Aside from the insurmountable physical limits of power output on terminal transmission distance, the biggest bottleneck facing today's wireless 4G networks is that more devices slow down network speeds.

In airports, stadiums, squares, subways, and other public spaces, network speeds can become unbearably slow when there are lots of people, regardless of the type of mobile phone used, even for short video clips. Current networks fall short when it comes to the data requirements of new applications as a result of current wireless network tech, limited radio spectrum, and shared bandwidth between all terminals in a cell.

The light at the end of the tunnel

Massive MIMO (multiple-input-multiple-output) uses multi-user spatial division to form separate narrow beam coverage in a given space for different users. Their data is transmitted simultaneously based on a user spatial isolation system, increasing system throughput dozens of times.

By 2021, global mobile data traffic will be seven times higher than it was in 2016. Video will account for more than 78 percent of all mobile data and smart terminals will consume an average of 15 GB of data per month. With wireless networks relying on spectrum for expanding network capacity and sharing air interface bandwidth, unprecedented challenges are creeping over the horizon.

By Di Yong

In Massive MIMO theory, user channels become orthogonal when the number of antennas approaches infinity, and the only determining factor for system capacity is user numbers. Based on the actual performance data of commercial networks, it's possible to increase single-user link performance by nearly tenfold and system capacity by fourfold to eightfold, even using Massive MIMO with limited 64T64R antennas.

A Massive MIMO system with large-scale, active multi-antennas is a beautiful vision, but supporting this scenario in base stations requires large amounts of resources, large-scale antenna pilot-channel estimates, and air division calculations, something that for a long time wasn't viable commercially.

After years of research, Huawei made a breakthrough in Massive MIMO by incorporating research on TDD channel reciprocity for multi-antennas. Working with China Mobile, Huawei conducted the world's first lab prototype test in September 2014 and the first commercial prototype of Massive MIMO in September 2015. Later, Beijing Mobile and SoftBank in Tokyo...
launched Massive MIMO commercial test sites in collaboration with Huawei at the end of 2015 and at the start of 2016, respectively. These trials saw single carrier wave speeds of over 650 Mbps, at a stroke lifting the curse of spectrum scarcity in wireless communications.

In the past year, Huawei has collaborated with over 20 leading operators around the world, conducting Massive MIMO verifications in various commercial mobile communications scenarios, plus rigorous testing in the main TDD frequency bands of 2.3, 2.6, and 3.5 GHz. These milestones have set the stage for commercially deploying Massive MIMO.

**Maximum value**

Data from several hundred Massive MIMO commercial test sites shows that the technology increases spectrum efficiency dozens of times, which will in turn allow operators to lease fewer spectrums. Moreover, it almost doubles outdoor coverage.

Unlike traditional encrypted base stations that suffer from co-channel interference, Massive MIMO sites feature zero-fault precision technology that enhances edge rate and slashes inter-site interference. Massive MIMO is ideal for indoor coverage, with 3D beamforming providing a direct solution for over 7 percent of urban indoor coverage scenarios.

TDD Massive MIMO only requires the transformation of network-side infrastructure before it starts benefiting existing and new users and ensuring service continuity. Massive MIMO can also directly evolve for 5G, as the hardware can already support it, further protecting operators’ investments. China Mobile and SoftBank’s 4G to 5G transformation proposals have in fact accelerated the commercial adoption of Massive MIMO.

The solution has received several awards, including the GTI award of Outstanding contribution to Innovative Solutions and Applications, the Special Industry Contribution Team Award and Network Solution Innovation Award in 2016, and the Best Mobile Network Infrastructure Award at Mobile World Congress 2017.

**Where we’re at now**

**Four application scenarios:** China Mobile and Huawei launched the first Massive MIMO base station trial operation in Shanghai’s Pudong area in September 2015. Today, Huawei has deployed Massive MIMO sites in more than 30 Chinese cities for China Mobile. The partners have tested and verified Massive MIMO in four main commercial application scenarios: high rise buildings, high traffic, high interference, and limited uplink. China-wide deployment was verified as viable.

**Enhanced capacity:** The commercial deployment of Massive MIMO will unleash suppressed demand for
traffic. Traffic statistics analysis shows that Massive MIMO provides three to six times the capacity of 8T8R in service hotspots such as university campuses, commercial streets, and transportation hubs. In CBDs and residential high-rises, it can boost capacity by an average of 300 percent, so a cell can bear three or more times the service volume of a single carrier on the original network.

**Enhanced coverage:** Massive MIMO’s 3D beamforming increases horizontal and vertical coverage capabilities. Previously, coverage in high-rise buildings required dedicated indoor networks. But now, Massive MIMO covers both high and low floors and can easily penetrate two walls.

**Enhanced experience:** Traditional 8T8R macro base stations can’t meet real-time service experience demands in high traffic scenarios with over 200 users. Massive MIMO solves this network awareness bottleneck, ensuring user uplink and downlink awareness requirements even when 600-plus users access the cell.

**SoftBank Japan: a world first for 5G**

SoftBank first field tested Massive MIMO at the end of 2015. By the end of 2016, it had commercially deployed over 100 sites in more than 40 cities across Japan. After simulating various Massive MIMO application scenarios, it launched a 5G project in September 2016 that officially adopted Massive MIMO tech on its commercial network.

Enhanced capacity: Massive MIMO uses large-scale antennas and beamforming to give each user precise coverage and high speeds even in crowded areas. In the 100-plus cells where Massive MIMO has been commercially deployed, speeds are ten times higher, with the average stable speed hitting 400 Mbps and average cell throughput up by 6.7 times.

More competitive: Massive MIMO is a leading 5G technology that will help make high-speed, high-capacity networks a reality by 2020. Widespread deployment of Massive MIMO has allowed Softbank to deliver a leading mobile experience, which alongside highly competitive data plans has helped it attract more users.

**What the future holds**

Bandwidth increases are not the only value that wireless network evolution will bring: IoT applications, high-quality content, and better user experiences will all follow. The widespread adoption of 5G tech for Massive MIMO’s large-scale active antenna arrays on 4G networks will eliminate the limited spectrum bottleneck in wireless networks before 5G arrives, and strengthen the value of mobile Internet.

Massive MIMO’s multi-user spatial multiplexing technology wraps a high-speed single-user experience in a high-capacity system. This can provide very high, gigabit-level cell throughput, similar to an ultra-wide
carrier, delivering astounding user capacity. Massive MIMO also offers equivalent bandwidth and QoS guarantees to fixed networks.

For these reasons, it’s set to become prevalent in next-gen wireless cellular networks. The Massive MIMO market has huge potential, with predictions showing that more than 90 percent of the world’s top 100 operators will have begun deploying it by the end of 2017.

The technology provides operators with a historic opportunity to provide a universal wireless broadband service. We foresee the following operational and service innovations thanks to the unlimited potential of Massive MIMO wireless networks:

Unlimited data plans: Since 2016, the appetite for HD video and real-time games has prompted an increasing number of operators to launch unlimited data plans. More operators are also teaming up with online service providers and adopting a backward charging model, triggering the rising popularity of unlimited wireless broadband packages.

Examples include KDDI’s Smartpass service with unlimited data, Digitel’s service in the Philippines for unlimited Facebook, and Chinese carriers and Internet companies collaborating to offer unlimited monthly plans. These innovations have unleashed the long-suppressed demand for mobile broadband.

Better home broadband with fiber-grade private line access: In 2014, Huawei proposed Wireless to the x (WTTx), a wireless home broadband solution that can eliminate the global digital divide in home broadband. Huawei followed this up by launching Massive MIMO-based WTTx 2.0, which represents significant progress in broadband capability, network convergence, O&M, and service bearing. WTTx 2.0 supports single-user fiber-grade broadband access and carries a range of services, such as IPTV and Smart Home, helping digital homes become smart homes.

Surplus capacity for vertical industries: The specific nature of sharing wireless broadband means that industry customers require dedicated frequency bands to carry services and guarantee QoS. But, Massive MIMO’s spatial multiplexing makes high spectrum reuse possible and boosts uplink bandwidth tenfold, providing operators with the commercial opportunity to develop enterprise applications. Wireless broadband will support valuable industry applications including wireless video surveillance, information terminals for wirelessly streaming media, and artificial intelligence.

Massive MIMO is set to revolutionize the ICT industry, pave the way to the 5G era, and benefit both the home and enterprise markets.

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