


Introduction to IoT

Jianhui Zhang, Ph.D., Prof.

College of Computer Science and Technology, Hangzhou Dianzi Univ.

Email: jh_zhang@hdu.edu.cn

About the course

- Assessment mode:

Attendance+ Seminar &discussion+ Final Exam.

15%+ 45% + 40%

- Others:

1. Keep silent in class when no discussion
2. Not be later.

About the course

- Homework

Each person is required to finish some exercises, which is given in the website: http://www.jhzhang.cn/resources.html

Hand in two versions including electronic and printed one. Send the e-version to my email: jh_zhang@hdu.edu.cn with the mail title: cs+your student ID+name.

About the course

- Division **Contact to ????**

You are divided into several groups and given problems to discuss once/twice. Each group has five persons and selects out a leader responding to contact to me. My email: jh_zhang@hdu.edu.cn.

- Presenation

Each group finds a topic related to computer science by yourself and then selects out a person to present your topic with a PPT. Prepare it now and will begin at 13th week.

About the course

Prepare it now and will begin at 11th week.

Chapter One

IoT Overview

Content

1.1 Origin and Development

1.2 Core Technology

1.3 Main Feature

1.4 Application Prospect

What is the Internet of Things?

How did the concept of IoT generate?

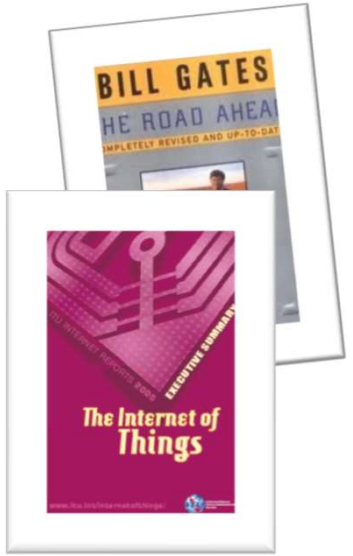
1.1 History

1995 *The Road Ahead* - Bill Gates

2005 "ITU The Internet of Things Interne to Things summary"

2008 "Smart Planet" - IBM

2009 "Reading China"




1.1 History: The Main Line is complex, the source is not single

RFID

Auto-ID Center of MIT firstly proposed the concept of EPC system and IoT

Pervasive Computing

Perception and interconnection

Embedded system

Sensor Network started in the late 1990s

NSF workshop on CPS (Cyber-Physical Systems) appeared in 2006


What is the Interest of Internet?

Conception

In computing, the Internet of Things refers to a network of objects, such as household appliances. It is often a self-configuring wireless network. The concept of the internet of things is attributed to the original Auto-ID Center, founded in 1999 and based at the time in MIT.

IoT is actually a Chinese invention, which integrates CPS(Cyber-Physical Systems), IoT(Internet of Things) , U-Japan and so on. **IoT** is a network based on the Internet, traditional telecommunications network and other information carriers so that all ordinary physical objects can independently achieve interconnection. The three important characteristics are equipment of common objects, interconnection of autonomous terminals and intelligence of pervasive services.


Other Definitions of IoT

Definition one: A network of objects with identities and virtual personalities that operate in intelligent Spaces and use intelligent interfaces to connect and communicate with the context of the user, society, and environment. (EpoSS, 2008.5)

Definition Two: The Internet of things is an integrated part of the Internet of the future. It is a global dynamic network facility with self-configuration capability based on standard and interoperable communication protocols. In this network, all physical and virtual objects have specific coding and physical characteristics, which are seamlessly linked through intelligent interfaces to achieve information sharing.
(RFID and Internet project team report of FP7, 2009.9)

Definition Three: A network that connects any item to the Internet through information sensing equipment and in accordance with the agreed protocol for information exchange and communication, so as to realize intelligent identification, positioning, tracking, monitoring and management. It is based on the Internet extend and expand the network. (Government report of China, 2010.3)

Content

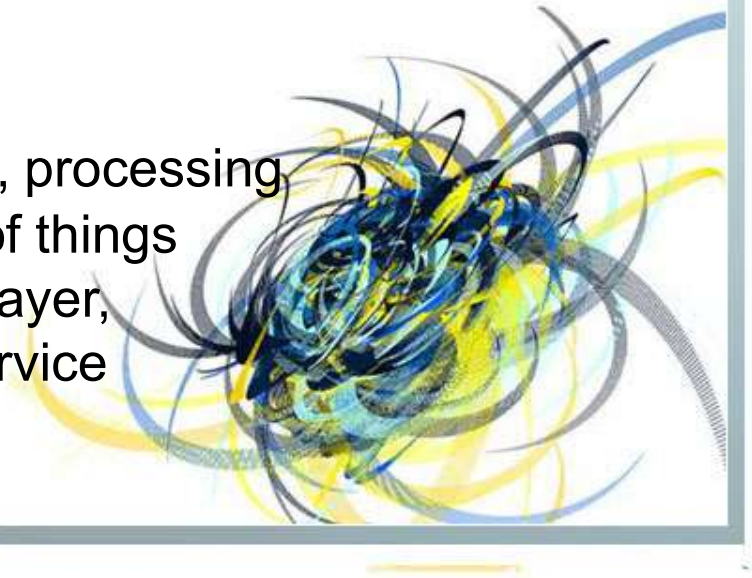
1.1 Origin and Development

1.2 Core Technology

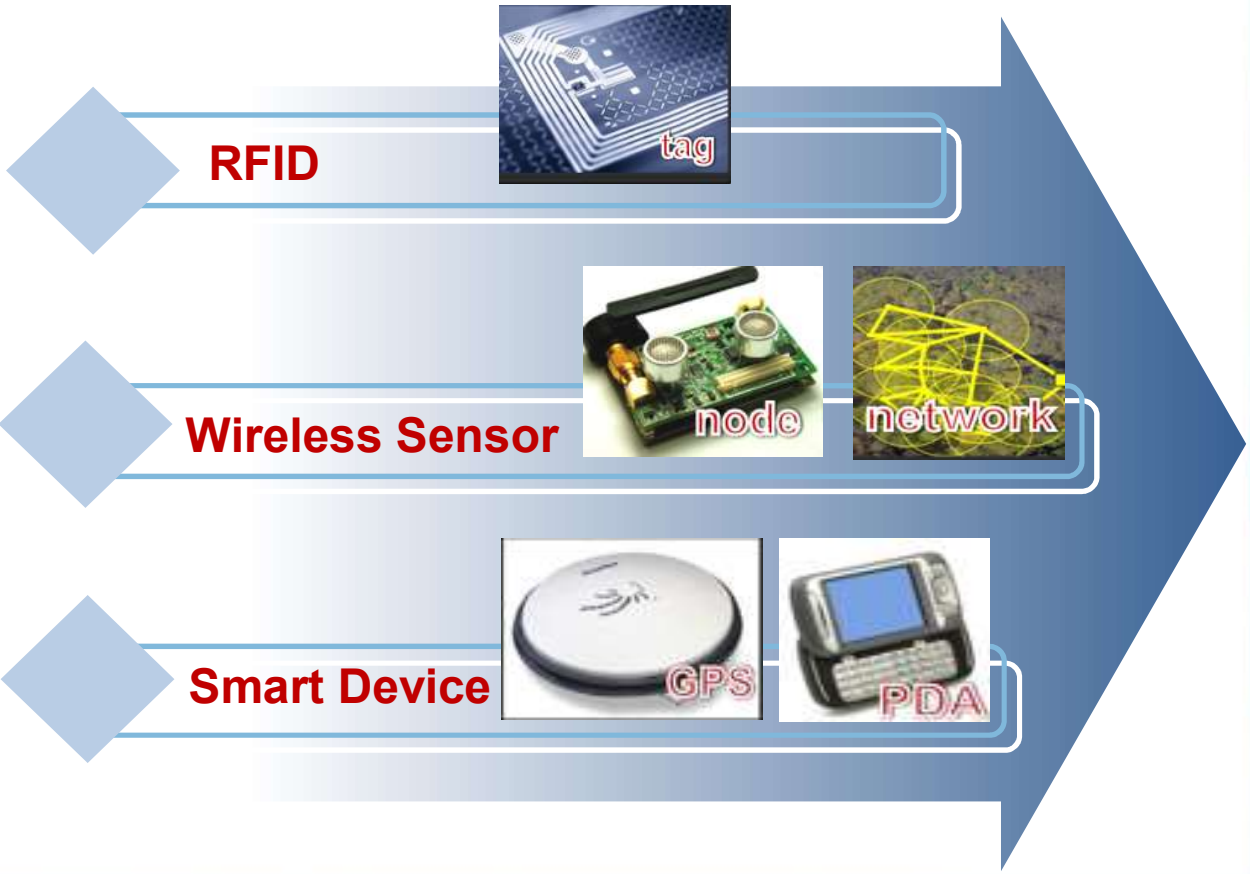
1.3 Main Feature

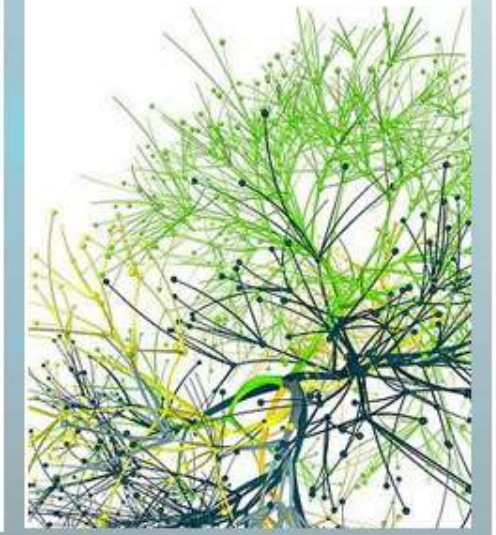
1.4 Application Prospect

According to the generation, transmission, processing and application of information, the Internet of things is divided into perception and identification layer, network construction layer, management service layer and comprehensive application layer.



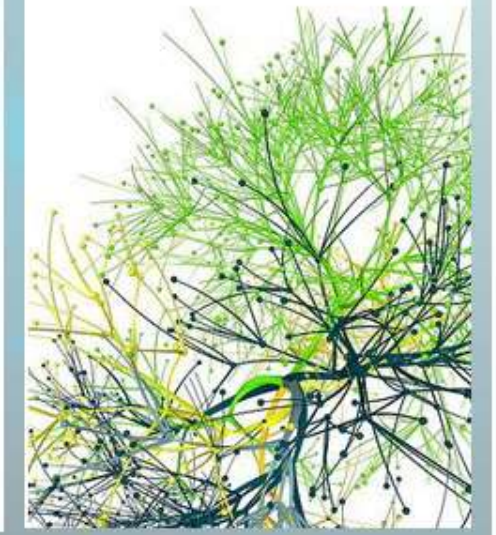
1.2 Perception and Identification layer





1.2 Perception and Identification layer

- Make things "speak and release information" through perceptual recognition technology is an important link that integrates the physical world and the information world, and is the most unique part of the Internet of things that distinguishes it from other networks.
- The "tentacles" of the Internet of things are a large number of information generation devices located at the perception and identification layer, including RFID, sensors and positioning systems that adopt automatic generation mode, as well as various intelligent devices that adopt manual generation mode, such as smart phones, PDA, multimedia players, netbooks, laptops and so on.
- Diversification of information generation is one of the important characteristics of the Internet of things.
- The perception and recognition layer is located at the bottom of the four-layer model of the Internet of things, which is the foundation of all superstructures.



RFID

Basic Composition： Industry often divides RFID systems into tags, readers and antennas.

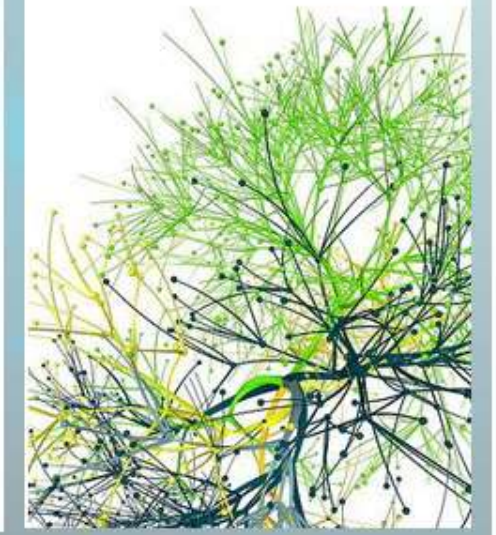
Working Principle： The reader sends an electronic signal through the antenna, and after the tag receives the signal, it transmits the internal stored identification information. The reader receives and recognizes the information sent back by the tag through the antenna, and finally the reader sends the identification result to the host computer.


Tag

Reader


Antenna

See in Chapter 2



Wireless Sensor

Development History:

Sensor→Wireless Sensor→Wireless Sensor Network

Application:

VigilNet: A system developed at the university of Virginia for military surveillance.

Mercury: Wearable medical monitoring sensor developed by Harvard University.

GreenOrbs: Forest monitoring sensor network system, suitable for environmental monitoring tasks.

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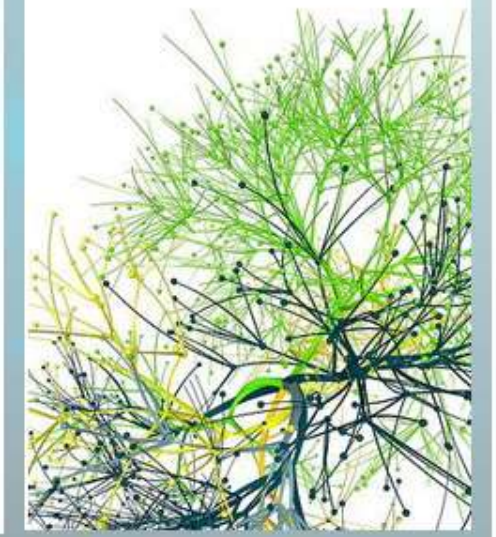


Positioning system

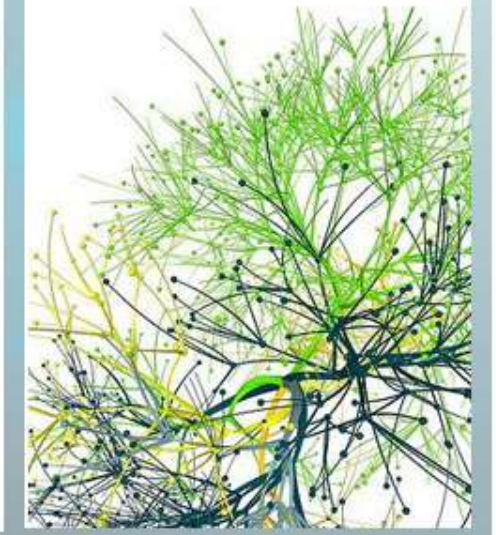
Location information expansion:
Location + Time + Object (person or device)

Positioning system and technology:
GPS, Cellular base station positioning, Wireless indoor environment positioning (Infrared/ Ultrasonic/ Bluetooth, New positioning system (A-GPS/Wireless AP/ Network location)

Challenge：

- ✓ Accurate positioning in heterogeneous network and changeable environment
- ✓ Large-scale application
- ✓ Location based Services
- ✓ Security and privacy protection issues

See in Chapter 4



Smart device

Traditional intelligent equipment :

PC/PDA/…

New smart devices :

Digital signage (Real-time information interaction)/Smart TV(Fully functional Internet, personalized experience)/Smart Phone/ …

Tendency:

- **Deeper intelligence:** Vertical (including traditional intelligent devices) + Vertical (integrating simple physical objects without computing power)
- **More thorough perception:** Active perception (deploy sensor) + passive perception (issue query request)
- **More comprehensive connectivity:** Connectivity and information sharing

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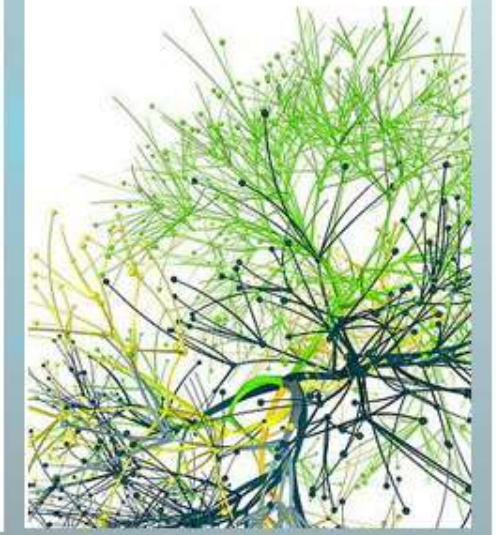
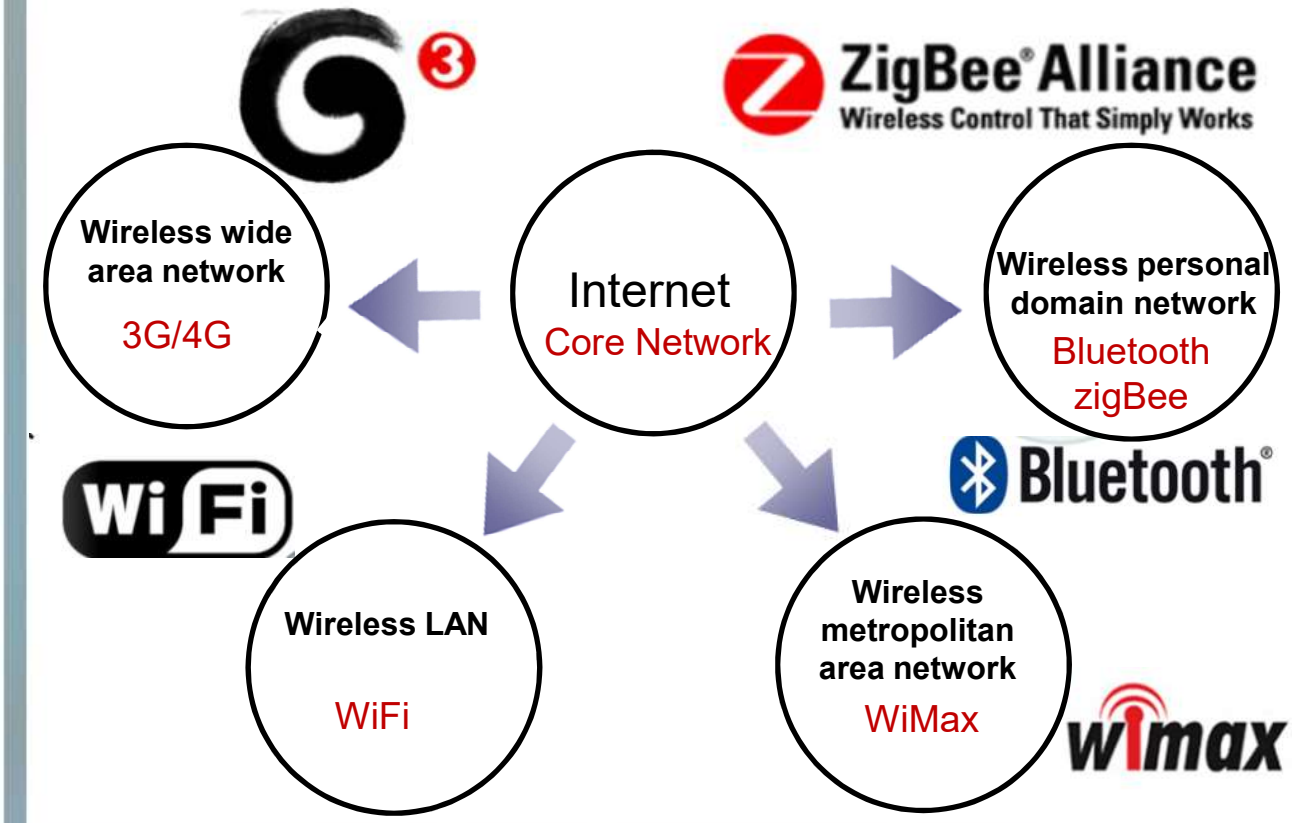


1.2 Network Construction Layer



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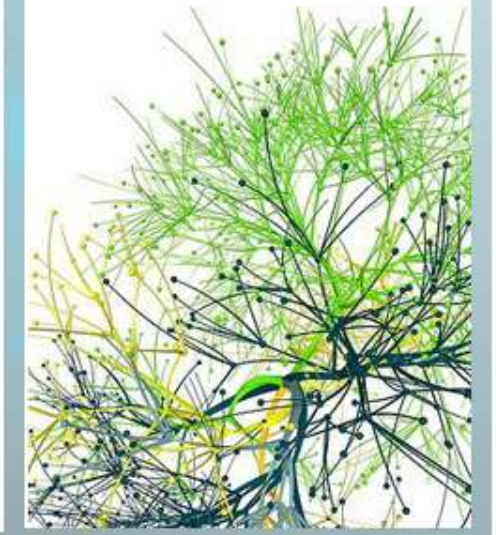


1.2 Network Construction Layer

The Internet is one of the most important infrastructures of the Internet of things.

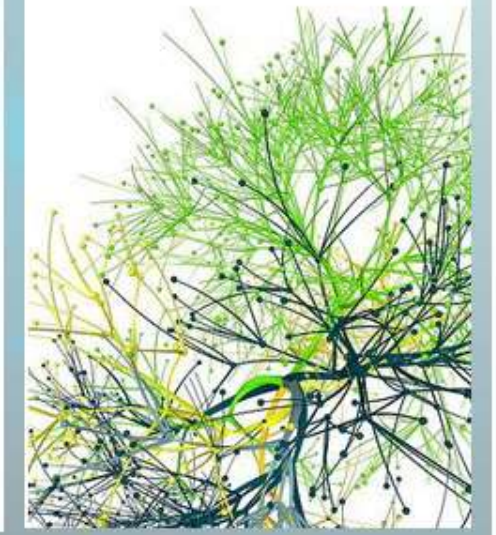
What are the similarities and differences between Internet of things networks and existing networks?

Will the Internet of things be the next Internet?

What role does wireless play in the Internet of things?

The network construction layer connects the perception recognition layer and management service layer in the four-layer model of the Internet of things, which has a powerful bond function, and transmits the data from the upper and lower layers efficiently, stably, timely and securely.

See in Chapter 6-9




How can various forms of network be applied to IoT?

Internet：IPv6 clears the way for a limit on the number of devices connecting to the network. Internet / Telecommunication network is the core network, platform and technical support of IoT.

Wireless broadband network：WiFi/WiMAX and other wireless broadband technologies have a wide coverage and fast transmission speed, providing the Internet of things with high-speed, reliable and cheap interconnection means that are not limited by device's location.

Wireless low speed network： ZigBee/ Bluetooth/Infrared and other low-speed network protocols can adapt to the characteristics of low-power nodes in the Internet of things, such as low rate, low communication radius, low computing power and low energy source.

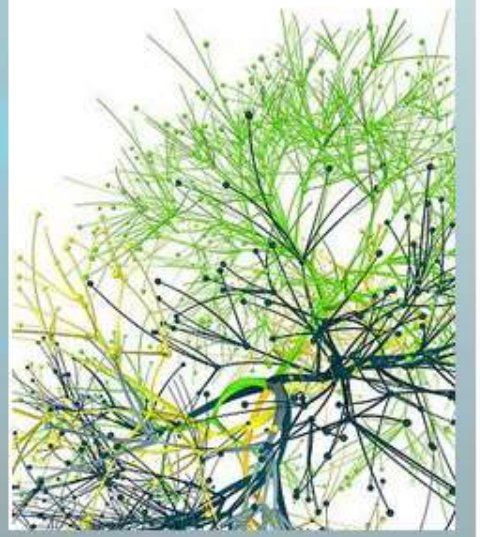
Mobile network：Mobile communication network will become a "comprehensive, anytime, anywhere" effective platform for transmission of information. High-speed, real-time, high coverage, multi-media data processing, creating conditions for "objects to touch the Internet".

1.2 Management service layer

The management service layer is located above the perceptual identification and network construction layer, and below the comprehensive application layer, which is the source of wisdom of IoT. People often call Internet of things applications "smart", such as smart grid, smart transportation, smart logistics, etc., the wisdom of which comes from this layer.

When a large amount of information generated by the perception-recognition layer is transmitted through the network layer and converged to the management service layer, if it cannot be effectively integrated and utilized, it is just like going into the treasure mountain and looking at the "ocean of data" and sighing.

The management services layer addresses the issues of how data is stored (database and mass storage technology), how to retrieve (search engine), how to use (data mining and machine learning), and how not to be abused (data security and privacy protection).



Databases and the Internet of things

Data characteristics of Internet of things :
Magnanimity, polymorphism, relevance and semantics

Relational database system is a data processing technology with a history of nearly half a century, it can still play a big role in the Internet of things and provide support for the operation of the Internet of things. At the same time, combined with the new requirements of Internet of things applications, database technology is also undergoing constant updates and developing new directions.

Emerging database system(NoSQL database)
For non-relational, distributed data storage, the database is not required to have a definite table schema, and the performance of the database is improved by avoiding connection operations.

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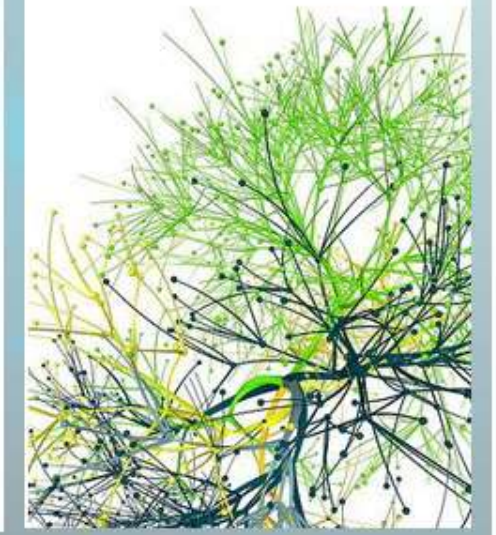

- Mass information storage and Internet of things

Network storage architecture：

- DAS
- NAS
- SAN

Difficult: Only meet the needs of medium-sized businesses

Data center includes not only computer system and supporting equipment (such as communication/storage equipment), but also redundant data communication connection/environmental control equipment/monitoring equipment and security devices. It is a large-scale system engineering. Provide timely and continuous data services through high security and reliability, providing good support for Internet of things applications.

Typical data center: Google/Hadoop

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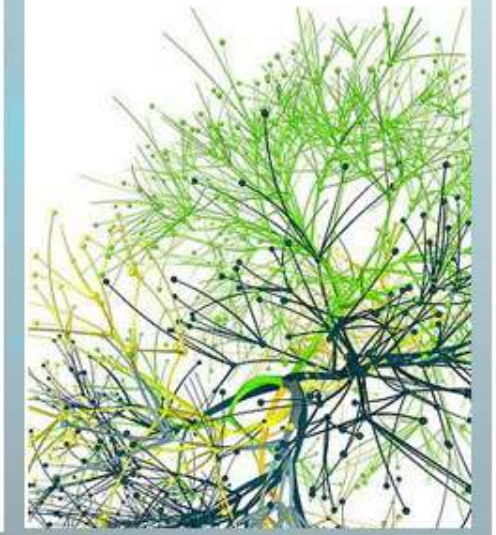

- Search engines and the Internet of things

Web search engine:

A combination of hits list services that return relevant information based on the user's query keywords in a reasonable response time.

Traditional Web search engines are based on query keywords, for the same keywords, you will get the same query results.

New thinking

Consider the relationship between search engine and objects from the perspective of intelligent objects, actively identify objects and extract useful information. The multi-modal information utilization from the user's perspective makes the query results more accurate, more intelligent and more customized.

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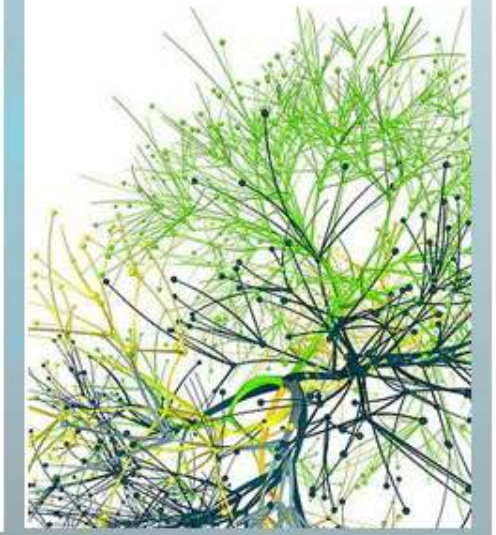

- Intelligent decision making in the Internet of things

Demand analysis:

More thorough perception requires multidimensional integration and analysis of massive data

Greater intelligence requires pervasive data search and services

Data mining technology

To extract potentially useful and understandable patterns from large amounts of data, basic types include association analysis, cluster analysis, evolutionary analysis, etc.

Application：

- •Precision agriculture: real-time monitoring of environmental data, mining important factors affecting yield, yield maximization configuration
- •Marketing: get customers' shopping orientation and interest through database marketing and basket analysis

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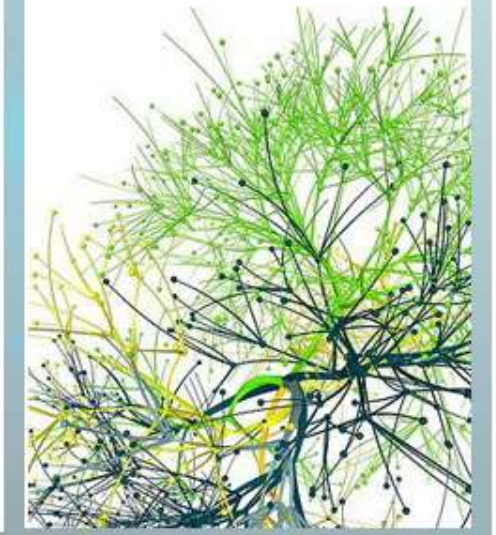

Information security and privacy protection

RFID Security

Major security and privacy concerns:

Eavesdropping, tracking, man-in-the-middle attacks, spoofing/replay/cloning, physical cracking, tampering with information, denial of service attacks, RFID viruses...

Protection:

Physical security mechanism/cryptography security mechanism /PUF.....

Location privacy

Definition : User control over their location: users are free to decide whether to publish location information, to whom, how, and in how much detail.

protection : Institutional constraints, privacy policies, anonymity, data confusion

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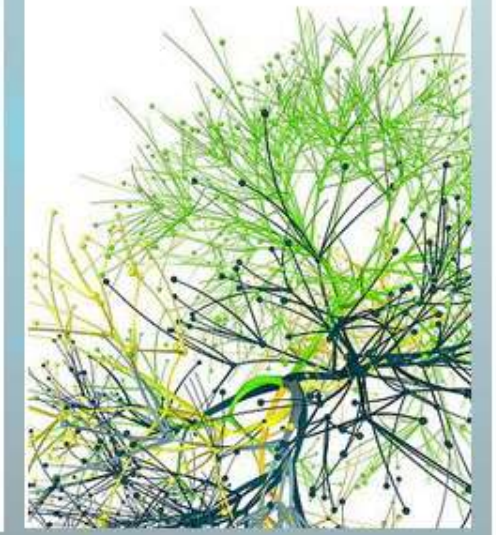
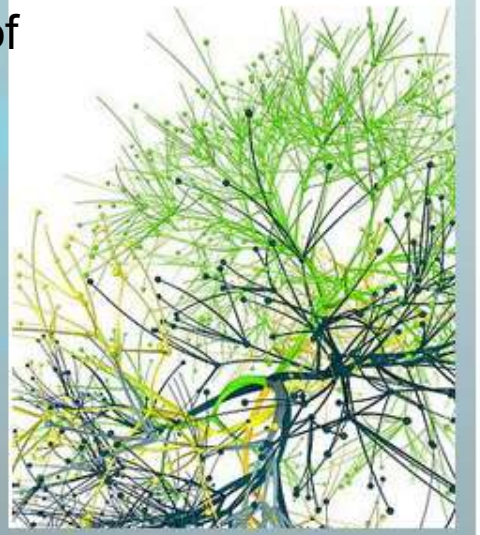


1.2 Comprehensive application layer

No matter what technology is, application is the key to success. The rich connotation of Internet of things promotes more extensive applications.

The traditional Internet has undergone the transformation from data-centered to human-centered. Typical applications include file transmission, E-mail, world wide web, e-commerce, video on demand, online games and social network. Internet of things applications center on "things" or the physical world, covering tracking, environmental awareness, intelligent logistics, intelligent transportation, smart grid and so on. Applications of the Internet of things are now in a rapid growth period, with characteristics of diversification, scale and industry.

See in Chapter 15-19



Content

1.1 Origin and Development
1.2 Core Technology
1.3 **Main Feature**
1.4 Application Prospect

What are the technical and application characteristics of the Internet of things relative to the existing communication and service networks?


1.3 Key features of the Internet of things

Universal perception and recognition

Ubiquitous perception and recognition highly integrates the traditionally separate physical and information worlds.

Heterogeneous device interconnection

Various heterogeneous devices use wireless communication modules and protocols to form a self-organized network, and the heterogeneous network interconnects through "gateway".

Networking terminal scale

In the era of Internet of things, every article has communication function to become a network terminal, and the scale of Internet terminal is expected to exceed 10 billion within 5-10 years.


1.3 Key features of the Internet of things(Next)

Intelligent management control

The Internet of things efficiently and reliably organizes large-scale data, and at the same time, operational research, machine learning, data mining, expert systems and other decision-making tools will be widely used in all walks of life.

Application service chain

Taking industrial production as an example, Internet of things technology covers all links from raw material introduction, production scheduling, energy conservation and emission reduction, storage and logistics to product sales and after-sales service.

Economic development is leapfrogging

Internet of things technology is expected to become an important driving force in the development of national economy from labor-intensive to knowledge-intensive and from resource-wasteful to environment-friendly.

Content

1.1 Origin and Development
1.2 Core Technology
1.3 Main Feature
1.4 **Application Prospect**

The rich connotation of Internet of things promotes more extensive applications.


1.4 The application prospect of Internet of things

Intelligent logistics: Modern logistics systems hope to use information generation equipment, such as RFID equipment, sensors or global positioning system and other devices combined with the Internet to form a huge network, and can realize intelligent logistics management in this materialized logistics network.
Intelligent transportation: To improve the safety, manageability, and efficiency of transportation systems while reducing energy consumption and negative impacts on the earth's environment through the extensive use of information and communication technologies in infrastructure and vehicles.
Green building: Internet of things technology brings new power to green buildings. Through the establishment of building equipment monitoring network aiming at energy conservation, various equipment and systems are integrated together to form the Internet of things application system centering on intelligent processing, which effectively provides strong support for building energy conservation and emission reduction.

1.4 The application prospect of Internet of things(Next)

Smart grid: An advanced modern power system based on advanced communication technology, sensor technology and information technology, and based on information interaction between power grid devices, so as to achieve reliable, safe, economic, efficient, environmentally friendly and safe operation of the power grid.

Environmental monitoring: To track the change of environmental quality, determine the level of environmental quality, and provide basic information, method guidance and quality assurance for environmental management, pollution control, disaster prevention and reduction, etc.


Conclusion

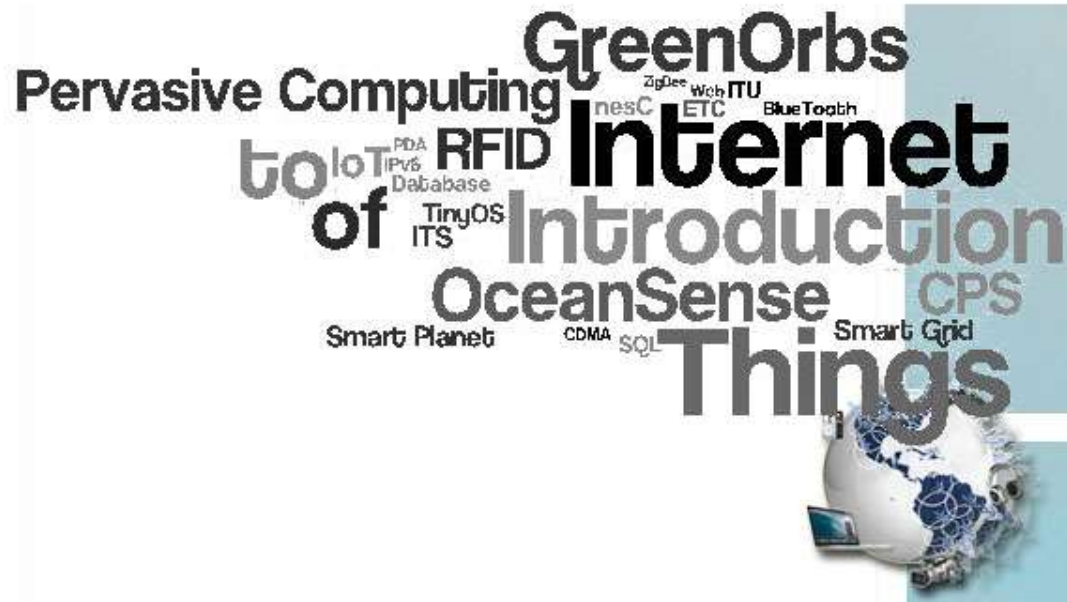
Review

This chapter discusses the origin and development of the Internet of things, core technologies, main features and application prospects.

Key Points

The basic concept of the Internet of things, understand the Internet/telecommunications network is the core network and information carrier of the Internet of things

The four-layer architecture model of Internet of things: perception and identification layer, network construction layer, management service layer, and comprehensive application layer.



Thank you!

Internet of Things