4.5G: Hello gigabit MBB, HD, and the Internet of Everything

4.5G is the next evolutionary step up from 4G on the way to 5G. It delivers gigabit mobile broadband (MBB), HD user experiences and Internet of Everything applications, through just software and minor hardware upgrades to legacy 4G infrastructure. Huawei has led the way with commercial trials of the solution, which has already been standardized by 3GPP. With over 60 networks rolling out this year, 2016 is the dawn of the new gigabit MBB era.

By Zhou Dongfei

Introducing 4.5G: The natural next step

Speed and capacity requirements on operator networks are continuing to surge. By 2020, skyrocketing growth in data consumption and users will see 6.7 billion projected MBB users devouring 5GB of data each – a massive tenfold increase over 2014. Accompanying this will be an exponential growth in IoT connections by the turn of the next decade.

Today’s 4G networks will not be up to the job of supporting this rise in data, users, and connections. This is where gigabit 4.5G can step in. Offering faster speeds, lower latency, and better connectivity than the best current 4G technologies, 4.5G will help telcos deliver new services and command new business opportunities. The solution will support emerging applications, such as virtual reality, real-time automated industrial applications, and Ultra HD video – as well as vital transformative ICT technologies such as cloud computing, big data analysis, cellular IoT (CIoT), and broadband trunking. Meanwhile, with four
years to go until 5G is deployed, 4.5G will provide a smooth evolutionary transition via software with minor hardware upgrades, while offering advantages like quick deployment, rapid time to market for services, and protection of legacy investment.

The 4.5G solution is based on the 3GPP’s new LTE marker, LTE-Advance Pro, standardized in October 2015. Proposed by Huawei and accepted in the industry, the three 4.5G benchmarks are: Gbps [for MBB with gigabit-plus peak rates versus 100 Mbps for 4G, better capacity and cell edge throughput]; Experience 4.0 [HD user experience with 4.0+ MOS and U-vMOS for voice and video]; and Connection+ to power vertical markets with support for cellular NB-IoT and LiTRA [LTE integrated Trunked Radio] for public security networks.

Gbps: Gigabit mobile is here

4.5G offers improved peak rate, capacity, and cell edge throughput compared with 4G. It achieves this by leveraging enabling capabilities including 3CC, CA (carrier aggregation), massive MIMO, and 256QAM. It provides 1.2 Gbps peak rate (eight times 4G), which will support new high-speed terminals and applications. Meanwhile, 4.5G eNodeBs deliver 600 Mbps, six times the capacity of 4G, for simultaneous playback of 75 2K video channels (8 Mbps per channel) compared with only 12 on 4G. Finally, 4.5G enables a tenfold increase in average cell edge throughput (30 Mbps), meeting 2K/4K UHD video requirements.

The key 4.5G Gbps technologies

Massive MIMO (FDD)

Massive MIMO will greatly increase spectral efficiency and improve cell edge user experience. Huawei’s innovative eMIMO (enhanced MIMO) will maximize the advantages of 4T4R RF modules, which will be widespread by 2016. These work in medium and high frequency bands, and have four TH channels, supporting 4x2 MIMO and 4x4 MIMO. eMIMO also supports Blade RRU with traditional antennas, Blade RRU with split antennas, or AAU (Active Antenna Unit) with 4T4R capability.

Massive MIMO (TDD)

Massive MIMO (TDD) will increase spectral efficiency by between three and five times, maximizing operators’ investments in base station and spectrum. At its core is an ultra large-scale multi-antenna system. Each module integrates 128 RF channels and 128 built-in antennas, featuring the maximum specification and highest integration levels, considerably decreasing networking costs while enhancing intensive coverage. The solution supports all mainstream LTE-TDD bands and 4G terminals. A single Massive MIMO base station delivers 3D-coverage to a large area, removing the need to deploy multiple cabinets. China Mobile Shanghai and Huawei launched the world’s first massive MIMO eNodeB on a commercial 4G network in September 2015.

Massive CA
4CC and 5CC CA (deployment planned for 2016) will increase peak rate, cell edge throughput, and average cell throughput. Huawei’s eCA (enhanced CA) uses inter-eNodeB CA based on relaxed backhaul to greatly boost the proportion of SCell activations. This innovative solution also allows flexible aggregation of optimal PCells and SCells for CA UEs to significantly increase perceived data rates. eCA will further optimize PCell and SCell selection, simplify implementation, and decrease inter-cell interference.

**High-order modulation**

Set for commercial deployment in 2016, 256QAM will raise peak rates by 33 percent compared with 64QAM, and is designed to maximize outdoor macro cell capacity.

**Flexible bandwidth**

4.5G will improve use of spectrum re-farmed from 2G and 3G by using any bandwidth from 1.4 MHz to 20 MHz.

**Say hello to HD voice and video with Experience 4.0**

With enhanced voice and video technologies, 4.5G will usher in HD mobile voice and video experiences with MOS and U-uMOS scores of over 4.0. This will deliver vastly improved user experiences compared with current 4G offerings.

**VoLTE Plus**

On early-stage 4G networks, featuring circuit switched fallback to 2G or 3G, average MOS is only 3.3 (Huawei mLAB). Typical user complaints include long call setup, unclear voice quality, noise, and dropped calls. A more advanced solution, VoLTE improves MOS; however, raising MOS to over 4.0 for entire networks remains an immense challenge, mainly due to signal level and inter-cell interference at cell edges.

4.5G boosts MOS to over 4.0 by using VoLTE Plus to enhance cell edge performance and ensure VoLTE-quality voice in interference, handover, and high traffic scenarios. 4.5G will also leverage new codecs such as EVS (enhanced voice service) in 3GPP’s Release 12. The codec supports an audio bandwidth of 20 kHz (for MP3 quality), and features high resistance to latency, jitter, and packet loss. This will prove handy in telcos’ battle against free OTT voice services, which are already delivering HD-level quality. Performance based on EVS will continue to improve with 4.5G.

**Video Plus**

Globally, the average U-uMOS
for 4G networks sits at lower than 3.5, according to Huawei mLAB. With 4.5G networks, operators will be able to boost U-uMOS scores thanks to higher peak rates, as well as Huawei’s innovative Video Plus solution. First, 4.5G delivers suitable data rates for 2K/4K HD video required for a 4.0+ U-uMOS score – that is, 8.4 Mbps and 8 Mbps for 2K in the video loading and playing phases, respectively, and 32 Mbps and 18 Mbps, respectively, for 4K. And, with Video Plus, 4.5G eNodeBs leveraging the WTCP proxy shorten initial buffering latency, perform video load balancing in high traffic scenarios, and adopt an optimized video scheduling mechanism to ensure video service quality without affecting other services. This is crucial because 4G’s U-uMOS score for initial buffering latency is particularly low (under 3.5).

Connection+: More connections, more business

4.5G technology will bring the fully connected Internet of Everything one step closer to reality, creating exciting new business opportunities in vertical markets.

NB-IoT

By 2020, there will be a projected 3 billion CIoT connections, up from 240 million in 2014. The vast majority of these will rely on low power wide area networks (LPWAN). The enhanced capabilities of 4.5G NB-IoT will meet key LPWAN requirements. These capabilities include: wide coverage (20-30 dB coverage enhancement over GSM for low signal locations); massive connections (100,000 connections per cell compared with up to 2,000 with 4G); high power efficiency (10 year battery life); cost savings (modules 30 percent cheaper than GSM); optimized architecture (insensitivity to transmission latency and downlink transmission); and extensible capabilities such as mobility, roaming, and locating. With their wide coverage, mobile networks will be well positioned to provide access to a multitude of CIoT applications via 4.5G NB-IoT.

LiTRA

Huawei’s LTE-powered – and 3GPP-approved – LiTRA brings trunked radio for public security, public utilities, and enterprise into the broadband era, delivering new capabilities and addressing legacy shortcomings. With 4.5G LiTRA (LTE-integrated trunked radio), telcos will be able to provide enhanced applications for these markets. High-bandwidth and low latency, LiTRA offers voice performance rivaling traditional PTT as well as high-speed broadband data services, including video calls, video surveillance, file transfer, and GIS services.

Deployed over existing LTE networks, LiTRA significantly reduces total cost of ownership, and provides better network coverage and roaming services. This remedies short fallings due to the private-network architecture of legacy solutions. LiTRA’s compatibility with smart LTE terminals also opens
up a previously closed industry chain, enabling operators to provide more professional and efficient trunking services. LiTRA also offers improvements like QoS, MCPTT, and congestion control to address the particular requirements of public security scenarios. Huawei’s LiTRA E2E product solution facilitates rapid service deployment.

Rolling out soon to a network near you

Huawei and dozens of global leading telcos, including Vodafone and Deutsche Telekom, have collaborated on 4.5G deployment since 2014, when Huawei first proposed the concept. In 2015, 1 Gbps+ transmission rates on commercial networks were demonstrated in multiple markets worldwide. And pre-commercial deployment of NB-IoT has got underway in some European and Asian regions. Meanwhile, the governments of UK and Korea have begun constructing national LiTRA-based public-safety networks. 2016 will see the major deployment of 4.5G networks, with 60 networks planned for rollout by mainstream operators.

To facilitate the introduction of 4.5G, Huawei has spearheaded efforts on terminal maturity, verification of key technologies and industry readiness, working with major chipset and terminal manufacturers to provide support for multiple antenna, carrier aggregation, and 256QAM technologies. In 2016, a number of chipmakers launched 4.5G chipsets for terminals which will drive commercial use of 4.5G smart terminals. Qualcomm and Huawei’s HiSilicon both released chips – Snapdragon 820 and Balong 750 respectively – that support 600 Mbps peak rate and 4x4 MIMO on a single carrier at the end of 2015.

The path to 5G

4.5G will provide a smooth evolutionary process toward 5G’s commercialization. Adopting 4.5G will facilitate phased introduction of candidate 5G technologies via software upgrades and network architecture modifications for long-term coexistence between 4.5G and 5G and eventual adoption of 5G. Meanwhile, some services marketed under 5G between now and 2020 will likely be based on 4.5G. As operators move towards 5G, stepping up to 4.5G will help them deliver better capabilities and user experiences, roll out more services, protect current investments, and command new business opportunities, so they can gain and maintain a crucial winning competitive edge.