



5G network benchmarks: Fast, efficient, intelligent

By Edward Deng, President of Wireless Solution, Huawei

5G is rolling out faster than any previous generation of wireless technology. To make this possible, overcome existing deployment challenges, and power the development of the 5G ecosystem, Huawei's end-to-end product portfolio spans solutions for spectrum sharing, network performance, site optimization, power-saving, automation, and more.

Banding together

Currently, C-Band is the most important band for capacity and coverage, so most 5G commercial networks and devices are C-Band and 2.6G. C-Band and sub-3G FDD bands will migrate to FDD NR in the near future.

CloudAIR enables LTE&NR dynamic spectrum sharing, so FDD NR can be easily deployed on low band to provide nationwide 5G coverage, enhance uplink capabilities, and shorten latency. mmWave

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will be used for hotspot and indoor scenarios in the future in light of its coverage limitations.

Massive MIMO (MM) is the mainstream product for C-Band and the performance of MM determines the quality of 5G networks. Huawei's global 5G shipments already exceed 400,000 units. This number will exceed 600,000 by the end of this year.

But there are still three major challenges for MM deployment.

- Larger bandwidth needs to be supported to match the requirements of discrete spectrum and RAN sharing scenarios.
- The solution needs to be lighter for ease of deployment.
- Power consumption must be further reduced to lower OPEX.

We've now released our third-generation MM, which will solve all three challenges and enable 5G MM's large-scale deployment, just like 2T2R and 4T4R did for 4G.

Four steps ahead with Massive MIMO

Our third-generation MM solution has four major advantages:

- **Sharing:** The industry's largest bandwidth of up to 400 MHz, which flexibly meets the needs of discrete spectrum and RAN-sharing scenarios.
- **Coverage:** The industry's highest transmission power, which greatly enhances coverage.
- **Weight:** The industry's lightest weight at typically 25 kg. This means it can be operated by one person, solving the biggest problem in MM commissioning.
- **Power:** The industry's lowest power consumption. Our current 5G MM leads the industry in terms of power efficiency, achieving similar levels to the 4G RRU with 16x the channels.

Although MM is powerful, many carriers only have one pole in some sites, which is already occupied

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by a sub-3G passive antenna, making it difficult to add an MM module. To address this issue, we provide the innovative Blade AAU, which integrates all sub-3G passive bands and 5G MM band into one band. As we're a leader in both the wireless radio and antenna fields, we're a unique player in being able to provide the most integrated Sub-6G all-in-one product.

Four leading site solutions

In the 4G era, pole sites were an important way of improving capacity and coverage. In some Chinese cities like Shenzhen, the number of pole sites exceeds macro sites. For 5G, we provide the simplified pole-site solutions 5G EasyMacro with 8T8R and 5G BookRRU with 4T4R, which will help pole sites and small cells become more popular in the 5G era.

As 5G frequency is higher, penetration loss is also higher. To ensure indoor 5G user experience, DIS is the go-to solution. For high-capacity scenarios, we've released LampSite Pro, which supports up to 400 MHz bandwidth. For cost-sensitive coverage scenarios, we've released Lampsite Grid, which can

extend RRU coverage by three times delivering a similar overall cost to DAS, but bringing a DIS experience.

The above four solutions – MM, BladeAAU, pole site, DIS – are solutions for enabling 5G C-Band's massive deployment for various scenarios.

Sub-3G bands will eventually move to 5G. To reduce the number of boxes required and better support evolution to FDD NR, the super wideband module has become the preferred choice.

Huawei has achieved another industry first when it comes to providing sub-1G triple bands with 2T4R and 4T4R, delivering the highest Tx power of dualband 4T4R: 1.8GHz and 2.1GHz.

With long-term experience in TDD MM combined with special innovations for FDD differentiation, we're also rolling out the industry's first dual-band 32T32R FDD MM and the only FDD MM viable for commercial use in terms of performance, engineering, and cost. So now with legacy spectrum, we can significantly increase 4G capacity and, at the same time, provide another choice for 5G for markets without enough C-Band.

Finally, mmWave can solve the coverage problem. Huawei provides the industry's highest Tx power 8T8R module, which supports up to 70 dBm and guarantees the best coverage.

A softer approach

It isn't enough to build a leading 5G network with powerful hardware capabilities only.

As legacy networks become larger, improving network value with software is crucial.

Moreover, due to the slowdown of Moore's law for hardware, it's necessary to build new capabilities with software algorithms.

In another industry first, we proposed the overall architecture of wireless algorithms at MBBF 2019. In the past, we prioritized hardware specifications. Hardware capabilities are dominant, while software capabilities are implicit. And these hidden capabilities are crucial to delivering leading network performance and quality.

The key to wireless performance is algorithms and the key to algorithms is mathematics.

Huawei utilizes the expertise of global mathematicians to reshape the classic theories by combining mobile network requirements. For example:

- **Capacity gains:** For 5G M-MIMO scenarios, we've extended the classic Shannon theorem of the single channel to multi channels to maximize network capacity.
- **Experience gains:** For latency-sensitive services, such as 5G cloud VR and cloud gaming, we've extended the traditional rate-first utility function

to the optimal combination of rate and latency to provide the best user experience.

- **Energy-efficiency gains:** We've extended the water-filling principle of single band power allocation to multi-bands to achieve highest network-wide energy efficiency.

Algorithms in action

Having built an E2E system of algorithms, Huawei's algorithm workflow runs from innovation to verification to implementation.

First, we identify the future direction of innovation, based on the first-principle theory, and then define the theoretical upper limits to guide innovation. Second, comes verification. Huawei's global commercial experience with massive road-tests of channels and beams has resulted in our experimental Omega platform to accelerate algorithm verification and optimization. Last, with our strong in-house chipset capabilities coupled with fast algorithm-to-chip conversion and dedicated algorithm accelerators in chipsets, we can greatly enhance algorithm capabilities.

Shannon Theorem in wireless

MM expands the Shannon Theorem to match multi-channel characteristics, thus achieving more capacity based on the optimization we've made to the MM algorithm.

The thousands of channels formed by 64TRx MIMO can be rapidly processed with dedicated algorithm accelerators in the chipset to form the most accurate beams. These can minimize interference among users and select the most suitable pairing of the target user to maximize the network capacity. For high-speed mobility scenarios,

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Introducing AI to implement autonomous operation and maintenance represents a convenient way to address the challenge associated with constantly growing 5G OPEX.

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advanced channel predictions and compensation algorithms enables resistance to Doppler shifts. Even in a 300 km/h mobility scenario, we can achieve the best MIMO user experience with a performance decrease of less than 10 percent. In deep coverage scenarios, Huawei provides the Super BF solution to support beamforming in control channels, giving users MM capacity gains in service channels and coverage gains in the control channel.

5G in 2C & 2B scenarios

In 5G 2C scenarios, our VR Turbo solution bases air traffic resource scheduling on bit stream, and enables intelligent scheduling and intelligent acceleration based on the VR frame, reducing the latency of each frame and significantly improving the 5G VR experience.

5G 2B scenarios have higher requirements in uplink. Jointly with our customers, we've achieved further innovations in uplink and downlink decoupling, providing a super uplink solution. By combining high frequency and low frequency synergy, TDD and

FDD complementary coexistence, and time domain and frequency domain aggregation, UL all-timeslot scheduling in TDD mode can be realized, increasing the uplink rate by up to 500 percent in the cell edge, and improving latency in the air interface by more than 30 percent. We've already worked with leading operators to promote it in R16, and Huawei will provide an E2E solution, including network features and devices, in 2020.

Green 5G

Our PowerStar solution improves power-saving algorithms across multi-modes and multi-bands, improving power-saving without impacting KPI. At last year's MBBF, we released PowerStar 1.0 which could save 10-15 percent in power across mobile networks – 2.0 increases that by 10 percent, realizing our “sleep deeper, sleep longer” target.

Wireless intelligence

Increased OPEX in the mobile industry is now a common challenge that requires future mobile networks to be more intelligent in terms of O&M.

At MBBF 2018, we released our 5-level architecture for mobile network automation.

In 2019, we defined specific requirements for L1-L5 in four major network scenarios: planning, deployment, maintenance, and optimization.

Our autonomous driving network is recognized in the mobile industry and is being gradually defined in the 3GPP standard. GSMA will release its intelligent autonomous network report this month.

3-layer ADN mobile solution

We've also released the industry's first ADN mobile solution, which includes:

iMaster NAIE: Our AI model training platform, which provides AI training services, spanning data lakes, network knowledge databases, and AI.

iMaster AUTIN: Our cross-domain AI unit, which provides autonomous services for multiple domains, including MBB/FBB/IT/IP/multi-vendor.

iMaster MAE: our MBB network AI unit, which enables network autonomous driving in MBB scenarios.

This three-layer architecture are hierarchically autonomous. Each layer can work independently as a minimal closed loop or vertically coordinate if required. Based on the ADN Mobile solution, Huawei will launch several L3 apps next year.

Two examples of apps

Site Express

Designed for auto-deployment, Site Express supports self-awareness in base station hardware to automatically realize self-detection. It performs

aggregation and classification on the initial configuration parameters and, based on AI training, seeks the optimal configuration parameter sets in different scenarios. Configuration can be done automatically, with higher accuracy than manual operations.

According to our test result with China Mobile, site deployment efficiency is three times higher than was previously possible. Huawei's delivery capability leads the industry, which will expand with Site Express, providing faster TTM for customers.

Alarm Turbo

Traditional alarm processing has always been labor intensive. Alarm Turbo aggregates the original alarms and merges similar items, significantly reducing the number of alarms. The knowledge map of the Bayesian algorithm coupled with the root cause analysis of associated alarms can significantly reduce alarm analysis time. Only one work order is required for associated alarms, greatly reducing the number of work orders and slashing fault handling time.

As well as built in apps that provide E2E autonomous network capabilities, we also provide open platform third parties; not just the data source, but also open API interface and IDE (integrated development environment) to enable our operators to develop self-defined apps or introduce third-party apps to meet various requirements.

We're always thinking of the next step, from passive processing to active prevention and building in AI-based fault prediction and prevention capabilities.

The 5G era has arrived with a full-speed engine that enables powerful 5G networks, a shift up in gears with advanced algorithms, and smart control with leading intelligence. 