Application of Gigabit Optical Network in Digital Education Transformation

ETSI/CCSA Workshop on Optical Communication

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Requirements of cloud VR education based on Gigabit optical network

Gigabit optical network has been a national strategy and played an important role for Chinese economic and social development. It also supports the construction of computing force network

The government work report and the 14th five-year plan

- Strengthen the overall layout of digital China and build digital information infrastructure

Double Gigabit plan of MIIT

- Action plan for collaborative development of double Gigabit networks

Computing force network

- CMCC：build a new information service system of "connection + computing force + ability"

☐ **Emerging services in Gigabit era require to improve network bandwidth, latency and stability**
☐ **VR education, as a typical service, promotes the digital development of education**

Policy of new teaching methods

- The Ministry of Education issued a notice on construction of virtual teaching and research classrooms

Home studying need lively and interesting

- Affected by COVID-19, strong demand for lively, interesting and efficient learning styles at home

Unbalance at educational resources

- Educational resources unbalance: east and west, urban and rural
- Strong demand for sharing educational resources

Introducing VR education to promote education informatization has obvious advantages
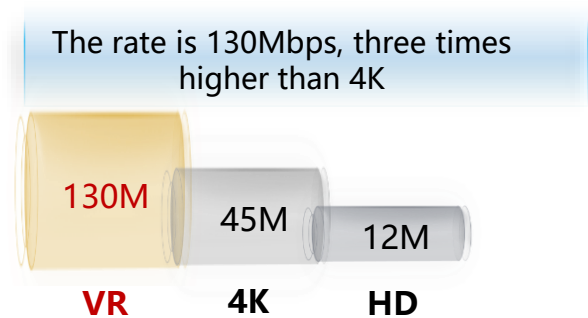
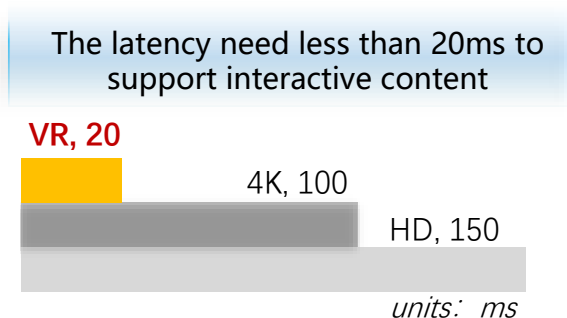resources sharing

Improve quality

Simple deployment

Save cost

Challenges for could VR application

Three technical requirements for cloud VR: ultra-large bandwidth, ultra-low latency and ultra-high reliability
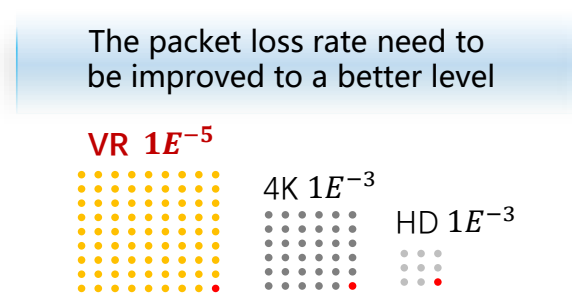
Ultra-large Bandwidth

The rate is 130Mbps, three times higher than 4K

130M
VR

45M
4K

12M
HD

Ultra-low Latency

The latency need less than 20ms to support interactive content

VR, 20

4K, 100

HD, 150

units: ms

Ultra-high Reliability

The packet loss rate need to be improved to a better level

VR $1E^{-5}$

4K $1E^{-3}$

HD $1E^{-3}$

Deploying cloud VR education need to improve the performance of traditional networking solution

The access bandwidth is ready, but the terminal need to be improved

◆ OLT has possessed the ability of gigabit access
◆ Home network is poor and bandwidth quality is unstable

VR services are cross-metropolitan and have large latency

◆ Traditional home broadband with many nodes, forwarding complex
◆ VR services across the MAN, the latency up to 100+ms in congestion
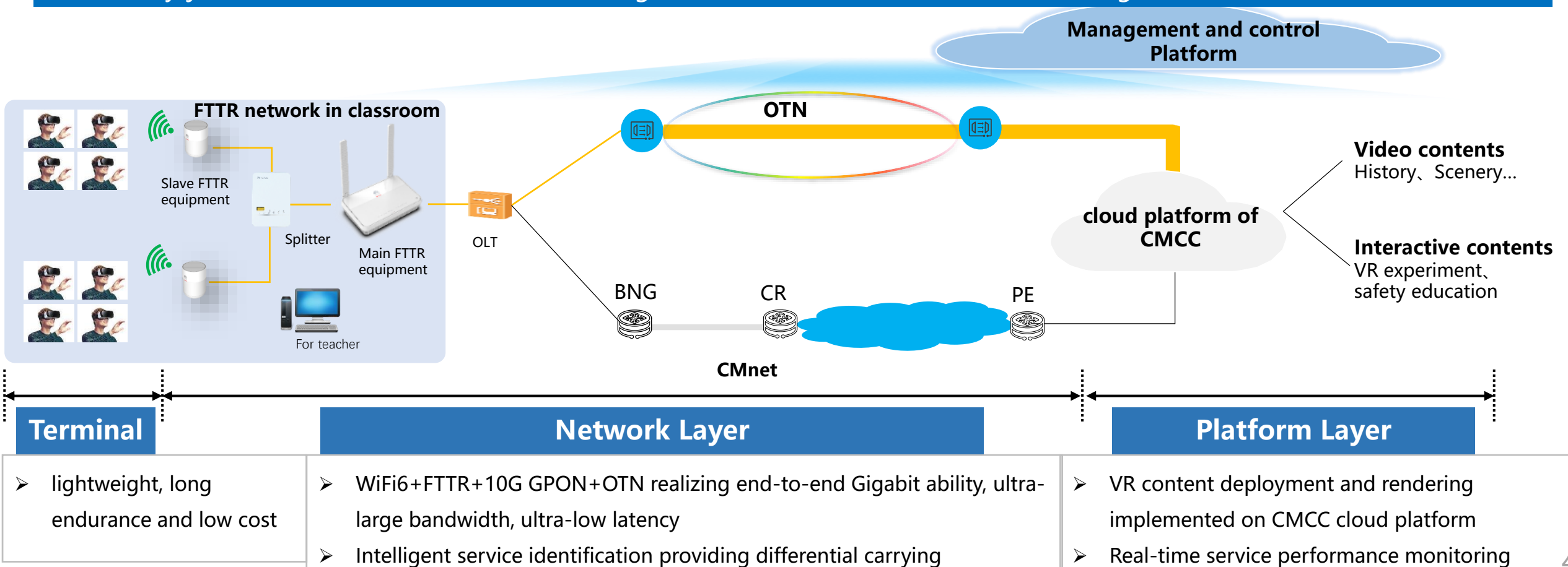
The packet loss rate is guaranteed by QoS

◆ Segmented QoS, no coordination between segments
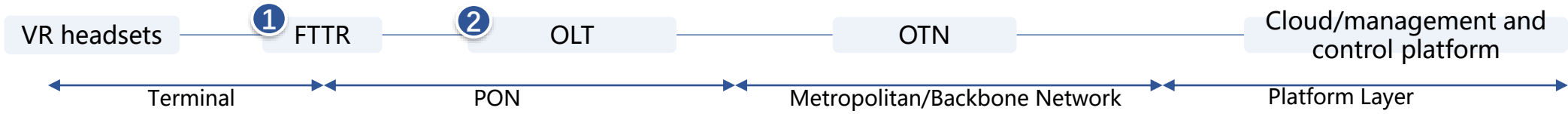◆ No quality assurance mechanism for home Wi-Fi

The network jitter need to be improved

◆ Large jitter from store and forward based on best effort
◆ Variation introduced by multipath forwarding

The technical solution of "Gigabit optical network + cloud VR education"
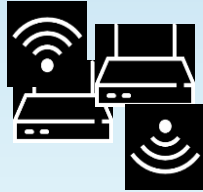
中国移动 China Mobile

The network architecture:

✓ Cloud VR contents are centrally deployed on CMCC cloud platform and accessed through Gigabit optical network. It realizes one point deployment and multi-point access, and quickly build cloud VR system ability for schools

✓ WiFi6+FTTR+10G GPON+OTN realizes end-to-end slice guarantee, providing stably large bandwidth and low latency/jitter for cloud VR services, and solving the bottleneck of traditional networking

Management and control Platform

FTTR network in classroom

Slave FTTR equipment

Splitter

Main FTTR equipment

For teacher

OLT

OTN

cloud platform of CMCC

Video contents
History、Scenery...

Interactive contents
VR experiment、safety education

BNG   CR   PE

CMnet

Terminal	Network Layer	Platform Layer
➢ lightweight, long endurance and low cost	➢ WiFi6+FTTR+10G GPON+OTN realizing end-to-end Gigabit ability, ultra-large bandwidth, ultra-low latency ➢ Intelligent service identification providing differential carrying	➢ VR content deployment and rendering implemented on CMCC cloud platform ➢ Real-time service performance monitoring

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Key Technology

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VR headsets ── ❶ FTTR ── ❷ OLT ──────── OTN ──────── Cloud/management and control platform

|← Terminal →|← PON →|← Metropolitan/Backbone Network →|← Platform Layer →|

❶ Intelligent FTTR all-optical Wi-Fi networking

- **Gigabit seamless coverage to ensure large indoor bandwidth**

  Gigabit access of VR terminals at all locations in the classroom through all-optical WiFi networking

- **All-optical Wi-Fi collaboratively optimizing to ensure low latency**

  Centralized control of multi-point WiFi collaboratively scheduling mechanism overcomes traditional WiFi competitive mechanism, the average RTT latency decreased from 30ms to <10ms (IEEE Future Network 2022 invited paper)

- **Fast roaming**

  Introducing link measurement and handover mechanism based on optical-link control channel, the average latency reduced from 100ms to less than 20ms

❷ Intelligent optical access network

- **10-gigabit optical access network to guarantee large-bandwidth access**

  GPON fully upgraded to 10G GPON, which supports three-mode combo, to guarantee two-generation PON gateway gigabit access
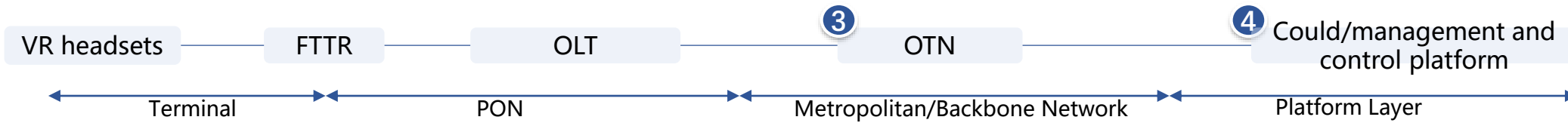
- **10G GPON line scheduling optimizing to guarantee low latency**

  Introducing protocol control and scheduling optimization mechanism, such as single frame multiple burst and dedicated activation, the average latency decreased from 600us to < 300μs
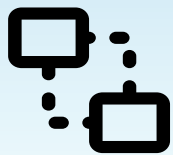
  Promoting standardization: G.9804, G.sup.PONslicing and G.sup.PONlatency

- **Intelligence**

  Introducing intelligent card to perceive network and service quality

Key Technology

VR headsets — FTTR — OLT — ③ OTN — ④ Could/management and control platform

Terminal | PON | Metropolitan/Backbone Network | Platform Layer

③ **PON+OTN collaboration**

- **PON+OTN collaboration to guarantee end-to-end low latency**

  PON recognize and perceive VR user on/off. OLT collaborates with OTN

  through interfaces. OTN network dynamically adjusts link resources according to

  demand, and end-to-end latency is less than 20ms. Presentation at OFC 2022

- **OTN technology innovation to flexibly guarantee deterministic large**

  bandwidth

  L1 multicast, link scheduling based on latency, dynamic bandwidth adjustment

④ **Digital platform of quality broadband**

- **End-to-end network and service quality visualization**

  Introducing intelligent card and telemetry technology, perceiving and

  reporting services and network quality from the minute level to the second level

- **Network intelligent optimization**

  Introducing intelligent application. Through accurately perceiving network

  and service quality, the root cause of quality difference, the recognition of

  network problems, and the real-time network optimization by employing SDN

  technology can be realized

End-to-end collaboration to construct an end-to-end Gigabit optical network with large bandwidth, low delay and highly reliable abilities

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Practical Application

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The Zhanjiang 12th Primary School has already deployed, and the 7th Primary School and 4th Middle School are under deploying. The project has won the innovation award in 2021 world VR conference, and the scheme can be promoted to the whole country

Benchmark landing
Zhanjiang 12th primary school

promotion landed in Zhanjiang No. 7 Primary School and No. 4 Middle School

Industry recognition
Innovation award at the world VR conference

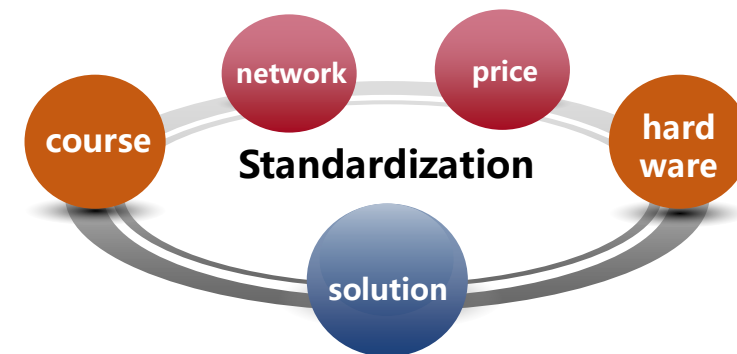"基于全光金管道承载的云VR教育系统"获世界VR大会创新奖

2021-10-21 15:01

由工信部和江西省政府共同主办的2021世界VR产业大会于2021年10月19日至20日在江西南昌举行。大会集中呈现了近一年来全球虚拟现实产业的最新发展成果，并继续组织世界VR产业大会VR/AR年度创新评选。经过层层评审，中国移动通信集团广东公司湛江分公司、湛江霞山区教育局、华为和煦象科技联合开发的"基于全光金管道承载的云VR教育系统"荣获VR/AR年度创新奖。

Won the Innovation Award

Standardization
Cloud VR K12 education information service

Five standardization supports large-scale replication and promotion
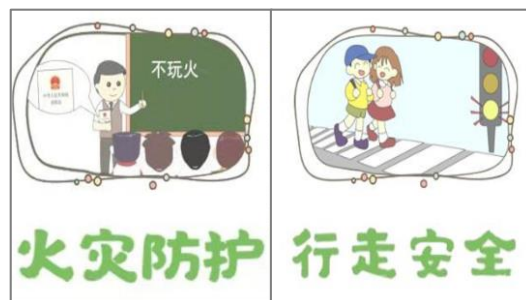
Quality education

only picture or imagination → immersive experience
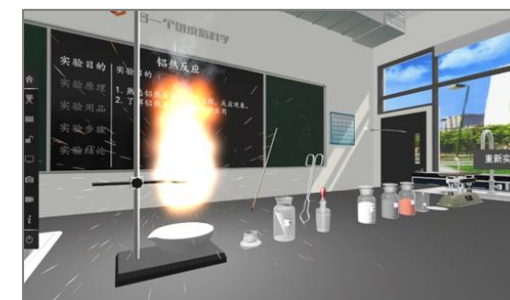
Education contents

Safety education

- venue requirement
- risk of injury
→
- indoor implement
- safe and lifelike

Physiology biochemistry experiments

- expensive equipment
- poisonous and harmful
→
- virtual experiment
- non-toxic harmless

[cut]

❑ The project will greatly drive the development of Gigabit optical network industry,

VR hardware industry and cloud VR content industry

❑ It is meaningful for realizing cross-regional sharing of education resources, which

can effectively solve the problem of unbalance. Meanwhile, this project will

promote the application of could VR in other industries, such as VR production

line and VR training

Thanks!