



# xMbps Anytime Anywhere

## White Paper





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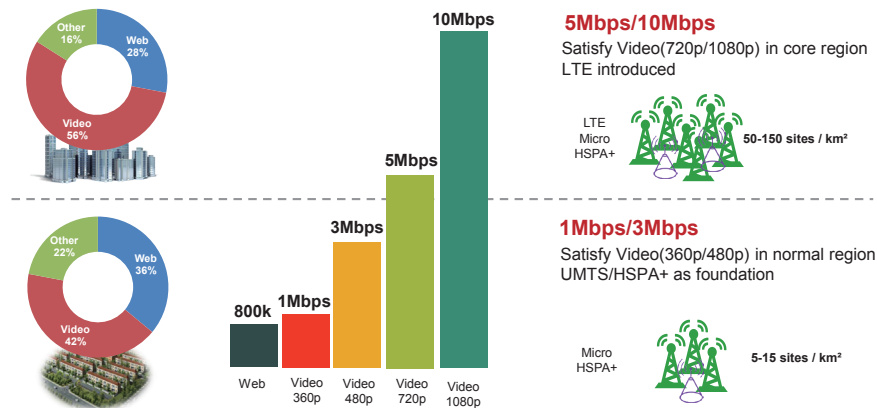
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# xMbps Anytime Anywhere

MBB networks provide diversified services, which are always online. Traditional KPI-based network construction cannot ensure good user experience for MBB services, such as fast web browsing and smooth video playback. Therefore, a new network construction standard and deployment strategy is required for MBB networks.

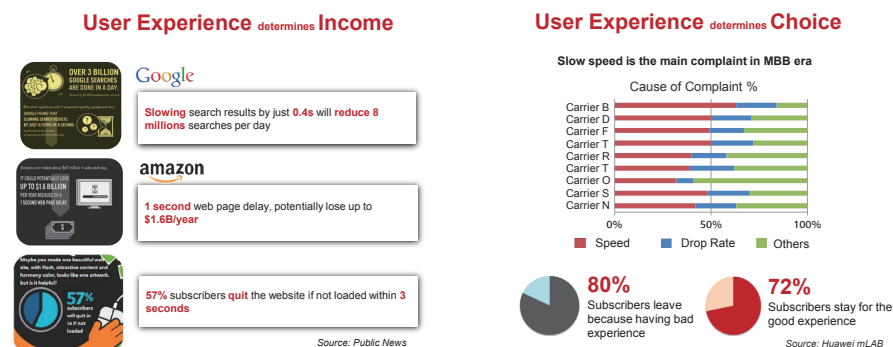
"xMbps Anytime Anywhere" sets appropriate target speed in different areas and enables refined analysis of network bottlenecks. By doing so, this solution ensures good user experience for various services and makes precise investment possible. The "xMbps Anytime Anywhere" solution is a fitting network construction standard for the MBB era and it provides strategy for deploying the best MBB networks.



# 1 Why Do We Need xMbps Anytime Anywhere?

## 1.1 User Experience Is the Key to Business Success in the MBB Era

In the MBB era, user experience directly affects user behaviors, thereby affecting operators' revenues. According to statistics released by Google, for every 0.4 second increase in network response latency, the number of network searches decreases by eight million per day. According to a similar report released by Amazon, for every one second delay when accessing Amazon's shopping websites, Amazon will suffer an annual revenue loss of 1.6 billion dollars. According to Huawei mLAB analysis, bad user experience (low speed) is the main cause of subscribers' complaints. 80% of subscribers leave their current networks because of bad user experience, and 72% stay in their current networks due to good user experience.

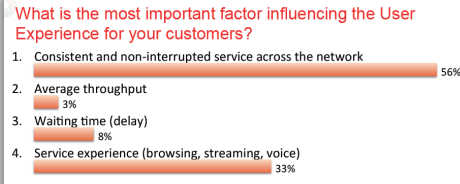


Mainstream operators broadly agree that it is very important to improve user experience. In Huawei User Group Meeting 2014, 89% of operators agreed that high-quality services and consistent user experience are core issues, and 96% of operators agreed that coverage and speed are the major concerns of end users.



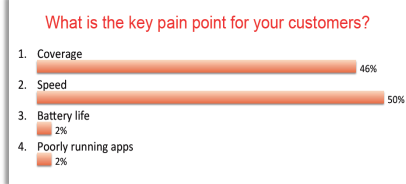
## Survey in Huawei User Group Meeting 2014

(300+ voters representing 142 operators partners, from 100+ countries)



*Consistent and no-interrupted service experience is expected by all customers and they don't appreciate for that. But if they loose coverage and loose service they will start to call you. The real difference for me is the service experience, customers want to pursue the Service Quality.*

— Vodafone




*Definition we use for customer is the freedom to use application anytime anywhere at the speed related to customer. So customer experience is the mixture of both coverage and speed because customer expects everywhere coverage and expectable speed, at least what customer has made contract with operator.*

— Dutch Telecom


More and more third-party consulting firms and well-known media outlets advocate better user experience. For example, the European company P3, performs annual benchmark tests on the local mobile networks of a certain country, such as German, Swiss, and Austrian, and announces the test benchmark results and ranking in the well-known European magazine Connect. P3 declares that the fundamental purpose of the benchmark test is to help end users to get better user experiences. The benchmark test results and ranking affect the loyalty of end users to their current mobile networks. Therefore, this is a big test every year for local mobile operators.

■ Local Famous Media or Regulation




Japan  
UK  
Singapore

■ Independent 3<sup>rd</sup> Party Evaluation



Widely recognized in Europe  
Widely recognized in North America

■ Popular Evaluation App – Speed Test




End users can test actual speed anywhere anytime

■ P3 Test Aims at Better Experience for End Users

**The main principle: transparency**

Based on the information provided, the network operators got the chance to optimize their network accordingly. Some pretended insiders, actually accused connect of this, connect was even threatened with uncovering this as an unfair practice. Of course, the operators can put special effort into preparing their networks for the connect test – but as the test takes into consideration the main and most aspects relevant for the end user at relevant test-locations, ultimately all users benefit from these network optimizations.



Source: German P3 test

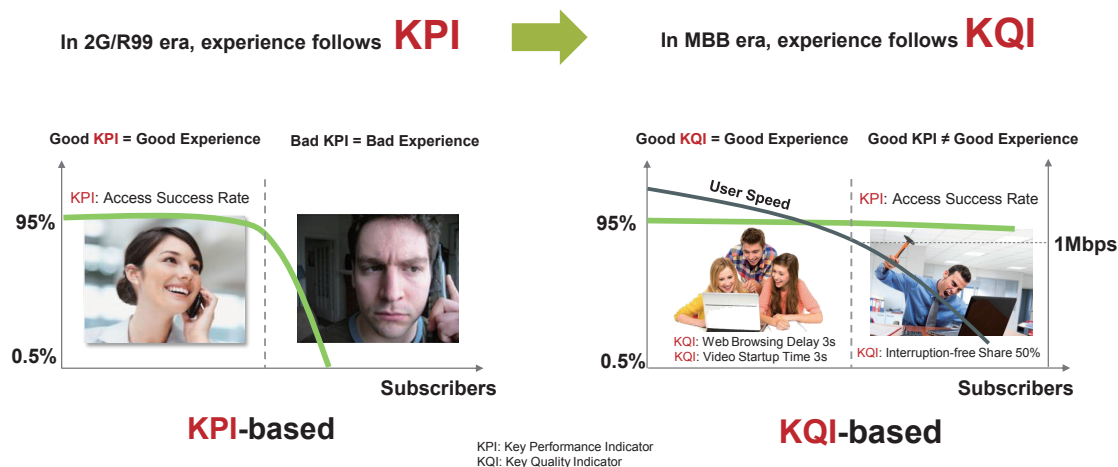
Therefore, user experience is the key to business success in the MBB era.

## 1.2 Different Services and Areas Require Different Target Speed

### 1.2.1 KQIs Measure the User Experience of Services

Because the KPI-based network construction which is used in the 2G, UMTS R99 era, cannot ensure good user experience for MBB services, a KQI-based network construction is required for MBB networks. MBB networks are suitable for supporting multiple services, and most MBB services are always online; as user number increases, the speed to bear MBB services decrease; consequently, user experience deteriorates; however, the traditional KPIs, such as the access success rate and call drop rate, do not noticeably deteriorate; therefore, KPIs cannot be used to determine user experience in MBB networks. The actual user experience of MBB services should be of concern. Generally, Key Quality Indicators (KQIs) are used to measure user experience of MBB services, and network construction based on KQIs is recommended.

In GSM or UMTS R99 networks, the speeds of voice or UMTS R99 data services are fixed. If too many users access a network, load congestion occurs, which leads to decreased access success rate and increased call drop rate. As a result, user experience deteriorates. Therefore, traditional KPIs can be used to determine the user experience in GSM or UMTS R99 networks, that is, network construction can be based on KPIs.



In the MBB era, KQIs are supplement to and development in traditional KPIs, good KPIs are the basis, and good KQIs are the objective.

Different types of MBB services use different KQIs to accurately measure user experience. For example, web browsing delay can be used to measure user experience of web services; user experience of web services is considered good if the web browsing delay is less than three seconds. The startup time and interruption-free share can be used to measure user experience of video services; user experience of video services is good if the startup time is less than four seconds and the interruption-free share is more than 95%.

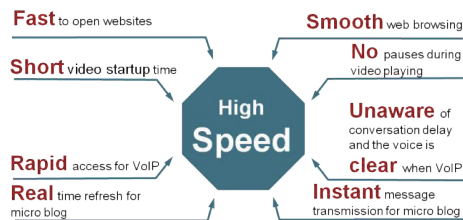


Service	KQI	User Experience
Web	Web Browsing Delay < 3s	Good
	Web Browsing Delay > 3s	Bad
Video	Startup Time < 4s Interruption-free Share >95%	Good
	Startup Time > 4s Interruption-free Share <95%	Bad

## 1.2.2 xMbps Ensures Good User Experience

Usually, a mobile network is limited on the air interface. User experience of MBB services is closely related to the speed of the air interface. High speed for MBB services ensures good user experience. Many operators rely on high speed for their branding, reflecting the widely acknowledged reality that speed is the key to improving user experience.

Good Experience all about  
High **Speed**



Operator Brands always with High **Speed**



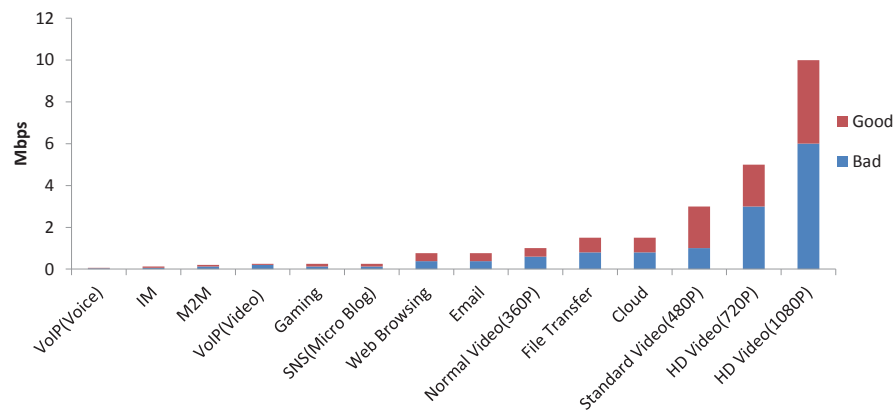
To ensure satisfactory user experience, different services require different speeds. Even for the same service, user experience needs to be measured with different KQIs. Various speeds may be required to meet the needs of different kinds of KQIs. In such a scenario, the highest speed should be used as the target one to ensure KQIs are all good. For example, for normal video (360p) services, at least 0.8 Mbps is required to ensure smooth playback, and at least 1 Mbps is required for a short startup time. Therefore, 1 Mbps is considered as the target speed for normal video services. Similarly, to satisfy user experience requirements for standard-definition (SD) (480p), high-definition (HD) (720p), and full HD (1080p) video services, the minimum speed of 3 Mbps, 5 Mbps, and 10 Mbps, are required, respectively.



Format	Resolution	Code	Bit Rate (Mbps)*	KQI	Bearer Rate (Mbps)	Network Requirement (Mbps)
360p	480x360	H.264	0.5-0.8	Startup Time < 4s	1	1
				Interruption-free Share >95%	0.8	
480p	640x480	H.264	1.2-2.3	Startup Time < 4s	3	3
				Interruption-free Share >95%	2.3	
720p	1280x720	H.264	2.1-3.8	Startup Time < 4s	5	5
				Interruption-free Share >95%	3.8	
1080p	1920x1080	H.264	5-7.7	Startup Time < 4s	10	10
				Interruption-free Share >95%	7.7	

\*Because the video resolutions are different, the bit rates of different video files are noticeably different. Even if the video resolutions are the same, the actual video bit rate may fluctuate greatly because the proportion of dynamic images ratio and video encoding level (Profile&Level) vary. The preceding table is obtained based on the YouTube website statistics.

By using the same method, the “xMbps” requirements for other type of services with good user experience can be obtained. The speeds required for a robust user experience for web browsing, VoIP(voice), and micro blogging are 768 kbps, 64 kbps, and 256 kbps, respectively.

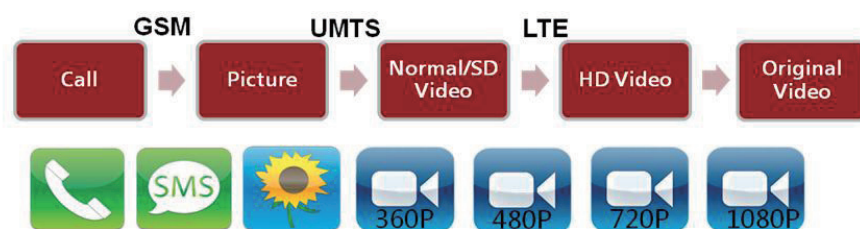


Source: Huawei mLAB, 2014

Mainstream MBB services can be classified into ten types: web browsing, video streaming, VoIP, social networking service (SNS), instant message (IM), cloud, email, file transfer, gaming, and machine-to-machine (M2M) service.

Therefore, the bearer speed xMbps plays a crucial role in determining user experience. The target xMbps of MBB networks should be determined based on the KQI requirements of target services. xMbps is the minimum bearer capability of MBB networks for target services.

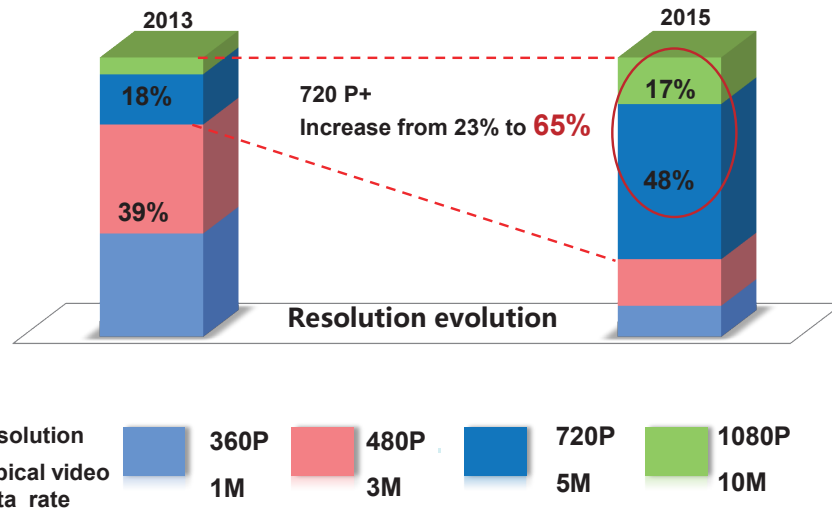
The industry is in agreement. We are moving past the age of 2G voice communications and stepping out into a streaming video future with MBB. And this video is also moving forward from the normal and SD of the time to a new age of HD and full HD.



Source: Huawei mLAB & Sohu.com

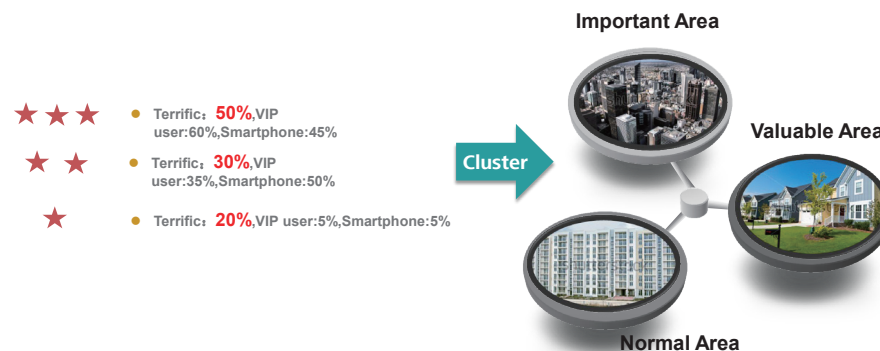
Huawei mLAB has predicted that HD 720P or higher-definition video will increase from 23% of total traffic in 2013 to 65% of total traffic in 2015.

As previously mentioned, normal, SD, HD, and full HD video require 1 Mbps, 3 Mbps, 5 Mbps, and 10 Mbps, respectively for robust user experience. The overall development of MBB services shows that 1 Mbps, 3 Mbps, 5 Mbps, and 10 Mbps can meet the user experience requirements for current and future mainstream services.



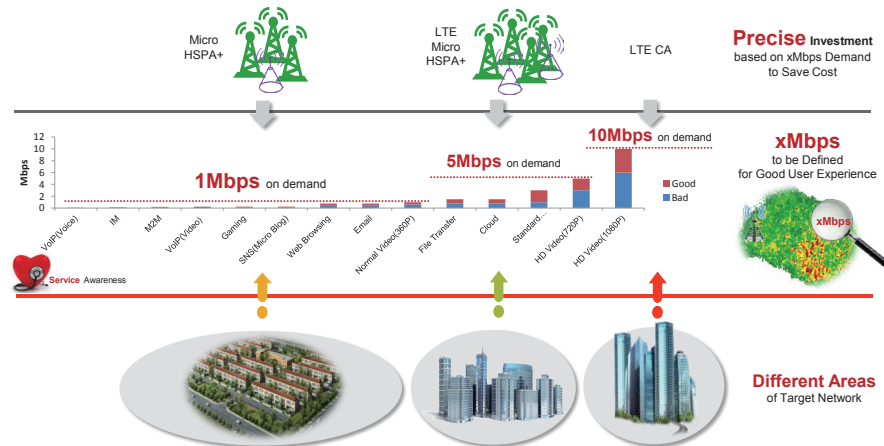
### 1.2.3 Different Areas Require Different xMbps

MBB services are not evenly distributed. Generally, a city center has higher xMbps requirements than a suburban area. It is unnecessary to implement high xMbps across the entire network. Implementing high xMbps in the entire network wastes significant resources. In actual network deployment, the target xMbps must be set by area. For example, we can divide the target area into important, valued, and normal areas based on the distribution of traffic, high-value subscribers, and terminals.



We should find the mainstream high-value services in each area and then set the xMbps network construction goal based on the mainstream high-value services and the service-to-xMbps baseline. For example, in an area with mainstream high-value services like web browsing and SD video, 1 Mbps is the target speed for network construction; in an area with mainstream high-value services like HD or full HD video, 5 Mbps or 10 Mbps is the target speed of network construction. Setting the target xMbps by area can reduce network construction costs, balance user experience and investment, and therefore implement precise investment.



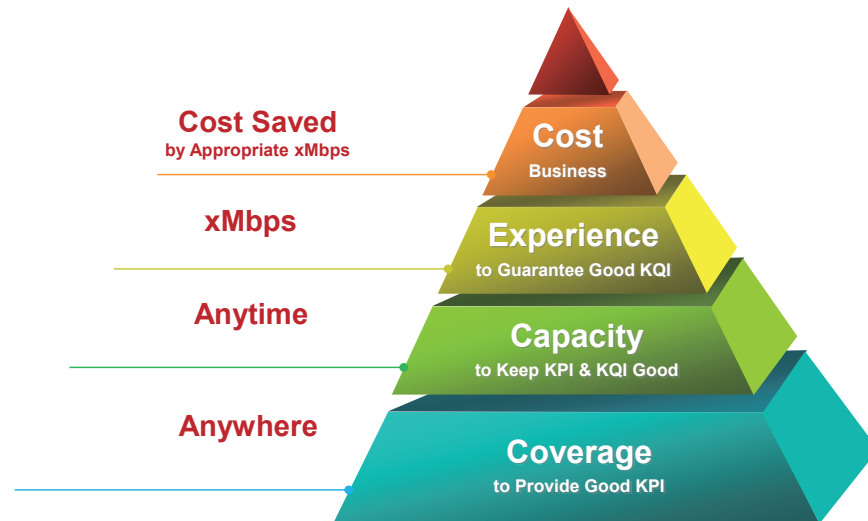


## 1.3 xMbps Anytime Anywhere Becomes the MBB Network Construction Standard

In addition to the xMbps objective for providing a robust user experience and area-based xMbps for reducing investment costs, you also need to consider the capacity and coverage in MBB network construction. Capacity, coverage, user experience, and cost are the four key dimensions of MBB network construction. These four dimensions can be summarized as "xMbps Anytime Anywhere".

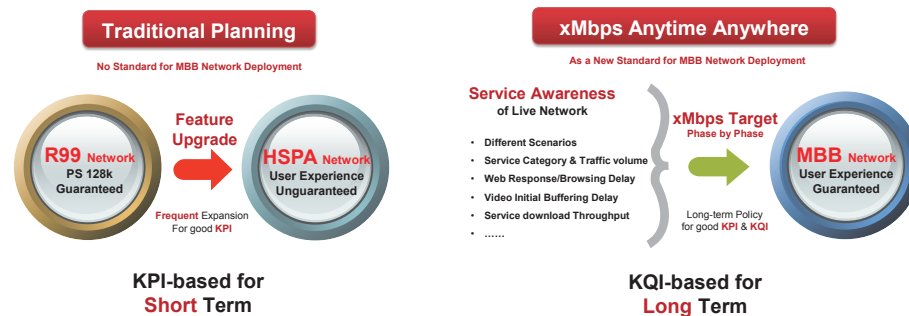
"xMbps" in the xMbps Anytime Anywhere solution reflects both user experience and the cost. "Anywhere" in the xMbps Anytime Anywhere solution reflects the coverage. Good coverage is the basis for satisfactory user experience. The operator must provide good network coverage so that users can access the network wherever needed and obtain the required services. "Anytime", in the xMbps Anytime Anywhere solution, reflects the capacity. If planned capacity is insufficient, resources will be insufficient in busy hours, leading to unsatisfactory user experience. Users can obtain required resources only when sufficient capacity is provided in time.

"xMbps Anytime Anywhere" also reflects the development from KPIs to KQIs. "Anywhere" ensures basic KPIs, "Anytime" indicates that KPIs and KQIs do not deteriorate, and "xMbps" guarantees good KQIs.



xMbps Anytime Anywhere is based on a comprehensive understanding of MBB services and operator's business policy. It focuses on user experience improvements and therefore becomes a new network construction standard for MBB networks.

As a network construction standard, the xMbps Anytime Anywhere solution helps operators set mid- and long-term network construction goals and avoid frequent network optimization.



In engineering planning, xMbps Anytime Anywhere can be defined as follows: In a specific scenario, a robust user experience can be achieved if the speed reaches xMbps within a certain percentage (for example, 90% is the typical value) of the time duration in a certain percentage (for example, 95% is the typical value) of the coverage area.

## 2 How to Deploy xMbps Anytime Anywhere?

xMbps Anytime Anywhere functions as both a network construction standard for the MBB era and a deployment strategy for building the best MBB networks. This strategy includes a sequential deployment procedure and comprehensive solutions and tools.

### 2.1 Three Steps for Achieving xMbps Anytime Anywhere

Perform the following three steps to achieve xMbps Anytime Anywhere:

- xMbps Business Insight.
- xMbps Network Discovery.
- Experience-based Solution Delivery.

#### Step 1: xMbps Business Insight

- Service-based MBB Visualization to Find Valuable Services
- Service-to-xMbps Baseline to Define xMbps Target

#### Step 2: xMbps Network Discovery

- Experience-based MBB Visualization to Discover Gap
- 50m\*50m Accurate Map to Show Experience & Bottleneck

#### Step 3: Experience-based Solution Delivery

- Innovative Solution Delivery in Coverage & Capacity
- KPI & KQI Acceptance



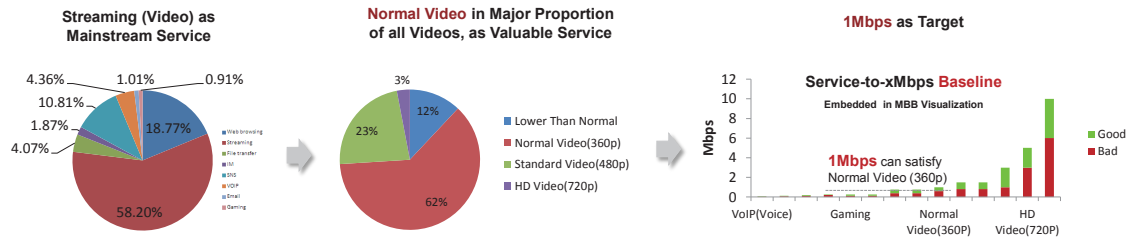
**Best MBB Network**

### 2.2 xMbps Business Insight

The MBB visualization solution helps accurately reflect user experience and distribution of traffic, users, and terminals on the live network. Based on the operator's business policy, this solution divides areas and finds mainstream high-value services in different areas. Then, according to the xMbps baseline requirements for good user experience, this solution determines the speed of the mainstream high-value services for each area. This speed is the target xMbps.

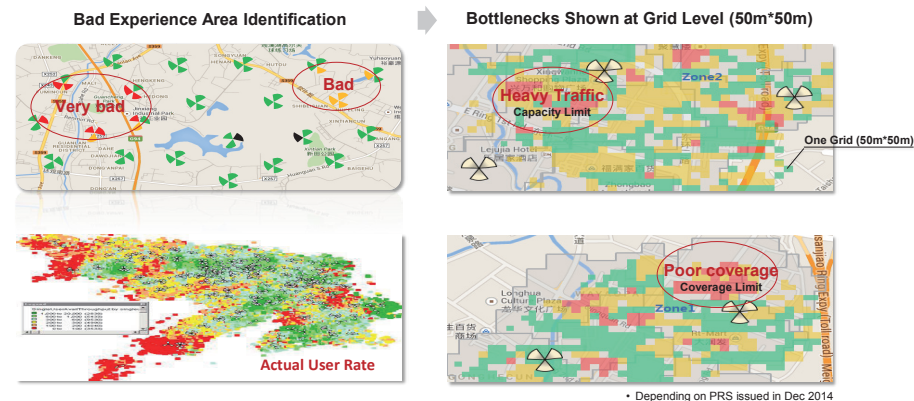


For example, the mainstream high-value services in common urban areas are normal video, and therefore the speed 1Mbps is required to achieve a robust user experience.



## 2.3 xMbps Network Discovery

The MBB visualization solution displays areas with poor user experiences in a 50 m x 50 m grid, thereby helping locate network bottlenecks. Poor user experience in radio networks is generally caused by poor coverage or insufficient capacity.



## 2.4 Coverage Solution

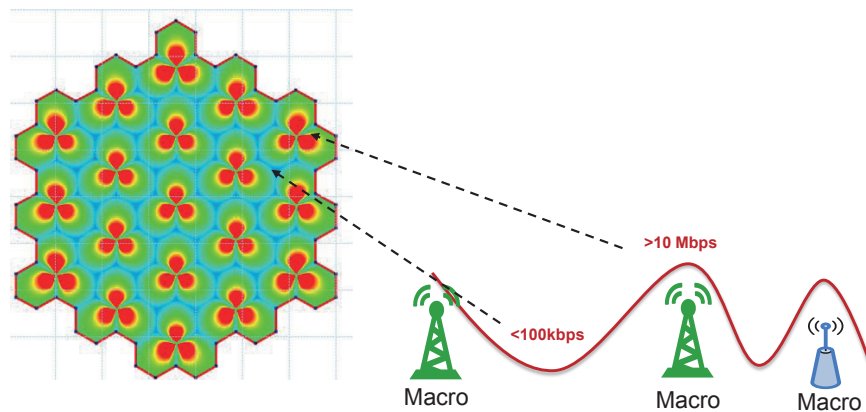
Coverage is the basis for MBB development. Good coverage provides good user experience and boosts service development.

Helping operators deploy a high-efficiency low-cost coverage network is the main focus. Ensuring appropriate inter-site distance, introducing low frequency bands, and improving the speed of cell edge users (CEUs) are the best solutions for implementing continuous coverage.



## 2.4.1 Ensure an Appropriate Inter-Site Distance

The mobile network uses a cellular structure. UEs at the cell center can have a speed higher than 10 Mbps because they are close to antennas and suffer less interference from neighboring cells, whereas UEs at the cell edge may have a speed lower than 100 kbps because they are far from antennas and suffer more interference from neighboring cells. Therefore, to improve the coverage performance, operators need to increase the speed of CEUs.

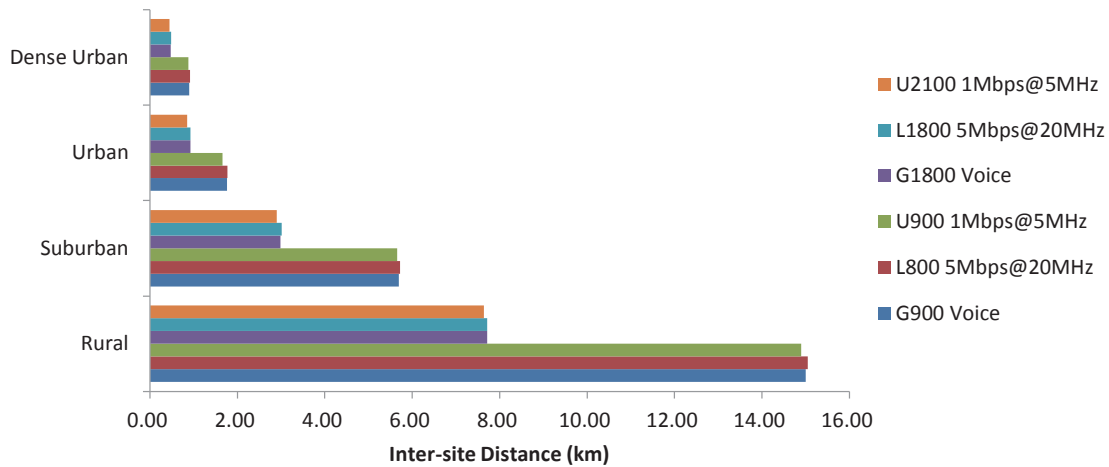


An appropriate inter-site distance guarantees the speed of CEUs and serves as a basis for continuous xMbps coverage. Based on our experience accumulated from successfully constructing commercial networks worldwide, we find that in high frequency bands, UMTS2100 continuous 1 Mbps(@5MHz) coverage, LTE1800 continuous 5 Mbps(@20MHz) coverage, and GSM1800 continuous voice coverage have the same typical inter-site distance; in low frequency bands, UMTS900 continuous 1 Mbps(@5MHz) coverage, LTE800 continuous 5 Mbps(@20MHz) coverage, and GSM900 continuous voice coverage have the same typical inter-site distance.

Network	Inter-site Distance (km)			
	Dense Urban	Urban	Suburban	Rural
U2100 1Mbps@5MHz	0.42~0.48	0.62~0.85	2.4~2.8	7~8
L1800 5Mbps@20MHz	0.45~0.51	0.78~0.93	2.8~3.2	7~8
G1800 Voice	0.44~0.49	0.76~0.91	2.7~3.1	7~8
U900 1Mbps@5MHz	0.85~0.94	1.21~1.75	4.9~5.7	13.8~15.9
L800 5Mbps@20MHz	0.88~0.99	1.49~1.81	5.3~6.3	13.9~16.2
G900 Voice	0.87~0.97	1.51~1.79	5.2~6.1	13.6~15.5

Note: LTE with DL 2x2MIMO, UMTS with HSDPA Cat14 64QAM, both on single carrier

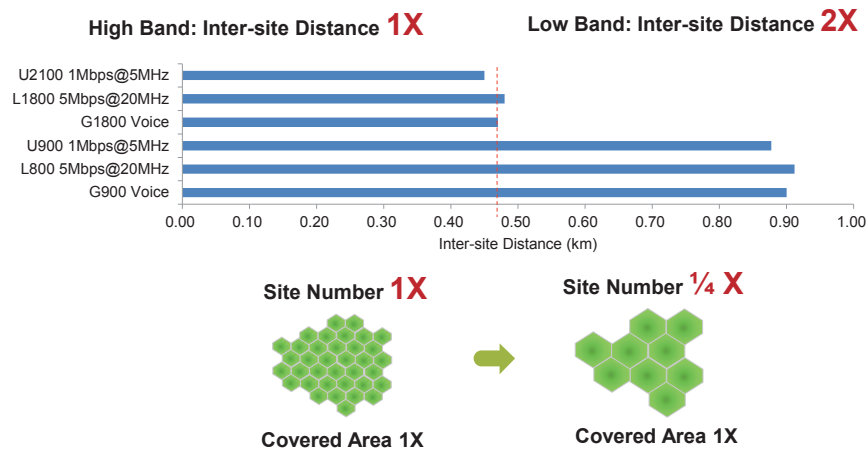




1 Mbps@5MHz) Anytime Anywhere can be implemented if the GSM network provides continuous voice coverage, and GSM and UMTS co-site with each other at a 1:1 ratio and are both working on high frequency bands or low frequency bands. Similarly, 5 Mbps@20MHz) Anytime Anywhere can be implemented if the GSM network provides continuous voice coverage, and GSM and LTE co-site with each other at a 1:1 ratio and are both working on high frequency bands or low frequency bands.

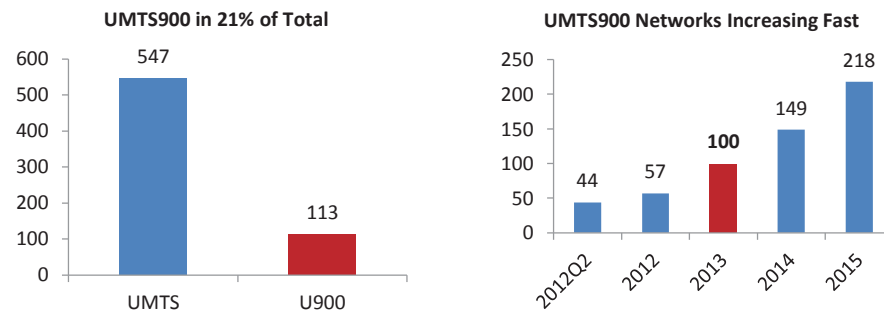
## 2.4.2 Introduce Low Frequency Bands

As described in 2.4.1 "Ensure an Appropriate Inter-Site Distance", the inter-site distance of low frequency band networks is more than twice that of high frequency band networks. To achieve the same network coverage, the low frequency band network only requires one-fourth the number of sites required by the high frequency band network. Therefore, it is necessary to introduce low frequency bands.



Generally speaking, low frequency bands are used for wide coverage in rural areas and deep indoor coverage in urban areas and are the most economical means of enhancing network coverage and achieving seamless coverage.

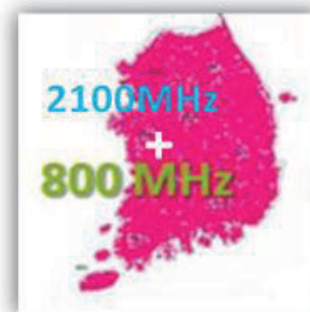
More and more operators are recognizing the cost-effectiveness of low frequency bands and have deployed their networks on low frequency bands. As of June, 2014, there are 547 UMTS networks worldwide. Of these networks, 113 networks operate in UMTS900, which occupies 21% of the total UMTS networks, as shown in the following figure. It is expected that the pace of introduction for UMTS900 networks will accelerate in the future.



Source: GSA & Huawei, 2014

Besides, more than 35 LTE800MHz networks, two LTE APT700 MHz networks, more than 20 LTE US700 MHz networks, and more than 10 LTE850MHz networks have been deployed globally. More and more operators choose to deploy low frequency band LTE networks.

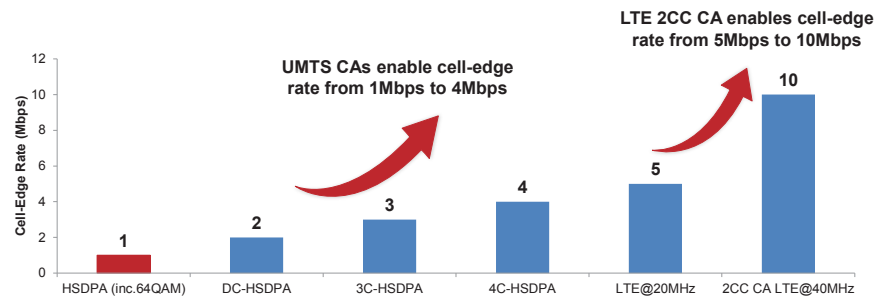
Of particular note, Vodafone Germany deployed nationwide LTE800MHz coverage within nine months. The network deployment significantly improves user experience. In July 2011, Korea LG Uplus started to deploy LTE850MHz, and the nationwide coverage was also deployed within nine months. Quick network deployment improves user experience and has a positive market brand effect.



Re-use Macro site resource

### 2.4.3 Improve Cell-edge User Speed

In the preceding sections, UMTS 1Mbps Anytime Anywhere and LTE 5Mbps Anytime Anywhere were based on a bandwidth of 5 MHz and 20 MHz, respectively for single-carrier terminals. As more and more terminals support carrier aggregation (CA), more and more operators use CA to increase user speed. With the CA technique, a network with 1 Mbps Anytime Anywhere implemented on single carrier can develop to 2 Mbps, 3 Mbps, or higher anytime anywhere even if no coverage sites are added. This adapts to the development of MBB services. For example, with the same inter-site distance, the DC-HSDPA, 3C-HSDPA, and 4C-HSDPA feature can increase 1Mbps Anytime Anywhere to 2Mbps, 3Mbps, and 4Mbps Anytime Anywhere, respectively. Similarly, the aggregation of two component carriers (referred to as 2CC CA in this document) for LTE can increase 5Mbps Anytime Anywhere to 10Mbps Anytime Anywhere.



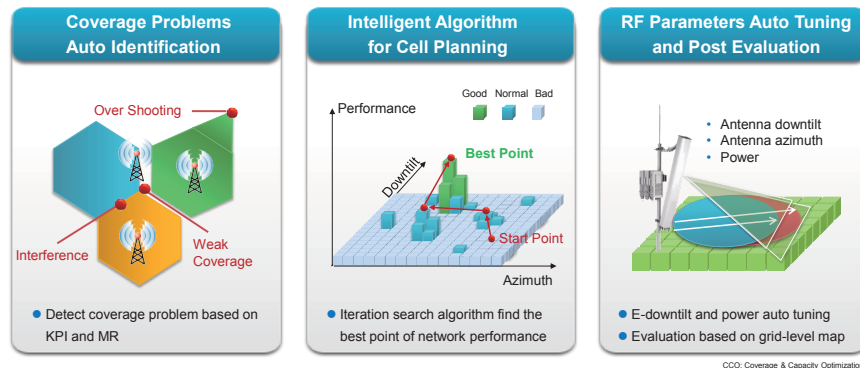
In UMTS and LTE networks, intra-frequency interference exists between neighboring cells, affecting user experience at cell edges. Interference becomes intensified with the development of new networks. First, the network load increases with the number of subscribers and traffic, and high load boosts interference at cell edges. Second, base stations are deployed with a higher density, causing more cell edges and deterioration in user experience at the new cell edges. To improve user experience at cell edges, operators should handle the intensified interference issues while achieving the purposes of wide and deep indoor coverage and capacity expansion in valuable areas. Interference suppression is also an important method of improving the rates of CEUs.

Huawei provides a series of solutions to reduce intra-frequency interference and improve the user experience at cell edges. These solutions include UMTS and LTE CCO, LTE aICIC, CSPC, SFN, and intelligent collaboration.

CCO stands for coverage and capacity optimization. CCO automatically detects pilot pollution, cross coverage, and weak coverage in the network and adjusts the antenna azimuth, tilt, and cell transmit power, thereby increasing the overall coverage.



## CCO: Improve Network Coverage Performance

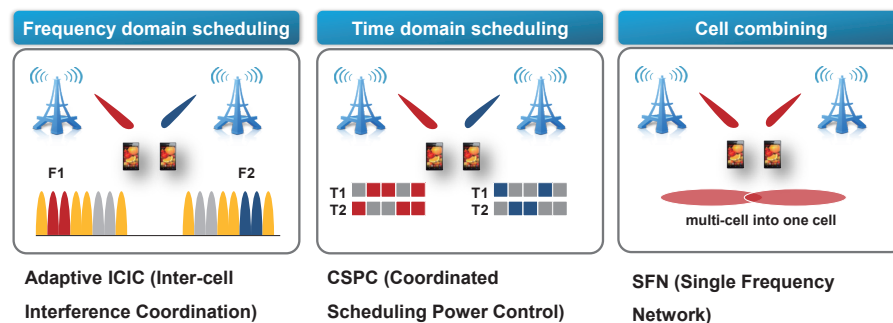


aICIC stands for adaptive inter-cell interference coordination. aICIC is a frequency-domain coordination technique. It monitors the interference level in the entire LTE network and coordinates spectrum allocation at cell edges based on network load and interference distribution. As a result, CEUs are allocated different frequency resources between cells to mitigate interference. Huawei aICIC much improve the speeds of CEUs. It addresses the industry issue where ICIC fails to obtain sustainable gains on live networks.

CSPC stands for coordinated scheduling based power control. CSPC is a time-domain coordination technique. It coordinates time-domain resource allocation between cells so that CEUs are allocated different time-domain resources. CSPC helps increase the speeds of CEUs.

SFN stands for single frequency network. SFN employs joint transmission, in which cells causing severe interference to each other are combined into a single cell, to mitigate interference. SFN increases the speed of original CEUs.

Different coordination techniques have different deployment requirements and are used in different scenarios. Huawei intelligent coordination solution automatically monitors network performance and radio interference distribution in real time and adaptively selects coordination techniques. This solution maximizes the speed of CEUs and system throughput.



## 2.5 Capacity Solution

Once MBB networks are widely deployed and the market grows, user behavior changes. This change poses challenges to the network capacity. The operators need to consider the traffic volume in the live network and the market profits in order to formulate a solution for this problem.

### 2.5.1 Define an Accurate Traffic Model

In a mobile network, the cell capacity is limited. Therefore, with an increasing number of subscribers (subscribers that are powered on and have attached to the network), the scheduling time for each CEU is equalized and decreases. That is, the traffic volume allocated for a given CEU decreases. In this case, the cell edge user speed drops. The minimum cell edge user speed is xMbps to be guaranteed, and the corresponding number of subscribers is the maximum number of subscribers that a cell supports.

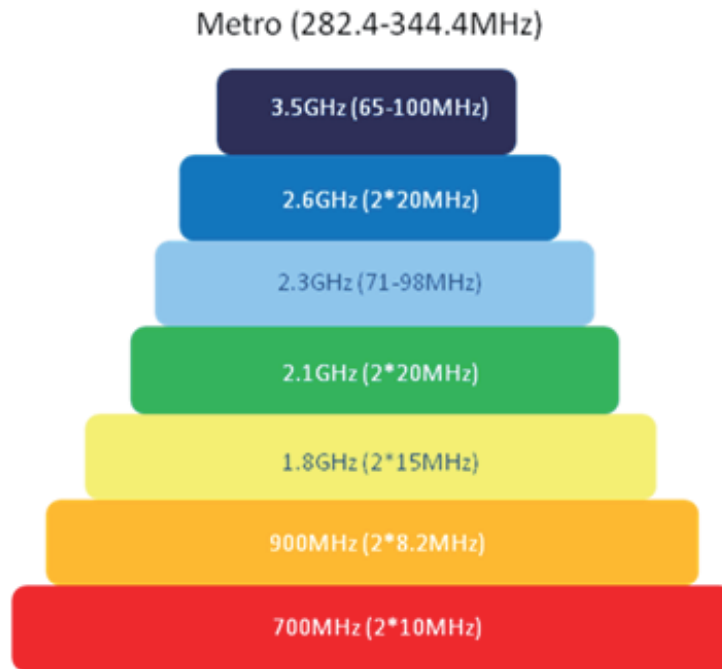
To ensure that the number of subscribers that a cell actually supports is within the capability of a cell, that is, within the maximum number of subscribers that a cell supports, is a prerequisite for providing the user experience of xMbps anytime anywhere.

The maximum number of subscribers that a cell supports is calculated based on the traffic model. Therefore, the accuracy of the traffic model is very important. With the development of MBB networks, the traffic model is also changing. For example, terminal screens are becoming larger and larger, and video services are evolving from SD videos to HD videos, to Full HD videos. All these make traffic model change. Meanwhile, MBB networks provide users with high speed, which changes user behavior and stimulates traffic consumption and further change traffic model. Therefore, when planning for capacity expansion, operators need to consider the user quantity increase and the traffic model changes to meet the service development requirements for the next few years.

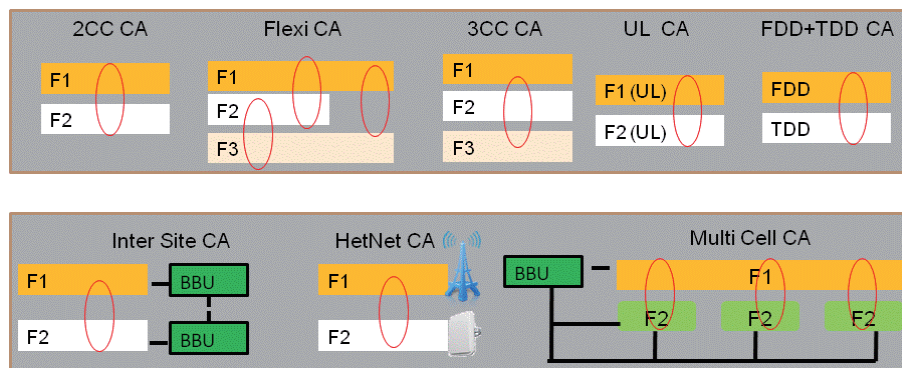
### 2.5.2 Add Frequency Spectrums

To ensure better user experience in hot profitable spots, frequency spectrums can be added to achieve multi-carrier deployment, thereby relieving network capacity pressure. In multi-carrier deployment, operators always adopt networking with a mix of low and high frequency bands. The low frequency bands work as the coverage layer and provide wide coverage nationwide. The high frequency bands work as the capacity layer and absorb traffic in hotspots. For example, Optus in Australia has seven frequency bands. At present, Optus is attempting to add more frequency bands to the existing network to expand capacity.





In multi-carrier networking, enabling CA helps improve user experience and increase the scheduling efficiency of multiple carriers, thereby improving system capacity. Huawei CA solutions provide customers with CA in all scenarios, including intra-site CA, inter-site CA, Cloud BB-based CA, and IP RAN-based CA. Therefore, CA can be used in all kinds of networking to maximize resource usage.



### 2.5.3 Densify Macro Base Stations

Along with the increase in the number of users and the traffic volume, capacity requirements exceed the maximum capacity provided by existing coverage sites (available spectrum exhausted). In this situation, new sites must be added to maintain user experience. In densely populated areas, a site is required to house devices used by multiple modes and multiple carriers. Adding sites in densely populated areas raises many issues such as insufficient space for installing antennas and cabinets, high space rental fees, and high equipment installation costs. Huawei AAU has evolved to rise to such challenges in the deployment of networks supporting multiple modes and multiple carriers. The AAU integrates antennas and RF modules supporting multiple modes and carriers and incorporates separated devices of RF amplifiers, jumpers, antennas, combiners, and tower-mounted amplifiers into an active antenna, thereby addressing the problem of insufficient space for installing antennas and catering to the trend towards dense site deployment. The AAU solution decreases space required for antenna and site deployment and contributes to capacity expansion in profitable areas.



In some hotspots, traditional macro base stations cannot support the ever increasing capacity requirements, and therefore post-mounted and wall-mounted base stations must be deployed in areas with high capacity requirements to improve capacity in these areas. Huawei introduces Easy Macro to provide large capacity. However, the Easy Macro adopts brand new design concepts to perfectly adapt to the environment. The Easy Macro features a small size and light weight and can be flexibly installed on posts, venues, and rooftops, as well as supporting single-post and wall-mounted installation, which does not occupy floor spaces and solves the problem of difficult adding more sites.

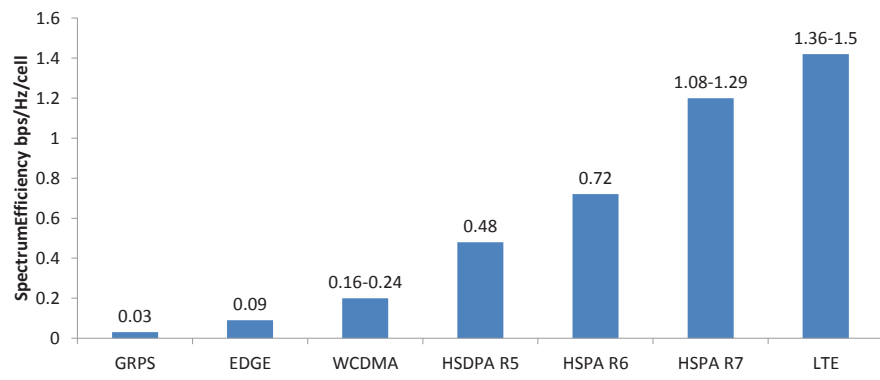




## 2.5.4 Improve Spectral Efficiency

Compared with adding frequency spectrums and macro base stations to improve the network capacity, the refarming solution improves the spectral efficiency, thereby increasing network capacity. Based on the operators' existing networks, refarming fully utilizes the existing base stations and resources to quickly deploy MBB networks and improve network capacity.

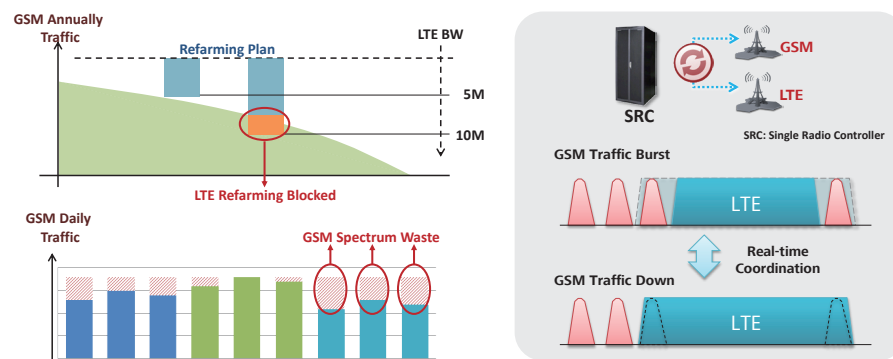
As shown in the following figure, the spectral efficiency of UMTS(R6) is more than eight times higher than that of Enhanced Data rates for GSM Evolution (EDGE), which is 0.09. That of LTE is even more. Given the same frequency bandwidth, the UMTS and LTE networks can bring more revenue for the operators.



Source: Huawei Simulation

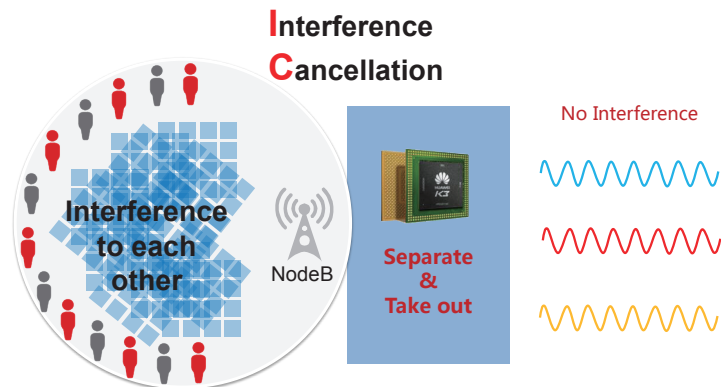
Huawei SingleRAN solution includes software-defined radio, co-MPT, co-BBP, and AAU technologies and allows the operators to reuse the legacy network to the maximum extent and quickly implement the refarming solution.

To allow the operators to make full use of rare spectrum resources, Huawei provides the GSM and LTE dynamic spectrum sharing feature. This feature allows some GSM spectrums to be shared by GSM and LTE networks. During heavy-traffic hours, the GSM network uses these shared spectrums. When the GSM network does not use the shared spectrums, the LTE network uses the shared spectrums to meet its capacity requirements.





The interference cancellation (IC) feature is an effective method of increasing spectrum efficiency. For example, UMTS IC solution can eliminate inter-user uplink interference. Given the same spectral bandwidth, uplink system capacity is much improved after IC is used.



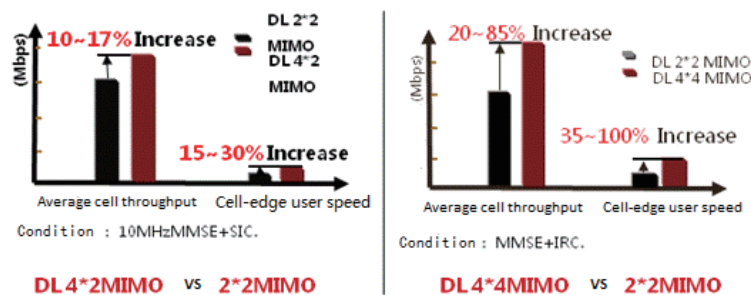
## 2.5.5 Use Higher MIMO

Multiple-input multiple-output (MIMO) allows multiple antennas to transmit and receive data simultaneously, thereby increasing channel reliability and improving network capacity.

MIMO increases network capacity by several times without adding frequency spectrums or base stations. The gains generated by MIMO can be categorized into the following types: diversity gains provided by multiple transmit and receive antennas, multiplexing gains provided by data transmitted over multiple channels, and precoding gains generated by precoding on the channels.

3GPP specifications Release 8 designs DL 4x4 MIMO (that is, four transmit antennas on the base station side and four receive antennas on the UE side), and 3GPP specifications Release 10 supports 8x8 MIMO. However, the mainstream UEs support 2R at present. UEs supporting 4R (4R UEs) will be developed in 2015.

If the base station uses four transmit antennas, the 2R UEs benefit from the gains provided by DL 4x2 MIMO. The simulation test result shows that DL 4x2 MIMO increases the average cell throughput by 10% to 17% and the speed of CEUs by 15% to 30% compared with DL 2x2 MIMO. If the base station uses four transmit antennas, the 4R UEs enjoy the gains provided by DL 4x4 MIMO. The simulation test result shows that DL 4x4 MIMO increases the average cell throughput by 20% to 85% and the speed of CEUs by 35% to 100% compared with DL 2x2 MIMO.



Source: Huawei Simulation



## 2.5.6 Deploy Small Cell

The penetration ratio of smartphones continuously increases and user behaviors change constantly. This brings constant upgrades of traffic models as well as more demanding requirements from users. In densely populated areas and indoor hotspots, adding spectrums or macro base stations may not provide sufficient capacity. In addition, site acquisition becomes extremely difficult in such areas. Small Cell base stations feature easy site acquisition and flexible deployment. Therefore, Small Cell base stations can precisely offload traffic in densely populated areas and hotspots and improve user experience.

Because of their light weight and small sizes, Huawei AtomCell base stations can be easily camouflaged and flexibly deployed in lamp poles, bus stations, and booths, making deployment in densely populated areas and hotspots easier. Solutions tailored for AtomCell base stations such as microwave, Wi-Fi, and e-Relay make AtomCell base station backhaul simpler.

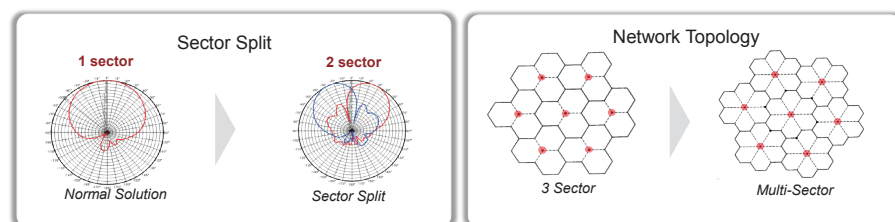
Huawei LampSite features large capacity, small size, and flexible deployment. Therefore, the solution can quickly improve indoor capacity to satisfy service requirements of indoor users.

Huawei LampSite has implemented full indoor LTE coverage in Beijing Capital Airport, providing users with an excellent experience.



## 2.5.7 Introduce Multi-Sector

More and more MBB network operators face the increasing pressure of capacity expansion because of unavailability of new sites and spectrums. The multi-sector solution increases site capacity by 50% to 85% and improves coverage performance by 3 dB without adding new sites or spectrums. This solution effectively addresses the concerns of MBB network operators and improves user experience.

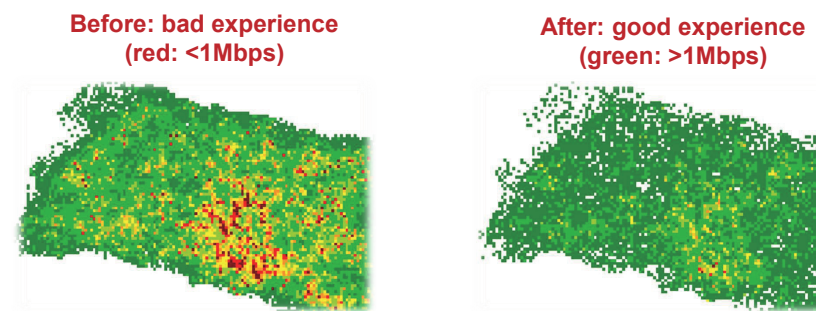


**Multi-sector: Max +85% in Capacity, Max +3dB in Coverage**



## 2.6 Accurate Verification and Ensure xMbps Anytime Anywhere

Simulation can be performed to verify whether the preceding capacity or coverage solutions have achieved the expected results. The simulation tools help efficiently and accurately conduct the verification.



The following table provides the integrated KQIs and KPIs for GSM, UMTS, and LTE networks. After the capacity or coverage solutions are implemented, data can be collected based on drive tests or traffic statistics. Then, a comprehensive and in-depth analysis can be conducted using MBB visualization solution and other assistant solutions to check whether xMbps anytime and anywhere has been implemented.

		Indicator	Reference	Measurement
xMbps	KQI (Experience)	Voice MOS	3~4	Drive Test
		Voice Call Setup Time (s)	3~6	Drive Test
		Web Session Duration (s)	3~5	Statistics
		File Download Session Duration (s)	2~4	Statistics
		File Upload Session Duration (s)	2~4	Statistics
		File Download 85% Faster than (Mbps)	xMbps	Statistics
		File Upload 85% Faster than (Mbps)	x'Mbps	Statistics
		Video Startup Time (s)	2~4	Statistics
		Video Interruption-free Share (%)	95%~99.5%	Statistics
		Coverage Probability (%)	90%~98%	Drive Test
Anywhere	KPI (Coverage)	RRC Setup Success Rate (%)	95%~99.5%	Statistics
		CS RAB Setup Success Rate (%)	98%~99.6%	Statistics
		PS RAB Setup Success Rate (%)	98%~99.2%	Statistics
		CS Call Drop Rate (%)	0.5%~1%	Statistics
		PS Call Drop Rate (%)	0.7%~3%	Statistics
		Average Throughput (Mbps/5MHz)	3~8	Statistics
Anytime	KPI (Capacity)	Admission Rejection Rate (%)	1%~3%	Statistics

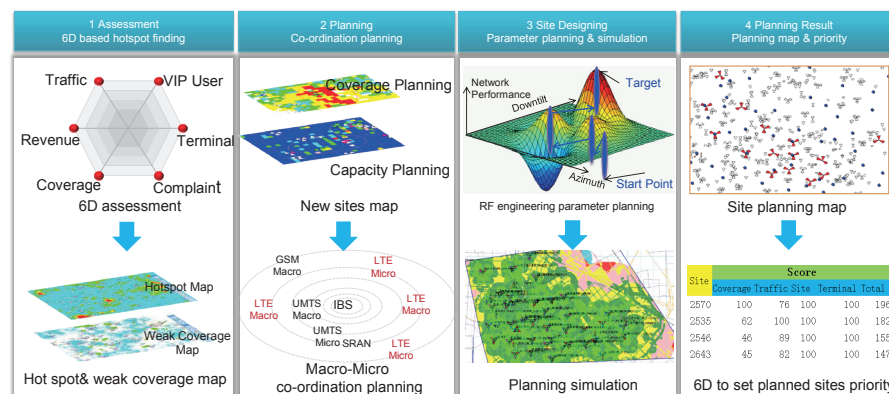


## 2.7 Automatic Site Planning and Cell Optimization for Efficient Deployment

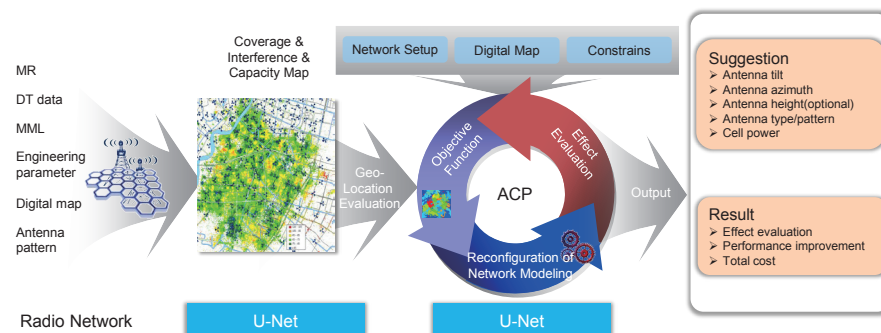
Planning and optimization in coverage and capacity are complicated iteration processes. During the coverage iteration process, measures must be taken to ensure xMbps at cell edges. These measures include adding sites, adjusting the antenna azimuth and downtilt, introducing low frequency bands, and activating new features. During the capacity iteration process, measures must be taken to ensure that site capacity is sufficient for providing a robust user experience. These measures include adding carriers, introducing the multi-sector solution, adding sites (such as Small Cell base stations), activating new features, and adjusting GUL bearer policies.

If all these operations are performed manually, the efficiency and accuracy of planning and optimization will be very low. Huawei launches the ASP and ACP solutions. These solutions enable automatic site planning and cell optimization, facilitating the deployment of xMbps Anytime Anywhere.

### Accurate Site Planning to Design New Sites Automatically



### Accurate Cell Planning to Optimize Network Effectively



# 3

## Future Prospects

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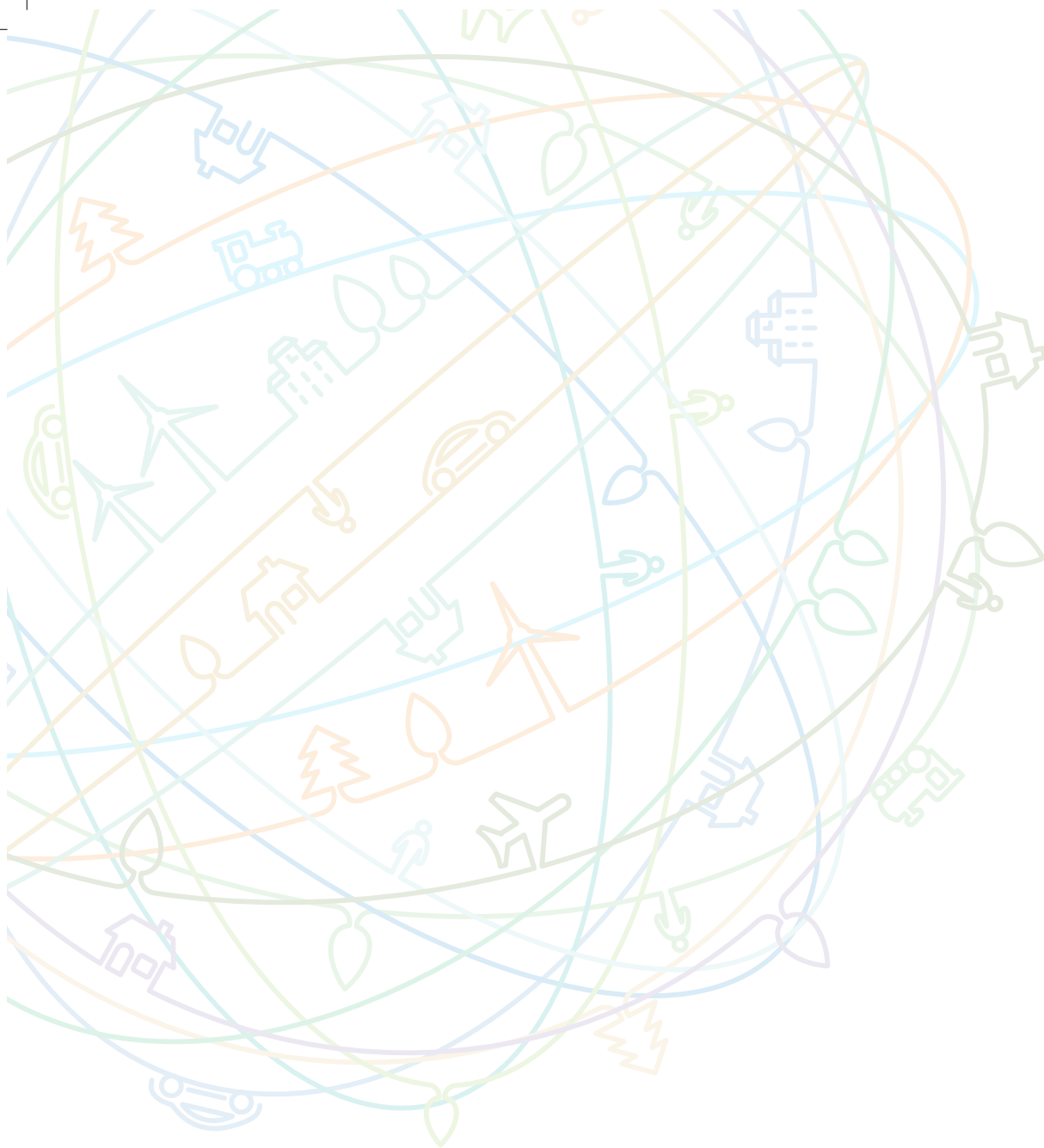
With the development of MBB services, the user experience requirements of high-speed services continue to grow. MBB network operators need to center on user experience and apply the "xMbps Anytime Anywhere" network construction idea to network construction and optimization.

- All UEs in a given cell share air interface resources. With the increase in the number of UEs, the experience of a single user decreases. Capacity must be expanded in time to avoid the problem that network throughput cannot meet the requirements of good user experience.
- With the development of terminals, smartphones feature bigger screens and higher definition. Higher-definition services carried by smartphones raise the requirements for the bearer capabilities of networks.
- Service innovations and changes in user behaviors bring ever-growing traffic consumption. This means that networks must continuously develop to adapt to the increasing service growth requirements.

In addition, network development will further promote service innovations and user behavior changes. New techniques such as cloud computing, online vehicle navigation, Internet of Things, and automobile cellular connections are emerging and continue to enrich people's life. These also create considerable revenues for operators. Operators need to continuously optimize their networks so that the networks become a driving force for user experience and service development, which in turn promote sound development of MBB networks.

It is worth noting that new techniques to improve user experience are constantly emerging. Such techniques include 3CC CA, MSA, LTE-U, 256 QAM, and higher-order MIMO. In addition, 5G standards, which target in providing 10 Gbps services to single UEs, are under development. The development of new technologies has provided a solid foundation for constructing xMbps Anytime Anywhere networks for operators. It is expected that MBB networks constructed based on the "xMbps Anytime Anywhere" concept will continue to bring business success for global telecom operators.





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#### HUAWEI TECHNOLOGIES CO., LTD.

Huawei Industrial Base  
Bantian Longgang  
Shenzhen 518129, P.R. China  
Tel: +86-755-28780808  
Version No.: M3-023985-20140902-C-2.0

[www.huawei.com](http://www.huawei.com)