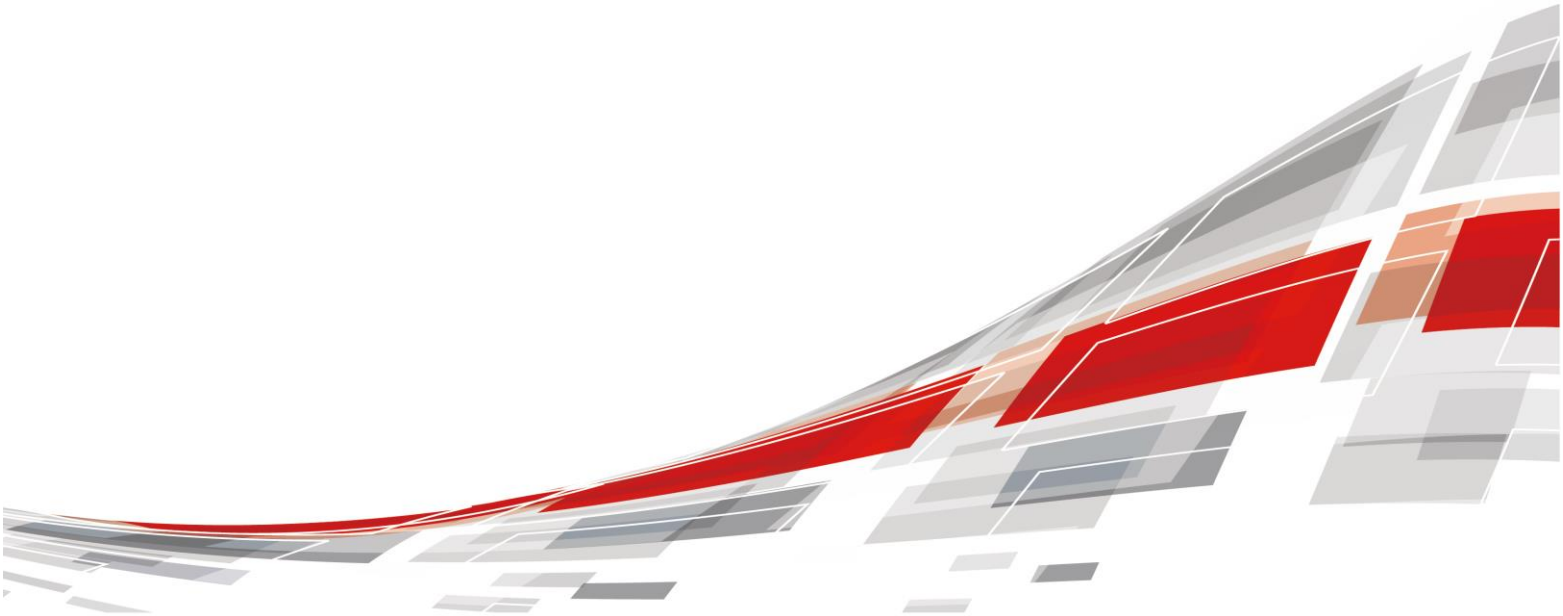
FusionDirector Management Software

Technical White Paper

Issue	**13**
Date	**2025-01-03**



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About This Document

Purpose

This document describes the application scenarios, system architecture, functions, and typical networking of FusionDirector.

Intended Audience

This document is intended for:

- Marketing engineers
- Technical support engineers
- Maintenance engineers

Symbol Conventions

The symbols that may be found in this document are defined as follows.

Symbol	Description
DANGER	Indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in equipment damage, data loss, performance deterioration, or unanticipated results. **NOTICE** is used to address practices not related to personal injury.
NOTE	Supplements the important information in the main text. **NOTE** is used to address information not related to personal injury, equipment damage, and environment deterioration.

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Change History

Issue	Release Date	Description
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09	2024-01-05	This issue is the ninth official release.
08	2023-09-27	This issue is the eighth official release.
07	2023-06-30	This issue is the seventh official release.
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01	2021-10-30	This issue is the first official release.

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Contents

About This Document ii

1 Brief Introduction 1

2 System Architecture 3

2.1 Architecture Overview 3
2.1.1 System Architecture 3
2.1.2 System Context Connection Mode 5
2.2 Key Technical Features 6
2.3 Deployment Mode 7
2.3.1 Enterprise Scenarios 7
2.4 Upgrade Method 8
2.5 Management Scale and Recommended Configurations 9

3 Product Functions 11

3.1 Overview 11
3.2 Quick and Flexible Management Mode 12
3.2.1 Server Management 13
3.2.1.1 Third-Party Server Management Capability 13
3.2.2 Chassis Management 14
3.2.3 iRM Management 15
3.2.4 Storage Management 15
3.2.5 Network Management 15
3.2.6 Infrastructure Management 15
3.2.7 OS Management 16
3.3 Comprehensive Device Information Monitoring 16
3.3.1 Server Information Display 16
3.3.2 Server Group Management 17
3.3.3 Server Information Search 18
3.3.4 Network Status Query 18
3.3.5 Alarm Management 18
3.3.6 Log Management 19
3.3.7 Performance Monitoring 19
3.3.8 Task Management 20
3.3.9 Health Inspection 21

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3.4 Intelligent Deployment Management 21
3.4.1 Customer Pain Points 21
3.4.2 Basic Device Configuration 21
3.4.2.1 Server Profile Management 21
3.4.2.2 Server Configuration Items 22
3.4.2.3 E9000 Network Management Model 23
3.4.2.3.1 Network Configuration Model 23
3.4.2.3.2 Switch Module Stacking 24
3.4.2.3.3 Uplink Port Group 25
3.4.2.3.4 Network 25
3.4.2.4 Network Configuration Items of the E9000 Chassis 25
3.4.3 Basic Device Deployment 25
3.4.3.1 Image Management 26
3.4.3.2 OS Deployment 26
3.4.4 Automatic Installation Planning 27
3.4.4.1 By Location 28
3.4.4.2 By SN/MAC 28
3.4.4.3 By Static IP Address 28
3.4.4.4 By Managed Device 28
3.4.4.5 Installation Plan Report Export 28
3.5 Intelligent Asset Management 29
3.5.1 Customer Pain Points 29
3.5.2 Solution Overview 29
3.5.3 Feature Description 31
3.5.3.1 Asset Panorama 31
3.5.3.2 Asset Details 31
3.5.3.3 Asset Change Statistics 31
3.5.3.4 Rack Details 32
3.5.3.5 Interconnection with a Third-Party CMDB 32
3.5.3.6 E-Warranty Management 32
3.5.3.7 Maintenance Management 32
3.5.4 Benefits 33
3.5.4.1 Automatic Asset Stocktaking and Asset Change Management with High Security and Efficiency 33
3.5.4.2 3D Visualization of DCs for Better Operation Efficiency 34
3.5.4.3 Faulty Asset Change Statistics for Fault Data Analysis 35
3.6 Intelligent Version Management 36
3.6.1 Customer Pain Points 36
3.6.2 Update Package Repository Management 36
3.6.3 Common Update Schedule Management 37
3.6.3.1 One-Off Update 37
3.6.3.2 Automatic Update Check 37
3.6.4 OTA Update Schedule Management 38

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3.6.5 Devices That Can Be Updated 38
3.7 Intelligent Fault Management 39
3.7.1 Customer Pain Points 39
3.7.2 Solution Overview 41
3.7.2.1 Fault Detection 42
3.7.2.2 DISK/DIMM Fault Diagnosis 43
3.7.2.3 NPU Fault Diagnosis 43
3.7.2.4 Fault Analysis 44
3.7.2.5 Fault Reporting 44
3.7.2.6 Disk Fault Prediction 44
3.7.2.7 DIMM Fault Prediction 45
3.7.3 Benefits 46
3.8 Intelligent Energy Efficiency Management 47
3.8.1 Customer Pain Points 47
3.8.2 Solution Overview 50
3.8.3 Benefits 52
3.8.3.1 Higher Rack Power Usage and Lower Equipment Room Construction Costs 52
3.8.3.2 Dynamic Energy Saving Without Service Awareness and Lower Power Costs 53
3.8.3.3 Automatic Server Status Identification for Service Deployment Optimization 55
3.9 Security Management 55
3.9.1 User Management 55
3.9.2 Authentication Management 56
3.9.3 Security Configuration 56
3.9.4 License Management 57
3.9.5 CC EAL2+ Certification 57
3.10 Layered Management 57
3.11 Interconnections 58
3.11.1 Remote O&M (Call Home) 58
3.11.2 Mobile O&M 59
3.11.3 SMTP Interconnection 60
3.11.4 vCenter Server Interconnection 61
3.11.5 SNMP Trap Interconnection 61

4 Typical Networking 62

4.1 Enterprise Networking 62
4.2 E9000 Embedded Networking 63

5 Networking Constraints 64

A Glossary 65

B Acronyms and Abbreviations 67

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1 Brief Introduction

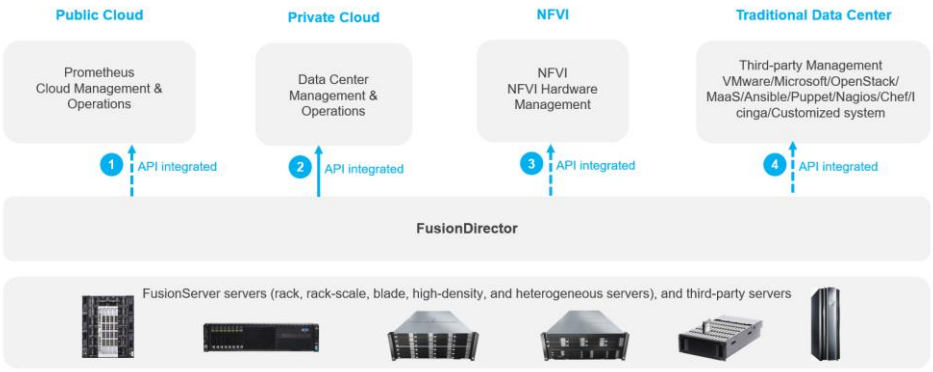
FusionDirector is a cluster management software which enables unified, simple, and efficient O&M for xFusion and third-party servers in their whole lifecycle, delivering public cloud and enterprise customers ultimate experience.

It implements 3D visualized management and fault diagnosis, and provides lifecycle management capabilities such as device management, device configuration, firmware upgrade, device monitoring, and OS deployment, improving O&M efficiency at more lower costs.

It can be widely used in public cloud, private cloud, NFVI, and traditional data centers. It is deployed in multiple scenarios such as AI, HPC, Internet, and Safe City.

It also provides standard Native Redfish interfaces to integrate or interconnect with customer systems.

Figure 1-1 Application scenarios



- Provides large-scale server automatic O&M capabilities for public clouds.
- Provides one-stop hardware management capabilities for private clouds.
- Provides a basic hardware management platform for NFVI.
- Provides refined hardware management capabilities for data centers.

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- Serves as a bridge between the hardware and open environment and provides core competitiveness of server products.

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2 System Architecture

2.1 Architecture Overview
2.2 Key Technical Features
2.3 Deployment Mode
2.4 Upgrade Method
2.5 Management Scale and Recommended Configurations

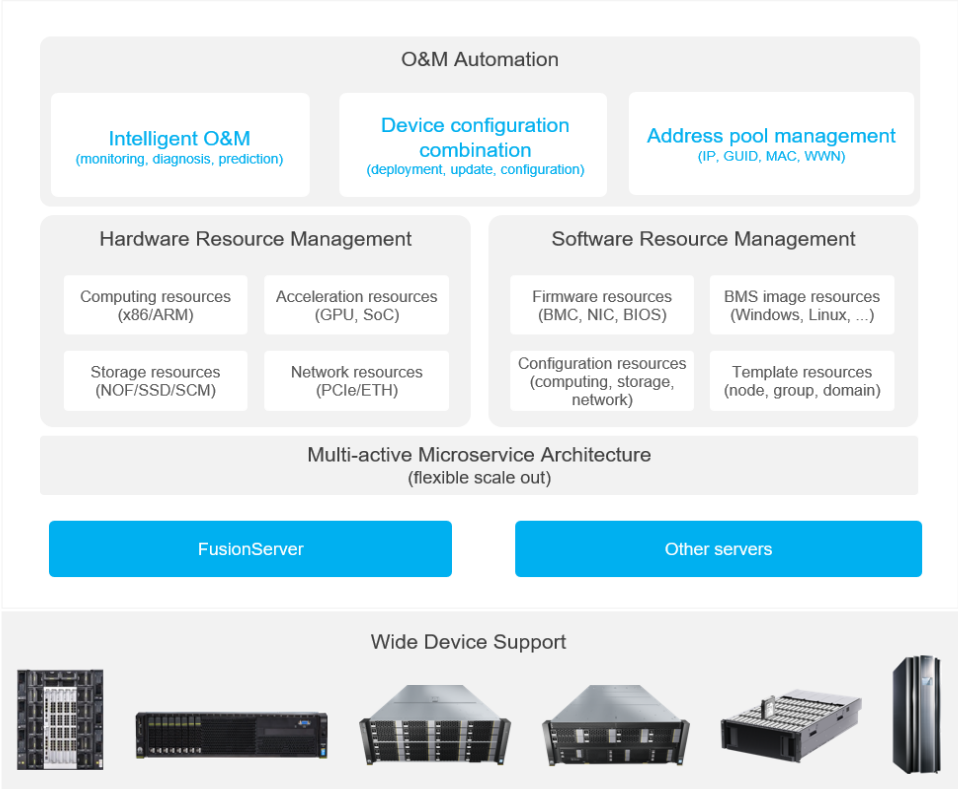
2.1 Architecture Overview

2.1.1 System Architecture

FusionDirector adopts a new software architecture to provide the functions shown in Figure 2-1.

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Figure 2-1 Software architecture



- Advanced RISC Machine (ARM): Smartphone/Device architecture
- Non-Volatile Memory Express (NVMe)
- System on Chip (SoC)
- Storage Class Memory (SCM)

Centralized Management and Scheduling

- Basic features: monitoring, alarm, logs, software upgrade, and Design for X (DFX)
- Five intelligences: intelligent deployment management, asset management, version management, fault management, and energy efficiency management

Support for Full-Series Servers

- Supports general-purpose devices such as rack servers, rack-scale servers, high-density servers, heterogeneous servers, and blade servers. For details, see the *FusionDirector Specifications List*.
- Allows hybrid management of multiple types of devices.

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High Availability and Flexible Scale-Out Capabilities

- Adopts the microservice-based architecture (Docker+Swarm) to support scale-out and multi-node multi-active (HA) features.
- Features lightweight and low resource consumption, and supports management of x86 servers.
- Supports a wide range of management scale from hundreds of devices to tens of thousands of devices.
- Adopts the container service architecture and supports RESTful APIs to build multi-scenario service capabilities.

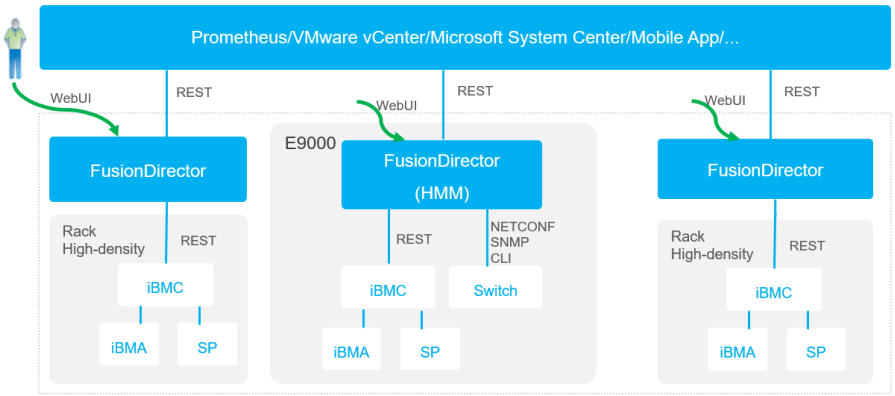
Flexible Combination of Installation Modes and Applications

- Supports enterprise VM image installation and built-in E9000 MM920 installation.
- Provides Native Redfish APIs for interconnection and integration.

2.1.2 System Context Connection Mode

- FusionDirector connects to the iBMC over the southbound REST interface (complying with the Redfish standard).
- FusionDirector connects to the E9000 server switch module over the southbound SNMP, NETCONF, or CLI interface.
- The northbound REST interface connects to the upper-layer management software, public cloud O&M platform, or third-party management system. OpenAPI documentation is provided on the technical support website and the system WebUI.
- The northbound WebUI interface is provided for O&M administrators.

Figure 2-2 System context connection mode



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2.2 Key Technical Features

Lightweight Deployment in Multiple Scenarios and Full-lifecycle Management of Devices

FusionDirector provides various deployment capabilities, including KVM, VMware, and Hyper-V VM deployment, built-in management module deployment, and bare metal server (BMS) deployment. It meets the requirements for server lifecycle management in small-, medium-, and large-sized enterprises, as well as large-scale public cloud projects. The management experience in the public cloud projects can be shared with enterprise customers for more efficient device management.

High Reliability and Scale-out Capability from 1 to N Nodes

FusionDirector provides high reliability in various scenarios and supports the smooth expansion of one set of FusionDirector system from 1 to N nodes to cope with capacity expansion scenarios without affecting existing services (the enterprise edition supports up to four nodes, and the E9000 edition supports up to six nodes).

Layered Deployment for Ultra-Large-Scale NMS Requirements

FusionDirector supports upper-layer and lower-layer deployment. FusionDirector Global provides a global monitoring interface and a unified management portal for up to 256 FusionDirector systems, improving the O&M efficiency of ultra-large-scale NMSs.

Comprehensive Device Status Monitoring for Overall Service Control

FusionDirector monitors the hardware status and performance of servers, helping O&M personnel quickly detect faulty devices.

Batch Configuration, Deployment, and Upgrade to Accelerate Service Rollout

FusionDirector allows operators to configure, deploy, and upgrade service systems on servers in batches, improving server O&M efficiency.

Batch Device Profile Configuration to Improve O&M Efficiency

FusionDirector provides the profile configuration function to flexibly change hardware configurations, improving the efficiency of faulty device replacement and server capacity expansion.

Online and Offline Version Management to Improve Version Management Efficiency

FusionDirector provides online and offline version management capabilities, improving server version management efficiency.

Intelligent Asset Management, Implementing Real-time Device Asset Management

FusionDirector interconnects with the Intelligent Rack Manager (iRM) to manage assets in real time. Asset installation, removal, and parts replacement can be

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synchronized to FusionDirector in real time. All asset changes are recorded in detail, improving asset counting efficiency and reducing asset management security risks.

Intelligent Fault Management for Better Service Experience

FusionDirector supports health status monitoring for all out-of-band hardware parts and fault prediction for disks, improving O&M efficiency and service experience.

Native Redfish Interfaces for Customer System Integration and Interconnection

FusionDirector provides standard Native Redfish interfaces to integrate or interconnect with customer systems.

NPU Fault Diagnosis for Enhanced Version Management Efficiency

FusionDirector supports NPU fault diagnosis to ensure the stability and reliability of NPU operation.

2.3 Deployment Mode

FusionDirector supports multiple deployment modes in the enterprise scenarios and provides cluster scale-out and layered management capabilities. The system can be expanded based on service requirements to support large-scale device management.

2.3.1 Enterprise Scenarios

- In the following deployment mode, FusionDirector is preinstalled and does not need to be installed by customers:

  FusionDirector is embedded in the management module MM920 of an E9000 server, installation free and plug-and-play.
- In the following deployment mode, a database is contained in the FusionDirector installation package and does not need to be prepared by customers:

  FusionDirector is deployed on existing OSs of customers: CentOS 7.6, FusionOS 22.0, and FusionOS 23.0. Packages for x86 and ARM architecture are provided.
- In the following deployment mode, a database and an OS are contained in the FusionDirector installation package and do not need to be prepared by customers.

  FusionDirector is deployed on the following BMSs: 2288H V5/V6/V7 and 1288H V5/V6/V7.

  FusionDirector is deployed on the following VMs: Table 2-1.

Table 2-1 Supported VM types in enterprise scenarios

Virtualization Type	Virtualization Platform OS Version	Description
VMware vSphere ESXi	6.5	Supports virtualization based on x86 physical machines.
	6.5 Update 1	

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Virtualization Type	Virtualization Platform OS Version	Description
	6.5 Update 2	
	6.5 Update 3	
	6.7	
	7.0	
	8.0	
	8.0 Update 1	
	8.0 Update 2	
Microsoft Hyper-V	Windows Server 2012 R2	Supports virtualization based on x86 physical machines.
	Windows Server 2016	
KVM	CentOS 7.6	Supports virtualization based on x86 physical machines.
	RHEL 7.2	
	RHEL 7.3	
	RHEL 7.5	
	RHEL 7.9	
	RHEL 8.4	
	RHEL 8.5	
	RHEL 8.6	
	FusionOS 22	Supports virtualization based on ARM physical machines.
	FusionOS 23	
	Kylin V10 SP3	

2.4 Upgrade Method

FusionDirector provides the **System Update** page to manage the upgrade of itself. On this page, you can view the current version information, upgrade time, and effective time of FusionDirector. You can upload an upgrade package to upgrade FusionDirector. When FusionDirector is upgraded but the new version has not taken effect yet, the information about the new version is also displayed on this page.

FusionDirector needs to be restarted for the new version to take effect. The restart takes about 10 minutes.

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2.5 Management Scale and Recommended Configurations

Table 2-2 Lower-layer FusionDirector management scale and recommended configurations

Scenario	Resources (Minimum Requirements per Node)	Device Management Scale of One Set of FusionDirector System		Remarks
		Single-Node	Triple-Node	
VM scenario	CPU: 4-core 2 GHz Memory: 8 GB Disk: 540 GB	≤ 2000 devices	≤ 3000 devices	-
	CPU: 8-core 2 GHz Memory: 16 GB Disk: 540 GB	≤ 5000 devices, with at most 100 OSs	≤ 7500 devices	Typical configuration.
	CPU: 16-core 2 GHz Memory: 32 GB Disk: 540 GB	≤ 7000 devices, with at most 1000 OSs	≤ 12000 devices	-
BMS scenario	CPU: 16-core 2 GHz Memory: 32 GB Disk: 480 GB (SAS or SATA disks and LSISAS3108/3408/3508 RAID controller card)	≤ 7000 devices, with at most 1000 OSs	≤ 12000 devices	Package format: ISO Supports deployment on the following bare metal servers: 2288H V5/V6/V7, 1288H V5/V6/V7, KunLun 2280, and KunLun E2180.
NOTE FusionDirector of the E9000 version is deployed on the MM920 management modules and can be deployed on a maximum of 6 nodes. A maximum of 2000 devices (including a maximum of 200 chassis) can be managed. In two-node deployment scenarios (including scenarios where multiple nodes are reduced to only two nodes), the two nodes must be in the same chassis.				

Table 2-3 FusionDirector Global management scale and recommended configurations

Scenario	Minimal Specifications	Lower-level FusionDirector Management Scale	Remarks
VM and BMS scenarios	CPU: 4-core 2 GHz	≤ 256 sets	In the BMS scenario, the

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Scenario	Minimal Specifications	Lower-level FusionDirector Management Scale	Remarks
	Memory: 8 GB Disk: 540 GB (SAS or SATA disks and LSISAS3408 RAID controller card)		package format is ISO and the following BMSs are supported: 2288H V5/V6/V7, 1288H V5/V6/V7, KunLun 2280, and KunLun E2180.
NOTE FusionDirector Global supports only single-node deployment.			

3 Product Functions

3.1 Overview
3.2 Quick and Flexible Management Mode
3.3 Comprehensive Device Information Monitoring
3.4 Intelligent Deployment Management
3.5 Intelligent Asset Management
3.6 Intelligent Version Management
3.7 Intelligent Fault Management
3.8 Intelligent Energy Efficiency Management
3.9 Security Management
3.10 Layered Management
3.11 Interconnections

3.1 Overview

FusionDirector is an intelligent management solution developed by xFusion Digital Technologies Co., Limited to achieve full server lifecycle coverage. It has the following features:

- Intelligence: delivers an Artificial Intelligence for IT Operations (AIOps) platform for managing servers.
- Simplicity: formalizes the routine O&M experience of 100+ enterprises to support scenario-based O&M.
- Distribution: adopts distributed architecture to support flexible expansion of 100,000+ servers for unified management.

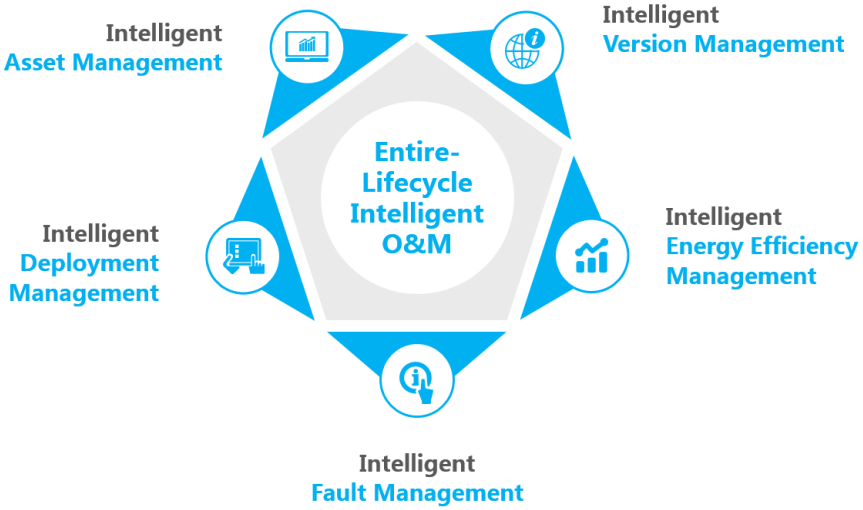
FusionDirector provides five intelligent management functions:

- Intelligent deployment management: automated deployment from power-on to OS installation based on automatic server U mark or SN identification, improving server deployment efficiency by over 10x.

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- Intelligent asset management: automatic U position identification, part-level asset management, and asset stocktaking, improving resource utilization.
- Intelligent version management: automatic software version management and one-click remote automatic update.
- Intelligent fault management: Disk fault prediction helps users quickly and accurately locate hardware faults, shortening service interruption time.
- Intelligent energy efficiency management: rack-level intelligent power capping, board-level intelligent energy saving, and L1 to L3 linkage energy saving.

Figure 3-1 Full-lifecycle intelligent O&M system



After FusionDirector is installed, all features are available for a 90-day trial period. After the trial period expires, you need to import a license file to continue to use advanced features of FusionDirector. Advanced features include cabinet management, 3D view, data center management, OS deployment, configuration, online repository planning, fault prediction, fault diagnosis, asset management, and energy efficiency management.

3.2 Quick and Flexible Management Mode

Multiple management methods such as batch import, manual addition, DHCP automatic IP address allocation, and Simple Service Discovery Protocol (SSDP) automatic discovery are supported to meet various service requirements. As long as the management network is connected and meet requirements in 5 Networking Constraints, devices in different regions can be managed.

- Batch import: applies to accurate device adding when the devices are configured with IP addresses and the device accounts and IP addresses are obtained. A maximum of 5000 devices can be imported at a time.
- Manual adding: applies to fuzzy device adding when the devices are configured with IP addresses, the device accounts are the same, and the IP addresses are consecutive.

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- DHCP automatic IP address allocation: applies to scenarios when the devices are in DHCP allocation mode and the device accounts, serial numbers (SNs), and media access control (MAC) addresses are obtained. If this method is used, you need to set up a DHCP relay server on the network and plan the IP address of each device.
- SSDP automatic discovery: The SN-IP mapping mode sets the device IP addresses to the preset IP addresses in batches when the device SNs and accounts are obtained. The IP resource pool allocation mode allocates random IP addresses to the devices when the device information is unknown. If this method is used, FusionDirector and the devices must be on the same L2 network.

3.2.1 Server Management

FusionDirector supports centralized management of server devices, including batch import, manual addition, DHCP automatic IP address allocation, and SSDP automatic discovery.

FusionDirector supports the management of mainstream FusionServer servers of xFusion and third-party servers. Management protocols such as Redfish, SNMP, IPMI, and SSH are supported. For third-party servers that support standard SNMP and IPMI interfaces, FusionDirector can implement management, power control, and UID indicator configuration in common server mode and can implement monitoring by importing MIBs dynamically and parsing alarms reported by SNMP. For details about the supported server models and functions supported on different series of servers, see the *FusionDirector Specifications List*.

Table 3-1 Server management performance specifications

Function	Operation Duration (Minutes/Server)	Operation Duration (Minutes/20 Servers)	Operation Duration (Minutes/100 Servers)
Time required for connecting to the server	0.5	1	5

3.2.1.1 Third-Party Server Management Capability

The overall management capability of third-party servers is weaker than that of xFusion servers:

FusionDirector enables users to view the alarm statistics, alarm reporting, device status, device information, system information, device status, and performance statistics of third-party servers. In addition, FusionDirector provides the function of performing power-on and power-off management, refreshing and deleting hardware, and password-free switching to the iBMC WebUI.

- Devices: Users can view the information of main components (such as processors that includes CPUs, GPUs, and NPUs, memory, storage, PSUs, fan modules, NICs, PCIe and PCIe components) of servers, such as the health status, basic technical parameters, and component codes, to quickly learn about the current status of servers.
- Firmware: Users can view the firmware information of third-party servers.

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- Current alarms: Users can view the current alarm list of third-party servers and refresh the alarm list.
- Alarm reporting: After a device is managed by FusionDirector, the user need to manually configure the SNMP trap server on the device. Users can implement alarm reporting by importing MIB files and configure alarm policies.
- Tasks: Users can view the tasks executed and being executed after third-party servers are connected to the system.
- Account management: Users can create and delete the iBMC accounts through the interface.
- Energy efficiency management: Energy consumption statistics are supported.
- Performance monitoring: Users can view the CPU temperature, inlet air temperature, other temperatures, input/output power, and fan speed.
- Health inspection: Users can inspect the health status of devices.

3.2.2 Chassis Management

FusionDirector supports centralized management of E9000 chassis. Only manual addition is supported to add chassis to FusionDirector. The compute node management protocol is Redfish, and the switch module management protocols include SNMP, CLI, and NETCONF.

The steps for adding a chassis to FusionDirector are as follows:

Step 1 Configure the chassis account and floating IP address.

Step 2 Configure the **ENCLOSURE_ServiceIPPool** and **ENCLOSURE_ManagementIPPool** address pools on FusionDirector. (You only need to configure the IP address pool once. The iBMC IP addresses can be configured manually or by DHCP.)

Step 3 Enter the chassis account, floating IP address, and set IP address management mode.

Step 4 Add the chassis on FusionDirector.

Step 5 Use the Hyper Management Module (HMM) to set the compute node IP addresses and accounts and add the compute nodes to FusionDirector.

Step 6 Use the HMM to set switch out-of-band IP addresses and accounts to add the out-of-band switching plane.

----End

Automatic discovery and IPv6 will be supported in the future. In this case, perform Step 4 to Step 6 to add a chassis.

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Table 3-2 Chassis management performance specifications

Function	Operation Duration (Minutes/Four Compute Nodes, Two Switch Modules, and One Management Module)	Operation Duration (Minutes/Five Compute Nodes, Three Switch Modules, and One Management Module)	Operation Duration (Minutes/Two Compute Nodes, One Switch Module, and Two Management Modules)
Time required for adding a chassis	6	8	5

3.2.3 iRM Management

FusionDirector can connect to the Intelligent Rack Manager (iRM) for intelligent rack asset management.

FusionDirector supports manual management for common racks without iRM.

3.2.4 Storage Management

FusionDirector supports centralized management of storage devices. You can import storage devices in batches or manually add storage devices.

The management scope includes mainstream centralized storage and OceanStor 100D. The management protocols are HTTPS and SNMP. Only the basic management, monitoring, and single-node jump are supported. For details about the management scope and functions supported by different storage devices, see the *FusionDirector Specifications List*.

3.2.5 Network Management

FusionDirector supports centralized management of network devices. You can import network devices in batches or manually add network devices.

The management scope includes the Huawei S5700 series, CE5800 series, CE6800 series, CE8800 series, CE12800 series, CE16800 series, AR6300 series and Ruijie S series. The management protocols are SSH and SNMP. Only the basic management, monitoring, and single-node jump are supported. For details about the management scope and functions supported by different network devices, see the *FusionDirector Specifications List*.

3.2.6 Infrastructure Management

FusionDirector support centralized management of CDUs. You can manually add CDUs.

The management scope includes the CDU305. The management protocol is SNMP. Only the basic management, monitoring, and single-node jump are supported. For

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details about the management scope and functions, see the *FusionDirector Specifications List*.

3.2.7 OS Management

This system supports centralized management of OSs by two modes: batch import and manual addition.

The following OSs can be managed: Linux (including CentOS, FusionOS, Rocky, Ubuntu, Red Hat, EulerOS, Kylin, UOS, and openEuler). The supported feature is listed as follows. For details about supported OSs and features, see the *FusionDirector Specifications List*.

- Basic information monitoring: Users can view information about the hostname, host IP address, OS type, OS category, OS version, SN, memory, disk, and processor list.
- General monitoring: Users can view the metrics trend charts of the current OS, including the CPU usage, memory usage, NIC download traffic, NIC upload traffic, disk read speed, disk write speed, and file system usage. Users can select the metrics to be viewed and set the time period.
- NPU monitoring: Users can view the NPU card statistics and trend charts of the host that runs the current OS, including the AI processor network health status, link status of AI processor network ports, AI processor health status, current AI core frequency of the AI processor, AI core usage of AI processors, AI processor temperature, AI processor power consumption, receiving rate of AI processor network ports, transmission rate of AI processor network ports, AI processor HBM, AI processor HBM memory utilization, DDR memory of AI processors, AI processor DDR memory utilization, number of RoCE packets received, number of RoCE packets sent, and number of excessive RoCE retransmissions. Users can select the NPU card ID and metrics to be viewed and set the time period.
- Monitoring software management: Users can install the Node-Exporter and NPU-Exporter monitoring software on OSs to monitor the performance of OSs and NPU devices on the host that runs the OSs. Besides, users can uninstall the monitoring software.
- Server binding: Users can bind OSs to servers for easier management.
- Alarm management: Users can view, operate, and synchronize alarms and events.

3.3 Comprehensive Device Information Monitoring

FusionDirector organizes the data center and device information in different views. You can use different views to quickly find the required information.

- DC 3D display provides information in the following views: abnormal device, space, temperature, power consumption and service time.
- Device hardware information display: provides information in the device model and device group views.

3.3.1 Server Information Display

FusionDirector can display and manage the information about the connected servers and the components. After servers are connected to FusionDirector, FusionDirector

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automatically manages servers without the installation of Agent and other operations. The system supports batch modification of server parameters, such as device labels and hostnames by the Excel template.

- **Power supply information**: name, health status, SN, rated power, firmware version, protocol, vendor, silkscreen, working mode, output power, input mode, input voltage, and output voltage
- **Fan information**: name, health status, part number, enabling status, and rotational speed
- **Information of processors** (**such as CPUs, NPUs, and GPUs**): name, vendor, model, frequency, temperature, location, number of cores/threads, cache, part number, usage, and rate ratio
- **DIMM information**: name, vendor, part number, capacity, SN, type, digit, voltage, status, and usage
- **Storage information**: name, type, firmware version, support for out-of-band management, driver name, driver version, health status, supported RAID level, mode, configuration version, memory capacity, device interface, SAS address, strip size range, cache pinned status, physical disk fault memory, copyback, copyback on SMART errors, JBOD mode, BBU name, BBU health status, BBU enabling status, and controller slot
- **NIC information**: name, model, location, number of network ports, vendor, MAC address, permanent physical address, media type, connection status, and protocol type
- **Port information**: port number, network port name, connection status, protocol type, media type, MAC address, permanent physical address, PCIe, WWPN, WWNN, and firmware version number.
- **Server information**: device SN, device type, asset label, host name, device alias, group, device label, alarm information, health status, power status, and profile
- **PCIe card**: SN, name, model, type, firmware version, status, vendor, board location, and description
- **AI module:** carrier board, NVSwitch, processor, MCU, and CPLD
- **Drive backplane:** name, location, vendor, number, type, PCB version, CPLD version, board ID, part number, and serial number

3.3.2 Server Group Management

FusionDirector supports custom grouping of connected servers, which allows O&M personnel to group devices based on actual service scenarios.

- Manual grouping and conditional grouping are supported.
  - Manual grouping: Users can create groups and manually add devices to groups.
  - Conditional grouping: Users can create groups based on the following conditions such as device IP addresses, device labels, and device models. Devices managed by FusionDirector are automatically added to groups based on the conditions.
- The following two types of groups can be created:
  - Private group: a group that can be viewed and used by only the user who creates the group.
  - Non-private group: a group that can be viewed and used by all users.
- You can use groups to:

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- Filter devices by group and select devices of a group in batches.
- Issue intelligent version management tasks to devices in a group in batches.

3.3.3 Server Information Search

FusionDirector provides quick search function for server information. You can search for server information by device IP address, SN, or MAC address in massive data.

3.3.4 Network Status Query

FusionDirector allows users to query the E9000 chassis network status, including:

- **Switch module information**: displays the name, slot number, stack relationship, management network port IP address, software version, and working status of each switch module in the chassis.
- **Switch port information**: displays the relationship between the ports and the switch modules, port name, type, status, rate, connection type, optical module, and traffic statistics.
- **Blade information**: displays the compute node models, NIC types, and physical connections between network ports and internal switch ports.

3.3.5 Alarm Management

FusionDirector supports centralized display, search, shielding, and email notification of server alarms, helping O&M personnel manage and handle alarms in a centralized and timely manner.

Table 3-3 Alarm management

Function Type	Description
Alarm Synchronization	Alarm loss detection and automatic synchronization ensure that alarms on the FusionDirector side are consistent with those on the equipment side.
Event to Alarm	Users can configure the rules for converting events into alarms based on the event ID and severity, including the alarm severity after conversion.
Alarm Masking	Users can create masking rules to mask unimportant alarms and avoid redundant information.
Alarm Display	FusionDirector displays alarms by severity or device type in the alarm panel and alarm list, which allows users to learn the real-time running status of the entire network.
Alarm Search	Users can search for current and historical alarms by a combination of alarm status, alarm severity, and alarm type to quickly locate the concerned alarm.
Alarm Notification	Emails, SMS, WeCom or DingTalk can be used to notify O&M personnel of real-time alarm information based on user-defined rules.
Alarm	Users can set the number of days for reserving historical alarms.

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Function Type	Description
Overflow Configuration	

3.3.6 Log Management

FusionDirector can manage logs of the system and servers, helping users with routine O&M and fault location.

Table 3-4 describes the system log management functions of FusionDirector.

Table 3-4 FusionDirector log management

Function Type	Description
Log export	Collects FusionDirector operation logs, system logs, security logs, run logs, and third-party component logs by one click and exports the logs from FusionDirector to a local directory.
Log search	Allows users to filter logs by log type, operation result, and time to quickly locate the concerned log.
Log configuration	Allows logs to be uploaded to a third-party log management server in real time by configuring the interconnected Syslog server IP address and log types to be collected, facilitating O&M.

FusionDirector supports managing the logs of managed servers. See Table 3-5.

Table 3-5 Device log management

Function Type	Description
Log export	Collects run logs of selected servers in one-click mode and exports the collected server logs to the local PC, including batch export of out-of-band iBMC logs and separate export of in-band software logs. This helps O&M personnel handle problems.

3.3.7 Performance Monitoring

Performance monitoring is to display performance statistics such as CPU usage, memory usage, disk usage, power, and fan speed in the form of indicator groups. This helps O&M personnel monitor the performance of the server.

The storage period (day) and scanning period of performance data can be configured.

Supported devices: xFusion servers that can be managed

The CPU usage, memory usage, and disk usage depend on the iBMA component.

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Table 3-6 lists the supported statistics types.

Table 3-6 Performance statistics type

Statistics Type	Description
CPU Statistics	Includes CPU usage statistics.
Memory Statistics	Includes memory usage statistics.
Disk Statistics	Includes disk usage, total capacity, and used capacity.
Power Statistics	Includes input power, output power, and current power consumption statistics, including the statistics of the server, CPUs, GPUs, NPUs, memory, and fans.
Fan Statistics	Includes fan speed and fan speed percentage statistics.
Temperature Statistics	Includes air intake vent temperature, CPU temperature, and other temperature statistics.

Table 3-7 describes the functions of FusionDirector performance monitoring.

Table 3-7 Performance monitoring functions

Function Type	Description
Statistics in the Latest Week	Displays server performance indicators in the latest week.
Statistics in the Latest Month	Displays server performance indicators in the latest month.
Performance Statistics Configuration	Allows you to enable the scheduled update function and the scanning period to periodically update performance statistics. In addition, you can set the storage period of performance statistics.
Performance Data Export	Allows you to collect and export server performance data. You can export the performance data of a single server or export server performance data in batches.

3.3.8 Task Management

FusionDirector displays and manages the tasks that are started during system running are, which helps customers to view the task progress and historical task results. The following task information is displayed: task name, number of subtasks, task status, task progress, and duration. Users can manage historical tasks and delete completed tasks.

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3.3.9 Health Inspection

FusionDirector provides the following health inspection capabilities:

- Inspection of servers, helping you quickly learn about the device health status
- Inspection of the compatibility of NPU software and hardware versions, as well as NPU driver and firmware versions through OSs with the acsend-dmi tool installed on OSs and the OS root privileges for quick understanding of the health status of NPUs
- Export of inspection reports in HTML/PDF formats
- Sending of inspection reports by email

3.4 Intelligent Deployment Management

3.4.1 Customer Pain Points

The following problems may occur when devices go online on a site:

- Long device rollout period cannot meet the requirements for fast service expansion.
- Complex configuration makes device rollout difficult for new staff.
- Pre-rollout acceptance for a single device requires nearly half an hour.

3.4.2 Basic Device Configuration

FusionDirector supports batch configuration using a profile consisting of all configurations of a device. The profile can be imported, exported, and quickly copied to other devices to flexibly change the hardware configuration. This improves the efficiency of faulty device replacement and server capacity expansion.

In addition, FusionDirector supports the configuration function for E9000 compute nodes. Compared with rack servers, FusionDirector supports the configurations of fan modules and PSUs for the E9000. Chassis configurations include compute node configuration, switch network configuration, fan speed adjustment mode configuration, power hibernation mode configuration, and power capping configuration.

3.4.2.1 Server Profile Management

FusionDirector supports profile management, which includes creating, importing, binding, applying, unbinding, deleting, exporting, and copying profiles.

Table 3-8 Profile management function

Function	Description
Create	Create a profile based on your application scenario. The parameters to be set include the configuration template name, configuration template description, and device model.
Import	Manually import a backup profile, rename the profile name, and modify description.

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Function	Description
Bind	Bind a profile with one or more devices.
Apply	Apply the configuration data in the bound profile to the selected devices. The configuration data can take effect immediately and later.
Modify	Modify the configuration items in a profile online.
Unbind	Unbind a profile from one or more devices in batches. The profile that has taken effect cannot be unbound.
Delete	Delete a profile from the configuration.
Export	Create a ZIP package by using the profile and save the package to a local directory.
Copy	Copy a profile online, rename the profile, and modify description. Then you can use the new profile online.

3.4.2.2 Server Configuration Items

FusionDirector supports template-based management of common graphical configuration operations in O&M scenarios. Table 3-9 lists the configuration types. For details about server configuration parameters, see "Server Profiles" in the *FusionDirector Operation Guide*.

Table 3-9 Server configuration items

Part Type	Configuration Type	Description
BIOS	BIOS	Allows O&M personnel to configure the BIOS for servers to meet different requirements. The main configuration items are as follows: boot configuration, system boot sequence, advanced power management configuration (such as energy efficiency scenario, CPU parameters, and boot performance mode), VT-D technology configuration, processor configuration, memory configuration, console redirection, iBMC configuration, PXE configuration, UPI configuration, power configuration, and IIO configuration.
RAID	RAID	Allows O&M personnel to perform RAID configuration for servers in batches, facilitating RAID configuration planning and modification, simplifying RAID configuration, and improving configuration efficiency.
iBMC	NTP	Allows O&M personnel to configure the NTP mode and NTP server address or configure FusionDirector as the NTP server.
	DNS	Allows O&M personnel to configure the DNS server information obtaining mode and DNS server address.
	LDAP	Allows O&M personnel to enable the LDAP function and

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Part Type	Configuration Type	Description
		configure the domain controller address, domain controller port number, domain name, user group login rule, and LDAP user group.
NIC	HBA	Allows O&M personnel to configure MZ220 and MZ221, for example, enabling or disabling the SAN boot function. When the SAN boot function is enabled, the **Target WWPN**, **Target LUN ID**, **Priority**, and **Target WWNN** parameters can be set.
	CNA	Allows O&M personnel to configure MZ520 and MZ521. The main configuration items are as follows: **SR-IOV**, **MultifunctionMode**, **Boot Protocol**, **FCoE Boot To Target**, **PXE VlanID**, **PF Type**, **Minimum Bandwidth**, **Maximum Bandwidth**, **Priority**, **Target WWPN**, and **Target LUN ID**.
	LOM	Allows O&M personnel to enable the network port function and configure the MAC address.
	Advanced configuration	Allows O&M personnel to enable automatic GUID setting and clear the NIC unique key.

3.4.2.3 E9000 Network Management Model

With the development of services, the scale of data centers becomes larger, network converged, and networking more complex. A flat network will prevail in the future. The E9000 chassis comes with switch modules, which function as switches and increase networking complexity.

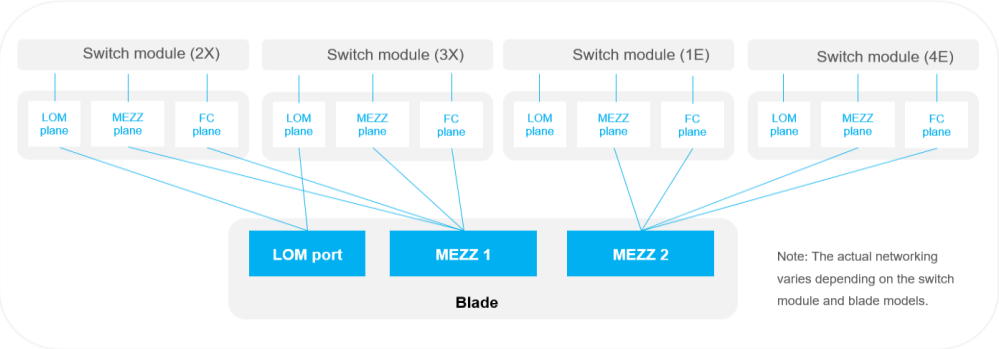
FusionDirector abstracts service flows in a chassis into a network. Users only need to know the service flow attributes (such as Ethernet or storage flow, and VLAN ID) and the blade network ports and the switch module ports for the service flow and can complete network configuration on the WebUI by simply drawing lines between the ports.

3.4.2.3.1 Network Configuration Model

In the chassis of an E9000 blade server, there are switch modules, which means a switching layer is added to the network. This increases the networking complexity. Figure 3-2 shows the connections between the blade NICs (mezzanine cards and LOMs) and the switch modules

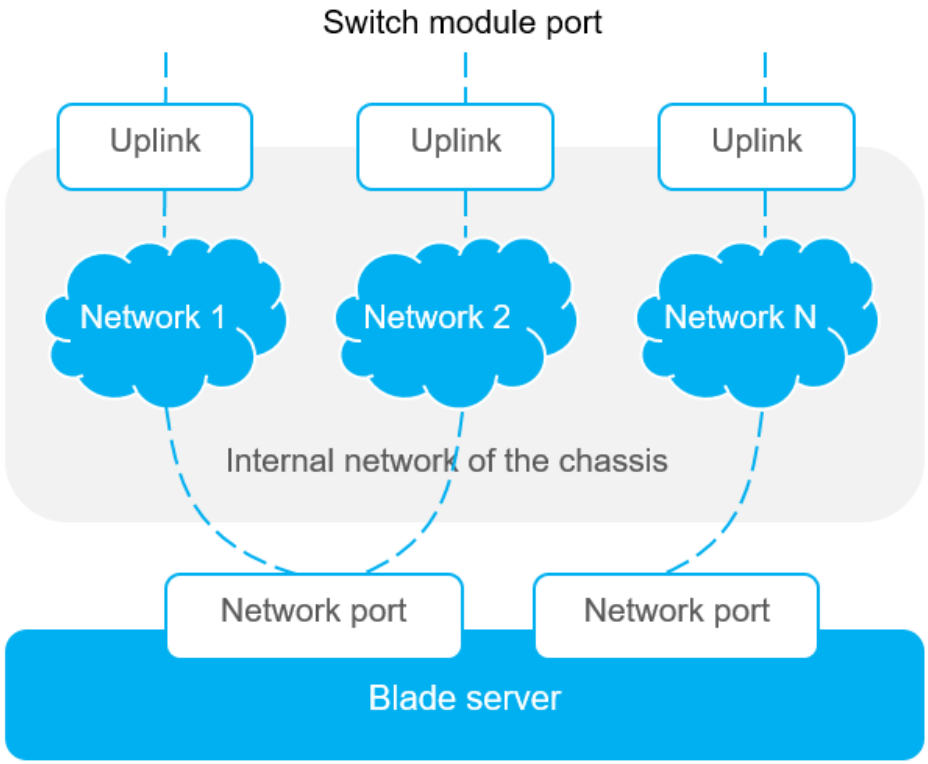
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Figure 3-2 Connections between the blade NICs and the switch modules



Before configuring the service network, you need to learn the port connections between the blade NICs and switch modules, the configuration relationship between switch modules, and the connections between the internal switch modules and external switches.

Figure 3-3 FusionDirector network configuration model



3.4.2.3.2 Switch Module Stacking

Stacking means that multiple switch modules of the same type are combined to form a logical switch. You can use FusionDirector to configure the stacking relationship

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between LOM planes or mezzanine planes of the same board type in any two slots of the same E9000 chassis. When a switch module is faulty, the other switch module works properly. To ensure the reliability of service data links, one uplink must contain ports of two switch modules.

3.4.2.3.3 Uplink Port Group

Uplink ports are provided by switch modules in a chassis to connect to external network devices. An uplink port group consists of one or more uplink ports in the same switch module (or the same stack logical switch). You can create multiple uplink port groups based on service requirements and actual number of physical ports.

Uplink port groups are classified into Ethernet, FCoE, and FC types based on physical port types. The link aggregation, SmartLink, and MonitorLink feature can be configured.

3.4.2.3.4 Network

A network is a data network defined based on the data flow attributes (such as Ethernet, storage, and VLAN ID) specified by users. Data streams are transmitted between the network ports and uplinks of the same network. Data streams between different networks are isolated from each other.

Networks can be classified into EthNetwork and SanNetwork based on the data flow type.

- EthNetwork: Ethernet network, supports the transmission of packets with specified VLAN tags or transparent transmission of packets with any VLAN tags in tunnel mode, and re-maps VLAN IDs on the uplink side.
- SanNetwork: storage network, supports direct connections to storage devices and SAN switches, and supports the Fiber Channel over Ethernet (FCoE), Data Center Bridging (DCB), and FIP Snooping Bridge (FSB) functions.

3.4.2.4 Network Configuration Items of the E9000 Chassis

On FusionDirector, the E9000 network configuration is based on the chassis profile. Configuration items include the following:

- **Hardware configuration**: configures the binding relationship between blade slots and server profiles, and configures the switch module type for each switch module slot.
- **Switch module port configuration**: configures port split, merge, fiber channel (FC) mode switching, rate mode switching, and traffic control.
- **Stack and internal port configuration**: configures the stacking relationship between switching planes, traffic control for internal ports, and link aggregation.
- **DCB configuration**: configures the PFC priority and ETS profile.
- **Network connection configuration**: configures the uplinks, networks, relationship between the uplinks and the networks, and relationship between the network ports and the networks.

3.4.3 Basic Device Deployment

Compared with traditional OS deployment based on the network (PXE), device deployment on FusionDirector does not require the Dynamic Host Configuration Protocol (DHCP), FTP, and network configuration and depends only on the

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out-of-band network. You can complete device deployment by performing a few steps on FusionDirector. Concurrent deployment is supported.

3.4.3.1 Image Management

You can manually import OS images and manage the imported OS images. Table 3-10 lists the supported OS image types and image versions. If the image version number is fuzzified, for example, Ubuntu 18.04.* or OpenEuler*, add the driver and firmware packages to the deployment template as required. For details, see the *FusionDirector Specifications List*.

Table 3-10 Supported image types

Image Type	Image Version
RHEL	RHEL 6U9, RHEL 6U10, RHEL 7U*, RHEL 8U*, RHEL 9U*
VMware	ESXi 6.0, ESXi 6.5, ESXi 6.7, ESXi 7.* ,ESXi 8.*
SLES	SLES 11SP4, SLES 12*, SLES 15*
CentOS	CentOS 6U9, CentOS 7U*, CentOS 8U*
Windows	Windows 2012_R2, Windows 2016, Windows 2019*, Windows 2022*
Ubuntu	Ubuntu 16.04, Ubuntu 16.04.1, Ubuntu 16.04.2, Ubuntu 16.04.6 LTS, Ubuntu 18.04.*, Ubuntu 20.04*, Ubuntu 22.04*
openEuler	openEuler *
Debian	Debian 9.*, Debian 10.*, Debian 11.*
BCLINUX	BCLINUX 7.*, BCLINUX 8.*
NeoKylin	NeoKylin 7.*
Kylin	KylinLinux V10.*
FusionOS	FusionOS *
Rocky	Rocky 8.*, Rocky 9*

3.4.3.2 OS Deployment

FusionDirector supports OS deployment using the iBMC out-of-band network. It supports single-RAID, multi-RAID, and non-RAID pass-through modes. A maximum of 30 devices can be deployed at the same time. The following deployment methods are provided. The first method is preferred in the background.

1. The board-mounted deployment tool is used to mount OS and custom application images. You can perform basic OS installation in batches, customize application images, and configure network parameters such as host names and IP addresses (IPv4 or IPv6 addresses).

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2. The virtual media is used to mount the OS to support the deployment of old servers or third-party servers.
3. The list of software to be installed with the OS can be customized. The following OSs are supported: Kylin V10.*, openEuler*, and RHEL 7U*.

For details about the supported device types, see the *FusionDirector Specifications List*.

3.4.4 Automatic Installation Planning

Traditional Device Provisioning

Traditional device provisioning can be performed only after devices are installed. Users need to create device provisioning tasks. Manual operations are complex and inefficient. The procedure is as follows:

Step 1 Device installation personnel install devices based on the planning template that is manually maintained.

Step 2 O&M personnel manually connect to each device to complete the initial IP address configuration.

Step 3 Management tasks need to be created on an NMS to manage devices.

Step 4 Manual checks need to be performed to verify that the installed devices are purchased by the customer.

Step 5 Configuration and deployment tasks need to be created on the NMS.

Step 6 Related tasks need to be started manually to take the devices online.

----End

Automatic Installation Planning on FusionDirector

FusionDirector automatic installation planning allows you to plan device IP addresses, device models, profiles, and OS deployment information in advance and export a planning template. Then device installation personnel install devices based on the exported planning template. After devices are installed, IP addresses are automatically configured for the devices, and the devices are automatically managed, checked, and deployed.

- Import the planning template. To shorten the installation time and improve the efficiency, plan the SN, MAC address, device name, IP address, subnet mask, gateway, username, old password, and new password for each device to be installed in advance.
- There are four allocation modes of the installation plan:
  - Allocate by Location
  - Allocate by SN/MAC
  - Allocate by Static IP Address
  - Allocate by Managed Device
- Implement installation plan.

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During the implementation, you can view the progress of each plan. If a plan fails to be implemented, you can modify the plan as prompted and try again. If the plan is not mandatory, you can skip it.

The installation plan starts immediately after the plans in **Allocate by Static IP Address** and **Allocate by Managed Device** modes are created.

- Enabling or Disabling an Installation Planning

  The data about the devices to be installed is activated only after the installation planning function is enabled. After the installation planning function is disabled, activated devices can still be installed.

  When location planning is enabled, the activation switch based on SN/MAC planning is automatically disabled.

  When SN/MAC planning is enabled, the activation switch based on location planning is automatically disabled.

3.4.4.1 By Location

Installation planning by location uses iRM to obtain the U marks of servers deployed in a rack.

You can plan the model, IP address, password, OS, and configuration parameters of a device to be installed by location. After the device is installed in the location, the device management, password change, configuration check, burn-in tests (on CPUs, DIMMs, drives, Ethernet NICs, HBA cards, GPU cards, and IB cards), OS deployment, and parameter configuration are automatically completed.

3.4.4.2 By SN/MAC

Installation planning by SN/MAC uses the DHCP to obtain server installation information. The device to be installed must be in the same DHCP broadcast domain as FusionDiretor.

You can plan the model, IP address, password, OS, and configuration parameters of a device to be installed by SN/MAC. After the device of the specified SN is installed, the device management, password change, configuration check, burn-in tests (on CPUs, DIMMs, drives, Ethernet NICs, HBA cards, GPU cards, and IB cards), OS deployment, and parameter configuration are automatically completed.

3.4.4.3 By Static IP Address

Based on the **Allocate by Static IP Address** mode, you can create the installation plan for devices according to iBMC IP addresses. The application scenario is that the IP address of the device to be managed is configured and the device is not managed by FusionDirector.

3.4.4.4 By Managed Device

Based on the **Allocate by Managed Device** mode, you can create the installation plan for devices that are managed by the system. The application scenario is that the IP address of the device to be managed is configured and the device is managed by FusionDirector.

3.4.4.5 Installation Plan Report Export

You can export the reports of device model comparison results, configuration check results, version status comparison results, and stress test results.

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3.5 Intelligent Asset Management

Based on the rack-level iRM, FusionDirector manages the physical locations, asset codes, and models of devices, supports third-party device management, and implements part-level asset management for servers.

3.5.1 Customer Pain Points

With the growing demands on IT devices, the number of devices in enterprise DC equipment room becomes larger. When managing thousands of DC devices, traditional IT asset management systems are slow and error-prone. Long device change process causes low efficiency.

Typical problems of IT asset management are as follows:

- Low efficiency of manual maintenance: Manual operations are required for device registration and rollout, causing in low efficiency. After devices arrive, asset administrators need to manually scan devices and record device information in the configuration management database (CMDB). The entire data input process is manually performed, and the data enters the IT system without verification. When moving devices out of the warehouse for device rollout, asset administrators need to manually scan the device barcode and add it to the CMDB change process.
- Difficulties in device inspection: Inspection of newly delivered devices is difficult. Asset administrators cannot verify whether new devices are consistent with the order.
- Risks in device change: Device rollout status is manually maintained, and device changes cannot be traced. After devices are installed in the equipment room, asset administrators need to manually enter the device location information in the CMDB. When a device is moved from one rack to another, manual process management causes low efficiency. Mistakes in onsite operations cannot be identified immediately and can be identified only after asset stocktaking.
- Risks of asset loss: Device movement is not automatically traced and depends on manual management. Some parts may be lost during device movement.
- Data security risks: Key parts in a DC may be replaced manually, and the data may be maliciously obtained or damaged.
- Difficult DC planning: Lack of DC space management makes it difficult to determine whether the available rack space is sufficient for new IT devices.
- Difficult asset stocktaking: Asset stocktaking is inefficient and requires a large amount of manpower and time.

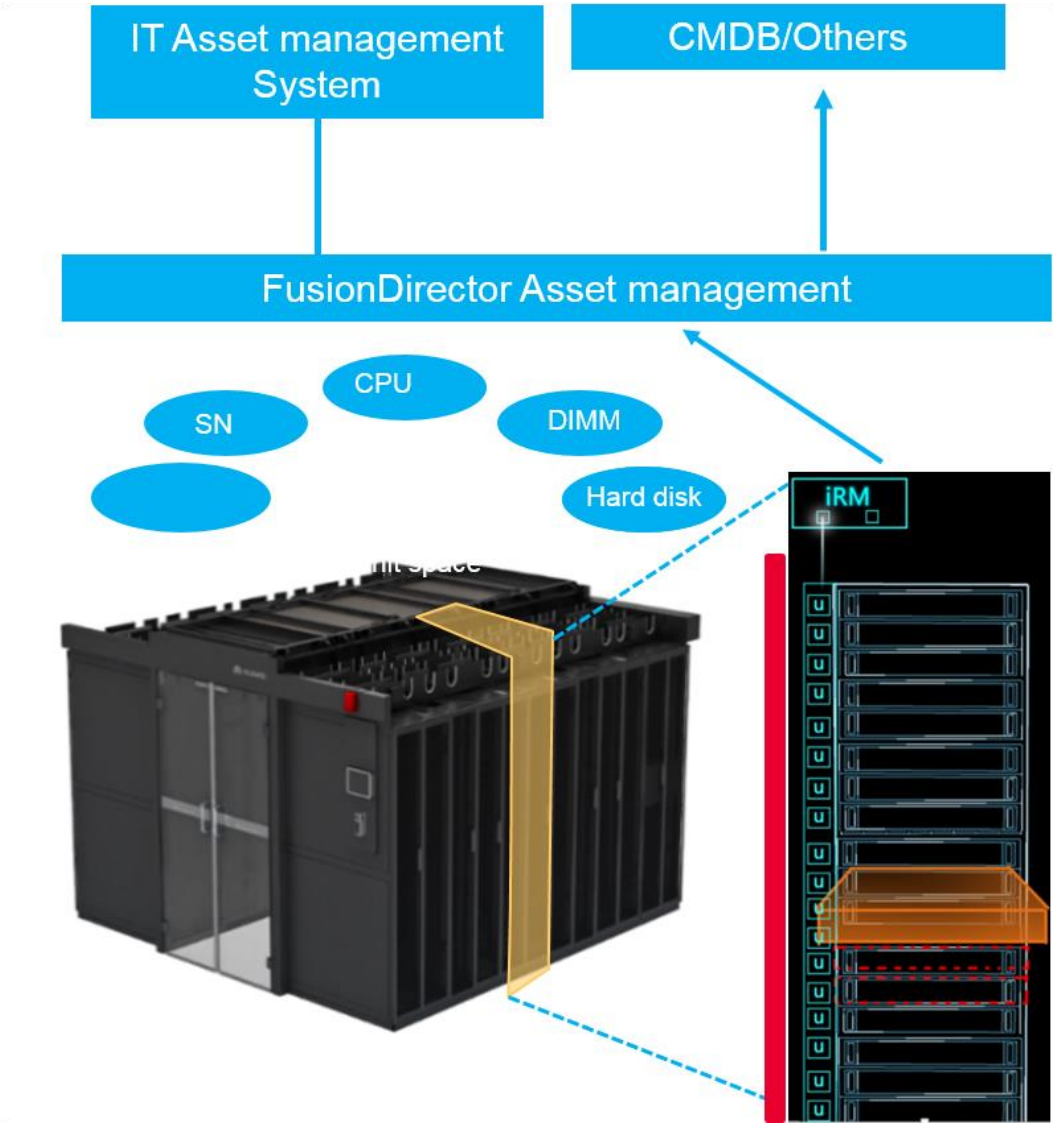
The preceding problems are frequently encountered in IT asset management. To solve the problem and achieve unattended asset management, online devices of a DC must be automatically synchronized with the asset management data in the CMBD.

3.5.2 Solution Overview

The FusionDirector asset management solution supports end-to-end automatic asset management covering device rollout, location identification, configuration check, asset location change, part change, rack space management, and coordination with the customer CMDB.

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Figure 3-4 Asset management solution



FusionDirector works with the iRM intelligent rack management suite to support automatic device discovery and location identification.

- The asset locator is used to locate the U space of rack devices and is installed on the left of the front panel of a rack. This part obtains the SN from the asset tag attached to a device to determine the mapping between the device SN and location.
- The asset locator supports wired expansion tags and wireless radio frequency identification (RFID) tags of connected devices. Device asset tags provide information including the device model, vendor, SN, required space, type, rollout time, weight, rated power, and asset owner. Customers can customize fields. Tags can be read, written, and modified using hand-held terminals. You can also perform these operations on the iRM window.
- iRM is the intelligent control module of a rack and supports the industry standard protocol, Redfish. This module monitors rack device changes and sends all asset and location information to FusionDirector by using the Redfish interface. It

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records the physical location of a rack and reports the device location information obtained from the asset locator to FusionDirector after the information is assembled.

- FusionDirector records the changes of all devices, including location changes, installation and uninstallation, and part changes. In addition, FusionDirector interconnects with the iBMC systems of servers. When a part is changed, iBMC reports the change to FusionDirector in real time to implement part-level asset management. For example, all common swapping and replacement of hard disks and DIMMs are recorded in the change history of FusionDirector.
- FusionDirector provides a northbound Redfish interface to interconnect with third-party CMDBs and asset management systems. FusionDirector proactively reports change events to trace asset changes in real time. Customers can use scripts to access the northbound interface that can be used to interconnect with asset systems for asset data and change event conversion to achieve automatic asset data management.

FusionDirector supports automatic device rollout check. This function compares device configurations and purchase orders to ensure the consistency.

3.5.3 Feature Description

3.5.3.1 Asset Panorama

You can view the asset information of each DC on FusionDirector, including:

- Total number of all assets, servers, storage devices, network devices, chassis, and racks
- Asset change overview, device installation/uninstallation statistics, and part changes
- Service life of servers, storage devices, and network devices
- Total number of assets and space usage of each DC.

3.5.3.2 Asset Details

You can view device and component statistics on FusionDirector, including:

- Device model statistics of servers, storage devices, network devices, chassis, and racks
- Names, SNs, IP addresses, locations, vendors, models, occupied space, and installation time of devices.
- Asset changes such as device installation/uninstallation and part changes.
- Part model statistics of hard disks, DIMMs, CPUs, and mainboards.
- Names, types, vendors, models, associated devices, and SNs of parts.

3.5.3.3 Asset Change Statistics

FusionDirector records detailed change events of devices and components and displays the top 5 devices, device change trends, and detailed change events by data center. A change event records the change time, change type, device name, asset code, device type, device location, and asset change details.

With asset change records, you can intuitively learn the device change trend in each phase and discover potential risks of devices and components.

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3.5.3.4 Rack Details

You can view rack details on FusionDirector, including:

- Basic rack information such as rack locations, rated power, and dimensions, and height (U)
- Power supply and space information of racks, including power supply types, circuit breaker currents and voltages, power supply statistics, and rack space
- IP addresses, models, and versions of FusioniRM modules
- Power capping status of racks
- Power consumption trend chart, showing the current power consumption, maximum power consumption, and power consumption forecast data.
- Rack temperature by time and space
- 2D rack layout, showing devices details such as types, dimensions, temperature, and power consumption
- Device list of a rack, showing device names, types, models, SNs, power consumption, alarm status, and temperature

FusionDirector allows you to view the detailed layout, power consumption, and temperature status of racks. This helps you learn the rack space, power supply capability, and temperature status. In this way, the rack usage can be further planned.

3.5.3.5 Interconnection with a Third-Party CMDB

In addition to the comprehensive asset management display and operation user interface, FusionDirector provides the REST interface for third-party interconnection. FusionDirector can connect to a third-party CMDB to facilitate integration into the customer's asset management system.

3.5.3.6 E-Warranty Management

- The system supports e-warranty import, export, and display, including the production date, service start time, and service period.
- The system supports server service life alarms. When the service life is about to expire, a risk warning is sent. When the service life expires, an alarm is sent.
- The system supports the e-warranty of FusionDirector.

3.5.3.7 Maintenance Management

The maintenance management function automatically obtains maintenance information of managed devices, implementing visualized management of maintenance information.

The **Maintenance Management** page displays the maintenance contract status and maintenance information list of devices. Maintenance information can be manually synchronized, imported, and exported.

- **Maintenance Contract**: displays the distribution information of managed devices in a bar chart based on the maintenance status. The maintenance time includes the status of expired, ≤ 30 days, 31 to 90 days, 91 to 180 days, > 180 days, and not applicable.
- **Maintenance List**: displays the basic maintenance information about managed devices and provides advanced search, synchronization, import, and export functions.

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3.5.4 Benefits

3.5.4.1 Automatic Asset Stocktaking and Asset Change Management with High Security and Efficiency

In traditional asset management systems, a device database consists of two parts: warehouse and DC.

- Warehouse management is simple as it only involves inbound and outbound logistics of devices.
- DC devices run on the live network and may be changed for migration or repair. Therefore, DC device management is complex. As time goes by, the actual asset status may be different from the data recorded on the asset management database. Therefore, periodic asset stocktaking is necessary.

The asset management solution can be interconnected with the customer's CMDB system to provide real-time device data on the live network, simplifying stocktaking for devices on the live network. In the past, asset stocktaking took several weeks. By conducting real-time asset stocktaking through out-of-band channels, asset data on the live network can be always consistent with that in the CMDB.

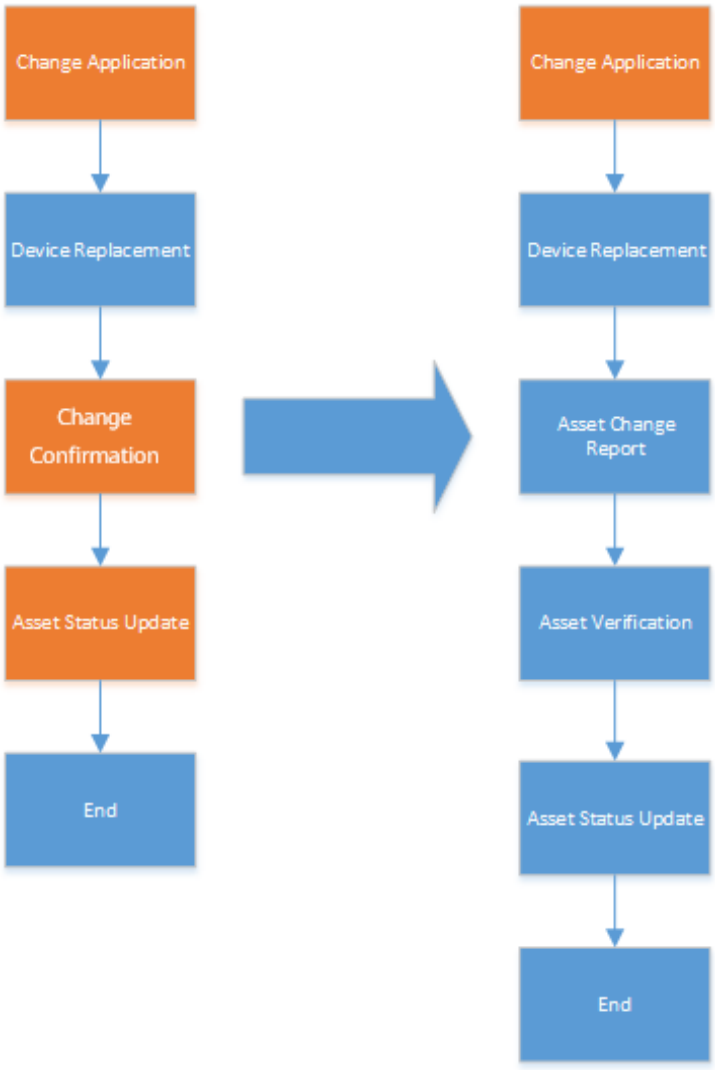
In addition to asset stocktaking, asset change is the most important factor that makes asset management complex. In the past, assets are not monitored during the change process. After asset change, asset administrators need to manually confirm the result and refresh the asset status. Whether the required device is changed cannot be verified. This poses a great challenge to asset security.

Figure 3-5 shows the improvements of the new asset management process.

- Manual intervention after asset change is eliminated. After the system is interconnected with FusionDirector, only **Change Application** requires manual intervention, and the subsequent **Change Confirmation** and **Asset Status Update** operations are automatic. The efficiency and data accuracy in the change process are improved.
- The change process is secure and controllable. By using FusionDirector, asset administrators can check asset information before and after the change process to ensure change accuracy.

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Figure 3-5 Asset change process



The asset management solution ensures data consistency between the live network and the background IT system, improving asset management efficiency and security. By using an intelligent deployment process, the solution solves live network device management problems in data collection, rollout verification, device change during system running, and device planning.

3.5.4.2 3D Visualization of DCs for Better Operation Efficiency

With the increasing demand for computing resources, equipment room space becomes increasingly scarce. In many cities such as Beijing and Tokyo, new DCs are no longer allowed. Therefore, many customers need to utilize existing data center space to the largest.

The asset management solution provides management views in multiple dimensions.

- Fault view: Users can filter out faulty physical devices to evaluate the overall running status of a DC.

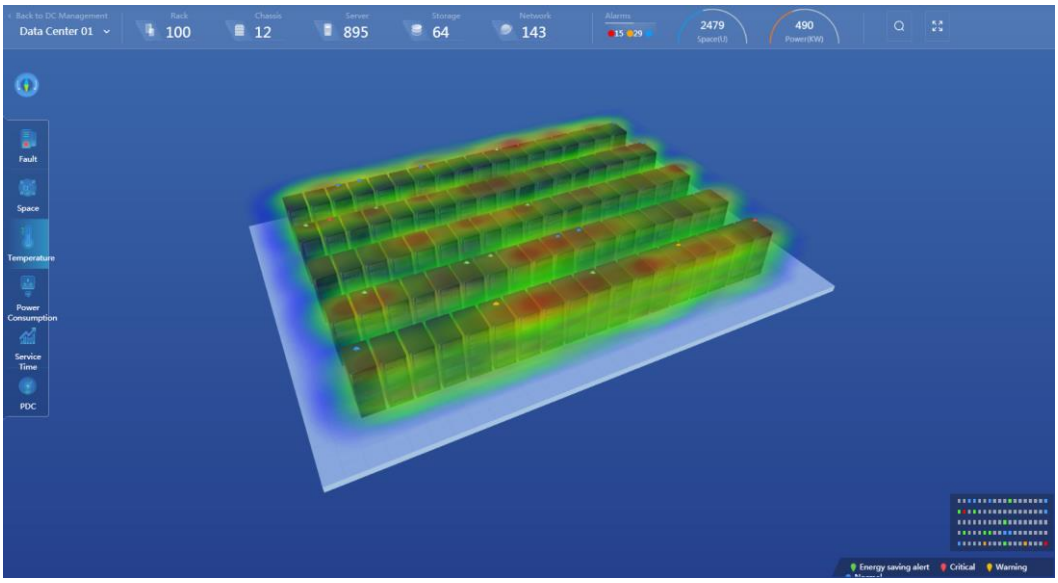
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- Space view: Users can view the available rack space and collect statistics on the rack space usage of an equipment room.
- Temperature view: Users can view the temperature cloud map of a DC to discover hot spots and optimize heat dissipation design and planning.
- Power consumption view: Users can view the power consumption of each rack in a bar chart.
- Service time view: Users can view the device and rack life time for device uninstallation planning and rack space planning.

The preceding views help customers obtain the overall status of a DC, providing reference data for DC device planning.

During product planning, customers need to consider the space utilization, power supply, and heat dissipation to assess how many devices can be installed in an equipment room and which racks can hold those devices. By providing DC views in multiple dimensions, FusionDirector helps customer obtain the equipment room layout and provides visualized information for optimization.

Figure 3-6 3D DC view



3.5.4.3 Faulty Asset Change Statistics for Fault Data Analysis

The asset management solution provides detailed statistics about device changes. Customers can easily collect statistics on device changes and evaluate the device quality for reference of asset service time management. By collecting statistics on device disconnections, customers can evaluate the device quality. If the cost of multiple repairs is higher than value of a device, customers can uninstall the device to reduce the overall system cost.

In addition, the asset management solution provides part-level asset information. By evaluating part change statistics, customers can evaluate the part quality for reference of part selection and procurement.

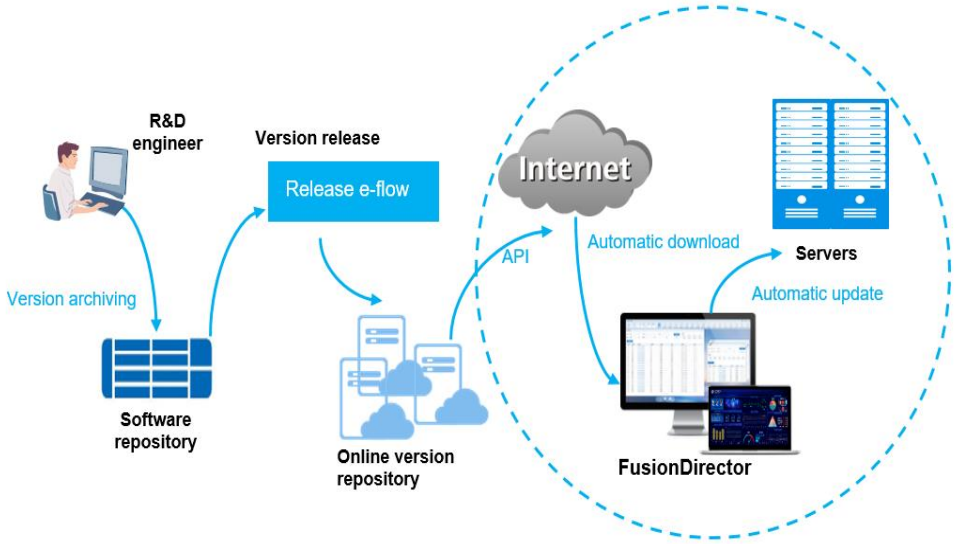
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3.6 Intelligent Version Management

FusionDirector supports lifecycle firmware update management for FusionServer servers. The firmware update function consists of three modules: Version Repository, Upgrade Schedule, and Device Version Information. Manual update or automatic update based on update schedules are both supported.

- FusionDirector supports XML configuration files of both old and new firmware versions.
- Updating device versions and making the update take effect are separate operations. The update process has no impact on the service system.

Figure 3-7 Automatic update process



3.6.1 Customer Pain Points

Firmware management is inefficient and difficult.

- Locating devices with outdated firmware is difficult.
- Searching for update packages is difficult.
- Downloading upgrade packages is difficult.
- Automatic update is required.
- Update compatibility is difficult to ensure.

3.6.2 Update Package Repository Management

- Automatic management: After FusionDirector is connected to the software repository directly or through a proxy, when a new update package or update baseline package is available, a dialog box is displayed based on the configuration period. FusionDirector can automatically download update packages or update baseline packages.

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  - Product version: You can obtain the version lists, and query and download update packages of managed device models.
  - Quarterly baseline: The stable quarterly baseline is released officially each month.
  - Customized baseline: You can customize the baseline after selecting update packages.
  - Latest baseline: The background automatically generates the latest version baseline for models in the selected model range.
- Manual management: If FusionDirector cannot connect to the software repository, you can download update packages from other devices that can connect to the software repository and manually import the update packages by using the FusionDirector portal.

3.6.3 Common Update Schedule Management

3.6.3.1 One-Off Update

You can specify target versions and devices to be updated to create a common update schedule online, and update devices immediately or at a specified time based on the update policy.

3.6.3.2 Automatic Update Check

You can create a common update schedule online, set the update policy to periodic check, specify baseline packages or update packages, and associate the update schedule with device groups or specific devices. When the device firmware versions are inconsistent with the versions specified in the update schedule, FusionDirector triggers an update notification and checks the update. This function helps O&M personnel update the server firmware versions in a timely manner.

The update notification and check are also triggered when the following events occur: the baseline package is automatically updated from the software repository website, new devices are added to a device group, or part replacement causes device firmware versions to be inconsistent with the versions specified in the update schedule.

In addition, the OTA update schedule is supported. You can select devices to be updated by batch. A dialog box is displayed before the batch update is performed.

Table 3-11 Automatic update scenarios

Scenario	Policy Description
Creating a periodic update schedule	If a device firmware version is different from the version specified in the update schedule, the system automatically updates the firmware to the version specified in the schedule. This function helps O&M personnel update server firmware versions in a timely manner.
Creating a group-based update schedule	A periodic or scheduled update schedule can update devices in a certain group. This function automatically manages the updates of new devices in a group. Users do not need to manually modify update schedule.
Replacing parts	When a part is replaced, FusionDirector automatically checks

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Scenario	Policy Description
	the version of the new part with the baseline version and automatically update the version of the new part.

3.6.4 OTA Update Schedule Management

OTA update is an advanced function and needs to be used with the online software repository. Compared with automatic detection and update, OTA update provides more flexible update capabilities, such as:

- Pop-up notices of the new baseline or recommended baseline
- Baseline modification description
- Warning pushing and display
- Update notice in advance
- Update report export

3.6.5 Devices That Can Be Updated

Table 3-12 Devices that can be updated

Category	Scope	Remarks
Firmware	E9000 management module: EMM, CPLD, LCD, fan module, RAID controller card CPLD, and AI module.	Update duration: about 120 minutes for one E9000 chassis.
	Out-of-band firmware: iBMC, BIOS, CPLD, and power supply. Supported models: V3 and later rack, high-density, and heterogeneous servers, rack-scale servers, and E9000 V5/V3 blade servers	Out-of-band update for a single part takes about 10 minutes.
	In-band firmware: NIC, RAID, SP, HDD/SSD, MCU, CDR, and Retimer. Supported models: V5 and later rack, high-density, and heterogeneous servers, and E9000 V5 blade servers	In-band update for a single part takes about 20 minutes.
	E9000 switch module: iBMC, CPLD, mezzanine plane OS/patch, LOM plane OS/patch, and FC plane OS.	Update duration: about 90 minutes for four switch modules.
Driver	• Supports the RAID controller card, NIC, and NPU driver updates. • The following OS types are	Out-of-band driver update for a single part takes about 10 minutes.

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Category	Scope	Remarks
	supported: SLES, RHEL, CentOS, Windows Server, VMware ESXi, and Ubuntu.	
Software	iBMA	-

3.7 Intelligent Fault Management

3.7.1 Customer Pain Points

The upper lifecycle limit of servers and key parts is five years. However, the lifecycle of some parts is shorter (as shown in Table 3-13). When the service life of a part reaches the upper limit, the failure rate is high. Reducing the impact of server faults is the key for ensuring system availability and reliability. FusionDirector supports iBMC alarm monitoring and allows users to view, search, mask alarms and send alarm notifications by email, helping users quickly fix faults. For details, see 3.3.5 Alarm Management. In addition, FusionDirector supports disk and memory fault prediction and subhealthy disk and memory diagnosis to inform users to migrate data and services in advance.

Table 3-13 Lifecycle of server parts

Part	Lifecycle (year)
CPU	8–10
Memory	8–10
HDD	3–5
SDD	3–5
PSU	3–4
FAN	3–5
Battery	3

Most faulty server parts are disks and memory. Disks account for 50% of all faulty server parts. This is mainly caused by the large number of disks and short lifecycle. Disks are the basic components of storage arrays. Currently, various redundancy technologies used in storage arrays can only allow a limited number of faulty disks. For example, RAID 3/5 arrays allow only one faulty disk, and RAID 6 arrays only allow up to two faulty disks. If the number of faulty disks exceeds the limit supported by the RAID redundancy mechanism, system breakdown or data loss may occur.

FusionDirector collects disk Self-Monitoring Analysis and Reporting Technology (S.M.A.R.T) information and disk run logs through the out-of-band channel without occupying in-band service resources. After data features are extracted, the built-in disk faulty prediction model of the software implements online inference and analysis

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of subhealthy disks. FusionDirector can proactively and accurately predict disk failures 20 days in advance.

The prediction function of FusionDirector can be enabled and disabled. Risk information overview, disk health trend statistics, and disk risk statistics and analysis are provided, helping users comprehensively obtain the disk running status.

- Risk information overview

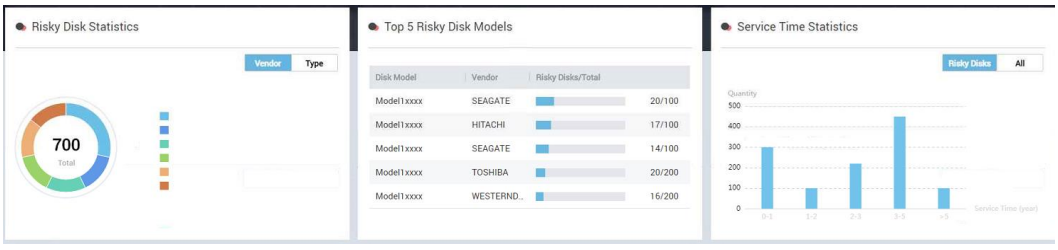
  Displays the distribution of disks in different states and the number and proportion of risky disks in each month of the recent year.
- Disk health trend statistics

  Displays the health score changes of disks in the recent month, disk locations, and SNs, helping users quickly replace faulty disks.
- Disk risk statistics and analysis
  - Displays the statistics of the total disk power-on time. Users can pay attention to disks that have been powered on for a long time.
  - Displays the total number of disks and subhealthy disks by type and by vendor.
  - Displays disk models with the highest number of subhealthy disks, helping users to make purchase choices.

Figure 3-8 Disk information overview



Figure 3-9 Disk risk statistics and analysis



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Figure 3-10 Disk risk details

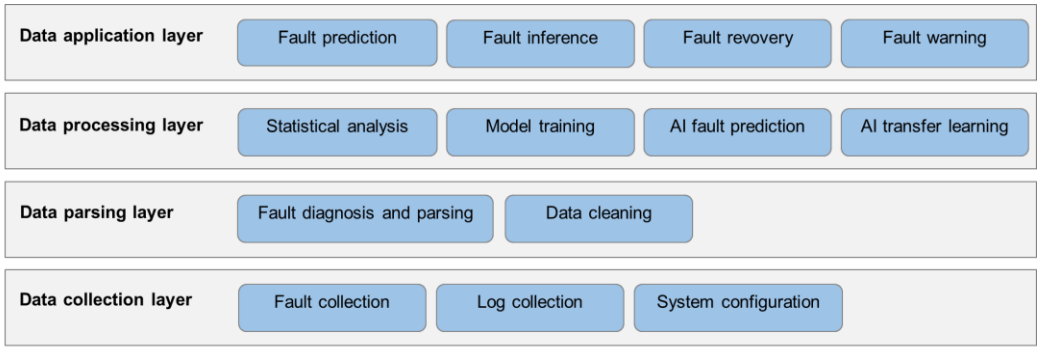


3.7.2 Solution Overview

The intelligent fault management system of xFusion servers consists of four functional modules, fault diagnosis, fault data analysis, fault prediction and recovery, and fault AI transfer learning.

The system can realize fault detection, fault prediction, fault inference, automatic fault recovery, and fault warning of servers. The intelligent fault management system consists of four layers, the data collection layer, data parsing layer, data processing layer, and data application layer. The data collection layer collects system logs, configuration information, and fault alarm information required for fault analysis. The data parsing layer parses and cleans the collected data and transfer it to the data processing layer. The data processing layer performs fault model training, AI fault prediction, and statistical analysis. The data application layer performs fault prediction, fault inference, and fault recovery.

Figure 3-11 Architecture of the intelligent fault management system



Based on the run log data of live network, xFusion established a big data platform of underlying faults on servers and summarized over 50 features of typical memory faults. The continuous deep research of memory data shows that the memory faults are often clustered. More than 90% of the faults occur in a small space within the memory chips. For servers that have experienced minor memory faults, the probability of breakdown increases greatly. For memory with specific fault features, the probability of breakdown is 80% in the next few months.

The self-developed intelligent memory fault prediction and self-healing technologies of xFusion trained memory fault feature models and memory fault prediction algorithms through the three-dimensional modeling of fault representation based on the

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cloud-based big data training platform. When servers are running, the memory fault information is collected by the data collection module, the fault source is located accurately by the fault prediction and diagnosis modules, and the fault is corrected and recovered by the isolated self-healing technology to avoid a system breakdown.

xFusion implements the AI transfer learning algorithm on FusionDirector to realize the quick adaptation to application scenarios and making the memory fault prediction results more accurate. When faults that cannot be self-healed occur, users can use the proactive migration technology of upper-layer services to implement service recovery in seconds.

3.7.2.1 Fault Detection

The iBMCs of xFusion servers implement comprehensive monitoring and provide a reliable mechanism for fault detection and alarm. The detectable faults are as follows:

- Faults of CPU hardware (CAT errors, self-check failures, and configuration errors).
- Overtemperature alarms (air inlets, CPUs, DIMMs, system PSUs, disks, and RAID controller cards).
- Power faults of mainboards and cards (including battery faults).
- Faults of fans.
- NIC MCE/AER faults.
- The precise alarm function of UCE faults for standard PCIe cards. PCIe faults will trigger alarms to specify the locations of faulty components.
- PSU faults (AC/DC input loss, high temperature, PSU fan faults, overvoltage, and overcurrent).
- Bus faults (I2C, IPMB, and QPI/UPI/HCCS).
- DIMM faults (excessive correctable ECC errors, uncorrectable ECC errors, high temperature, configuration and initialization faults, and CE overflows). DIMM faults, like UCE Non-Fatal, will trigger alarms to specify the locations of faulty DIMMs. DIMM fault isolation is supported. The DIMM CE errors can be identified in advance and the risky areas can be isolated to reduce service breakdown.
- DIMM edge connector faults, including the faults on the contact points between the DIMM edge connectors and the mainboard slots.
- Storage faults, including RAID controller card faults (internal faults, DIMM UCEs, excessive DIMM correctable ECC errors, NVRAM errors, and BMC access failures), disk faults (faults, preliminary faults, rebuilding failures, identification failures of installed disks by RAID controller cards, and SSD remaining life monitoring), faults of logical disks (offline and degraded), low BBU voltage and BBU faults, and link bit errors (link bit errors of RAID controller cards and disk backplane expander and the S.M.A.R.T. information collection of SAS and SATA disk internal faults).
- System breakdown.
- The iBMA software can be used to enhance the fault identification capabilities of the BMC software. The excessive CPU occupancy, DIMM occupancy, and disk partition usage alarms can be realized. The Ethernet NIC, link, and optical module fault alarms can be realized.

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3.7.2.2 DISK/DIMM Fault Diagnosis

Server fault diagnosis realizes functions of data collection, record, diagnosis, alarm, and log export of the disk and DIMM faults. Alarms and events are displayed on the WebUI in the format of a tree. The application scenarios of the troubleshooting system include:

1. When a breakdown, black screen, or response failure occurs during the running of a data center server, the generated MCE codes cannot be recorded because the OS does not support MCE codes or due to other reasons. Only the iBMC records the occurrence of CAT error events, and and no further information required for problem locating can be obtained.

2. After a long-time operation of servers, although a breakdown does not occur, a large number of recoverable or correctable faults exist, such as ECC. These faults do not affect business temporarily but need to be found and rectified in advance to avoid catastrophic faults.

3. Disk and DIMM faults occur at a low probability and are difficult to be reproduced. The faults are mainly located based on manual experience. Inserting, removing, and replacing disk and DIMMs for multiple times result in low efficiency and a great impact on customers.

4. There is no complete fault record after the faults occur.

5. There are two fault diagnosis methods:

- Online fault diagnosis

  FusionDirector can automatically collect BMC log packages of online devices to perform online disk and DIMM fault diagnosis.
- Offline fault diagnosis

  You can manually import BMC log packages of offline devices to FusionDirector to perform offline fault diagnosis for disks and DIMMs.

3.7.2.3 NPU Fault Diagnosis

With the widespread adoption of AI applications, NPUs have been widely used in data centers, edge computing devices, and mobile devices. Conducting NPU fault diagnosis is crucial to ensure system stability and reliability. NPU diagnosis mainly addresses the following issues:

- Reduce downtime: Promptly detect and fix NPU faults to avoid system downtime or performance degradation, ensuring server continuity.
- Prevent potential issues: Regular diagnostics identify potential problems, enabling preventive measures to avoid severe failures.

Leveraging expert experience in AI applications and hardware, the system offers the following capabilities:

- NPU diagnosis image management
- TDP, HBM, bandwidth, RoCE port, and EDP tests on NPU devices
- Display of diagnosis results, error causes, and handling suggestions of managed devices
- The out-of-band network instead of the in-band network is used in diagnosis.

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3.7.2.4 Fault Analysis

The BMCs of servers provide the function of fault analysis, which supports the analysis of fault logs of CPUs, DIMMs, disks, RAID controller cards, and self-developed cards, and the query of the historical events of fault warning.

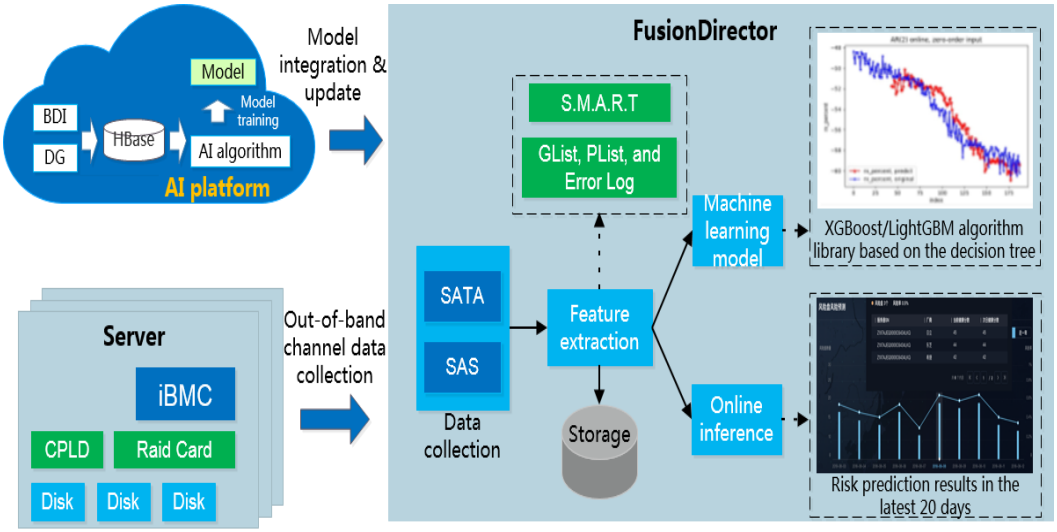
3.7.2.5 Fault Reporting

Servers support real-time fault reporting. The system faults will be reported to the upper-layer NMS or remote servers through SNMP and Redfish interfaces, which are used for fault analysis and processing later.

3.7.2.6 Disk Fault Prediction

Currently, fault prediction supports only for SAS/SATA HDDs, and SSDs of xFusion's servers later than V5 and KunLun servers.

Figure 3-12 Disk fault prediction process



1. Disk data collection
   - RAID out-of-band collection channel

     The data flow direction is Disk -> RAID -> iBMC -> FusionDirector. Out-of-band channel collection does not affect user services and in-band network bandwidth, and the monitoring data is stored in iBMC for a period of time. In extreme cases, after data loss caused by OS breakdown, FusionDirector can still obtain the data through the out-of-band channel.
   - S.M.A.R.T

     As a disk monitoring standard, S.M.A.R.T has been developing for 15 years and is highly recognized in the industry. Routine disk inspection depends on S.M.A.R.T information. The S.M.A.R.T function continuously collects information from each sensor on disks and saves the information in the system reserved area of the disks. S.M.A.R.T supports more than 200 monitoring counters. Not all counters are suitable for prediction. The selection and preprocessing of data features are the key for the algorithm to achieve good results. FusionDirector works with third-party AI training platforms to collect data of 300,000 server disks, analyzes the data of faulty

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disks based on experts' experience, and extracts more than 10 data items as the input of the algorithm model.

- Disk logs

  Most disk fault prediction functions in the industry are based on S.M.A.R.T. However, SAS HDDs or SSDs cannot provide S.M.A.R.T monitoring data. SAS disks and SSDs provide SCSI Log Page information. The information in Log Page records the current disk status and performance counters, such as grown defect list (GList), non-medium error, and read/write/verify uncorrected errors. FusionDirector obtains the preceding logs through the out-of-band collection channel, extracts key data features to provide fault prediction for SAS disks.

2. Machine learning model optimization

   Training is based on the model algorithm. The model algorithm is optimized through finite iterations. FusionDirector uses offline inference to analyze data, extract features, and optimize models on the third-party AI training platforms.

3. Inference model selection

   FusionDirector uses algorithms such as XGBoost and LightGBM to build an optimal disk failure model. The decision is made based on two years of continuous data collection, testing, and expert analysis of more than 1 million SAS disks and hundreds of thousands of SATA disks.

4. For online devices whose BMC/BIOS interfaces support fault collection, FusionDirector collects the fault information of devices in real time, uses the trained model to predict disk failures, and output the prediction results.

   According to experience and data verification results:

   - The prediction accuracy is improved when the prediction time window is reduced. However, users have less time to migrate data and prepare spare parts and the prediction benefit is less.
   - The prediction accuracy is lower when the prediction time window is increased. In this case, the disk failure rate is increased and shutdown for maintenance is more frequent.

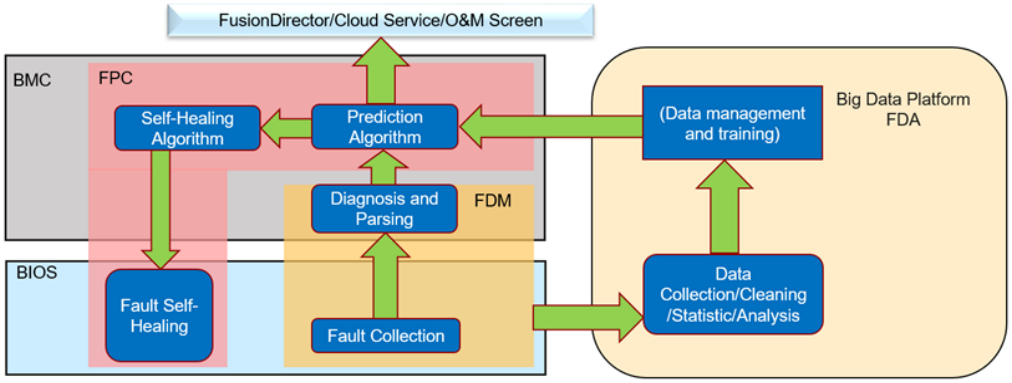
   To balance the accuracy and maintainability, FusionDirector predicts risky disks 20 days in advance. The false discovery rate (FDR: number of faulty disks identified in advance/total number of faulty disks) can reach 80% or higher, and the false acceptance rate (FAR: number of false positive disks/total number of good disks) is less than 0.2%.

3.7.2.7 DIMM Fault Prediction

Currently, fault prediction supports only xFusion's servers later than V5 and KunLun servers.

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Figure 3-13 DIMM fault prediction process



1. Introduction of components of DIMM fault prediction

- Failure Diagnostic Management (FDM): specifies the fault diagnosis and management system The system can realize fault collection, diagnosis, and parsing and obtain device running error data.
- Failure Data Analysis Platform (FDA): specifies the big data analysis platform of faults. The platform implements big data analysis of faults and AI training to obtain fault prediction algorithms. Currently, the running log data of more than 100000 servers covers the data of mainstream customers in industries such as cloud service, financial, and large-scale enterprises.
- Failure Prediction and Correction (FPC): specifies the prediction and self-healing system of faults. Fault prediction and self-healing algorithms are embedded in BMCs to implement isolation recovery or warning reporting.

2. For online devices whose BMC/BIOS interfaces support fault collection, FusionDirector implements online fault prediction to device DIMMs after collecting fault information of devices in real time.

3.7.3 Benefits

- Proactive prevention, improving system reliability

  Predicts disks memory modules in the subhealthy state in advance and informs users to inspect disks, migrate services to prevent major problems on the live network such as service breakdown and data loss.
- Multi-dimensional analysis, comprehensively monitoring disk status

  One-stop management of warning and alarm information, real-time monitoring of disk hardware and software status, rich statistics and analysis functions, accumulated disk usage time analysis, and top N disk types and models that are prone to faults, helping customers make disk purchase plans.
- Accurate spare parts preparation, ensuring zero waste of spare parts

  Long-term fault prediction helps customers prepare spare parts 20 days in advance, relieving inventory pressure and reducing spare parts costs.

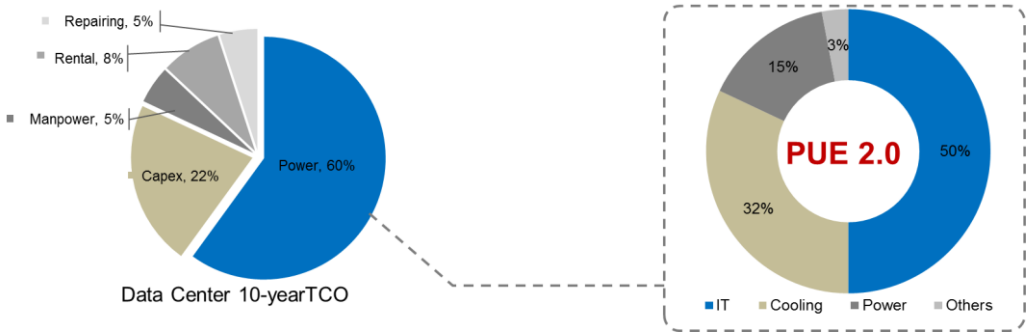
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3.8 Intelligent Energy Efficiency Management

3.8.1 Customer Pain Points

As DC scales become larger and larger, DC energy efficiency problems become more and more prominent. Reducing operating expenses (OPEX) has become an important issue for customers. As shown in Figure 3-14, the 10-year overall power consumption of a DC accounts for 60% of the total cost of ownership (TCO). 50% of the electricity is consumed by IT devices and mostly by servers. Therefore, server system energy saving can effectively reduce the OPEX.

Figure 3-14 TCO analysis



The following two issues obstruct server energy efficiency improvement.

1. Technological difficulty. To improve server energy efficiency, a large number of parameters need to be modified, including BIOS parameters, heat dissipation parameters, power supply parameters, CPU parameters, hard disk parameters, PCIe device parameters, and parameters provided by server vendors. Adjusting these parameters requires a strong technical background and misoperations may affect service performance.
2. Adjustment timing. When services require high performance, the system needs to be adjusted to the performance mode. When high performance is not required, the system needs to be adjusted to the energy-saving mode.

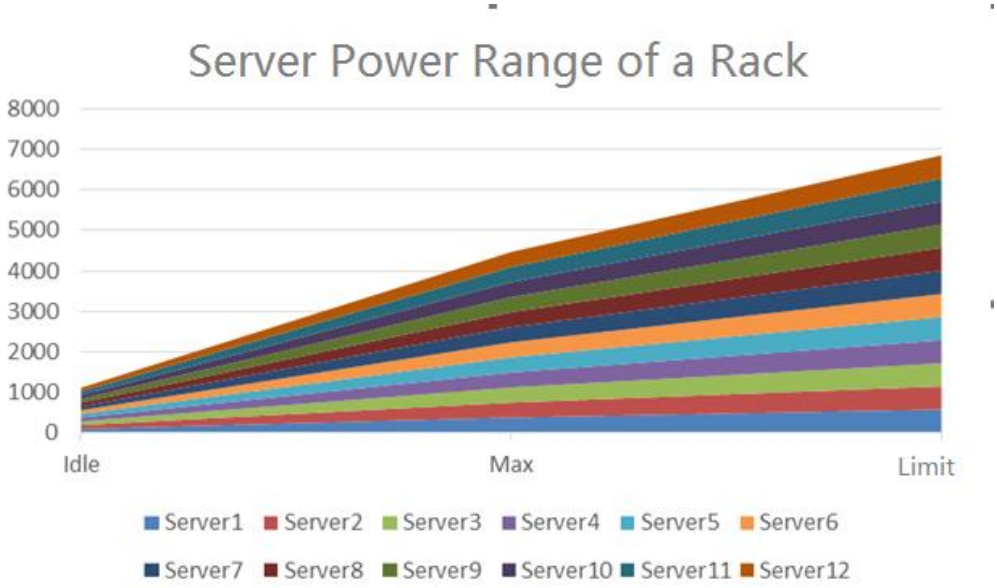
In addition to energy saving, power supply is also a major problem. The service life of a DC equipment room is generally 10 years, and servers are upgraded about every three years. Therefore, an equipment room needs to support three generations of servers. The power consumption of servers in each generation is higher than that of the last generation, causing difficulties in adapting early-stage power supply plan to server power consumption in the future. The actual situation is worse. As shown in Figure 3-15, the power of a typical server is 100 W to 400 W, and can be 500 W in an extreme situation. The power range of a server is large. As a result, the power supply design of most racks is based on server power at 100% CPU usage. This design may cause power supply risks, but the risks are small and the design is reasonable.

In Figure 3-15, a 4500 W rack can support 12 full-load servers. If the height of each server is 2U, the servers use only 24U of the 42U rack space. The deployment density is about 60%. However, the DC equipment room space is still insufficient. Therefore, a large amount of DC space is wasted.

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- Can new equipment rooms provide more space? Governments in developed regions such as Beijing, Tokyo, and Singapore have explicitly restricted the construction of new DC equipment rooms.
- Can increasing power supply capability improve deployment density? Generally, equipment rooms in developed areas use mains supply. Mains supply is costly and difficult to reconstruct.

Figure 3-15 Power consumption curve



Is it impossible to resolve the conflict between space and power supply? Figure 3-16 shows the 10-day average CPU usage of 608 servers in a DC. The average CPU usage of about 66% of the servers is lower than 20%, and the maximum CPU usage of 45% of the servers is lower than 30%. The overall server CPU usage is low.

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Figure 3-16 CPU usage distribution

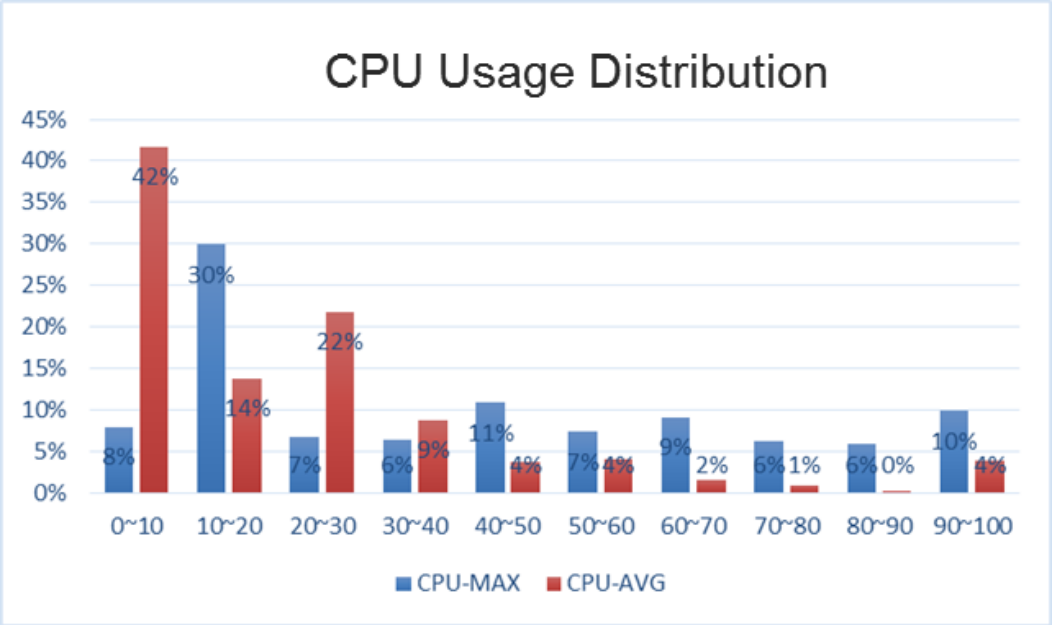
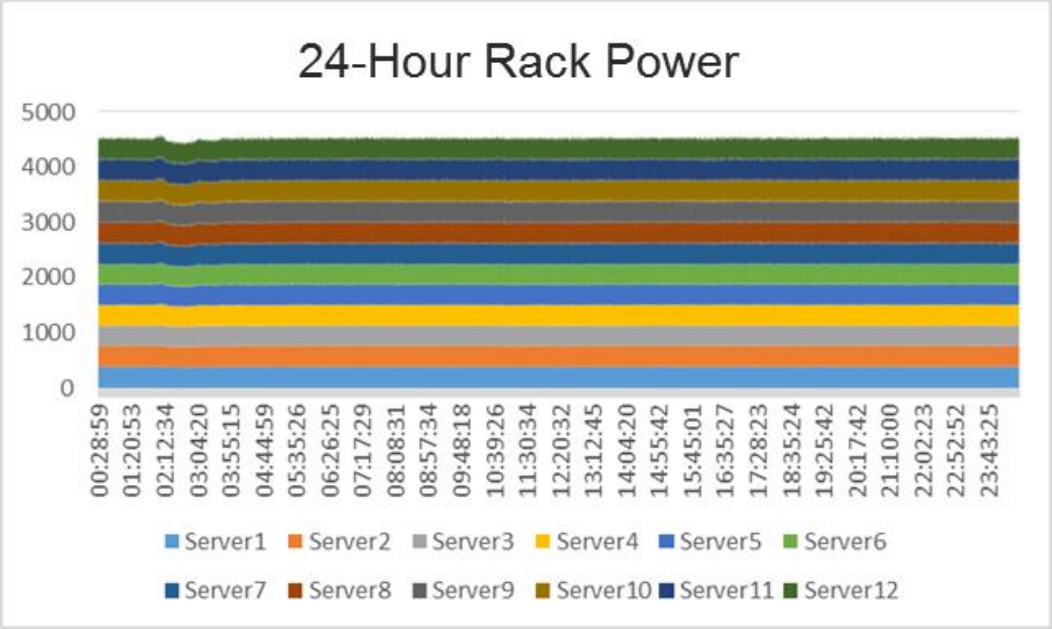


Figure 3-17 shows the 24-hour power statistics of a rack in the DC. The power of each server in the rack is stable.

Figure 3-17 Power statistics



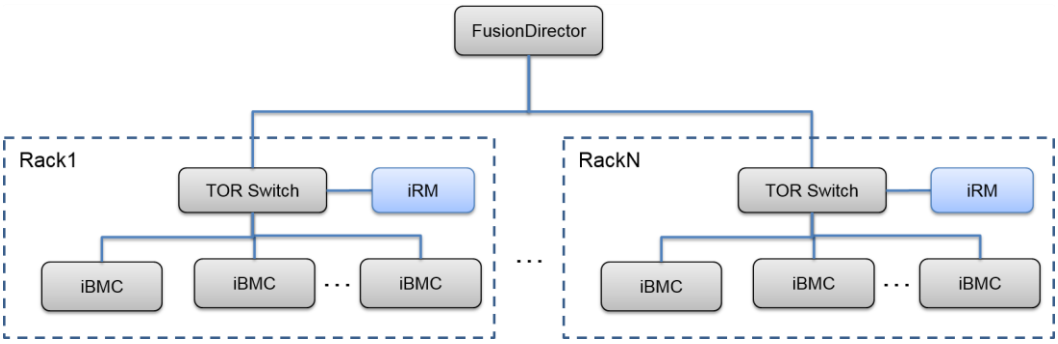
The preceding statistics show that DC power and space have large potential. The intelligent energy efficiency management solution well addresses the problem.

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3.8.2 Solution Overview

The intelligent power control and energy saving for DCs and racks is provided to ensure reliable power supply. Figure 3-18 shows the overall networking of the intelligent energy efficiency solution. The solution supports energy efficiency management for V5 and later servers.

Figure 3-18 Networking of intelligent energy efficiency solution



FusionDirector connects to the iRM system and server iBMC system to manage servers and racks at the same time. To achieve rack-level intelligent power consumption control, FusionDirector, iRM, and iBMC have different functions.

- iBMC has a built-in AI data collection model. This model collects device status based on a specified time slice, formats the data, and stores the data in the local flash of iBMC. iBMC can store running data of 15–30 days, including power consumption data, CPU load data, memory load data, environment data, and part status indicators. iBMC provides a Redfish interface for data collection. By working based on the time sequence, FusionDirector can efficiently obtain data in certain time slices.
- FusionDirector collects the power consumption data sequence of each server through the iBMC Redfish interface, uses the built-in AI engine to infer the future power consumption trend of each server, and delivers the power consumption trend to the rack management component iRM. FusionDirector delivers the power consumption trend of a long period to iRM. iRM adjusts the power consumption trend based on the actual situation.
- As the management component of each rack, iRM collects iBMC power consumption data every several seconds and slightly adjusts the prediction model based on the prediction benchmark delivered by FusionDirector. In this way, the real-time power consumption prediction model is implemented.

The power of each server in a rack fluctuates dynamically and no server always runs at the maximum status. Therefore, the power of each server has crests and troughs. However, the power of the entire rack does not fluctuate drastically.

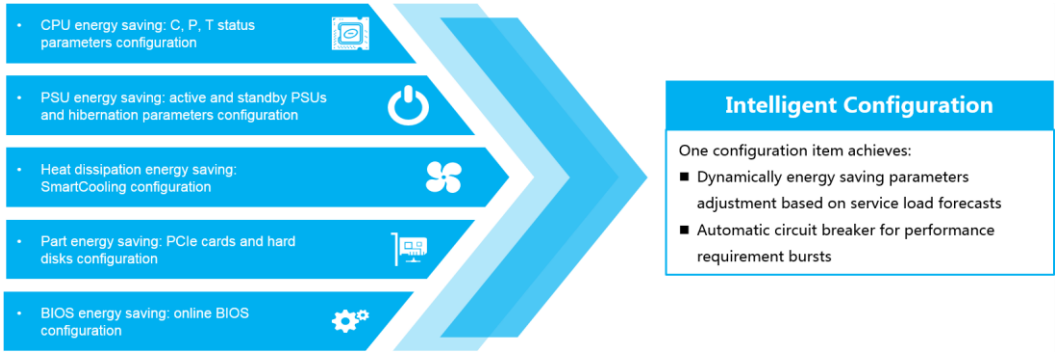
The intelligent energy efficiency management system records the power data of each server continuously, infers the required power of each server in the future based on the data, provides power margin in advance, and dynamically adjusts the power cap of each server. In this way, each server has a maximum power limit. As long as the power limit does not exceed the power supply capability of the rack, the power supply of the rack is secure. By using intelligent power prediction, FusionDirector ensures that the power cap of each server is higher than the actual power requirement without causing perceivable service performance change. Sudden bursts of server resource

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requirements will trigger power capping and affect service performance. However, the impact is controlled within 10 seconds. iRM detects the power exception within 10 seconds and reallocates the rack power.

The intelligent energy efficiency management system achieves intelligent energy saving. It records resource status during service running, predicts the service load in the next period, and automatically implements dynamic energy efficiency configuration based on the service load forecast. When the service performance requirement suddenly increases, the intelligent energy efficiency management system immediately initiates the circuit breaker mechanism, cancels the energy-saving configuration, and automatically restores the performance mode. Figure 3-19 shows the intelligent energy saving mechanism. Customers do not need to configure energy saving items. The smart energy efficiency system dynamically adjusts energy efficiency parameters based on the service load in real time to ensure low power at low service loads and high performance at high service loads.

Figure 3-19 Intelligent configuration



The intelligent energy efficiency management system provides the following features:

- Energy consumption statistics: displays energy consumption statistics based on data centers or customized groups.
- Dynamic rack power supply: adjusts the power cap of each server based on the server prediction. This ensures the power supply security of the cabinet without affecting services.
- Dynamic power adjustment: adjusts the power configuration items of each server based on the service trend to ensure the lowest power at low and medium performance.
- Low-load server analysis: analyzes long-term low-load servers and provides optimization suggestions for service adjustment and further energy saving measures.
- Power supply trend analysis: displays the DC, rack, and server power trends and energy saving statistics after energy saving is enabled.
- Power supply/space risk analysis: collects statistics on power supply risks and rack space usage and provides optimization suggestions for customers so that they can adjust services to prevent impacts when sudden situations occur.
- Environment temperature analysis: analyzes environment temperature and identifies environment hot spots and provides optimization suggestions.
- One-click batch energy saving management: supports one-click energy saving in the following scenarios: HPC, power efficiency, general computing-integer,

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general computing-floating point, low latency, memory throughput, I/O throughput, energy saving, and NFV.

- Carbon emission management: facilitates the handling of carbon asset information in data centers and enables the calculation, aggregation, analysis, and mitigation of carbon emissions.

3.8.3 Benefits

3.8.3.1 Higher Rack Power Usage and Lower Equipment Room Construction Costs

In equipment rooms leased by rack, the power supply capability and rack space are fixed. The leasing party limits the maximum power of each rack. Exceeding the rated power will cause huge extra charges. To ensure that the power of each rack at the maximum service load does not exceed the power supply capability, rack users are conservative when they design the device power. As a result, the power of each rack is far lower than the power supply capability.

In self-built equipment rooms, most racks use only about 60% of the power supply capability, and the power supply capability is far higher the used power.

The intelligent energy efficiency management system improves the rack deployment density and power supply utilization without compromising security. As shown in Table 3-14, with the intelligent energy efficiency management system, a customer's power supply utilization is increased from 60% to 80%, 2 to 4 more servers can be deployed in a single rack, 20% more servers can be deployed in the same equipment room.

Table 3-14 Rack power supply

Rack Power Supply Capability (W)	Original Deployment			Recommended Deployment			Added Server Quantity	Deployment Density Improvement	Power Supply Utilization Improvement
	Server Quantity	Used Power (W)	Power Supply Utilization	Server Quantity	Used Power (W)	Power Supply Utilization			
4000	7	2485	62%	9	3195	80%	2	28.6%	28.6%
5000	9	3195	64%	11	3905	78%	2	22.2%	22.2%
6000	10	3550	59%	13	4615	77%	3	30.0%	30.0%
7000	12	4260	61%	15	5325	76%	3	25.0%	25.0%
8000	14	4970	62%	18	6390	80%	4	28.6%	28.6%

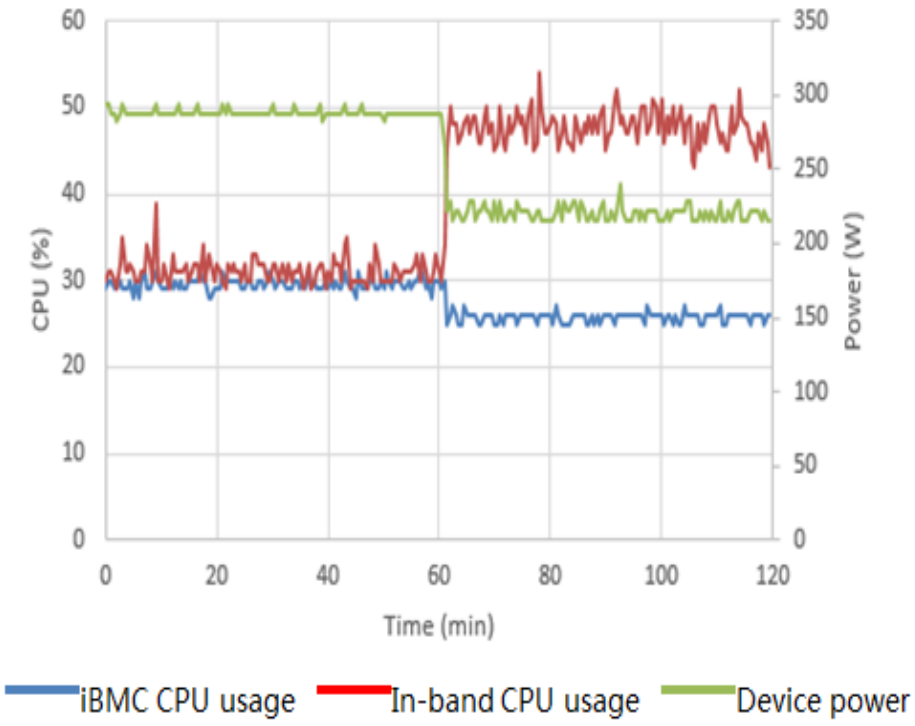
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3.8.3.2 Dynamic Energy Saving Without Service Awareness and Lower Power Costs

Customers' biggest concern about energy saving is the impact on performance. Especially, CPU energy saving configuration reduces CPU frequency. Does the energy saving configuration reduce the performance?

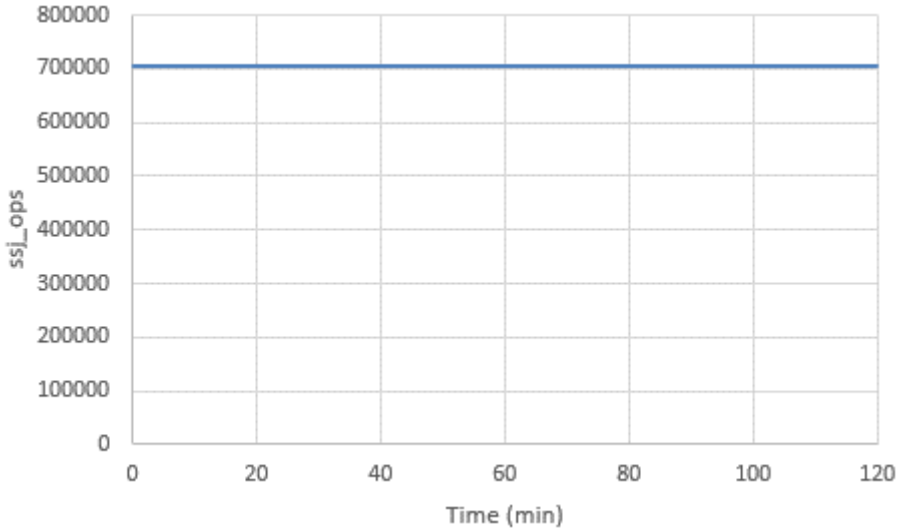
According to a SPEC power test, CPU frequency adjustment at low and medium loads does not affect services. As shown in Figure 3-20 and Figure 3-21, the blue line indicates the CPU usage monitored by the out-of-band iBMC system, and the red line indicates the CPU usage collected by the OS. After the CPU frequency is adjusted, the device power is reduced by about 60 W. The service performance parameter of the SSJ model is stable, and no performance deterioration occurs. The SSJ test model is an industry standard model for testing the relationship between performance and power. The model is based on Java and simulates a service process during which the CPU, memory, hard disk, and network are accessed. This model is a comprehensive service test model. For details about the test model, visit the official website of SPECpower.

Figure 3-20 CPU usage



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Figure 3-21 SSJ model



What is the difference between the intelligent energy saving technology of intelligent energy efficiency management and the OS energy saving function? In typical enterprise scenarios, the energy-saving mode of low-load servers saves more than 10% power consumption compared with the OS frequency adjustment function. Table 3-15 shows the energy saving results of OS frequency adjustment and intelligent energy saving frequency adjustment. In the test, only the CPU frequency is adjusted for energy saving, and other parameters are unchanged.

Table 3-15 CPU frequency adjustment for energy saving

Load Status	**OS Frequency Adjustment Enabled** **Intelligent Power Saving Algorithm Disabled**		**OS Frequency Adjustment Disabled** **Intelligent Power Saving Algorithm Enabled**	
	Energy Saving (W)	**Energy Saving Ratio**	**Energy Saving (W)**	**Energy Saving Ratio**
No-load (0%)	26	9.7%	77	28.9%
Low-load (1% to 30%)	28 to 33	9.9% to 10.6%	62 to 73	19.4% to 26%
Medium-load (40% to 50%)	8 to 30	3.2% to 8.7%	25 to 31	7.3% to 8.7%
High-load (>50%)	–5 to 2	–1.2% to 0.5%	0	0

Table 3-16 lists the software and hardware configurations in the test.

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NOTICE

Test environment: CentOS Linux Release 7.3.1611 (Core).

Table 3-16 Hardware and software configurations

Part	Model	Quantity
CPU	Gold Skylake 6130T	2
DIMM	16 GB 2R x 4 PC4-2400T	4
Front hard disk	-	0
Rear hard disk	2.5-inch 600 GB SAS	2
RAID controller card	LAI SAS3416	1
PSU	PS-2152-2H 1500W Platinum	2

3.8.3.3 Automatic Server Status Identification for Service Deployment Optimization

With the emergence of enterprise private clouds, one server shared by multiple services is increasingly common. Long-term low-load servers are a waste of resources. The intelligent energy efficiency management system records the energy efficiency data of servers in a long period and analyzes statistics of low-load servers. The system identifies low-load servers, helping customers optimize the resource utilization of physical machines.

The system also analyzes the power supply and space of racks and collects statistics on racks that have risks in power supply, helping customers adjust the physical space deployment of servers to achieve the optimal configuration of physical rack resources. The system also identifies high temperature areas, helping customers identify hotspots and system-level risks in equipment rooms.

3.9 Security Management

The FusionDirector system controls and ensures its own security through a series of security policies, such as user management, login management, and certificate management.

3.9.1 User Management

By default, FusionDirector provides the **Administrator** user as the super administrator. The user password is encrypted using the irreversible algorithm PBKDF2 to ensure security.

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- Allows users to view, add, delete, and modify user information. Supports management permission control based user roles.
- A user can be locked or unlocked for login permission control.
- Supports two-factor login authentication (user password + email or SMS random code).

FusionDirector supports scope management. Different roles can be bound to different scopes to restrict the scope of resources that can be operated by different roles.

- Allows users to view, add, delete, and modify scopes.
- The following resources can be divided into scopes: servers, chassis, server profiles, chassis profiles, GUID pools, IP address pools, MAC address pools, WWN pools, and baselines.

3.9.2 Authentication Management

FusionDirector has two authentication modes: local authentication and LDAP authentication.

- Local authentication: Default authentication mode. Functions such as user management, login authentication, and security policy are provided.
- LDAP authentication: supports multiple user groups and interconnections with multiple LDAP servers. To improve system security, users can log in to FusionDirector by using a user domain, group domain, and LDAP account of a user domain. The preceding information is configured on the domain controller.

3.9.3 Security Configuration

FusionDirector adopts security configuration by default and provides the Secure Shell V2 (SSHv2), Simple Network Management Protocol V3 (SNMPv3), Secure File Transfer Protocol (SFTP), and Hypertext Transfer Protocol Secure (HTTPS) security services. Insecure communication protocols such as Telnet, File Transfer Protocol (FTP), Hypertext Transfer Protocol (HTTP), SNMPv1/SNMPv2, and the SSH login permission of the **root** user are disabled.

The FusionDirector login terminal can be an SSH client or web browser. If you do not perform any operations within the specified period, FusionDirector logs you out to ensure security. The default timeout period is 5 minutes for SSH terminals and 10 minutes for web browsers. Users can change the timeout period based on site requirements. You can change the SSH timeout period by using configuration files choose **Menu** > **Settings** > **Security** > **Security Policy** on the WebUI to change the web timeout period.

When a user attempts to use a FusionDirector login terminal (SSH client or web browser) for login, the account will be locked after multiple consecutive login failures (three by default). The default lock period is 5 minutes. The lock period can be changed. On the FusionDirector WebUI, choose **Menu** > **Settings** > **Security** > **Security Policy** and change the lockout period.

Table 3-17 describes the protocols and algorithms used by the product.

Table 3-17 Description about the protocols and algorithms

Protocol	Encryption Algorithm	Algorithm Strength
HTTPS	AES	256

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Protocol	Encryption Algorithm	Algorithm Strength
(TLS 1.2)		
SFTP (SSHv2)	AES	128 or greater
SSHv2	AES	128 or greater
SNMPv3	• Authentication protocol: HMAC-SHA1 • Privacy protocol: CFB-AES	128

3.9.4 License Management

The FusionDirector WebUI adopts the HTTPS access mode by default and supports HTTPS license management.

The licenses refer to SSL licenses, which are used in HTTPS connections to authenticate web servers. License management refers to various management operations on the SSL license, including viewing the current license information (such as the user, issuer, validity period, and serial number), generating the CSR file, importing the signed license generated by the CSR, and importing custom licenses.

License management supports WebServer (Nginx) license request file generation and download, license private key and public key update, and license information query. Currently, only the PEM encoding license format is supported.

3.9.5 CC EAL2+ Certification

Common Criteria for Information Technology Security Evaluation (CC) is used to evaluate the security of information systems and information products. The evaluation of CC is in respect of security function requirements and security assurance requirements. The FusionDirector has obtained the international CC EAL2+ certification.

3.10 Layered Management

In the big data era, cloud computing and edge computing are developing rapidly. Customers are managing more and more devices, and devices are deployed across regions. Single-layer NMSs cannot meet complex NMS requirements.

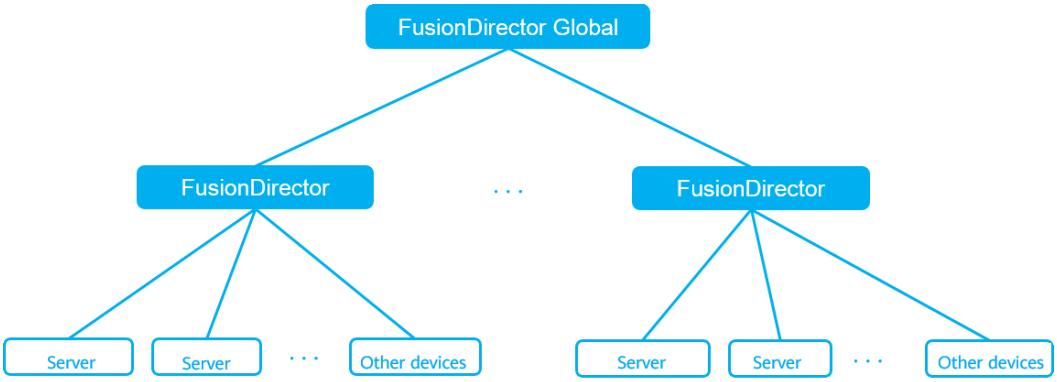
FusionDirector layered management provides the following benefits:

- Supports flexible expansion of device management scale to meet ultra-large-scale NMS requirements.
- Supports layered management of devices distributed across regions to reduce bandwidth requirements on the backbone network and improve management efficiency.
- Meets higher isolation and permission management requirements.
- Provides a global monitoring interface and a unified management portal to improve O&M efficiency.

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FusionDirector supports upper-layer and lower-layer deployment. You can deploy the layered system based on service requirements. Figure 3-22 shows the layered deployment networking.

Figure 3-22 Layered deployment networking



FusionDirector Global functions as the upper-layer NMS in a layered system and provides the following features:

- Supports management of a maximum of 256 lower-layer FusionDirector systems and a maximum of 3 million (256 x 12000) devices.
- Provides a global monitoring interface, which centrally displays statistics such as global alarm status, top N devices for alarm quantity, health status, number of data centers, number of assets, number of containerized applications, and running status of container instances.
- Provides a unified management portal and allows users to seamlessly jump to a lower-layer FusionDirector for management.
- Supports centralized file push. Image files and resource files can be pushed to lower-layer FusionDirector systems in batches.
- Provides the user management function. You can set the user roles and the scope of lower-layer FusionDirector systems that can be managed by a user.

3.11 Interconnections

FusionDirector supports flexible system interconnection capabilities including the interconnection with FusionOnline for remote O&M, with SMTP for email management, with vCenter Server for plug-in management, and with the SNMP Trap server, WeChat server, and DingTalk server for alarm management.

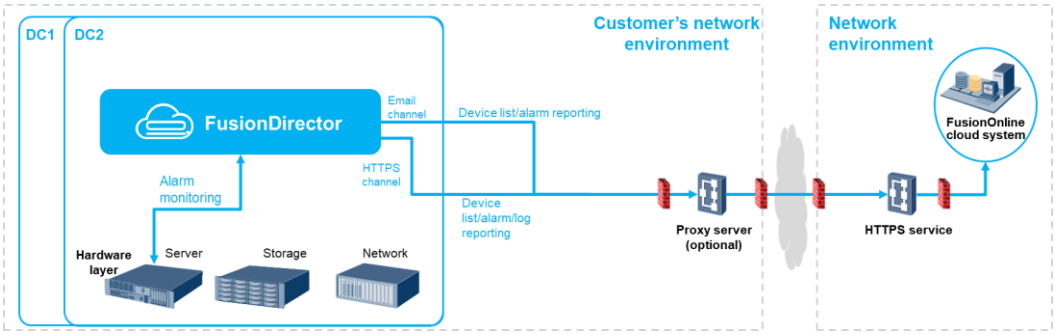
3.11.1 Remote O&M (Call Home)

FusionOnline is the Call Home product of xFusion. After obtaining customers' authorization, FusionOnline collects customers' device information (including device list, alarms, performance, device logs and audit logs) and reports the information to the xFusion's service support center. The service support center can monitor device information in the first place and handle problems in a proactive and timely manner.

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The Call Home system consists of the FusionOnline client and the backend FusionOnline cloud deployed in the xFusion support center. FusionDirector functions as the FusionOnline client and reports device information to the FusionOnline cloud through HTTPS or emails. Then, the FusionOnline cloud sends device information back to customers.

Figure 3-23 Networking diagram of the interconnection between FusionDirector and FusionOnline

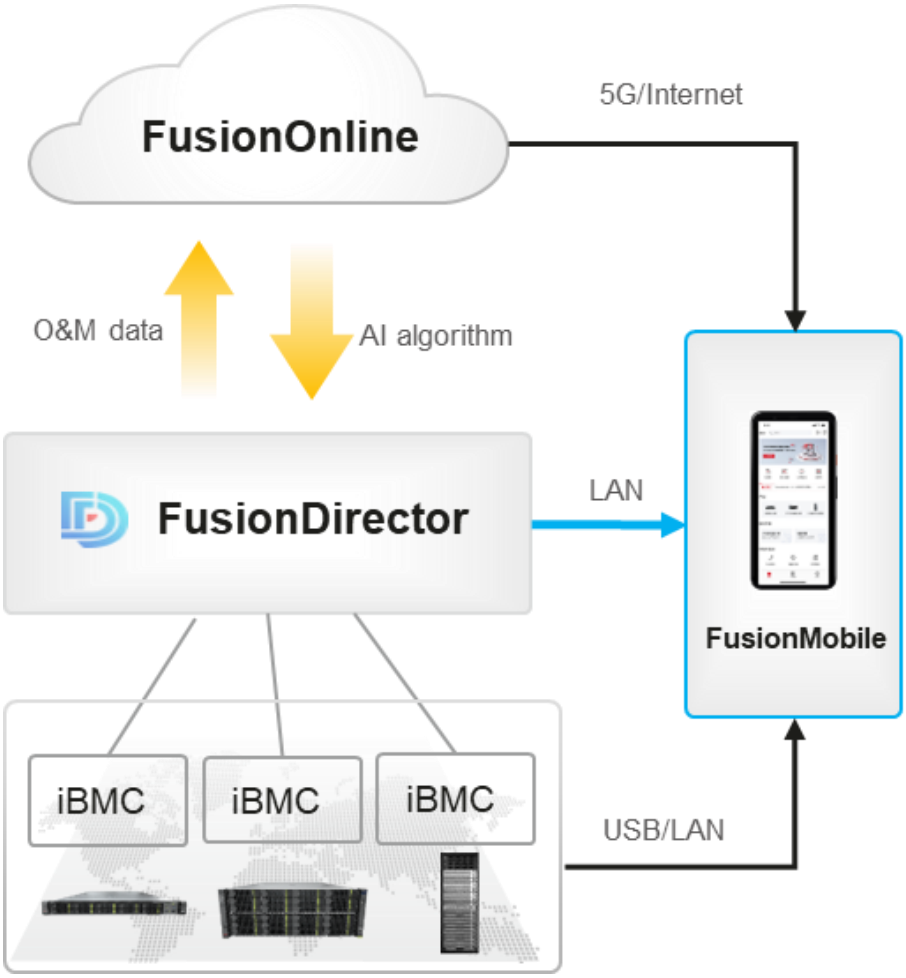


3.11.2 Mobile O&M

FusionDirector can interconnect with FusionMobile, realizing mobile O&M capabilities such as asset management and device alarm monitoring.

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Figure 3-24 Mobile O&M networking diagram



3.11.3 SMTP Interconnection

FusionDirector connects to third-party SMTP servers by using the SMTP protocol to send the alarms of itself and the alarms of managed servers to the specified email addresses in real time based on the customized email format.

Table 3-18 describes the functions supported by FusionDirector SMTP.

Table 3-18 SMTP functions

Function Type	Description
SMTP Function Setting	Allows you to enable or disable the SMTP function.
Email Configuration	Allows you to configure SMTP servers, including IP address, port number, and TLS authentication mode.
Email	Allows you to configure the sender, sender email address,

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Function Type	Description
Information	password, anonymous sending, and email subject.

3.11.4 vCenter Server Interconnection

FusionDirector supports the adding, modifying, and deleting function for vCenter Server. After vCenter Server is interconnected, the system automatically installs and registers plug-ins with vCenter Server. Customers do not need to install independent vCenter plug-in management software (such as FDIVV), saving deployment resources and improving management efficiency.

3.11.5 SNMP Trap Interconnection

FusionDirector connects with third-party SNMP Trap servers by using the SNMP protocol to send the alarms of itself and the alarms of managed servers to the SNMP Trap servers.

Table 3-19 lists the functions supported by FusionDirector SNMP Trap.

Table 3-19 SNMP Trap functions

Function Type	Description
Operating Parameter Configuration	You can set the parameters for interconnecting with an SNMP Trap server, including the user name, authentication password, encryption password, and alarm severity.
Trap Server Configuration	You can configure the IP addresses and port numbers of a maximum of four SNMP Trap servers.

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4 Typical Networking

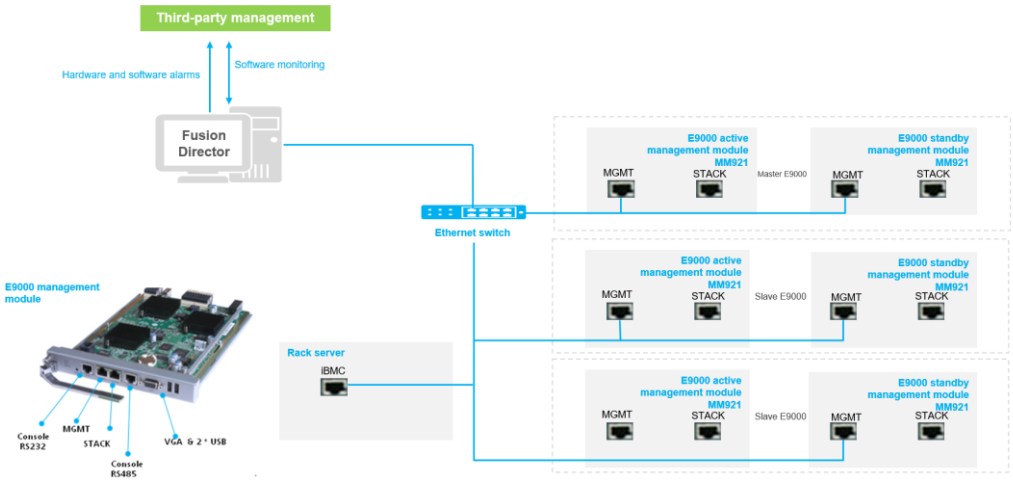
4.1 Enterprise Networking
4.2 E9000 Embedded Networking

4.1 Enterprise Networking

FusionDirector adopts all out-of-band networking and has the following advantages:

- In-band and out-of-band management depends on only one management network and does not depend on the service network. The networking is simple.
- Only one network port is required.
- Management is independent of the DHCP service.

Figure 4-1 Enterprise networking



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4.2 E9000 Embedded Networking

- Two management modules are configured in active/standby or active-active mode in an E9000.
- FusionDirector is installed in the MM920, but not in the MM921.
- The master chassis and slave chassis need to be cascaded through management modules or connected through an external switch.

Figure 4-2 Connected through an external switch

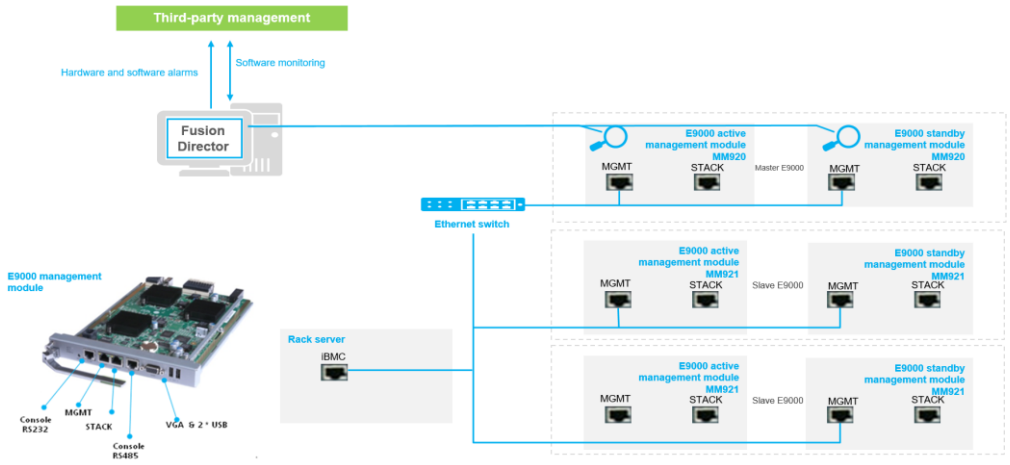
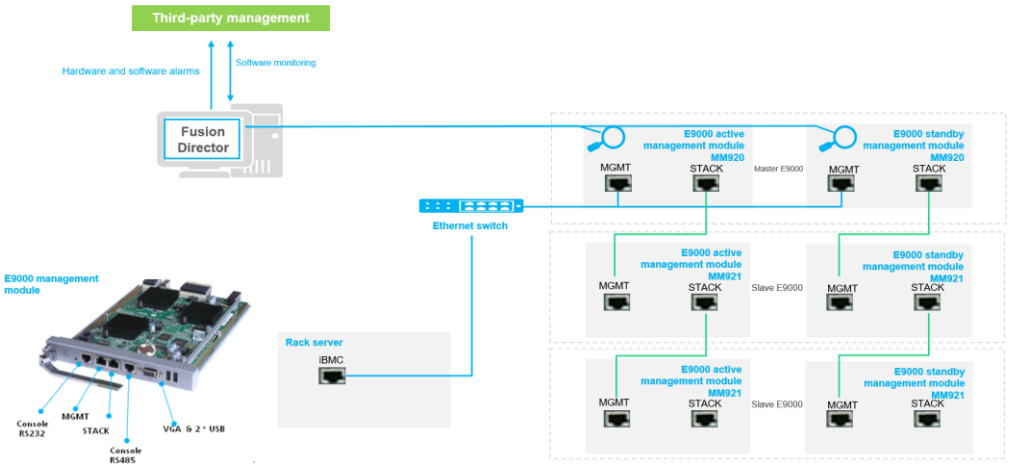


Figure 4-3 Cascaded through management modules



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5 Networking Constraints

1. FusionDirector supports IPv4, IPv6, and dual-stack networking.
2. The 10.255.0.0/16 network segment has been occupied for internal use by the FusionDirector. During IP address planning, devices related to the FusionDirector services cannot use IP addresses from this network segment. The devices include but are not limited to clients used to log in to the FusionDirector, devices managed by the FusionDirector, and NTP and DNS servers connected to the FusionDirector.
3. To ensure the normal running of the FusionDirector and avoid frame freezing or slow upload and download, the network bandwidth must meet the following requirements:
   - The disk I/O speed of the FusionDirector management node ≥ 100 MB/s
   - The bandwidth between the FusionDirector management node and the device ≥ 50 Mbit/s
   - The bandwidth between the FusionDirector management node and the web client ≥ 10 Mbit/s
   - The bandwidth between the upper-level and lower-level management nodes of the FusionDirector ≥ 10 Mbit/s
   - The bandwidth between management nodes in the FusionDirector cluster ≥ 100 Mbit/s
   - Other network requirements: delay < 30 ms, packet loss rate < 0.1%.

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A Glossary

B	
BIOS	Basic Input/Output System
C	
CMC	Central Management Console
CNA	Converged Network Adapter
CPLD	Complex Programmable Logic Device
F	
FC	Fiber Channel
H	
HBA	Host Bus Adapter
HMM	Hyper Management Module
I	
IB	InfiniBand
iBMC	Intelligent Baseboard Management Controller
ICT	Information Communications Technology
IPMI	Intelligent Platform Management Interface
L	
LCD	Liquid Crystal Display
LDAP	Lightweight Directory Access Protocol
N	
NIC	Network Interface Card
NVDIMM	Non-Volatile Dual In-Line Memory Module
R	
RAID	Redundant Array Of Independent Disks

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S	
SNMP	Simple Network Management Protocol
SSD	Solid-State Disk
SSDP	Simple Service Discovery Protocol
T	
TCP/IP	Transmission Control Protocol/Internet Protocol

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B Acronyms and Abbreviations

B	
BIOS	Basic Input Output System
C	
CMC	Central Management Console
CNA	Converged Network Adapters
CPLD	Complex Programmable Logic Device
F	
FC	Fiber Channel
H	
HBA	Host Bus Adapter
HMM	Hyper Management Module
I	
IB	Infiniband
iBMC	Intelligent Baseboard Management Controller
ICT	Information and Communications Technology
IPMI	Intelligent Platform Management Interface
L	
LCD	Liquid Crystal Display
LDAP	Lightweight Directory Access Protocol
N	
NIC	Network Interface Card
NVDIMM	Non-volatile Dual Inline Memory Module

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R	
RAID	Redundant Array of Independent Disks
S	
SNMP	Simple Network Management Protocol
SSD	Solid State Drives
SSDP	Simple Service Discovery Protocol
T	
TCP/IP	Transmission Control Protocol/Internet Protocol

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