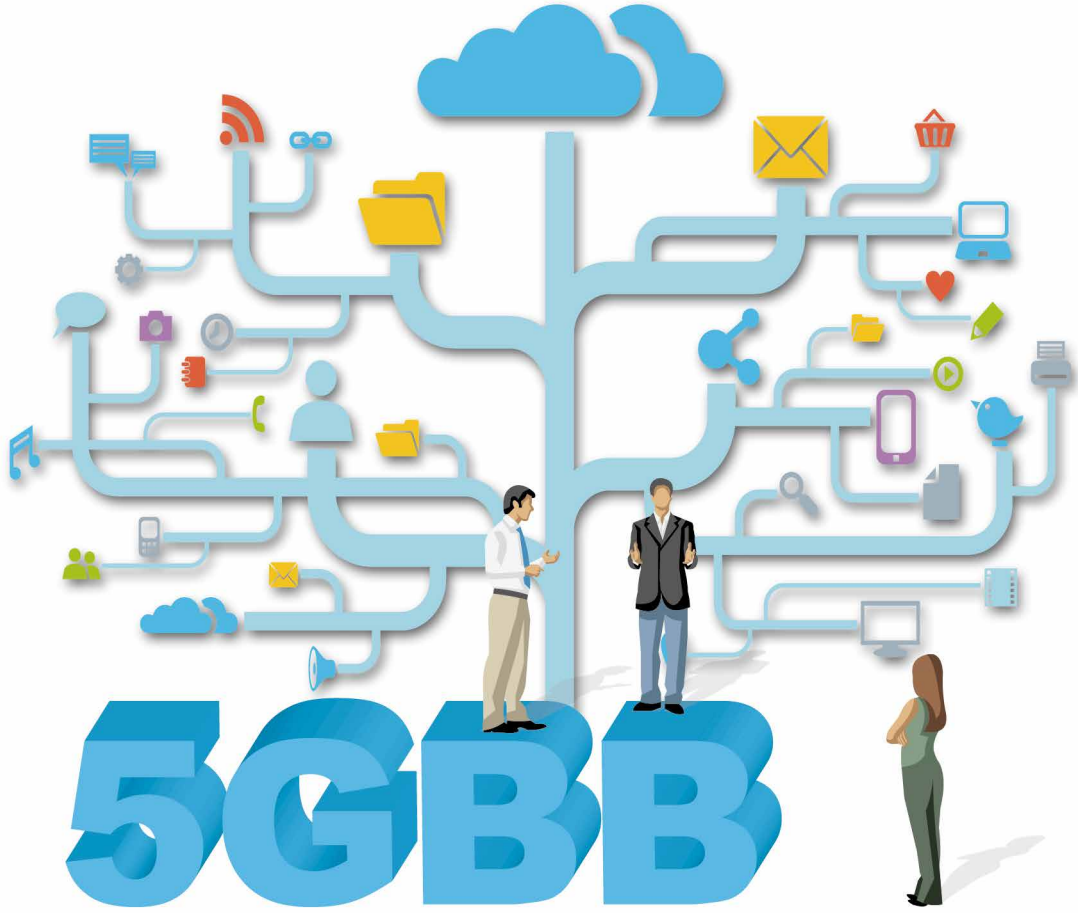
Recognizing the market demand for maximizing DOCSIS 3.1 performance, some hub-based CCAP vendors are preparing to offer remote PHY (R-PHY) where a digital optical system is inserted between a new D3.1 MAC module and a remote digital node with a built-in D3.1 PHY. Although the proposed R-PHY solutions can potentially allow hub-based CCAP to hit the DOCSIS 3.1 performance target, the approach reverts a fully integrated CCAP back to a modular architecture as described in CableLabs' Modular Headend Architecture version 2 (MHAv2). In doing so, it created a DAA option for the M-CMTS platform that deviates from the migration path set forth by CCAP and does little to solve any of the issues addressed by I-CCAP.

D-CCAP is based on the mature FTTN architecture that has been widely deployed for more than a decade. Many of the FTTN solutions available today are based on the highly evolved PON OLT platform that has been addressing challenges such as density, space and power; the same set of challenges addressed by CCAP. In the Gbps access era, most broadband access systems will be PON-based with FTTH making up an increasing share of the deployment base. For the cable industry, FTTH is already used in most greenfield projects, and there is a growing consensus FTTH would be needed to overbuild parts of the brownfield HFC network facing competitive FTTH entrants.

With D-CCAP, HFC remains competitive. It remains to be seen how competitive DOCSIS 3.1 and CCAP class of solutions will be against competitors' FTTx solutions. In addition to the size and scalability of the access pipes, many other factors are just as important in determining the outcome. But as history has shown, the advantages of HFC network gave MSOs a strong competitive edge in the pre-Gigabit era. Holding on to this advantage in the access infrastructure should be a prime objective.

Against a backdrop of uncertainty, it would be prudent for the MSOs to consider a scenario where FTTx may be needed sooner, and in a larger part of the HFC network. An overlay PON optical distribution network (ODN) provides a flexible FTTx migration path. With D-CCAP, MSOs can select a lower-cost FTTN option capable of delivering multi-gigabit bandwidth to around 75 subscribers from fiber deep nodes. When an all fiber business case presents itself, FTTH can be built out to business and residential customers. The highly efficient OLT can easily support FTTx expansion from any hub or headend and the small footprint makes it possible to coexist with other hub-based CCAP platforms, which facilitates a smooth migration process.

In the coming few years, as we approach the target timeline (2016/2017) for both fiber deep node splits and DOCSIS 3.1 rollout, it will be increasingly evident that the broadband access competitive landscape has changed with accelerating build-out of fiber access networks. As a cable-exclusive FTTN solution, D-CCAP provides an all important competitive edge and should be part of the HFC migration planning for any cable operator.



The upcoming 5GBB

The fourth-generation broadband (4GBB) project set out in 2009 to create an "ultimate DSL technology" for copper, culminating in 2012 with G.fast. And while G.fast is certainly a quantum leap over what came before, Huawei thinks that copper has more left to give, and envisages the development of a fifth generation (5GBB) standard for the medium.

Fang Liming
Director of Huawei Access Technology Research Department

5GBB: Next-gen broadband

As copper technologies have evolved, optical fiber has moved closer to the end user (Figure 1), with 4GBB standards specifying a distance of 20 to 200 meters away.

According to ITU definition, the maximum spectrum for G.fast is 106MHz, and can provide 1Gbps access rates. G.fast is now well recognized in the industry, with vendors now directly or

indirectly announcing plans for its commercialization, and targets now being set for the end of 2015.

But then what? History demonstrates that generational leaps in copper technology are achieved every eight years (Figure 2), and work on G.fast began in earnest in 2009. Thus, work on a fifth generation will probably commence sometime in the next two or three years, but what are the challenges involved and are the goals worthy of the effort?

Is 4GBB going to be the last generation of copper access technology? It has been six years since the appearance of G.fast. If the pattern holds, next-generation 5GBB will attract a lot of attention in the next one or two years.

Technical and engineering challenges to 5GBB

Capacity limits

Increased capacity requires increased frequency. To realize a capacity leap on par with that for G.fast, the frequency must increase to 1GHz. However, high-frequency transmission over copper is very lossy, so the lengths will have to be shortened. And what's more, the 1GHz band overlaps with many other radio frequencies, and that means a lot of interference. Some frequency bands will have to be lowered or even restricted in order to prevent this.

Testing and capacity simulations show that, in the absence of interference, a 30 meter-long loop of category-5 twisted pairs can reach a speed of 12Gbps, with a drop line rate of 10Gbps. At 50 meters, the capacity drops to 5Gbps. However, reality brings background noise, bridge taps, and radio interference into the equation, and these are among the problems that must be resolved before 5GBB over 30m loop line is commercialized.

Installation & maintenance

A shorter length of copper usually means an increase in the number of remote installations.

According to TNO research statistics (Geographic Deployment and Cost Studies for G.fast, 2014 TNO DSL Seminar), there are currently 2,100 fiber-to-the-curb (FTTC) nodes in Amsterdam, covering 360,000 home users, with 192 users supported per node. If G.fast is to be deployed, that the maximum copper length would decrease to 150 meters, as would the node capacity (48 users). Thus, 10,300 fiber-to-the-distribution-point (FTTdp) nodes would be needed, a fivefold increase.

In a 5GBB scenario, with copper lengths shortened to 50 meters or less, the number of nodes balloons to nearly 100,000, a fiftyfold increase and a nightmare in terms of installation and maintenance.

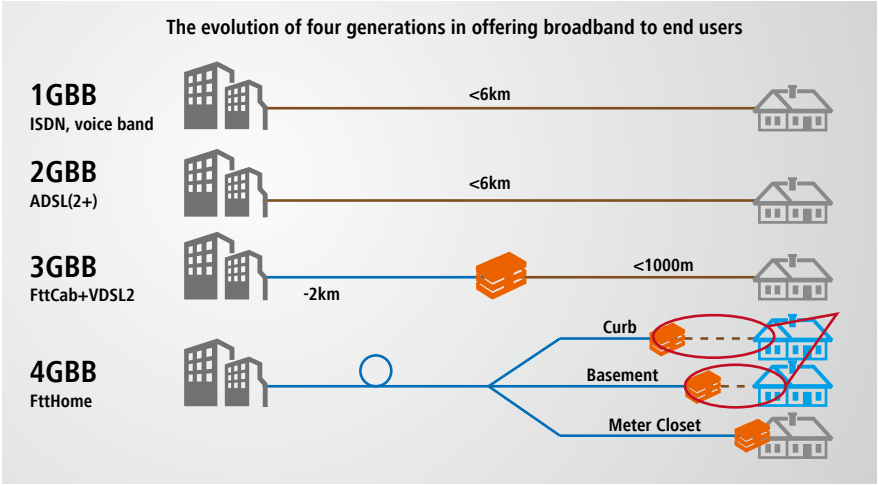


Figure 1 Development of broadband access

5GBB access architecture

As you see, without a major rethinking of the access architecture, 5GBB just isn't viable. FTTH, even in the most difficult situations, would still be preferable to 100,000 FTTdp nodes. However, traditional FTTx architecture is dual-level, making remote DSL services complex. Both hardware resources and software

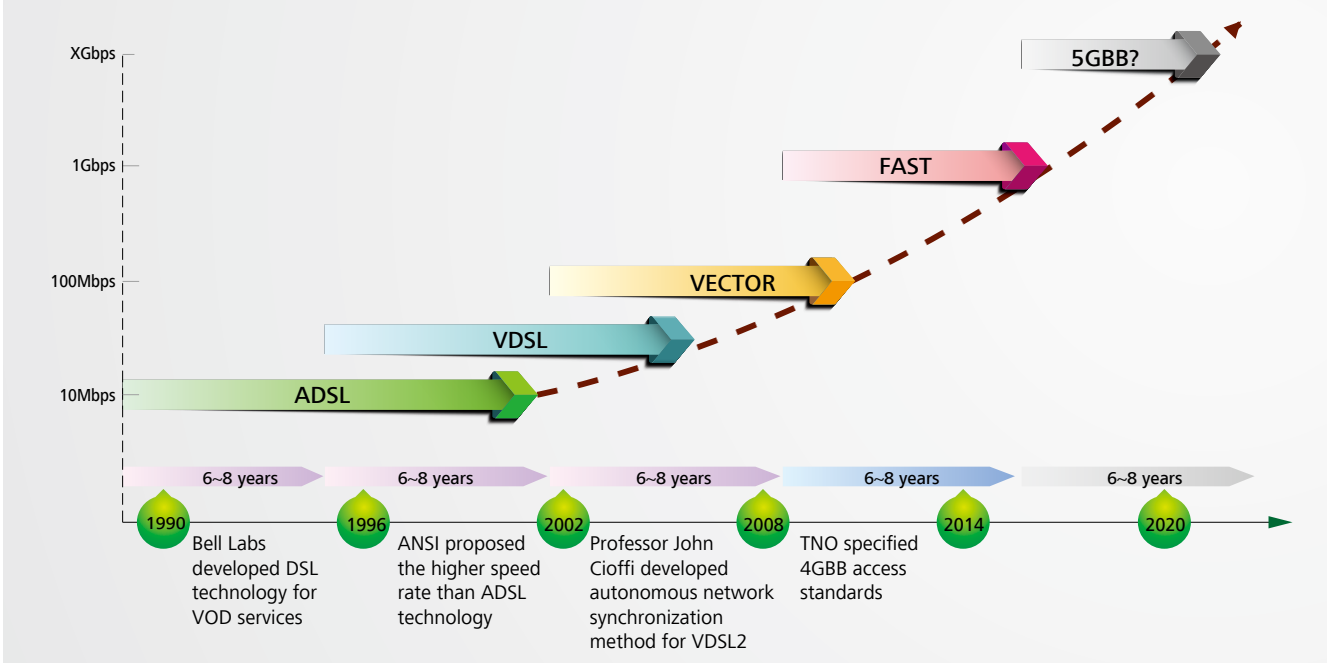


Figure 2 Development of DSL technology

resources for management, control, and data processing are needed, with centralization and simplification of the remote gear a must.

Centralized access networks

Centralized network architecture would move remote device functions to the central office, leaving certain interfaces connecting the remaining remote modules with the centralized modules so that network functionality remains consistent. In terms of precedent, hybrid fiber coaxial (HFC) network architecture enables all modem functions to be centralized in the hub equipment room, with remote devices basically functioning as amplifiers.

In theory, remote DSL devices can utilize multiple interface categories. In addition to the commonly used Layer-2 interfaces, interface allocation is also an option. Different interfaces have different characteristics. Analog interfaces ("Layer-0 interfaces") allow for the simplest and most reliable remote devices. Hybrid and analog circuits provide better forward compatibility.

5GBB network architecture

"Layer-0" interfaces can simplify remote devices to the greatest extent, transforming them into protocol-free analog circuits, while hardware simplification reduces the size, power consumption, and cost of devices, making large-scale deployment much easier. Hardware simplification also minimizes device faults, thus increasing device reliability and cutting maintenance costs.

If the maximum analog capability of a remote device is 1GHz, then regardless of the DSL standards used by the central office, as long as the analog bandwidth does not exceed this number, there is no need to upgrade remote devices. Carriers can simply upgrade the DSL line cards in the central office, saving a lot of the

In addition to technological challenges, 5GBB also faces engineering and maintenance challenges. Therefore, carriers must consider how to optimize the architecture of 5GBB networks to make them more cost effective than FTTH solutions.

5GBB will take advantage of more advanced digital signal processing technologies for coding and modulation to further improve spectrum utilization and the access rate. In 5GBB construction, another factor to be considered is reducing power consumption.

network upgrade costs.

If all DSL line cards are in the central office, signals can be processed using pooled resources. On the one hand, flexible DSL resource allocation can deliver statistical multiplexing, which saves DSL line card resources. DSL upgrade can be realized by replacing algorithm software, without the need for line card replacement.

What's more, concentration of line cards facilitates joint signal processing. So far, due to interference and geography, lines between the central office and remote sites cannot be accelerated through Vectoring. However, line card concentration would make Vectoring viable.

5GBB network topology

The access rate per port for 5GBB networks will be 1-to-10Gbps, but most users won't need such high speeds all the time. If multiple users can share one port, a lot of network construction costs would be saved, with the power consumption of network devices reduced greatly. Therefore, 5GBB networks should use point-to-multipoint (P2MP) virtual topology, with crosstalk channels used to share information.

Underlying technology of 5GBB

5GBB will take advantage of more advanced digital signal processing technologies for coding and modulation to further improve spectrum utilization and the access rate. Power consumption is another consideration with 5GBB.

Modulation-demodulation technology

From the perspective of modulation-demodulation, with ADSL, discrete multi-tone (DMT) has been widely used with excellent results. DMT's frequency orthogonality mode effectively decouples crosstalk, reducing the difficulties in crosstalk cancelation, especially with Vectoring. Thus, we see no need for a change with 5GBB.

However, 5GBB shortens the copper loop. If the maximum distance is 50 meters, the available frequency range for copper can be 500MHz to 1GHz. Therefore, the specific DMT parameters must be adjusted and uplink/downlink duplex solutions should be considered. A proper solution should be developed that provides high performance at a modest cost.

Coding technology

Channel coding is another way to improve spectrum utilization, and 5GBB will certainly use more advanced and complex coding technologies to increase the net coding gain. One option is low-density parity-check (LDPC) coding. Practices have shown that LDPC coding provides higher performance than TCM+RS, and it has been adopted for the latest technical standards such as LTE-A, DOCSIS 3.1, G.hn, and DVBS2. LDPC Coded Modulation (LCM) is another option, but either would provide at least 1.5dB more gain than TCM+RS.

Polar code would be a more radical solution. Proposed by Erdal Arikan in 2007, based on the channel polarization theory, polar code is currently a focus of study, and reports already indicate superiority to LDPC.

Energy saving

To reduce the power consumed during idling, ADSL2 defines the L2 mode. G.fast adopts a discontinuous mode, so the power consumption is zero during idle times. However, the digital signal processor's consumption is not reduced, so we recommend burst mode for 5GBB. No signal would be sent, with the entire signal link in an idle state, when there is no service data transmission. Power consumption in digital signal processing and the static power consumption of the digital signal processor should be reduced as well. **(Wang Xiang & Liu Jianhua also contributed to this article)**

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"Huawei's solution provides a powerful package for us coordinators, enabling us to implement real-time, visualized coordination with voice and multimedia services. This solution plays a significant role in and greatly facilitates our games."

Li Nan, Manager, the Communications and Network Department of the Game Organizer

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