



The countdown to commercialized operator-provided Cloud VR has begun

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In 2014, Facebook's US\$2 billion acquisition of the virtual reality hardware company Oculus brought about explosive growth in the VR industry. The market research institute IDC predict that the sales volume of VR/AR devices will increase from 8 million units in 2017 to 12.4 million units in 2018, reaching 68.9 million in 2022, an 800 percent rise over 2017.

Despite the positive outlook, the popularity of VR is still facing challenges. For example:

- Host VR devices that deliver a good experience are prohibitively expensive for the average person.
- Head-mounted displays (HMDs) aren't comfortable due to weight.
- Cord connections degrade experience.

- The VR ecosystem is disorganized, which complicates content acquisition.

Cloud VR can address these problems by transferring video storage and game rendering to the cloud. Telecom operators have E2E communication networks, mature video service platforms, and massive user bases. Therefore, they have unique advantages in providing Cloud VR services.

China Mobile Fujian: A Cloud VR pioneer

As the leading full-service operator in Fujian province, China Mobile Fujian (China Mobile Fujian) focuses on customer experience to deploy high-



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quality communications networks, providing, for example, ultra-HD 4K video services for 4 million broadband TV users in the province. To further explore network potential, maximize the commercial value of gigabit home broadband, and extend its leadership in the network, service, and quality domains, China Mobile Fujian joined Huawei and VR industry partners in launching the world's first Cloud VR service-AND Cloud VR on July 18, 2018. This launch marked the first step of China Mobile Fujian's smart home video service into the VR era.

Cloud VR solves several problems in the VR industry, but also places higher demands on operator networks. At least 200 Mbit/s bandwidth and less than 20 ms E2E network latency (fair-experience phase) are needed. Small problems on networks are easily amplified, affecting end user experience. Therefore, Cloud VR is a true test of network quality. Based on high-quality optical broadband networks and 4K video operation experience, China Mobile Fujian successfully launched the world's first Cloud VR service, bringing high-quality VR products to the home.

Major features

Cloud computing reduces costs

At present, host VR devices that deliver the best experience in the industry need to be accompanied by high-performance PCs that cost around US\$2,000. In contrast, Cloud VR uses the computing capabilities of cloud platforms as a substitute for PCs. Users only need to purchase an all-in-one VR HMD for about US\$300 to connect to broadband through their home Wi-Fi network and enjoy high-quality VR content. The overall cost is reduced by 70 percent to 80 percent, but the experience is just as good as on a high-end PC.

Wireless transmission is free from cable connections

The cords connecting host VR HMDs and PCs greatly interfere with user movement. Cloud VR uses 5 GHz Wi-Fi to achieve the high-speed data transmission of HMD data, eliminating the need for wires and allowing users to enjoy VR services more freely.

An aggregation platform aggregates massive content

In the past, VR content was bound to hardware platforms, and transferring content between platforms wasn't possible. After VR cloudification, China Mobile Fujian built a unified content aggregation platform and implemented software

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and hardware decoupling with HMDs, making the selection of VR content as simple as selecting a TV show.

Cloud VR enables VR content display on TV screens

Through collaboration between the screen-sharing modules of devices, clouds, and STBs, Cloud VR implements HMD content display on home TV screens. Users can share content in the VR world with family members at any time, meaning that VR has the potential to become the new home entertainment center, replacing TV.

E2E solution verification and optimization enable successful implementation of Cloud VR

In the world's first operator-provided Cloud VR service, China Mobile Fujian has achieved multiple technological innovations and breakthroughs in platforms, networks, terminals, content, and the last-mile connection to intelligent home networks. It has streamlined E2E service processes, and set up a complete Cloud VR technology and service system.

The collaboration of platforms, content, and terminals enables the quick rollout of a high-quality service system

China Mobile Fujian uses the content distribution system and CDN resources on the existing video platform to implement fast deployment of the solution. Only some dedicated systems are developed and adapted, such as the VR video platform, VR cloud rendering platform, and VR screen mirroring system. This saves costs and accelerates service rollout. At the same time, Huawei's VR OpenLab assisted China Mobile Fujian in finding industry-leading partners, acquiring a variety of content resources and VR terminal products, and achieving high-quality service operations.

Well-designed target networks ensure a good user experience

Cloud VR services and video services are similar on the bearer network side. Therefore, Cloud VR services in the fair-experience phase can be quickly deployed by using existing 4K video networks to reduce network construction costs and protect initial investment. In the future, the networks can be further optimized if required. For Cloud VR to be used in home networks, all-in-one VR HMDs must be connected to 5 GHz Wi-



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Fi to ensure flexible user operations under cordless connections.

The architecture of the integrated bearer network is simplified to ensure the Cloud VR service experience

Cloud VR provides video and game services based on cloud computing. To guarantee high-quality user experience for these services, HD video streams and a fast response are required, which depend on ultra-broadband and simplified networks with high bandwidth and low latency.

In recent years, China Mobile Fujian has constructed a number of high-quality communications networks. Based on the network construction concept of all-optical access, flatness, and low convergence, China Mobile Fujian has built a smooth and stable 4K video bearer network, and therefore quickly provisioned Cloud VR services for some users. However, according to multiple surveys and implementation results, some OLTs on the network still use switch aggregation networking, which features a high convergence ratio and complex homing relationships, and also presents difficulties in carrying Cloud VR services. Some BRASs and OLTs, and also CRs and BRASs, are connected through GE and 10GE links, which cannot address traffic growth. Therefore, further

architecture simplification and link expansion are necessary in future service expansion.

Home Wi-Fi network quality needs to be improved for breakthroughs in cordless VR experience

According to live network surveys and lab tests, Cloud VR services are facing many problems and challenges on home networks. For example, 5 GHz Wi-Fi is required because 2.4 GHz Wi-Fi cannot carry Cloud VR services due to narrow frequency bandwidth. Severe adjacent-channel and co-channel interference significantly deteriorates service experience, and therefore signal conflicts must be avoided. Additionally, 5 GHz Wi-Fi devices with uneven quality make results uncertain.

To address these challenges, China Mobile Fujian chose the Huawei SmartWi-Fi solution to achieve the last 10-meter connection. Based on the all-optical access FTTH network, the solution further improves Wi-Fi performance experience for home network terminals and achieves fiber to the home and 300 Mbit/s to the room. Moreover, a smart home networking service is provided to serve the following functions:

- Detecting interference and planning channels in



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advance.

- Offering a strong independent Wi-Fi working frequency band for Cloud VR services.
- Solving the problems caused by coexistence of Cloud VR, Internet access, and IPTV services.

Increasing home broadband revenue

As new territory for both China Mobile Fujian and the entire telecom industry, Cloud VR has no mature business models yet. However, according to an analysis of Cloud VR, at least four types of sales revenue are possible: content revenue, broadband sales revenue, home intelligent networking service revenue, and VR HMD revenue.

They can also be bundled to carry out preferential marketing and quickly increase user numbers. Currently, the Cloud VR service of China Mobile Fujian is only used by about 100 users. China Mobile Fujian planned to develop 1,000 users this year, and to increase the number to 10,000 in 2019. User feedback shows they're satisfied with such a good VR product at a US\$300 price tag. Next, China Mobile Fujian plans to introduce high-quality video and game content to further boost user satisfaction.

It is foreseeable that Cloud VR will become an important application that can be monetized through gigabit broadband services, with a bandwidth of 200 Mbit/s or higher, for customer groups with all-optical access.

In general, Cloud VR brings enjoyment, diverse content, and a wide variety of application scenarios to households.

Accessing the enterprise market

Cloud VR also has much potential for enterprises.

Hotels: Competition in the hotel industry is fierce and a VR product experience could be used to show differentiated advantages. However, specialized personnel would be needed to construct and maintain VR systems for hotels, increasing management difficulties and operation costs.

Cloud VR services provided by operators can be used to implement fast deployment, so customers can enjoy high-quality VR content quickly, improving both hotel service quality and customer accommodation experience.

Education: While VR is popular in education scenarios,

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localized deployment is complex, making upgrades and maintenance difficult. By introducing systematic VR education content and leveraging their own broadband advantages, operators can provide simpler and more efficient solutions for schools.

With clear requirements and sufficient funds, these types of industry applications can be easily monetized and provides a focus area China Mobile Fujian.

As the world's first operator to provision Cloud VR services, China Mobile Fujian has made an active

attempt to innovate services in the telecom industry. In 2020, the industry will witness the large-scale deployment of 5G. China Mobile Fujian expects to attract more than 50,000 Cloud VR users on 5G networks and provide a mature and stable cloud platform architecture that can be shared with 5G VR services. These lay a solid foundation for the fast rollout of 5G VR services.

Looking ahead, China Mobile Fujian plans to continue working with Huawei to further explore Cloud VR service operations and translate project success into business success. [www](#)

