HFC hybrid fiber coaxial

networkEvolution to all-IP broadband

access networkMultiGBASE-T1 Over

Coax access network and technology

01

All-IP Gigabit Coaxial Broadband Access Technology

MultiGBASE-T1 Over Coax

The value of HFC coaxial network - "saving time, labor and money"

Although the rapid development of FTTH fiber-to-the-home has made fiber technology a common choice, with the integration of wired and 5G wireless mobile technologies over IP, the coaxial resources of HFC networks are becoming a unique and valuable resource for cable TV networks and a competitive advantage for curbing user churn, as the cost of building new fiber-optic networks is extremely high.

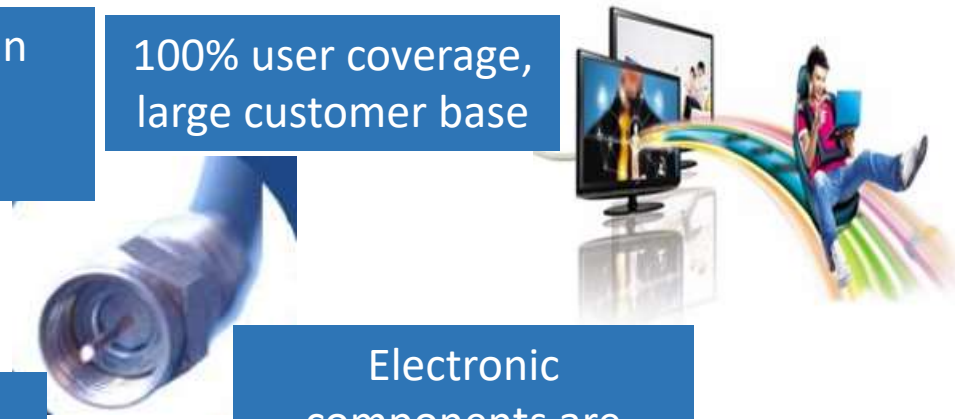
Coaxial cable is an existing resource and inherent treasure of wired network. Making full use of coaxial cable means more, faster, better and cheaper.

- **"Large stock" - The stock of coaxial network cables in the world is very huge, at least more than 100 billion, so there is no need to waste it.**
- **"Quick effect" - It can achieve immediate results and quickly curb user loss.**
- **"Good performance" - Like EPON/GPON/10G xGPON fiber optic networks, it can also achieve ultra-large bandwidth of 1-10Gbps and full IP access, supporting 4k/8K. The performance of coaxial network is extremely strong.**
- **"Save time, labor and money" - It does not require large-scale engineering construction and fiber optic cable installation, and its construction investment in engineering and equipment procurement is minimal.**

The value of coaxial networks has not yet been fully realized

Coaxial lines can support up to 10Gbps

100% user coverage, large customer base



Obvious CAPEX/OPEX advantages

Electronic components are falling in price in line with Moore's Law

Fiber-to-the-home pain points

It is difficult to get fiber into the home, and the access rate of coaxial cable is high

Through a survey of 10 companies with FTTH access rates below 30%, more than 40% of the companies have difficulty in accessing fiber to homes. 。

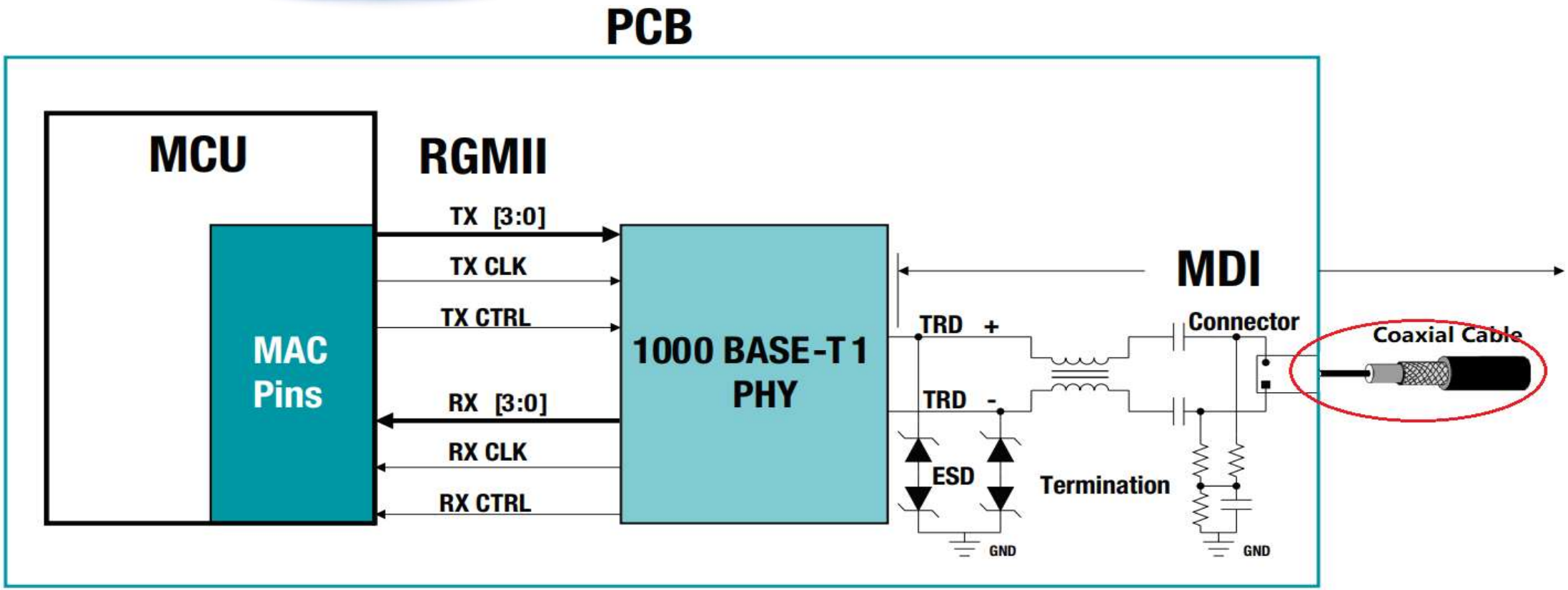
UserDoes not agree to punching

Indoor wiring affects decoration and appearance

Fiber-to-the-home construction is complex and time-consuming

Access construction High labor cost

- Adaptation technology of 1000BASE-T1 and coaxial cable - IEEE802.3bp Gigabit Coaxial Ethernet Protocol (Internet of Vehicles Specification)



Particularly suitable for HFC network architecture:Achieve 1000Mbps high-speed baseband transmission with strong anti-interference ability.Coaxial IP technology with extremely high performance-price ratio - large bandwidth and lowest cost.

Internet of Vehicles Standards and Specifications

name	standard	Release	rate	Line pair
100BASE-Tx	802.3u	1995	100Mbps	2
1000BASE-T	802.3ab	1999	1000Mbps	4
10GBASE-T	802.3an	2006	10000Mbps	4
100BASE-T1	802.3bw	2016	100Mbps	1
1000BASE-T1	**802.3bp**	**2016**	**1000Mbps**	**1**
2.5GBASE-T1	802.3ch	2020	2500Mbps	1
10GBASE-T1	802.3ch	2020	10000Mbps	1

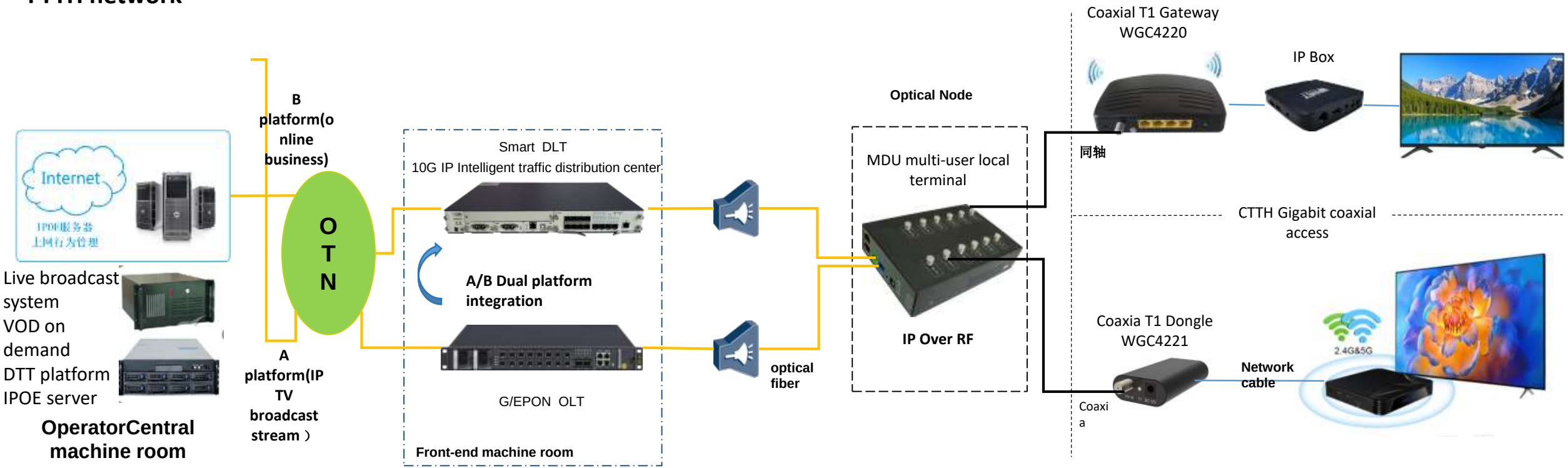
02

HFC Fiber-Coaxial All-IP Broadband Access Network Architecture

MultiGBASE-T1 Over Coax

All-IP fiber-coaxial hybrid broadband access network architecture - Evolving the A/B dual platform to an all-IP A platform

The essence of the all-IP HFC network built based on MultiGBASE-T1 Over Coax technology is IP Over RF, which evolves the traditional A/B dual platform of cable TV to the RF radio frequency A platform:On the A platform, TV IP broadcasting is realized, DVB-C digital TV evolves to IP TV broadcasting, and all the characteristics and advantages of broadcasting and television are retained - All Digital TV To All IP TVIP TV broadcasting (IPVB, IP Video Broadcast) is compatible with DVB-C broadcasting or IPTV live broadcasting transmitted by SPTS or MPTS.On the A platform, IP two-way high-speed data access services are realized at the same time, supporting Internet and OTT Internet TV services.Each household has exclusive two-way gigabit, and the average household bandwidth is better than the general GPON and xGPON FTTH network



10G IPVB（IP Video Broadcast）Technology - Implementation of IP Live TV (UDP stream) broadcasting

Its IP broadcast is compatible with DVB-C broadcast or IPTV live broadcast transmitted by SPTS or MPTS

TV Channel Name	Multicast address + port number	TS ID	Service ID
SKY	udp://232.0.0.1:10001	1	2011
CNN TURK	udp://232.0.0.1:10002	2	2001
FOX 5	udp://232.0.0.1:10003	3	1504
BBC TWO	udp://232.0.0.1:10004	4	1601
TV Magazine	udp://232.0.0.1:10005	5	1602
BS11	udp://232.0.0.1:10006	6	1505
FOX 11	udp://232.0.0.1:10007	7	1603
HYUNDAI	udp://232.0.0.1:10008	8	1604
CW	udp://232.0.0.1:10009	9	1605
TV5	udp://232.0.0.1:10010	10	603
club	udp://232.0.0.1:10011	11	1001
DSTV	udp://232.0.0.1:10012	12	1004

- **Avoids the limitation of RF transmission technology of 38Mbps/each 8MHz@64QAM.Supports large data transmission of 4K (40Mbps), 8K (80~160Mbps) and VR (160~300Mbps).**
- **Sufficient bandwidth supports simultaneous broadcast of SDTV, HDTV and 4k/8K multiple streams - up to 10Gbps** 。

All-IP networks should not only support IP unicast and IP multicast services, but also IP broadcast services——TV is everywhere

TVe TV everywhere

- The 10Gbps downstream IP service flow is aggregated, processed and mapped into IP packets, and the multicast channel of each service flow is marked by a unique UDP port number and IP address set.
- The fused IP data packets will be delivered to the terminal equipment at the user end through the ODN optical fiber distribution network via 10G Ethernet technology.

IPVBSOAN

Application Layer	DVB-TV, OTT-TV, VOD, SI files	SI Tables
Transport Layer	UDP	
Network layer	IP	
Data link layer	MAC IEEE802.3ae	
Physical layer	Optical Channel (1550nm)	

A/BIntegration of two platforms: Implementation of VOD video on demand and OTT Internet video service (TCP)

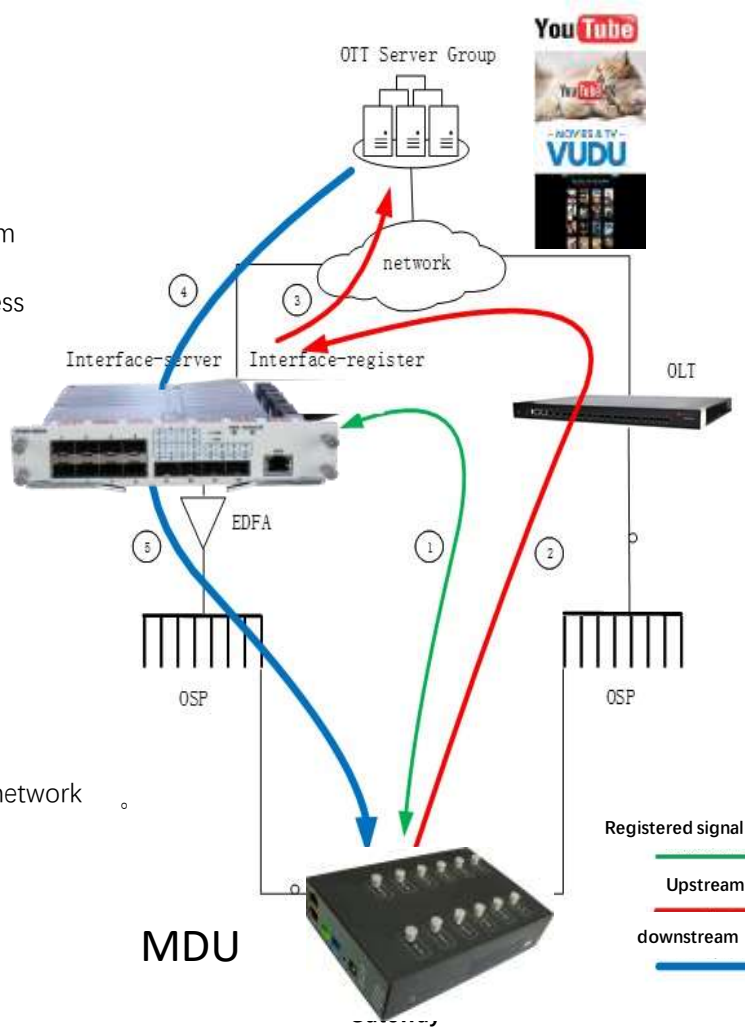
Support 12.5/1.25Gbps bidirectional broadband access services

Supports IP TCP services

- ✓ Supports OTT TV
- ✓ Compatible with existing OTT Internet video platform
- ✓ Provides 12.5/1.25Gbps asymmetric broadband access

Key technology of two - channel integration → **Smart DLT**

IP Distribution Line Terminal



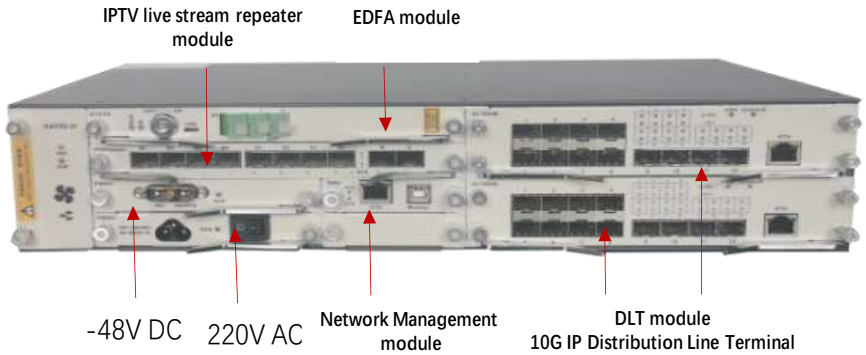
Support IPTV VoD service based on RTSP protocol

- ✓ Compatible with existing IPTV VoD system
- ✓ The ODN Optical fiber distribution network of the network does not need to be rebuilt

Compatible with existing OTT TV service platforms and supports Internet access

Supports interactive video services such as OTT TV, IPTV and VOD

10G All-IP service convergence platform **I-CAP2000**

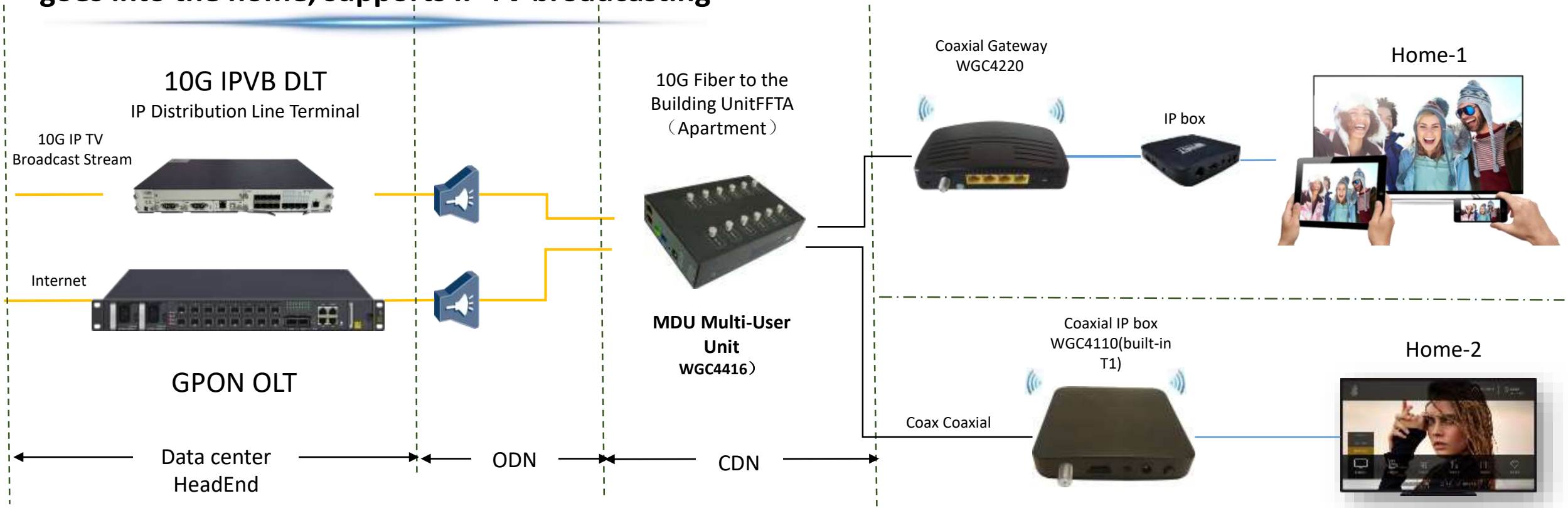


Key equipment for achieving A/B dual-platform integration - IP intelligent distribution central office DLT and MDU, IP Over RF 。

03 Five application scenarios in cable TV networks

MultiGBASE-T1 Over Coax

Application of full IP HFC network 1 - FTTA 10G fiber goes deep into the building unit, Gigabit coaxial goes into the home, supports IP TV broadcasting



- Each household has exclusive two-way Gigabit, and the average household bandwidth is better than the general GPON and xGPON FTTH network.Integrating IPVB broadcasting technology, supporting IP TV live broadcast services (4k/8K), seamlessly connecting to the DVB-C digital TV service platform, and smoothly realizing the evolution and upgrade from All Digital TV to All IP.

This is the broadband access mode with the lowest overall cost. It can almost eliminate the need for an access device. One machine can provide full services such as TV (set-top box STB) and broadband access (WiFi), which can greatly improve the competitiveness of cable TV networks and curb user churn.

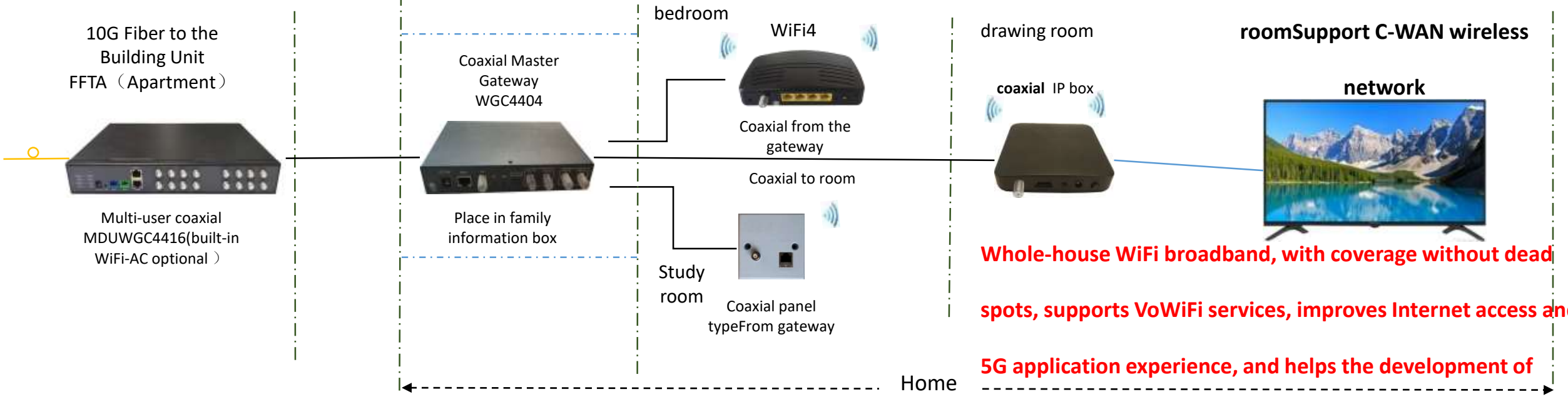
Building a C-WAN coaxial wireless access network based on CTTR (coaxial to room)

Building a C-WAN (Centralized Wireless-Coax Access Network) CTTR centralized wireless coaxial access network - Benchmarking the telecom FTTR all-optical network

With the 4-way GCAN Gigabit coaxial main bridge WGC4304 as the control center, it realizes orderly transmission and reception of intra-domain Wi-Fi networking, supports cross-domain seamless roaming for CTTR dense deployment scenarios, and combines advanced dual-band Wi-Fi technology to ensure all-round WiFi coverage and seamless switching of home networks, bringing users unprecedented network experience 。

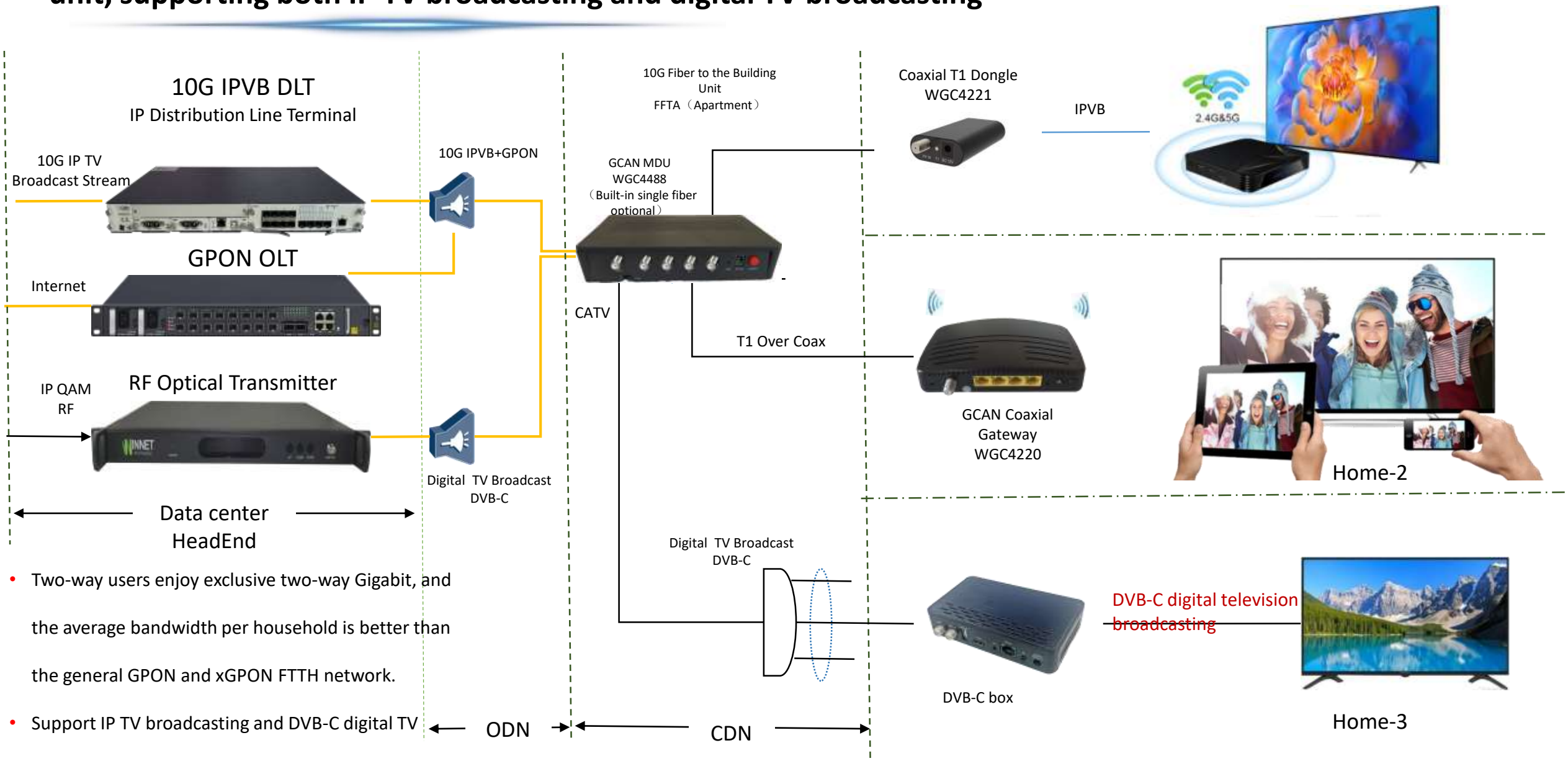
- ✓ There are more and more CPE devices in the home, especially wireless STA devices. It is necessary to avoid conflicts in data packets transmitted in the air when they are used at the same time, which will cause network congestion.
- ✓ For users who need to work remotely at home or conduct video conferences, sufficient bandwidth and stability must be provided to ensure the continuity and efficiency of work.
- ✓ For smart home devices (light bulbs, sockets, security cameras) that need to be online 24 hours a day, the network stability must be higher and powerful edge computing must be used to ensure the normal operation of the smart home system.

CTTR coaxial Gigabit to roomSupport C-WAN wireless network



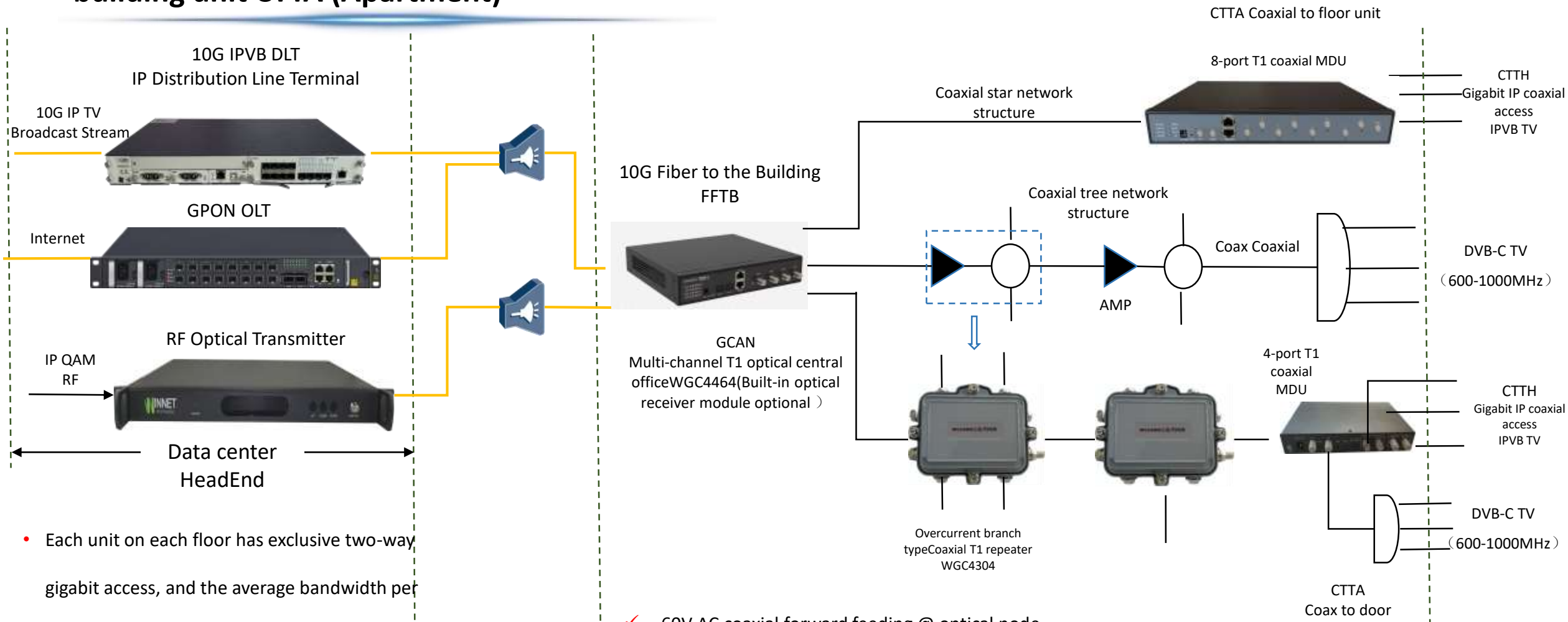
Whole-house WiFi broadband, with coverage without dead spots, supports VoWiFi services, improves Internet access and 5G application experience, and helps the development of radio and television 5G services.

Coaxial full IP and DVB-C digital TV hybrid application mode 2 - FTTA optical fiber goes deep into the building unit, supporting both IP TV broadcasting and digital TV broadcasting



- Two-way users enjoy exclusive two-way Gigabit, and the average bandwidth per household is better than the general GPON and xGPON FTTH network.
- Support IP TV broadcasting and DVB-C digital TV broadcasting
- Support CTTR Gigabit coaxial to room, whole house

Fiber to the optical node FTTN, Gigabit coaxial home application 3 - multi-level star or tree coaxial to building unit CTTA (Apartment)

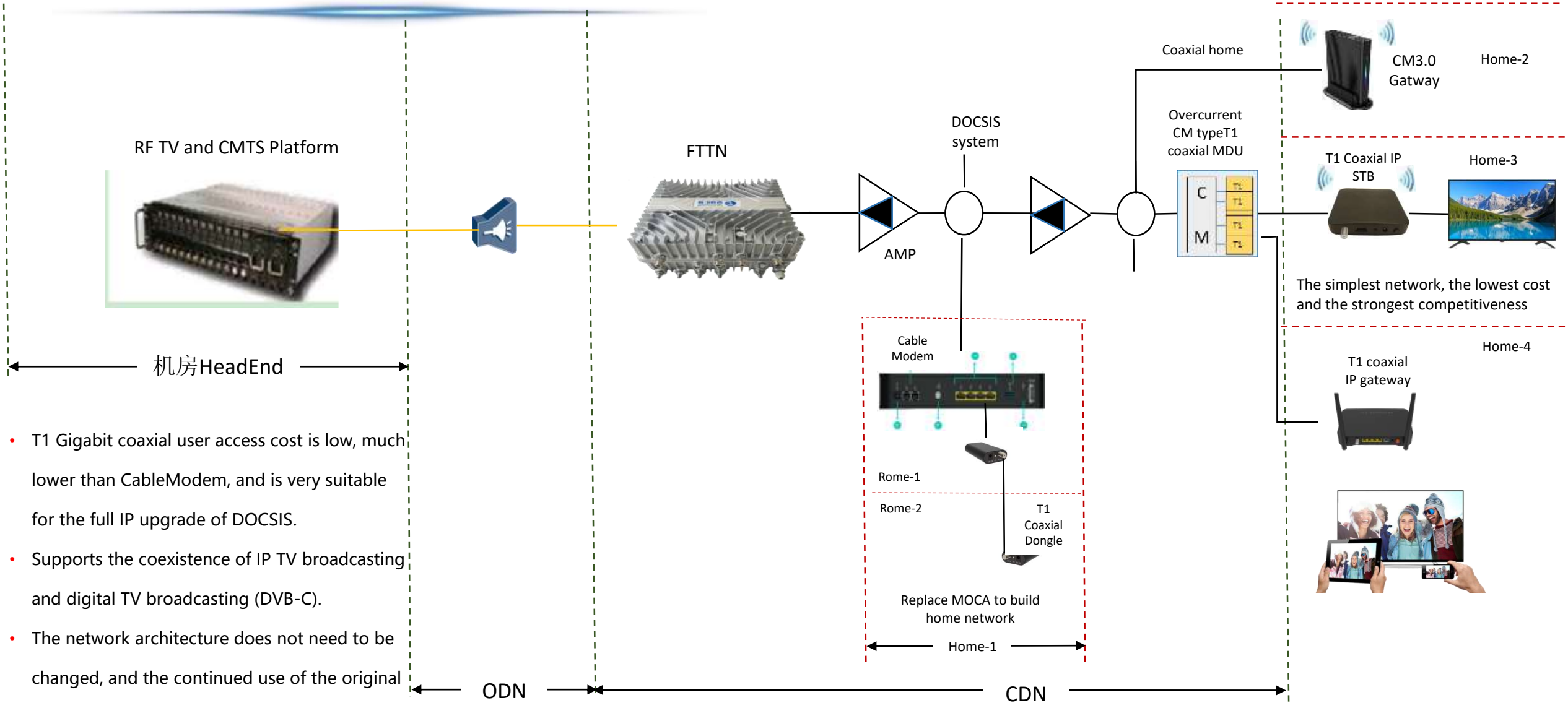


- Each unit on each floor has exclusive two-way gigabit access, and the average bandwidth per household is better than the general GPON fiber-to-the-home network FTTH.Supports IP TV broadcasting and digital TV broadcasting (600-1000MHz, DVB-C)

✓ 60V AC coaxial forward feeding @ optical node

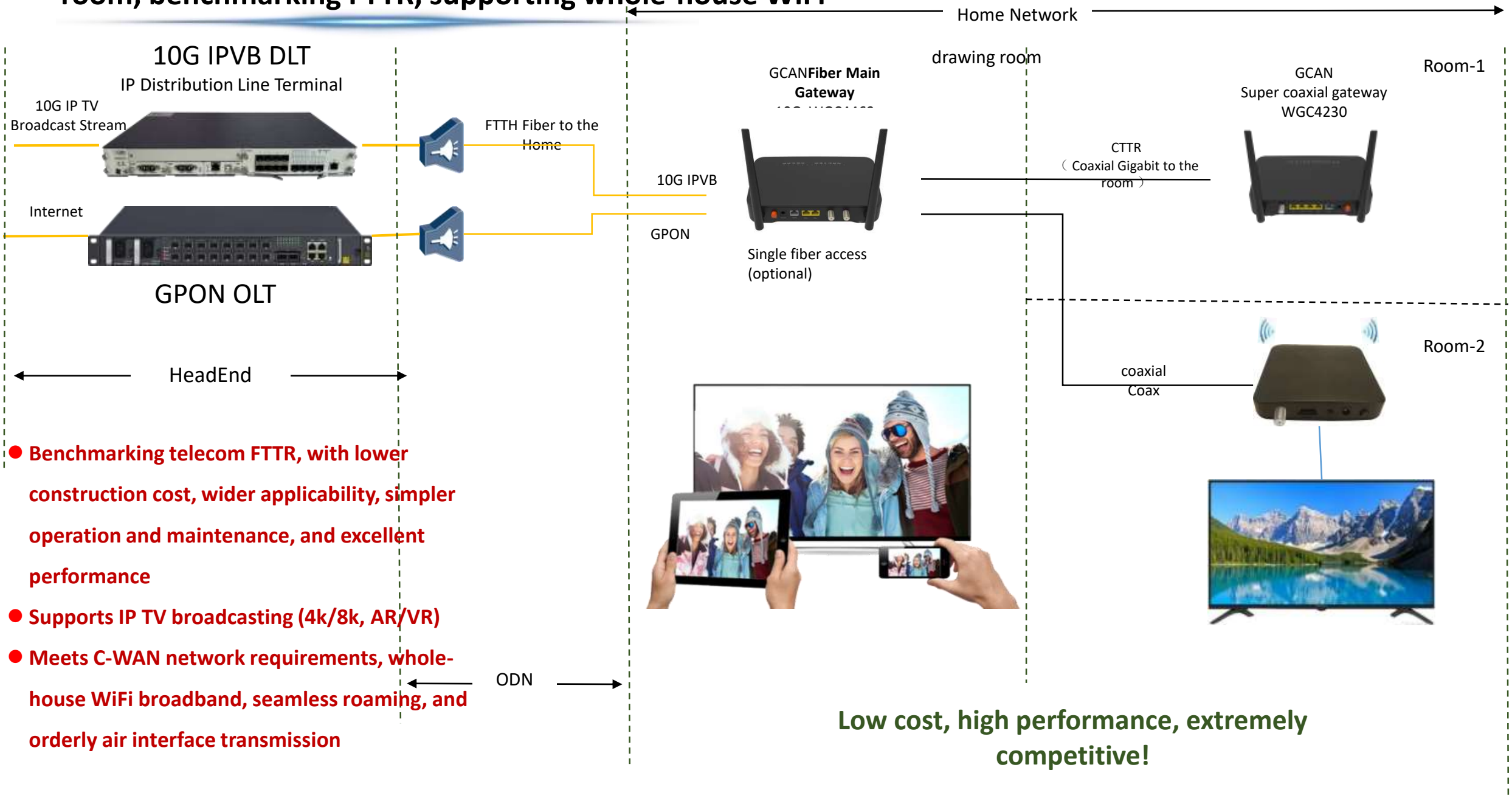
✓ 60V AC coaxial reverse feeding @ power supply point

MultiGBASE-T1 Over Coax Application of Gigabit Ethernet over Coaxial Network in DOCSIS Network 4 - Low-cost and comprehensive IP-based DOCSIS network



- T1 Gigabit coaxial user access cost is low, much lower than CableModem, and is very suitable for the full IP upgrade of DOCSIS.
- Supports the coexistence of IP TV broadcasting and digital TV broadcasting (DVB-C).
- The network architecture does not need to be changed, and the continued use of the original CM equipment is not affected.

Application mode 5 in FTTH+CTTR network - FTTH 10G fiber to the home, CTTR Gigabit coaxial to the room, benchmarking FTTR, supporting whole-house WiFi



- **Benchmarking telecom FTTR, with lower construction cost, wider applicability, simpler operation and maintenance, and excellent performance**
- **Supports IP TV broadcasting (4k/8k, AR/VR)**
- **Meets C-WAN network requirements, whole-house WiFi broadband, seamless roaming, and orderly air interface transmission**

Low cost, high performance, extremely competitive!

GCAN万兆光单元系列产品WGC446x

Supports CTTR Gigabit coaxial to room, whole-house WiFi broadband, meets C-WAN requirements, seamless roaming, and orderly air interface transmission.

⑦ 10GFTTH GCAN 10G optical gateway - WGC4462

WiFi6 Broadband access

TV IP Broadcast

10G IPVB+GPON

Gigabit Ethernet cable

Room-1

CTTR Gigabit coax to room

Room-3

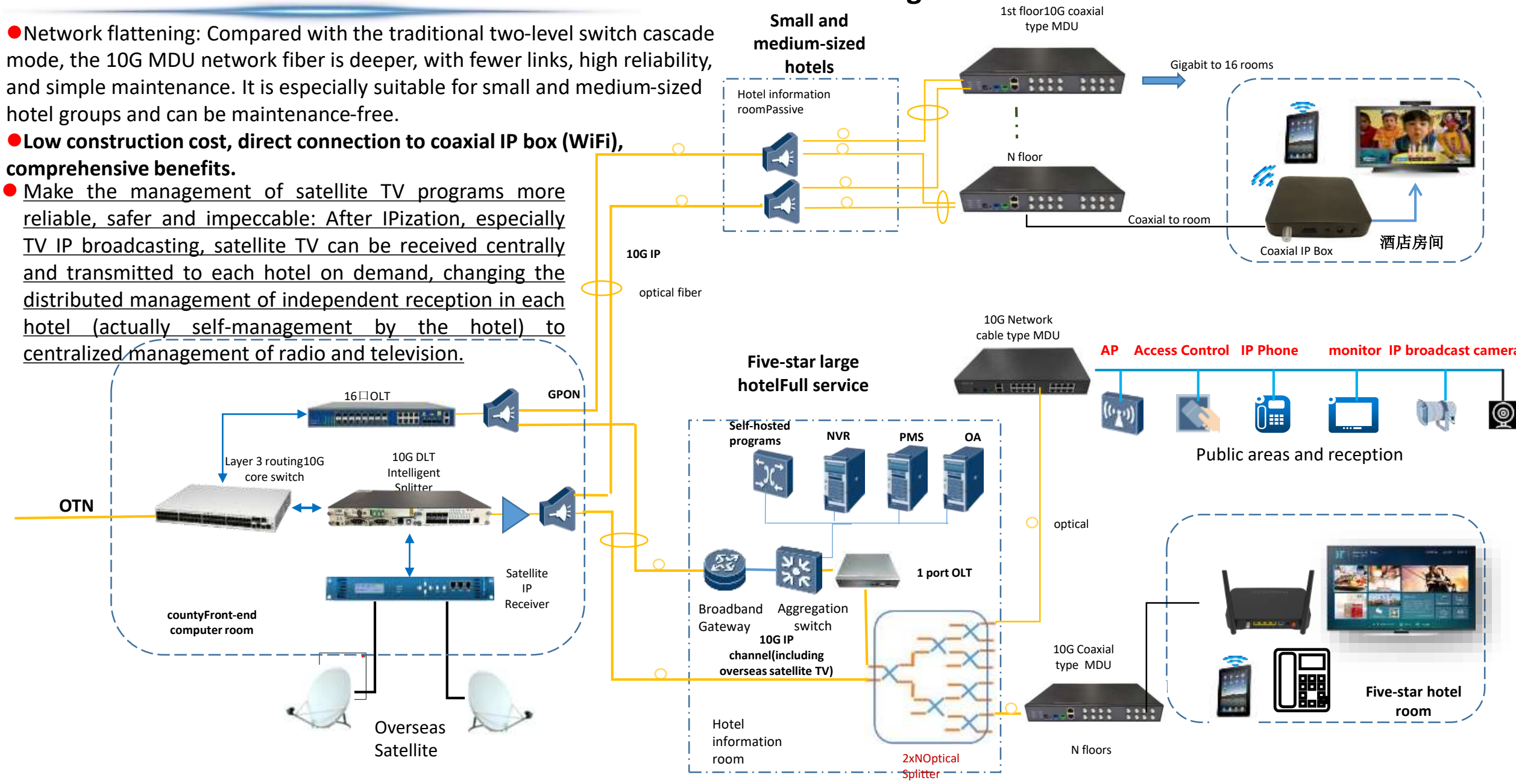
Room-2

- 2-way or 1-way fiber uplink: 10G IPVB and GPON2-way Gigabit coaxial downlink to the room, 2-way RJ45 GE network port and 2-way GE coaxialSupport IP TV broadcasting, 4K/8K ultra-high-definition TVWiFi6, AX3000, support C-WAN (centralized wireless all-optical access network)Application: FTTH+CTTR fiber to the home and Gigabit coaxial to the room

04 MultiGBASE-T1 Over Coax Application in hotels, schools, hospitals and enterprise networks

Application mode in the hotel - 10G fiber to the floor, 1G coaxial to the room, one line and one network, centralized control of overseas satellite TV directional broadcasting

- Network flattening: Compared with the traditional two-level switch cascade mode, the 10G MDU network fiber is deeper, with fewer links, high reliability, and simple maintenance. It is especially suitable for small and medium-sized hotel groups and can be maintenance-free.
- **Low construction cost, direct connection to coaxial IP box (WiFi), comprehensive benefits.**
- Make the management of satellite TV programs more reliable, safer and impeccable: After IPization, especially TV IP broadcasting, satellite TV can be received centrally and transmitted to each hotel on demand, changing the distributed management of independent reception in each hotel (actually self-management by the hotel) to centralized management of radio and television.



Application in enterprise networks and residential home networks

Applicable scenariosWidely used in long-distance network transmission, elevator monitoring, security monitoring, video conferencing,traffic monitoring systems, etc.

- **Compared with network cables, coaxial connections：**

Small loss, longer transmission distance;

Good shielding, stronger anti-interference ability, more adaptable to complex industrial environments;

Wide bandwidth, more stable transmission performance;

More convenient and easier on-site construction;

High reliability, good stability;Simple maintenance, lower cost;

High cost performance, the price of coaxial cable is relatively affordable, and the performance is stable 。

05

Summary and Outlook

MultiGBASE-T1 Over Coax

MultiGBASE-T1 Over Coax Application Prospects and Significance of Gigabit Coaxial All-IP Access Network

This is an innovative broadcasting and television gene technology that integrates IEEE 802.3bp high-speed Ethernet protocol technology with 10G IPVB video IP broadcast technology, and is a qualitative improvement to coaxial networks!

- Supports IP broadcasting of TV programs, with high enough QoS transmission quality and QoE user experience for radio and television broadcasting, and supports 8K ultra-high-definition TV 。
- **Supports CTTR and FTTH+CTTR. Benchmarking FTTR, it can immediately achieve full IP upgrade of cable TV network, effectively suppress user loss, and expand more IP users.** 。
- Users enjoy exclusive two-way gigabit access, with an average household bandwidth that is better than general GPON and 10G xGPON FTTH networks, meeting C-WAN requirements, supporting digital home upgrades towards immersive experience, and driving home networks to gradually upgrade from L1 to L2 experience - the shift from L1 to L2 can unleash the potential for digital home service innovation.

L0 experience mainly includes voice, Internet access, and standard definition video;L1 experience includes 4K/AR/VR, real-time games, and online education;L2 experience includes cloud games, 8K video, interactive AR/VR, etc. 。

Future

Rapid deployment capability

By replacing the ONU fusion device, you can quickly deploy and implement high-bandwidth IP service access, achieve high-bandwidth service installation and operation, and improve two-way operation efficiency and user satisfaction. 。

Constructio n cost ≈ 0

Compared with the FTTH fiber-to-the-home solution, the construction cost of the 1000BASE-T1 technical solution based on the broadcasting and television coaxial scenario is basically zero. Based on the calculation of 3 million households in two-way operation across the entire network, the construction cost is saved by approximately RMB 450 million.

Low equipment cost

The 1000BASE-T1 technical solution based on the broadcasting and television coaxial scenario fully leverages the huge industrial market of in-vehicle Ethernet, unites broadcasting and television network operators, chip manufacturers, and equipment manufacturers to establish a rich end-to-end industrial chain, expand marginal utility, and further reduce equipment costs.

1000BASE-T1 technical solution based on coaxial broadcasting scenarios

THANKS