



Email: hwilab@huawei.com

Huawei official website: <http://www.huawei.com/en/ilab>

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Trend Analysis of 8K Technology

iLab

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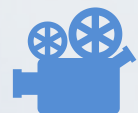
The word "8K" became a hot word all of a sudden as the Japanese company NHK live broadcasted the opening and closing ceremonies and part of the track and field, and swimming events of the Rio Olympics with an 8K resolution in August, 2016. Today, Huawei iLab will analyze the problems that 8K technology faces during its future application and its requirements on the networks from the perspectives of technology forward-looking, business development trend, and network impact trend.

Main findings by iLab are as follows:

1. The industry chains related to 8K technology are becoming mature and are currently in the

initial stage of commercial use, according to an analysis of the chips, video ports, panels, display terminals, program contents, shooting and production, storage and bandwidth, and projecting play.

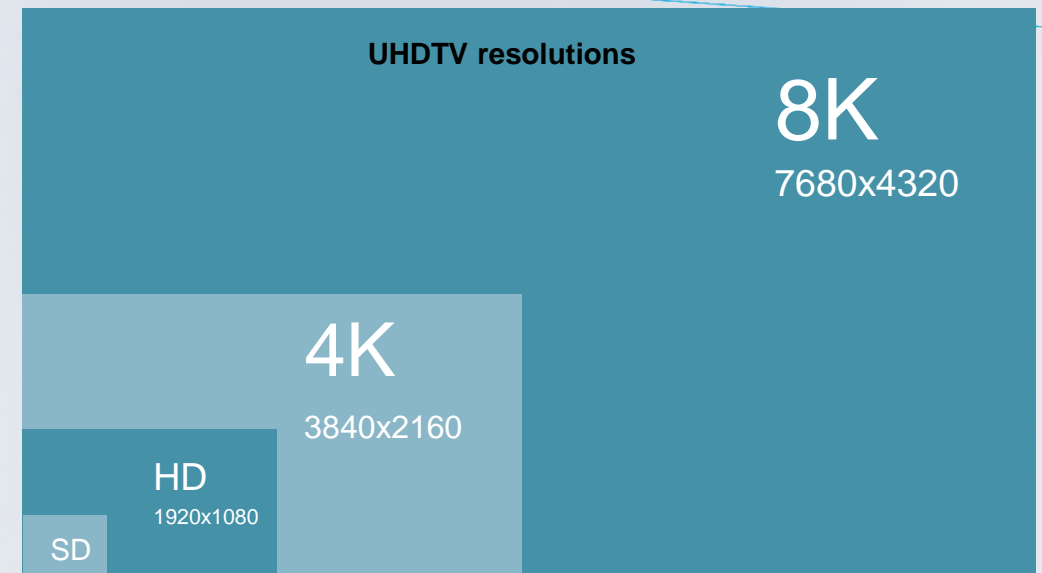
2. 8K TV tends to be applied in "all-sharing-joy" form events, such as large-scale sports events rebroadcasting, digital signage, and theater projection. Apart from that, it can also be applied in enterprise dedicated fields, such as remote medical care, remote education, and security monitoring.
3. 8K will merge with VR or accompany VR to further improve the immersive experience of AR and VR.



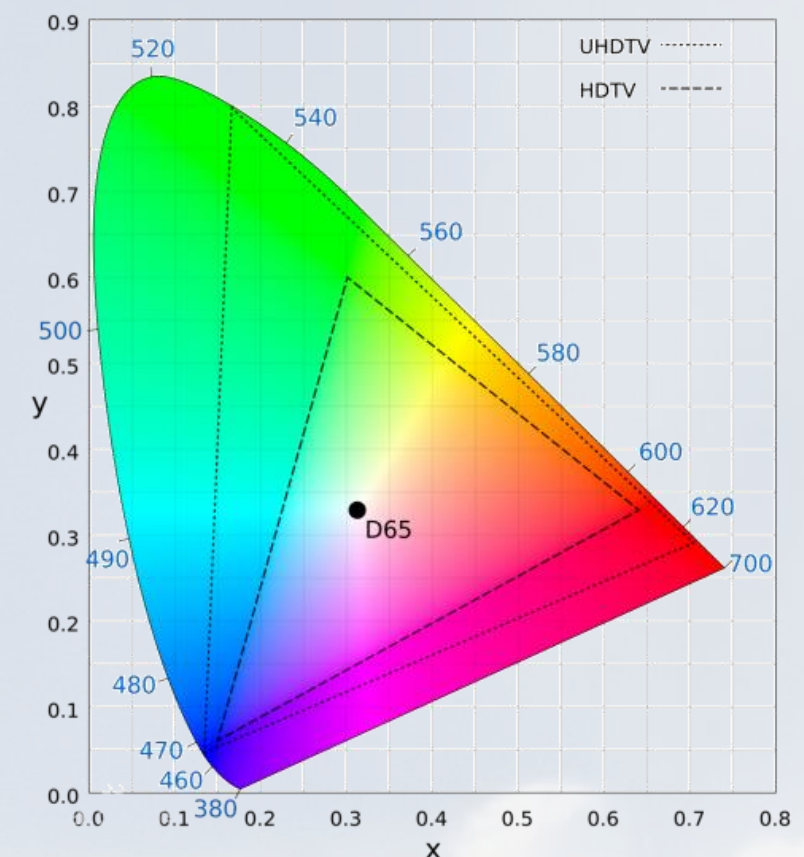
1. History of 8K Technology

In fact, the concept of 8K was put forward ten years ago. In 2006, NHK submitted the initial draft of the Super Hi-Vision video technology to the International Telecommunication Union (ITU) and Society of Motion Picture and Television Engineers (SMPTE). After investigation and evaluation, ITU used the Super Hi-Vision video technology as a recommendation draft of the ultra-high-definition television (UHDTV) technology. Therefore, the predecessor of 4K and 8K technologies was born.

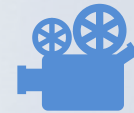
UHDTV defines the next-generation television technologies, including two different standards: UHDTV1 and UHDTV2. The resolution of UHDTV1 is 3840x2160, or known as 4K technology. It is the entry level of UHDTV. The resolution of UHDTV2 is up to 7680x4320, or known as 8K technology, which is the highest level of the technology in the television and video field at the moment, and is also the development direction of the field.



Resolution: 8K is 4 times of 4K and 16 times of 1080p.



Colorimetric method: the same as 4K, adopting Rec.2020 and 12-bit color depth



2. Solutions for the Maturation of 8K Video Technology

The business success of 8K technology needs a comprehensive development of software, hardware and content.

Chips: 4K chips are flourishing at the moment and 8K chips are under preparations.

• **TV SoC:** Due to the lack of 8K SoC chips to support 8K panels, the only solution to improve the transmission signal to the 8K level is using 4K SoC chips accompanied with motion estimate and motion compensation (MEMC).

• **STBs:** In October 2016, NHK cooperated with another two Japanese companies KDDI and J:COM, and developed 4K/8K UHD cable TV STBs.

Video interfaces: New standard outdates the HDMI interface.

• **DisplayPort 1.4:** supports the 60 Hz output of 8K videos.

• **SuperMHL:** can fully support 6 channels and reach a maximum transmission rate of 270 Gbit/s. Therefore, it supports 120 fps output of 8K videos and brings a higher color depth of 36 bits.

Panels: There is no technical bottleneck in panel technologies and multiple vendors are fully prepared.

• 65-inch 8K panel of Taiwan's Innolux has been promoted to established international vendors.

• 65-inch 8K panel of Taiwan's AU Optonics (AUO) is put into production.

• In addition, South Korea's LG and China's BOE follow closely

after the above two companies.

• NHK: displayed 8K OLED screen at IBC exhibition and the thickness of the screen was only 1 mm.

Display terminals: TV vendors have launched TVs for 8K, followed by PCs and tablets.

• At 2013 CES exhibition, Japan's Sharp launched the world's first 85-inch 8K TV.

• Furthermore, at 2015 U.S. CES exhibition, Korea's Samsung displayed the world's largest 110-inch 8K TV.

• At the latest IFA, China's Skyworth, Changhong, Hisense, and BOE released their own 8K TVs.

Apart from TVs, many Japanese vendors such as JDI and Orutu, launched their 9.6- to 17-inch 8K LCDs at last year's CEATEC, which are likely to be used on tablets, PCs or laptops.

Program contents: The application of 8K contents is gradually increased, but is still far from popularization.

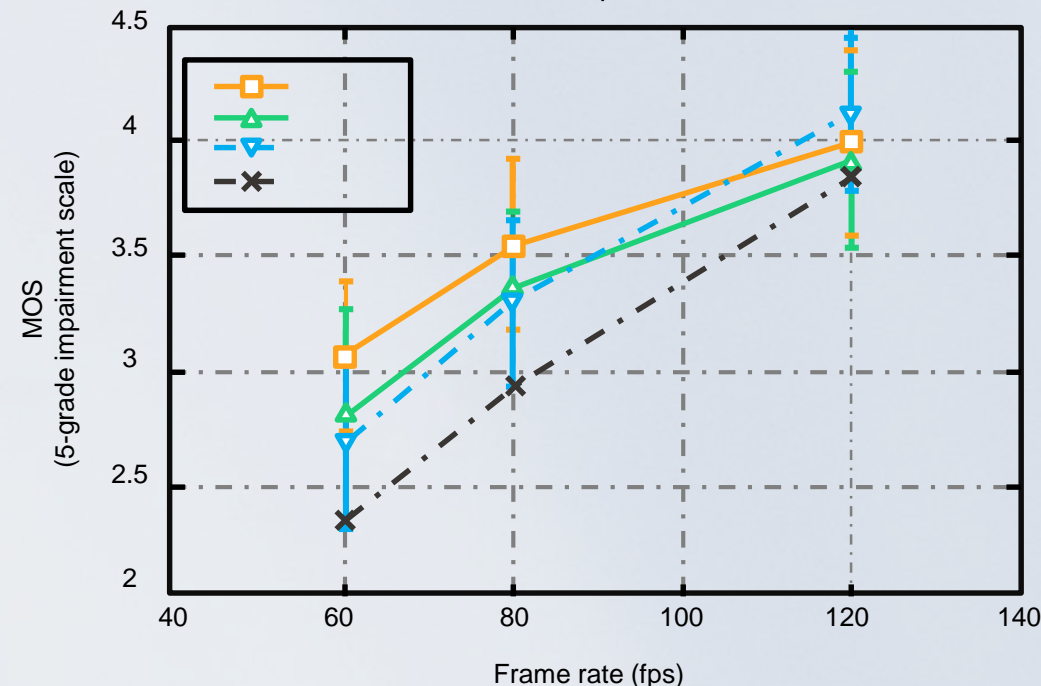
• As early as in 2005, NHK displayed 8K technology at Aichi exhibition.

• In August, 2016, NHK broadcasted 8K TV programs for the first time in the world.

• Part of the events at the Rio Olympic Games were live broadcasted using 8K technology. Meanwhile, NHK is planning to broadcast the Tokyo Olympic Games using 8K technology in 2020.

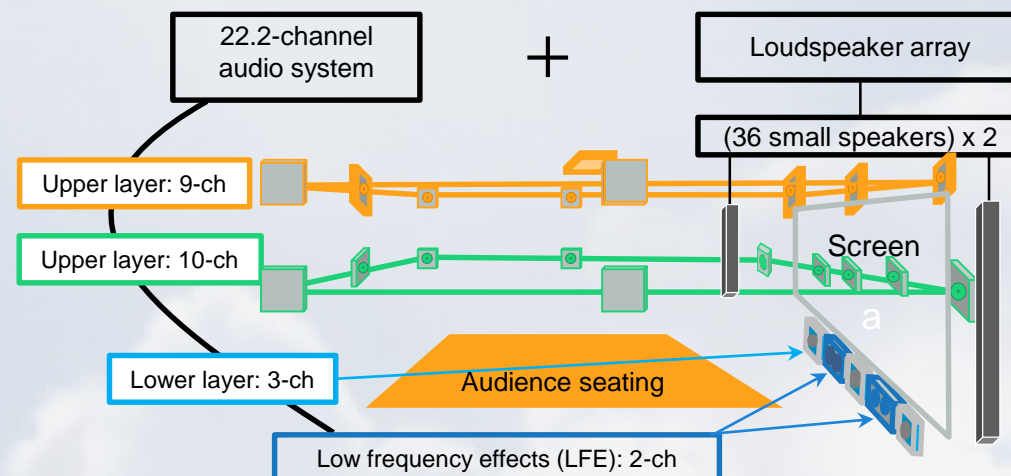
• In 2017, *Guardians of the Galaxy 2* will become the world's first 8K movie.

Relationship between image quality score and frame rate for stroboscopic effect



Frame rate: the same as 4K, the highest frame rate is 120 fps.

Audio system configuration




Audio: 22.2-channel. Currently, the common surround stereo is 5.1-channel and very few of them are 7.1-channel.

Shooting and production: The technology is for commercial application. The high cost makes it difficult to achieve civil popularization.

- In 2006, NHK cooperated with another Japanese company Fujitsu, and launched 4CMOS system and achieved the shooting of 8K videos.
- After 2012, various video vendors such as Japan's Hitachi and Sony, and America's Red Digital Cinema Camera Company (RED), have launched their own 8K cameras that have been widely applied in major film and television companies.
- Due to the expensive price and space-consuming features of 8K technology, its application is confined to national TV stations or large film companies.

Storage and bandwidth: The combination of high resolution and 22.2-channel requires massive storage spaces and high speeds.

- The capacity of a one-minute original 8K video is up to 200 GB.
- Through H.265/HEVC coding, the data can be compressed to 700 MB to 1 GB per minute.
-  The superior experience of 8K

3. Requirements for Optimal 8K View Experience

According to the technology module quarterly of *The Economist* in 2012, the median (the view distance for most people) of the distance between their eyes and the TV screen is 2.7m in average American families. In 2004, British Broadcasting Corporation (BBC) conducted a view distance survey and revealed that most participants kept about a 3-meter view distance.

While the optimal view effect is

videos, the bit rate can be up to 220–400 Mbit/s.

- NHK once proposed that the company would discuss the new compression standard in 2018 and H.266 might be the one in the future. The new standard would further compress the storage space of HD videos. This will facilitate the promotion and application of 8K videos.

Projecting play: Being underdeveloped and costly, it is very difficult to achieve civil popularization.

- Early in 2013, Japan's JVC cooperated with NHK and launched a dedicated projector to play 8K videos. However, the price reached as high as 261,000 dollars. Other vendors have not taken any action up till now.
- As the mainstream 4K leading vendor, Sony released a relatively cheap 4K projector with a price of nearly 10,000 dollars. The 8K projectors will be much more expensive.

related to eyesight and view distance. Under the same view distance, the better eyesight, the higher requirement on screen resolution because the audience with good eyesight can perceive a higher number of pixels from each angle.

Under the same eyesight and the same view distance, the size of an 8K TV screen should be twice the size of a 4K screen. Reversely, under the same screen size, the 8K view effect

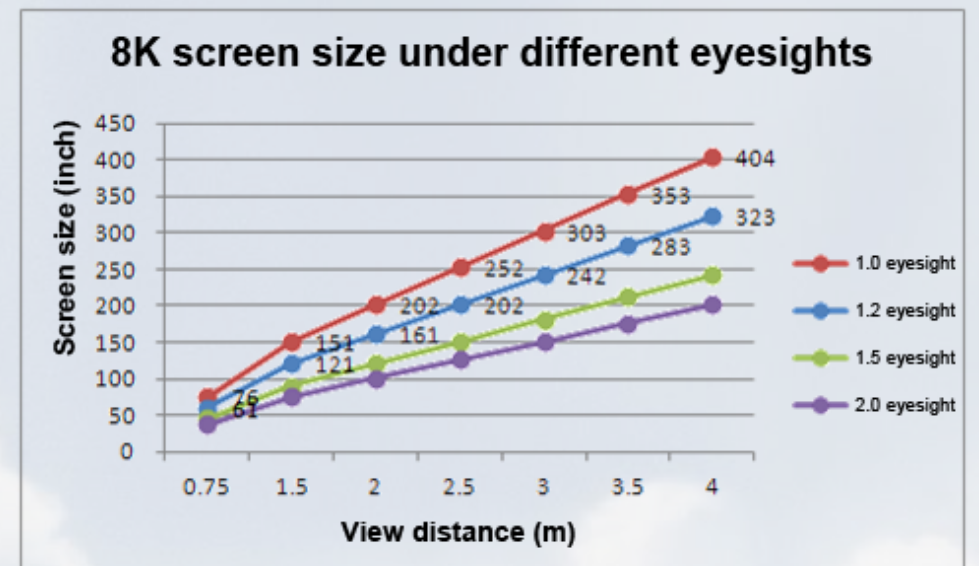
can only be reached when the view distance is half that of 4K and the audience will get an immersive experience. The better the eyesight is, the higher the requirements are on TV resolution.

For example, if the audience has an eyesight of 2.0 and the view distance is 3 meters, then the screen size of a

4K TV should be within 76 inches. If the screen is larger than 76 inches, the image will not meet the pixel per degree (PPD) value of a 2.0 eyesight and thus affect user experience. In this case, if you want to purchase a TV with a larger screen, you will need an 8K TV to obtain the superior experience.



The screen of an 8K TV should be twice the size of a 4K TV under the same eyesight and view distance.



The better the eyesight, the higher requirements on TV resolution.



4. Bottlenecks Facing 8K TVs

Therefore, 8K TV can bring excellent immersive experience by its high resolution, 22.2-channel, and ultra large screens.

At the 2012 London Olympic Games, NHK and BBC cooperated and recorded on-site events with the latest 8K ultra HD

technology (Japan named 8K technology Super Hi-Vision before ITU released 4K and 8K related BT.2020 standards). The representatives from overseas media used only two words "absolutely amazing" to describe the actual view effect when interviewed by local media.



However, will 8K TV enter into ordinary households in the future? The answer is probably "no" due to the following reasons:

High Production Costs and Limited Video Sources

The video sources are limited due to the high costs of 8K cameras and the high demands for storage spaces for uncompressed 8K videos.

High Transmission Costs

For operation-level 8K videos, their bit rate still reaches 100 Mbit/s after they are compressed by H.265,

then a certain transmission rate is required to achieve real-time transmission. The current network conditions are still far from reaching the requirements.

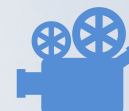
High User Experience Costs

- On September 16, 2015, Sharp announced that the world's first 8K TV would be officially on sale since October 30 and the price was up to 133,000 dollars.
- Due to the room space of most Chinese households, the view distance is between 2 to 3.5 meters. Within this distance, 4K TV and

8K TVs show no difference in current common sizes. This means that 1080p or 4K is enough for ordinary households. According to the analysis, for the audiences that have a standard 1.0 eyesight and keep a 3-meter view distance, they will need a

300-inch 8K TV. This is almost the size of the entire wall and generally too large for ordinary households.

Conclusion: Only large-sized 8K TV can highlight its experience advantages while it is not applicable to ordinary households due to the size and the cost.



5. Prospects of 8K Technology

Above all, 8K technology, along with its 22.2-channel and 100-inch or larger screen, can be applied in the rebroadcasting of large-scale sports events, theater projection, and outdoor digital signage under the form of "all-sharing-joy". Apart from that, it can also be applied in some enterprise dedicated fields, such as security monitoring and HD video conferencing in remote medical care and remote education.

Events Rebroadcasting

8K technology can be applied to rebroadcast events in bars, museums and outdoor plazas with large screens and high definition.

For example, at the Rio Olympic Games, Brazil equipped a 98-inch 8K display in the "Museum of Tomorrow" and live broadcasted the event with 8K technology for the first time in the world.



Theater Projection

Recently, NHK and France's Louvre jointly shot an 8K

movie and the movie would be on the 8K specialized theaters in the middle of November.



Digital Signage

Digital signage integrates networks with multimedia technologies and is widely used in finance, telecommunication, hospitals, super markets, and public places. With the development of science

and technology, HD videos are applied in more and more fields and bring perfect experience to users. With a panoramic ultra HD screen, 8K technology will be fully utilized in digital signage applications.



HD Video Conferencing

Compared with traditional video conferences, HD video conferences present participants a better view effect with more fluent and clearer images. 8K technology can present an immersive experience to the participants and achieve the face-to-face effect with its large HD screen.

HD video conferences can be widely used in remote conferencing, training, education, and medical treatment.

The senior vice president of BOE, Zhang Yu, recently indicated at the Germany IFA exhibition that the prospect of 8K technology lied on remote medical treatment.



Security Monitoring

Security monitoring is more and more widely used in enterprises and households. Thus video monitoring

will develop towards high definition as well. With the development of H.265 coding, 8K videos will be applied in security monitoring systems in the future.



6. The 8K Technology is Imperative for VR Development

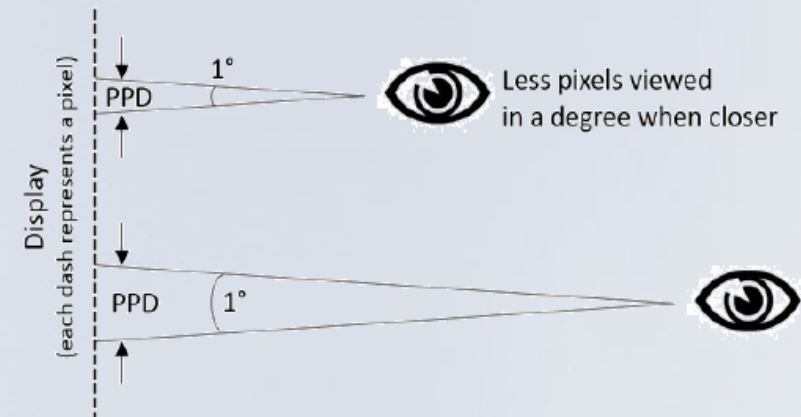
The definition of a 4K TV with flat screen is fairly high. However, it is far from enough for a 360° immersive VR.

At 2015 NAB exhibition, NHK indicated that 8K technology might become VR's good partner in the future. But how come?



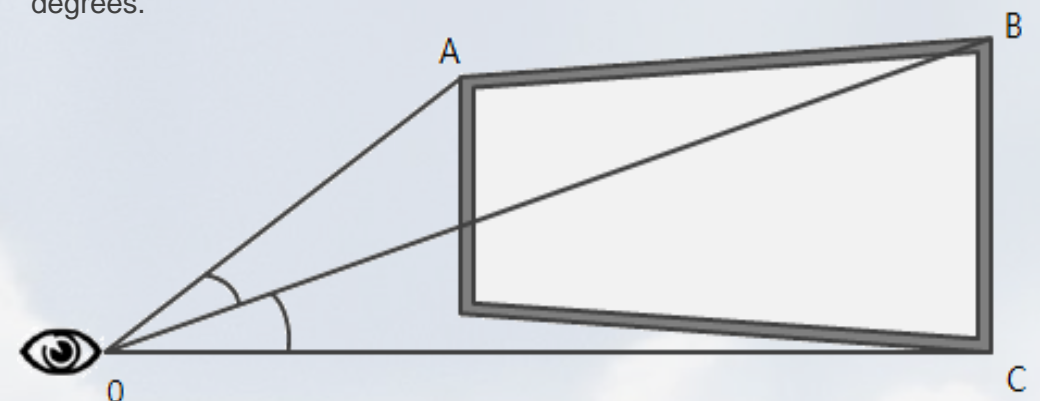
PPD refers to the perception of the number of pixels per angle. It is an important factor in determining users' experience towards the resolution of TV or VR. For a person with a standard 1.0 eyesight, the best

PPD value should reach 60 so that the screen will not look granular. As shown in the following figure, the shorter the view distance, the fewer the pixels from each angle and the higher requirement on the resolution.



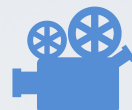
For immersive VR, the field of view (FOV) is much wider than that of PCs and TVs because the view distance is short. The view-angle coverage of a single human eye can reach 156 degrees while generally it is 120 degrees. Currently, VR's FOV is 90 degrees.

The visible scope of a single eye is only part of the VR 360 video. For example, for a 90-degree FOV, the visible scope is 1/8 of the entire spherical video.



For example, a single eye can receive 960x960 resolution of a 4K VR video under the calculation of 90-degree FOV. In this case, each degree will receive 10 PPD value, which is much lower than the 60 PPD value required by standard 1.0 eyesight. While a single eye can receive 1920x1920 resolution and 22 PPD value of an 8K VR video. This can greatly improve the image quality.

Therefore, to improve VR immersive experience and to solve the common "screen-door effect" that VR head-mounted display faces, the resolution must be more than 8K. In the future, the technology may improve to 12K or 24K. But at least in recent years, 8K technology is a predictable good partner of VR.



7. 8K Videos Will Bring Greater Traffic Storms

The year of 2016 is named as "Year of Big Videos" and video services have developed from the cultivation phase towards maturity.

China's three major telecom operators (China Mobile, China Unicom, and China Telecom) recently released the interim results of 2016 and the results revealed that their services were mainly based on "broadband+video" form and faced the development of "broadband+digital life". The operators gradually take video

services into fundamental services.

In the H.265 coding mode, the average bit rate of operation-level 4K is 25M, and the average bit rate of 8K is 4 times that of 4K, which will reach 100M. The latency and packet loss requirements for 8K are also higher than 4K.

Therefore, the application of 8K videos in various fields will inevitably bring greater traffic storms. In addition, 8K will require larger bandwidth and lower latency.

