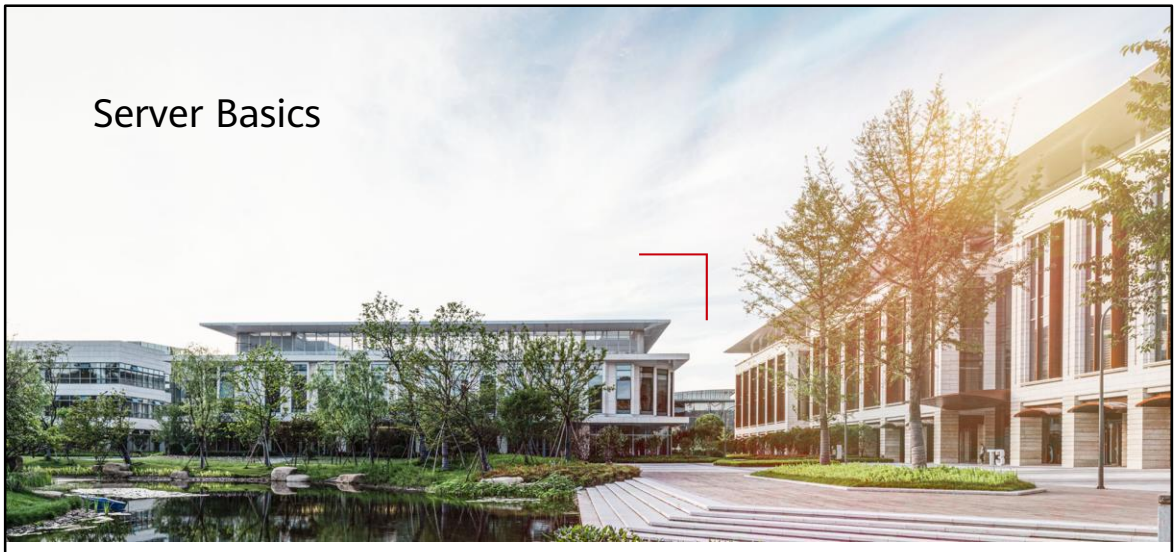
Server Basics



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Foreword

- Servers are the foundation of all service platforms, including cloud computing platforms. But what is a server? What are the key technologies for servers? Let's find the answers in this course, and start our learning journey into cloud computing.

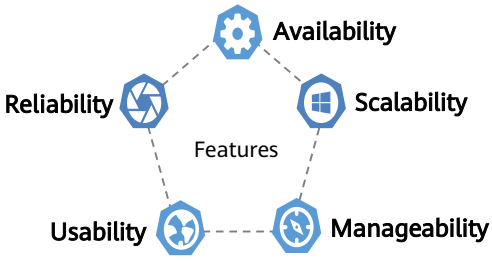
Objectives

- Upon completion of this course, you will be familiar with servers':
  - Role and features
  - Types
  - Hardware components
  - Key technologies

Contents

Server Definition and Features

- Definition
  - A server is a type of computer. It runs faster, carries more loads, and costs more than ordinary computers.
  - A server provides services to users. There are file servers, database servers, and application servers.



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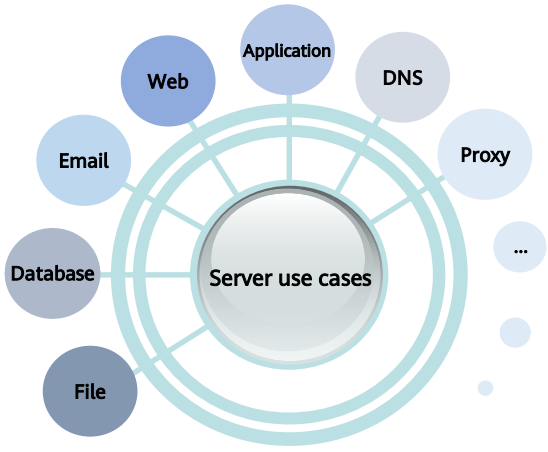
- A server is a mainstream computing product developed in 1990s. It can provide network users with centralized computing, information release, and data management services. In addition, a server can share dedicated communication devices connected to it, such as drives, printers, and modems with network users.
- A server has the following features:
  - R: Reliability – the duration that the server operates consecutively
  - A: Availability – percentage of normal system uptime and use time
  - S: Scalability – including hardware expansion and operating system (OS) support capabilities
  - U: Usability – easy to maintain and restore server hardware and software
  - M: Manageability – monitoring and alarm reporting of server running status, and intelligent automatic fault processing

Server Application Scenarios



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- Servers have been widely used in various fields, such as the telecom carrier, government, finance, education, enterprise, and e-commerce. Servers can provide users with the file, database, email, and web services.
- Server application deployment architecture:
  - C/S: short for Client/Server. In this architecture, the server program runs on the server, and the client software is installed on the client. The server and client perform different tasks. The client carries the front-end GUI and interaction operations of users, and the server processes the background service logic and request data. This greatly improves the communication speed and efficiency between the two ends. For example, you can install the vsftpd program on a file server and start the service. After you install the FileZilla or WinSCP client on your PC, you can upload and download files using the client.
  - B/S: short for Browser/Server. In this architecture, users only need to install a browser. The application logic is centralized on the server and middleware, which improves the data processing performance. For example, when accessing a website, we only need to enter the domain name of the website in the browser, for example, **www.huawei.com**. Then we can see the web services provided by the background servers of the website. We do not need to care the background servers that provide services, such as the database service, proxy service, and cache service.

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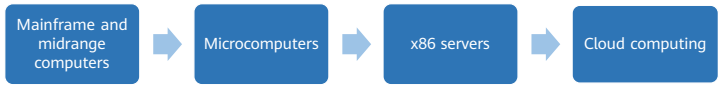
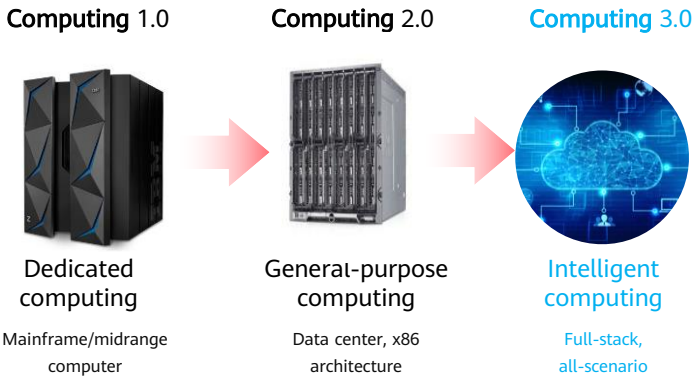
Server Development History



- Mainframe phase
  - In the 1940s and 1950s, the first generation of vacuum tube computers emerged. The computer technology develops rapidly from vacuum tube computers, transistor computers, integrated circuit computers, to large-scale integrated circuit computers.
- Midrange computer phase
  - In the 1960s and 1970s, mainframes were scaled down for the first time to meet the information processing requirements of small- and medium-sized enterprises and institutions. The cost was acceptable.
- Microcomputer phase
  - In the 1970s and 1980s, mainframes were scaled down for the second time. Apple Inc. was founded in 1976, and launched Apple II in 1977. In 1981, IBM launched IBM-PC. After several generations of evolution, it occupied the personal computer market and made personal computers popular.
- x86 server era
  - In 1978, Intel launched the first-generation x86 architecture processor, 8086 microprocessor.
  - In 1993, Intel officially launched the Pentium series, which brought the x86 architecture processor to a new level of performance.
  - In 1995, Intel launched Pentium Pro, the x86 processor for servers, ushering in the x86 era. The standardization and openness of Pentium Pro also promoted the market development and laid a solid foundation for the cloud computing era.

- Cloud computing era
    - Since 2008, the concept of cloud computing has gradually become popular, and cloud computing becomes a popular word. Cloud computing is regarded as a revolutionary computing model because it enables the free flow of supercomputing capabilities through the Internet. Enterprises and individual users do not need to purchase expensive hardware. Instead, they can rent computing power through the Internet and pay only for the functions they need. Cloud computing allows users to obtain applications without the complexity of technologies and deployment. Cloud computing covers development, architecture, load balancing, and business models, and is the future model of the software industry.

A Leap from Computing 1.0 to Computing 3.0



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- The computing industry has developed for nearly half a century and continuously changed other industries. The computing industry itself is evolving.
- In the early mainframe and midrange computer era, dedicated computing is used, which is called computing 1.0. In the x86 era, under the leadership of Intel and driven by Moore's Law, computing has shifted from dedicated to general-purpose. A large number of data centers have emerged, which is called computing 2.0. With the rapid development of digitalization, the world is developing towards intelligent. Computing is not limited to data centers, but also enters the full-stack all-scenario (computing 3.0) era. This era is featured by intelligence, so it is also called intelligent computing.

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Server Classification - Hardware Form

Server Category					
	Mainframe	Midrange computer	Tower server	Blade server	Rack server
Hardware form					

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- **Tower server:**
  - Some tower servers use a chassis roughly the same size as an ordinary vertical computer, while others use a large-capacity chassis, like a large cabinet. An ML series server can be converted into a rack server by using a conversion bracket. ML series servers are housed in a large chassis in which a large number of expansion cards and drives can be installed. Therefore, when user applications increase continuously, the processing capability of the servers can be improved by adding components, meeting the increasing requirements of users and maximizing the return on investment (ROI). The ML series servers feature high availability and support multiple redundant components to prevent system breakdown caused by component faults. Therefore, this series of servers, from entry-level servers to enterprise-level servers, are suitable for a wide range of scenarios. They can support file storage and printing of small-sized enterprises and run central database applications for large-sized enterprises.
- **Rack server:**
  - The appearance of a rack server is different from that of a computer, but is similar to that of a switch. The specifications of a rack server include 1 U (1 U = 1.75 inches), 2 U, and 4 U. A rack server is installed in a standard 19-inch cabinet. Most of the servers in this structure are functional servers. A rack server is usually small in size. Multiple servers can be placed in a cabinet at the same time to obtain a higher processing capability. In addition, the DL series servers are small in size. Therefore, many server features are included in the design, such as the integrated array card and redundant NIC configuration.

For applications that require large data storage space, external extended storage devices can be used. DL series servers are suitable for enterprise data centers and environments with multiple applications. For mission-critical applications, DL series servers are preferred.

- Blade server:
    - Each blade server is a plugboard equipped with processors, memory modules, hard drives, and related components. Due to the special architecture, blade servers require dedicated chassis. Generally, a chassis can hold several to dozens of blade servers, suitable for scenarios such as high-performance computing, front-end servers running multiple applications, and backend central databases.
- For details about mainframes and midrange computers, see the preceding description.

Server Classification - Service Scale

Server Category				
Service scale	Entry-level server	Work group server	Department-level server	Enterprise-level server
	Similar to a PC server	Low-end server that provides small-scale services (about 50 clients)	Mid-range server that serves about 100 clients	High-end server that is accessed by hundreds of clients

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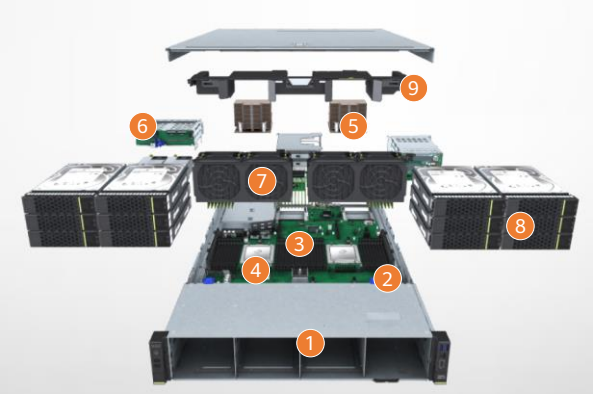
Hardware Structure

- Huawei TaiShan 200 server



1 Chassis
2 Motherboard
3 Memory
4 CPU
5 CPU heat sink
6 Power supply unit (PSU)
7 Fan
8 Drive
9 Air duct

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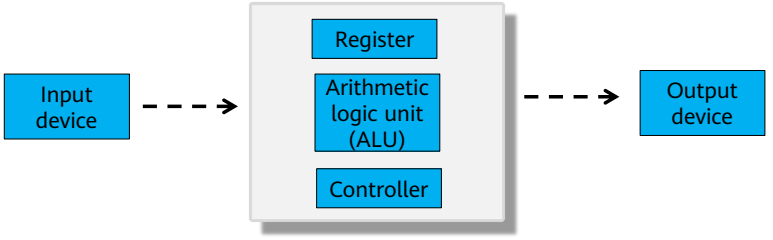
- TaiShan 200 Server User Guide
- 3D model display for a Huawei TaiShan 200 server: https://support-it.huawei.com/server-3d/res/server/taishan2280e/index.html?lang=en

Contents

CPU Definition and Components

- Definition
  - The Central Processing Unit (CPU) is the computing and control core of a computer.
  - The CPU, internal storage, and input/output devices are key components of a computer.
  - The CPU interprets computer instructions and processes computer software data.
- Components
  - The CPU consists of a logic operation unit, a control unit, and a storage unit.



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- The CPU is the core processing unit on a server, and a server is an important device on the network and needs to process a large number of access requests. Therefore, servers must have high throughput and robust stability, and support long-term running. Therefore, the CPU is the brain of a computer and is the primary indicator for measuring server performance.
- The computer controls the entire computer according to a pre-stored program, and the program refers to an instruction sequence that can implement a function. The controller is an organization that issues commands to various logic circuits according to the instructions. The controller is a command center of the computer, controls work of an entire CPU, and determines automation of a running process of the computer.
- The ALU is a part of a computer that performs a variety of arithmetic and logical operations. Basic operations of an ALU include arithmetic operations such as addition, subtraction, multiplication, and division, logical operations such as AND, OR, NOT, and XOR, and other operations such as shift, comparison, and transfer. The ALU is also called the arithmetic logic component.
- The register is used to temporarily store the data involved in operations and the operation results. It can receive, store, and output data.

CPU Frequency

- Dominant frequency
  - The dominant frequency is also called clock speed. It indicates, in MHz or GHz, the frequency at which a CPU computes and processes data.
- External frequency
  - The external frequency is the reference frequency of a CPU, measured in MHz. The CPU external frequency determines the speed of the motherboard.
- Bus frequency
  - The bus frequency directly affects the speed of data exchange between a CPU and a dual in-line memory module (DIMM).
- Multiplication factor
  - The multiplication factor is the ratio of the dominant frequency to the external frequency.

Contents

Memory

- Definition
  - Storage is classified, by purpose, into main memory and external storage. Main memory, referred to as internal storage, is the storage space that the CPU can address.
  - Memory is used to temporarily store CPU operation data and the data exchanged with external storage devices such as hard drives.
  - Memory, one of important computer components, communicates with the CPU.
  - Memory consists of the memory chip, circuit card, and edge connector.

- Storage, an important computer component, is used to store programs and data. For computers, the memory function can be supported and normal working can be ensured only when the storage is available.
- As a main computer component, the memory is in opposition to the external storage. Programs, such as the Windows operating system, typing software, and game software, are usually installed on external storage devices such as drives. To use these programs, you must load them into the memory. Actually, the memory is used when we input a piece of text or play a game. Bookshelves and bookcases for putting books are just like the external storage, while the desk is like the memory. Generally, we store large volumes of data permanently in the external storage and store small volumes of data and a few programs temporarily in the memory.
- Memory, one of important computer components, communicates with the CPU. Memory performance has great impacts on computers because all computer programs operate in the memory. The memory consists of the memory chip, circuit card, and edge connector.
- DIMM slots and configuration principles:
  - DIMMs on the same server must be of the same model.
  - At least one DIMM must be configured in slots supported by CPU 1.
  - Optimal memory performance can be achieved if the processors in a server are configured with the same number of DIMMs and the DIMMs are evenly distributed among the memory channels. Unbalanced configuration impacts memory performance and is not recommended.

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Server Hardware

- Hardware Structure
- CPU
- Memory
- Drive
- RAID Controller Card
- NIC
- PSU and Fan Module

Drive

- The drive is the most important storage device of a computer.
- The drive interface, connecting a drive to a host, is used to transmit data between the drive cache and the host memory. The drive interface type determines the connection speed between the drive and the computer, how quickly programs run, and overall system performance.

	SATA	SAS	NL-SAS	SSD
Rotational speed (RPM)	7,200	15,000/10,000	7,200	N/A
Serial/Parallel	Serial	Serial	Serial	Serial
Capacity (TB)	1 TB/2 TB/3 TB	0.6 TB/0.9 TB	2 TB/3 TB/4 TB	0.6 TB/0.8 TB/1.2 TB/1.6 TB
MTBF (h)	1,200,000	1,600,000	1,200,000	2,000,000
Remarks	Developed from ATA drives, SATA 3.0 supports data transfer up to 600 MB/s. The annual failure rate of SATA drives is about 2%.	SAS drives are designed to meet high-performance enterprise requirements and are compatible with SATA drives. The transfer rate ranges from 3.0 Gbit/s to 6.0 Gbit/s, and can increase to 12.0 Gbit/s. The annual failure rate of SAS drives is less than 2%.	An NL-SAS drive is an enterprise-level SATA drive with a SAS interface. It is used to implement tiered storage in a drive array, simplifying drive array design. The annual failure rate of NL-SAS drives is about 2%.	A solid-state drive (SSD) is a hard drive housing a solid-state electronic storage chip array. An SSD consists of a control unit and a storage unit (flash or DRAM chip). An SSD is the same as a common hard drive in terms of interface specifications and definition, function, usage, and product shape and size.

- MTBF: Mean Time Between Failures
- SATA and NL-SAS drives are cheaper, SAS drives are more expensive, and SSDs are the most expensive.

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Server Hardware

- Hardware Structure
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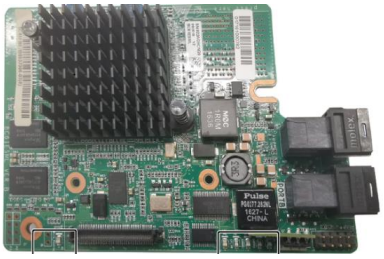
RAID Controller Card

- Also called the RAID card.
- Functions of the RAID controller card:
  - Combines multiple drives into a system managed by the array controller according to requirements.
  - Improves drive subsystem performance and reliability.



LSI SAS3108

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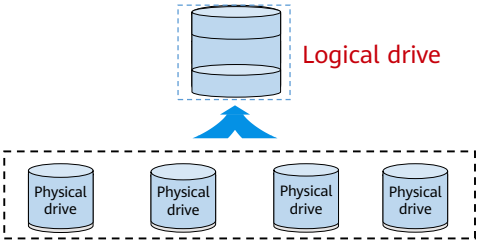
- LSI SAS3108 RAID Controller Card User Guide: https://support.huawei.com/enterprise/en/doc/EDOC1100048773/653c6b1f

RAID

- Definition
  - Redundant Array of Independent Disks (RAID) is a data storage virtualization technology that combines multiple physical disk drive components into one or more logical units for the purposes of data redundancy, performance improvement, or both.

--Wikipedia



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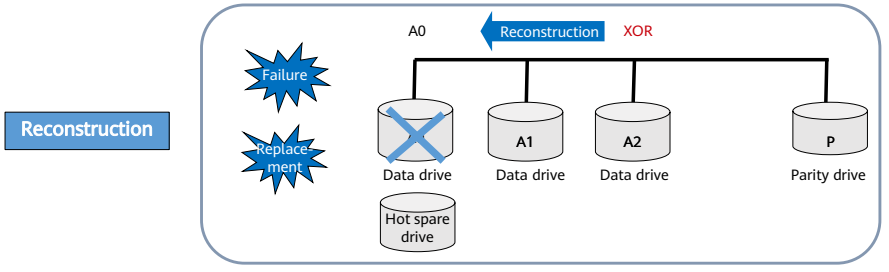
- For details about the working principles of RAID, see the course of storage basics.

RAID Hot Spare and Reconstruction

- Hot spare definition
  - If a drive in a RAID array fails, a hot spare is used to automatically replace the failed drive to maintain the RAID array's redundancy and data continuity.
- Hot spare types
  - Global: The spare drive is shared by all RAID arrays in the system.
  - Dedicated: The spare drive is used only by a specific RAID array.



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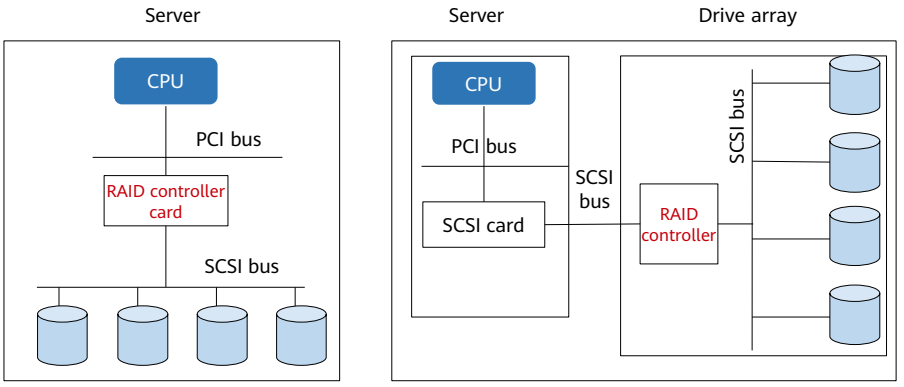
- Data parity: Redundant data is used to detect and rectify data errors. The redundant data is usually calculated through Hamming check or XOR operations. Data parity can greatly improve the reliability, performance, and error tolerance of the drive arrays. However, the system needs to read data from multiple locations, calculate, and compare data during the parity process, which affects system performance.
- Generally, RAID cannot be used as an alternative to data backup. It cannot prevent data loss caused by non-drive faults, such as viruses, man-made damages, and accidental deletion. Data loss here refers to the loss of operating system, file system, volume manager, or application system data, not the RAID data loss. Therefore, data protection measures, such as data backup and disaster recovery, are necessary. They are complementary to RAID, and can ensure data security and prevent data loss at different layers.

RAID Implementation - Hardware



Hardware RAID mode 1: built-in plug-in card

Hardware RAID mode 2: external independent drive array

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- Hardware RAID is implemented using a hardware RAID adapter card.
- The hardware RAID can be a built-in or external RAID.
- A RAID controller card has a processor inside and can control the RAID storage subsystem independently from the host. The RAID controller card has its own independent processor and memory. It can calculate parity information and locate files, reducing the CPU computing time and improving the parallel data transmission speed.

RAID Implementation - Software

- Definition
  - Software RAID implements RAID functions by installing software on the operating system.
- Characteristics
  - Software RAID does not require expensive RAID controller cards, reducing the cost.
  - RAID functions are performed by CPUs, requiring significant CPU resources, such as for large numbers of RAID 5 XOR operations.

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- Software RAID does not provide the following functions:
  - Hot swap of drives
  - Drive hot spare
  - Remote array management
  - Support for bootable arrays
  - Array configuration on drives
  - S.M.A.R.T. for disks

RAID Implementation - Mode Comparison

Mode	Software RAID	Built-in RAID	External RAID
Characteristics	All RAID functions are implemented by CPUs, resulting in high CPU usage and reduced system performance.	Built-in RAID improves performance by reducing host CPU usage caused by intensive RAID operations.	External RAID, connecting to a server through a standard controller, is independent of the operating system. All RAID functions are implemented by the microprocessor on the external RAID storage subsystem.
Advantages	▫ Low implementation cost ▫ Flexible configurations	▫ Data protection and high speed ▫ Better fault tolerance and performance than software RAID ▫ More cost-effective than external RAID ▫ Support for bootable arrays	▫ Provides ultra-large-capacity storage systems for high-end servers. ▫ Configures dual controllers to improve data throughput or provide shared storage for the two-node cluster. ▫ Supports hot swapping. ▫ Delivers better scalability.

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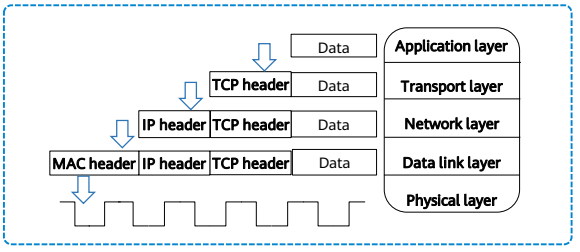
- NIC
- PSU and Fan Module

NIC Definition and Functions

- Definition
  - A network interface card (NIC or network adapter) is an indispensable part of a computer network system. An NIC enables a computer to access networks.

- Functions
  - Fixed network address
  - Data sending and receiving
  - Data encapsulation and decapsulation
  - Link management
  - Encoding and decoding



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- *TaiShan 200 DA121C Server Node Maintenance and Service Guide*

Huawei Server NICs

- LOM card
  - It is embedded directly into the PCH chip on the server motherboard and cannot be replaced.
  - It provides two external GE electrical ports + two 10 Gbit/s optical/electrical ports. LOM cards do not occupy PCIe slots.
- PCIe card
  - Huawei has both self-developed and purchased PCIe cards. They can be installed in standard PCIe slots.
- FlexIO card
  - Huawei-developed, non-standard PCIe card, which can only be used with Huawei rack servers.
- Mezzanine card
  - Mezzanine cards are only used on the compute nodes of Huawei E9000 blade servers.


LOM card


PCIe card


FlexIO card


Mezzanine card

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- PCI-Express (PCIe) is the third-generation I/O bus, or 3GIO, following ISA and PCI buses. This bus was proposed by Intel at the Intel Developer Forum (IDF) in 2001 and renamed PCI-Express after being certified and released by the PCI special interest group (SIG). Its main advantages are high data transmission rate, strong anti-interference, long transmission distance, and low power consumption.
- For Huawei servers, a PCIe card refers to the NIC in a PCIe slot.
- Visit the link below to learn how to install and remove a PCIe card:

https://support.huawei.com/enterprise/en/doc/EDOC1100002169?section=o00d

- *FusionServer Rack Server Product Documentation*
- *TaiShan 200 DA121C Server Node Maintenance and Service Guide*
- *E9000 Blade Server Product Documentation*

Contents

Server Hardware

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PSU and Fan Module

- Supplies power to servers.
- Supports redundancy to prevent power supply failures.
  - Fault warning and prevention
  - Pre-fault preventive maintenance
  - Non-disruptive server services
- The power supply subsystem includes:
  - Intelligent PSU
  - Fan module

PSU

Fan module

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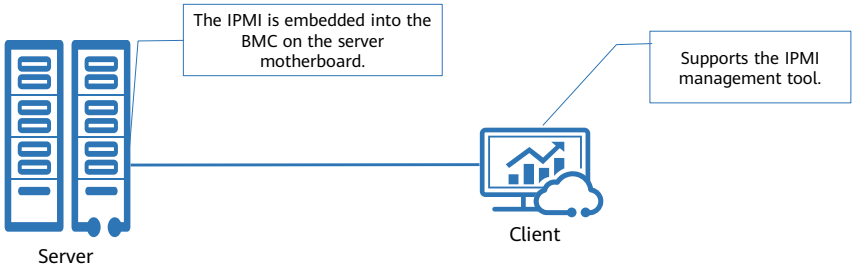
- Power supply redundancy modes:
  - 1+1: In this mode, each module provides 50% of the output power. When one module is removed, the other provides 100% of the output power.
  - 2+1: In this mode, three modes are required. Each module provides 1/3 of the output power. When one module is removed, each of the other two modules provides 50% of the output power.
- *E9000 Blade Server Product Documentation*

Contents

What Is IPMI?

- Definition
  - The Intelligent Platform Management Interface (IPMI) is a set of open and standard hardware management interface specifications that defines specific methods for communication between embedded management subsystems.
  - IPMI information is exchanged using the baseboard management controller (BMC). Entry-level intelligent hardware, not the OS, handles management.



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- The IPMI is an industrial specification used for peripherals in Intel-based enterprise systems. This interface specification was laid down by Intel, HP, NEC, Dell, and SuperMicro. Users can use the IPMI to monitor the physical health status of servers, such as the temperature, voltage, fan status, and power status. Moreover, the IPMI is a free specification. Users do not need to pay for this specification.
- IPMI development:
  - In 1998, Intel, DELL, HP, and NEC put forward the IPMI specification. The temperature and voltage can be remotely controlled through the network.
  - In 2001, the IPMI was upgraded from version 1.0 to version 1.5. The PCI Management Bus function was added.
  - In 2004, Intel released the IPMI 2.0 specification, which is compatible with the IPMI 1.0 and 1.5 specifications. Console Redirection is added. Servers can be remotely managed through ports, modems, and LANs. In addition, security, VLANs, and blade servers are supported.

BMC

- Definition
  - The BMC complies with the IPMI specification. It collects, processes, and stores sensor signals, and monitors component operating status. It supplies the chassis management module with managed objects' hardware status and alarm information. The management module uses this information to manage the devices.

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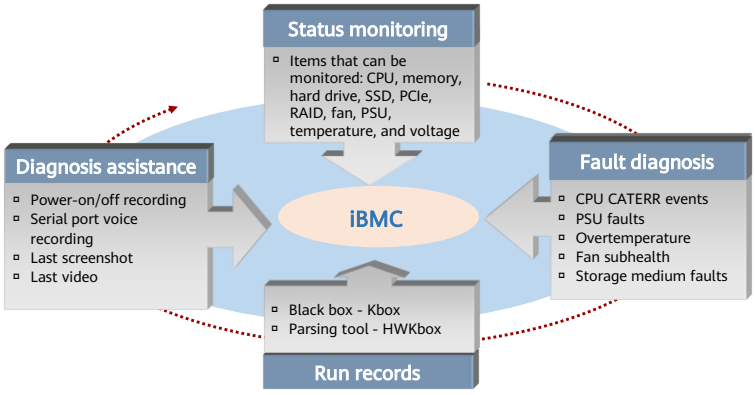
- The BMC provides the following functions:
  - Remote control
  - Alarm management
  - Status check
  - Device information management
  - Heat dissipation control
  - Support for IPMItool
  - Web-based management
  - Centralized account management

iBMC

- The Huawei Intelligent Baseboard Management Controller (iBMC) is a Huawei proprietary embedded server management system designed for the whole server lifecycle.



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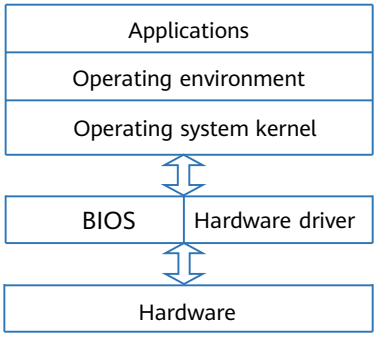
- The iBMC provides a series of management tools for hardware status monitoring, deployment, energy saving, and security, and standard interfaces to build a comprehensive server management ecosystem. The iBMC uses Huawei-developed management chip Hi1710 and multiple innovative technologies to implement refined server management.
- The iBMC provides a variety of user interfaces, such as the CLI, web-based user interface, IPMI integration interface, SNMP integration interface, and Redfish integration interface. All user interfaces adopt the authentication mechanism and high-security encryption algorithm to enhance access and transmission security.

Contents

BIOS

- Basic Input/Output System (BIOS)
- The BIOS is a system's foundation: a group of programs providing the most direct control of system hardware.



BIOS functions:

- Hardware detection and initialization
- OS boot
- Advanced power management

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- The BIOS is a bridge between the system kernel and the hardware layer.
- Functions of the BIOS:
  - Software upgrade and loading
  - Basic OAM functions
  - Serial port management
  - Fault recovery
  - ECC management
  - Hardware diagnosis

Quiz

1. Which of the following statements are true about the NICs of Huawei servers?
   A. The LOM card is embedded into the PCH chip on the server motherboard and cannot be replaced.
   B. Huawei-developed PCIe cards can be installed in standard PCIe slots.
   C. A FlexIO card is integrated with the server panel for front-end service connection.
   D. Mezzanine cards can be used with Huawei rack servers.
2. The BMC complies with the IPMI specification. It collects, processes, and stores sensor signals, and monitors component operating status.
   A. True
   B. False

- Answers:
  - AB
  - A

Summary

- In this course, we have learned the basic concepts, development history, hardware components, and key technologies of servers. In the following course, we will learn about storage technologies. Stay tuned.

Recommendations

- Huawei iLearning
  - https://e.huawei.com/en/talent/portal/#/
- Huawei Support Case Library
  - https://support.huawei.com/enterprise/en/knowledge?lang=en

Acronyms and Abbreviations

- BIOS: Basic Input/Output System
- BMC: Baseboard Management Controller
- B/S: browser/server architecture
- C/S: client/server architecture
- CPU: Central Processing Unit
- iBMC: Huawei Intelligent Baseboard Management Controller
- IPMI: Intelligent Platform Management Interface
- MTBF: Mean Time Between Failures
- NIC: Network Interface Card
- RAID: Redundant Array of Independent Disks

Thank you.

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每个组织，构建万物互联的智能世界。

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