On the path to 5G with 4.5G

In 2020, operators must support the coexistence of 4.5G and 5G new air interfaces if they want to deliver a superior mobile broadband experience. Evolving 4.5G in parallel to 5G new air interfaces will help operators develop new services, user behaviors, business models, and industry chains before 5G arrives, paving the way for next-gen 5G tech.

By Zhou Dongfei

Huawei announced the 4.5G concept in October 2014, with the 3GPP standards organization later officially dubbing it LTE-Advanced Pro. A year or so on, there's been major progress in 4.5G technology and deployment. Meanwhile, the ITU set out the marker, vision, and timeline for 5G in June 2015.

3GPP has started on the path to 5G standardization. With 5G widely predicted to be commercially deployed in 2020, why should operators invest in 4.5G now? What is the relationship between 4.5G and 5G?

The rise of mobile broadband

4G cannot meet new service and business demands

Huawei's mLAB forecasts that MBB users will double to 6.7 billion between 2015 and 2020, while average monthly data consumption per user will balloon tenfold to 5 GB. In the next two to three years, new services with higher demands on MBB network speed, capacity, and latency will start to emerge, including 2K and 4K video, virtual reality (VR), augmented reality (AR), and remote drones.

According to GSMA, the number of CIoT connections will surge to 1 billion by 2020, up from 243 million in 2014. As the report doesn't take into account the possibility of new services that could generate explosive data growth, the actual number of connections may be much greater than predicted.

The demands of the latest MBB services in terms of peak speeds, capacity, massive connections, and low latency already exceed the capabilities of today's 4G. Targeting new businesses individuals, homes, companies, and different verticals with MBB services requires 4G needs to be multi-purpose – something 4G networks were not designed to be.

Ultra-high capacity, massive

connections, and ultra-low latency

Next-gen mobile 4.5G and 5G technology will be defined using three measurement criteria: peak speed (plus capacity), number of connections, and latency.

Peak speed: 4G is defined as 150 Mbps, 4.5G as 1 Gbps and above, and 5G as 10 to 20 Gbps.

Connection numbers: A 4G network cell can carry several thousand, 4.5G uses CIoT to carry 100,000, and 5G will be required to carry 1 million connections per square kilometer.

E2E latency: Commercial 4G networks average 50 ms, 4.5G is required to deliver 10 ms, and 5G aims for 1 ms.

Protecting investment

When 4.5G was proposed, the aim was to achieve technical targets through 4G network evolution to protect operators' investments and maximize the value of network resources.

Key 4.5G technologies include Massive CA (carrier aggregation), High Order MIMO, and 256QAM high order modulation, which can increase peak speeds and capacity, and Narrow-Band IoT (NB-IoT) for massive connections. Each of these technologies can be built on current technology.

Massive CA reuses existing carrier baseband boards, requiring only additional RF modules or baseband resources for new carriers. 256QAM high-order modulation can reuse the vast majority of existing RF modules. NB-IoT can also reuse the vast majority of legacy RF modules. 4.5G therefore only requires software upgrades and a small amount of new hardware to implement.

3GPP officially renames 4.5G

After Huawei proposed 4.5G, it approached the 3GPP to standardize the name. Following a process of discussion involving operators, equipment vendors, and chip makers, 3GPP confirmed LTE-Advanced Pro as the name for the LTE next-gen evolution solution on October 22, 2015. The approval of the marker and specifications indicated an industry consensus on 4.5G.

Major vendors have since released white papers describing the evolutionary path to next-gen LTE, and have started to incorporate 4.5G into their product plans. Qualcomm, for example, launched a 1 Gbps modem chipset at the Mobile World Congress (MWC) 2016, and demonstrated a 1 Gbps smart device prototype with Huawei.

4.5G goes global

4.5G network benchmarks: Gbps, Experience 4.0, and Connection+

Huawei has worked closely with the world's leading operators to discover their network pain points and service development trends for the coming two to three years and has developed three network construction benchmarks for 4.5G: Gbps, Experience 4.0, and Connection+.

Gbps: increases peak rates from 4G's 100 Mbps to 1 Gbps. Gbps is synonymous with

MBB pipeline capability and boosting peak rates, capacity, and cell edge rates.

Experience 4.0: requires MOS (voice service quality) and vMOS (video service quality) scores of 4.0 for high-definition voice and video.

Connection+: currently supports technologies such as NB-IoT, LiTRA (LTE integrated Trunked Radio) broadband trunking for public safety, and WTTx (wireless to the x) to power vertical markets.

The year of 4.5G: 2016 to see 60 networks rolled out globally

As of May 2016, 20 4.5G commercial and test networks had been deployed around the world, with 60 more expected before the end of the year.

1 Gbps-plus transmission rates on commercial networks have been demonstrated in Norway, Turkey, Germany, Kuwait, Saudi Arabia, UAE, China, Japan, Canada, Singapore, Thailand, and the Philippines. The UK and Korea have begun constructing national LiTRA-based public-safety networks, and pre-commercial deployment of NB-IoT is underway in Spain, South Korea, China, UAE, and Germany.

4.5G and 5G set for long-term coexistence

4.5G is the path to 5G

4.5G is an essential step to 5G. Although the ITU outlined the marker, vision, and timeline for 5G in June 2015, the telecom industry has yet to set out a process for moving from 4G to 5G. Why?

Widespread commercial deployment of 5G still a long way off: According to the ITU's timetable for 5G, technical performance requirements and evaluation methods will be defined over 2016 and 2017, technical proposals will be accepted and evaluation carried out between 2018 and 2019, and final specifications will be set in 2020, which means widespread 5G deployment will likely start after 2020.

5G is likely to adopt higher frequency spectrum: The advantage of using higher frequency spectrum is greater bandwidth. But, the cost of deep and wide-area network coverage is too high, so legacy low-frequency networks must coexist with 5G for the long-term to make up for a lack of coverage.

New 5G services can be cultivated on 4G networks: An example of this is NB-IoT's first commercial deployment in 2016. NB-IoT supports connectivity for 100,000 plus devices per cell. In addition, there is LTE-V Internet of Vehicles, which is the next major 4.5G target market. 3GPP will begin more standardization work on this in 2016 and 2017 to speed up development.

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4G needs to lay the groundwork for 5G's arrival: Adjusting wireless network architecture using CloudRAN will make it easier for operators to introduce new 5G air interfaces onto existing networks so as to avoid the need to carry out large-scale E2E network reconstruction.

4.5G evolving in parallel with 5G

From 2016, the 3GPP will start 5G standardization in step with

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ongoing LTE evolution. This will permit introduction of 5G technology on 4.5G networks. This 4G-ization of 5G, or introducing 5G technology on 4G networks, in fact began before the standardization process.

Massive MIMO: A key 5G technology. Commercial deployment of LTE TDD supporting 128T128R (128 transceiver channels) is already underway in China. FDD Massive MIMO that can support 16, 32, and 64 antennas is being continually refined in 3GPP's R13 and R14.

Shorter TTI (transmission time interval): A crucial technology for achieving the 1 ms latency target of 5G, and one that 3GPP has begun standardizing. 4.5G is expected to support OFDM (Orthogonal frequency-division multiplexing) symbol-level latency, which approaches 5G air interface latency requirements.

Network slicing: Another key 5G technology that has been introduced in 4.5G networks. Network slicing allows NB-IoT, LiTRA, and WTTx to be implemented on a single network. The next step will introduce CloudRAN architecture for more flexible and efficient RAN slicing, enabling multiple services on a single network.

Huawei spearheads 4.5G

At MWC 2016, Huawei announced GigaRadio based on 4.5G network construction standards. The solution supports gigabit peak speeds for individual users, gigabit throughput on a single module, single site x-gigabit capability, and a seamless indoor gigabit experience. GigaRadio is over a year ahead of the industry in terms of capabilities, and will help drive technological innovation, user experience, and commercial success for operators.

During the Huawei Global Analyst Summit 2016, Huawei announced the CloudRAN solution. Using a cloud-based hardware and software system, CloudRAN supports functions virtualization, resource cloudification, and systematic cloud capabilities that can be flexibly coordinated. CloudRAN enables fully flexible new network architecture from topology to resource distribution. The solution's multi-connectivity supports 4G, 4.5G, 5G, and Wi-Fi for multiple technology and multi-cell coordination, on-demand deployment of real-time and non-real-time functions, and network slicing.

CloudRAN enables operators to carry out 5G-oriented network architecture cloud transformation on 4G and 4.5G networks, which will allow them to directly deploy 5G air interfaces via CloudRAN architecture when the 5G era rolls around.

By 2020, it will be essential for operators to support 4.5G and 5G new air interface collaboration and coexistence if they want to deliver a superior MBB experience.