Huawei Cloud Data Center Converged Resource Solution
V100R001C20

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1 Overview

About This Chapter

The following table lists the main information in this chapter.

Title	Content
1.1 Objectives of the DC^2	Describes the objectives of the DC^2.
1.2 Overall Architecture of the DC^2	Describes the logical architecture of the DC^2.
1.3 Logical Deployment of the DC^2	Describes the logical deployment of the DC^2.
1.4 Logical Concepts of the DC^2	Describes the logical concepts of the DC^2.

1.1 Objectives of the DC^2

To address challenges for data centers and conform to technology development trends, Huawei launches the Distributed Cloud Data Center (DC^2) Solution. The DC^2 Solution is a solution that is driven by services and supports physically discrete but logically unified resources, synergy between the cloud and pipes, and service perception.

This solution provides a virtual data center (VDC) platform to support fine-grained IT operation by using an integrated architecture (converging computing, storage, and network resources) as the fundamental unit of the resource pool, constructing a software-defined networking (SDN) service perception network, and managing physically dispersed resources through automated and intelligent management. The main idea of the DC^2 Solution is physical distribution and logical unification. The DC^2 Solution integrates data centers all over the world into a large server which provides services externally. This solution aims at integrating multiple data centers to improve IT efficiency for enterprises. Delocalization, software-defined data center construction, and automation are characteristics of the DC^2 Solution. Logical unification has two meanings:

- Users manage, schedule, implement O&M for all data centers and resources in the data centers in a unified manner and implement rights- and domain-based management. To

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support these capabilities, the DC^2 Solution must provide a unified O&M management platform.

- If the distributed cloud data center needs to provide services externally, a unified portal is required to display services, and a unified process is required to support service provisioning. In this case, the DC^2 Solution must provide a unified service platform.

The DC^2 Solution does not aim at improving efficiency and user experience of a single data center. It regards multiple data centers as one and provides the cloud platform that migrates cloud resources across data centers, the O&M management system that centrally manages and schedules resources of multiple data centers, the layer 2 ultra-high bandwidth network, and software-defined data centers based on cross-data center management, resource scheduling, and disaster recovery (DR) design. The DC^2 is an epoch-making, revolutionary data center architecture, which brings unprecedented benefits and user experience to customers. The DC^2 provides the following benefits:

- Reduced total cost of ownership (TCO) and increased return on investment (ROI)

  The DC^2 adopts virtualization technologies to ensure that software is independent of hardware and enable the infrastructure with low usage to provide elastic, automated, and secure computing resource pools. Resources can be allocated to applications on demand. The Huawei DC^2 Solution helps enterprises reduce infrastructure investments and operation costs by resource consolidation and automation. The distribution technology logically unifies resources of multiple data centers, improving resource usage and reducing infrastructure investments. The DC^2 provides DR and backup services. Application availability and resource usage are improved by using the cross-data center application migration service for load balancing. Improved availability and shortened downtime help enterprises save intangible costs. Availability of virtual machines (VMs) can be improved by using the VM migration service. In addition, encapsulation attributes of VMs and virtual disks and capabilities of obtaining VM status accelerate VM backup and restoration.

- Enhanced service agility, quick service rollout, and improved users satisfaction

  The DC^2 allocates resources on demand through virtualization and supports all-round management and service automation. Self-service capabilities allow users to apply for computing, storage, and network resources by themselves on demand. Services are quickly provisioned and deployed, and the dynamic load balancing function is supported. Applications can be quickly deployed and created based on templates. The service modeling function provided by service templates allows users to repeatedly and quickly create, configure, and deploy applications in the cloud. The application deployment process is visualized. Applications can be configured between private and public clouds. The service rollout time is reduced from several days to several minutes. The DC^2 provides different SLAs for different applications. The DC^2 supports elasticity, which means that it can automatically scale out or up based on configured scheduling policies. This ensures that the IT system quickly responds to service changes and converts the data center from a costly center to a valued center.

- Fewer IT system management and maintenance resources

  The DC^2 supports self-service capabilities. Users can apply for services by themselves, which minimizes dependency on the IT department. Automated workflows are created based on standard processes, such as event management, problem management, change management, and release management processes, which improves IT management efficiency. Centralized O&M, proactive management, and correlation of service requirements and IT processes eliminate failures and reduce manual operations, so that the O&M efficiency of multiple data centers is improved.

The DC^2 provides the following capabilities:

- Provides data center as a service (DCaaS) for tenants using VDCs.

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VDCs are an implement of Software-Defined Data Center (SDDC). Resources of VDCs come from different resource pools of multiple physical data centers. VDC resources are classified into computing, storage, network, and bare-metal physical machine resources. VDC resource capacity is applied for by the VDC Service Manager or specified by the Domain Service Manager. Resources are provided for users after application approval.

Users can use VDC resources after they submit an application and the application is approved by the VDC Service Manager. The VDC Service Manager is responsible for service approval, service template management, service management, resource configuration, resource provisioning, and self-service O&M. The VDC Service Manager implements life cycle management for services provided by a VDC. The VDC Service Manager can define services and publish the services to service catalogs to be applied for by users, approve users' applications, and cancel published services. Access rights to VDC resources can be controlled. VDC networks can be defined by the VDC Service Manager. A VDC is divided into multiple virtual private clouds (VPCs). A VPC includes multiple subnets and implements security and network management using virtual firewalls (vFWs) and virtual routers (vRouters). VDCs provide multiple types of computing, storage, network, and application services at the IaaS layer. The virtual application (vApp) service supports flexible definition and elastic scaling of software and applications.

The VDC service provides some self-service O&M capabilities, including viewing VDC alarms, performance, capacity, and topologies. The VDC service provides resource metering information by VDC, enabling tenants to measure charging information.

- Provides cloud infrastructures based on application scenarios.

  In different application scenarios, cloud infrastructure requirements vary. The DC^2 provides different infrastructures for different application scenarios to meet differentiated requirements of upper-layer applications and improve infrastructure efficiency and quick delivery capabilities. Cloud infrastructures are provided for four scenarios:

  - Standard virtualization scenario

    The common application virtualization infrastructure and desktop cloud infrastructure are provided.

  - High-throughput scenario

    The infrastructure supporting online analytical processing (OLAP) applications is provided. The infrastructure is optimized in aspects of storage and networks and supports high-performance network connections such as InfiniBand.

  - High scalability scenario

    The computing and storage convergence solution is adopted to proved rapid scaling capabilities for applications.

  - High-performance scenario

    To meet requirements of online transaction processing (OLTP) applications and replace midrange computers with x86 servers, servers adopt multiple Reliability, Availability, and Serviceability (RAS) technologies to improve reliability. Storage devices support input/output operations per second (IOPS) in millions, and servers supports response in microseconds.

- Supports unified and flexible management of cloud data centers.

  Resources of the DC^2 come from multiple physical data centers. Diversified resources make management complex. To simplify management, the DC^2 supports unified management, including:

  - Unified management of multiple data centers

    Resources from multiple data centers can be centrally accessed and managed.

  - Unified management of physical and virtual resources

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Physical servers, storage devices, and network devices and virtual resources are managed in a unified manner, and topologies between resources are displayed in a unified view.

- Unified management of multiple virtualization platforms

  Various virtualization platforms, such as VMware, Xen, and KVM platforms, are managed in a unified manner.

1.2 Overall Architecture of the DC²

Figure 1-1 Logical architecture of the DC^2

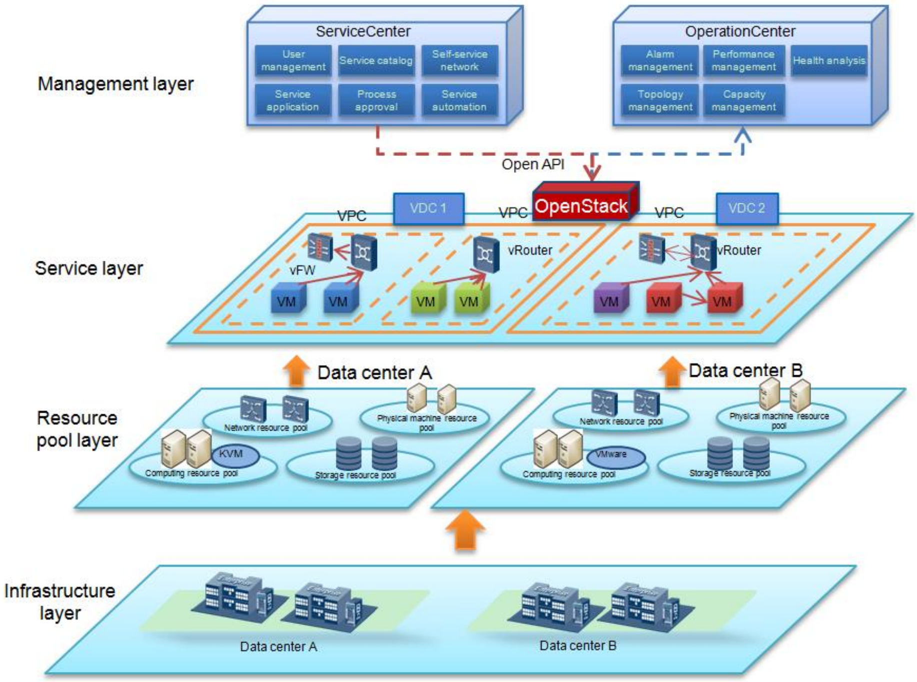

Figure 1-1 shows the overall architecture of the DC^2, which consists of the infrastructure layer, virtualization layer, and service layer. Each layer provides interfaces to its upper layer.

Table 1-1 Layers in the DC^2

Functional Layer	Description
Infrastructure layer	The infrastructure layer provides capabilities of constructing computing, storage, and network resource pools. The point of delivery (POD) is provided for various scenarios to construct virtual computing, storage, and network resource pools based on physical resources.
Resource pool layer	The resource pool layer provides virtual computing, storage, and network resources. The DC^2 provides management capabilities of converged resource pools, heterogeneous virtualization platforms such as VMware and FusionSphere, and physical resource pools.

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Functional Layer	Description
Service layer	The DC^2 supports OpenStack and FusionSphere management, image management, service management, and resource scheduling, and provides SDN service capabilities, including VPC service capabilities.
Management layer	The management layer supports unified management and resource scheduling for multiple cloud data centers and provides DCaaS based on VDCs. A VDC provides multiple types of cloud services. This layer also supports unified O&M of virtual and physical resources.

1.3 Logical Deployment of the DC^2

The Huawei DC^2 Solution adopts OpenStack as the basic cloud management platform. With the support capabilities of OpenStack for heterogeneous virtual resources, the solution provides unified management and scheduling of multiple virtualization platforms, and implements converged resource pool capabilities. Based on OpenStack, a unified O&M management platform across multiple data centers is constructed, achieving the objectives of the DC^2. Figure 1-2 shows the deployment of the DC^2 components.

Figure 1-2 OpenStack-based DC^2 component deployment

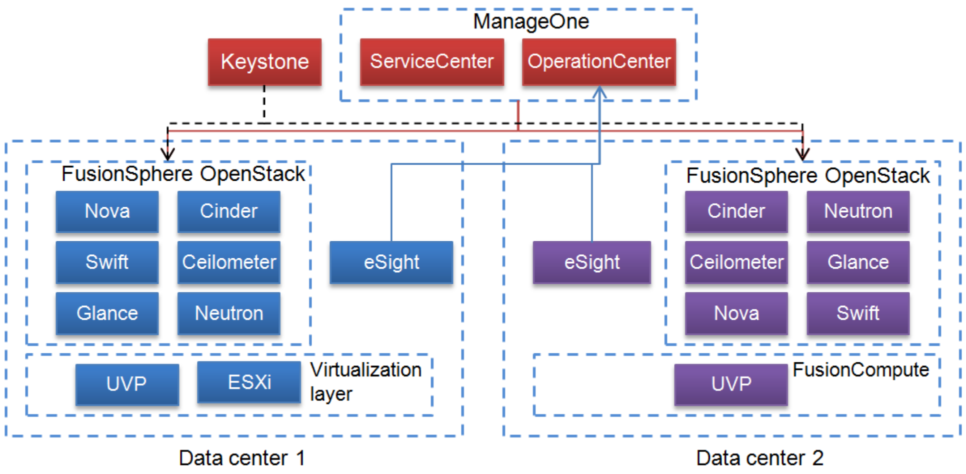

Figure 1-2 shows the component connections in the OpenStack architecture. Keystone is deployed in the domain to implement unified authentication for multiple OpenStack instances. The OpenStack platform provides native capabilities to adapt to heterogeneous virtualization platforms, and supports multiple virtualization platforms such as VMware and FusionSphere.

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Table 1-2 Components in the DC^2

Component	Function Description
ManageOne	ManageOne provides ServiceCenter and OperationCenter. ServiceCenter: implements unified service orchestration and automatic management based on cloud and non-cloud resources provided by resource pools, including customizable heterogeneous and multiple resource pool policies and orchestration, customizable enterprise service integration, resource pool management capabilities supplemented by third-party components, and especially automatic provisioning capabilities for heterogeneous traditional resources. OperationCenter: implements maintenance based on scenarios and visualized status, risk, and efficiency analysis for data center services, and proactively analyzes problems and works with the service center to implement data center self-optimization and self-healing based on analysis results.
FusionCompute	FusionCompute virtualizes and pools computing, storage, and network resources.
eBackup	eBackup is a backup system that is used to back up VM data.
FusionSphere OpenStack	OpenStack is an open-source cloud management system. OpenStack consists of multiple components which are decoupled using Representational State Transfer (REST) interfaces and message queues. OpenStack can manage heterogeneous virtualization platforms, such as VMware, and UVP. OpenStack consists of the following components: • Nova: virtual computing component • Glance: mirroring component • Cinder: virtual disk component • Neutron: virtual network component • Swift: object storage component • Keystone: authentication component • Ceilometer: monitoring component

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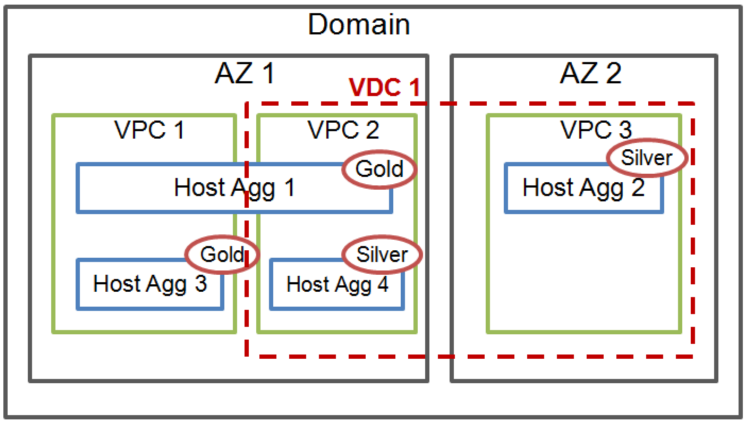
1.4 Logical Concepts of the DC^2

Figure 1-3 Concepts of the DC^2



Concepts of the DC^2 are as follows:

- Domain: indicates the management scope of the data center management system. For the DC^2, a domain includes multiple physical data centers and physical and virtual resources in the data centers.
- Available Zone (AZ): is a logical zone of physical resources (including computing, storage, and network resources). Devices in an AZ communicate with each other at layer 2. An AZ is an independent failure domain. AZs connect to the same aggregation switch.
- VDC: goes across multiple AZs. One VDC includes multiple VPCs.
- VPC: adopts network isolation technologies to ensure network security in an AZ. One VPC belongs only to one AZ.
- Host Aggregate: is defined by OpenStack. An Aggregate is a cluster of resources that have the same properties. Properties are described by metadata. The Scheduler component selects an Aggregate to allocate resources based on users' requirements. One Aggregate belongs only to one AZ.

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2 Key Features

About This Chapter

The following table lists the main information in this chapter.

Title	Content
2.1 VDC	Describes the VDC concept and features.
2.2 Unified Management	Describes the Huawei cloud data center unified management solution.
2.3 OpenStack-based Architecture	Describes the Huawei OpenStack cloud management platform.
2.4 SDN	Describes the Huawei SDN solution.
2.5 Backup Management	Describes the backup service.
2.6 Security Management	Describes the cloud data center security solution.

2.1 VDC

2.1.1 Application Scenarios

VDCs apply to the following scenarios:

In the private cloud of enterprises, leased resources must be independently managed, and networks must be isolated. Each VDC is an independent management entity that enjoys self-operation and self-maintenance capabilities. VDCs can be flexibly divided based on application scenarios of an enterprise.

- VDCs are divided based on departments. Each department can independently manage its resources.
- VDCs are divided based on fields, such as the development VDC and testing VDC.

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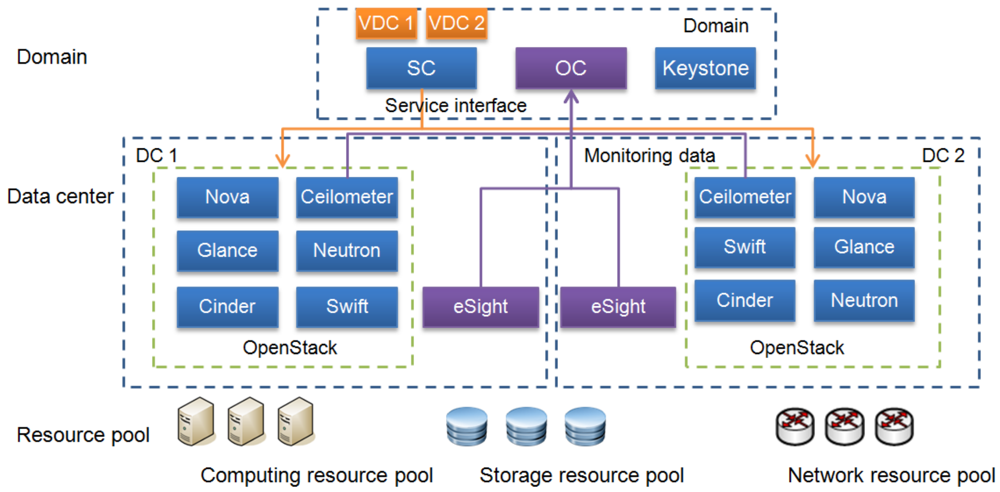
NOTE
Resources of a VDC come from one or multiple physical data centers. Customers can benefit from capabilities of VDCs, including self-service operation and maintenance and resource isolation management.

2.1.2 Deployment Architecture

Figure 2-1 ServiceCenter+OpenStack deployment mode



In the ServiceCenter+OpenStack deployment mode, OpenStack serves as the cloud management platform, and ServiceCenter provides VDC services. ServiceCenter connects to OpenStack through REST application programming interfaces (APIs) provided by OpenStack. VDC resources come from multiple OpenStack deployment resource pools of multiple physical data centers. ServiceCenter provides the self-service maintenance capabilities of VDCs and OperationCenter provides the maintenance capabilities at the data center layer.

2.1.3 VDC Roles

Table 2-1 describes VDC roles.

Table 2-1 VDC roles

Role	Responsibility	Layer	Component
Domain Service Manager	The Domain Service Manager is responsible for service operation management of the DC^2, such as VDC management, domain service catalog management, and resource pool management.	Domain	ServiceCenter

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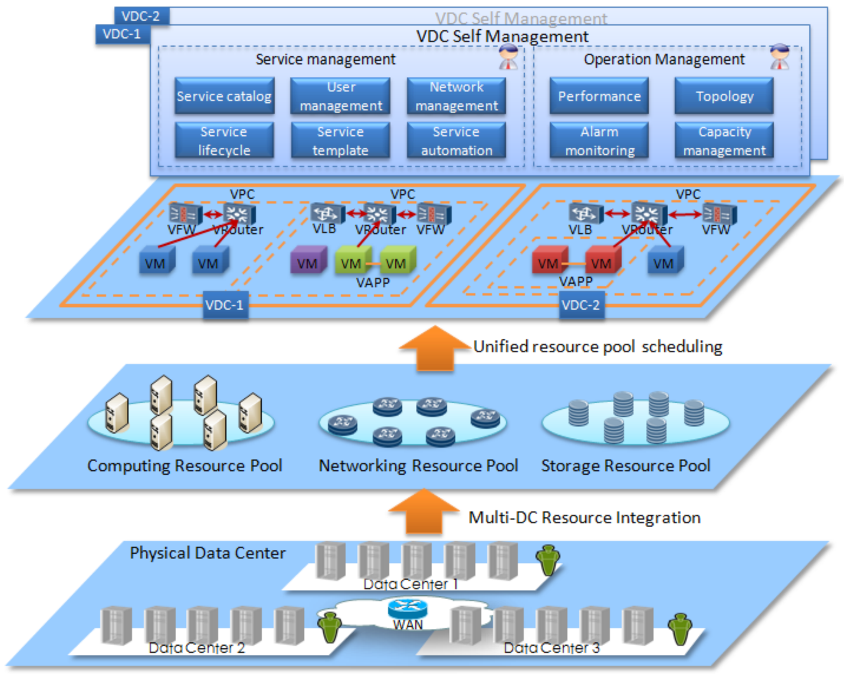
Role	Responsibility	Layer	Component
VDC Service Manager	The VDC Service Manager is responsible for VDC user management, VDC service catalog maintenance, service application and approval, and VDC self-service maintenance.	VDC	ServiceCenter
Service User	The Service User is the end user of VDC services.	App/VDC	ServiceCenter

2.1.4 Key Features

Figure 2-2 VDC functions



Unified Resource Management for Multiple Data Centers

A VDC obtains resources from resource pools in multiple physical data centers. Resource pools are provided by AZs. When an AZ is selected, a specific resource pool is selected. When creating a VDC, the administrator selects AZs from a list based on requirements. When users apply for resources, resources are provisioned from the AZs.

Each AZ is divided into different Host Aggregates. Each Aggregate provides different SLAs. For example, the Aggregate that provides SSD hard disks is the high-performance Aggregate. The administrator divides Aggregates based on SLA requirements. Aggregate is invisible to users. When applying for resources, users can specify SLA requirements, and the Scheduler selects resources from the Aggregate that meets the SLA requirements.

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VDC Isolation

VDCs provide management, network, and resource isolation capabilities.

- Management isolation

  After logging in to a VDC, users can apply for services provided by the VDC and use the services after their applications are approved by the VDC Service Manager. Each VDC provides independent user management, service management, template management, service catalog management, capacity management, O&M management, and approval process management capabilities. The VDC Service Manager manages the local VDC only without affecting management of other VDCs. This ensures isolated VDC management.
- Network isolation

  The VDC network topology can be self-defined, which includes multiple security domains. Security domains are isolated from each other using VLANs or VXLANs. Virtual resources (such as VMs) are included in security domains. External users must access resources in security domains through vFWs. ACL, application specific packet filter (ASPF), and NAT rules set on vFWs ensure secure access. Different security domains communicate with each other through the Internet Protocol Security virtual private network (IPsec VPN), ensuring network data security.
- Resource isolation

  Resources include virtual resources (such as VMs and virtual disks), service templates, and software libraries. Resources of each VDC are independently managed. For example, VMs and vFWs of a VDC can be managed only in the VDC. VDCs do not share resources. Only the user who owns a certain resource can view information about the resource and operate the resource in a VDC, such as starting and stopping VMs and expanding capacity. Users of other VDCs cannot view information about the resource and operate the resource.

Quota Management

VDC resources can be controlled based on quota. The quota is specified by an applicant when a VDC is created and approved by the Domain Service Manager. The quota can also be specified by the Domain Service Manager when the Domain Service Manager creates a VDC. Quotas include the numbers of vCPUs VLANs, VPCs, subnets, and VMs, memory capacity, and network bandwidth. If users apply for resources that exceed the quota, the VDC automatically rejects the application. The quota usage is displayed, facilitating capacity control for the VDC Service Manager.

User Management

Each VDC supports independent user management. The VDC Service Manager can assign VDC access rights to users. After being granted rights, users can log in to the VDC and apply for services of the VDC. A user can be granted rights to access multiple VDCs.

Service Management

The VDC Service Manager manages service catalogs and service life cycles. The VDC Service Manager can define service catalogs which include services that have been published and can be subscribed to by users. The VDC Service Manager defines services, including the service name, description, specifications, and properties, and then publishes the services to a service catalog. VDC users can browse the service catalog and apply for services from the

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catalog. The VDC Service Manager can cancel services that are not provided anymore. The canceled services are not displayed in the service catalog and cannot be applied for by users.

Template Management

VDCs provide multiple types of service templates that help the VDC Service Manager to quickly define new services. Service configuration specifications and default values can be defined in service templates. Service templates provided by VDCs include VM templates and vApp templates. The service templates enable the VDC Service Manager to quickly create and deploy services.

Service Automation

Service automation supports automatic service provisioning and rollout. After users apply for services from service catalogs and their applications are approved, the service automation engine invokes related service implementation processes based on subscribed services. Service processes are implemented by the internal business process management (BPM) engine. The BPM engine automatically invokes REST interfaces of virtualization systems and ensures the process implementation sequence and results. The system provides default services processes covering VM, virtual disk, and virtual network device services. The administrator can define new service provisioning processes to meet new service requirements.

Self-service Network Management

VDC self-service network management is implemented by the basic capabilities provided by the virtualization layer. The following items support self-service management:

- VPC

  Users can define VPCs in a VDC. Each VPC includes multiple subnets. VPCs include three types, direct network, internal network, and routed network. A vRouter can be defined for a routed network VPC to serve as the assess point of the VPC. Users can also define virtual network components, such as vFWs and vLBs, in a routed network VPC. Security policies can be set on vFWs to control access to resources in VPCs.
- Subnet

  A security domain can be divided into multiple subnets. Subnets are isolated from each other at layer 2 using VLANs. Users can manage IP addresses of subnets.
- VDC network topology

  Users can view VDC network topologies. The network topology displays connections between security domains in a VDC, network resources and subnets in each security domain, and vApp and VM resources of each subnet. The virtual network topology displays mapping relationships between physical and virtual resources, such as the mapping relationships between vFWs and physical firewalls.

VDC Metering Management

The VDC metering capability includes the metering of the CPU, memory, disk, VPC, elastic IP address, security group, and VM resource quotas. The VDC quota metering feature provides metering data for the service settlement. Administrators and tenants use the metering data to perform the offline charging and settlement. VDC quotas that can be metered include the numbers of vCPUs, elastic IP addresses, VPCs, VMs, and security groups, memory capacity, and disk space. The VDC quota metering feature provides functions such as querying VDC metering statistics of a specified period and exporting metering statistics.

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Self-service O&M Management

- Capacity management

  The VDC Service Manager can view resource usage and capacity usage of a VDC. Usage of CPUs, memory, disks, and bandwidth can be queried. The VDC Service Manager can set capacity thresholds. When the resource usage exceeds the threshold, the system reports an alarm.

- Performance management

  The VDC Service Manager can view the performance data of resources in a VDC on OperationCenter, including performance indicators such as CPU, memory, disks, and networks.

Preset Services

After logging in to the VDC self-service portal, users can view multiple types of preset cloud services in service catalogs, including:

- Cloud host service

  The cloud host service enables users to use cloud hosts like using local PCs. When applying for the cloud host service on the self-service portal, users can select VM templates and specify VM specifications (such as storage and memory capacity) and submit the application. Users can use log in to cloud hosts using assigned IP addresses after their applications are approved. Users can start, stop, hibernate, and wake up cloud hosts and expand or reduce capacity of cloud hosts.

- Physical server service

  Users can apply for the physical server service online. During application, users can specify server specifications and OS types. After the application is approved, OSs can be installed in the preboot execution environment (PXE) mode. Users can log in to physical servers and perform related service operations such as software installation.

- EBS service

  Elastic Block Storage (EBS) provides block storage services to VMs. The EBS service enables users to expand storage space on demand. The OSs on user VMs access block storage space by volume. The EBS service allows users to expand or reduce block storage capacity.

- Elastic IP address

  The elastic public IP address is also called the elastic IP address service. This service configures one-to-one mapping between the private IP address and the public IP address for users' requested VMs or physical servers. Users can access VMs or physical servers in a data center using public IP addresses.

- vApp service

  The vApp service includes the following sub-features:

  - Rapid vApp deployment

    Application templates can be prepared for common applications and middleware (such as LAMP, WebSphere, and Hadoop). Application templates allow users to quickly create and deploy applications. The DC^2 provides convenient application making methods and the rapid application deployment service. Administrators or application developers can make VM templates and upload application software packages on the self-service portal based on requirements. Applications are automatically rapidly deployed using VM templates, application templates, and the user-defined orchestration function.

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Users can create their own VM templates and application templates. The templates can be made by considering computing, storage, network, and elasticity factors. Users can implement rapid and automatic application deployment based on templates.

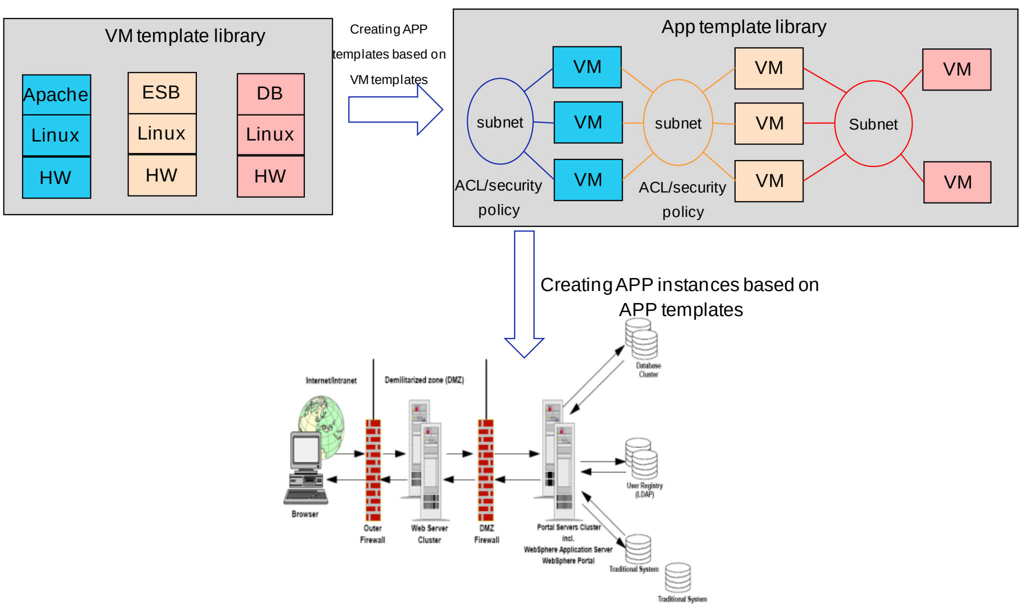
After the system receives an application deployment request, the system automatically creates VMs, installs application software on VMs, and creates dependency and networks between application software based on resource definitions in application templates.

Users can specify scaling policies. The system automatically triggers capacity expansion and reduction for scaling groups based on user-defined monitoring conditions. The system adjusts resources in scaling groups to ensure stable running of applications.

NOTE

In the OpenStack scenario, applications can be deployed only using images but cannot be deployed using software packages.

Figure 2-3 Template-based rapid service deployment



After application templates are published, users select a template in the service catalog, enter basic application information, configure application networks and application parameters, and create applications by following a wizard. The management system automatically allocates cloud resources, installs application software, and configures networks based on users' settings to quickly construct an available application environment.

Users can directly create deployment scripts without using a template. Based on the scripts, the Huawei OpenStack HEAT can automatically perform related operations, such as creating VMs and configuring networks.

– vApp scalability

The DC^2 provides the elasticity service for application systems that have different use frequencies in an hour, a day, or a week. Resources occupied by applications are automatically adjusted based on preset policies to ensure that the number of occupied resources matches service needs. This reduces costs.

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Users can create scaling groups in applications and set scaling policies for scaling groups. A scaling group contains VMs to which the same scaling policies are applied. The system monitors indicators of VMs, such as CPU usage and memory usage, based on user-defined scaling policies to implement scalability. Scalability refers to creating or deleting, starting or stopping, and waking up or hibernating VMs. The scalability service aims at controlling resources used by scaling groups by controlling VM resources and controlling resources occupied by applications.

Users can set scaling policies for a single application and set inter-application resource sharing policies for multiple applications.

An inter-group policy is applied to enable resource sharing among different scaling groups and manage the resource allocation and preemption among scaling groups in one resource pool, thereby ensuring the proper operation of the entire resource pool. Applications that are not in scaling groups or do not preempt resources are not managed by the inter-group policy. The inter-group resource sharing policy can work with scaling policies of scaling groups to meet requirements of scalability between multiple applications. Users need to set inter-group resource sharing policies, reserved resources of resource pools where the inter-group resource sharing policies are applied, and resources used by scaling groups of different applications. When the system detects that the resources in resource pools are fewer than reserved resources, the system reclaims resources from scaling groups of applications with a low priority to ensure that applications with a high priority can be allocated with resources.

Inter-group policies can be also used with scheduled tasks for time-based resource reuse purposes. Importance and required resources of applications at different time points are different. Users can define scheduled task policies to adjust the limit of used resources and priority of scaling groups in different time periods to implement time-based resource reuse.

2.2 Unified Management

2.2.1 Application Scenarios

The unified management capabilities of the DC^2 apply to the following scenarios:

- Unified multi-data center management

  Multiple physical data centers must be managed in a unified manner.

- Unified physical and virtual resource management

  Physical and virtual resources of a data center must be managed in a unified manner. For example, physical and virtual resources are centrally monitored and managed in a topology.

- Unified heterogeneous resource pool management

  Heterogeneous virtualization platforms in a data center must be managed in a unified manner. For example, the vSphere and Huawei UVP virtualization platforms are managed in a unified manner.

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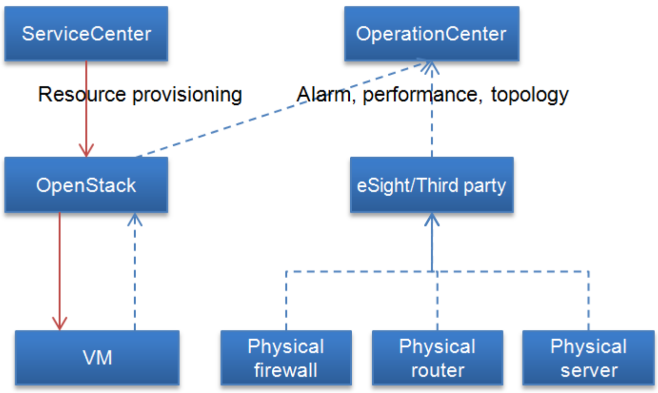
2.2.2 Deployment Architecture

Unified Cloud and Non-Cloud Management

Figure 2-4 Unified cloud and non-cloud management

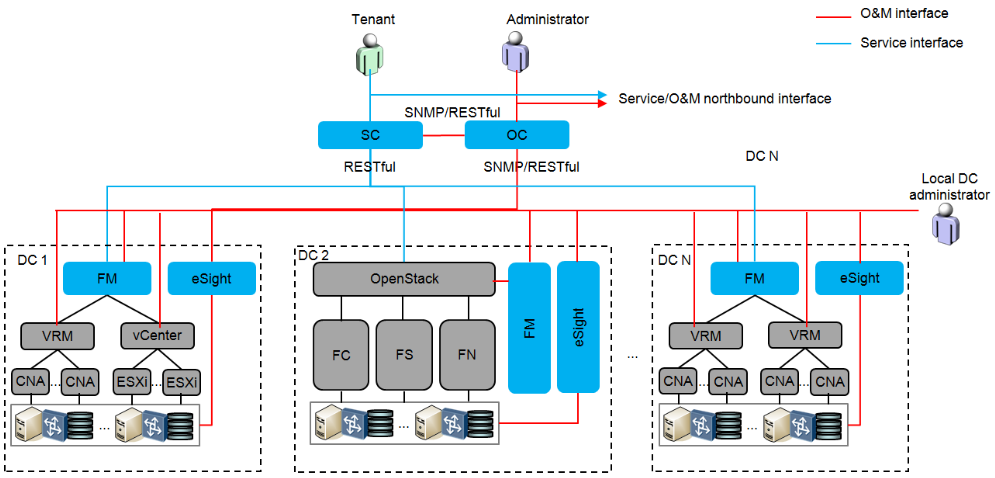


Unified management of cloud and non-cloud resources is supported:

- Non-cloud resource management: manages performance, alarms, and topologies of physical resources.
- Cloud resource management: manages cloud resource automated deployment and operation capabilities, performance, topologies, and capacity of cloud resources, and mapping relationships between cloud and non-cloud resources.

Unified Heterogeneous Virtualization Management

Figure 2-5 Heterogeneous virtualization management



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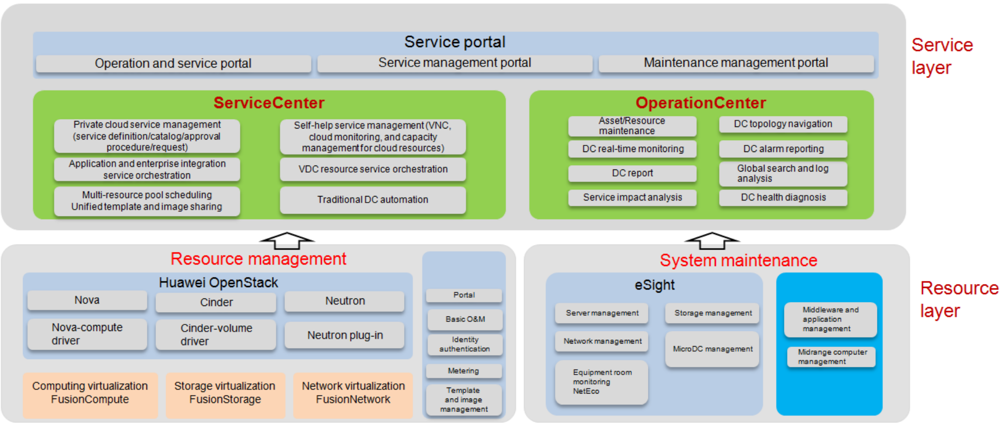
Different heterogeneous virtualization modes are adopted for different solutions.

Huawei FusionSphere OpenStack supports VMware vSphere, and the Huawei UVP connects to the OpenStack management platform and provides the unified resource provisioning and management capabilities of heterogeneous resource pools. vSphere adopts the OpenStack access solution provided by VMware. Similar to the access mode of VMware, Huawei FusionSphere connects to the VRM by adding plug-ins to Nova and Cinder. OpenStack implements heterogeneous virtualization, simplifies the cloud data center management architecture, and avoids management silos.

2.2.3 Key Features

Figure 2-6 Overall architecture of the DC^2 management subsystem



Unified Cloud and Non-Cloud Monitoring

Alarms of virtual and physical resources are monitored in a unified manner. Alarms of physical resources, such as servers, storage devices, and network devices, are monitored. The ManageOne system connects to VMware vCenter and the Huawei cloud management platform to obtain alarm data of virtualization platforms. For details about the monitored devices, see the monitored object list of related software.

Different monitoring software is selected for different maintenance scenarios:

- Cloud resource pool: OpenStack is deployed.
- Huawei infrastructure: OperationCenter and eSight are deployed, which support some heterogeneous platforms.

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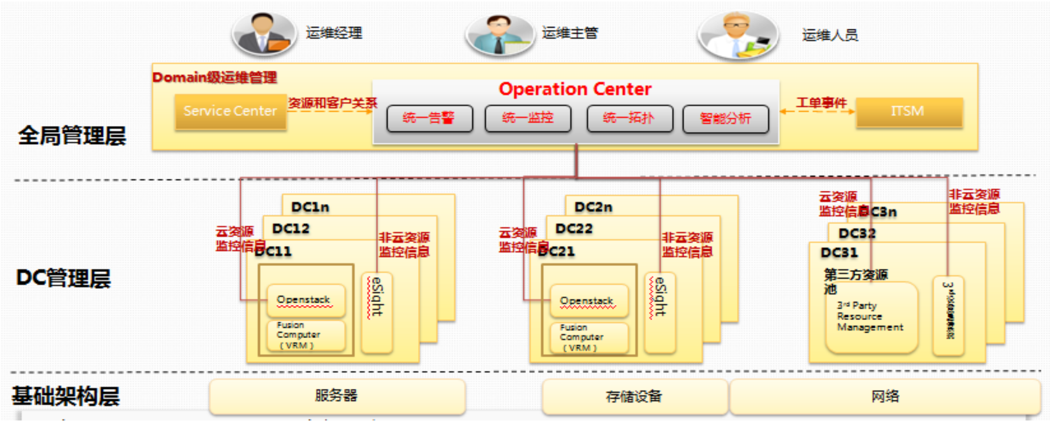
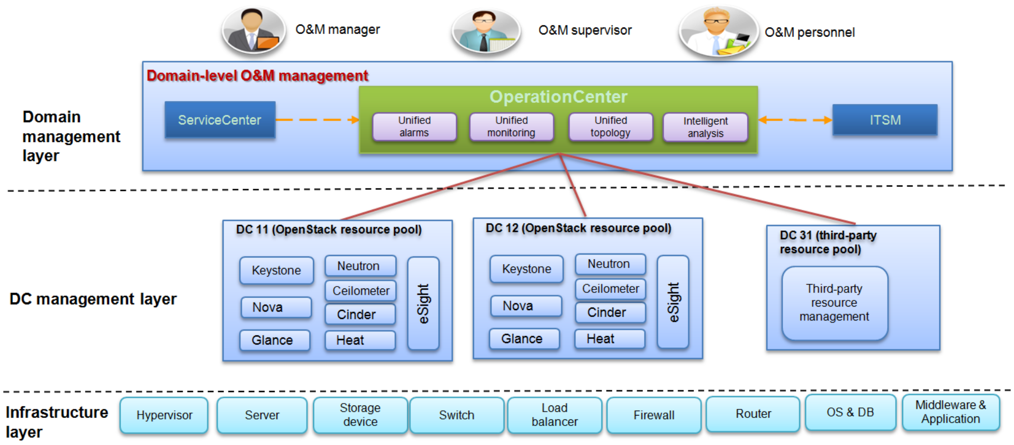
Figure 2-7 DC^2 management system components





Unified management capabilities of cloud and non-cloud resources include:

- Provides a unified platform for managing virtualization and bare servers, supports mainstream virtualization products and OSs, and is compatible with customers' existing IT resources.
- Provides rapid resource provisioning, which shortens the service rollout time.
- Supports unified monitoring over tradition equipment (such as servers, network equipment, and storage equipment) and virtualization equipment (such as VMware, Huawei FusionCompute, Huawei OceanStor, and Huawei desktop cloud). The monitoring functions include automatic discovery, unified resource provisioning, unified alarm report and processing portal, and performance monitoring and report.
- Supports the alarm processing on OperationCenter, including alarm display, alarm masking, alarm acknowledgement, and alarm and work order transfer.

Cloud and Non-Cloud Performance Management

Cloud and non-cloud performance management includes obtaining performance data and handling threshold crossing alarms.

- VM performance

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The ManageOne system connects to vCenter to monitor VM performance indicators, including the CPU usage, memory usage, network bandwidth, and disk I/O.

- Physical resource performance

  Performance data of physical resources is obtained from eSight or third-party monitoring components. Monitored physical resources include physical servers, network devices (including switches, routers, and firewalls), and storage devices. Monitoring indicators include the CPU usage, memory usage, and network bandwidth, which vary according to device types. Monitoring software sends monitoring results to OperationCenter, and OperationCenter centrally displays the results. OperationCenter can display Top N performance indicators of servers, storage devices, and network devices.

- Threshold crossing alarms

  The administrator can define performance thresholds. When performance indicator values of monitored objects exceed the threshold, the system generates an alarm, prompting the administrator to handle performance risks.

Cloud and Non-Cloud Topology Management

Cloud and non-cloud topology management provides the following functions:

- Physical topology management

  Physical resources and connections between physical resources are automatically detected. Third-party components automatically detect topologies, and OperationCenter integrates topologies of third-party components and displays the topologies in a unified manner.

- Virtual topology management

  Topological relationships between virtualization components in a VDC are displayed. The administrator can define virtualization components and their connections, so virtual topologies are displayed based on definitions.

- Topological relationship mapping

  Virtual networks are overlaid on physical networks. Therefore, virtual network devices have mapping relationships with physical network devices.

Cloud Resource Capacity Management

OperationCenter obtains cloud resource data from OpenStack. OperationCenter centrally displays the cloud resource usage, including usage of vCPUs, memory, disk space, and bandwidth. Resource capacity can be displayed based on physical data centers and VDCs.

Heterogeneous Virtualization Platform Management

Huawei FusionSphere OpenStack provides the heterogeneous virtualization platform management capabilities.

The OpenStack architecture provides native capabilities to support multiple types of virtualization platforms. Currently, Huawei FusionSphere OpenStack can connect to the UVP and VMware platforms through interfaces.

Data Center Health Check

OperationCenter provides proactive maintenance capabilities in three aspects: health assessment, risk assessment, and efficiency assessment. These capabilities are used to assess the health status of a running data center based on the analysis and handling (including

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predictions, dynamic thresholds, and points) of data center infrastructure alarms and performance monitoring data, thereby generating alarms when faults occur to reduce the maintenance risks.

- Health assessment

  The health assessment comprehensively assesses the running status of a maintenance object from three dimensions: workload, abnormal fluctuation, and alarm. The health assessment dynamically determines the abnormal fluctuation of indicators based on the historical behavior of indicators, resolving the time-based adjustment failures of traditional static thresholds.

  The health assessment implements the analysis in two aspects, abnormality (long term) and fluctuation (short term), comprehensively measuring the stability of indicators. The health analysis can accurately identify abnormalities. The dynamic configuration is supported, such as the configuration of historical duration and sensitivity. The health abnormal fluctuation algorithm adopts the time sequence processing in the sliding window to select a time sequence, and the amplitude of thresholds can be changed dynamically. The result can be obtained by adding or subtracting K times of the standard deviation based on the average value, and the K value can be set flexibly as required.

Figure 2-8 Abnormal fluctuation analysis

- Risk assessment

  The risk assessment comprehensively assesses the capacity and performance risks of a maintenance object from three dimensions: remaining time, remaining capacity, and pressure. The key difficulties of the risk assessment are the accuracy of the remaining time prediction and the pressure measurement method. Huawei supports the combination of weekly prediction and daily prediction for the remaining time prediction. The prediction error is less than one week. As for the pressure measurement of an object, the assessment involves two factors, time and amplitude, based on points.

  For the weekly prediction, the average value of busy hours during workdays in a week is used. Busy hours in the latest four weeks can be adopted for the prediction. The daily prediction provides finer-grained prediction based on the result of the weekly prediction. The time when the maximum value (100%) is reached in a duration of N+1 weeks is used as the prediction result. If workday D is M days later than the current time, the remaining time is (N x 7 + M) days. If the number of sampling days is too large, the daily prediction may cause prediction curve distortion (such as non-monotone). By the combination of weekly prediction and daily prediction, prediction distortion can be reduced and the prediction result can be accurate to day.

  The pressure algorithm adopts the area points. The percentage of the area that exceeds the pressure line in the entire pressure area is calculated every hour. The pressure of an object is displayed in a 24/7 heat map. The pressure algorithm adopts the point mode and also considers the pressure duration and amplitude, thereby comprehensively reflecting the pressure of an object.

- Efficiency assessment

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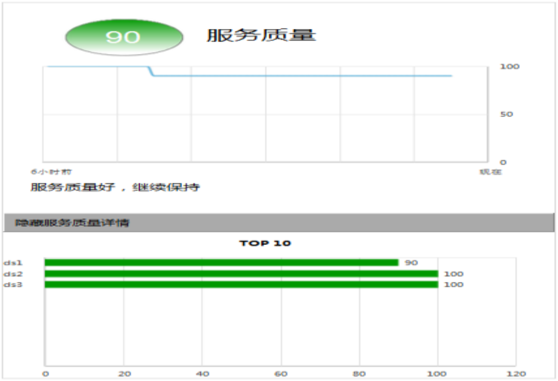
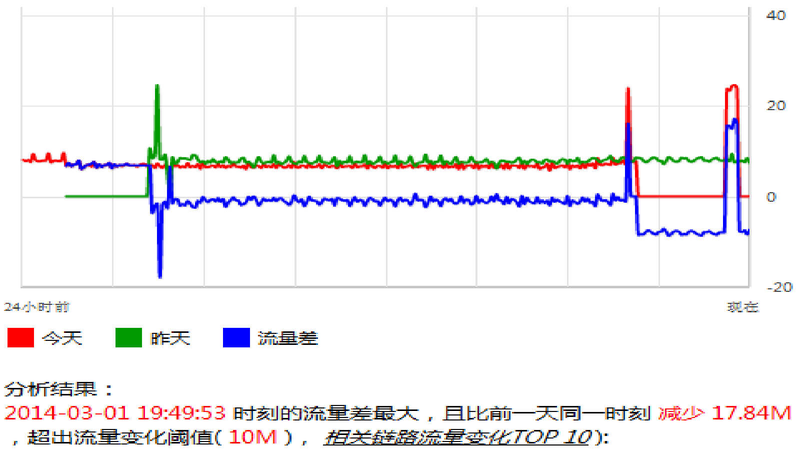
The storage resource pool is used as an example to describe the resource efficiency assessment. The QoS of the storage resource pool is reflected by the read/write I/O latency of Data Store. Based on the Data Store historical data, the dynamic threshold of the Data Store latency is estimated by standard distribution and is used as a reference for measuring the Data Store QoS. The overall storage QoS is reflected by the comprehensive assessment of QoS impacts of Data Store.

Figure 2-9 Storage resource pool QoS analysis



In addition, the network burst traffic analysis is supported. Traffic changes of specific switch ports and network partition entries and exits are monitored, burst traffic is identified, and the source of burst traffic is analyzed. The network burst traffic analysis helps the administrator the abnormal traffic in a timely manner and locate the host that causes the traffic change.

Figure 2-10 Burst traffic analysis



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2.3 OpenStack-based Architecture

2.3.1 Application Scenarios

The Huawei cloud management platform implements open architecture based on OpenStack. As the most active open-source project, OpenStack involves the participation of multiple vendors. OpenStack can be expanded in plug-in mode, supporting third-party devices and heterogeneous virtualization platforms. In this mode, customers are not bound to the infrastructure and virtualization platform of a single vendor, and the open northbound APIs of OpenStack can be easily invoked and managed by third parties. Based on OpenStack architecture, Huawei implements the support for converged resource pools. Converged resource pools apply to the following scenarios:

- Hybrid deployment of heterogeneous virtualization platforms

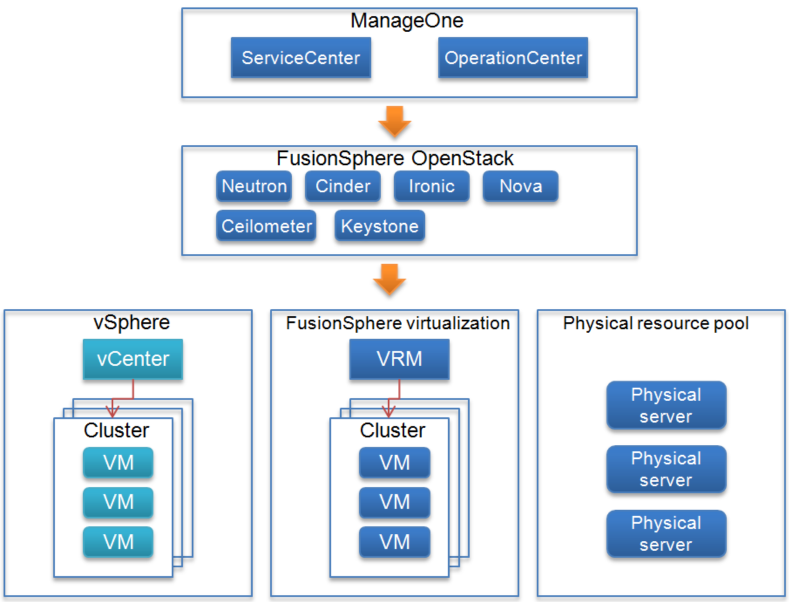
  Unified management of heterogeneous virtualization platforms is supported. Resource provisioning capabilities are provided for heterogeneous resource pools such as Huawei FusionSphere and VMware.

- Hybrid management of physical servers and VMs

  In some cloud data centers, high-performance and high IOPS applications (such as databases) are deployed on physical servers, and common-performance applications (such as middleware applications) are deployed on VMs.

2.3.2 Logical Architecture

Figure 2-11 Logical architecture of the converged resource pool



OpenStack architecture provides support for converged resource pools. The Huawei FusionSphere resource pool, third-party resource pools (such as VMware vSphere), and physical resource pools can be constructed separately, but they are managed by Huawei FusionSphere OpenStack in a unified manner. The ManageOne cloud management platform

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provides unified monitoring and resource provisioning capabilities for heterogeneous resource pools. The selection of resources is determined according to the resource quality of service (QoS) requirements and resource types (such as vSphere or FusionSphere VM).

2.3.3 Key Features

Unified Management of Heterogeneous Resource Pools

The Huawei FusionSphere solution provides unified management of heterogeneous virtualization resource pools. The heterogeneous management capabilities of Huawei OpenStack provide management of the VMware vSphere virtualization resource pool and the Huawei FusionSphere virtualization resource pool. Different virtualization platforms are converged into a resource pool that features physical distribution and logical unification. Huawei OpenStack provides OpenStack-based northbound APIs, facilitating management operations such as resource creation and deletion.

The ManageOne cloud management platform supports heterogeneous virtualization resource management in a VDC. By selecting a resource pool type, tenants can apply for the creation of different VMs and manage different virtualization platforms.

Figure 2-12 Heterogeneous VMware management solution

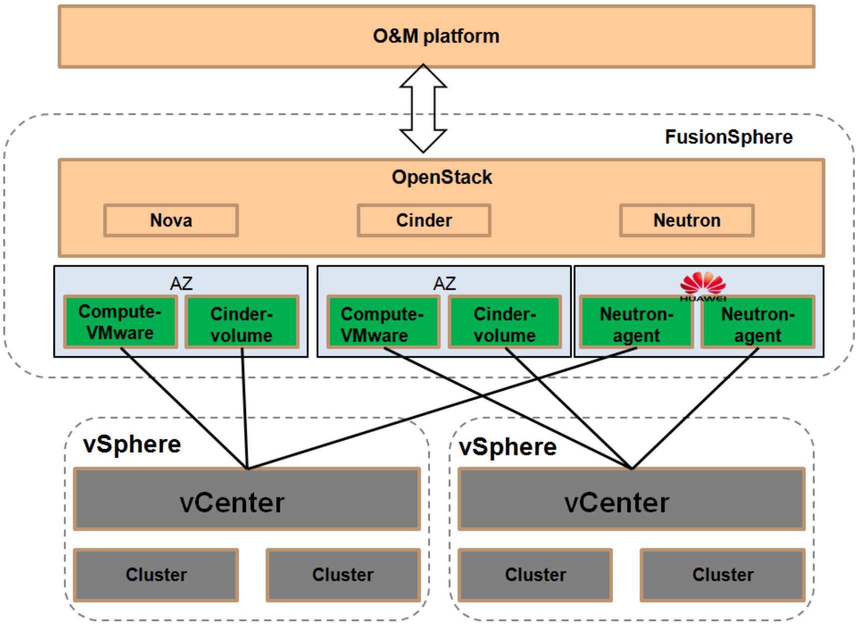

Figure 2-12 shows the Huawei heterogeneous VMware vSphere management mode. By adding plug-ins to the computing component Nova, storage component Cinder, and network component Neutron, Huawei OpenStack connects to northbound APIs of VMware vCenter and implements life cycle management of VMware resources.

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Figure 2-13 Huawei OpenStack management solution for FusionSphere

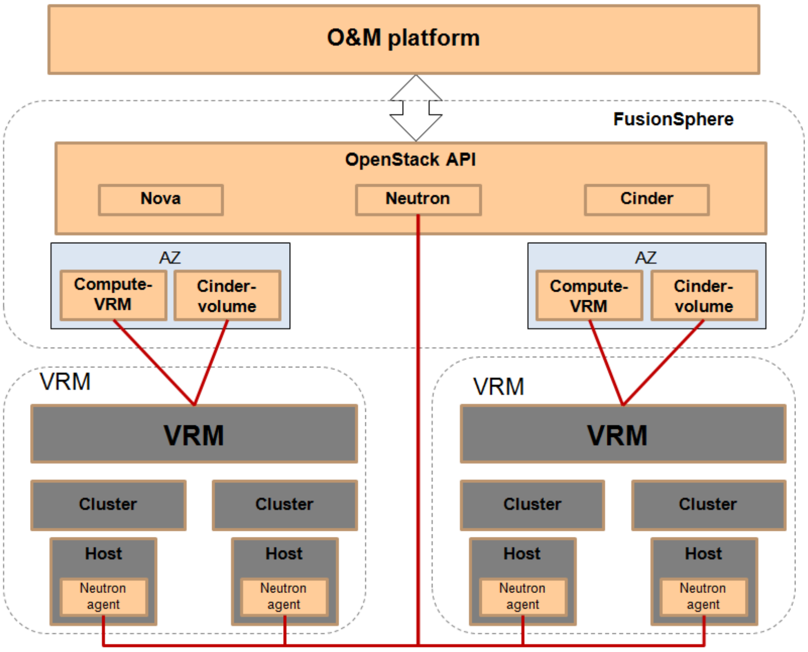

Figure 2-13 shows the Huawei OpenStack management solution for the FusionSphere virtualization platform. The management mode is similar to that of VMware. By adding plug-ins to Nova, Cinder, and Neutron, Huawei OpenStack connects to the Huawei VRM, and invokes APIs to implement life cycle management of FusionSphere resources.

Huawei OpenStack Enhancements

Targeting the disadvantages of the open-source OpenStack, Huawei implements some enhancements to meet commercial requirements. Huawei OpenStack implements the following enhancements:

- Enhanced reliability

  Huawei OpenStack implements enhanced reliability based on the open-source OpenStack, including the HA capabilities for all components where single points of failure may occur (such as LBaaS Agent and L3 Agent), eliminating single points of failure from the entire system. Huawei OpenStack also provides monitoring capabilities for the health status of component processes, supporting restart of faulty components and quick restoration of the system. In addition, Huawei OpenStack supports backup of management data. If the system is faulty, management data of the entire system can be restored using backup files.

- Enhanced manageability

  In terms of manageability, Huawei OpenStack aims to simplify OpenStack maintenance. Huawei OpenStack supports the one-click installation and deployment and the role-based automatic multi-node concurrent installation, improving maintenance efficiency using automatic deployment on the WebUI. Huawei OpenStack supports smooth upgrades and upgrade processes such as upgrade assessment and upgrade confirmation, implementing strict upgrade procedures. Upgrade rollbacks provide reliability assurance for upgrade operations. Huawei OpenStack also supports the collection of system diagnosis information, such as system run logs and operation logs, and supports remote fault

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locating. Huawei OpenStack supports refined monitoring and fault alarming capabilities, and provides multiple monitoring indicators.

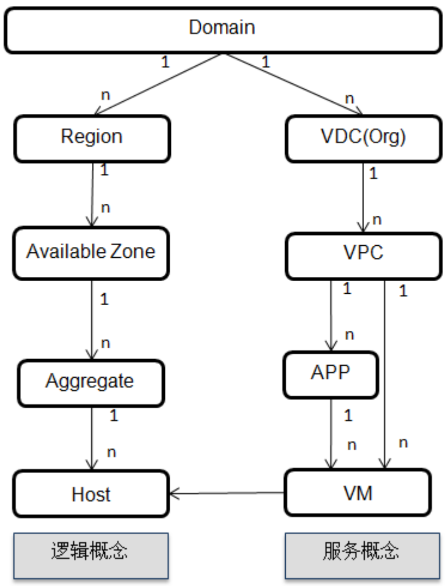
- Enhanced support for infrastructures by adding plug-ins

  Expansions aim to enhance the usability, reliability, compatibility, and automatic management level of the standard OpenStack, and provide an OpenStack-based cloud platform solution for commercial use. All expansions and enhancements are implemented based on the native standard plug-ins and driving mechanisms of OpenStack. The OpenStack main code is not modified. Drivers from other vendors can be seamlessly integrated with the Huawei OpenStack solution for commercial use, ensuring the openness of OpenStack. The enhanced functions can be easily migrated to OpenStack of a later version when OpenStack upgrades.

Resource QoS Management

Resource QoS management aims to meet customers' requirements on the resource QoS, and provide services of a balance between cost-effectiveness and QoS. To implement resource QoS management, SLAs must be clearly defined for resources. An SLA is an agreement between the service provider and customers to ensure the performance and reliability of services to be provided at certain costs. SLAs are provided to ensure a balance between QoS and costs.

Figure 2-14 Resource model



The DC^2 supports the QoS tag group defining for resources. Multiple tags can be added to a resource. The following table provides an example.

Host Group	Tag
Host group 1 (Aggregate 1)	SSD = true, Reliability = high, GPU = true
Host group 2 (Aggregate 2)	Reliability = medium, Security = true

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Multiple tags are defined for the two host groups to describe the QoS features of the host cluster. For resource selection, the administrator can define flavor tags. The flavor tags include resource QoS tags. For example, the high-reliability flavor can be defined as the selection of VMs in host group 1 and the high-security flavor can be defined as the selection of VMs in host group 2. During VM creation, users can select the QoS according to the flavor tags. For example, if a user requires a high-security VM, the scheduling algorithm creates a VM in host group 2 for the user.

Physical Server Management

Some data center applications cannot run on VMs, such as the Oracle database that is sensitive to performance. To meet the requirements of these applications, physical server resource pools must be built for data centers. Huawei FusionSphere supports unified management of physical servers, and can obtain the monitoring, alarm, and performance data of physical servers.

2.4 SDN

2.4.1 Application Scenarios

SDN is new network architecture that provides programmable networks. The SDN architecture provides maximum network control flexibility. With the development of the mobile Internet and big data technologies, more and more IT services are migrated to data centers. Network as a service (NaaS) is a basic IT service in the cloud data center. Tenants can flexibly apply for virtual network resources to meet IT service requirements.

The DC^2 supports the layer 2 VLAN automation, and hardware devices must be configured manually. In the cloud data center, SDN applies to the following scenarios:

- Network automation

  Northbound APIs are provided for upper-layer management software, so that upper-layer management software can invoke APIs to implement network automation and provide real-time network services. This ensures quick service rollout.

- Flexible service network

  Based on the SDN architecture, the physical network is virtualized to provide different service networks. This ensures flexible deployment of service networks. Tenants are isolated. Users can define network policies by themselves to protect access to data center resources.

2.4.2 Deployment Architecture

The DC^2 network subsystems adopt the network design of the SDN architecture, as shown in Figure 2-15.

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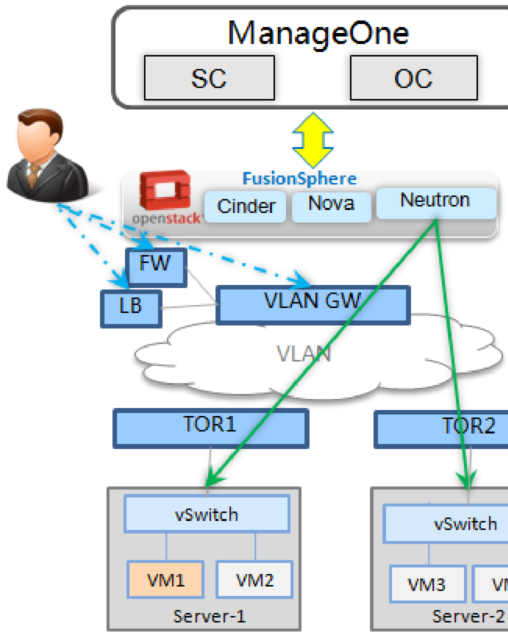
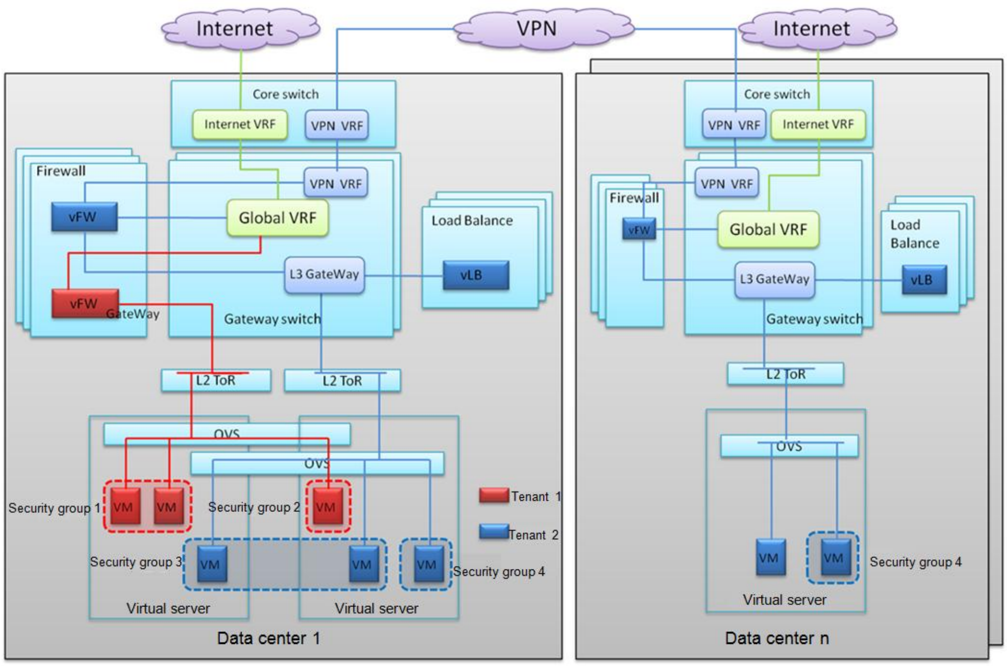
Figure 2-15 DC[2] SDN architecture (OpenStack)



The preceding SDN architecture virtualizes the network and automatically provides the virtual network environment for each tenant, as shown in Figure 2-16.

Figure 2-16 DC[2] network subsystem architecture



The core switch is configured with the virtual private network virtual routing and forwarding (VPN VRF) and Internet VRF. The VPN VRF interconnects with the VPN VRF on the

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aggregation switch, and the Internet VRF interconnects with the global VRF on the aggregation switch. Networks are isolated between tenants.

The aggregation switch is configured with a global VRF. Each tenant's vFW connects to the global VRF to access the public network.

The aggregation switch is configured with multiple VRFs to provide vRouters for tenants and the routing function for tenants' service gateways. A layer 3 gateway serving as a service gateway is configured under VRF. Each VRF connects to vFWs of tenants to protect tenants' services. If tenants lease vLBs, the vLBs connect to vRouters to provide the load balancing function for servers. The vLBs are protected by vFWs.

Virtual switches (vSwitches) logically connect to Top of Rack (TOR) switch ports. Each tenant has an independent vSwitch. Different port groups are available on a vSwitch, and different port groups provide different network attributes. Network interface cards (NICs) of VMs can be added to different port groups to isolate tenants.

Tenants can create multiple security groups. A VM can be added to different security groups through different virtual network interfaces. Different security groups are configured with different security access policies to isolate tenants' VMs.

2.4.3 Feature Design

Multi-Tenant Network Design

The DC^2 supports multi-tenant management, improving resource usage. Resources of different tenants must be isolated in the date center to ensure end-to-end (E2E) isolation and meet tenants' security requirements.

To support multiple tenants, the DC^2 Solution adopts virtualization technologies to logically plan multiple virtual networks. Each virtual network is configured with independent routing tables, address space, security services, and configuration management functions. Support for multi-tenancy depends on device virtualization.

Data Center Intranet Design

- Layer 3 design

  At the core layer or aggregation layer, the VRF technology is used to isolate tenants at layer 3. Each tenant is assigned with an independent routing and forwarding table. Data stream exchange between VRFs is not allowed. IP addresses of different tenants can overlap. Each VRF can be bound to multiple layer 3 gateways to carry services of multiple subnets. The VRF provides gateway functions for VMs or physical servers. Gateways under the same VRF can access each other.

- Layer 2 design

  Networks are isolated by VLANs or VXLANs at layer 2. Different layer 2 networks of a tenant communicate with each other through gateways. Networks of different tenants cannot communicate with each other by default.

- Network service design

  Firewalls and load balancers are virtualized to provide vFW and vLB functions for each tenant.

  - vFW

    A physical firewall can be virtualized into several logically independent vFWs or software vFWs running on VMs. Each vFW is configured with independent routing and forwarding tables, security service policies, and configuration management

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functions. Modifying vFW configurations by a tenant does not affect the proper running of other tenants' vFWs. The throughput and number of sessions of vFWs are limited to ensure that vFWs of a tenant do not occupy vFW resources of other tenants.

- vLB

  A physical LB can be virtualized into several logically independent vLBs or software vLBs running on VMs. Each vLB is configured with independent routing and forwarding tables, load balancing policies, and configuration management functions. Modifying vLB configurations by a tenant does not affect the proper running of vLBs of other tenants' vLBs. The throughput and number of sessions of vLBs are limited to ensure that vLBs of a tenant do not occupy vLB resources of other tenants.

Inter-Data Center Network Design

- Internet

  Data centers can interconnect with each other through the Internet. Tenants access services using public IP addresses. Cross-DC resource scheduling is supported, but long latency may occur in the case of long physical distance due to relatively poor network quality of the Internet.

- VPN or private line

  Physical data centers, especially remote data centers of enterprises, can interconnect with each other through leased VPNs or private lines. VPNs and private lines are recommended because of their stability.

2.4.4 Key Features

Table 2-2 Supported modes for VPC network service provisioning

VPC Service	Supported Mode
vRouter	Manual mode
Network	Automatic mode
Subnet	Automatic mode
EIP	Manual mode
SNAT	Manual mode
ACL	Manual mode
IPsec VPN	Manual mode
LB	Manual mode
SEG	Automatic mode
VM network	Automatic mode

- Multi-tenant isolation

  Network resources of different tenants are isolated. Each tenant has an independent network control plane, data forwarding plane, and policy configuration management function. Running of a tenant's resources does not affect other tenants' resources.

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- NaaS

  Network resources are provided for end users as infrastructure services, such as subnets, vFWs, vLBs, and VPN services.
- Network automation

  The minimum unit that can be orchestrated and abstracted from network device functions is regarded as the network service unit (network object). The network service units are combined in different ways based on service requirements to provide different network models. Network automation provides basic network environments for rapid service deployment, which reduces administrators' configuration operations and simplifies network configuration.

2.4.5 Device Mappings and Compatibility

Device mappings and compatibility are supported to ensure the continuity of version upgrades. Table 2-3 lists the device mappings for carriers.

Table 2-3 Device mappings for carriers

Network Device Mapping	Device Form	Version
VXLAN GW/Egress router	NE40E-X8/X16	V800R006C30
		V800R007C00
VLAN GW/NVE	CE128/CE78	V100R003C10
	CE128/CE78/CE6850HI	V100R005C00
Switch	CE128/CE6850EI/CE58	V100R003C00
		V100R002C00
FW	E8000E-X	V200R001C01
		V300R001
	E1000E-X	V300R001C10
LB (integrating F5)	F5-BIG-LB-8900	BIG-IP 11.6

2.5 Backup Management

2.5.1 Application Scenarios

The number of x86-based VMs increases rapidly, and the VM density becomes higher and higher. Compared with the traditional IT systems, VM services can be centrally provisioned and managed. On one hand, the application of VMs improves efficiency; on the other hand, higher data security and reliability are required. A comprehensive backup system is required to protect services running on VMs. Huawei OceanStor eBackup is designed as enterprise-level virtualization environment backup software.

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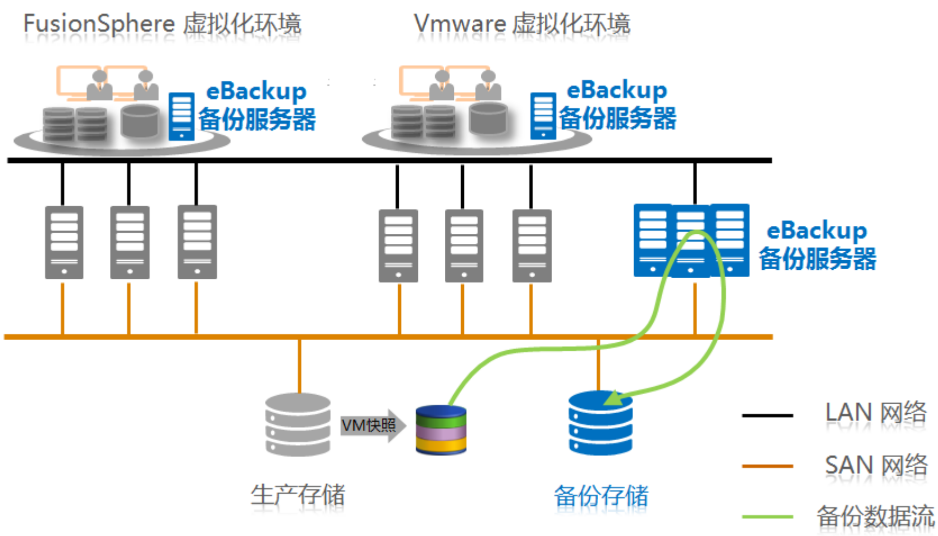
- It provides comprehensive data protection for the Huawei FusionSphere virtualization solution.
- It provides comprehensive data protection for the VMware vSphere virtualization platform.

2.5.2 Deployment Architecture

Figure 2-17 eBackup architecture



The OceanStor eBackup-based backup solution consists of the backup object, backup server, backup storage, and backup policy.

- Backup object

  A backup object indicates an object to be backed up. eBackup can protect data of VMs on the Huawei FusionSphere and VMware vSphere virtualization platforms.
- Backup server

  eBackup adopts the distributed architecture design. Backup capacity can be smoothly expanded by adding backup servers. Backup servers can be deployed in virtualization environments and physical environments.
- Backup storage

  SAN or NAS disk storage devices can serve as backup storage. They provide better backup performance and higher reliability than traditional physical tape libraries.
- Backup policy

  eBackup creates backup policies for a VM or one or multiple VM disks. The permanent incremental backup mode is adopted. A full backup is implemented for the first time, and follow-up backup tasks are all conducted in the incremental backup mode (the manually triggered full backup is also supported). In this mode, the backup window is saved and the capacity occupied by backup data is reduced.

2.5.3 Key Features

eBackup has the following key features.

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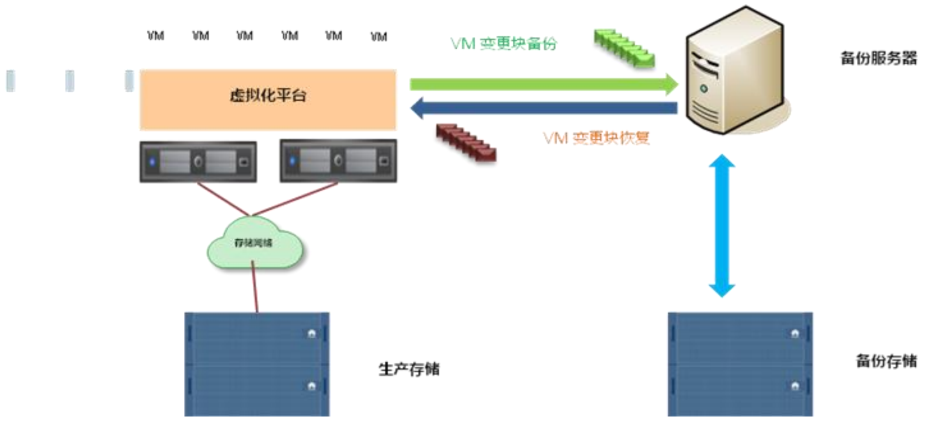
Figure 2-18 eBackup agentless backup



- Agentless backup

  eBackup uses the online backup to back up data without interrupting the running of VMs. eBackup backs up data using snapshots of VMs. No backup agents are installed on VMs, minimizing the affect on VMs during backup. eBackup supports the VM block-level incremental backup and restoration, improving the backup and restoration efficiency and shortening the backup and restoration window.

- Distributed deployment and elastic expansion

  eBackup adopts the distributed architecture and supports elastic expansion. The backup server works as the control center of the backup system to centrally manage the backup system. The backup agent is responsible for handling specific events and can be flexibly expanded with the increase of VMs to meet the growing service requirements.

- High reliability

  The load balancing and failover of backup tasks between different backup agents are supported, which improves the reliability of backup tasks. The retry mechanism of failed backup tasks is provided. The database backup mechanism of the backup server is provided, which ensures quick restoration of the backup server upon a failure.

- Flexible storage management

  SAN and NAS devices serve as backup media. The backup storage is hierarchically managed based on the storage unit, storage pool, and storage library. The storage library capacity can be expanded (if the storage pool has sufficient space) by modifying the capacity configuration to meet service requirements. The backup plan does not need to be modified, which reduces maintenance workloads.

- Diversified backup plans

  Backup plans can be made by following a wizard. The overall device backup and disk backup are supported, and the reservation period and priority can be set.

- Optimized backup set organization that improves restoration efficiency

  The backup data generated by eBackup each time is stored in multiple 4 MB backup files. Data files that have dependency on each other between different backup tasks are referenced in the pointer index mode. Each backup point is a virtual full backup. During restoration, backup data does not need to be combined, which ensures high restoration efficiency. If specific backup data is deleted, only the data blocks that are not depended by other backup data are deleted.

- Efficient and convenient maintenance

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Alarms in the backup system are reported in real time, helping users learn about the running status of the backup system in real time. Inspection tools are provided for users to check the running status of backup software. The email notification function is provided. Log collection tools are provided, helping users collect log information quickly.

2.6 Security Management

2.6.1 Application Scenarios

With the IT development, for example, as Web2.0, service oriented architecture (SOA), and cloud computing technologies are emerging and mobile devices, remote access devices, browsers, plug-ins of various applications, intelligent terminals, and cloud hosts come into being, information security faces new challenges. Attacks from the intranet and extranet and system vulnerabilities are major threats to information security. The most valuable information assets are frequently attacked. As the core of information, data centers bear the brunt.

Based on cloud computing and distributed deployment of data centers, data center elements embrace some changes, such as virtualization and boundary extension. Therefore, a systematic DC^2 security solution should cover all elements, and security elements should support logical isolation. Security of all elements cannot be ensured by only traditional technologies and physical boundaries.

The security subsystem of the DC^2 is designed based on the best practice in the industry and Huawei's expertise and experience. Objectives of the security subsystem architecture are as follows:

- Modularization

  The security subsystem is designed based on eight modules: physical security, network security, host security, application security, virtualization security, user security, security management, and security services. Security architecture can be quickly formed based on customer requirements to provide a customized security system.

- E2E security

  The security subsystem provides E2E protection from user access, use, and exit. Technologies such as two-factor authentication, rights control technology for privileged users, VPN, application protection technology, and event auditing technology are used to control user access to IT resources, ensure data communication security and secure application access, and audit operations.

- Low coupling

  The security subsystem must provide protection for multiple layers, such as the data layer, network layer, and application layer. Therefore, the security subsystem involves various security technologies, products, and security management policies. The security subsystem features low coupling. That is, various security technologies are not tightly associated, security products provided by different vendors can be used and are not limited to specific models, and security management policy formulation does not depend on specific security products.

- Logical isolation

  Network security technologies, such as the firewall, Anti-DDoS, IDS, IPS, network antivirus, and Web security gateway, support the one-to-N virtualization mode, and can

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build logical boundaries for distributed cloud data centers (which do not have clear physical boundaries), to ensure VDC security.

- Scalability

  The security subsystem is a guiding framework. Users can implement security construction based on the guiding framework and security requirements, which protects investments while meeting security requirements.

- Standards compliance

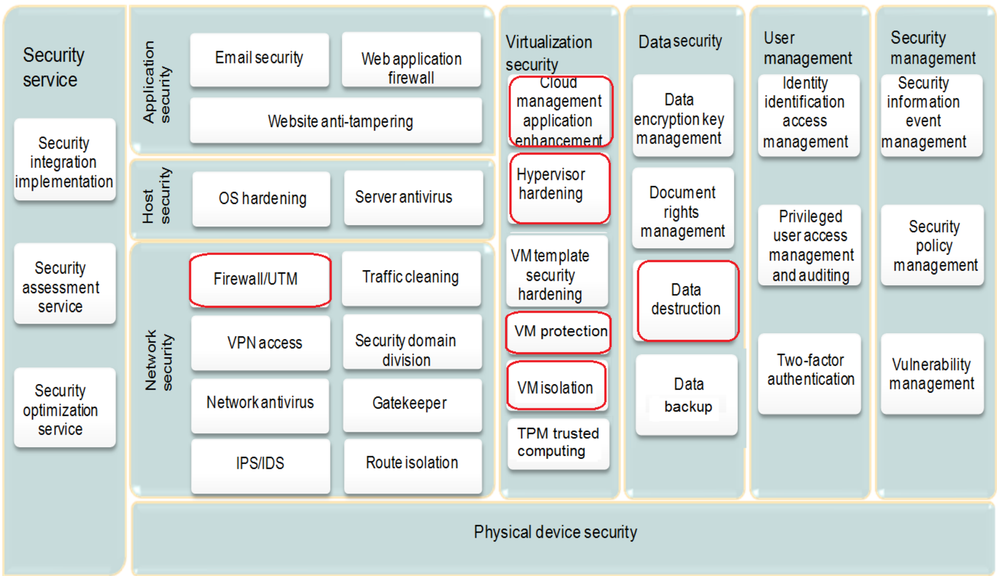
  The security subsystem of the DC^2 is designed from aspects of physical security, network security, host security, application security, data security, user management, and security management to meet level 3 security protection requirements of e-government. The security subsystem is one of the best guiding frameworks for constructing e-government data centers. Virtualization security is also ensured by the security subsystem based on cloud computing characteristics.

  The DC^2 security solution meets the requirements for e-government security protection (level 3).

2.6.2 Deployment Architecture

According to the ideas of layered and in-depth defense, the security subsystem is divided into physical device security, network security, host security, application security, virtualization security, data security, user management, and security management layers. The security subsystem meets different security requirements. Figure 2-19 shows the security subsystem architecture, in which the modules in red boxes are the basic security modules of the DC^2.

Figure 2-19 Security subsystem architecture



This architecture provides the following security capabilities:

- Physical device security: uses the access control system, video surveillance system, and environment monitoring system to control physical access and ensure the security of data center environments and facilities.
- Network security: uses the firewall, IPS, SSL VPN, Anti-DDoS, IDS/IPS, and network isolator technologies to ensure the isolation and security of VDC boarder, VDC internal

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system, data, and communication. These technologies prevent data from being damaged, changed, or disclosed accidentally or intentionally. With these technologies, the system is reliable, secure, and able to run continuously without service interruption.

- Host security: protects host OSs. Hosts are protected against attacks by security hardening, antivirus software, host IPS, and host patch management.
- Virtualization security: implements virtualization layer hardening, cloud management application hardening, and VM isolation to ensure virtualization security.
- Application security: uses protection technologies, such as the email protection technology and Web application protection technology, to protect the data on the application layer. These technologies prevent application data from being damaged, changed, or disclosed accidentally or intentionally.
- Data security: uses data encryption, residual data protection, data backup, and other technologies to ensure data security.
- User management: audits access requests from privileged users.
- Security management: adopts security information and event management technologies.
- Security service: covers security integration, security assessment, security optimization, and phase-specific professional services, and constructs a secure IT system for users.

2.6.3 Key Features

Network Security

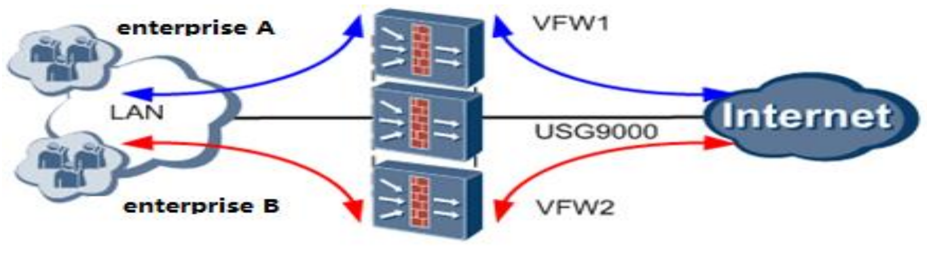
The firewall, IDS, IPS, SSL VPN, Anti-DDoS, network antivirus gateway, and data ferry technologies are used to protect systems and communication data. These technologies prevent data from being damaged, changed, or disclosed accidentally or intentionally. With these technologies, the system is reliable, secure, and able to run continuously without service interruption.

Traditional physical boundaries cannot meet security requirements for scenarios where VDCs are used as the main body of distributed cloud data centers. To meet the requirements of cloud technology development, network security products evolve to support virtualization as well as one-to-N device virtualization, and provide logical network security isolation. The vFW technology is the most widely used cloud technology. In addition, cloud technology-based software boundary firewalls and security groups provide comprehensive security protection.

- vFW

  A firewall is logically divided into multiple vFWs to provide independent security insurance for enterprises and maximize resource usage of firewalls. A vFW can be provided by a physical firewall or software firewall.

Figure 2-20 Logical architecture of the vFW



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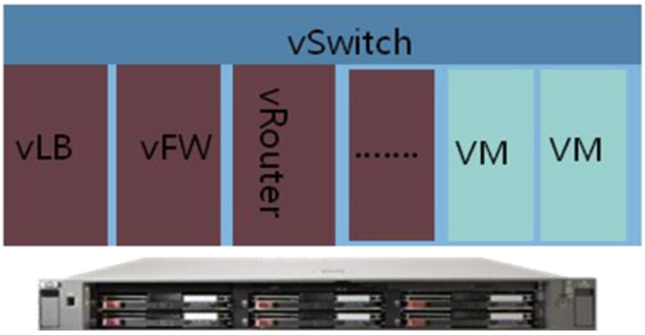
Each vFW provide the private routing service, security service, and configuration management service for users.

- Software vFW virtual service appliance (VSA)

  The Huawei virtualization service application system is a software virtualization network boundary gateway. The VSA is deployed on the VM. The VSA provides the following functions:

  - vRouters and vFWs: support L3 route forwarding, OSPF/BGP, ACL, NAT, and IPsec/GRE VPN.
  - vLBs: support TCP, HTTP, and HTTP load balancing. Multiple vLBs can be deployed as required.

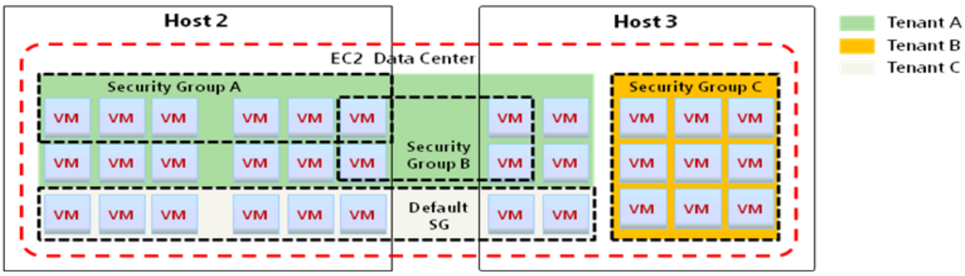
Figure 2-21 Software vFW



- Security group

  Users can create security groups based on VM security requirements. Each security group provides a set of access rules. VMs that are added to a security group are protected by the access rules of the security group. Users can add VMs to security groups when creating VMs.

Figure 2-22 Security group



  VMs in the same security group can be distributed on different physical servers. The VMs in a security group can communicate with each other, while the VMs in different security groups are not allowed to communicate with each other. However, the VMs in different security groups, when configured, can also communicate with each other.

- Next-generation firewall protection

  Huawei next-generation firewall (NGFW) supports the firewall, VPN, IDS, IPS, Anti-DDoS, antivirus gateway, anti-spam protection, and Web protection technologies. These security protection technologies can also be virtualized.

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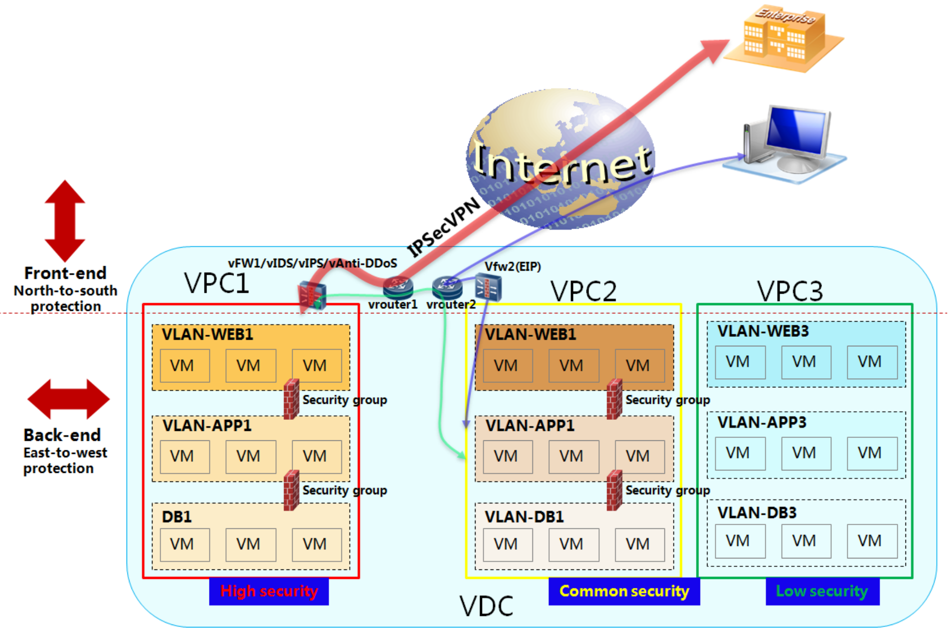
- VDC network security protection framework

  On VDC boundaries, vFWs (hardware firewall in one-to-N virtualization mode or software VSA) and network security technologies such as vIDS, vIPS, and vAnti-DDoS are deployed to protect the north-to-south traffic of VDC. In a VDC, VPC boundaries protect the east-to-west traffic between VPCs using vFWs. In a VPC, the east-to-west traffic between applications is protected by security groups.

Figure 2-23 VDC security protection framework



- Anti-counterfeit of IP addresses and MAC addresses

  Binding an IP address to a MAC address prevents users from initiating IP address or MAC address spoofing attacks after changing the IP address or MAC address of a virtual NIC, and therefore enhances the network security of user VMs. With this policy enabled, an IP address is bound to an MAC address using DHCP snooping feature, and then the packets from untrusted sources are filtered through IP Source Guard and dynamic ARP inspection (DAI).

- DHCP quarantine

  DHCP quarantine of VMs is supported. DHCP quarantine disallows users from unintentionally or maliciously enabling the DHCP server service for a VM, ensuring common VM IP address assignment.

- Broadcast packet suppression

  In server consolidation and desktop cloud scenarios, if broadcast packet attacks occur due to network attacks or virus attacks, the network communication may be abnormal. In this case, the broadcast packet suppression can be enabled for vSwitches.

  The ARP broadcast packet suppression, IP broadcast packet suppression, and suppression bandwidth threshold for VM outbound traffic can be configured on vSwitches. Layer 2

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network bandwidth consumption can be reduced by enabling the broadcast packet suppression and setting thresholds on the port group where the VM NIC is located.

On the system portal, the administrator can enable the ARP and IP broadcast packet suppression and set thresholds on a port group basis.

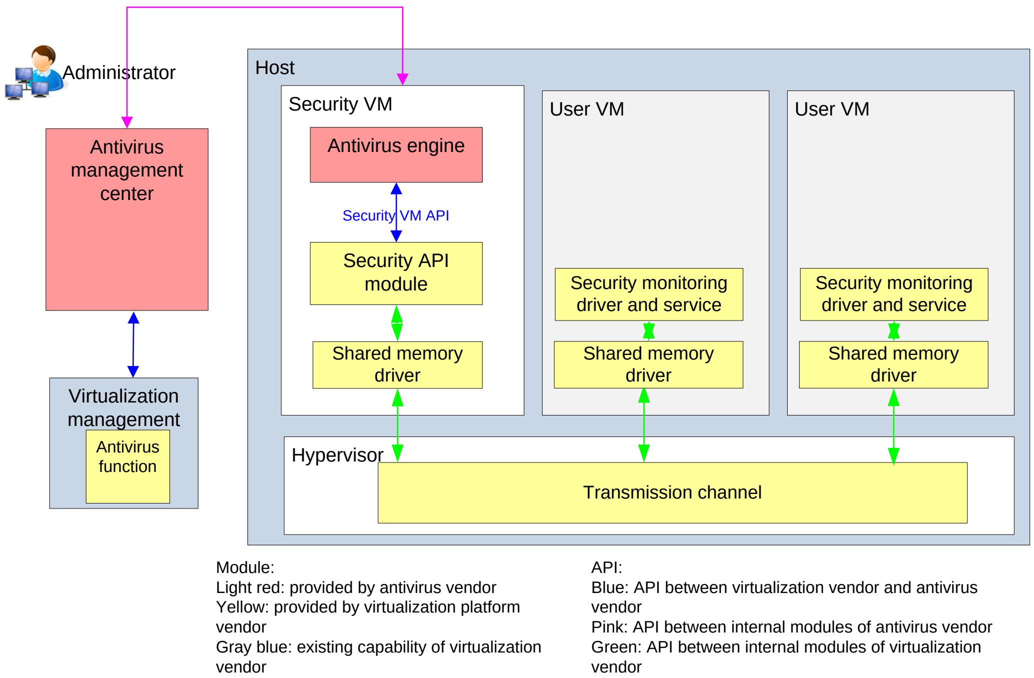
Virtualization Agentless Antivirus

The Huawei virtualization platform provides APIs for antivirus vendors to perform secondary development and generate virtualization antivirus solutions that allow users to remove viruses by deploying an antivirus engine in a specific security VM and installing a lightweight driver on a local VM. The virtualization agentless antivirus supports the integrated verification with Rising, Trend Micro, and Kaspersky virtualization antivirus software, and supports the agentless antivirus on Windows cloud hosts.

The agentless antivirus has two advantages:

- Advantages on virus library management, that is, only security VM management is required, instead of management of virus library installation and update on each VM.
- Virus scan results are shared on all VMs of the host, which improves the virus scanning efficiency.

Figure 2-24 Virtualization antivirus architecture



TPM Integrity Protection

The cloud OS is tailored and hardened, and is implemented security configuration to effectively improve security. However, security risks, such as encoding security vulnerabilities, cannot be prevented. Therefore, the cloud OS integrity protection solution is required to prevent security vulnerabilities from being used. The Huawei cloud platform supports the hardware TPM chip-based integrity verification, which can protect the integrity

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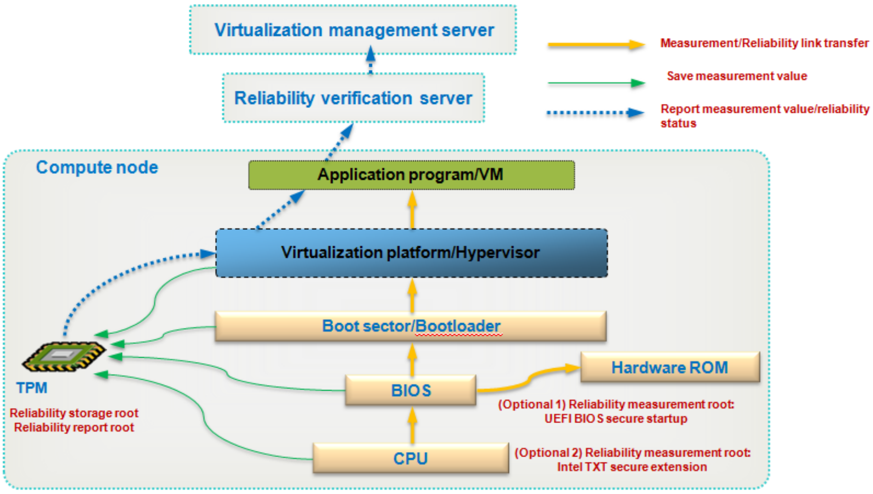
of hosts as well as VMs and handle damages in a timely manner to protect user data. The integrity protection solution ensures that untampered software with correct configuration is always running on the virtualization platform. TPM provides the reliability root of compute node. The startup and running of virtualization OS and host OS are based on the reliability root. Based on the integrity measurement by level on the reliability link, reliability VM services are provided.

Figure 2-25 TPM reliability computing architecture



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3 Typical Deployment

About This Chapter

The following table lists the main information in this chapter.

Title	Content
3.1 Single Data Center Deployment	Describes the physical deployment and recommended configurations of a single cloud data center.
3.2 Distributed Data Center Deployment	Describes the deployment architecture of multiple cloud data centers.

3.1 Single Data Center Deployment

3.1.1 Physical Architecture

Figure 3-1 shows the physical deployment for the flattened two-layer architecture.

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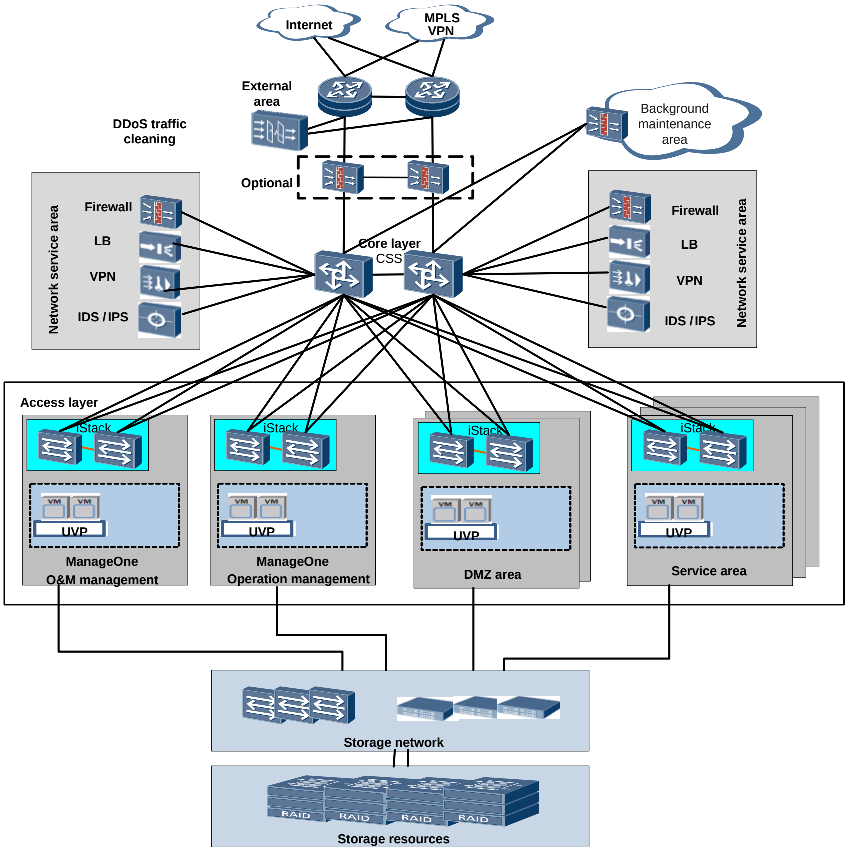
Figure 3-1 Physical deployment for the flattened two-layer architecture



3.1.2 Architecture Overview

- The data center adopts the flattened two-layer architecture design. The internal switching architecture is simple and clear. The data center network consists of the aggregation and access layers.
- The data center is divided into four areas based on the network logical functions: external area, aggregation area, network service area, and access area.
  - The external area connects to the Internet and connects users to the network.
  - The aggregation area is the switching core of the data center and consists of high-performance switches.
  - The network service area provides value-added services such as traffic statistics collection, IDS/IPS, firewalls, load balancing, and VPN.
  - The access area provides access for data center server nodes.
- At the aggregation layer, subrack switches are used to form a cluster, and multiple switches are logically virtualized into a switch to implement device redundancy. Only one management IP address is required to manage the devices.
- The CSS+iStack+Eth-Trunk mode is used to construct a reliable, loop-free, and two-layer network.
- At the aggregation layer, the VRF technology is used to logically isolate network areas and service areas at layer 3.

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- With the network virtualization function, vFWs, vLBs, and vSwitches are provided to meet user requirements on virtualization and isolation.
- At the access layer, VLANs are used to implement layer 2 isolation.
- Servers can be blade servers or rack servers. If blade servers are used, the blade servers connect to the core switch through the switching backplane. If rack servers are used, the rack servers connect to the core switch through the access switch.
- Storage devices connect to the storage plane ports of servers through the FC switch over the FC SAN, or connect to the storage plane ports of servers through the IP switch over the IP SAN.

3.1.3 Component Specifications Recommendations

Table 3-1 Configuration table for the flattened two-layer deployment

Data Center Area	Device Type	Device Model (Carrier)	Device Model (Enterprise)	Quantity	Optional or Mandatory
Aggregation area	Switch	CE12800	CE12800	2	Mandatory
	Firewall (select one model)	E8000E-X	USG9500	2	Mandatory
		E1000E-X	USG5500	2	Mandatory
		E1000E-N	USG5500	2	Mandatory
	LB (F5)	BIGIP2000S	BIGIP3900	2	Optional
		BIGIP4000S	BIGIP6900	2	Optional
		BIGIP5000S	BIGIP8900	2	Optional
Access area	Access switch	CE5800, CE6800, and CE7800 series	CE5800, CE6800, and CE7800 series	Configured as required.	Optional
Server	Blade server	Huawei E9000		Configured as required.	Optional
	Rack server	Huawei RH2288 and RH5885		Configured as required.	Optional
Storage network area	FC switch	Huawei SNS2000 and SNS5000 series		Configured as required.	Optional
	IP switch	Huawei S5300, S6300, S6700, and CE6800 series		Configured as required.	Optional

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Data Center Area	Device Type	Device Model (Carrier)	Device Model (Enterprise)	Quantity	Optional or Mandatory
Storage resource area	SAN	Huawei OceanStor V3 series: S5300 V3, S5500 V3, S5600 V3, S5800 V3, S6800 V3, and 18000 V3		Configured as required.	Optional
	NAS	Huawei OceanStor 9000 series		Configured as required.	Optional
Virtualization software	Virtualization platform	VMware 5.1/5.5		1	Optional
		Later than FusionSphere 5.1		1	Optional
Data center management software	Distributed cloud data center management software	Later than FusionSphere 5.1 and ManageOne 2.3		1	Mandatory

3.2 Distributed Data Center Deployment

3.2.1 Physical Architecture

Figure 3-2 shows the physical deployment architecture of multiple data centers.

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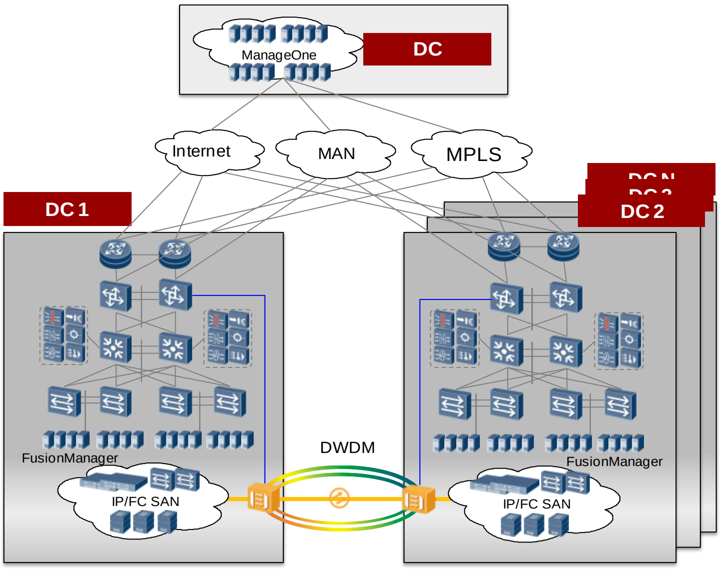
Figure 3-2 Physical deployment of multiple data centers



3.2.2 Architecture Overview

- Management deployment

  The DC^2 management software ManageOne is deployed in a third place or the production center. ManageOne manages other data centers and centrally allocates and schedules resources through private lines.

  Confidentiality, reliability, and low latency are ensured for data flows during service provisioning.

- Data center interconnection architecture
  - Data centers can interconnect with each other through the Internet, MPLS network, MAN, or bare fibers.
  - When data centers are interconnected through the Internet or MAN, layer 3 routes are used.
  - When data centers are interconnected through the MPLS network, border routers serve as MCEs to construct layer 3 network interconnection.
  - When data centers are interconnected through bare fibers, the core switch is used to implement layer 2 interconnection.

3.2.3 Component Specifications Recommendations

One set of DC^2 management software is deployed. Multiple virtualization platforms are deployed for multiple data centers. The management software centrally manages and schedules data center resources. For details about the deployment of other components, see recommendations for the single data center deployment.

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