Access Network Overview

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Objectives

- Upon completion of this course, you will be able to understand:
  - Development of broadband access technology
  - Common technologies of the access network
  - Common networking structure of the access network

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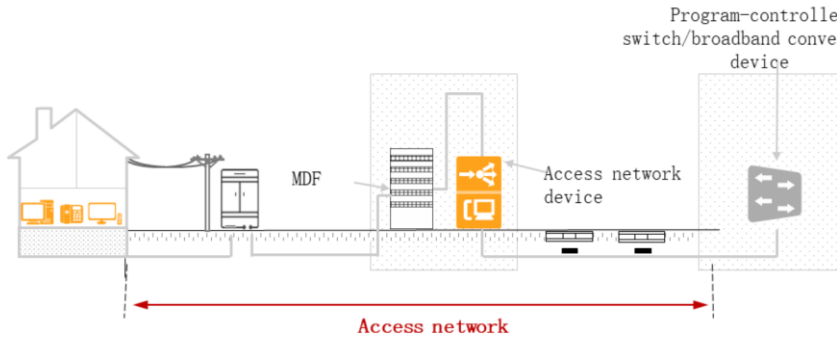
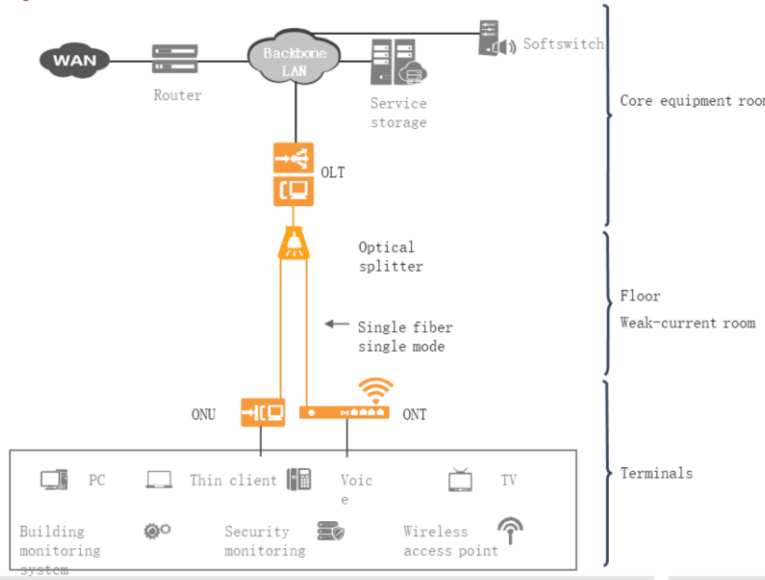
Basic Concepts of the Access Network



- An access network consists of a series of transport entities (such as line facilities and transmission facilities) between the service node interface (SNI) and the related user network interface (UNI). The access network is an implementation system that provides the bearer capability for telecom services.

- The preceding is the definition of the access network defined by the ITU-T.
- The Access Network (AN) consists of all devices and lines between a local switch and user terminals. It directly provides services for users and various application systems through different transmission media. It is the largest part of the telecom network and generally accounts for 1/2 of the network investment.
- Access networks are classified into narrowband and broadband access networks based on the bandwidth. Narrowband and broadband are classified based on the amount of data to be transmitted. Generally, a bandwidth greater than 2 Mbps is a broadband service. Narrowband services include voice and fax services. Broadband services include Internet access, video, game, and HDTV services.
- AN: access network
- SNI: service node interface
- UNI: user network interface

Position of the Access Network in an Enterprise Network



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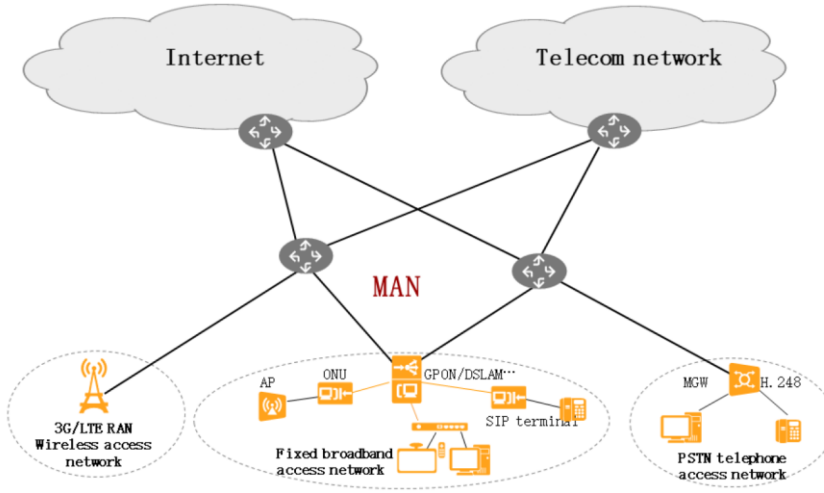
Position of the Access Network in a Carrier Network



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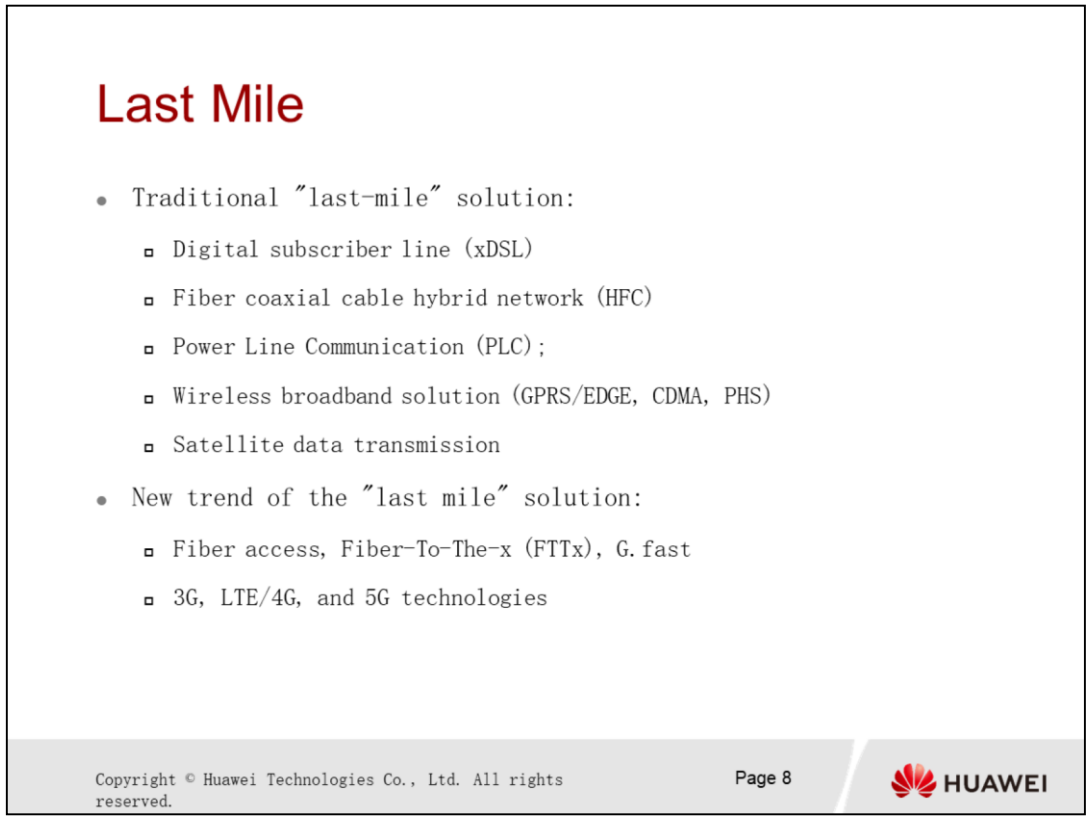

- The last mile refers to the last mile of a long journey in life. The communication industry often uses "last mile" to refer to the connection between the equipment room switch of a communication service provider and terminal devices such as user computers.

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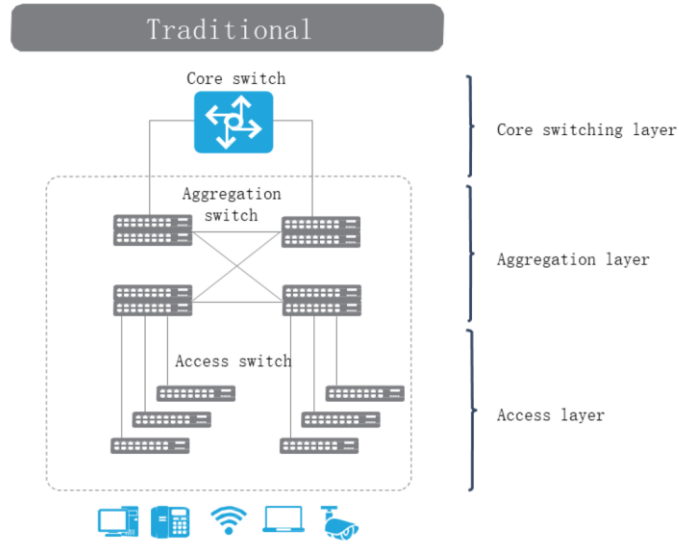
Traditional Enterprise LAN Deployment Solution



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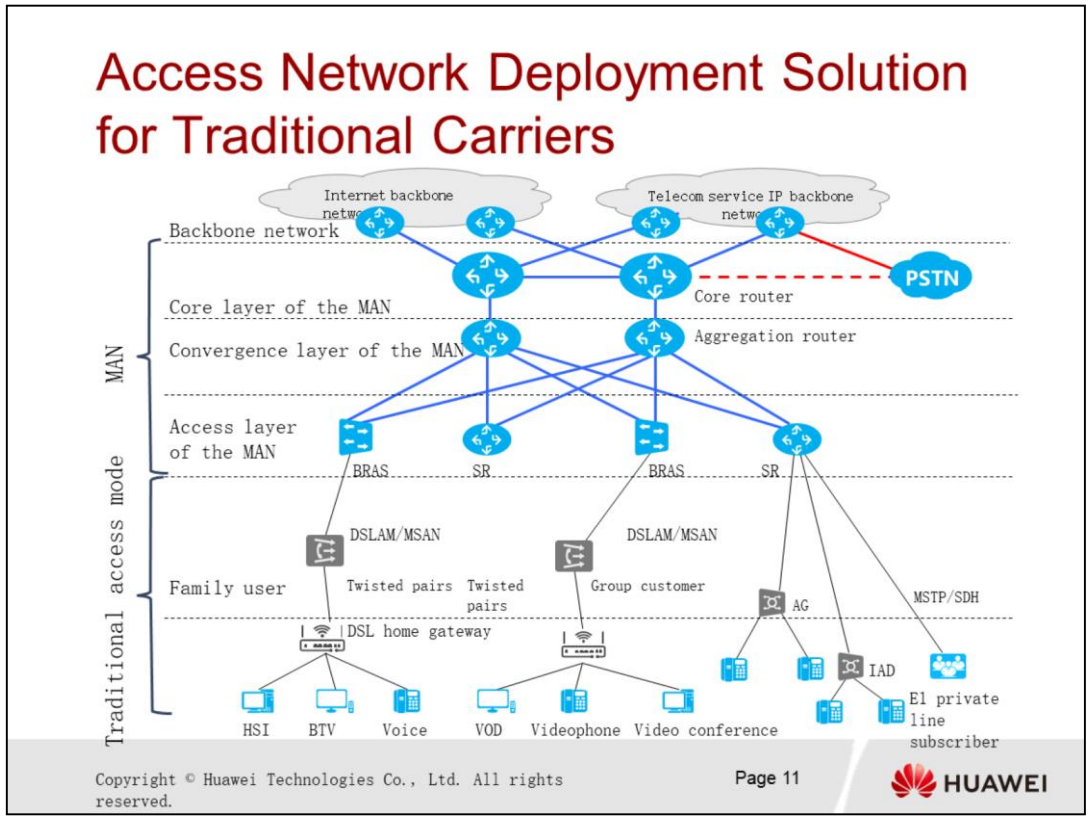
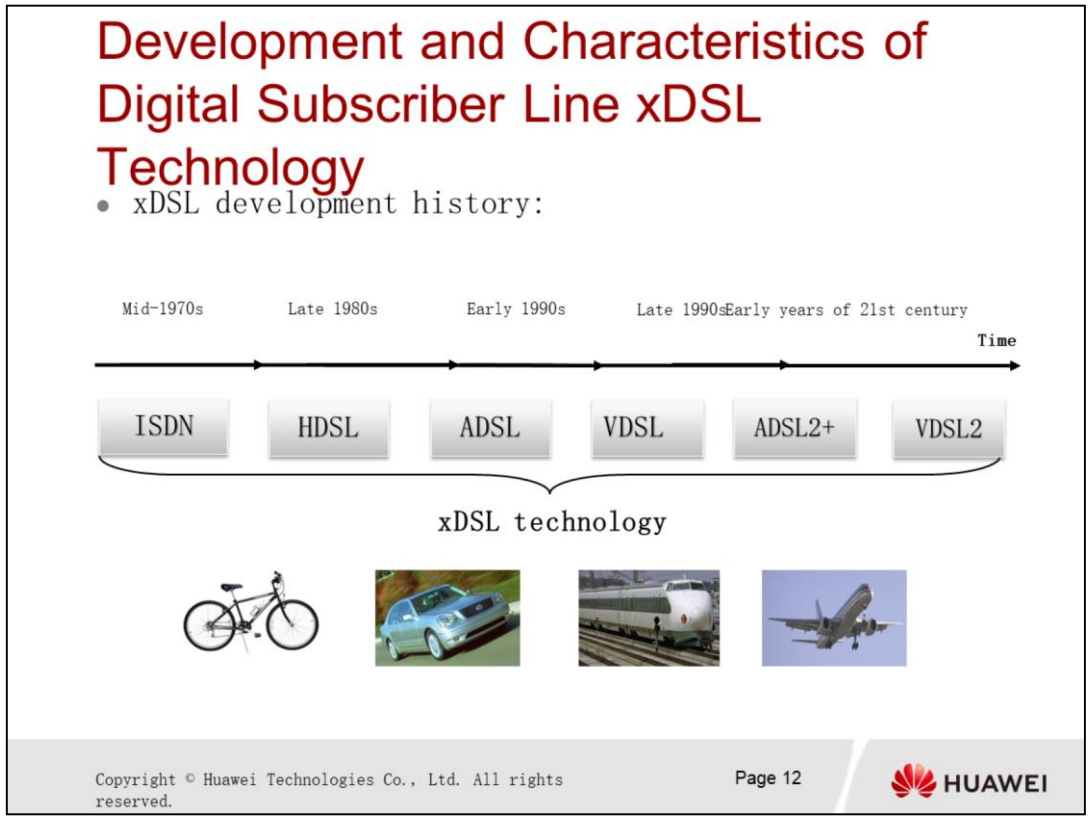


- In a MAN, a large number of scattered users use voice services through PCs, IADs, or E-phones. How to connect these services to the bearer network?
- L2 access:
  - Individual broadband users can access the BRAS through the ATM DSLAM, IP DSLAM, and LAN.
  - Enterprise and commercial users can access the network through ADSL, Ethernet switches, MSTP, or bare fibers.
- L3 convergence:
  - On the MAN access layer, the BRAS is used to authenticate users and send user data to the aggregation router of the Internet or the backbone network of telecom services based on user characteristics, such as the domain and destination IP address.



- DSL is short for digital subscriber line.
- DSL is a technology developed by the telecom industry to utilize the copper lines of millions of kilometers around the world. Therefore, DSL is also called the copper line access technology.
- Let's review the origin and development history of the xDSL technology.
- The copper line access technology can be traced back to the mid-1970s.
- To cater for the access of multiple services, the ITU-T proposes the idea of using the digital subscriber line of the integrated service digital network, that is, the ISDN technology. ISDN is recognized as the first generation DSL technology.
- ISDN has two interface rates: BRI and PRI. The transmission rate of BRI can reach the 144 Kbps, and that of the PRI can reach 2.048 Mbps or 1.544 Mbps.
- By the late 1980s, with the development of digital signal processing technologies, the HDSL technology, that is, the high bit rate digital subscriber line technology, is introduced. The HDSL technology can provide the transmission rate of 2.048 Mbps or 1.544 Mbps.
- In the early 1990s, engineers from Bell realized that it is possible to provide asymmetric services, that is, the rate in one direction could be much higher than that in the other direction.
- This asymmetry is suitable for the video-on-demand test proposed at the time. So the ADSL technology, namely asymmetric digital subscriber line technology, is developed.
- With the development of the digital subscriber line technology, a technology with a higher rate than the ADSL is considered.
- In the late 1990s, the VDSL technology came into being, that is, the very

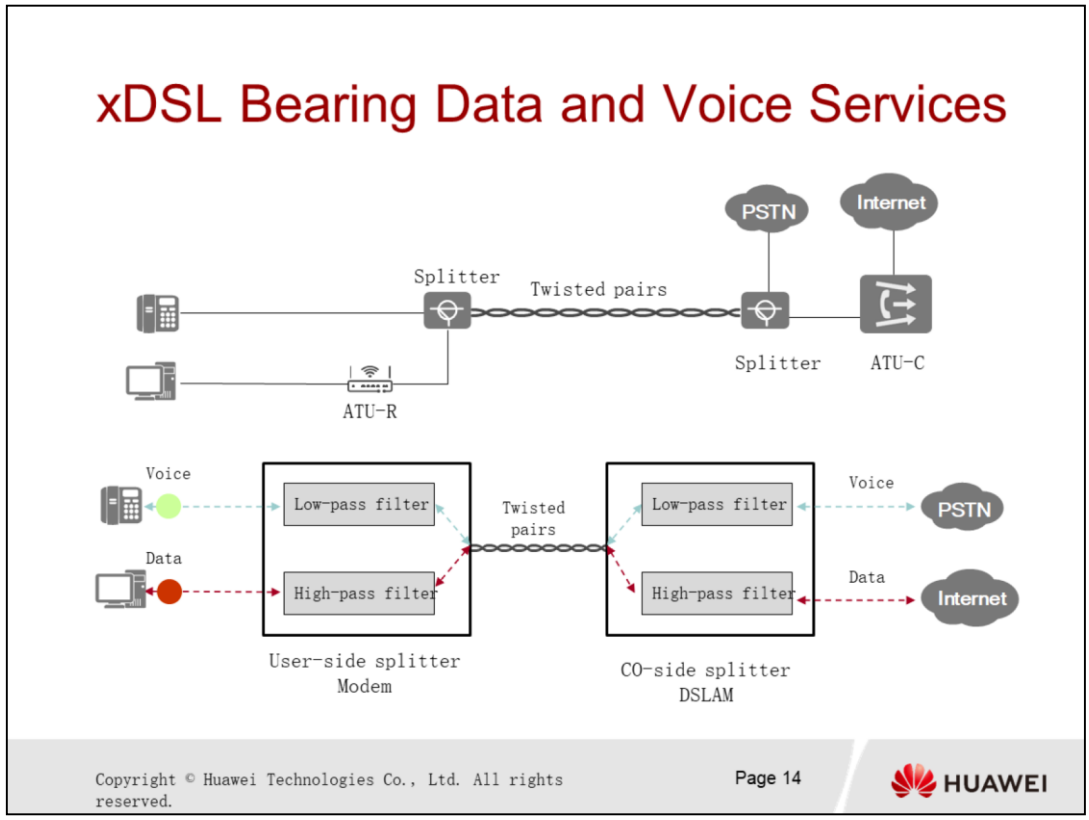
high speed digital subscriber line technology.

- So far, some other DSL technologies are also developed and called xDSL technologies.

DSL Performance Summary

xDSL technology	Symmetry	Transmission rate	Maximum transmission Distance (km)	Wire pair	POTS
ADSL	Asymmetric	Maximum downstream rate: 8 Mbps Maximum upstream rate: 640 Kbps	5	1	Supported
ADSL2+	Asymmetric	Maximum downstream rate: 24 Mbps Maximum upstream rate: 1.5 Mbps	5	1	Supported
VDSL	Symmetric / Asymmetric	Maximum downstream rate: 52 Mbps, Maximum upstream rate: 26 Mbps	1.5	1	Supported
VDSL2	Symmetric/ Asymmetric	Maximum upstream and downstream rates: 100 Mbit/s	1	1	Supported
Vectoring	Symmetric/ Asymmetric	Maximum upstream and downstream rates: 100 Mbit/s	1	1	Supported
G.fast	Symmetric/ Asymmetric	Maximum rate: 1 Gbit/s	0.25	1	Supported

- ADSL provides asymmetric transmission rates. Downlink rate, that is, from the central office to the user side, can reach 8 Mbps. The upstream rate, that is, from the user side to the central office, ranges from 16 Kbps to 640 Kbps. The maximum transmission distance is 5 km. The ADSL is specially designed to run at a frequency higher than the voice frequency band, and can run on the same line as the ordinary telephone service at the same time.
- VDSL supports both symmetric and asymmetric transmission. The maximum upstream rate is 26 Mbps, and the maximum downstream rate is 52 Mbps. The maximum transmission distance can reach 1.5 km. The VDSL service can be transmitted on the same line as the ordinary telephone service and ISDN service.
- The G.993.2 (VDSL2) transmission standard is based on the Discrete Multi-tone Modulation (DMT) technology. In this standard, the ADSL2+ technology is used to provide long-distance transmission, and the high data transmission rate of VDSL is enhanced from 70/30 Mbps to symmetric 100 Mbps. To achieve such a high transmission rate in a range of 350 meters, the spectrum of VDSL2 has increased from 12 MHz to 30 MHz. In addition, the transmission power has increased to 20 dBm to meet the requirements for medium- and high-ring transmission.



- The xDSL technology can transmit data signals and traditional analog voice signals (except SHDSL) on the same twisted pair.
- This slide uses ADSL as an example.

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Advantages of PON

- Passive Optical Network (PON)
  - Four advantages:

High bandwidth and excellent scalability: The optical fiber access bandwidth is large enough to meet users' current and future bandwidth requirements. The upstream and downstream rates can reach 1.244 Gbps and 1.244 Gbps/2.488 Gbps respectively.

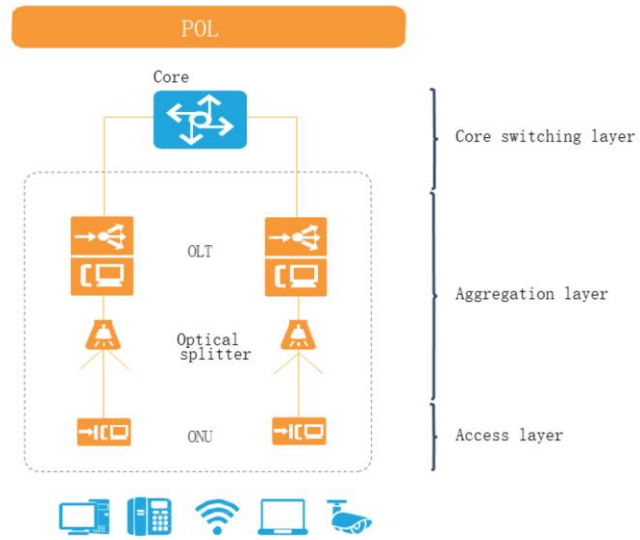
Point-to-multipoint (P2MP) access, saving backbone optical fibers: Optical fibers are split at the CO side into multiple optical fibers to households to save optical fiber resources.

Passive optical network (PON), low OPEX: There is no active component on the line, free of maintenance and power consumption.

Low fiber loss and wide coverage: Meets the network construction requirements of large capacity and few offices. Using optical fibers for transmission, the coverage radius of the PON access layer can reach dozens of kilometers.

- OPEX:Operating Expense

PON - POL in the Enterprise Scenario



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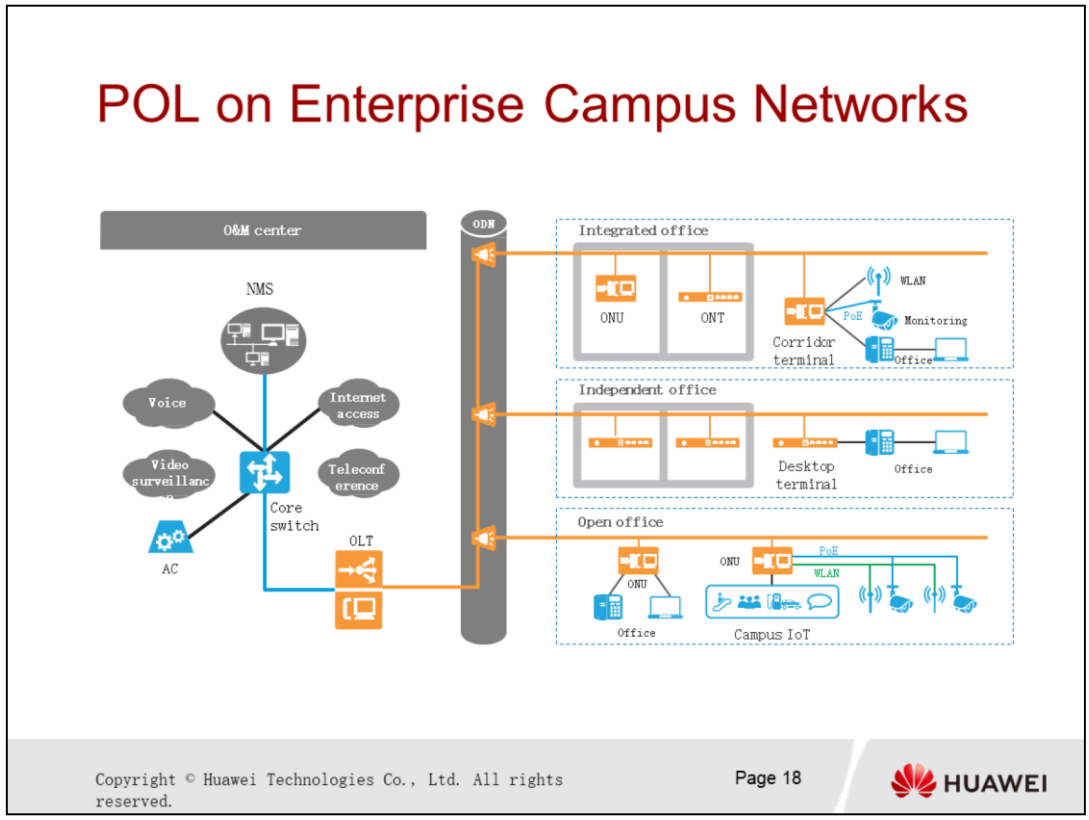
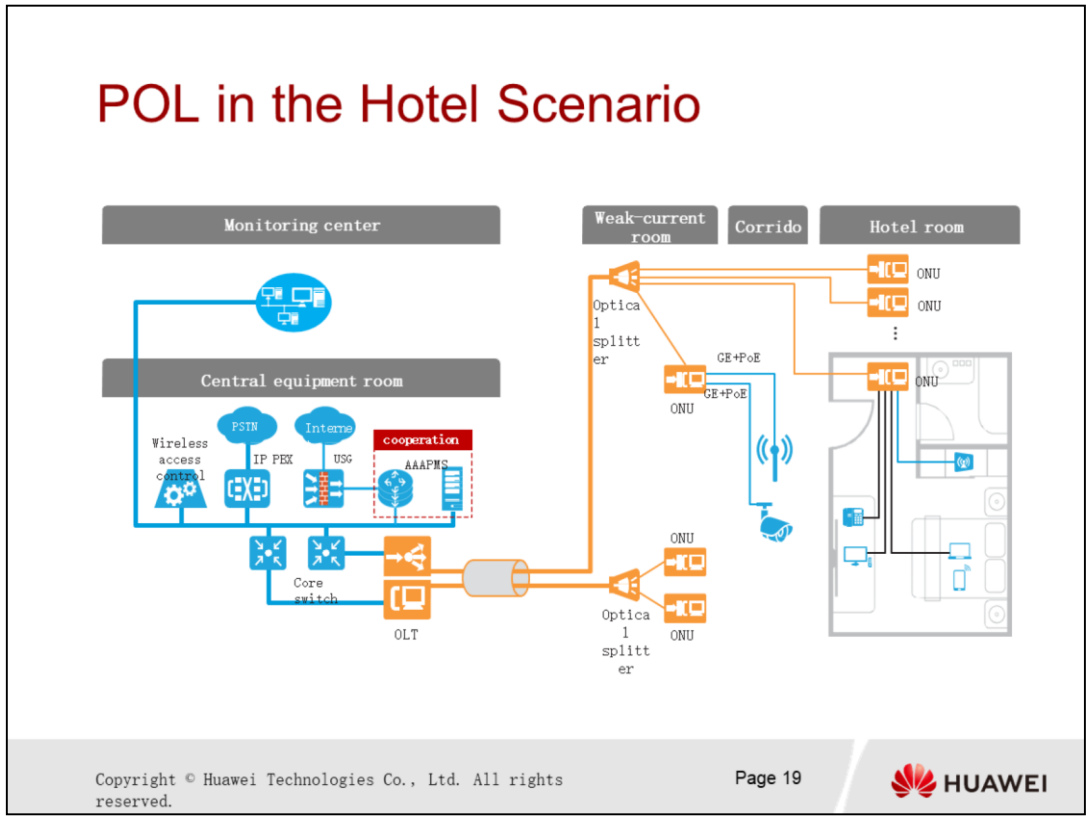


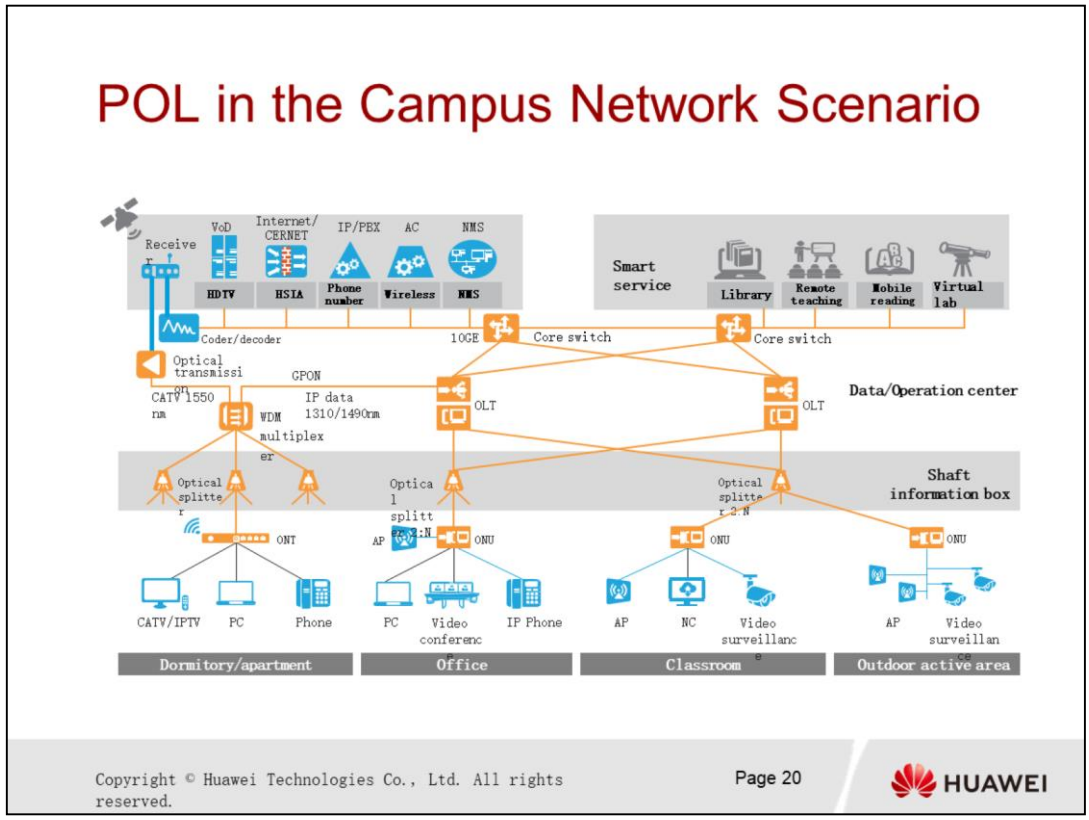
- Large-scale enterprises face the following challenges in network construction:
  - A large number of switches occupy equipment room space, consume much power, and are difficult to cool.
  - The connections between aggregation routers are complex and occupy pipe space. Therefore, cabling and maintenance are difficult.
  - Switches are scattered and difficult to manage, requiring a large maintenance team.
  - Adding new devices on the network is complex, and the capacity expansion capability is poor.
- Advantages of PON:
  - Optical cables replace traditional network cables, reducing investment costs and simplifying construction. The optical cables are antioxidant, durable, and easy to maintain.
  - The passive convergence optical splitter greatly reduces the number of aggregation switches and auxiliary equipment rooms, saving space and power consumption.
- Integrated office: Provide unified bearer for corridor terminals. The PoE is used to solve the problem of power supply.
- Independent office: One desk and one line, providing 1000 Mbps bandwidth. The cable is connected the IP phone and then to the PC. The networking is

simple.

- Open Office: PoE supplies power to Wi-Fi and cameras. Office services are carried in a unified manner (telephone).

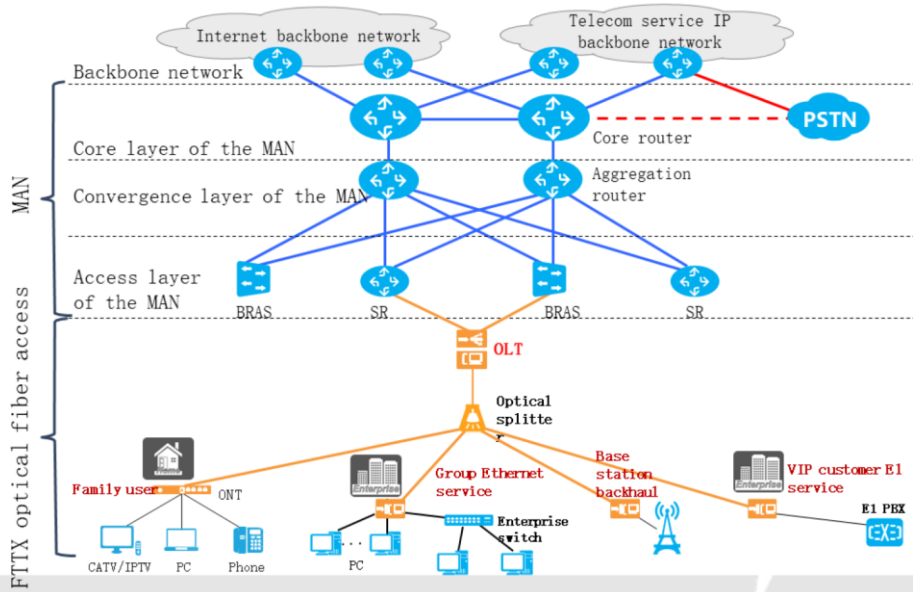


- The hotel network is evolving from traditional single services such as telephone and TV to monitoring, Wi-Fi, intelligent control of guest rooms, and environment awareness, becoming diversified, intelligent, and mobile.
  - Higher bandwidth: New service requirements of smart hotels, such as 4K HD videos, require higher bandwidth.
  - Access to the network anytime and anywhere: Seamless connection between guest rooms, corridors, lobbies, and conference rooms.
  - Rich value-added services: Video on demand (VoD) and intelligent guest room control
  - Economic operation cost: A large number of guest rooms and wide coverage require a simple network that features easy deployment and O&M.
- The Huawei Agile POL Converged Hospitality solution integrates the development of wireless, wired, video, voice, and guest room surveillance services with the concept of all-optical smart hotel and the service bearing mode of "one room one fiber, and multiple services" to meet the requirements of various information systems using simplified networking and management
  - One room one fiber simplifies the network and reduces costs.
  - Multi-scenario and multi-service coverage: Provides seamless coverage for HSI, voice, TV, Wi-Fi, and control services in guest rooms, halls, corridors, and restaurants.



- Cloud education and remote teaching require high-bandwidth and high-reliability campus networks that support smooth evolution.
- Campuses require full wireless coverage, unified authentication for wired and wireless access, and seamless roaming.
- Meets the desktop cloud requirements and carries multiple services in a unified manner, simplifying the network planning, cabling, and O&M.
- The all-optical campus solution uses an optical fiber network to carry full services in multiple scenarios in a unified manner. The passive ODN network provides higher reliability and supports flexible capacity expansion (P2MP architecture) and flexible evolution (PON/10G PON/40G PON).
- The WDM equipment is used to multiplex CATV signals and GPON signals into one optical fiber for transmission to the dormitories and apartments.
- One optical fiber carries all types of services in classrooms, offices, and outdoor entertainment areas.

Carrier Deployment Solution Based on the FTTx Access Network



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Summary

- Definition of the access network
- Implementation of the last mile solution
- Traditional access modes for enterprises and carriers
- Advantages of PON and applications in various scenarios

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