



Data Communication Network Basis



Foreword

- Communication has always been with us ever since the origin of human society. Communication has been playing an increasingly important role especially since human society entered the information era in the 1970s or 1980s.
- The communication mentioned in this course refers to the communication implemented through a data communication network. This course describes the concepts related to communication and a data communication network, information transfer process, network devices and their functions, network types, and typical networking. In addition, this course briefly introduces the concepts related to network engineering and network engineers.



Objectives

- On completion of this course, you will be able to:
 - Understand the concepts related to communication and a data communication network.
 - Be able to describe the information transfer process.
 - Differentiate network devices of different types and understand their basic functions.
 - Understand different network types and topology types.
 - Understand the concepts related to network engineering and network engineers.



Huawei Device Icons



General router



General switch



Core switch



Aggregation switch



Access switch



Stacked switches



Firewall



General NMS



AP



Base station



General server



Cluster



FTP server



Authentication server



PN user



Enterprise network user



Enterprise



Business trip



AC



Wi-Fi signals



Internet



Network cloud 1



Network cloud 2



IP phone



PC



Pad



Mobile phone



Laptop



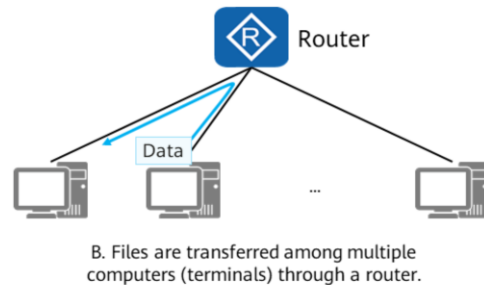
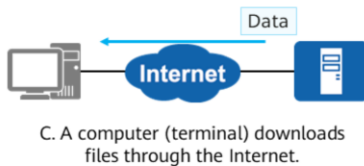
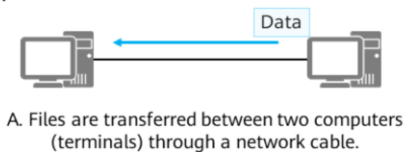
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- 1. Communication and Networks**
2. Network Types and Topology Types
3. Network Engineering and Network Engineers



Concept of Network Communication

- Communication refers to the information transfer and exchange between people, between people and things, and between things through a certain medium and behavior.
- Network communication refers to communication between terminal devices through a computer network.
- Examples of network communication:

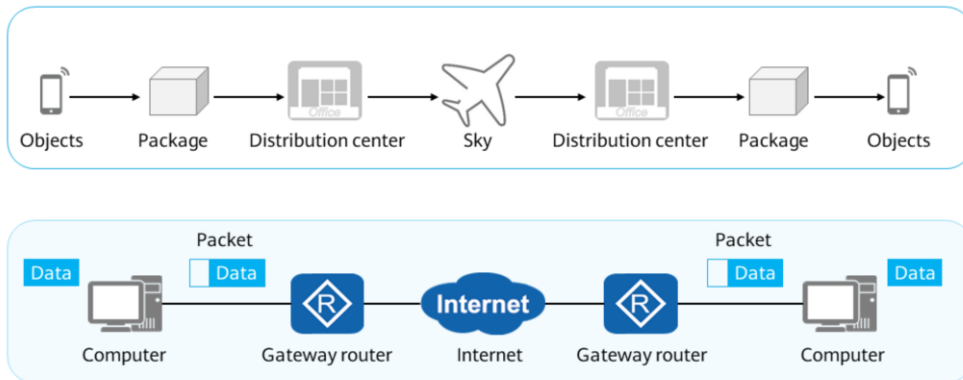


- Examples of network communication:
 - A. Two computers connected with a network cable form the simplest network.
 - B. A small network consists of a router (or switch) and multiple computers. In such a network, files can be freely transferred between every two computers through the router or switch.
 - C. To download a file from a website, a computer must first access the Internet.
- The Internet is the largest computer network in the world. Its predecessor, Advanced Research Projects Agency Network (ARPAnet), was born in 1969. The wide popularization and application of the Internet is one of the landmarks of the information age.



Information Transfer Process

- Virtual information transfer is similar to real object transfer.



- Comparison between express delivery (object transfer) and network communication:
- Objects to be delivered by express delivery:
 - The application generates the information (or data) to be delivered.
- The objects are packaged and attached with a delivery form containing the name and address of the consignee.
 - The application packs the data into the original "data payload", and adds the "header" and "tail" to form a packet. The important information in the packet is the address information of the receiver, that is, the "destination address".
 - The process of adding some new information segments to an information unit to form a new information unit is called encapsulation.
- The package is sent to the distribution center, where packages are sorted based on the destination addresses and the packages destined for the same city are placed on the same plane.
 - The packet reaches the gateway through the network cable. After receiving the packet, the gateway decapsulates the packet, reads the destination address, and then re-encapsulates the packet. Then, the gateway sends the packet to a router based on the destination address. After being transmitted through the gateway and router, the packet leaves the local network and enters the Internet for transmission.
 - The network cable functions similarly as the highway. The network cable is the medium for information transfer.

- Upon arrival at the destination airport, packages are taken out for sorting, and those destined for the same district are sent to the same distribution center.
 - After the packet reaches the local network where the destination address resides through the Internet, the gateway or router of the local network decapsulates and encapsulates the packet, and then sends the packet to the next router according to the destination address. Finally, the packet reaches the gateway of the network where the destination computer resides.
- The distribution center sorts the packages based on the destination addresses. Couriers deliver packages to recipients. Each recipient unpacks the package and accepts the package after confirming that the objects are intact, indicating that the whole delivery process is complete.
 - After the packet reaches the gateway of the network where the destination computer resides, the packet is decapsulated and encapsulated, and then sent to the corresponding computer according to the destination address. After receiving the packet, the computer verifies the packet. If the packet passes the verification, the computer accepts the packet and sends the data payload to the corresponding application for processing, indicating that the network communication process ends.



Common Terms

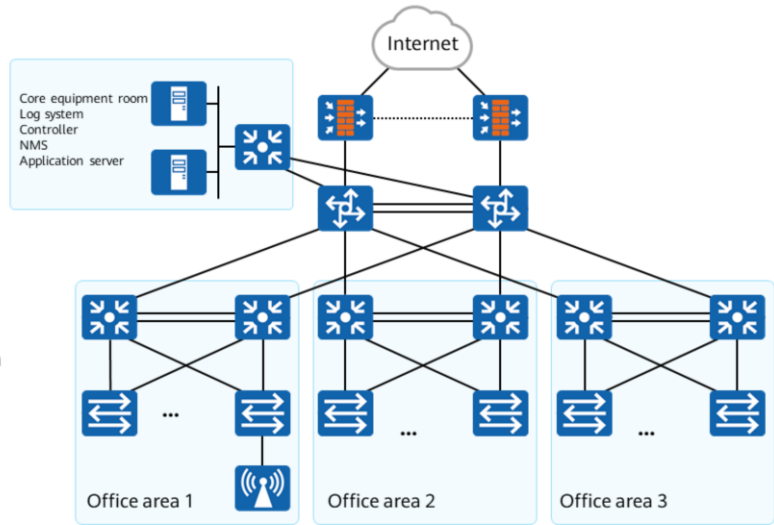
Term	Description
Data payload	Information conveyed
Packet	Data unit switched and transmitted on the network
Header	Information segment added before the data payload
Tail	Information segment added after the data payload
Encapsulation	Process of adding a header and a tail to a data payload to form a new packet
Decapsulation	Process of removing the header and tail from a packet to obtain the data payload
Gateway	Network device that provides functions such as protocol conversion, route selection, and data exchange
Router	Network device that selects a forwarding path for packets
Terminal device	End device of a data communication system, used as a sender or receiver of data

- **Data payload:** It can be considered as the information to be transmitted. However, in a hierarchical communication process, the data unit (packet) transmitted from the upper layer to the lower layer can be called the data payload of the lower layer.
- **Packet:** a data unit that is exchanged and transmitted on a network. It is in the format of header+data payload+tail. During transmission, the format and content of packets may change.
- **Header:** The information segment added before the data payload during packet assembly to facilitate information transmission is called the packet header.
- **Tail:** The information segment added after the payload to facilitate information transmission is called the tail of a packet. Note that many packets do not have tails.
- **Encapsulation:** A technology used by layered protocols. When the lower-layer protocol receives a message from the upper-layer protocol, the message is added to the data part of the lower-layer frame.
- **Decapsulation:** It is the reverse process of encapsulation. That is, the header and tail of a packet are removed to obtain the data payload.
- **Gateway:** A gateway is a network device that provides functions such as protocol conversion, route selection, and data exchange when networks using different architectures or protocols communicate with each other. A gateway is a term that is named based on its deployment location and functionality, rather than a specific device type.
- **Router:** a network device that selects a transmission path for a packet.
- **Terminal device:** It is the end device of the data communication system. As the data sender or receiver, the terminal device provides the necessary functions required by the user access protocol operations. The terminal device may be a computer, server, VoIP, or mobile phone.



Concept of the Data Communication Network

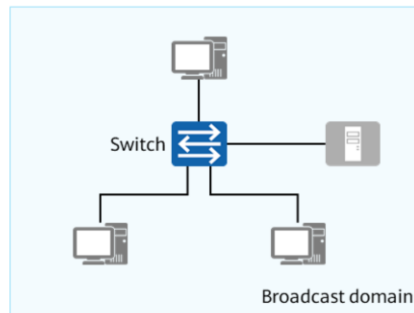
- Data communication network:
Communication network that consists of routers, switches, firewalls, access controllers (ACs), access points (APs), PCs, network printers, and servers
- Function:
To implement data communication





Switches

- Switch: a device closest to end users, used to access the network and switch data frames
 - Network access of terminals (such as PCs and servers)
 - Layer 2 switching

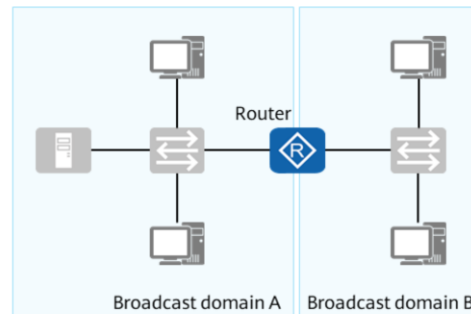


- Switches:
 - On a campus network, a switch is the device closest to end users and is used to connect terminals to the campus network. Switches at the access layer are usually Layer 2 switches and are also called Ethernet switches. Layer 2 refers to the data link layer of the TCP/IP reference model.
 - The Ethernet switch can implement the following functions: data frame switching, access of end user devices, basic access security functions, and Layer 2 link redundancy.
 - Broadcast domain: A set of nodes that can receive broadcast packets from a node.



Routers

- Router: a network-layer device that forwards data packets on the Internet. Based on the destination address in a received packet, a router selects a path to send the packet to the next router or destination. The last router on the path is responsible for sending the packet to the destination host.
 - Implementing communication between networks of the same type or different types
 - Isolating broadcast domains
 - Maintaining the routing table and running routing protocols
 - Selecting routes and forwarding IP packets
 - Implementing WAN access and network address translation
 - Connecting Layer 2 networks established through switches

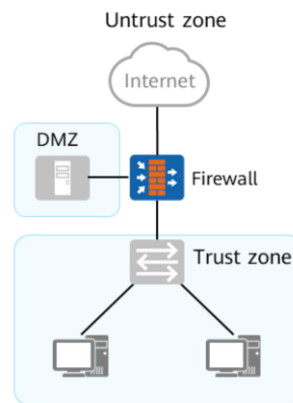


- Routers:
 - Routers work at the network layer of the TCP/IP reference model.
 - Routers can implement the following functions: routing table and routing information maintenance, route discovery and path selection, data forwarding, broadcast domain isolation, WAN access, network address translation, and specific security functions.



Firewalls

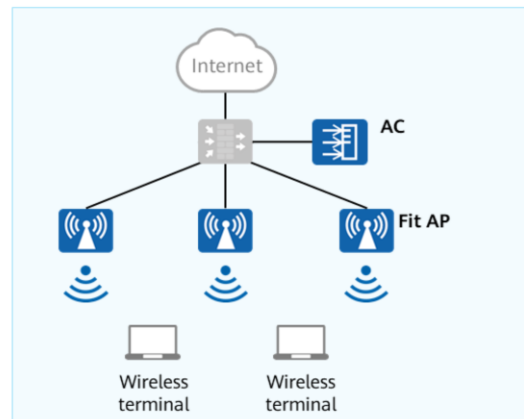
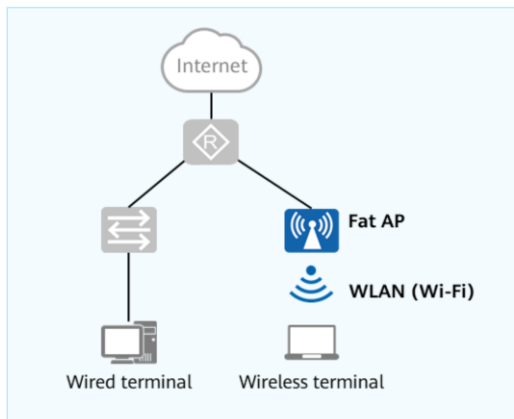
- Firewall: a network security device used to ensure secure communication between two networks. It monitors, restricts, and modifies data flows passing through it to shield information, structure, and running status of internal networks from the public network.
 - Isolating networks of different security levels
 - Implementing access control (using security policies) between networks of different security levels
 - Implementing user identity authentication
 - Implementing remote access
 - Supporting data encryption and VPN services
 - Implementing network address translation
 - Implementing other security functions



- Firewall:
 - It is located between two networks with different trust levels (for example, between an intranet and the Internet). It controls the communication between the two networks and forcibly implements unified security policies to prevent unauthorized access to important information resources.



Wireless devices



- In a broad sense, WLAN is a network that uses radio waves, laser, and infrared signals to replace some or all transmission media in a wired LAN. Common Wi-Fi is a WLAN technology based on the IEEE 802.11 family of standards.
- On a WLAN, common devices include fat APs, fit APs, and ACs.
 - AP:
 - Generally, it supports the fat AP, fit AP, and cloud-based management modes. You can flexibly switch between these modes based on network planning requirements.
 - Fat AP: It is applicable to homes. It works independently and needs to be configured separately. It has simple functions and low costs.
 - Fit AP: It applies to medium- and large-sized enterprises. It needs to work with the AC and is managed and configured by the AC.
 - Cloud-based management: It applies to small- and medium-sized enterprises. It needs to work with the cloud-based management platform for unified management and configuration. It provides various functions and supports plug-and-play.
 - AC:
 - It is generally deployed at the aggregation layer of the entire network to provide high-speed, secure, and reliable WLAN services.
 - The AC provides wireless data control services featuring large capacity, high performance, high reliability, easy installation, and easy maintenance. It features flexible networking and energy saving.



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LAN, MAN, and WAN

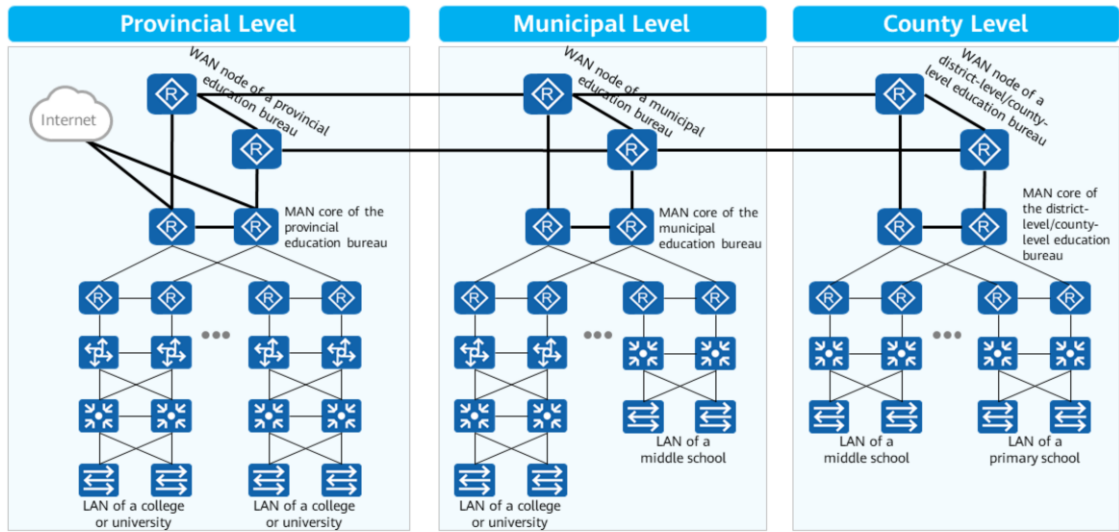
- Based on the geographical coverage, networks can be classified into local area networks (LANs), metropolitan area networks (MANs), and wide area networks (WANs).
 - LAN
 - A LAN is a network that consists of computers, servers, and network devices in a geographic area. The coverage of a LAN is generally within several thousand square meters.
 - Typical LANs include a company's office network, a cyber bar network, a home network.
 - MAN
 - A MAN is a computer communication network established within a city.
 - Typical MANs include broadband MANs, education MANs, and municipal or provincial e-government private lines.
 - WAN
 - A WAN generally covers a large geographical area ranging from tens of square kilometers to thousands of square kilometers. It can connect networks of multiple cities or even networks of countries (as an international large-scale network) and provide long-distance communication.
 - The Internet is a typical WAN.

- Based on the geographical coverage, networks can be classified into LANs, WANs, and MANs.
- LAN:
 - Basic characteristics:
 - An LAN generally covers an area of a few square kilometers.
 - The main function is to connect several terminals that are close to each other (within a family, within one or more buildings, within a campus, for example).
 - Technologies used: Ethernet and Wi-Fi.
- MAN:
 - Basic characteristics:
 - A MAN is a large-sized LAN, which requires high costs but can provide a higher transmission rate. It improves the transmission media in LANs and expands the access scope of LANs (able to cover a university campus or city).
 - The main function is to connect hosts, databases, and LANs at different locations in the same city.
 - The functions of a MAN are similar to those of a WAN except for implementation modes and performance.
 - Technologies used: such as Ethernet (10 Gbit/s or 100 Gbit/s) and WiMAX.

- WAN:
 - Basic characteristics:
 - A WAN generally covers an area of several kilometers or larger (thousands of kilometers for example).
 - It is mainly used to connect several LANs or MANs that are far from each other (for example, across cities or countries).
 - Telecom operators' communication lines are used.
 - Technologies used: HDLC and PPP.



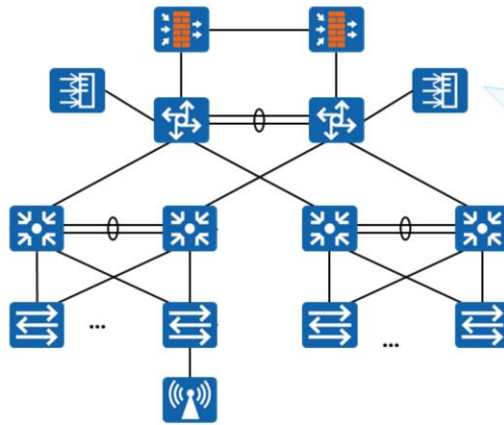
LAN, MAN, and WAN in the Education Industry





Network Topologies

- A network topology is a structured layout presented using transmission media (such as twisted pairs and optical fibers) to interconnect various devices (such as computer terminals, routers, and switches).



The network topology is used to describe the physical or logical structure of a network in the network engineering field, and is a very important network concept.

- Network topology drawing:
 - It is very important to master professional network topology drawing skills, which requires a lot of practice.
 - Visio and Power Point are two common tools for drawing network topologies.

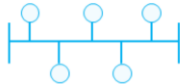


Network Topology Types

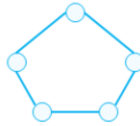
- Network topologies are classified into star, bus, ring, tree, full-mesh, and partial-mesh network topologies.



Star network topology



Bus network topology



Ring network topology



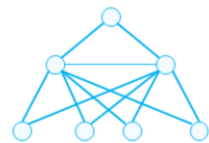
Tree network topology



Full-mesh network topology



Partial-mesh network topology



Combined network topology

- Star network topology:
 - All nodes are connected through a central node.
 - Advantages: New nodes can be easily added to the network. Communication data must be forwarded by the central node, which facilitates network monitoring.
 - Disadvantages: Faults on the central node affect the communication of the entire network.
- Bus network topology:
 - All nodes are connected through a bus (coaxial cable for example).
 - Advantages: The installation is simple and cable resources are saved. Generally, the failure of a node does not affect the communication of the entire network.
 - Disadvantages: A bus fault affects the communication of the entire network. The information sent by a node can be received by all other nodes, resulting in low security.
- Ring network topology:
 - All nodes are connected to form a closed ring.
 - Advantages: Cables resources are saved.
 - Disadvantages: It is difficult to add new nodes. The original ring must be interrupted before new nodes are inserted to form a new ring.

- Tree network topology:
 - The tree structure is actually a hierarchical star structure.
 - Advantages: Multiple star networks can be quickly combined, which facilitates network expansion.
 - Disadvantages: A fault on a node at a higher layer is more severe.
- Full-mesh network topology:
 - All nodes are interconnected through cables.
 - Advantages: It has high reliability and high communication efficiency.
 - Disadvantages: Each node requires a large number of physical ports and interconnection cables. As a result, the cost is high, and it is difficult to expand.
- Partial-mesh network topology:
 - Only key nodes are interconnected.
 - Advantages: The cost of a partial-mesh network is lower than that of a full-mesh network.
 - Disadvantages: The reliability of a partial-mesh network is lower than that of a full-mesh network.
- In actual networking, multiple types of topologies may be combined based on the cost, communication efficiency, and reliability requirements.



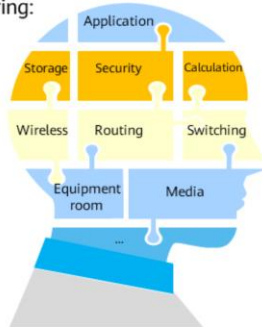
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Network Engineering

- Network engineering
 - Network engineering refers to planning and designing feasible solutions based on network application requirements and computer network system standards, specifications, and technologies under the guidance of information system engineering methods and complete organizations, as well as integrating computer network hardware devices, software, and technologies to form a cost-effective network system that meets user requirements.
- Technical modules covered by network engineering:



- Network engineering covers a series of activities around the network, including network planning, design, implementation, commissioning, and troubleshooting.
- The knowledge field of network engineering design is very wide, in which routing and switching are the basis of the computer network.



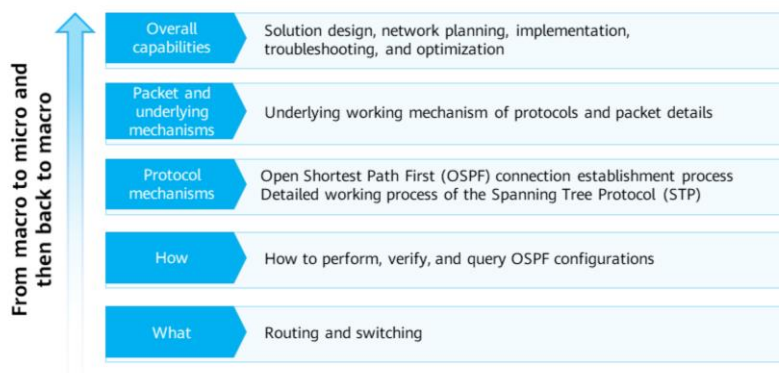
Network Engineer

- Network engineer
 - Network engineers are technology professionals who master professional network technologies, have professional skills, professionalism, and project implementation experience in the network engineering field, and are able to fully communicate with customers or other project stakeholders onsite. In addition, they can develop implementation solutions and project plans (recognized by project stakeholders) based on customer requirements and environment factors, fully mobilize resources of all parties to ensure timely and high-quality project implementation, and provide training for stakeholders and deliver engineering documents after the project is implemented.
- Comprehensive capability models for network engineers:

Process specification	Business etiquette	Team collaboration
Industry knowledge	Values	Business management
Engineering knowledge	Service awareness	Presentation capability
Product knowledge	Information collection	Problem solving
Technical knowledge	Learning competency	Communication capability
Professional knowledge	Basic qualification	Professional skills



Network Engineers' Technology Development Path





Huawei Certification Injects Vitality into Talent Development for Enterprises

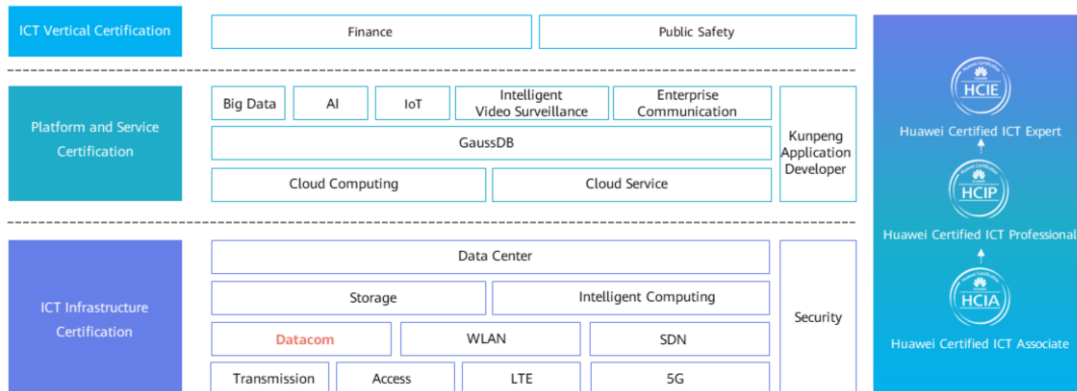




Huawei Certification Portfolio

- Huawei certification covers all ICT fields and is committed to providing a leading talent cultivation architecture and certification standards, cultivating ICT professionals in the digital era, and building a healthy ICT talent ecosystem.

Huawei Certification



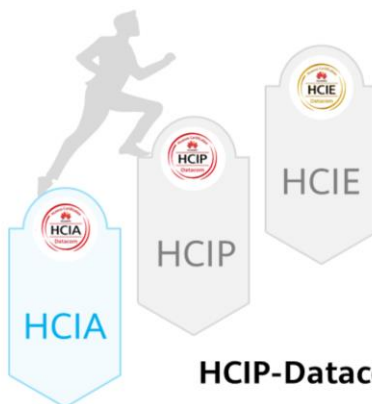
- Huawei talent ecosystem website: <https://e.huawei.com/en/talent/#/home>



Huawei Datacom Certification Portfolio

HCIA-Datacom

Aiming to cultivate network engineers with basic datacom theories and skills



HCIP-Datacom

Aiming to cultivate senior network engineers for cross-field solution planning and design or single-field planning and deployment

HCIE-Datacom

Aiming to cultivate network experts with solid theoretical foundation and deployment capabilities for cross-field solutions

- HCIA-Datacom: one course (exam)
 - Basic concepts of data communication, basis of routing and switching, security, WLAN, SDN and NFV, basis of programming automation, and network deployment cases
- HCIP-Datacom: one mandatory course (exam) and six optional sub-certification courses (exams)
 - Mandatory course (exam):
 - HCIP-Datacom-Core Technology
 - Optional courses (exams):
 - HCIP-Datacom-Advanced Routing & Switching Technology
 - HCIP-Datacom-Campus Network Planning and Deployment
 - HCIP-Datacom-Enterprise Network Solution Design
 - HCIP-Datacom-WAN Planning and Deployment
 - HCIP-Datacom-SD-WAN Planning and Deployment
 - HCIP-Datacom-Network Automation Developer
- HCIE-Datacom: one course (exam), integrating two modules
 - Classic network:
 - Classic datacom technology theory based on command lines
 - Classic datacom technology deployment based on command lines
 - Huawei SDN solution:
 - Enterprise SDN solution technology theory
 - Enterprise SDN solution planning and deployment



Quiz

1. (Single) Which of the following type of network topology has the highest reliability? ()
- A. Star network topology
 - B. Ring network topology
 - C. Full-mesh network topology
 - D. Tree network topology

1. C



Summary

- This section describes the concepts of network communication and data communication network. The basic function of a data communication network is to implement network communication.
- This section also introduces various network devices, the differences between LAN, MAN and WAN, and various network topologies. In actual networking, multiple topologies are combined according to the requirements of multiple parties.
- This section also describes network engineering and network engineers and introduces Huawei datacom certification system.



Thank You
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