


Introduction to IoT

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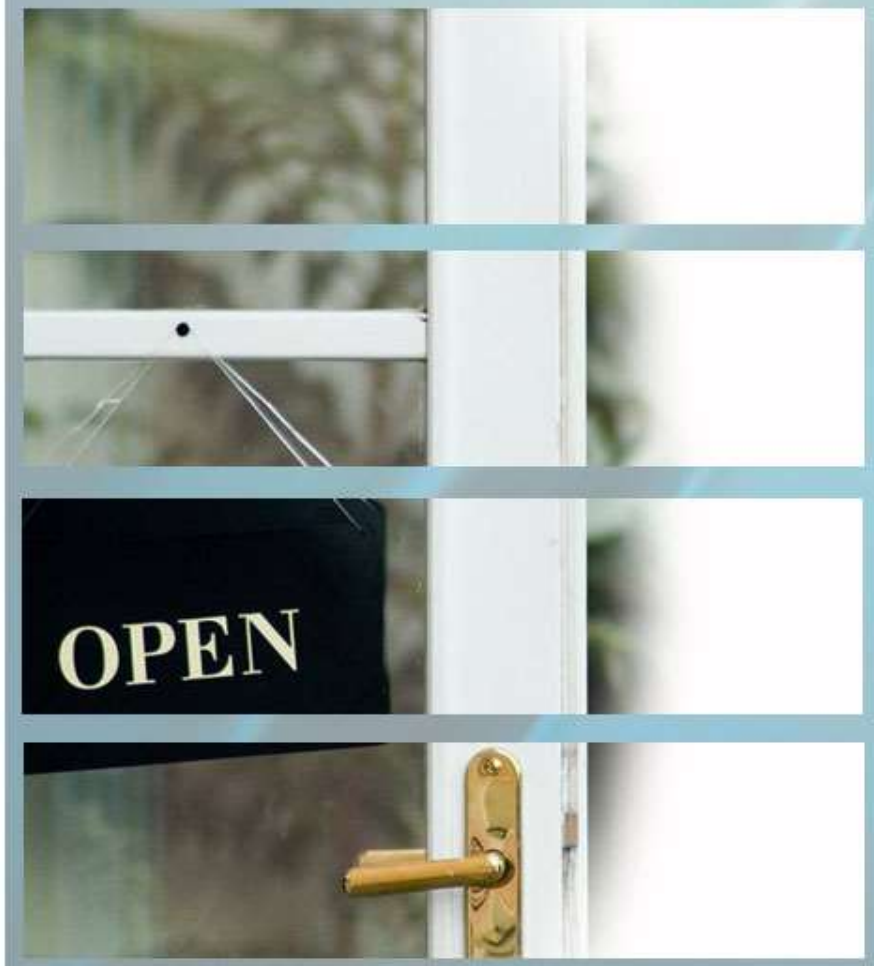
Chapter Six

Internet

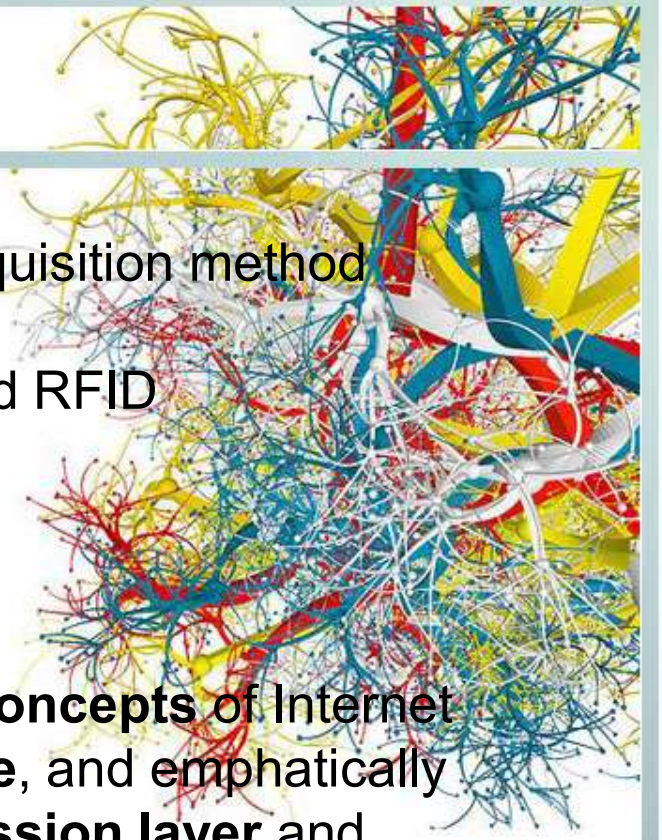


The network is one of the most important infrastructures of the Internet of Things. Is the Internet of Things the next generation of Internet? In order to solve this problem, we first need to knowthe Internet。

This chapter introduces the basic concepts and architecture of the Internet.

Content

Review



- Chapter 2-5 introduces the information acquisition method of the perceptual recognition layer.
  - Automatic identification technology and RFID
  - Sensor Technology
  - GPS
  - Intelligent information device

- This chapter mainly introduces the **basic concepts** of Internet elements, **access mode** and **network core**, and emphatically introduces **the application layer**, **transmission layer** and **network layer** of Internet layered architecture.

Content

6.1 Internet overview

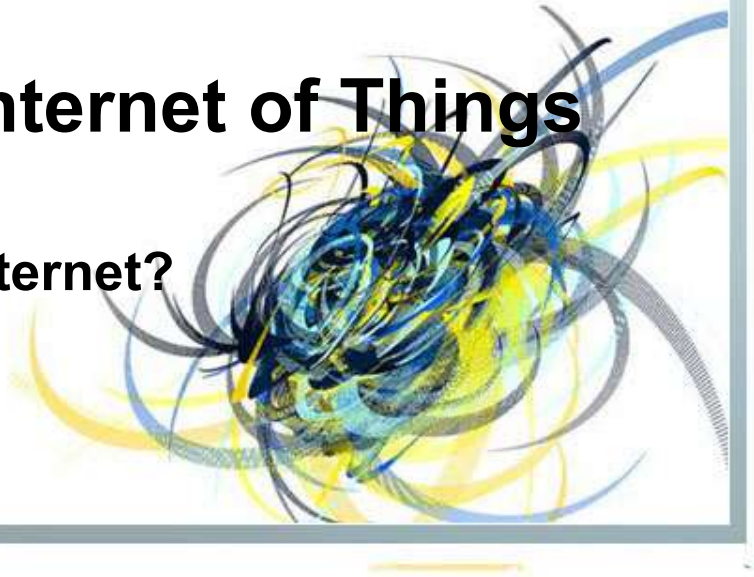
6.2 Application layer

6.3 Transport layer

6.4 Network layer

6.5 From the Internet to the Internet of Things

What are the basic components of the Internet?
In what way is connectivity achieved?

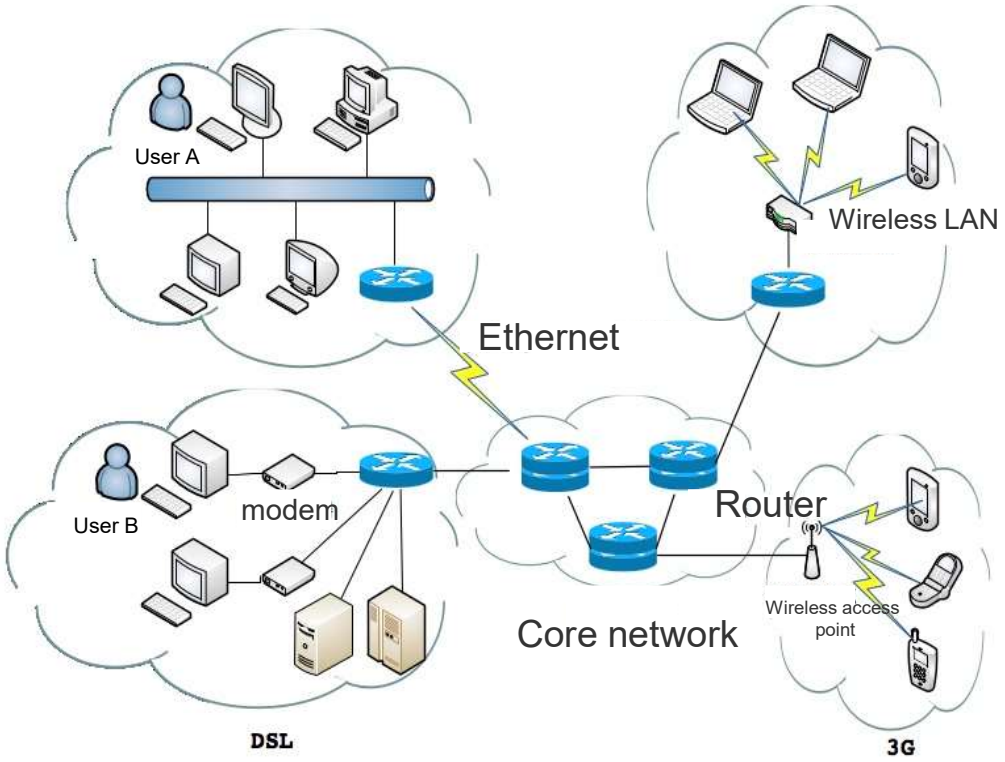


6.1 Internet overview: a network of "networks"

Network Terminal:

- •Server
- •Personal computer
- •Smart phone
- •……

Various terminal devices access the Internet through **different access ways**.



Network access method

- **Dial-up Internet:** At the beginning of the popularization of the Internet, the most commonly used wired access mode, which uses the telephone number provided by the local operator to dial up the Internet through the **Modem**, is a low-speed access, with the highest data transmission rate of 56kbps.
- **DSL:** At present, the most widely used wired access, broadband access technology based on ordinary telephone lines. Peak upload rate: 1Mbps (usually less than 1Mbps), peak download rate: 8Mbps (usually less than 2Mbps), stable rate, exclusive bandwidth, and voice service independence.
- **Power line:** A new wired access method for network data transmission using power lines, with a maximum speed of 14Mbps, flexible structure, wide application range and low cost.

Network access method

- **Ethernet:** the most widely used LAN communication technology, including 10Mbps, 100Mbps, 10Gbps and other speed range, with **high rate**, **strong anti-interference ability**, suitable for all kinds of enterprises and institutions, can achieve all kinds of high-speed Internet applications, but the one-time wiring cost is high.
- **Wi-Fi:** the most common form of **wireless** access, is a **short-range** transmission technology suitable for office and home environments, with rates ranging from 11Mbps to 54Mbps to 300Mbps.

Network core: How does the Internet provide communication service?

Data exchange: The process of transferring data from sender to receiver

The core problem in network design: How to transmit data?

- Data Exchange
  - **Circuit switching**
  - Message exchange
  - Packet switching
    - Virtual circuit
    - **Datagram**

Circuit switching Vs Packet switching

Circuit switching

Data circuit: circuit
Features: Instant messaging, quality of service guarantee
Poor scalability and long preparation time

Packet switching

Communication data unit: Grouping
Features: High resource utilization, high information transmission efficiency, and insecure service quality

In most cases, **Internet of things** services **do not require real-time communication capability** with delay guarantee, so efficient and low-cost packet switching will become the preferred mode of data exchange in the Internet of things.

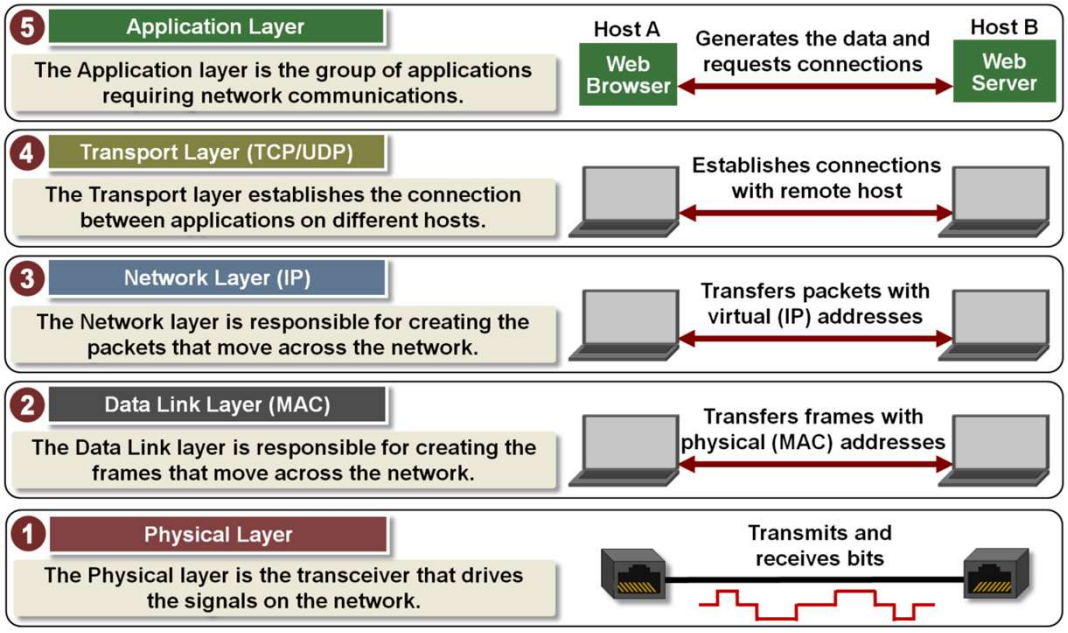
6.1 Internet overview: Network protocols and their hierarchical structure

Why do you need a layered structure?

- Network size
- Network features

The Internet can generally be divided into **5** layers:

- Application layer
- Transport layer
- Network layer
- Datalink layer
- Physical layer




6.1 Internet overview: Network protocols and their hierarchical structure

Application layer

HTTP, FTP, SMTP, DNS Protocol; Data unit: Message

Transport layer

TCP, UDP Protocol; Data unit: Data segment

Network layer

IP, ICMP, GMP Protocol; Data unit: Packet

Datalink layer

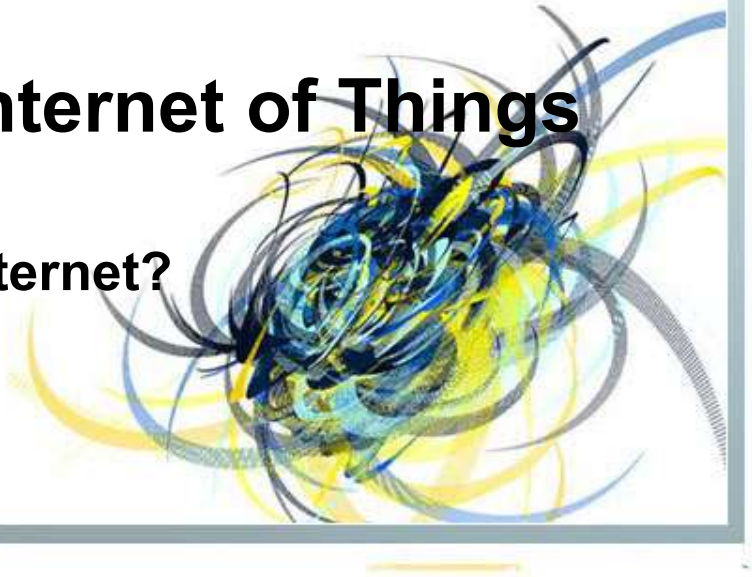
MAC Protocol; Data unit: Frame

Physical layer

Data unit: Bit

Content

What are the basic components of the Internet?
In what way is connectivity achieved?

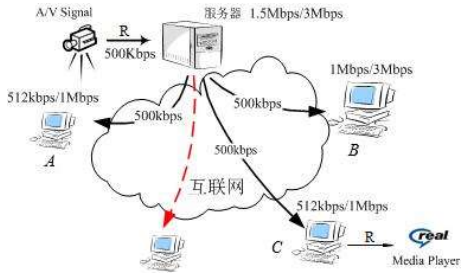


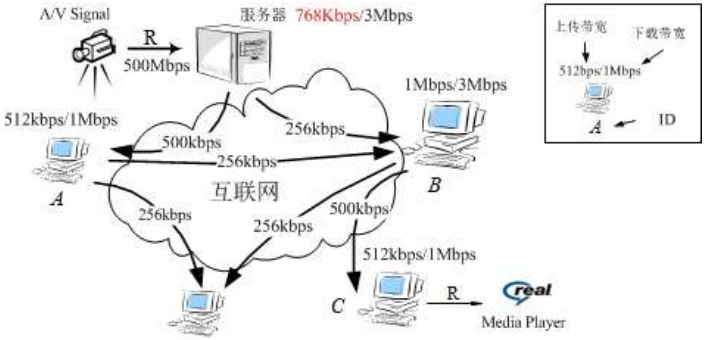
6.2 Application layer: application architecture

Application layer describes **business logic**, including **application process**, **application state**, **data content and form**

Application architecture

- Client-server mode
  - ✓The server provides services directly to all users
  - ✓High cost and poor scalability
- Peer-to-peer mode
  - ✓Each network terminal is both a resource user and a resource provider.
  - ✓Strong scalability and high resource utilization
  - ✓Management difficulties, unstable services





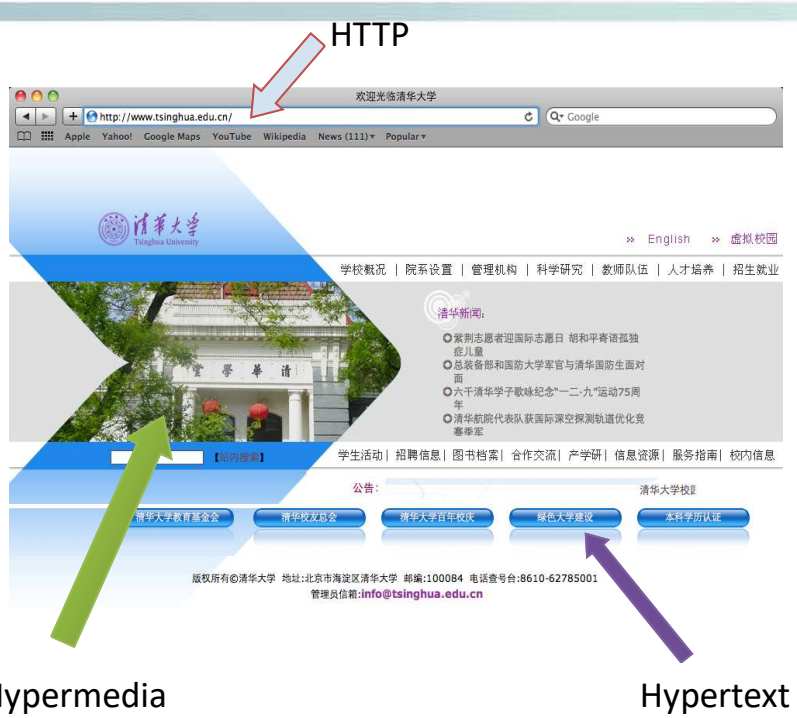
6.2 Application layer: Web And HTTP protocol

The Web contains three important concepts

- hypertext
- hypermedia
- Hypertext transfer protocol (HTTP)

The characteristics of the Web

- Graphical interface
- Terminal independence
- Interactivity and dynamics



6.2 Application layer: Web And HTTP protocol

HTTP protocols is the core of the Web, responsible for the communication between the Web server and the client application layer. Define the order of communication between the server and the user and the data format.

- Server side: webpage
- Client: Browser

URL

For example, http://www.tsinghua.edu.cn , the user can be accessed through the HTTP protocol host tsinghua.edu.cn web resources

6.2 Application Layer: Domain Name System

Domain name:

- Unique identity of the Web server on the network (identity role)
- An identity used to locate a Web server in a network (location)

A domain name usually has some semantic information that can be understood directly, such as http://tsinghua.edu.cn

- Cn: the server is located in China
- Edu: server for educational institutions
- Tsinghua: the web server is owned by Tsinghua university

Domain name and IP address:

- IP is the Internet internal use of the identity, there is a fixed length, domain name no length limit.
- Domain name to IP address conversion: domain name system

6.2 Application Layer: Domain Name System (Next)

Hierarchical organization of DNS (domain name system) service structure

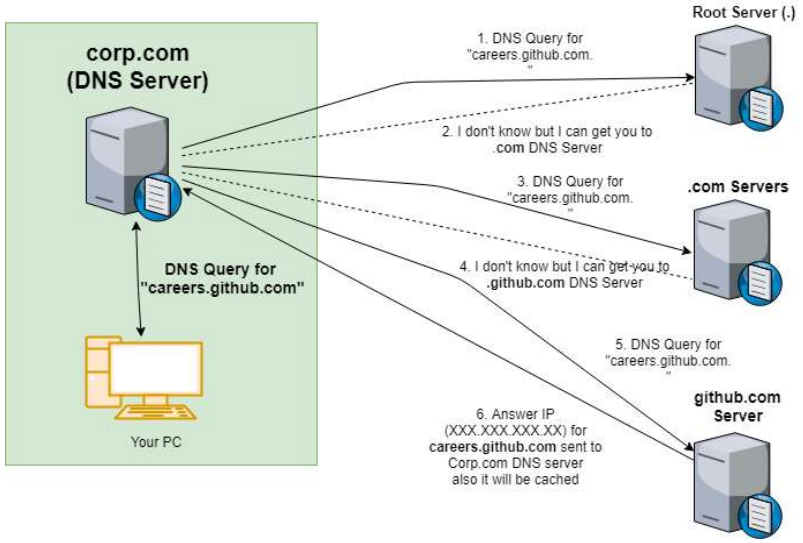
- Root domain name system server
  13 root domain servers
- Primary domain name server
  - ✓ Responsible for top-level domains such as. Com,. Edu,. Net
  - ✓ Responsible for representing the country region. Cn, ca domain name
- Authoritative domain name server
  Service every institution that owns the Web
  Two types of service
    - ✓ Self-maintaining authoritative domain name server
    - ✓ Third party authoritative domain name server

Domain name servers work together to **resolve domain names**

6.2 Application Layer: Domain Name Resolution

Interactive domain name resolution:
hierarchical inquiry

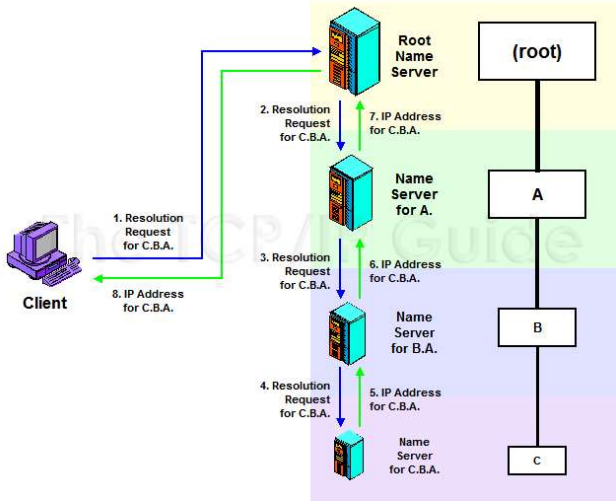
When the user requests resolution from the local DNS server, if the local DNS server already holds the corresponding IP of the required domain name, the information will be returned to the user; otherwise, the root server will start to inquire layer by layer, until the corresponding IP of the domain name is obtained and returned to the user.



6.2 Application Layer: Domain Name Resolution(Next)

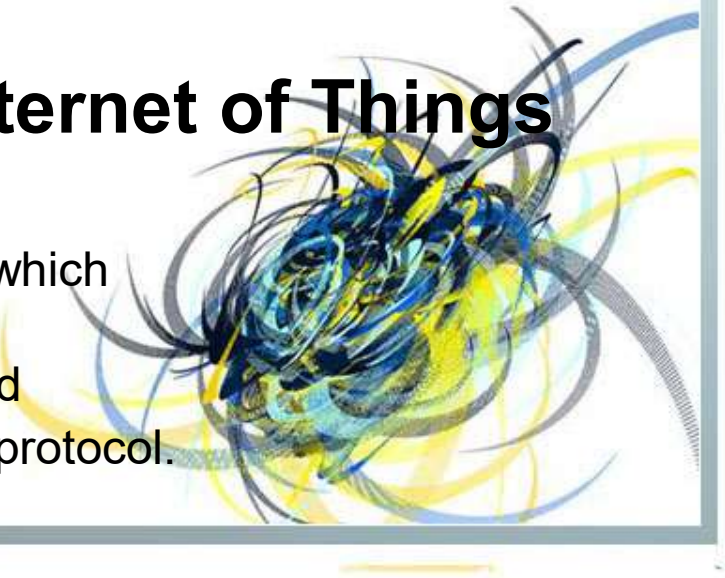
Recursive domain name resolution: Local DNS server proxy

Whenever a DNS server is queried for the IP address of a domain name, if the server has no record, the server will personally get the IP address of the domain name on behalf of the inquirer until it gets the information.



Content

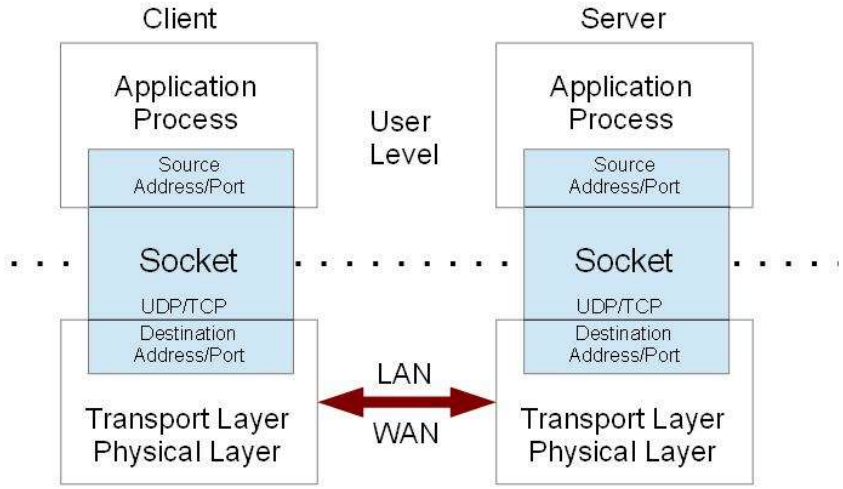
The transport layer is the first end-to-end layer in which a network terminal communicates over a network. The transport layer establishes a virtual end-to-end transport path for an application layer program or protocol.



6.3 Transport layer: socket

Socket: A gate through which applications communicate with the transport layer so that when a network terminal runs multiple network applications, the sending and receiving of messages from different applications does not create confusion.

Sockets require **IP addresses** and **port Numbers** to distinguish between different applications running on the same terminal.
IP addresses are used to distinguish **different terminals**, and port Numbers are used to distinguish **different applications on the same terminal**.




How to establish an end-to-end logical connection on the transport layer?

End-to-end connections at the transport layer are **process-to-process** connections (not terminal-to-terminal connections)

The required information

- ✓ IP address of the sender: identifies the initiator host terminal
- ✓ Port number of the sending end: identifies the initiator host specific process
- ✓ IP address of the receiver: identifies the receiver host terminal
- ✓ Port number of the receiving end: identifies the recipient host specific process

Transport layer protocol

UDP protocol: provides data delivery without reliability guarantees

TCP protocol: provides data transfer with guaranteed accessibility

6.3 Transport layer: UDP protocol

UDP protocol: User Data Packet Protocol (User Datagram Protocol), providing a simple and unreliable information transmission service for the transport layer.

Protocol characteristics

Data communication does not need to establish a connection →**Small startup delay**
Data communication does not require maintenance connection status →**A small amount of resource consumption**
Lightweight communication overhead →**Shorter packet format**

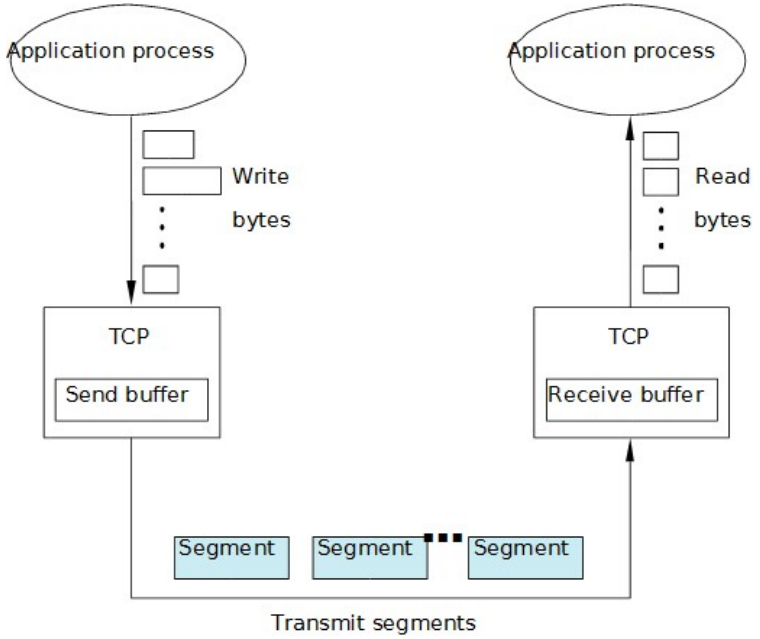
Application

Network telephony, **network video** and other packet delays usually cause more harm than packet loss harm applications.

6.3 Transport layer: TCP protocol

TCP protocol: Transmission Control Protocol provides a reliable, Byte throttle-based transport service for upper-level applications.

Since the network layer protocol (IP protocol) on which TCP protocol is based does not provide reliable transmission guarantee, the reliability of transmission is completely realized by various mechanisms contained in TCP.



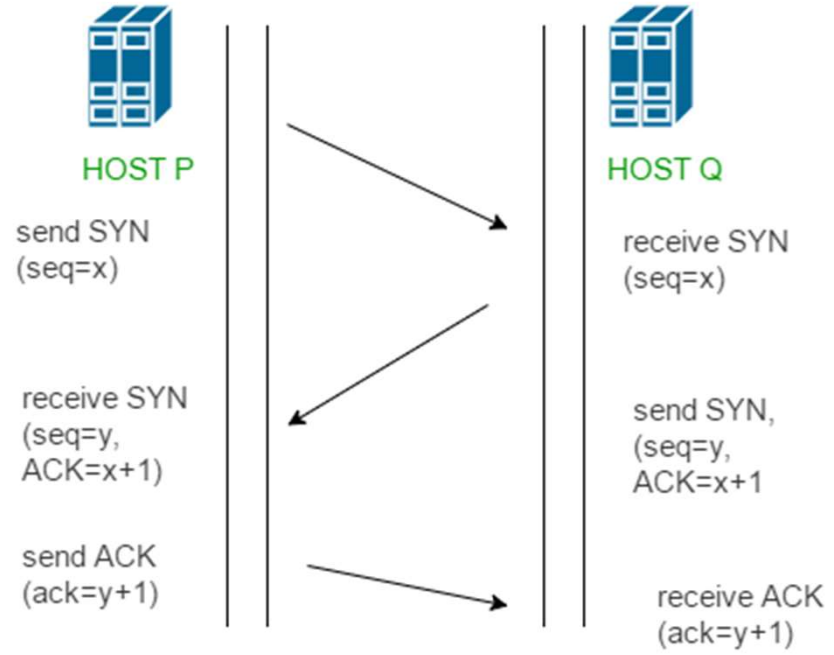
Reliability transmission implementation mechanism

- ✓ Data segmentation
- ✓ Data number
- ✓ Receive feedback

TCP: implementation of reliable transmission

The reliability guarantee mechanism of TCP protocol

- Data segmentation
- **Three-way handshake**
- Data transfer



Reliability transfer mechanism

✓Data segmentation

✓Data number

✓Receiving feedback

TCP setup: Three handshakes

First handshake:
Initiated by the requester, the first handshake message initiated by the client is called SYN message, which contains the starting number of the initiator's first real data message.

Second handshake:
After the server receives the SYN packet, it sends the confirmation information to the client, which is called the SYNACK packet. After the second handshake, the server allocates network resources and bandwidth.

Third handshake:
Sent by the client, including the client wants to get data resources from the server, the server received the request, TCP connection successfully established.

Reliability transfer mechanism

✓Data segmentation
✓Data number
✓Receiving feedback

Characteristics of TCP protocol

- **Connection-oriented transmission:** the state of the connection maintained by both communicating parties.
- **Reliability transmission:** ensure that the transmission is not lost or out of order.
- **Flow control:** matches the sending and receiving rates.
- **Congestion control:** avoid network overcrowding and consider the fairness between different communication parties.

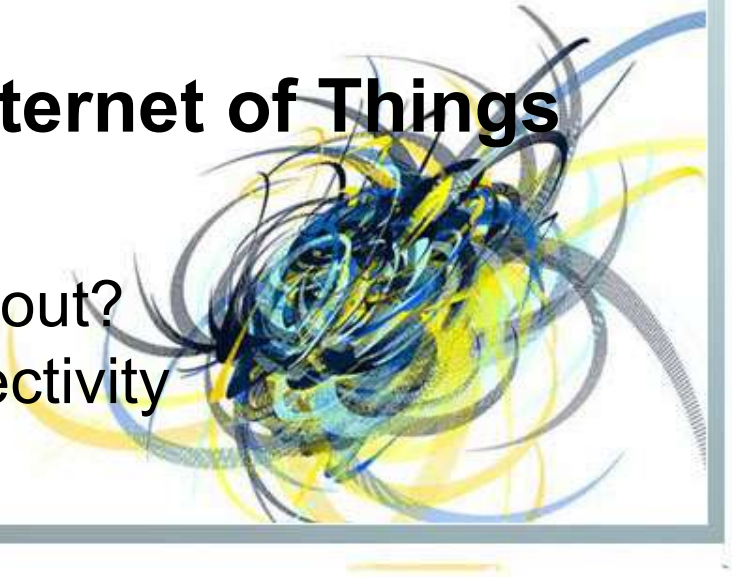
Reliability transfer mechanism

✓Data segmentation

✓Data number

✓Receiving feedback

Content



When data communication is carried out?
what is the way to achieve interconnectivity within the Internet?

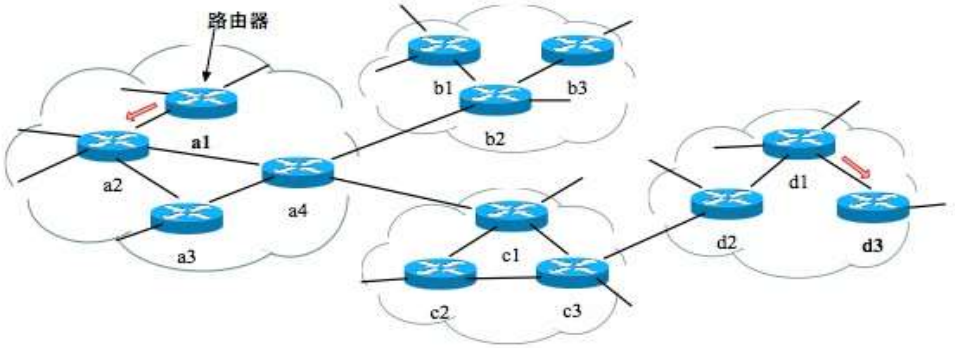
6.4 Network layer: Router

Router

- It is a bridge of network connectivity
- The router selects the data transmission path through the routing algorithm

Routing table: IP address, port number

When the router receives a packet, it will check the IP address of the receiving terminal in the packet network layer header and forward the packet through the corresponding port according to the information in the routing table



Destination address range	The port number
11011111 00000001 00010001 00000000 To 11011111 00000001 00010001 09999999	1
11011111 00000001 00010001 10000000 To 11011111 00000001 00010001 10000000	2
other	3

6.4 Network layer: IP protocol

IPv4protocol

- 32Bit

Address allocation:

- By ICANN Overall allocation, total 5-class IPv4 address
- A Class: Government agencies
- B Class: Medium-sized companies and companies
- C Class: Small organizations and individuals
- Class D and Class E: special use

The problem

Quantity exhaustion problem →IPv6

IPv6 protocol

- 128Bit

Protocol advantage:

- Huge amount: one can be assigned IP address to each grain of sand
- The header format has been further improved, more concise, and smaller communication delay
- Increase in safety

The problem

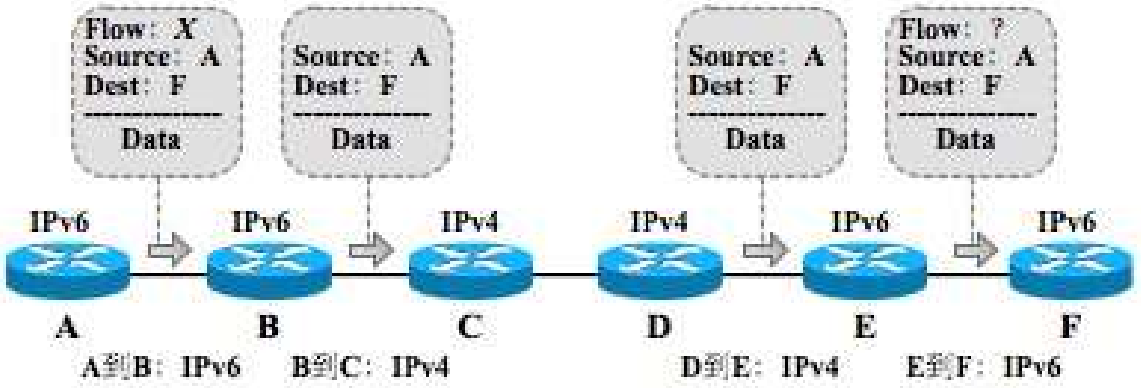
Compatibility with IPv4

How to translate IPV4 to IPv6?

Dual stack technology

Adding the IPv4 stack to an IPv6 device enables the device to support both protocols.

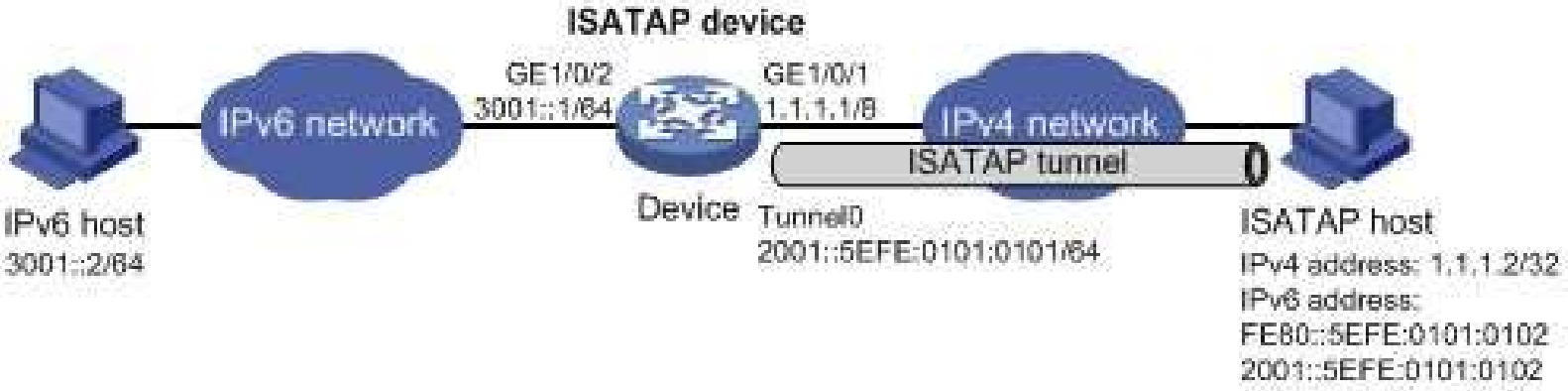
The problem: if IPv6 packets are converted to IPv4 packets during communication, the original IPv6 packets cannot be restored.



How to translate IPV4 to IPv6?

Tunnel technology

Package IPv6 packets as IPv4 packets
Constructing transmission tunnel
IPv6 packets can be restored



Content

Will the Internet of things be the next Internet?


6.5 Next generation Internet exploration

The next generation Internet should have the following characteristics:

- Larger scale: IPv6 is gradually replacing IPv4 to connect more terminals and users.
- Faster speed: target at least 100Mbps.
- Higher security: network security controllability, manageability enhanced.
- Easier to use: seamlessly integrated with mobile communication technology, users are no longer limited by geographical location.

6.5 Next generation Internet exploration

CNGI project

Project title: China's Next Generation Internet, launched in China in 2003

Four breakthroughs:

- The world's first pure IPv6 LAN
- New system of IPv6 source address authentication interconnection
- Independent research and development of IPv4 and IPv6 transition technology
- Domestic IPv6 router

Beijing builds cngi-6ix, a national/international interconnection center

High-speed interconnection of 6 CNGI trunk networks is realized

It has realized the high-speed next generation Internet connection with North America, Europe, Oceania and other regions


6.5 From the Internet to IoT

Extension of the Internet

- Terminal diversification
  - ✓ Get rid of the shackles of "people on the Internet"
  - ✓ The online world and the physical world are more closely connected
- Diverse ways of obtaining information
  Active acquisition, passive disclosure
- Intellectualization of perceptual behavior
  Man's control over the physical world has never been greater

The importance of the Internet in the Internet of things

The Internet of things is the extension and expansion of **Internet application**, and the Internet is the most important and main way to realize more comprehensive interconnection between things (people) and things (people).


Conclusion

Review

This chapter introduces the basic components and architecture of the Internet, focuses on the application layer, transport layer and network layer functions, and briefly introduces the typical protocols and applications of each layer.

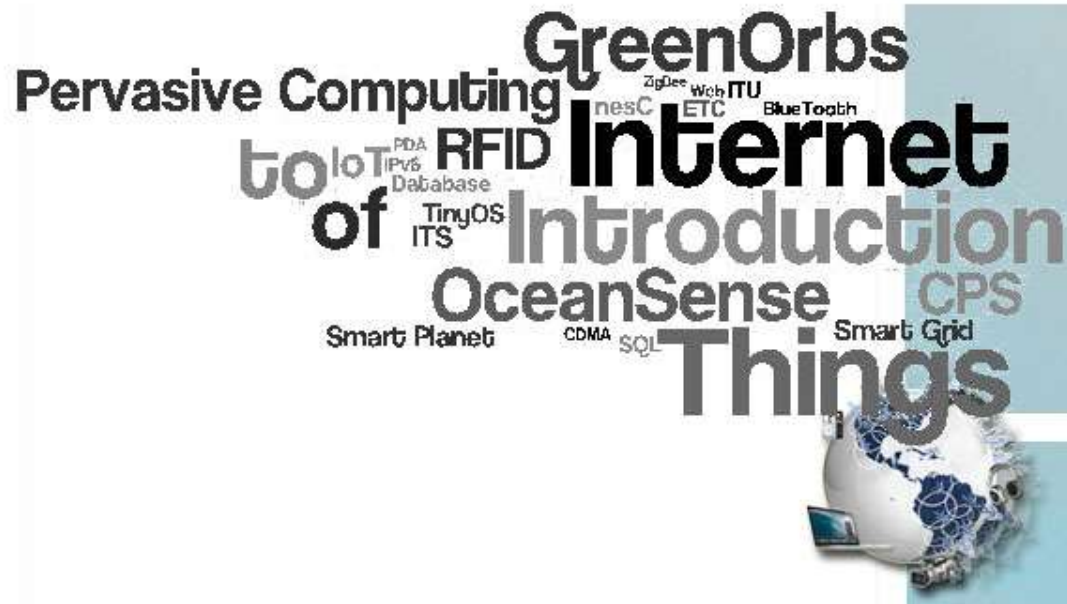
Key Points

- Be familiar with common Internet access methods.
- Focus on understanding the principle and characteristics of circuit switching and packet switching.
- Keep in mind the five layers of the Internet, including the key protocols involved in each layer.
- Understand application architecture: client-server and peer-to-peer patterns.

Conclusion

Key Points(Next)

- Understand Web and HTTP protocols, focus on domain name system, hierarchical structure of DNS and domain name resolution.
- Master the concept and function principle of socket and understand the characteristics of UDP protocol, focus on the study of the principle and characteristics of TCP protocol, and the difference with UDP.
- Understand the function and working principle of router, master the structure and classification of IPv4 protocol, focus on learning IPv6 protocol, including structure and IPv4 compatibility technology.
- Master the role and function of the Internet in the Internet of things.



Thank you!

Internet of Things