



Cloud VR+ 2B Scenario White Paper



Copyright © Huawei Technologies Co., Ltd. 2019. All rights reserved.

No part of this document may be reproduced or transmitted in any form or by any means without prior written consent of Huawei Technologies Co., Ltd.

Trademark Notice

, HUAWEI , and are trademarks or registered trademarks of Huawei Technologies Co., Ltd. Other trademarks, product, service and company names mentioned are the property of their respective owners.

NO WARRANTY

THE CONTENTS OF THIS MANUAL ARE PROVIDED "AS IS". EXCEPT AS REQUIRED BY APPLICABLE LAWS, NO WARRANTIES OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE MADE IN RELATION TO THE ACCURACY, RELIABILITY OR CONTENTS OF THIS MANUAL.

TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO CASE SHALL HUAWEI TECHNOLOGIES CO., LTD BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, OR LOST PROFITS, BUSINESS, REVENUE, DATA, GOODWILL OR ANTICIPATED SAVINGS ARISING OUT OF OR IN CONNECTION WITH THE USE OF THIS MANUAL.

HUAWEI TECHNOLOGIES CO., LTD.

Bantian, Longgang District

Shenzhen 518129, P. R. China

Tel: +86-755-28780808

www.huawei.com

FOREWORD

Cloud virtual reality (Cloud VR) is the ultimate expression of VR development. In July 2018, Huawei VR OpenLab helped China Mobile Fujian release the world's first commercial Cloud VR service for homes (2H), demonstrating commercialization of Cloud VR. The business market (2B) has a wider variety of VR application scenarios and diverse value requirements. Many business practices and application innovations have emerged in fields such as personnel training, education, government services, culture and tourism, marketing, design, and healthcare. VR will inject new vitality into traditional industries. The broad industry market will become the best stage for VR to provide social and economic benefits. To address this new development trend, this paper discusses the 2B scenario in which VR is most likely to be popularized. It promotes establishment of a generalized preferential Cloud VR platform, accelerating integration of VR and the industry.

We hope that this paper helps industry customers understand the value of VR and provides useful references for integrating VR with business practice and for governments to formulate VR industry policies. Huawei VR OpenLab is willing to work with industry chains to promote Cloud VR commercialization.

This paper is jointly drafted and released by the China Academy of Information and Communications Technology and Huawei Technologies Co. Ltd with the support of Beijing Growlib Science and Technology Co. Ltd, Beijing Mythware Information Technology Co. Ltd, Beijing Noitom Technology Ltd, JD Logistics, Shanghai SpaceMax Technology Co. Ltd, Tus-Digital World (Beijing) S&T Culture Co. Ltd, Fujian Hua Yu Education Technology Co. Ltd, Shanghai Cloudwave Network and Technology Co. Ltd, Shenzhen Skyworth New World Technology Co. Ltd, Shenzhen GTA Education Tech Ltd, Shenzhen Realis Multimedia Technology Co. Ltd, and other partners. Their contributions and support are much appreciated.

CONTENTS

Foreword	01
01 Huawei VR OpenLab Is Dedicated to Promoting Development of the VR Industry	03
02 VR Has Broad Application Prospects in 2B Markets	05
03 VR Will Soon Be Widely Used in 2B Markets	09
3.1 Enterprise Practical Training	11
3.2 Vocational Education and Higher Education	14
3.3 K-12 Education	16
3.4 Government Services	18
3.5 Theme Experience Pavilion	20
3.6 Marketing	21
04 Generalized Preferential Cloud VR Is the Optimal Choice for Accelerating Industry Development	25

In October 2017, Huawei released the VR OpenLab industry cooperation plan during the Global Ultra-Broadband Forum (UBBF). This plan, based on Huawei's innovative iLab, connects industry partners to jointly promote technological innovation and business incubation in the VR industry. After more than one year of joint efforts, the VR OpenLab industry cooperation plan has achieved fruitful results:

- The VR OpenLab in Shenzhen, which serves as the incubator of Cloud VR, is officially launched and open for experience.
- More than 60 leading Cloud VR industry partners have collaborated to promote industry-wide prosperity.
- More than 10 influential White Papers have been published, for example, the *Cloud VR+ Scenario White Paper*, *Cloud VR Solution White Paper (2018)*, and *Cloud VR Solution Practice Report (2018)*, covering multiple dimensions, such as service scenarios and transport networks.
- In February 2018, the industry's first end-to-end Cloud VR system prototype was released during the Mobile World Congress (MWC), and has been experienced by more than 30,000 people.
- In July 2018, Huawei VR OpenLab helped China Mobile Fujian launch the world's first commercial operator Cloud VR service, leading home broadband to increase from 100 Mbit/s to 1000 Mbit/s.
- In September 2018, China Telecom and Huawei launched the industry's first Cloud VR product to serve the next tens of millions of users.
- In October 2018, Huawei's Cloud VR business solution won the Gold Award for VR/AR Innovation at the 2018 World Conference on VR Industry.
- In November 2018, the *Cloud VR Overall Technology Research White Paper* was officially published by CCSA, marking an important milestone in Cloud VR technology standardization.
- In January 2019, Huawei and CAICT jointly released the *Virtual Reality/Augmented Reality White Paper (2018)* during the annual meeting of the Virtual Reality Promotion Committee (VRPC), winning the Cloud VR Solution Contribution Award.

Cloud VR introduces the concepts and technologies of cloud computing and cloud rendering into VR service applications. With the help of high-speed and stable networks, the display and sound outputs from the cloud are encoded and compressed, then transmitted to user terminals, providing VR service content and achieving rendering on the cloud. With significant advantages such as reducing consumption costs, improving user experience, popularizing business scenarios, and protecting content copyright, Cloud VR has become an important development path selected by the VR industry. With continuous industry development, popular VR terminals are emerging, service platform solutions are being shaped, content is being continuously enriched, and some operators have launched Cloud VR services for homes. All these indicate that the Cloud VR industry is gradually maturing and Cloud VR is extending to more scenarios.

01

Huawei VR OpenLab Is Dedicated to Promoting Development of the VR Industry



02

VR Has Broad Application Prospects in 2B Markets

VR technology is applicable to a wide range of scenarios and has strong integration capabilities.

- VR can significantly improve audiences' experience. Providing immersive experience and omniscient perspective, VR breaks through real-world time and space limitations, and perfectly suits fields such as gaming, video, music, and social networking, using high-quality experience to attract players.
- VR helps avoid harm to personnel and ecological environments. For some high-risk activities, such as production safety training, flight training, military training, and high-risk teaching experiments, rehearsals can be conducted using VR so that personnel can experience a lifelike learning process before entering the real environment, reducing the possibility of injury.
- VR helps solve the limitations of using resources in physical environments, or problems of excessively expensive or difficult to obtain resources. For example, display and exhibition of cultural relics, marketing display of large equipment, presentation of city planning sand boxes, and medical professional human anatomy internships can be implemented using VR.
- VR offers unique advantages in scenarios where traditional methods are ineffective or the presentation effects are poor, especially in the education industry, for example, learning abstract concepts (electromagnetic waves and magnetic fields), macroscopic objects (cosmic objects), microscopic objects (molecular structures and internal cell anatomy), historical scenarios, and future scenarios. In industrial and graphic design, VR helps creators perfect their works in a more stereoscopic and visual way .
- VR can improve work efficiency significantly. The nature of "virtual" can reduce the time and cost of real environment construction and personnel travel. In large-scale personnel training scenarios, the virtual environment can also reduce requirements for physical environment and resource quantity and increase the number of trainees in a batch, improving overall training efficiency.



PC
Entry of Internet



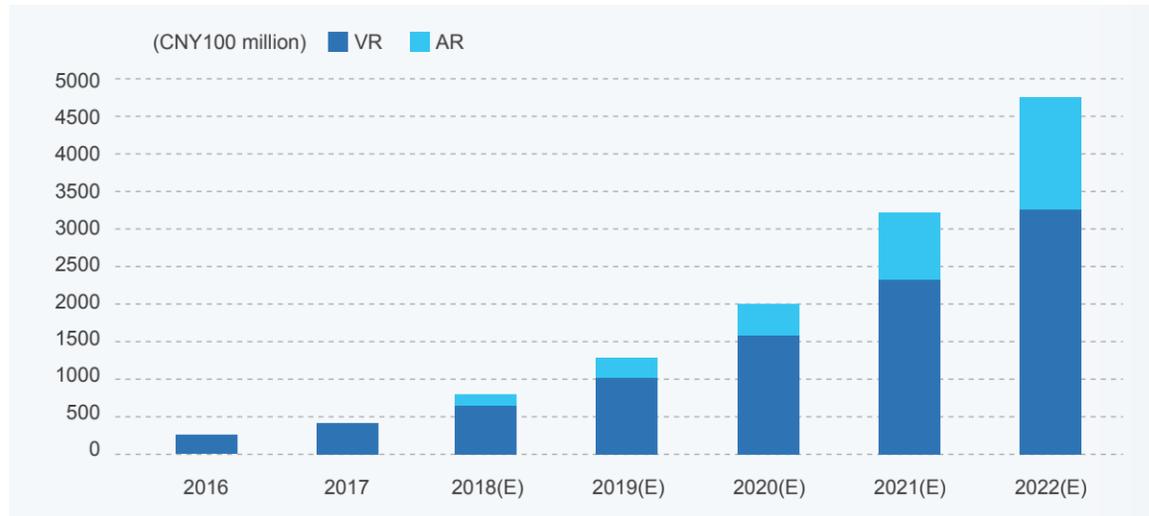
Smartphone
Entry of Mobile Internet



VR
Entry of the digital virtual world

Like personal computers and smartphones bring extensive changes to society, VR is widely applicable, binding various industries to create huge social benefits and start a new era. This also means that the VR industry has huge market potential and economic benefits. According to Greenlight, the global VR market space in 2018 exceeded CNY70 billion, a year-on-year increase of 126%. It is estimated that the global VR industry scale will exceed CNY200 billion by 2020.

Figure 2-1 Global VR market scale



As shown in Figure 2-2, VR disappeared from Gartner's Hype Cycle curve for emerging technologies (2018), indicating that VR has gone through hot speculation and a low trough, and has gradually matured. The industry's investment and financing are now rational, and the whole industry has embarked on a steady development path. VR industry players focus on business value, and the old development mode often ignoring costs and using large capital transfusions is no longer sustainable. The first large-scale popularization of VR saw significant streamlining of the business model. Only by achieving a mutually beneficial situation can we bring positive feedback to each industry link and make the VR industry grow in line with the market.

Figure 2-2 Gartner's emerging technology maturity curve (2017&2018)

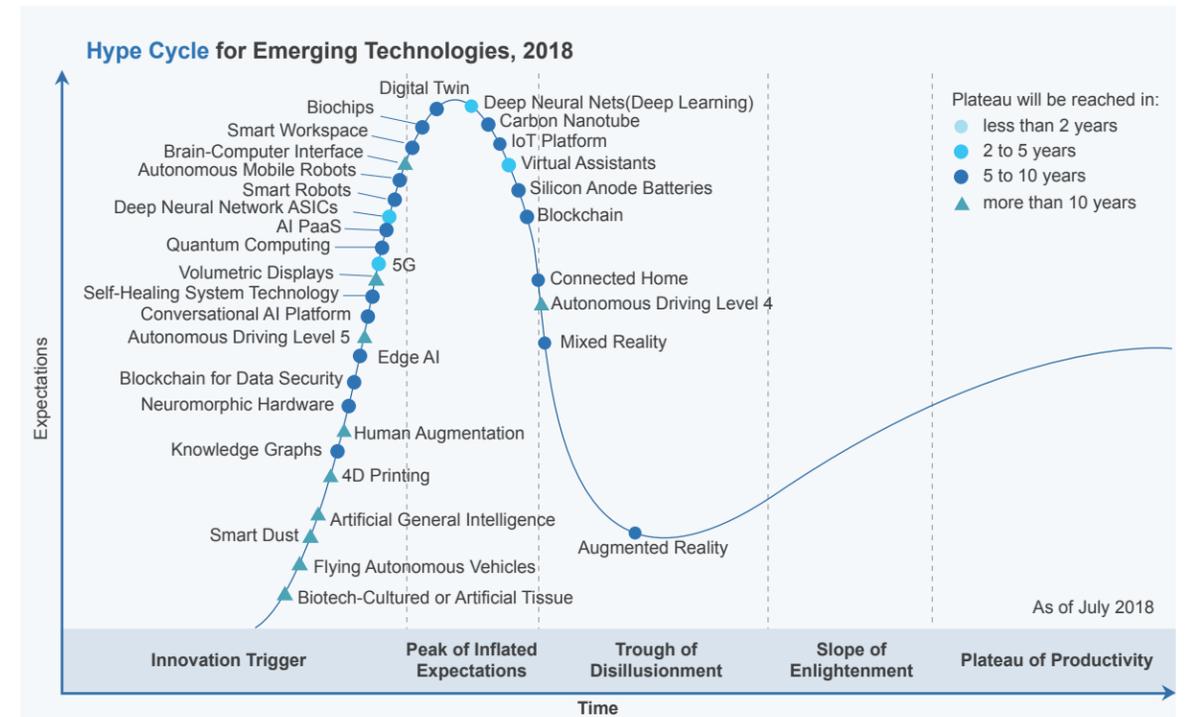
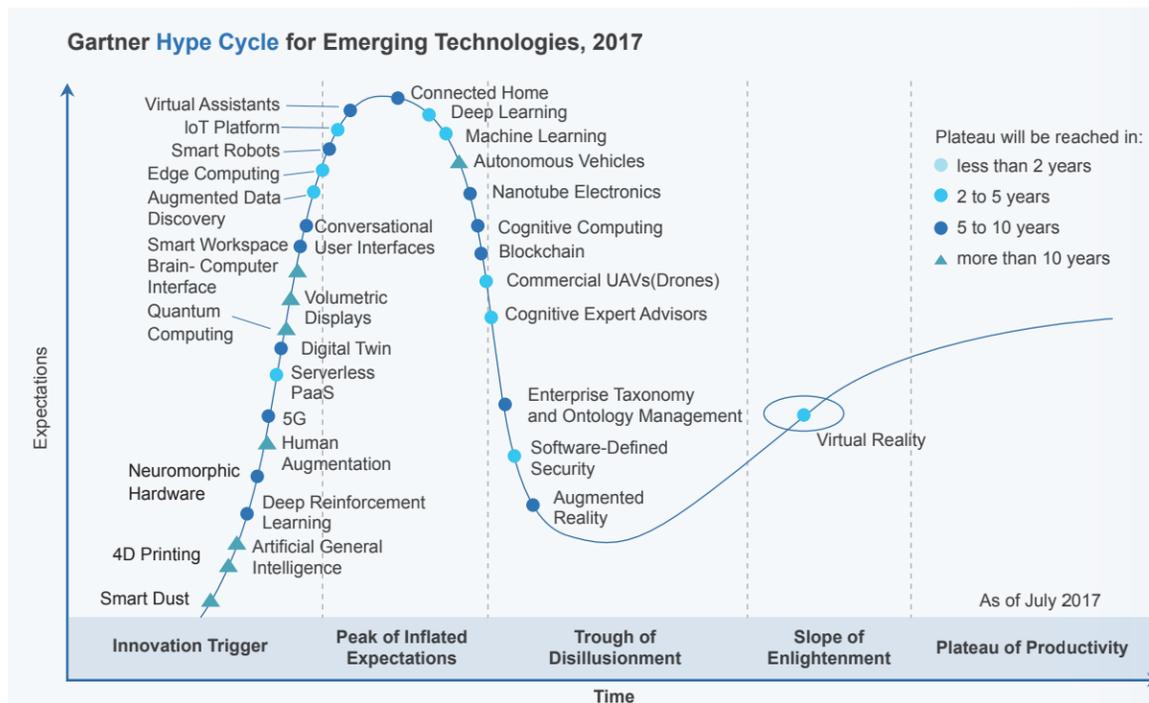
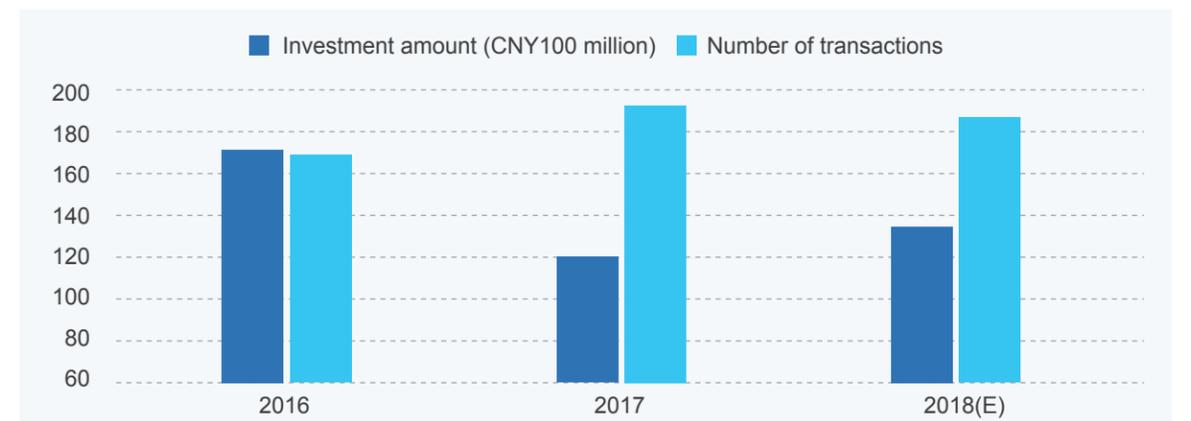


Figure 2-3 Global VR risk investment market situation



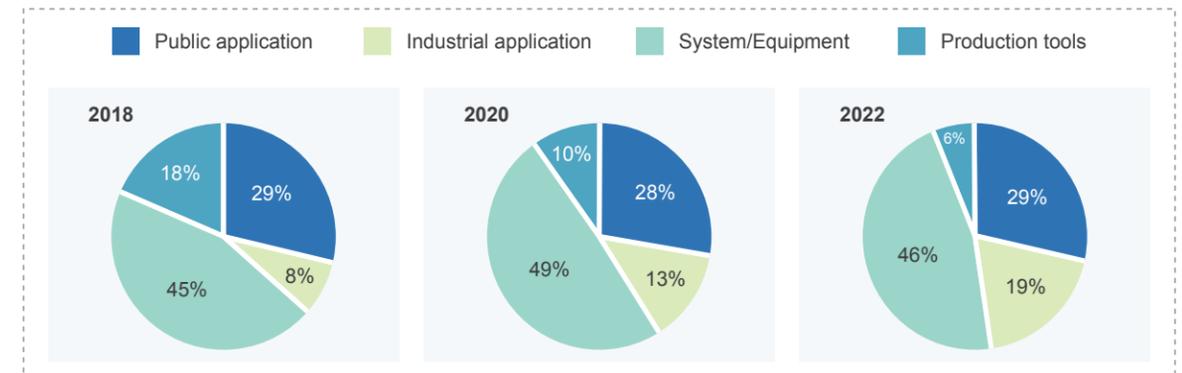
In the 2C market, VR is mainly used for entertainment of individual consumers, and its major value focus is user experience. In the 2B market, enterprises and government departments have more productive considerations and clear requirements on the value of VR. Their requirements for scenarios and values are diverse. The broad 2B market allows VR to quickly promote social and economic benefits.



VR Will Soon Be Widely Used in 2B Markets

In the 2B market, content and implementation of VR are developed and customized based on the industry's general requirements or customers' requirements. Over a long use period, customers' requirements for content will be relatively stable. This makes it easier to grasp customers' requirements and expectations in the 2B industry compared with the 2H market, and helps ensure the overall customer experience, making customers feel the value of VR persistently. These objective factors benefit the rapid popularization of VR in the 2B market.

Figure 3-1 Industrial structure distribution of the global VR market



According to the implementation of VR, all vendors have a large number of business practices and innovations in the 2B market. Local policy documents and VR analysis of industry consulting firms and research institutes also introduce many 2B scenarios, which are categorized according to use purpose.

Table 3-1 VR 2B scenario classification

Category	Scenario	Value for Enterprises or Government Departments
Knowledge & Skill learning	<ul style="list-style-type: none"> Enterprise practical training: Training on employee position skills and safety production, etc. Education: Vocational education, higher education, K-12 education, etc. Government services: Civic education, environmental education, security education, and other public services Medical training Military training Firefighting training Virtual pavilion ... 	<ul style="list-style-type: none"> Reduce training costs. Improve training efficiency. Improve learning effects.
Entertainment	<ul style="list-style-type: none"> VR theme experience library VR e-sports pavilion ... 	Generate new revenue and profits.
Work assistance	<ul style="list-style-type: none"> Marketing: Real estate/design exhibition, automobile marketing, retail marketing, tourism marketing, product display, etc. Design: Industrial design, urban planning and design, and creation of cultural works Medical treatment: Social cognition training in patients with autism, anxiety and depression treatment, management of artificial limb pain, brain injury assessment and rehabilitation, child hyperactivity treatment, management of diagnostics and imaging/visualization, etc. ... 	Improve work effects.

VR can easily be popularized in scenarios where the commercial value is clear and measurable and the potential userbase is large. Business value targets the requirement side and its focus is measurable. Value that can be more clearly measured, such as good return on investment (ROI), significant reduction of operation cost, and great improvement of work efficiency, proactively drive investment on the requirement side and simplify business model establishment. Potential userbase is the basis for evaluating the market space. A larger space can more easily aggregate capital, and is more likely to incubate a big industry.

- In knowledge and skill learning scenarios, VR can significantly reduce the overall training cost of enterprises or government departments, improve training efficiency, and its business value is clear. Especially in risky and expensive physical environments and scenarios such as strict skill training, customers easily accept VR and use it to improve training. These scenarios will be the first to establish a VR business model.

- In entertainment scenarios, VR is used to increase revenues and ROI. However, whether VR can create stable income depends on many factors, such as passenger traffic, content, overall experience, and consumers' recognition of VR. Currently, the profits of many VR offline experience stores are not optimistic or difficult to sustain, demonstrating that it is not easy to make money solely by relying on VR. However, applying VR experiences for tourist attractions is a lucrative business model, because of the huge passenger traffic, locally featured cultural content, and tourist spending psychology.

- Work assistance scenarios have unlimited possibilities. VR has demonstrated unique value in marketing, industrial design, art creation, and medical care. Among these, marketing as a universal demand of all industries provides easy monetization. Applying VR to the broad physical economy will inevitably lead to countless innovations.

The following describes the 2B scenarios that are most likely to be popularized. We hope that potential customers can better understand the value brought by VR and contribute useful references for the commercialization of industry vendors.

3.1 Enterprise Practical Training

3.1.1 Scenario Definition

VR simulates work environments and processes, and trains enterprise employees in various fields, such as position-specific skills, production safety, and enterprise processes.

3.1.2 Scenario Value

Make breakthroughs in various hardware difficulties, such as huge equipment, insufficient space, and high cost. In practical training scenarios involving electric power, oil, heavy machinery, and rail transportation, hardware and protection costs are high. In addition, sites are insufficient. VR can resolve these issues.

Effectively avoid risks that may be caused by real experiments or operations. Chemical and medical industries involve high risks. It is difficult to carry out training in high-risk scenarios, and employee training in these

scenarios enters a bad cycle. Specifically, training is insufficient and safety cannot be guaranteed. Serious personal injury and property loss are risks. This kind of training can be simulated with VR.

3.1.3 Application Case

VR+ Welding Training

The VR welding training system launched by Shenzhen GTA Education Tech Ltd. (GTA for short) simulates the formation, flow, and cooling of melting pools to provide users with immersive experience and interaction. In the whole welding process, moving angle, working angle, arc length, and welding speed are visible, facilitating employees' self-regulation and teachers' classroom instructions. This avoids harm of electric shock, burn, arc radiation, noise, welding dust, and harmful gas. The process does not require welding wires, welding protection gas, and any other welding materials, greatly reducing the enterprise training cost.

Figure 3-2 VR welding training (source: GTA)

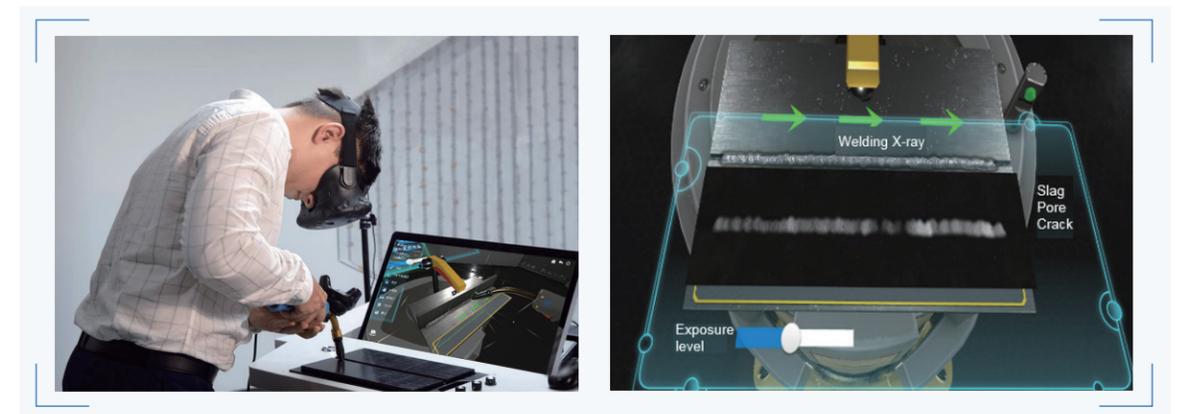


Figure 3-3 Comparison between traditional welding training and virtual welding training for an American company (source: GTA)

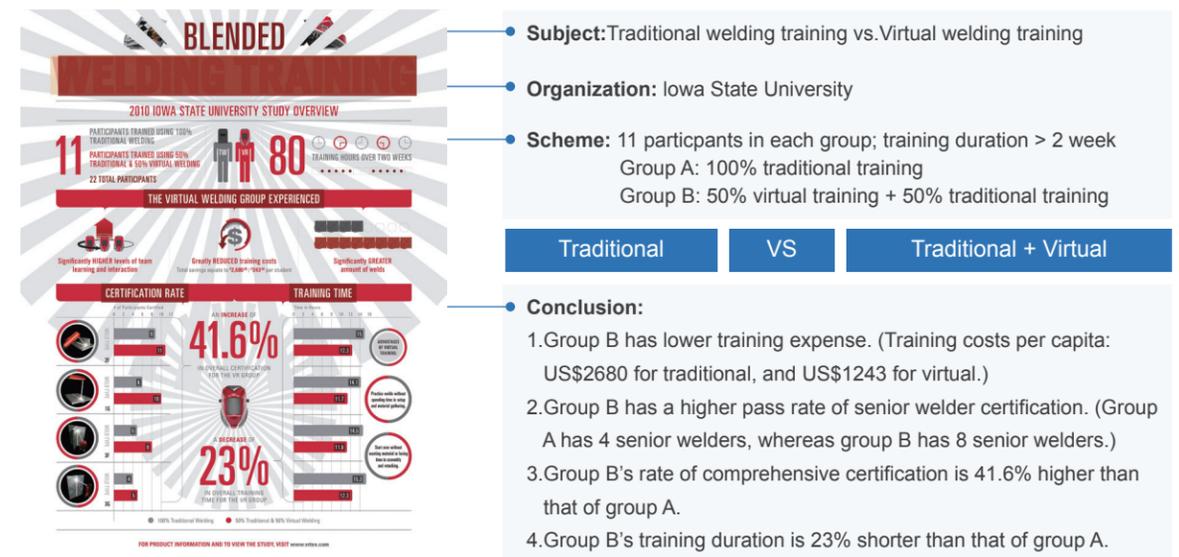


Figure 3-4 Experiment data comparison between traditional welding training and VR welding training for a nuclear power project (source: GTA)

Table 1 Materials consumption					
Training Item	Base Metal/kg	Welding Material/kg		Gas/Gylinder	
	Q235	J422	CHE507	Oxygen	Acetylene
Simulator + Practical operation	847.8	90	180	24	15
Practical operation	1380	170	340	40	25
Saved volume	532.2	80	160	16	10
Saving rate(%)	38.57	47.06	47.06	40.00	40.00

Table 2 Cost analysis					
Training Item	Qualification	Training Month	Traning Fee (CNY10,000/person)	Number of Welders (Person/α)	Total Cost (CNY10,000/α)
Practical operation	Support/Tablet	6	4	50	200
Simulator + Practical operation	Support/Tablet	5	3.3	50	165
Saved volume	—	1	0.7	—	35

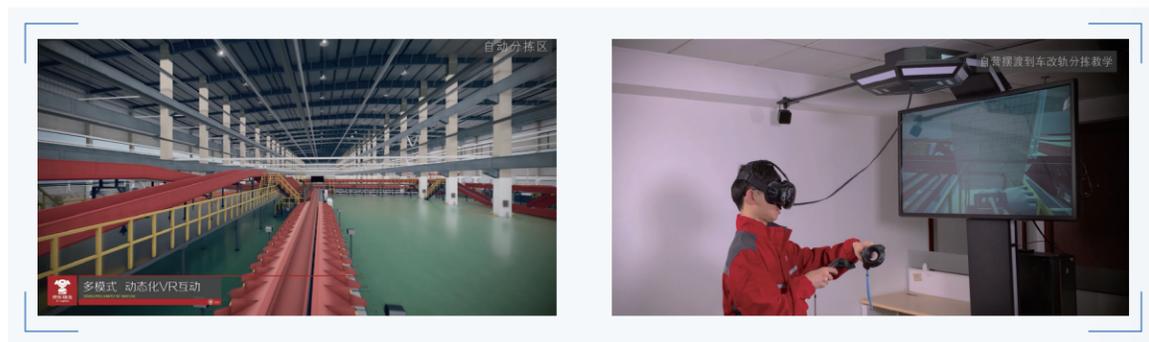
Note: α represents year.

Figure 3-3 and Figure 3-4 show that VR welding training can greatly improve trainees' certification pass rate, reducing training time by over 20%, and reducing training institutions' materials costs by about 40%.

VR+ Logistics Training

In November 2018, JD Logistics launched a VR logistics training course. Using VR, employees can efficiently learn to sort goods, paste face sheets, and wrap tapes. In JD Logistics, new employees in the sorting center are guided by masters, which may cause damage to orders, loss of orders, and misoperations because of their unfamiliarity with businesses. With this intelligent virtual training mode, the enterprise can help employees improve their work abilities in a relaxed and enjoyable atmosphere, and shorten the training of new employees from 15–20 days to 1–2 days.

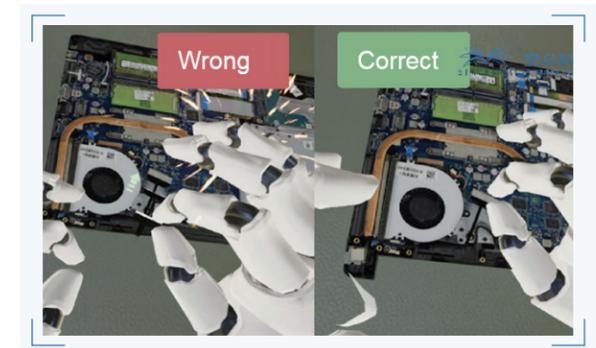
Figure 3-5 JD Logistics VR training (source: JD Logistics)



VR+ Manufacturing Training

Shanghai SpaceMax Technology Co., Ltd. (SpaceMax) and Compal Electronics, the largest laptop manufacturer in the Asia-Pacific, use VR to simulate the entire assembly process, for example, splitting core actions including pressing transparent Mylar fixing tapes, sorting LVDS cables, and inserting KB membranes to train employees' operation skills. The training effect is substantial. In traditional training, each employee requires about three days of on-boarding and one week of skills training. Using VR, 1400 new recruits are trained without occupying the production line, improving training efficiency by 30% to 35%. Simultaneously, employee skills can be appraised, serving as an effective input for intelligent distribution of employees.

Figure 3-6 VR assembly training system of Compal Electronics (source: SpaceMax)



3.2 Vocational Education and Higher Education

Vocational education refers to the education of vocational knowledge, skills and professional ethics necessary to engage in certain professions. Higher education includes education of specialty, undergraduate, and postgraduate, adult higher education, and other higher education.

3.2.1 Scenario Definition

Based on VR, multimedia, human-computer interaction, databases, and network communications technologies, highly simulated virtual experiment environments and experimental objects can be constructed for students to learn, experiment, and practice in the virtual environments, achieving teaching effects required by vocational education and higher education syllabi.

3.2.2 Scenario Value

Enhancing Learning Interests and Improving Learning Efficiency

Research shows that the teaching efficiency is about 10% for a single media (text or picture), 30% for audiovisual or multimedia teaching, and 70% for highly immersive VR media. VR greatly improves teaching and learning efficiency. It will eliminate the cognitive obstacles brought by time and by space in traditional education, provide students with vivid and lifelike learning environments, and help students master abstract concepts effectively.

Reducing Education Costs

Many courses in universities and vocational colleges require expensive teaching equipment and the teaching environment is difficult to build. Educational experiments face various resource scarcities, and not all students have sufficient resources to participate. Using VR in some experiments can reduce the cost of experiment resources.

Making Practice Training Content Reversible and Repeatable

For students in medical and chemistry majors, VR can be used to perform irreversible operations repeatedly and analyze multiple groups of data for irreversible problems. The whole process can tolerate errors for multiple times without loss of raw materials.

Avoiding Safety Risks in High-Risk Experiment Operations

For example, students studying chemical engineering, mechanical engineering, and power and energy engineering require experimental training, and many experiments are performed in dangerous situations, where misoperation can cause serious safety accidents. In the VR simulation lab, all experimental tools, scenarios, and materials are made into stereoscopic models by using three-dimensional simulation technology, and students operate based on the simulation models. Even if a fault occurs, the simulated catastrophe hurts no one. Experiments in VR can greatly reduce safety risks.

3.2.3 Application Case

According to statistics from China's Ministry of Education in 2017, more than 4,500 higher education schools and more than 9,000 vocational schools operate in China. Under the guidance of national policies, VR has a vast potential market space in vocational education and higher education. The business value of its scenarios is clear, and the business model can develop quickly. In 2B scenarios, VR is inevitably first popularized at a large scale.

/// VR+ Automobile Repair Teaching

GTA deeply integrates VR and vocational education training. For example, its VR vocational training software details knowledge points based on the syllabus, integrates teaching resources, and provides 10 modules and 100 knowledge points to meet requirements of multiple professional core courses, such as the Automotive Engine Technology and Maintenance, Automotive Chassis Technology and Maintenance, and Vehicle Construction. VR breaks the space limit for students in vocational schools, allowing them to enter the interior of objects for observation. It also breaks through the time limit, allowing students to observe some processes that would naturally take decades or even hundreds of years. Using VR, students can also observe operations of automobile brake parts. The disassembly of a component can be repeatedly displayed from multiple angles, and automobile principles can also be displayed in multiple directions.

Figure 3-7 VR training system for vehicle maintenance (source: GTA)



Currently, the software is being used by several Chinese vocational schools, including Shenzhen Polytechnic, Nanjing Institute of Railway Technology, Anshun Vocational and Technical College, Fuzhou Polytechnic, and Cangzhou Industry and Trade School.

/// VR+ Interior Design Teaching

Fujian HuaYu Education Technology Co., Ltd. (NetDragon Huayu Education) combines VR with interior design to provide professional teaching and practice training solutions, which have been used in several Chinese vocational schools, including Field Vocational Technical Secondary School (Datian in Fujian province), Quanzhou Huaqiao Vocational School, Guizhou Polytechnic of Construction, Jiaxing Construction Industry School, and Jinjiang Huaqiao Vocational School.

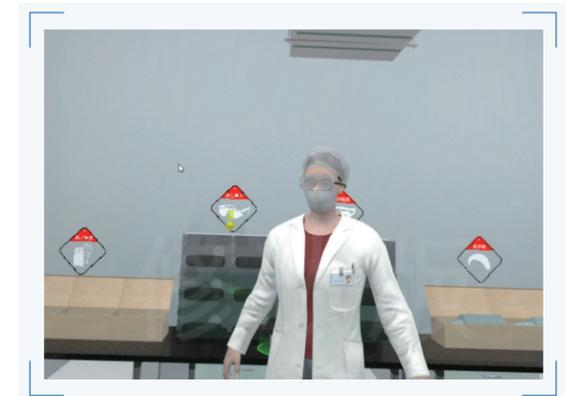
Figure 3-8 VR interior design course (source: NetDragon Huayu Education)



/// VR+ Chemistry Teaching

Before conducting a formal chemistry experiment, students in a Chinese university can rehearse in the virtual lab to become familiar with the overall process, involved utensils, and chemicals. Finally, they perform the hands-on experiment, improving success rate and minimizing potential hazards.

Figure 3-9 Virtual training in a chemical lab (source: Growlib)



3.3 K-12 Education

In China, K-12 refers to the education from primary school to high school, and involves diverse application scenarios for VR.

3.3.1 Scenario Definition

VR is used to virtualize learning environments and scenarios, such as celestial objects in the universe, artistic conceptions in ancient poetry, microscopic cell biology, and geological and geomorphological changes, presenting knowledge vividly to make students master it.

3.3.2 Scenario Value

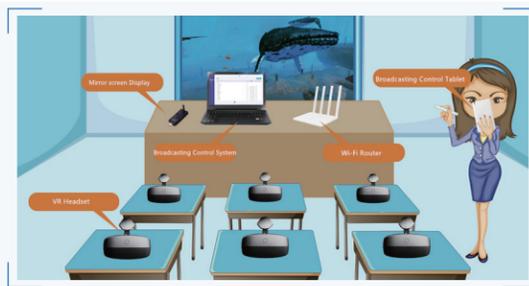
VR can break time and space limits and present knowledge to students in a more vivid and intuitive way. By improving learning interest, VR helps students memorize and understand concepts, enhancing learning.

3.3.3 Application Case

Applying VR to K-12 education is a new pedagogical focus and represents the future of information education. In July 2017, Beijing Growlib Science and Technology Co., Ltd. (Growlib) launched 100+ courses combining VR and

primary and secondary education. After just one and a half years, as of December 2018, there are over 1000 VR courses, covering thousands of 3D models. In terms of school entry, virtual classrooms have been set up for VR education, and each virtual classroom is equipped with 30 to 50 standalone VR headsets. Educational content includes Mathematics, English, Physics, Chemistry, Biology, Geography, Applied Science, Safety, and Chinese language. These courses are highly regarded by teachers and students. Growlib VR education has already been popularized in the following Chinese schools: the Beijing No. 4 High School, the Experimental School of Capital Normal University, the Shazikou Primary School in Laoshan District of Qingdao, and the Zhoupu Senior High School Attached to East China Normal University in Shanghai.

Figure 3-10 VR Biology class (Source: Growlib)



Teachers from Shazikou Primary School think that VR teaching is a revolutionary model, diversifying classes and improving teaching quality and means.

Figure 3-11 VR classroom of the Shazikou Primary School in Laoshan District of Qingdao (source: Growlib)



/// VR+ Chinese Language Teaching

Lesson 21, *Old Summer Palace Destruction*, in volume I of the Chinese textbook for grade five has the following description: Golden halls and exquisite pavilions were located throughout the Old Summer Palace. Wandering there you might feel as though you have entered the realm of fantasy. The destruction of the Old Summer Palace was a major historical loss of Chinese culture and even world culture. Students can only learn about and imagine the original grandeur of the Old Summer Palace based on these words. Shanghai Cloudwave Network and Technology Co., Ltd (Cloudwave Technology) uses VR to visualize the original Dashuifa of the Old Summer Palace, so that students experience roaming the garden using their VR headsets. The description in the textbook is no longer merely text but a fantastic immersion in the garden.

Figure 3-12 Dashuifa of the Old Summer Palace (source: Cloudwave Technology)

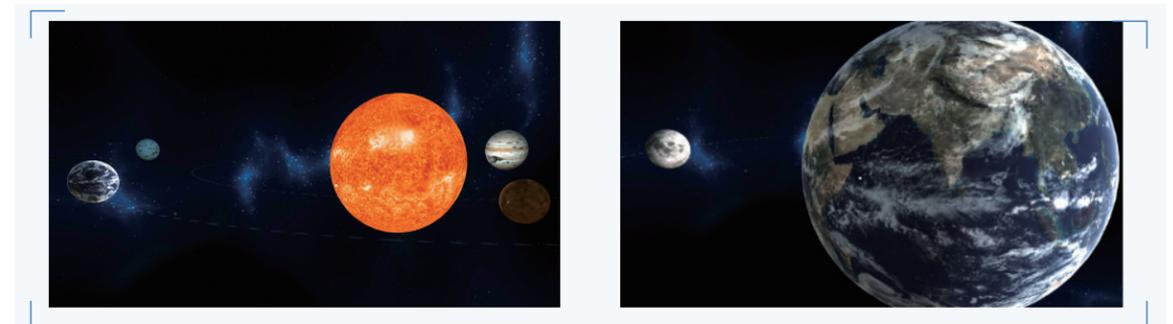


/// VR+ Applied Science Teaching

In Shenzhen Delong Primary School, the Skyworth VR applied science class covers fire fighting, transportation, electricity consumption, typhoon, earthquake, and other safety education content. It teaches students some disaster response and recovery knowledge, improving students' safety. The class also covers some VR content about the universe, geography, and history. For example, students can learn about the operation of planets in the solar system, and observe landforms and relative positions

of the planets in a simulated universe. Abstract content that takes three class hours in traditional education now takes only one hour with VR.

Figure 3-13 Cosmology course in Skyworth VR popular science class (source: Skyworth)



3.4 Government Services

3.4.1 Scenario Definition

VR can be used to construct virtual environments and simulate municipal traffic and natural disasters, helping governments provide services such as city planning, disaster prevention training, and public service communication. It also supports novel and immersive ways to restore historical fragments, showcase national achievements, and foster patriotism.

3.4.2 Scenario Value

Providing better social and public services for the public has always been vital for government agencies, and their forms have evolved from the earliest posters and newspapers to radio broadcast and television with technological development. With the development of the Internet and smartphones in the 21st century, networks and mobile platforms have become important interfaces. With the emergence of VR, governments around the world seek ways of applying this technology broadly to improve the quality of government services.

With its high fidelity and immersive experience, VR is widely used in scenarios that have high environment construction costs but poor effect presentation, such as earthquake disaster response, fire safety training, traffic accident simulation, environmental protection campaigns, and urban planning. Simultaneously, VR supports public education of economic, environmental, and other challenges, and fosters intercultural understanding in a divided world.

3.4.3 Application Case

/// VR+ Public Disaster Prevention Training

Natural disasters have occurred since ancient times, and always bring great destruction. It is impossible to

completely prevent natural disasters, but taking preventive measures can mitigate losses. Among these measures, public education and awareness improvement are vital, along with disaster prevention and response information. In the past, people learned through simple evacuation drills and passively from pictures and videos, but this method cannot easily simulate disasters. VR can be used to vividly restore disaster scenes, letting people experience natural disasters safely and learn self-rescue and escape skills.

Figure 3-14 VR fire safety education
(source: NetDragon HuaYu Education)



In January, 2018, the Public Security Bureau of Xiamen, China, held an emergency response publicity day activity entitled "Staying Safe in the Modern World". NetDragon Huayu Education deployed an onsite VR fire safety education exhibition area, simulated fire disasters through VR, and taught participants how to rescue themselves in fire disasters. People called it addictive and practical experience. This new method of education is better for children. For example, a child of 12 years old, wearing a VR headset, mastered using a fire extinguisher to put out virtual flames. She said she would now know what to do if she encountered a real disaster.

Figure 3-15 Experience of VR safety education in primary schools of Yichang city in China
(source: NetDragon Huayu Education)



In China, March 26 is the fire safety education day for national primary and secondary school students. On this day of 2018, the fire brigade and education bureau of Yichang, in Hubei province, launched the first fire safety knowledge education activity in the city. The VR fire safety education content provided by HuaYu Education attracted more than 500 teachers and students from more than 30 schools in the surrounding areas. The students played happily with their teachers and learned about fire hazards and coping strategies. The teachers said that students' enthusiasm and devotion to VR exercises was much higher than past education lacking VR.

3.5 Theme Experience Pavilion

3.5.1 Scenario Definition

By connecting with peripheral devices such as motion capture devices and force feedback devices, traditional entertainment projects can be combined with VR technology and content to construct an experience pavilion. VR experience pavilions can demonstrate gaming, sports competitions, escape rooms, history education, cultural tourism, and so on. The purpose is to bring players into the virtual world and better understand the idea of the pavilions.

3.5.2 Scenario Value

VR experience pavilions are important for offline VR industry development and an important part of the VR market. In addition to large amusement parks such as Disneyland, many small entertainment venues are emerging, such as games halls, board game bars, and escape rooms. The emergence of VR fosters new innovation in these entertainment fields. For example, building traditional amusement parks is costly, with the cost of one roller coaster reaching one hundred million dollars. VR head-mounted displays (HMDs) and 4D motion seats can be used together to realistically simulate a roller coaster experience even in a shopping mall. Simultaneously, with a rich set of experience scenes, players can virtually climb mountains, cross ocean, and even explore the universe or Jurassic jungles. VR experience pavilions bring highly immersive and enjoyable experience with low costs.

These pavilions can also be built at tourist attractions or cultural sites to reproduce famous events and ancient customs, breaking through time and space restrictions to enrich user understanding.

3.5.3 Application Case

VR+ Original Animation IP Entertainment Center

Shenzhen Realis Multimedia Technology Co., Ltd (REALIS) constructed a multi-person VR battleground using Chinese animation technology called "Pihotrain-Wonder Gate" debuted in a shopping mall of Shenzhen. The VR playground covers about 120 square meters and hosts 24 people for 12-minute experiences. This new VR experience has proven highly popular among young people. Especially the ending snowball fight game, which fills children with wonder impossible to experience physically in snowless Shenzhen.

Figure 3-16 Scene of final snowball fight in the VR entertainment center (source: REALIS)



REALIS CEO Xu Qiuzi said: The development of China's animation industry chain is still in the early stage, especially proprietary IP development. REALIS will play a connection and optimization role in the animation industry chain. Core VR multi-person interaction technology helps construct high-quality VR content for valuable animation or game IP, increasing the value-added space and gradually developing the industry.

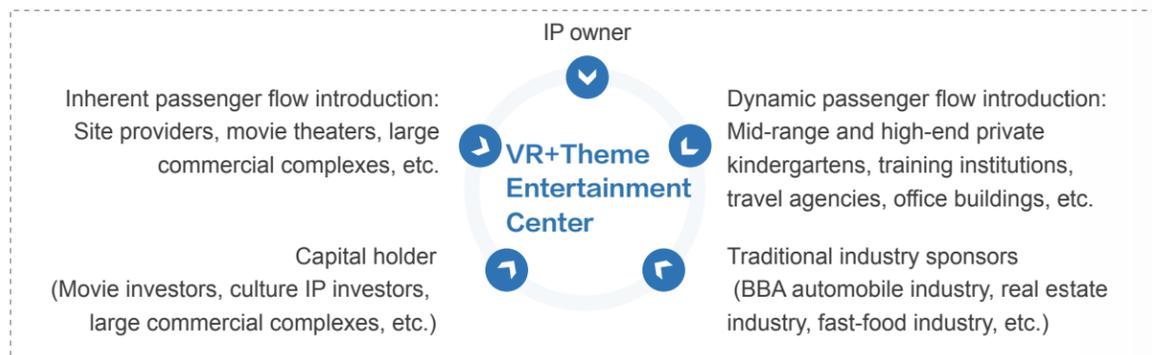
Figure 3-17 VR entertainment center in a shopping mall of Shenzhen (source: REALIS)

REALIS divides customers into the Post-00s generation and the Post-90s generation. It combines self-media and group-buying platforms online, and combines cinemas, shopping malls, and physical stores offline to promote marketing. The project is expected to be profitable within one year after being implemented.



VR entertainment centers need to follow the rules in the offline entertainment industry. They must be clearly positioned and attract target audiences using high-quality featured content, for example, introducing Hollywood movies and TV shows to attract video and film fans, or combining with animation IP to attract younger audiences.

Figure 3-18 Operation model reference for VR entertainment centers (source: REALIS)



3.6 Marketing

3.6.1 Scenario Definition

The application of VR technology to traditional marketing (such as background publicity, product introduction, and pre-experience) overcomes disadvantages of traditional media forms. It enables marketing recipients to learn more about products and feel their advantages through active experience, promoting purchases.

3.6.2 Scenario Value

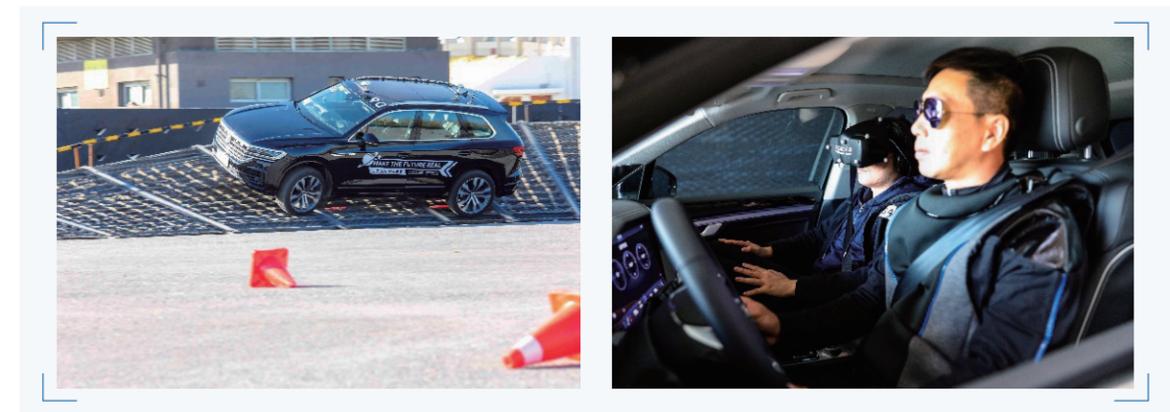
VR marketing covers all aspects of the VR industry in a wide variety of forms, such as product background promotion, comprehensive product introduction, and product pre-experience. Based on the high immersion and interaction features of VR, VR marketing helps users understand products more clearly and actively, and collects user behavior data more comprehensively and conveniently under users' permits to support user behavior analysis in big data, for example, collecting data about the aspects stared at by users for the longest time and users' operation habits, thereby achieving precise and effective digital marketing.

3.6.3 Application Case

VR+ Automobile Driving Experience

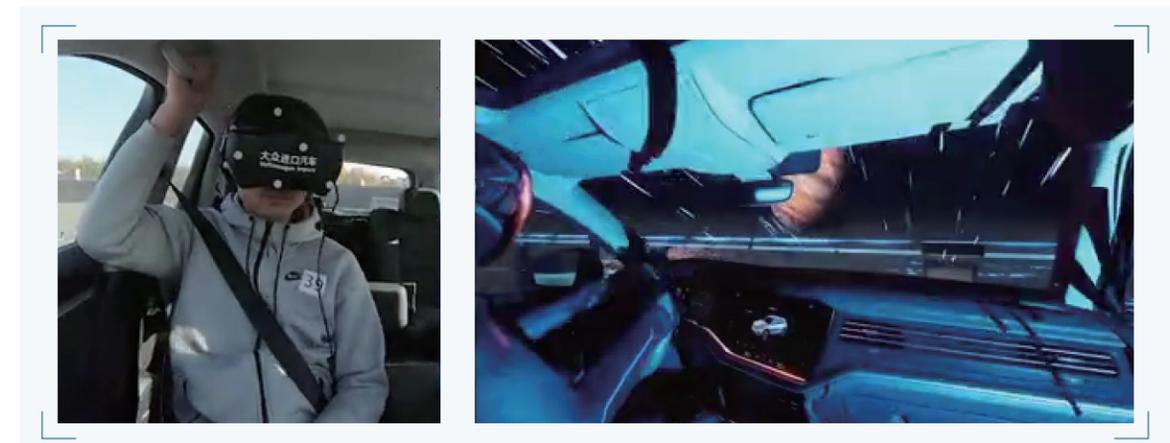
From September to November 2018 in Beijing, Zhuhai, Hangzhou, and Chengdu, Beijing Noitom Technology Ltd. (Noitom) collaborated with Volkswagen to create a full-body object-scene integrated VR driving experience in a new generation Touareg launch event. Guests wore VR HMDs to experience a journey full of suspense and excitement in vehicles driven by professional drivers.

Figure 3-19 VR driving experience (source: Noitom)



Based on pre-boarding scene statement and on-boarding vision/sound effects and guidance, a legendary adventure experience is constructed. In the real world, the drivers drove passengers on the ground, while in the virtual world, passengers flew through the universe and into a fantasy world. For passengers, this was not only a shocking experience of VR but also an experience of powerful vehicle performance and advanced functions.

Figure 3-20 VR content presented during driving experience (source: Noitom)



The media, including China's Xinmin Net, Tencent Technology, and Huanqiu Net, commented that this experience was not only a major technical breakthrough, but also a key step for car companies into the forefront of digital technologies, and it led industry development.

/// VR+ House Selection and Decoration

In the past, homebuyers had to pre-screen houses using mainly text description and pictures, deciding which to spend their valuable time visiting in person. Sellers often consciously avoided showing less-desirable parts of their houses, or revealing defects. Likewise, renters often encounter unexpected problems, for example, the furniture is not suitable or the decoration style is different from the description. Now, the VR panorama roaming feature provides more information for buyers and renters, allowing them to view every corner of houses. This greatly improves the efficiency of house selection.

Figure 3-21 VR panorama of house decoration (source: AIPANO)



In 2018, Beijing Mythware Information Technology Co., Ltd (AIPANO) developed VR home decor applications for B&Q to apply in more than 10 cities, including Beijing, Shanghai, and Shenzhen. The applications combine the products of B&Q stores with multiple households, so that customers can experience different home decor styles in the virtual world. In addition, customers can place their orders directly within VR applications.

Figure 3-22 VR experience of home decoration (source: AIPANO)



AIPANO CEO Liang Bin said that VR marketing will break the traditional marketing mindset, and interactive experience will help users to select more optimally. In the second half of 2019, more industries and companies will use VR/AR content or tools for brand promotion. With the promotion and implementation of 5G, VR marketing will supplement existing marketing models and become a new norm.



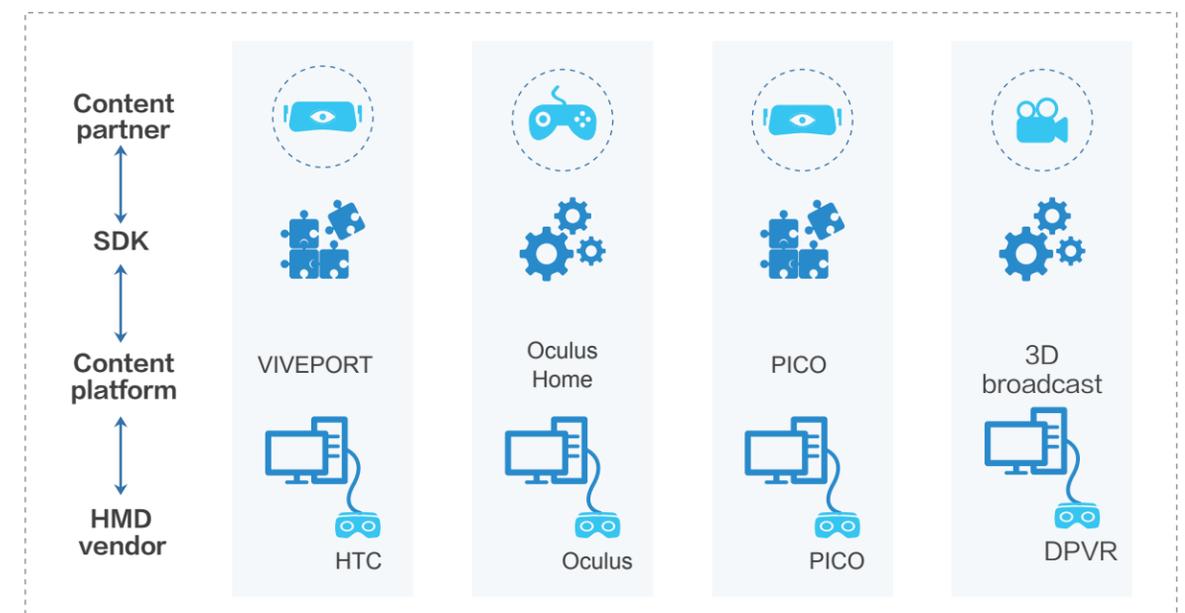
04

Generalized Preferential Cloud VR Is the Optimal Choice for Accelerating Industry Development

As part of a new generation of innovative technologies, VR is driving a new round of technological revolution and industry transformation. This is highly valued by China and countries worldwide seeking to promote their technology sectors. VR is included in China's 13th Five-Year Plan, China Manufacturing 2025, Internet+, and other major strategies, and become a frontier field in China's economic globalization. Since 2016, more than 10 Chinese cities and ministries have released specific VR policies to promote its rapid development. In 2018, several cities, including Chengdu and Nanchang, released industry support initiatives, reinforced by the *Guidance Opinion on Accelerating the Development of Virtual Reality Industry* issued by China's Ministry of Industry and Information Technology (MIIT). These policies encourage VR innovation and entrepreneurship, increasing training and improvement of VR talents, and promoting R&D. Based on local characteristics, these policies recommend application scenarios for VR layout, promoting VR industrial solutions and accelerating industry development.

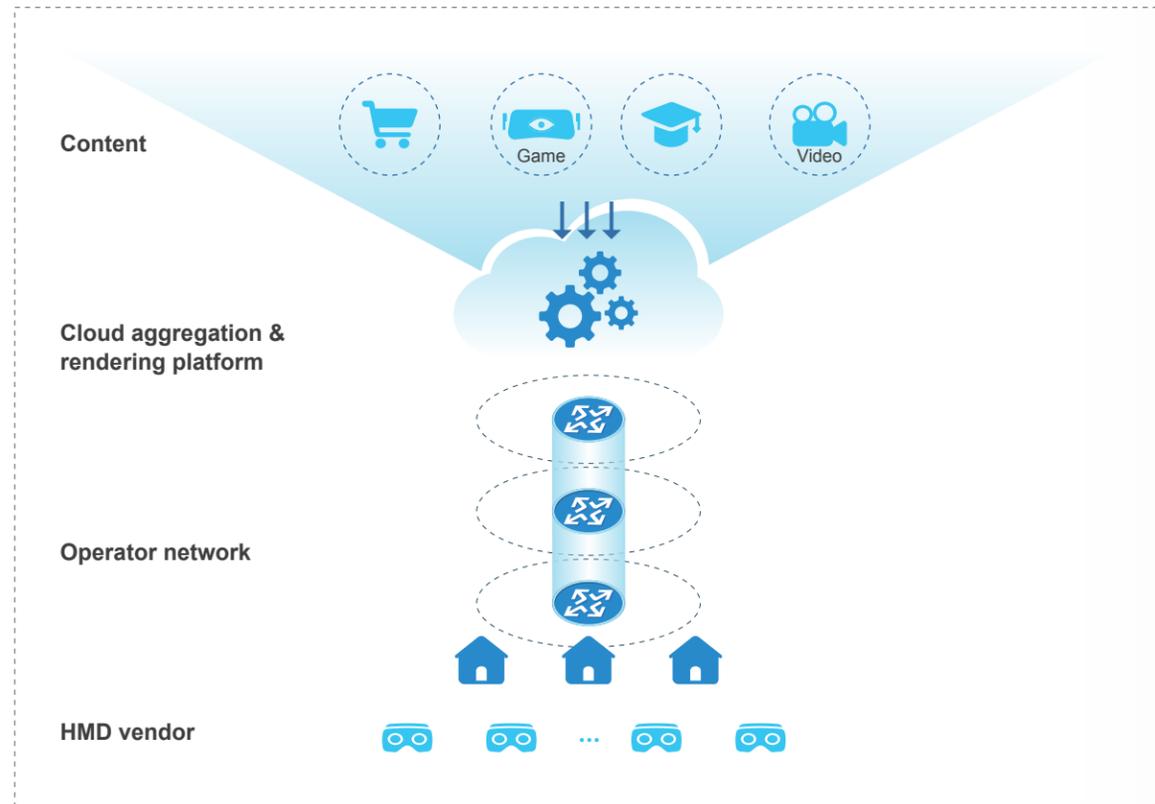
These policies aim to create a prosperous industry, focusing on improving the industry chain; building an industry ecosystem; and integrating elements such as capital, technology, talent, innovation, and public service platforms. This will support manufacturing, content, software development, and distribution platforms. The ecological chain of the VR industry has already formed and grown around mainstream HMD vendors. Content developers develop and adapt content for different mainstream vendors' devices. HMD vendors promote device sales by relying on rich content. HMD vendors such as HTC and Oculus have developed their own ecological chains, and there is currently no dominant ecological chain in the industry. The computer and smartphone industry development process shows that with the evolution and deepening of industry development, the ecological chains inevitably become integrated. **A universal platform that can adapt to various types of terminals and that has extensive content aggregation capabilities will inevitably promote rapid industry ecosystem growth.** The universal platform will undoubtedly occupy an important position in a mature market ecosystem.

Figure 4-1 Current ecosystem growing based on hardware vendors



Cloud VR is most likely to be a universal platform. Cloud VR has the following advantages over local host rendering:

Figure 4-2 Cloud VR is suitable for ecological chain expansion



- **Facilitates content distribution and aggregation.**

The unified Cloud VR platform can adapt to different types of VR content on different VR terminals. Content providers only need to adapt to the platform without having to consider adaptation to each terminal. This allows them to focus on improving VR content quality and quantity. In addition, aggregating high-quality content on the unified platform allows users to obtain it more conveniently.

- **Facilitates content copyright protection.**

Currently, a large amount of VR content can be used only offline, making it difficult to effectively manage and control content copyright. Instead, VR content can be uploaded and managed centrally in the cloud, preventing unauthorized reading, copying, and spreading. This avoids content piracy and protects the sustainable development of the VR industry.

- **Facilitates combining big data analysis and artificial intelligence.**

Data is stored in the cloud. Cloud-based powerful computing and analysis capabilities are used to analyze big data or combine with artificial intelligence, bringing more industry innovation and value.

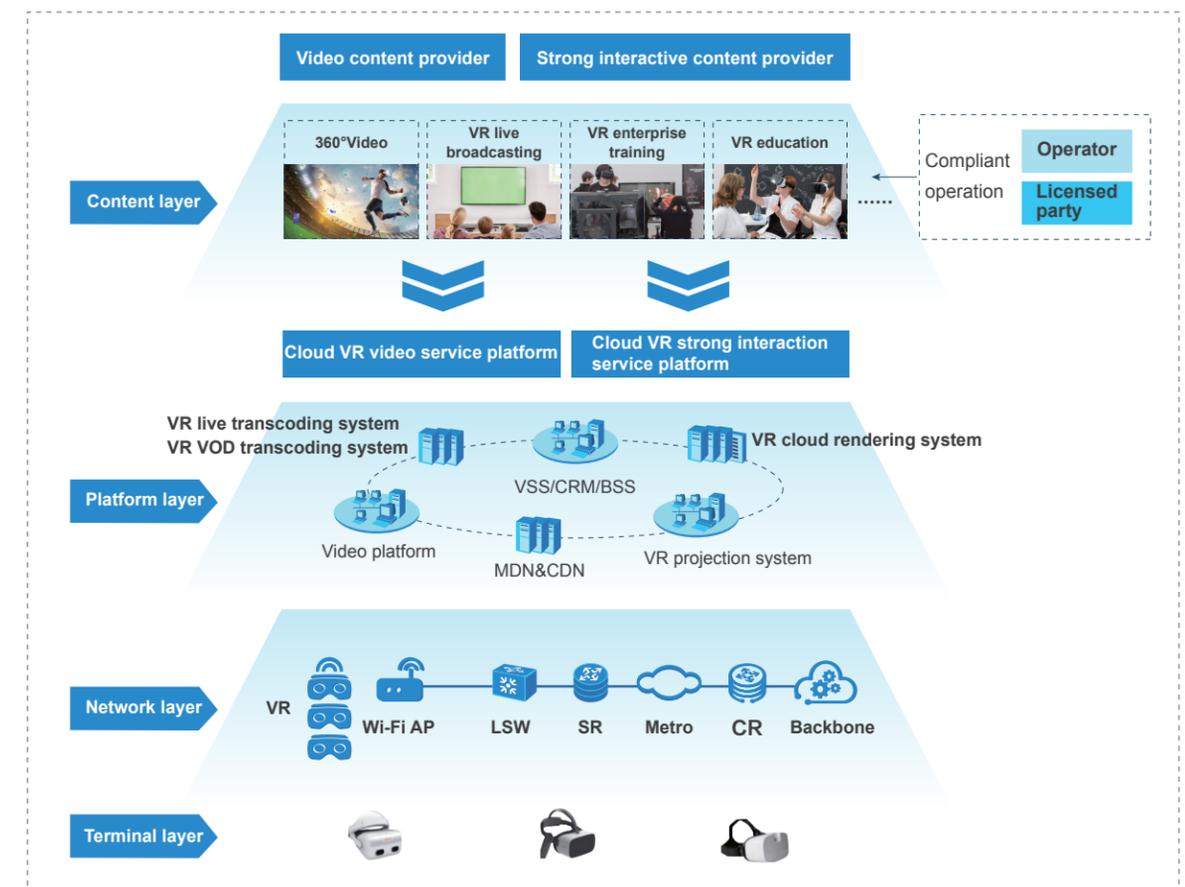
- **Reduces the price of terminals.**

Cloud rendering greatly reduces the CPU+GPU rendering requirements and hardware requirements of terminals, without needing local high-performance hosts and their associated costs.

- **Improves user experience.**

Since local hosts are not required, lines for connecting VR HMDs and hosts are no longer needed. Cordless HMDs free users' movement and greatly improve VR world user experience.

Figure 4-3 Cloud VR solution architecture



Cloud VR is an inevitable trend of the large-scale development of the VR industry. In the *Guidance Opinion on Accelerating the Development of Virtual Reality Industry*, China's MIIT proposes a device-cloud collaborated VR network distribution and application service aggregation platform (Cloud VR). This will promote establishment of efficient and secure VR content and application payment platforms and distribution channels.

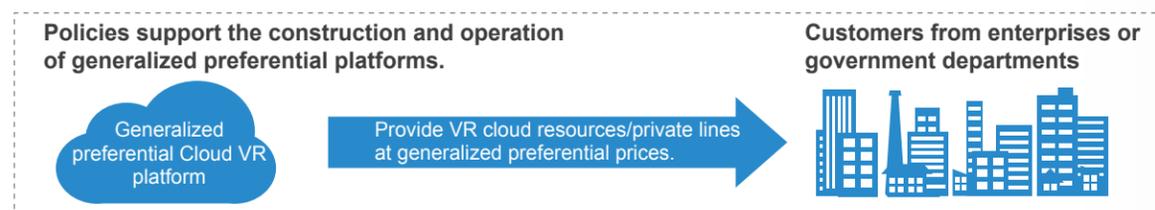
To effectively promote industry development, Cloud VR shall not only ensure that customers are able to use the technology, but also ensure that customers can afford it. Currently, cloud GPU rendering services and private lines are expensive, especially government/enterprise private lines. For example, the monthly fee for a 1G

government/enterprise private line in China was up to CNY40,000 in 2018. Such fees are extremely high for most customers, hindering industry expansion. Therefore, it is necessary to build and operate generalized preferential Cloud VR, and provide VR cloud virtual machines, cloud GPU resources, and cloud private lines to enterprises or government departments with generalized preferential prices to reduce the cost and technical threshold of VR. This will encourage potential customers to adopt VR technology in their organizations, increasing market demand and promoting a healthy industry chain.

Generalized preferential Cloud VR is the optimal choice to accelerate development of the VR industry. The generalized preferential mechanism can stimulate market vitality and contribute to economic development. Based on a comparison with the development of the 4K TV industry, the increasing influence of generalized preferential Cloud VR on related industries can be roughly evaluated. According to the government of Guangdong province, popularization of 4K TV network applications could increase output value of related industries in the province by over CNY600 billion by 2020, bringing the investment such as that in broadband construction to exceed CNY100 billion. VR has wider application scenarios and a larger potential audience than 4K TVs. After VR is cloudified, demand for bandwidth will reach 1000 Mbit/s (several times that of 4K TV). In addition, the price of hardware and content is not lower than that of 4K TV. Therefore, from the perspective of the overall industry, the economic value of production to meet generalized preferential Cloud VR demand will be at least equivalent to that of the 4K TV industry.

It is difficult to develop a generalized preferential mechanism by relying solely on the power of the market. Implementing generalized preferential Cloud VR requires government support. Governments should issue relevant policies to encourage players with abundant capital to participate in constructing the Cloud VR platform. For example, in the Cloud VR platform construction and early operation phases, relevant governments can provide appropriate financing, equipment procurement allowances, and tax incentives for platform financing parties, accelerating platform development. After Cloud VR businesses increase to a large scale, market forces can spontaneously form a positive business cycle.

Figure 4-4 Generalized preferential Cloud VR accelerating the popularization of VR



The most likely investors in the generalized preferential Cloud VR platform are telecom operators who have cloud, network, and government/enterprise customer resources, and meet the objective conditions for best construction and operation. Mainstream players in the cloud field may also become investors. Relying on the advantages of existing cloud resources and content aggregation, their business scopes can be extended to VR.

Huawei hopes that players with abundant capital will invest in generalized preferential Cloud VR, and that government agencies willing to develop the VR industry will support generalized preferential Cloud VR to jointly promote a prosperous ecosystem.