

Alibaba Cloud Apsara Stack Enterprise Security Whitepaper

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Document conventions

Style	Description	Example
	A danger notice indicates a situation that will cause major system changes, faults, physical injuries, and other adverse results.	 Danger: Resetting will result in the loss of user configuration data.
	A warning notice indicates a situation that may cause major system changes, faults, physical injuries, and other adverse results.	 Warning: Restarting will cause business interruption. About 10 minutes are required to restart an instance.
	A caution notice indicates warning information, supplementary instructions, and other content that the user must understand.	 Notice: If the weight is set to 0, the server no longer receives new requests.
	A note indicates supplemental instructions, best practices, tips, and other content.	 Note: You can use Ctrl + A to select all files.
>	Closing angle brackets are used to indicate a multi-level menu cascade.	Click Settings > Network > Set network type.
Bold	Bold formatting is used for buttons, menus, page names, and other UI elements.	Click OK .
Courier font	Courier font is used for commands.	Run the <code>cd /d C:/window</code> command to enter the Windows system folder.
<i>Italic</i>	Italic formatting is used for parameters and variables.	<code>bae log list --instanceid</code> <code>Instance_ID</code>
[] or [a b]	This format is used for an optional value, where only one item can be selected.	<code>ipconfig [-all -t]</code>

Style	Description	Example
<code>{}</code> or <code>{a b}</code>	This format is used for a required value, where only one item can be selected.	<code>switch {active stand}</code>

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1 Overview

Data security and user privacy are top priorities of Alibaba Cloud Apsara Stack. Alibaba Cloud is committed to providing a public, open, and secure Apsara Stack cloud computing service platform. With technical innovation, Apsara Stack is constantly improving its computing capability and economies of scale to turn cloud computing into the infrastructure of true sense.

Apsara Stack is designed to provide users with stable, reliable, secure, and compliant cloud computing basic services and protect the availability, confidentiality, and integrity of users' systems and data.

This document introduces the Apsara Stack security system in the following parts:

- **Attribution of security power and responsibilities and security capacity co-construction**
- **Security compliance**
- **Security of the Apsara Stack platform architecture**
- **Security features provided by Apsara Stack products**
- **Security services provided by Apsara Stack Security**

This document also provides the best practices for secure use of Apsara Stack products and Apsara Stack Security products, which helps users make better use of the Apsara Stack platform and get an insight into the overall environment of security control.

2 Attribution of security power and sharing of security responsibilities

2.1 Attribution of security power

The products, design, model algorithm, programs, and its relevant intellectual property provided by Alibaba Cloud in various types of Apsara Stack environment all belong to Alibaba Cloud unless the contract stipulates clearly otherwise. Users have the access rights within the time period authorized by License.

The national standard *GBT 31167-2014 Information Security Technology - Cloud Computing Service Security Guide* (this document puts forward the national standard of the security control solution for the government to use cloud service. It has four deployment forms of cloud computing including Apsara Stack (private cloud). Other customers can also regard this standard as a reference when using Apsara Stack service) stipulates that "the customer owns the data, device, and other resources that the customer submits to cloud provider. The customer also owns the data and document collected, produced, and stored by customer business system on the cloud computing platform. The right of the customer to visit, use, and dominate these resources must not be limited."

In Apsara Stack environment, users are entitled to the ownership of the user data of project planning and implementation, the operation data produced during operations, and the business data that are transferred to the cloud environment . Alibaba Cloud can access the data within the scope of users' authorization, and cloud users must avoid authorizing business data to Alibaba personnel.

2.2 Sharing of security responsibilities

2.2.1 Security responsibilities of Alibaba Cloud

In Apsara Stack environment, Alibaba Cloud is responsible to provide users with cloud computing products and solutions, help users with customized deployment , or facilitates operations within the scope of the contract. Alibaba Cloud takes the following responsibilities:

- Provides users with security testimonial for compliance requirement of Alibaba Cloud Apsara Stack.
- Provides the vulnerability recognition service and technology for Apsara Stack products and helps users fix Apsara Stack on the product side.
- Protects users' Apsara Stack information system or infrastructure and provides relevant solutions and techniques, including authorization management, encryption, and auditing feature. Based on the preceding solutions and methods, Alibaba Cloud provides best practices of security management for users and puts forward the security capacity building.
- According to Alibaba Cloud security regulation and customer's requirement, the Alibaba Cloud personnel is required to sign the confidential agreement and receive proper security training and education.

2.2.2 Security responsibilities of users

The national standard *GBT 31167-2014 Information Security Technology - Cloud Computing Service Security Guide* stipulates that "the responsibility of information security control must not transfer to the outsourcing service partner. No matter the customer data and business are placed in the customer internal information system or on the cloud computing platform of the cloud service provider, the customer holds the responsibility for the information security." In Apsara Stack environment, the user exercises the security control based on the security solutions and technology provided by Alibaba Cloud or the third party and takes the following responsibilities for the results:

- Establishes the security control personnel, organization, security system, and operation system, which all support the Apsara Stack environment. The control object includes relevant project members of Alibaba Cloud.
- Practices admittance examination, confidentiality agreement, security training and education for relevant project members of Alibaba Cloud in the Apsara Stack environment, according to the national law, regulation, and customer requirements.
- Executes the transfer control for code and program in the Apsara Stack environment and takes responsibility for data leakage that is caused by users' fault.

- **Leads the vulnerability fix process for Apsara Stack products, reviews the relevant implementation plan, and authorizes the change of plan during the upgrade process.**
- **Implements the account assignment, authorization, and log audit in each console in the Apsara Stack environment. Manages to achieve minimized authorization and normalized audit.**
- **Implements the security configuration of each console and products in the Apsara Stack environment, or authorizes the Alibaba Cloud field personnel to perform the security configuration.**
- **Users must perform backup and recovery drills for key data on regular basis to guarantee the business data is backed up and can be restored.**

3 Security compliance

3.1 Overview

The security process of Alibaba Cloud has been recognized by authorities inside and outside China. By using years of expertise in defense against Internet security threats of Alibaba Group, Alibaba Cloud provides security protection for the Apsara Stack platform and integrates multiple compliance standards into the internal control and product design of the cloud platform. Alibaba Cloud also participates in the development of standards for various cloud platforms and contributes the best practices. Certified by more than 10 agencies inside and outside China currently, Alibaba Cloud is a cloud service provider with the most complete scope of certifications in Asia.

Certified by more than 10 agencies in and outside China, Alibaba Cloud is the cloud service provider with the most complete range of certifications in Asia. Alibaba Cloud has certifications as listed in Alibaba Cloud has the following qualifications.

Table 3-1: Certifications awarded to Alibaba Cloud

Certification	Description
ISO 27001	The international Information Security Management System (ISMS) Certification. It certifies Alibaba Cloud for fully performing its security duties in regard to data security, network security, communication security, and operation security.
CSA STAR	The International Cloud Security Management System Certification. The certification organization awarded the first cloud security gold medal to Alibaba Cloud.

Certification	Description
ISO 20000	The IT Service Management System Certification. This certifies that Alibaba Cloud has established and strictly implemented a standard service process . The standardized cloud platform services can improve IT efficiency and reduce the overall IT risk.
ISO 22301	The Business Continuity Management System Certification. This certifies that Alibaba Cloud meets the requirements for business continuity planning, disaster recovery, and regular drills to enhance the stability of the cloud platform.
Classified protection (level 4)	Alibaba Cloud Apsara Stack platform complies with the security and technology capabilities that are requested by Cloud computing platform classified protection 2.0 compliance specifications (level 4), which is formulated in accordance with GB/T22239 - 2019 <i>Information security technology - Baseline for classified protection of cybersecurity</i> .
Cloud service capability standard test by Ministry of Industry and Information Technology (MIIT)	CNAS certification for cloud products is the only product-level classified certification based on national standards.
Service Organization Control (SOC) audit certification	Alibaba Cloud has passed SOC3 audit, and the TYPE II of SOC1 and SOC2.

Table 3-2: List of domestic Apsara stack qualifications

Qualifications/certification	Certification authority
ITSS cloud computing service capability (private cloud IaaS service/level 1)	Chinese Electronics Standardization Association
Trusted cloud - the protection of the user data of cloud service (private cloud)	China Academy of Information and Communications Technology

Qualifications/certification	Certification authority
Security level assessment report of the information system of the Ministry of Public Security(level 4, private cloud)	Information security rating center of the Ministry of Public Security
Security classified protection evaluation report of the Ministry of Public Security Information System Apsara stack V3.0	Information security rating center of the Ministry of Public Security
Security assessment report of big data simple Apsara Stack platform of the security of the information system of Ministry of Public Security	China Academy of Information and Communications Technology
Cloud evaluation certificate-Cloud computing reference architecture-cloud solution	China Electronics Standardization Institute
Trusted cloud-open-source solutions (agile private cloud version)/virtualization and virtualization management software	China Academy of Information and Communications Technology

3.2 Security compliance

Alibaba Cloud keeps improving its management and system based on relevant standards and best practices in the industry. It is certified in a series of standard certifications, third-party audits, and self-assessment, which aims to better demonstrate its compliance practices to users.

The overall compliance architecture of Alibaba Cloud is divided into the following parts according to compliance requirements from different perspectives, industries , and regions:

Management system compliance

These compliance authentications demonstrate the mature management system of Alibaba Cloud and the best industry practices that Alibaba Cloud complies with:

- ISO 27001: Information Security Management Standard
- ISO 20000: IT Service Management Standard
- ISO 22301: Business Continuity Management Standard
- CSA STAR: maturity model of cloud service security
- Classified protection (level four)

- CNAS test for cloud computing standards in China

Systematized compliance reports

These compliance authentications demonstrate the integrity and effectiveness of control in Alibaba Cloud platform, including the continuous effectiveness of system control, accuracy of separation of duties, and completeness of operations audit.

SOC 1/2 TYPE II: The Service Organization Control (SOC) reports are a series of audit reports from independent third parties to indicate the continuous effectiveness of the key compliance control and objectives of Alibaba Cloud. These reports aim to help users and their auditors learn the control measures behind operation and compliance. The SOC reports that Alibaba Cloud has are categorized into the following three types:

- **SOC 1 TYPE II: internal control report over financial reporting**
- **SOC 2 TYPE II: reports over security, availability, and confidentiality**
- **SOC 3: report over security, availability, and confidentiality**

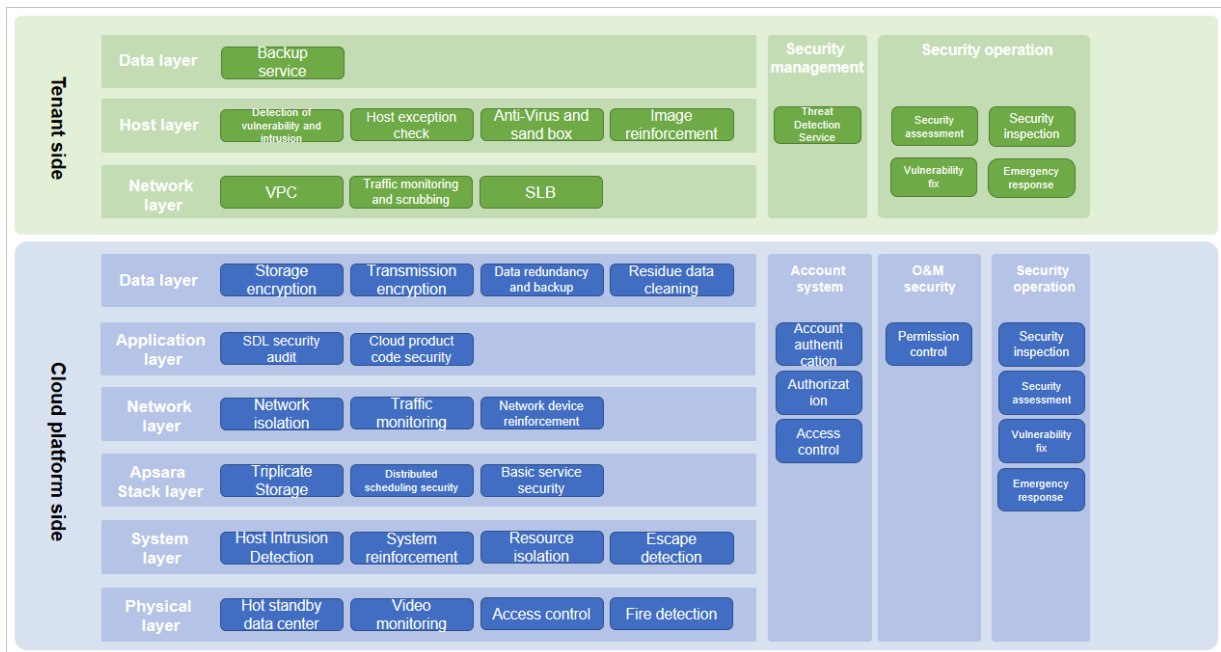
3.3 Alibaba Apsara Stack classified protection 2.0 compliance whitepaper

According to *Cloud Computing Security Classified Protection Compliance Capability Framework* , and under the guidance of China's technology community of the cloud computing security classified protection compliance capacity specification system, Information security rating center of the Ministry of Public Security and Alibaba Cloud Computing Co., LTD. jointly compiled and issued *Apsara Stack Network Security Classified Protection 2.0 Compliance Capability Whitepaper* . The whitepaper explains in details from the technical verification architecture of classified protection capability, the compliance status of Apsara stack classified protection 2.0 to the usage recommendations for the whitepaper. With this whitepaper, customers can quickly obtain compliance protection on the Apsara stack platform side in multiple delivery scenarios. It also integrates customer-side application, security management, and protection measures such as physical environment, to jointly construct an overall security defense system of information systems to meet the needs of classified protection and customers.

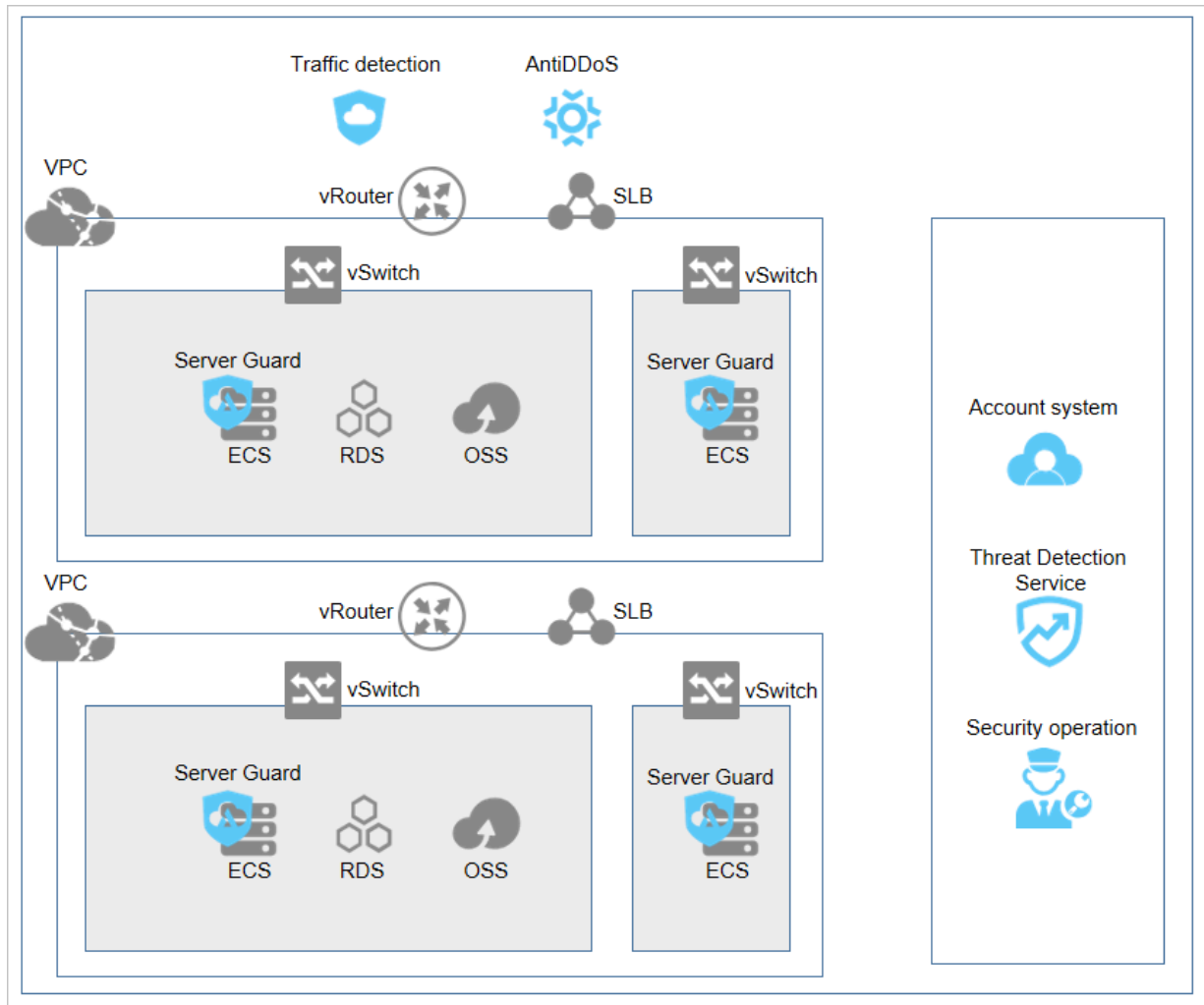
4 Apsara Stack security architecture

4.1 Apsara Stack security architecture

Apsara Stack is designed with an in-depth multi-layer security defense system and provides security assurance of architecture on the cloud platform side, including infrastructure, system, distributed Apsara system security, network, application, database, cloud platform account, O&M, and operation service, and also on the cloud users (tenants) side, including network, host, application, data, and operation service.



In the Apsara Stack environment, the security deployment condition of each security product is shown as follows.



4.2 Cloud platform security

4.2.1 Apsara Stack infrastructure security

The requirements for the physical security of Apsara Stack data centers include the following security measures: dual-circuit power supply, access control, video monitoring, fire detection, and hot standby data centers.

Dual-circuit power supply

To guarantee 24/7 non-stop services, each load in the Apsara Stack data center must be connected to two power supplies that support mutual switchover. If one power supply fails, the load is connected to the other power supply.

Access control

Access control must be set for the Apsara Stack data center and the physical devices in the data center. For example, the access control policies must be set for the

entry/exit of personnel and devices in the data center and also for the configuration , start-up, shutdown, and fault recovery of physical devices.

Video monitoring

A video monitoring system or dedicated persons must monitor the channels or other important locations in the Apsara Stack data center around the clock. For example, the video monitoring system must monitor the entry and exit, and the alert device must collaborate with the video monitoring system or access control device to effectively monitor the monitoring sites.

Fire detection

The Apsara Stack data center must be equipped with an automatic fire alert system , including the automatic fire detector, regional alert, and centralized alert and controller. The automatic fire alert system sends alert signals by sound, light, or point on the fire location, starts the automatic fire extinguishing device, cuts off the power, and turns off the air conditioners.

Hot standby data centers

When a fault occurs, the faulty unit is automatically replaced by a hot standby unit based on the preset fault recovery plan to achieve automatic fault recovery.

4.2.2 Apsara Stack system security

4.2.2.1 System security of physical host

Alibaba Cloud comprehensively enhances the security of Apsara Stack physical server systems, including but not limited to account security, file permissions, system services, and host intrusion detection systems.

Account security

Set the password length, complexity, password length, and password lifecycle for physical server accounts, delete accounts with empty passwords, and set the logon TIMEOUT parameter.

File permission

Monitoe integrity of important directories to immediately detect intrusions when hackers tamper with or write files.

System services

Disable unnecessary system services on the physical server to reduce attacks on the server.

4.2.2.2 Virtualization system security

Virtualization lays the technological foundation for the cloud computing platform and guarantees isolation between multiple tenants in a cloud computing environment by means of virtualized computing, storage, and network. Virtualization security technology of Alibaba Cloud involves tenant isolation, hotfix patches , and escape detection to guarantee the security of the virtualization layer of the Apsara Stack platform.

Tenant isolation

The virtualization management layer plays a vital role in tenant isolation. Based on the hardware virtualization technology, virtual machine management isolates virtual machines that have multiple computing nodes at the system layer. Tenants cannot access unauthorized resources to guarantee the basic computing isolation between computing nodes. The virtualization management layer also provides storage isolation and network isolation.

- **Computing isolation**

The Apsara Stack platform provides various cloud-based computing services including computing instances and services, and allows automatic scaling to meet the requirements of applications and users. These computing instances and services provide computing isolation at multiple levels to protect data and guarantee flexible configuration to meet users' needs. The computing isolation is directly provided by Hypervisor, and the key computing isolation boundaries are between the management system and users' virtual machines, and also between users' virtual machines. In the virtualized environment of Apsara Stack platform, user instances run as standalone virtual machines. The isolation is enforced with physical processor-level permissions to avoid unauthorized users' virtual machines to access physical hosts and the system resources on other users' virtual machines.

- **Storage isolation**

In the basic design of cloud computing virtualization, Alibaba Cloud separates computing based on virtual machine from storage. This separation allows

computing and storage to be extended independently and makes it easier to provide multi-tenant services. At the virtualization layer, Hypervisor uses the separation device driver model to implement I/O virtualization. Hypervisor intercepts and processes all I/O operations of a virtual machine to make sure that the virtual machine can only access the physical disk space allocated to it. This realizes security isolation of hard disk space between virtual machines. After the releasing of a user instance server, the original disk space is reliably cleared to guarantee the user data security.

- **Network isolation**

To guarantee the network connections of virtual machine instances, Alibaba Cloud connects virtual machines to the Apsara Stack virtual network. A virtual network is a logical structure built on the physical network structure. Each logical virtual network is isolated from other virtual networks. This isolation prevents the network traffic data being accessed by other instances during deployment.

Escape detection

A virtual machine takes two steps to perform escape attack: first it places the virtual machine controlled by the attacker on the same physical host as one of the target virtual machines. Then, it destroys the isolation boundary to steal sensitive information of the target or perform operations that compromise the functions of the target.

The virtualization management of Apsara Stack platform uses the advanced virtual machine layout algorithm to prevent virtual machines of malicious users from running on specific physical machines. At the software level of virtualization management, Alibaba Cloud also provides reinforcement, attack detection, and hotfix of virtualization management programs to prevent attacks from malicious virtual machines.

Hotfix patches

The Apsara Stack virtualization platform supports the hotfix patch technology, which can fix system defects or vulnerabilities without restarting the system and then avoid affecting users' business.

4.2.3 Distributed Apsara system security

4.2.3.1 Security of distributed file system

The distributed file system adopts triplicate technology to store data in the system. If one of the three copies is lost, system automatically performs copy operation to maintain the three copies in the system all the time. The three copies are stored in the same physical storage medium according to security policy. They are kept separately for operation.

All the access operation of the distributed file system must be certified by the Capability. Only the access with approved Capability is allowed to communicate with the system, which avoids unauthorized access operation.

Data stored in the distributed file system adopts binary format to avoid information leakage caused by the direct access to the plain information.

4.2.3.2 Security of remote process call module

The remote process call module adopts binary format for remote communication in Apsara Stack operation system. This guarantees an efficient and secure transmission and also guarantees that even if data is hijacked by any intermediary, data cannot be restored.

4.2.3.3 Security of job scheduling module

The job scheduling module isolates programs by using the method of sand box.

4.2.3.4 Security of basic service module

Basic service module deploys specific security measures for NTP and DNS servers, such as DDos attack protection, DNS zone forward, DNS amplified attack defense, and NTP amplified attack defense.

4.2.4 Network security

4.2.4.1 Basic network security

Logical isolation

The Apsara Stack platform adopts security isolation for the management network (OPS), business network, and physical network in the Apsara Stack network environment. The OPS, business, and physical networks are logically isolated from each other by using network access control policies to prevent mutual

access. Apsara Stack platform also takes network control measures to prevent unauthorized devices from connecting to the internal network of the cloud platform and prevents the physical servers of the cloud platform from connecting to external devices.

Anti-IP/MAC/ARP spoofing

IP/MAC/ARP spoofing always challenge traditional networks. Hackers use IP/MAC /ARP spoofing to disturb the network environment and intercept network secrets . The Apsara Stack platform solves the address spoofing problem by using the underlying network technology on the physical server.

The Apsara Stack platform isolates the abnormal protocol access initiated by a server to external targets on the data link layer of the physical server, blocks the MAC/ARP spoofing of the server, and avoids IP spoofing of the server on the network layer of the host.

Apsara Stack Security - Traffic Security Monitoring

Traffic Security Monitoring module is a millisecond(ms)-level attack monitoring product that is developed independently by Alibaba Cloud security team. With an in-depth analysis of incoming image traffic packages in the Apsara Stack environment, this module can detect various attacks and abnormal behaviors in real time.

For more information about the Traffic Security Monitoring module, see [Features > Apsara Stack Security Standard Edition > Traffic Security Monitoring in Apsara Stack Security Technical Whitepaper](#) .

4.2.4.2 Network device security

Account security

Reinforces the storage encryption of the account password policies and password configuration files for network devices.

- Provides network devices with read-only accounts that can only view configurations to separate the reading configuration accounts from changing configuration accounts.
- Uses the centralized control policy to manage accounts in a unified manner.
- Uses multi-factor authentication to guarantee the account security for network devices.

Services

Disables services on network devices to reduce attack surface of the network devices and disables features uncorrelated to the network devices.

Log centralization

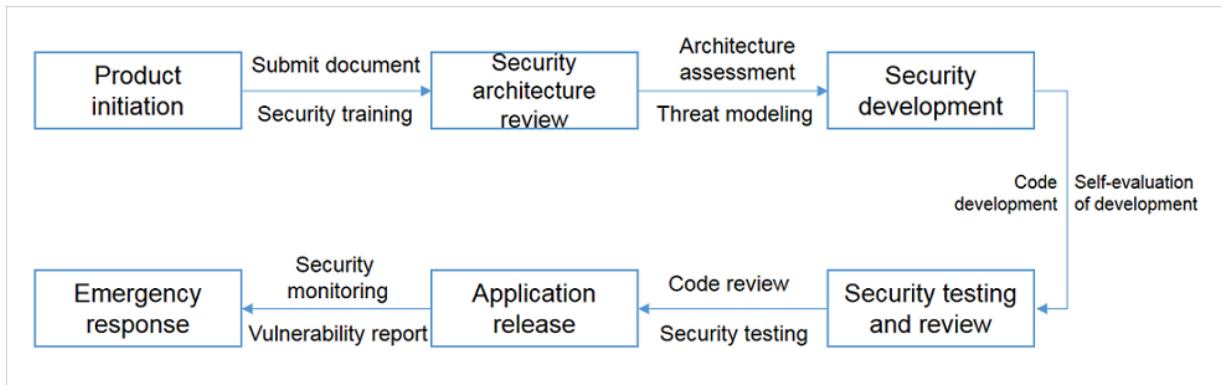
Collects and manages logs generated by network devices in a centralized manner.

4.2.5 Application security

4.2.5.1 Secure Product Lifecycle (SPLC)

Secure Product Lifecycle (SPLC) is tailored by Alibaba Cloud for cloud products , which aims to integrate security into the entire product development lifecycle. With SPLC, a complete security review module is implemented at each node from product architecture review, development, test review, to emergency response. This makes sure that the product security performance can meet the strict cloud security requirements, effectively improves security capabilities of cloud products, and reduces security risks.

The entire SPLC of a cloud product can be divided into the following six phases: product initiation, security architecture review, security development, security testing and review, application release, and emergency response.



- **In the product initiation phase, the security architect works together with the product team to establish a functional requirements document (FRD) and a detailed architecture diagram based on the business contents, business process, and technical frameworks. This also extracts the *Security Baseline Requirements* that is applicable to the product scope from all the security baseline requirements for the this Apsara Stack product. In this phase, specific security training courses and exams are also arranged for the product team members to avoid obvious security risks in subsequent product development.**

- In the security architecture review phase, the security architect evaluates the security architecture of products and creates threat models of the products based on the FRD and architecture diagram established in the preceding phase. In the process of threat modeling, the security architect creates detailed models for every asset that requires protection, security requirements of assets, and scenarios where attacks may occur, and then proposes corresponding security solutions. The security architect then works with the product team to determine all the *Security Requirements* for the products, based on the preceding *Security Baseline Requirements* and the security solutions proposed during threat modeling.
- In the security development phase, the product team must abide by the secure coding standards in product development in accordance with the *Security Requirements* and achieve relevant security features and requirements of the products. To guarantee a rapid and continuous development, release, and deployment of cloud products, the product team carries out self-evaluation in this phase to confirm that the *Security Requirements* is implemented. Then, the team provides the security engineer who is responsible for testing with corresponding test information, such as the code implementation address and self-testing result report, to prepare for the security testing and review in the next phase.
- In the security testing and review phase, the security engineer implements comprehensive security reviews on the architecture design and server environment of the products according to their *Security Requirements*. The engineer also performs code review and penetration testing on the products. The product team must fix and reinforce products with security problems found in this phase.
- In the application release phase, only products that pass the security review and get the security approval can be deployed in the production environment by using a standard release system. This prevents products with security vulnerabilities from running in the production environment.
- In the emergency response phase, the security emergency team constantly monitors possible security problems in the cloud platform. They also identify security vulnerabilities by using external channels such as ASRC or internal channels, such as internal scanners and self-testing on security. If a security vulnerability is detected, the emergency team quickly rates it, determines its priority, and schedules it for fixing. The team allocates resources appropriately to quickly fix vulnerabilities. This guarantees the security of Alibaba Cloud and its users.

4.2.5.2 Web Application Firewall (on the platform side)

The Apsara Stack platform uses Web Application Firewall (WAF) to protect the security of platform applications. WAF blocks and intercepts OWASP Top 10 attacks , including Structured Query Language (SQL) injection, cross-site scripting (XSS) attack, and other attacks on Web applications to guarantee the security of platform applications.

For more information about the Web Application Firewall module, see [Features > Apsara Stack Security Standard Edition > Web Application Firewall in *Apsara Stack Security Technical Whitepaper*](#) .

4.2.6 Data security

4.2.6.1 Data security system

Alibaba Cloud develops its data security system comprehensively and systematically by taking management and technical measures based on the data security lifecycle. Data security is managed and controlled during the data lifecycle, from data production, data storage, data usage, data transmission, data distribution, to data destruction.

The Apsara Stack platform has corresponding security management systems and security technologies at each stage of data security lifecycle.

4.2.6.2 Data ownership

In July 2015, Alibaba Cloud initiated the first Data Protection Proposal among cloud computing service providers in China. This public proposal appeals that the ownership of data of developers, companies, governments, and social institutions on the cloud computing platforms all belongs to the users. The cloud computing platforms cannot use the data for other purposes. Platform providers have responsibility and obligation to help users protect the privacy, integrity, and availability of their data.

4.2.6.3 Multi-copy redundancy storage

Apsara Stack uses the distributed storage technology to divide a file into many data fragments, stores them on different devices, and creates multiple copies for each data fragment. Distributed storage improves data reliability and security.

4.2.6.4 Full-stack encryption

Apsara Stack provides full-stack encryption to guarantee the data security, namely sensitive data encryption in applications, transparent data encryption in ApsaraDB for RDS, block storage data encryption, object storage system encryption, hardware encryption modules, and network data transmission encryption. To encrypt sensitive data in applications, Apsara Stack uses encryption solutions in a hardware-trusted execution environment provided by the processor.

4.2.6.5 Residual data cleanup

After memories and disks that once stored user data are released and recycled, all the residual data on them are automatically cleared.

4.2.6.6 Operations data security

Without the permission of users, operations personnel cannot access unpublished data of users in any way.

Complying with the principle that production data stays within the production clusters, the Apsara Stack platform technically controls the channels where the production data flows out of the production clusters. This prevents the operations personnel from copying data from the production system.

4.2.7 Account system security

4.2.7.1 Overview

The Apsara Stack platform provides various security measures to help users protect their accounts and avoid operations of unauthorized users. These security measures include logon as a cloud account, RAM user creation, centralized management of RAM user permissions, data transmission encryption, and audit operation of RAM users. Users can use these measures to protect their cloud accounts.

4.2.7.2 Super administrator

The Apsara Stack platform has a default super administrator who can create system administrators and notify them of the default password by SMS or email. You must modify the password of your username as instructed when you log on to the Apsara Stack console for the first time. To improve security, the password must meet minimum complexity requirements, that is, 8 to 20 characters in length and

containing at least two types of the following characters: English uppercase or lowercase letters (A to Z or a to z), numbers (0 to 9), or special characters (such as exclamation marks (!), at signs (@), number signs (#), dollar signs (\$), and percent signs (%)).

4.2.7.3 Apsara Stack account

An Apsara Stack account is used to manage operations on the Apsara Stack platform and resources of cloud tenants.

An Apsara Stack account is the basic unit for the Apsara Stack resource ownership and the resource usage measurement. A user must register an Apsara Stack account before using Apsara Stack services. An Apsara Stack account has full permissions to all the resources it owns. By default, a resource can only be accessed by the Resource Owner. Other users must be explicitly authorized by the owner to access the resource, that is, the owner must grant the object to other users. Therefore, from the perspective of permission management, the Apsara Stack account is similar to the root or administrator account of an operating system. Sometimes the Apsara Stack account is called the root or primary account.

An authorized Apsara Stack account can have management permissions of the cloud resources or operations permissions of the cloud platform. The operations permissions of the cloud platform are managed by using OAM and the resource management permissions of the cloud tenants are managed by using RAM. RAM also supports the system of primary account and RAM users.

4.2.7.4 Identity credential

An identity credential is used to verify the real identity of a user. It usually refers to a user's logon password or AccessKey. Identity credentials are confidential, so users must keep their credentials secret.

- Logon username/password

Users can use the logon username and password to log on to the Apsara Stack console to apply for resources and perform operations on resources.

- AccessKey

Users can use the AccessKey to construct an API request (or use cloud service SDKs) to perform operations on resources.

4.2.7.5 RAM

Cloud tenants can use Resource Access Management (RAM) to build a system of primary account and RAM users.

RAM is an Apsara Stack service designed for user identity management and access control. You can use RAM to create and manage user accounts (such as employees, systems, and applications), and grant the accounts operation permissions to their resources. If multiple users collaboratively work with resources, RAM allows you to avoid sharing the password or AccessKey of your Apsara Stack account with other users. You can grant users the minimum permissions as required to reduce information security risks.

RAM user identity types

RAM supports two different user identity types: RAM-User and RAM-Role.

- **RAM-User**

A RAM-User is a physical identity with a fixed ID and authentication key. Generally, it corresponds to a specific person or application.

- **RAM-Role**

A RAM-Role is a virtual identity with a fixed ID, but no authentication key. A RAM-Role must be associated with one or more physical identities before it becomes available. For example, it can be associated with RAM-Users under the current or another Alibaba Cloud account, with Apsara Stack services such as Elastic Compute Service (ECS), and with external physical identities such as a local enterprise account.

Permissions

A permission is used to allow or deny a user's operation on a certain kind of resources.

Operations can be divided into two categories: resource control operations and resource use operations.

- **Resource control operations** are operations for lifecycle management and Operation and Maintenance (O&M) management of cloud resources, such as creating, pausing, and restarting Elastic Compute Service (ECS) instances, and creating, changing, and deleting Object Storage Service (OSS) buckets.

Resource control is generally oriented to resource owners or O&M personnel in an enterprise organization.

- Resource use operations are the use of the core functions of the resources, such as user operations in an ECS instance operating system, and uploads/downloads of OSS bucket data. Resource use is oriented to applications or R&D personnel in an enterprise organization.

For elastic computing and database products, resource control operations are managed by using RAM and resource use operations are managed in each product instance, such as the permission control of ECS instance operating system or MySQL database. For storage products, such as OSS and Table Store, resource control operations and resource use operations can be both managed by using RAM

.

Authorization policies

An authorization policy is a type of simple language specification that describes a permission set.

RAM supports two types of authorization policies: system access policies managed by the Apsara Stack platform and custom access policies managed by users. For system access policies managed by the Apsara Stack platform, users can only use and cannot change the policies, and the platform updates the policy versions automatically. For custom access policies managed by users, users can create and delete policies and maintain the policy versions by themselves.

RAM allows users to create and manage multiple authorization policies under an Apsara Stack account. Each authorization policy is essentially a set of permissions. The administrator can allocate one or more authorization policies to RAM users (namely RAM-User and RAM-Role). The RAM authorization policy language can convey the authorization meaning in details, which can grant permissions to a specified API-Action and Resource-ID and can also support multiple restrictions such as the source IP address and access time.

4.2.8 Operations security

4.2.8.1 Overview

Apsara Stack provides a set of centralized operations management system, the Apsara Stack Operations system, briefly called ASO. It enables various kinds of operations roles for Apsara Stack, including field operations engineer, user

operations engineer, cloud platform operations and management engineer, and operations security personnel or audit management personnel. ASO enables operations engineers to control the system operation status in time and perform corresponding operations actions.

4.2.8.2 OAM permission and authorization

Operation Administrator Manager (OAM) is a permission management platform for Apsara Stack Operations. OAM uses a simplified Role-Based Access Control (RBAC) model. Administrators can assign roles to operations personnel by using OAM. The operations personnel have different operation permissions to different operations systems based on their roles.

OAM permission model

In RBAC, the administrator does not directly grant system operation permissions to specific users, but creates a role set between the sets of users and permissions. Each role corresponds to a group of permissions. After being assigned a role, a user can have all permissions of that role. Therefore, when creating a user, you are only required to assign a role to the user, without granting specific permissions to the user. The change of role permission is less frequent than that of the user permission, which simplifies permission management and reduces system overhead.

OAM authorization system

The administrator grants permissions to operations personnel of different roles by configuring the following parameters:

- **Subject:** operators to the access control system. OAM subjects include users and groups.
- **User:** administrators and operators of the operations system.
- **Group:** a set of multiple users.
- **Role:** core of the RBAC system. Generally, a role can be considered as a set of permissions. A role can contain multiple RoleCells and/or roles.
- **RoleHierarchy:** In the OAM system, a role can contain other roles to form a RoleHierarchy.
- **RoleCell:** specific description about a permission. A RoleCell consists of resources, operation sets, and authorization options.

- **Resource:** description about authorization objects. For more information about resources on each operations platform, see the permission list of each operations platform.
- **ActionSet:** description about authorized actions. An ActionSet can contain multiple actions. For more information about actions on each operations platform, see the permission list of each operations platform.
- **WithGrantOption:** maximum number of authorizations in cascaded authorization, which is an integer greater than or equal to zero. If the value is not zero, the permission can be granted. If the value is zero, the permission cannot be granted.

For example, when administrator A grants a permission to administrator B, the WithGrantOption value is 5, indicating that the permission can be granted for five times at most. When administrator B grants the permission to administrator C, the WithGrantOption value can be up to 4. If WithGrantOption is set to 0 when administrator B grants the permission to operator D, operator D can only use the permission but cannot grant the permission to others.

4.2.8.3 Apsara Infrastructure Management Framework permission management (data center management)

Apsara Infrastructure Management Framework is an automatic data center management system that manages the hardware lifecycles and various static resources in the Apsara Stack data center, including programs, configurations, operating system images, and data.

Apsara Infrastructure Management Framework provides a set of universal version management, deployment, and hot upgrade solutions for the Apsara system and applications and services of various Apsara Stack products. Services based on Apsara Infrastructure Management Framework can realize automatic operations in a large-scale distributed environment, which makes the operations more efficient and the system more available.

Permission management

The permission management of Apsara Infrastructure Management Framework is based on the OAM system. The user permissions of Apsara Infrastructure Management Framework include the Admin permissions, Project permissions, and Service permissions:

- **Admin permissions:** Administrators can manage all pages on the Apsara Infrastructure Management Framework platform.
- **Project permissions:**
 - The administrator must grant users the Project permissions to view the project information in Operations > Project Operations on the Apsara Infrastructure Management Framework platform.
 - The administrator must grant users the Project permissions to view the cluster information and perform operations on the cluster in Operations > Cluster Operations on the Apsara Infrastructure Management Framework platform.
- **Service permissions:** The administrator must grant users the Service permissions to view the service information and perform operations on the service in Operations > Service Operations on the Apsara Infrastructure Management Framework platform.

4.3 Security operation service (on the platform side)

Apsara Stack Security provides multiple platform security operation services that are specified on the platform side of Apsara Stack.

Security inspection

Apsara Stack Security investigates and sorts lists of cloud platform services, including the number of physical machines and the version of each product. Apsara Stack Security also analyzes event logs of basic security products that are provided by the cloud platform and defends against the security risks of products.

Security evaluation and reinforcement

Apsara Stack Security evaluates the security of the cloud platform system, detects security risks of network, host, and application on the cloud platform, and then reinforces security against the detected risks.

Vulnerability fixing

Apsara Stack Security fixes security vulnerabilities, such as password and configuration problems detected during the cloud platform running process.

Security emergency response

If a security emergency such as an intrusion occurs, Apsara Stack Security responds to the emergency in time and analyzes the event cause.

4.4 Cloud user (tenant) security

4.4.1 Network security

4.4.1.1 Virtual Private Cloud

Virtual Private Cloud (VPC) helps users establish an isolated network environment based on Alibaba Cloud. It supports the customization of IP address range, Classless Inter-Domain Routing (CIDR) block, route table, and gateway. VPC can also be connected to a traditional data center by using leased lines or VPN to build a hybrid cloud.

Security isolation

By using the tunneling technology, VPC isolates networks to the same effect as the traditional VLAN. VPC isolates broadcast domains at the NIC level, thoroughly blocks network communication by VLAN isolation, and classifies different security domains for access control.

Access control

VPC supports flexible access control rules based on the security group firewall.

4.4.1.2 Distributed firewall

A security group is the distributed virtual firewall provided by Alibaba Cloud, which provides the status detection and packet filtering features.

A security group is a logical group that consists of instances in the same region with the same security requirements and mutual trust. Security groups are used to set network access control rules for one or more Elastic Compute Service (ECS) instances. As an important network security isolation measure, security groups are used to divide network security domains on the cloud.

Each instance must belong to at least one security group. Instances in the same security group can interwork by using networks. By default, instances in different security groups cannot interwork by using the intranet, but a certain source

security group or source Classless Inter-Domain Routing (CIDR) block can be authorized to access a target security group to implement the interworking.

4.4.1.3 Server Load Balancer

Server Load Balancer (SLB) is a load balancing service that distributes traffic among multiple Elastic Compute Service (ECS) instances. It can scale up the service capability of an application by distributing traffic and make the system more available by eliminating single points of failure.

4.4.1.4 Apsara Stack Security - Traffic Security Monitoring

Traffic Security Monitoring module is a millisecond(ms)-level attack monitoring product that is developed independently by Alibaba Cloud security team. With an in-depth analysis of incoming image traffic packages in the Apsara Stack environment, this module can detect various attacks and abnormal behaviors in real time. Then it reports the security events to the Apsara Stack Security center and combines with other protection modules to fully protect users' system. Traffic Security Monitoring module provides robust information and basic data support.

For more information about the Traffic Security Monitoring module, see [Features > Apsara Stack Security Standard Edition > Traffic Security Monitoring in Apsara Stack Security Technical Whitepaper](#) .

4.4.1.5 Apsara Stack Security - DDoS Traffic Scrubbing

DDoS Traffic Scrubbing module provides automatic detecting, scheduling, and scrubbing for DDoS attacks to implement attack detection, traffic traction, and traffic scrubbing within five seconds by combining with the Traffic Security Monitoring module of Apsara Stack Security. It guarantees the business network stability of cloud tenants. For the defense trigger condition, DDoS defense system not only relies on the thresholds for traffic, but also bases on the statistical judgement of network behaviors, which guarantees accurate recognition of DDoS attack and maintains users' business availability when being attacked by DDoS.

For more information about the DDoS Traffic Scrubbing module, see [Features > Optional Security Services > DDoS Traffic Scrubbing in Apsara Stack Security Technical Whitepaper](#) .

4.4.2 Host security

4.4.2.1 Operating system of ECS instances

Users have full control over the operating systems of their Elastic Compute Service (ECS) instances. Alibaba Cloud does not have any permission to access users' instances and operating systems on them. We recommend that users must access and operate ECS instances by using secure methods, such as using the SSH public/private key pair and protecting the private key well (a complex password must be used at least and it can be set upon creating instances), telnetting by using a safer SSHv2, and escalating the privilege temporarily by using sudo command.

4.4.2.2 Image reinforcement

An image is an environment template for running Elastic Compute Service (ECS) instances. It generally includes an operating system and preinstalled softwares. ECS tenants can use images to create ECS instances or change the system disks of ECS instances.

Security measures for Alibaba Cloud basic images (supporting various Linux/Windows release versions) include basic security configuration, vulnerability fixing, and adding host security software by default. Basic images are configured with best security practices for the hosts by default. Alibaba Cloud host security software is added to all Alibaba Cloud basic images by default to guarantee the security of instances upon start-up.

Alibaba Cloud uses the data check algorithm and one-way hash algorithm to guarantee image integrity and prevent the images from malicious tampering. After detecting a new high-risk vulnerability, users must promptly update their basic images. Users can also upgrade the operating system or fix vulnerabilities of their ECS instances autonomously.

4.4.2.3 Image snapshot

Elastic Compute Service (ECS) in the Apsara Stack platform provides snapshots and custom images. Snapshots can save the status of system data at a certain time point for data backup, which allows users to achieve disaster recovery quickly. Users can create custom images by using snapshots, which includes the whole operating system and data environment information of the snapshots in the images

. Snapshots are incremental and only the changed data is copied between two snapshots.

4.4.2.4 Apsara Stack Security - Server Guard

Apsara Stack Security Server Guard module provides security protection measures such as vulnerability management, baseline check, intrusion detection, and asset management for Elastic Compute Service (ECS) by means of log monitoring, file analysis, and feature scanning. The Server Guard module is divided into client side and server side. Server Guard client side works with server side to monitor attack behavior and vulnerability at the host system layer and application layer, which protects the host security in real time.

Vulnerability management

The vulnerability management provided by Server Guard for ECS incorporates multiple scanning engines (namely network side, local side, and PoC verification) to detect all vulnerabilities in the system at a time. Features such as one-click fixing, fixing command generation, and one-click batch verification are provided to implement closed-loop vulnerability management.

Baseline check

The baseline check provided by Server Guard can automatically detect the risk points of system, database, and account configuration for ECS and provide suggestions for fixing the risks correspondingly.

Intrusion detection

The intrusion detection provided by Server Guard includes remote logon reminder, identification of brute force attack behaviors, Webshell detection and removal, and host exception detection.

For more information about the Server Guard module, see [Features > Apsara Stack Security Standard Edition > Server Guard](#) in *Apsara Stack Security Technical Whitepaper* .

4.4.3 Application security

4.4.3.1 Code security

In the Secure Product Lifecycle (SPLC) of cloud products, Alibaba Cloud security experts strictly review and evaluate the code security on each development node to guarantee the code security for Alibaba Cloud products. We recommend that

enterprise users must perform black-box and white-box code security test for their online applications to prevent security vulnerabilities and improve the security robustness of their businesses.

4.4.3.2 Apsara Stack Security - Web Application Firewall

Web Application Firewall module is a security defense system for Web applications of cloud tenant. Based on the intelligent semantics analysis engine, WAF defends against common Web attacks such as SQL injection, XSS attack, common web server plugin vulnerabilities, trojan uploads, unauthorized access to core resources, and other common OWASP attacks. It filters out numbers of malicious access attempts to prevent the leakage of users' website assets and data, and safeguard website security and availability.

For more information about the Web Application Firewall module, see [Features > Apsara Stack Security Standard Edition > Web Application Firewall in Apsara Stack Security Technical Whitepaper](#) .

4.4.4 Data security

4.4.4.1 ApsaraDB

Tenant layer isolation

ApsaraDB in the Apsara Stack environment isolates tenants by using the virtualization technology, which allows each tenant to have independent database permissions. Alibaba Cloud also reinforces the security of the server on which databases run. For example, users cannot access system files by reading from or writing to databases, which makes sure that users cannot access data of other users .

Database accounts

After a user creates an ApsaraDB instance, the system does not create any initial database account for the user. The user must create a common database account in the console or by using APIs and configure database-level read/write permissions. If the user requires more fine-grained permission control, such as table/view/field-level permission control, the user can also create a super database account in the console or by using APIs, and use the database client and super database account to create a common database account. Then the user can use the super database

account to configure table-level read/write permissions for the common database account.

IP address whitelist

By default, ApsaraDB instances are set to be inaccessible from any IP addresses, that is, the IP address whitelist contains only 127.0.0.1. Users can add IP address whitelist rules by using the data security module in the console or APIs. An IP address whitelist rule can take effect without restarting ApsaraDB instances and does not affect the usage. Multiple groups can be configured in the IP address whitelist, and each group can contain up to 1,000 IP addresses or IP address segments.

VPC isolation

Users can perform advanced network access control by using Virtual Private Cloud (VPC) in ApsaraDB. VPC is a private network environment that the user sets in the cloud platform. It strictly isolates network packets by using underlying network protocols and controls access at layer 2 of the network. Users also can connect server resources of self-built data centers to the Alibaba Cloud platform by using VPN or leased lines, and solve possible IP resource conflicts by using the IP address segments of ApsaraDB instances defined by VPC. This allows self-owned servers and ECS instances to access ApsaraDB instances simultaneously.

VPC and IP address whitelist guarantees a securer ApsaraDB instance.

Data transfer encryption

ApsaraDB supports Secure Sockets Layer (SSL) protocol. Users can use root certificate on the server side to verify whether the target address and port database service are provided by ApsaraDB to avoid Man-in-the-Middle (MITM) attack. ApsaraDB also provides the implementation and renovation capability of SSL certificate on the server side to allow users to change SSL certificate as required, which guarantees the security and availability of the certificate.

Primary node and standby node

ApsaraDB adopts a high availability architecture with three nodes replica sets. Three data nodes locate in different physical servers and synchronize data automatically. Primary node and secondary node both provide service. When

primary node encounters fault, the system selects new primary node automatically . When the secondary node is unavailable, the standby node takes charge.

ApsaraDB also provides automatic backup feature that supports one-click data recovery to make sure that the data is integral and reliable.

4.4.4.2 MaxCompute

Authorization management

Project is the basis for implementing the multi-tenant architecture of MaxCompute in the Apsara Stack platform, and the basic unit for user data management and computing. After a project is created for a user, the user is the owner of the project . All objects such as tables, instances, resources, and UDFs in the project belong to the user. Unless authorized by the owner, no one can access objects in the project.

When the owner of a project decides to authorize another user, the owner must add the user to the project. Only users added to the project can be authorized.

A **role** is a collection of access permissions. A role can be used to assign the same permissions to a group of users. Role-based authorization greatly simplifies the authorization process and reduces the authorization management cost. Role-based authorization should be used preferentially when a user is authorized.

MaxCompute can assign different permissions to users or roles in a project based on four different objects, namely the project, table, function, and resource instance .

Cross-project resource sharing

If a user is the owner or administrator of a project, other users must apply for the permission to access resources of the project. If the applicant belongs to the project team of the owner, the owner is advised to use the user and authorization management function of the project. If the applicant does not belong to the project team of the owner, the owner can use the Package-based cross-project resource sharing function.

Package is used for sharing data and resources across projects, which implements the cross-project user authorization. After Package is used, the administrator of project A can perform packaging authorization on the objects to be used in project B, namely, creating a Package, and then permits project B to install the Package . After the administrator of project B installs the Package, the administrator can

determine whether to grant permissions of the Package to the users of project B as required.

Data protection

If a project contains highly sensitive data that cannot be shared with other projects , project protection can be used by setting ProjectProtection. Project protection explicitly requires that only inbound data is allowed in the project.

4.4.4.3 Sensitive Data Discovery and Protection of Apsara Stack Security

The Sensitive Data Discovery and Protection (SDDP) system makes full use of big data analysis capabilities and AI-related technologies of Alibaba to achieve classification based on business needs by using intelligent sensitive data identification. The dynamic and static desensitization, global circulation monitoring, and exception detection are implemented based on precise identification to achieve precise identification, precise detection, precise analysis, and effective protection, which meets visible, controllable, and compliant security protection requirements . This product supports MaxCompute, OSS, Table Store and other Alibaba Cloud big data products.

For more information about the SDDP module, see *Apsara Stack Security Technical Whitepaper* Features > Optional security services > SDDP.

4.4.5 Security management

4.4.5.1 Apsara Stack Security - Threat Detection Service

The Threat Detection Service (TDS) module is the big data security analysis system developed by Alibaba Cloud security team. It performs an in-depth analysis of host traffic and network traffic in the Apsara Stack environment by using machine learning and data modeling, and detect abnormal behaviors such as threat, attack , and access. From the attacker's perspective, it effectively captures vulnerability attacks and new virus attacks conducted by advanced attackers and displays ongoing security attacks to implement the visualization and awareness of business security.

Based on the Internet visualized technology, TDS also presents the result of big data threat analysis on a dashboard with a visual graph, which provides the entire

security information and supports the security decision-making of Apsara Stack platform for users.

For more information about the Threat Detection Service module, see [Features > Apsara Stack Security Standard Edition > Threat Detection Service in Apsara Stack Security Technical Whitepaper](#).

4.4.6 Security operation service (on the tenant side)

Alibaba Cloud provides cloud tenants with the security operation service to operate resources and management policies on the Apsara Stack platform, including configuration and hosting of security product, response of security event, accident tracking, security inspection, monitoring and scanning, and security process management. This service continuously guarantees the consecutive and secure operation of tenants' businesses.

4.4.7 Best security practices

We recommend that tenants must migrate previous security policies during the cloud migration and take the following best practices of security configuration offered by Alibaba Cloud as a reference to guarantee the security of their businesses:

- **Cloud resource security:** the security of cloud resources, which must be guaranteed by using Virtual Private Cloud (VPC).
- **Apsara Stack Security:** Apsara Stack Security is used to guarantee the security of tenants' businesses. The synchronization feature can synchronize the latest Apsara Stack Security rules in time. We recommend that users use Web Application Firewall (WAF) to protect Web applications.

- **Security configurations of cloud products:**
 - **Complex passwords must be set for Elastic Compute Service (ECS) instances to prevent intrusions by brute force cracking.**
 - **Secure Shell (SSH) and Remote Desktop Protocol (RDP) management ports must be restricted by using security groups.**
 - **If high-risk ports are enabled on ECS instances, the IP address whitelist must be configured for access control.**
 - **Server Load Balancer (SLB) instances are prohibited to enable access of SSH, RDP, MySQL, Redis, and other high-risk port services to the Internet.**
 - **High-intensity passwords must be set for RDS instances, and the IP address whitelist must be configured for access control.**
 - **The access to Object Storage Service (OSS) instances must be restricted by using access control rules, and public read/write operations are disabled.**
- **Application deployment security: The compressed packages, .svn hidden directories, and .git hidden directories must be deleted before code deployment. Security of Linux, Windows, and other operating systems must be reinforced. We recommend that users use WAF to protect Web applications.**

5 Security of Apsara Stack products

5.1 Elastic Compute Service (ECS)

5.1.1 Platform security

5.1.1.1 Security isolation

Instance security isolation includes the following aspects:

CPU isolation

ECS supports the KVM hypervisor. Using VT-x virtualization, the hypervisor runs in vmx root mode while ECS instances run in vmx non-root mode. Hardware isolation prevents ECS instances from accessing the privileged resources of other instances.

Memory isolation

The hypervisor isolates memory on the virtualization layer. When ECS instances are running, extended page tables (EPT) ensure that ECS instances cannot access the memory resources of other instances.

After an ECS instance is released, all of its memory is cleared by the hypervisor to prevent other ECS instances from accessing the physical memory released by this ECS instance.

Storage isolation

On the virtualization layer, the hypervisor uses a device driver model to achieve I/O virtualization. ECS instances cannot directly access physical disks, and all I/O operations are intercepted and processed by the hypervisor. The hypervisor ensures that ECS instances can only access the allocated virtual disk space, thus realizing the security isolation of disk space between different ECS instances.

Network isolation

ECS uses Virtual Switches (VSwitches). Messages destined for an ECS instance are only sent to the VSwitch port corresponding to the virtual network interface of the ECS instance.

ECS instances, even those running in hybrid mode, are not able to receive or intercept messages intended for other ECS instances. Even if you set the network interface to the hybrid mode, the hypervisor does not transmit any traffic destined for an instance to any other instances.

Alibaba Cloud further uses Virtual Private Networks (VPCs) and security groups to isolate networks.

A security group is an additional security barrier for ECS instances provided by Alibaba Cloud. It implements a distributed virtual firewall with stateful packet inspection. A security group is independent of the operating system firewalls on the ECS instances within the group. The security group provides additional protection from outside of ECS instances. Security groups allow you to implement isolated security domains by configuring inbound or outbound policies for a single IP address or port.

A security group is a logical group that consists of a group of instances in the same region that share security requirements and have mutual access permissions. Security groups are used for network access control for one or more ECS instances and allow you to divide a cloud into separate security domains.

With the preceding isolation measures, even if two instances owned by the same user run on the same physical server, the two instances are unable to intercept each other's traffic.

In addition, we recommend that you encrypt data before saving it to ECS instance disks with either an encrypted file system or disk encryption. For more information, see [ECS disk encryption](#).

5.1.1.2 Authentication

5.1.1.2.1 Identity authentication

Account authentication verifies the identity credentials of a user. An identity credential usually refers to a logon password or AccessKey (AK). You can create AccessKey pairs in Apsara Stack console. An AccessKey pair is composed of an AccessKey ID and an AccessKey Secret. The AccessKey ID is a public key that is used to identify a user. The AccessKey Secret is the key used to encrypt signature strings and verify those signature strings on the server. The AccessKey Secret is used to authenticate a user's identity and must be kept confidential.

ECS authenticates each request with its included signature information for both HTTP and HTTPS requests. ECS uses AccessKey pairs to implement symmetric encryption and authenticate the identity of a request sender.

AccessKey pairs are issued by Alibaba Cloud to users and can be applied for and managed through the official Alibaba Cloud website. The AccessKey ID acts as a unique identifier for a user, while the AccessKey Secret is used to encrypt and verify signature strings. AccessKey Secrets must be kept confidential.

5.1.1.2.2 Access control

Resource Access Management (RAM) is a centralized user management and resource access control service provided by Alibaba Cloud. Using RAM, you can create independent user accounts for your employees, systems, or applications and control their access to cloud resources. Each RAM user can log on to Apsara Stack console or call service APIs by using an independent logon password or AccessKey. By default, a newly created RAM user does not have any permissions on resources. Only an authorized RAM user can operate resources on behalf of the corresponding Apsara Stack tenant account.

With RAM, you can avoid sharing your AccessKey with other users and assign minimum permissions to different users, thus reducing security risks to the data of your enterprise. An Apsara Stack tenant account can have multiple RAM users. RAM provides features such as multi-factor authentication (MFA), strong password policies, isolation of console users from API users, custom fine-grained authorization policies, group-based authorization, temporary authorization credentials, and temporary account disabling. RAM authorization can address an API action or resource ID. You can specify limits, such as source IP address, secure access channel SSL/TLS, access time period, or MFA.

We strongly recommend that you ensure that the operating systems of ECS instances are only accessed in a secure manner. Some steps to ensure access security include keeping the private key confidential when using SSH key pairs, setting complex logon passwords when creating instances, using SSHv2 for remote logon, and using the sudo commands to temporarily escalate permissions.

ECS users can create RAM users and different groups to manage and control resource access permissions.

RAM helps you manage resource access permissions. For example, you can enhance network security by assigning an authorization policy to a group. If the original IP address of an access request is not from an intranet address specified in the policy, the access request is rejected.

You can assign different permissions to different groups to manage ECS resources:

- **SysAdmins:** This group needs permissions to create and manage ECS images , instances, snapshots, and security groups. You can assign to this group an authorization policy, which permits the group members to perform all ECS operations.
- **Developers:** This group only needs permissions to use ECS instances. You can assign to this group an authorization policy, which permits the group members to call `DescribeInstances`, `StartInstance`, `StopInstance`, `CreateInstance` , `DeleteInstance`, and other APIs.

If a developer becomes a system administrator and needs higher permissions, they can be easily moved from the Developers group into the SysAdmins group.

ECS can also provide the functions of a RAM user to an instance by using STS. The instance RAM role function enables ECS instances to play certain roles with certain access permissions.

The instance RAM role function allows you to associate a RAM role with an ECS instance, so that the ECS instance can access other cloud services by using the STS temporary credential from the instance. The temporary credential is updated periodically. In this way, AccessKey security is ensured and fine-grained permission control is implemented based on RAM.

5.1.1.3 Data security

5.1.1.3.1 Overview

Key Management Service (KMS) provides key management and encryption mechanisms for the storage of encrypted data necessary on the cloud platform. The encrypted data includes authorization credentials, passwords, and keys.

5.1.1.3.2 Triplicate storage technology

When ECS users read or write data from or to virtual disks, the operations are translated into reads or writes from or to the files stored in the Apsara Stack data system. Apsara Stack uses a flat design in which a linear address space is divided

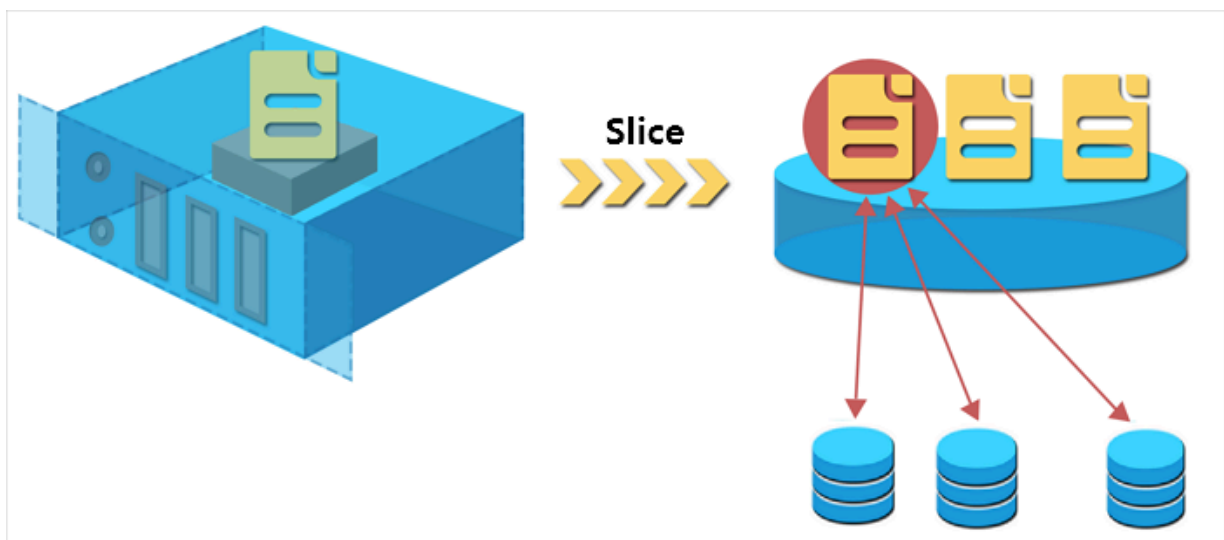
into slices, also called chunks. For each chunk, three replicas are created and stored on different nodes in the cluster to ensure the reliability of data.

Triplicate technology involves three key components: master, chunk server, and client. The write operation of an ECS user goes through several conversions, as shown in the following procedure:

1. The client determines the chunk corresponding to the write operation.
2. The client sends a request to the master to query the chunk servers on which to store the three chunk replicas.
3. The client sends a write request to the three corresponding chunk servers based on the results returned from the master.
4. If the write operation succeeds on all three chunk replicas, the client returns a success message to the user. Otherwise, the client returns a failure message.

The call distribution policy of the master takes into account the disk usage of all chunk servers in the cluster, the chunk server distribution on different switch racks, power supply, and machine load. The policy ensures that the three replicas of each chunk are distributed across different chunk servers on different switch racks. This effectively avoids data unavailability caused by the failure of chunk servers or racks where data is stored.

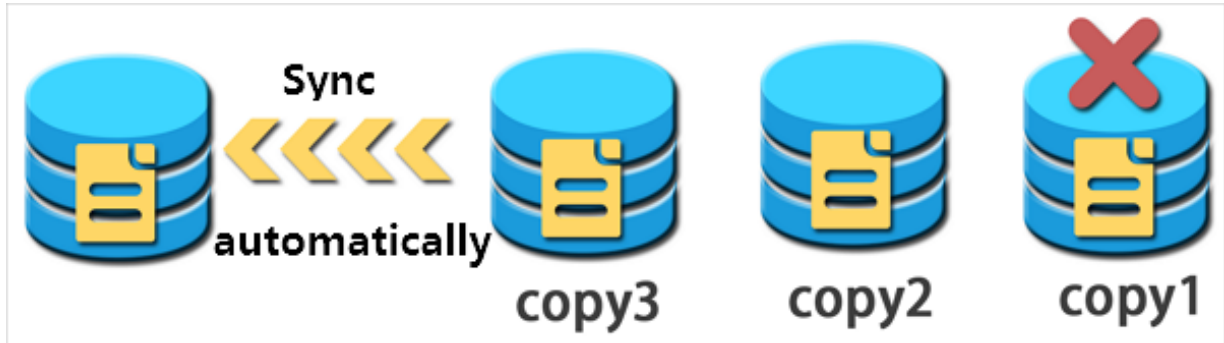
Figure 5-1: Triplicate backup



When a data node is damaged or disk faults occur on a data node, the total number of valid replicas of some chunks in a cluster becomes less than three. In such cases,

the master replicates data between chunk servers to ensure that each chunk in the cluster has three valid replicas.

Figure 5-2: Automatic replication



To summarize, all your (add, modify, and delete) operations on cloud disk data are synchronized to the three chunk copies at the bottom layer. This approach ensures that user data stays reliable and consistent.

When data is deleted, Apsara Distributed File System reclaims the released storage space and makes it inaccessible to any users. Data in this storage space is erased completely before it is made available for other users. This procedure ensures that user data remains secure and confidential.

5.1.1.3.3 ECS disk encryption

ECS disk encryption is a simple and secure encryption method that can be used to encrypt new cloud disks.

With ECS disk encryption, there is no need to create or maintain your own key management infrastructure, change existing applications and maintenance procedures, or add additional encryption operations. Disk encryption does not have any negative impact on your business processes. After an encrypted ECS disk is created and attached to an ECS instance, the following types of data can be encrypted:

- Data on the cloud disk.
- Data transmitted between the cloud disk and instance. Data in the instance operating system is not encrypted again.
- All snapshots created from the encrypted cloud disk. These snapshots are called encrypted snapshots.

The data transmitted from the ECS instance to the cloud disk is encrypted on the host where the ECS instance resides.

Disk encryption is supported on all available cloud disks (basic cloud disks, ultra cloud disks, and SSD cloud disks) and shared block storage (ultra and SSD) for all Apsara Stack instances.

5.1.1.4 Encrypted transmission

Alibaba Cloud provides HTTPS encryption to ensure the security of data transmissions. If you operate data from Apsara Stack console, the console uses HTTPS for encrypted data transmission. All Alibaba Cloud services provide HTTPS-enabled APIs. Users can use AccessKey pairs to call Apsara Stack service APIs. To meet the needs of secure encrypted data transmission, Apsara Stack services use the standard SSL/TLS protocol with support for keys up to 256 bits in length.

5.1.1.5 ARP spoofing prevention

ARP spoofing severely challenges traditional networks. Hackers can use ARP spoofing to imitate the routing address of another user and intercept confidential data.

To prevent ARP spoofing, Alibaba Cloud provides an ARP firewall at the Network Egress. Only MAC addresses that are allocated by the platform are authorized for communication.

5.1.2 Tenant security

5.1.2.1 Log audit

User authentication credentials and permission control are designed to avoid security issues. Security logs can help Alibaba Cloud users better understand and diagnose a variety of security situations. Alibaba Cloud provides centralized security log management for cloud resources operations. The logon and resource access operations of each account are logged, providing information about the operator, operation time, source IP address, resource object, operation name, and operation status. With all operation records saved, users can perform security analysis, intrusion detection, resource change tracking, and compliance audit. In a compliance audit, users may need to provide detailed operation records of the Apsara Stack tenant accounts and RAM users.

5.1.2.2 Secure images

Apsara Stack images integrate patches for all known high-risk vulnerabilities to prevent the host from being exposed to high risks after going online. After detecting a new high-risk vulnerability, Alibaba Cloud promptly updates images and delivers the updated images to customers. Besides, Alibaba Cloud also ensures image integrity and avoid malicious tempering by using a data verification algorithm.

Users can quickly upgrade their basic images after new high-risk vulnerabilities are detected. Moreover, users can upgrade the operating system or fix vulnerabilities of their ECS instances by themselves.

Alibaba Cloud strongly recommends that users employ Apsara Stack basic images as the first step to implement cloud migration without affecting business deployment.

5.1.2.3 Block storage

Block Storage is a low-latency, persistent, and high-reliability random block-level data storage service provided by Alibaba Cloud for ECS instances. Block storage automatically replicates data within a zone to prevent unavailability caused by unexpected hardware faults and to protect your business. Just like a physical hard disk, you can format block storage attached to an ECS instance, create a file system, and persistently store data there.

Block Storage automatically encrypts block storage devices used inside of virtual machines to ensure data is secure and stored in a distributed system.

5.2 Auto Scaling (ESS)

5.2.1 Platform security

5.2.1.1 Security isolation

ESS implements user account-based isolation. You can manage the scaling groups, configurations, and rules in your account, such as performing create, modify, and delete operations. ESS can only use ECS instances in your account for automatic scaling. ESS performs symmetric encryption by using AccessKeys to authenticate

users who operate ECS instances. It authenticates each access request to ensure security isolation.

5.2.1.2 Authentication

5.2.1.2.1 Authentication

You can create an AccessKey pair in the Apsara Stack console. An AccessKey pair is composed of an AccessKey ID and an AccessKey secret. The AccessKey ID is a public key that is used to identify a user. The AccessKey secret is the key used to encrypt signature strings and verify those signature strings on the server. The AccessKey secret is used to authenticate a user's identity and must be kept confidential.

Auto Scaling authenticates each access request. Therefore, each request must contain signature information, regardless of whether it is sent through HTTP or HTTPS. Auto Scaling uses AccessKey pairs to implement symmetric encryption and authenticate the identity of a request sender.

The AccessKey ID and AccessKey secret are officially issued by Alibaba Cloud to users. You can request and manage them on the Alibaba Cloud official website. The AccessKey ID indicates the identity of a user. The AccessKey secret is the key used to encrypt the signature string and verify the signature string on the server. The AccessKey secret must be kept confidential.

5.2.1.2.2 Access control

Resource Access Management (RAM) is a service that Alibaba Cloud provides to you to manage user identities and to control resource access. You can use RAM to create and manage user accounts, such as employee accounts, system accounts, and application accounts. You can also manage the operation permissions that these user accounts have on resources of your account. If multiple users in your enterprise operate resources collaboratively, RAM allows you to grant permissions to other users without sharing the AccessKey pair of your Apsara Stack tenant account with other users. Instead, you can grant users the minimum permissions necessary for them to complete their work. Thus, security risks to your enterprise information are reduced.

RAM allows you to create different roles and assign different permissions on cloud services to each role. Auto Scaling allows you to configure the `RamRoleName` parameter. You can configure this parameter to assign different roles to your

ECS instances, allowing different instances to have permissions on different cloud services. Before configuring the `RamRoleName` parameter in Auto Scaling, you must ensure that the current RAM permission policy allows your ECS instance to act as the specified role. Otherwise, the scaling configuration cannot make the ECS instance available.

5.2.2 Tenant security

5.2.2.1 Log audit

ESS generates scaling activity logs which record information about each scaling activity, such as activity ID, status, status information, start time, end time, reason for an activity, and detail.

The status of a scaling activity are rejected, in progress, successful, warning, and failed. Status information includes the status details. Reason for an activity includes the results of scaling activities executed in a scaling group. Detail includes information about instances involved in a scaling activity.

5.3 Object Storage Service (OSS)

5.3.1 Platform security

5.3.1.1 Security isolation

OSS slices user data and discretely stores the sliced data in a distributed file system based on specific rules. The user data and its indexes are stored separately. OSS users are authenticated using symmetric AccessKeys. The signature in each HTTP request is verified. If verification is successful, OSS reassembles the distributed data. This implements data storage isolation between multiple tenants.

5.3.1.2 Authentication and access control

5.3.1.2.1 Authentication

You can create an AccessKey on Apsara Stack Management Console. An AccessKey consists of AccessKey ID and AccessKey Secret. AccessKey ID is public and used to identify a user. AccessKey Secret is private and used to authenticate a user.

Before a request is sent to OSS, a signature string must be generated in the format specified by OSS for the request. Then, the signature string is encrypted using AccessKey Secret and the HMAC algorithm, to form a verification code. The verification code carries a timestamp to prevent replay attacks. After receiving the request, OSS finds the corresponding AccessKey Secret using AccessKey ID and extracts the signature string and verification code using the same method. If the calculated verification code matches the one provided, the request is valid. Otherwise, OSS rejects the request and returns an HTTP 403 error.

5.3.1.2.2 ACL settings

Access to OSS resources is divided into access by the owner and access by third-party users. An owner owns a bucket, while third-party users are other users who access resources in the bucket. Access can be either anonymous or signature-based. If the access is initiated with an OSS request without any identification information, the access is considered to be an anonymous access. Based on the rules in the OSS API documentation, if the access is initiated with a request that contains signature information in its header or carried URL, the access is signature-based. OSS provides access control for buckets and objects.

Three kinds of bucket access permissions are available: public read/write, public read, and private.

- **Public read/write:** All users (including anonymous users) can perform write (Put, Get, and Delete) operations on objects in the bucket.
- **Public read:** Only the bucket creator can perform write (Put, Get, and Delete) operations on objects in the bucket. All users (including anonymous users) can perform read (Get) operations on objects in the bucket.
- **Private:** Only the bucket creator can perform read/write operations on objects in the bucket. The other users cannot access objects in the bucket.



Note:

When you create a new bucket without configuring bucket permissions, OSS automatically sets its access permission to private.

Four kinds of object access permissions are available: public read/write, public read, private, and default.

- **Public read/write:** All users can perform read/write operations on the object.

- **Public read:** Only the object owner can perform read/write operations on the object. Others can perform read operations on the object.
- **Private:** Only the object owner can perform read/write operations on the object. Others cannot access the object.
- **Default:** The object inherits the access permissions of the bucket.

**Note:**

If you do not configure any bucket permission when uploading an object, the object will use the default access permission set by the OSS.

5.3.1.2.3 Support for RAM and STS

OSS supports Resource Access Management (RAM) and Security Token Service (STS) authentication.

RAM is a resource access control service provided by Alibaba Cloud. RAM allows you to create sub-accounts under a primary account. All resources belong to the primary account. The primary account can grant access permissions on resources to sub-accounts.

Alibaba Cloud STS provides temporary access credentials and short-term access permission management. STS can generate a temporary access credential for users. The access permission and expiration date of the credential are user-defined. The access credential expires automatically upon the expiration date.

5.3.1.3 Data security

An error may occur when data is transferred between the client and server. OSS supports CRC and MD5 verification to secure data.

CRC

OSS can return the CRC64 value of objects uploaded through any of the methods provided. The client can compare the CRC64 value with the locally calculated value to verify data integrity.

OSS calculates the CRC64 value for newly uploaded objects and stores the result as metadata of the object. OSS then adds the `x-oss-hash-crc64ecma` header to the returned response header, indicating its CRC64 value. This CRC64 value is calculated based on [Standard ECMA-182](#).

MD5 verification

To check whether the object uploaded to OSS is consistent with the local file, attach the Content-MD5 field value to the upload request. The OSS server verifies the MD5 value. The upload can succeed only when the MD5 value of the object received by the OSS server is the same as the Content-MD5 field value. This method can ensure the consistency between objects.

5.3.1.4 Data encryption

5.3.1.4.1 Server-side encryption

OSS supports server-side encryption for the data uploaded by users. When you upload data, OSS encrypts the data using AES256 and permanently stores the encrypted data. When you download the data, OSS automatically decrypts the data, returns the original data to you, and declares in the header of the returned HTTP request that the data had been encrypted on the server.

When creating an object, you only need to add the HTTP header of x-oss-server-side-encryption to the Put Object request and set its value to AES256. Then, the object can be encrypted on the server side before it is stored.

5.3.1.4.2 Client-side encryption

OSS allows you to use client-side encryption to encrypt data before the data is sent to the remote server while the data encryption key (DEK) used is kept only on the local client. Other users cannot obtain the raw data without the DEK and Enveloped Data Key (EDK), even if the data is leaked. OSS uses functions in the SDK to encrypt the data locally before the data is uploaded to the OSS bucket.

5.3.2 Tenant security

5.3.2.1 Key management

Alibaba Cloud Key Management Service (KMS) is a secure and highly available service that integrates hardware and software to provide a key management system that can be extended to the cloud. KMS uses Customer Master Key (CMK) to encrypt OSS objects. It uses the KMS API to generate data encryption keys (DEKs) in a centralized manner, check key usage, and define policies to control key usage. You can use these keys to protect data in OSS buckets.

5.3.2.2 Log audit

OSS automatically saves access logs. After access logging is enabled for a source bucket, OSS generates an object that contains access logs for that bucket (by hour), names the object based on predefined naming rules, and writes the object into the bucket specified by the user. These logs are used for later auditing and behavior analysis. Request logs contain information such as the request time, source IP address, request object, return code, and processing duration.

5.3.2.3 Hotlink protection

To prevent your data in OSS from being leached, you can configure hotlink protection through the following parameters:

- **Referer Whitelist:** Only specified domain names are allowed to access OSS resources.
- **Allow Empty Referer:** If this parameter is disabled, a request is allowed to access OSS resources only if the request includes the Referer field configured in the HTTP or HTTPS header.

For example, for a bucket named oss-example, you can add `http://www.aliyun.com/` to the Referer whitelist. Then, requests with a Referer of `http://www.aliyun.com/` can access objects in this bucket.

5.4 Table Store

5.4.1 Platform security

5.4.1.1 Security isolation

Table Store uses a shared storage mechanism. This mechanism allows the instances of different users to share the same cluster resource. Table Store uses data partitions as the smallest unit and supports the load balancing mechanism at the data partition level to isolate the impact between different instances.

Network isolation

Table Store supports instance-level VPC access control. The following three types of VPC access settings are supported:

- **Allows arbitrary network access:** Access from the Internet and bound VPCs is allowed.

- **Allows specific VPC access: Only access from bound VPCs is allowed and access from unbound VPCs is denied.**
- **Allows specific console or VPC access: Only access from bound VPCs and the Table Store console is allowed and access from other sources is denied.**

Storage isolation

Table Store uses a shared storage mechanism. This mechanism allows the instances of different users to share the same cluster resource. Table Store uses data partitions as the smallest unit and supports the load balancing mechanism at the data partition level to isolate the impact between different instances.

5.4.1.2 Authentication

Identity authentication

Table Store authenticates requests based on AccessKey pairs. Each valid Table Store request must carry the correct AccessKey information. Table Store authenticates each request from applications to prevent unauthorized data access and ensure data security.

Access control

Table Store supports Security Token Service (STS) and enables users to control access of RAM users. STS is a temporary access credential service provided by Alibaba Cloud. It provides temporary access control. You can use STS to generate a temporary access credential. You can determine the permissions and validity period of the credential. The access credential expires automatically upon its expiration date.

Table Store supports access permissions for individual tables and operations.

5.4.1.3 Data security

Table Store uses Apsara Distributed File System that provides linear storage space. Linear address space is split into chunks. Three replicas are created for each chunk. Each replica is stored in a different node of the cluster to ensure data reliability.

In Table Store, data is serialized before it is written to disks for persistent storage. Each data block is written to one or multiple chunks.

Apsara Distributed File System evaluates the disk usage of all nodes, the distribution of these nodes on different racks, the power supply, and the host loads to ensure

that the chunk replicas are distributed to different hosts across different racks. This prevents host or rack faults from affecting service availability.

When a data node is damaged or encounters a disk fault, the number of valid replicas becomes less than three for some chunks in the cluster. If this occurs, Apsara Distributed File System starts the automatic replication process to replicate data among different service nodes. In this way, all chunks in the cluster have three valid replicas.

You are granted the write permission on Table Store only after the three replicas are written to the disks, ensuring that all partitions are equally distributed.

5.4.2 Tenant security

5.4.2.1 Key management

Alibaba Cloud Key Management Service (KMS) is a secure and highly available service. It integrates hardware and software to provide a key management system that can be extended to the cloud. KMS uses customer master keys (CMKs) to encrypt OSS objects and uses the KMS API to generate data encryption keys (DEKs) in a centralized manner. You can define policies in KMS to control and monitor key usage. You can use these keys to protect data in OSS buckets.

5.5 ApsaraDB for RDS

5.5.1 Platform security

5.5.1.1 Secure isolation

Tenant isolation

ApsaraDB for RDS uses virtualization technology to isolate tenants. Each tenant can maintain their own database permissions independently. Alibaba Cloud also implements increased security for servers that run databases to prevent other users from accessing your data. For example, databases cannot read or write system files.

5.5.1.2 Authentication

ApsaraDB for RDS secures data through authentication.

Identity authentication

Account authentication uses your logon password or AccessKey pair to verify your identity. You can create an AccessKey pair from Apsara Stack Management Console . An AccessKey pair consists of AccessKey ID and AccessKey Secret. AccessKey ID is a public key used for identification. AccessKey Secret is used to encrypt signature strings sent from the client and verify signature strings sent by the server. You must keep your AccessKey Secret confidential.

The ApsaraDB for RDS server authenticates the sender identity of each access request. Because of this, each request must contain signature information, regardless of whether it is sent using HTTP or HTTPS. ApsaraDB for RDS uses AccessKey ID and AccessKey Secret to implement symmetric-key encryption and authenticate the identity of a request sender. AccessKey pairs can be applied for and managed from the Apsara Stack. The AccessKey Secret will only be known to you, so it is necessary to take precautions to keep it confidential.

Permission control

ApsaraDB for RDS does not automatically create initial database accounts for a newly created instance. You can use the console or API to create a standard database account and configure database-level read and write permissions. To implement fine-grained permission control, such as table-level, view-level, or field-level permissions, you can use the console or API to create a master database account. You can then use the database client and master database account to create standard database accounts. A master database account can configure table-level read/write permissions for standard database accounts.

Access control

All ApsaraDB for RDS instances that are created by an Apsara Stack tenant account are managed as resources by that account. By default, an Apsara Stack tenant account is granted full operation permissions on all resources belonging to the account.

ApsaraDB for RDS supports Resource Access Management (RAM). You can use RAM to allow RAM users to access and manage RDS resources under your account.

ApsaraDB for RDS can also provide short-term access permissions with temporary credentials provided through STS.

5.5.1.3 Data security

ApsaraDB for RDS secures data through hot standby, data backups, and log backups.

High-availability ApsaraDB for RDS instances implement two database nodes for hot standby. When the primary node fails, the secondary node immediately takes over services. Database backups can be initiated anytime. To improve data traceability, ApsaraDB for RDS can restore data to any previous point in time based on the backup policy.

Automatic backup at regular intervals is required to guarantee the integrity, reliability, and restorability of databases. ApsaraDB for RDS provides two backup functions: data backup and log backup.

5.5.1.4 Data encryption

SSL

ApsaraDB for RDS provides Secure Sockets Layer (SSL) for MySQL. You can prevent man-in-the-middle attacks by using the server root certificate to verify whether the destination database is an ApsaraDB for RDS instance. ApsaraDB for RDS also allows you to enable and update SSL certificates for servers to guarantee data security and validity.

Although ApsaraDB for RDS can encrypt the connection between an application and a database, SSL cannot run properly until the application authenticates the server. SSL consumes extra CPU resources, which affects the throughput and response time of instances. The severity of the impact depends on the number of user connections and the frequency of data transfers.

5.5.1.5 DDoS attack prevention

ApsaraDB for RDS prevents DDoS attacks by using the traffic scrubbing and black hole filtering features.

When you access an ApsaraDB for RDS instance from the Internet, the instance is vulnerable to DDoS attacks. When a DDoS attack is detected, the RDS security system first scrubs inbound traffic. If traffic scrubbing is insufficient or if the black hole threshold is reached, black hole filtering is triggered.

Triggering conditions for traffic scrubbing and black hole filtering are listed as follows:

- **Traffic scrubbing**

Traffic scrubbing only targets traffic from the Internet. Traffic is redirected from an IP address to the scrubbing device, which then checks whether the traffic is normal. Abnormal traffic is discarded and traffic to the server is limited by the scrubbing device to mitigate damage on the server. These operations may have an impact on normal traffic.

ApsaraDB for RDS triggers and stops traffic scrubbing automatically. Traffic scrubbing is triggered for a single ApsaraDB for RDS instance if any of the following conditions are met:

- Packets per second (PPS) reaches 30,000.
- Bits per second (BPS) reaches 180 Mbit/s.
- The number of new concurrent connections per second reaches 10,000.
- The number of active concurrent connections reaches 10,000.
- The number of inactive concurrent connections reaches 10,000.

- **Black hole filtering**

Black hole filtering only targets traffic from the Internet. If an RDS instance is undergoing black hole filtering, the instance cannot be accessed from the Internet and connected applications will not be available. Black hole filtering is triggered for a single ApsaraDB for RDS instance if any of the following conditions are met:

- BPS reaches 2 Gbit/s.
- Traffic scrubbing is ineffective.

Black hole filtering is automatically stopped 2.5 hours after being triggered. Then, the instance will undergo traffic scrubbing. If the DDoS attack is still occurring, black hole filtering is triggered again. Otherwise, the system restores the normal state.

5.5.2 Tenant security

5.5.2.1 Log audit

ApsaraDB for RDS can audit logs to identify security issues.

ApsaraDB for RDS allows you to view SQL transactions and periodically audit the SQL server to identify and resolve issues. RDS Proxy records all SQL statements sent to ApsaraDB for RDS, including the IP address, database name, user account used for execution, execution period, number of returned records, and execution time of each statement.

5.5.2.2 IP address whitelist

ApsaraDB for RDS uses the IP address whitelist to prevent access from invalid IP addresses.

ApsaraDB for RDS instances can be accessed from any IP address by default. Because of this, the IP address whitelist contains only the entry 0.0.0.0/0. You can add IP address whitelist rules through the data security module in the console or by calling an API. The IP address can be updated without restarting the ApsaraDB for RDS instance. Whitelist updates will not affect the normal operation of the instance. Multiple groups can be configured in the IP address whitelist. Each group can contain up to 1,000 IP addresses or IP address segments.

5.5.2.3 Software update

ApsaraDB for RDS supports post-restart update and mandatory update for software.

ApsaraDB for RDS automatically provides you with new versions of installed database software. In most cases, it is not required to update software immediately. Only when you manually restart an ApsaraDB for RDS instance does the system update the database software to the latest compatible version.

In rare cases such as critical bugs and security vulnerabilities, ApsaraDB for RDS will force the database to update during the maintenance period of the instance. Such mandatory updates only result in temporary database disconnections, and will not have any adverse impact on the application if the database connection pool is configured properly.

You can use the console or API to change the maintenance schedule to prevent a mandatory update from occurring during peak hours.

5.6 AnalyticDB for PostgreSQL

5.6.1 Platform security

5.6.1.1 Security isolation

Network isolation

In Apsara Stack, you can use IP address whitelists to control access. You can also use a VPC to control network access.

A VPC is a private network environment that you can set in Apsara Stack to strictly isolate network packets at the network layer by using network protocols and control access.

By default, AnalyticDB for PostgreSQL instances deployed within a VPC are only accessible from the ECS instances within the same VPC. You can also apply for a public IP address to receive access requests from the Internet (not recommended). The requests include but are not limited to:

- **Access requests from ECS EIPs.**
- **Access requests from the Internet egress of your on-premises IDC.**



Note:

The IP address whitelists apply to all connections to AnalyticDB for PostgreSQL instances. We recommend that you configure whitelists before applying for a public IP address.

Tenant isolation

AnalyticDB for PostgreSQL uses virtualization to isolate tenants and grants each tenant their own database permissions. Alibaba Cloud also hardens security for database servers. For example, to prevent other users from accessing your data, users cannot use a database to read or write operating system files.

5.6.1.2 Authentication

AnalyticDB for PostgreSQL instances created by your Apsara Stack tenant account are also owned by the account. Alibaba Cloud tenant accounts have full access permissions on their resources.

AnalyticDB for PostgreSQL supports Resource Access Management (RAM) and Security Token Service (STS). You can use RAM to grant access and management permissions on the AnalyticDB for PostgreSQL resources of your account to other

RAM users. You can use STS to issue temporary access credentials to RAM users for short-term access to resources.

5.6.1.3 Primary and secondary nodes

Each AnalyticDB for PostgreSQL instance consists of two components: the coordinator node and the compute node. Each node adopts a primary/secondary architecture. If the primary node fails, the service is quickly switched to the secondary node. You can back up databases at any time. AnalyticDB for PostgreSQL can restore data from backup sets based on backup policies to improve data traceability.

5.6.2 Tenant security

5.6.2.1 Database account

After you create an instance, you can create a superuser account in the console or by using an API operation. You can execute the `GRANT` statement to authorize other database accounts.

5.6.2.2 IP address whitelist

AnalyticDB for PostgreSQL instances cannot be accessed from any IP addresses by default. The default whitelist contains `127.0.0.1`. You can add IP addresses to a whitelist on the Security Controls page of the console or by using an API operation. Updating the IP address whitelist does not require an instance to restart nor affect operations on the instance. You can configure multiple IP address whitelists. Each whitelist can contain up to 1,000 IP addresses or CIDR block entries.

5.6.2.3 SQL audit

AnalyticDB for PostgreSQL allows you to view SQL details. You can audit SQL operations on a regular basis to locate problems in a timely manner. The Proxy module records the information of all SQL statements executed in AnalyticDB for PostgreSQL, including the IP address, the name of the accessed database, the account that executed the statement, the SQL statement, the execution duration, the number of returned records, and the execution time point.

5.6.2.4 Backup and restoration

To ensure data integrity and reliability, a database must automatically back up data on a regular basis to ensure that data can be restored. AnalyticDB for PostgreSQL allows you to restore instances from backup sets.

5.6.2.5 Software update

- New versions of database software are provided by AnalyticDB for PostgreSQL on a regular basis.
- Software updates are optional and only implemented when you request them.
- If the current database version that you are using contains critical security risks, the AnalyticDB for PostgreSQL team will notify you and recommend that you schedule an update. The AnalyticDB for PostgreSQL team can provide full support throughout the update process.
- AnalyticDB for PostgreSQL updates are usually completed within five minutes. During updates, instances may be disconnected several times and will become read-only for about a minute. There is minimal interruption to services if the database reconnection settings or connection pool are properly configured for your applications.

5.7 KVStore for Redis

5.7.1 Platform security protections

5.7.1.1 Security isolation

Tenant isolation

KVStore for Redis uses the virtualization technology to isolate tenants. Each tenant can maintain independent database permissions. Alibaba Cloud also increases security protections for the servers that run databases. For example, you cannot read from or write to system files by using the databases, so you cannot access other users' data.

Network isolation

In Apsara Stack, in addition to the whitelist, you can use Virtual Private Cloud (VPC) to restrict connections.

A VPC is a private network that you specify in Apsara Stack. The VPC strictly isolates your network packets based on network protocols and restricts connections at the network layer. You can use a virtual private network (VPN) or a leased line to connect server resources in your IDC to Alibaba Cloud, and use CIDR blocks in a VPC to prevent IP conflicts. In this way, your own servers and ECS instances can connect to KVStore for Redis instances at the same time. Protections based on the VPC and IP address whitelist improve the instance security.

By default, ECS instances in a VPC can only connect to KVStore for Redis instances in the same VPC. You can also request a public IP address to accept connections over a public network. We recommend that you do not use this connection method. The connection requests include but are not limited to:

- Those from ECS Elastic IP addresses (EIPs).
- Those from the public IP addresses in your own IDC.

**Notice:**

The IP whitelist is applicable to all types of connections to KVStore for Redis instances. We recommend that you set the whitelist before requesting the public IP address.

5.7.1.2 Authentication

The instances that you create by using your Alibaba Cloud account are the resources under this account. By default, the Alibaba Cloud account is granted full operation permissions on all the resources under the account.

KVStore for Redis supports Resource Access Management (RAM) and Security Token Service (STS) services. By using RAM, you can create and manage RAM users. You can grant access and management permissions on KVStore for Redis resources under your Alibaba Cloud account to the RAM users. By using STS, you can manage short-term permissions granted to RAM users. You can use STS to grant permissions to temporary users.

5.7.1.3 Transmission encryption

KVStore for Redis provides secure encryption based on the Secure Sockets Layer (SSL) and Transport Layer Security (TLS) protocols. You can use the server root certificate from KVStore for Redis to verify that KVStore for Redis provides database services based on the target IP address and port. This can effectively

prevent man-in-the-middle attacks (MITM). Also, KVStore for Redis allows you to enable and update SSL and TLS certificates for servers. Therefore, you can replace the SSL or TLS certificate to ensure security and validity.



Note:

- To use the transmission encryption feature, you must enable server verification in your application.
- Transmission encryption consumes extra CPU resources and affects the throughput and response time of KVStore for Redis instances. The performance depends on the number of connections and the data transfer frequency.

5.7.2 Tenant security protections

5.7.2.1 Database account

To connect to KVStore for Redis, you must pass password authentication. The password is the access credential. KVStore for Redis optimizes the performance of transient connections. Therefore, when you enable password authentication, the performance of KVStore for Redis instances is not affected.

5.7.2.2 IP address whitelist

KVStore for Redis allows you to use an IP address whitelist to restrict connections and secure your data. You can set an IP address whitelist for each KVStore for Redis instance.

By default, KVStore for Redis instances block connections from all IP addresses or CIDR blocks. In this case, the IP address whitelist is set to 127.0.0.1. To add an IP address or CIDR block to the whitelist, in the KVStore for Redis console, choose Instance Information > Change Whitelist. After you modify the IP address whitelist, you do not need to restart the instance, so you can still run the instance normally. You can specify multiple IP address groups for a whitelist. Each group contains a maximum of 1,000 IP addresses or CIDR blocks.

5.7.2.3 Backup and recovery

Databases require regular automatic backups to guarantee data integrity, reliability, and restorability. KVStore for Redis supports instance recovery based on backup sets.

5.7.2.4 Software upgrade

- **KVStore for Redis regularly provides database upgrades.**
- **The upgrades are not mandatory. Databases upgrade to the specified version only when you request.**
- **When the KVStore for Redis team determines that your version has major security risks, KVStore for Redis notifies you to enable the upgrade. The KVStore for Redis team supports the whole upgrade process.**
- **KVStore for Redis completes the upgrade within five minutes. During the upgrade, temporary disconnections may occur, and the instance may stay in read-only status for one minute. If you have correctly configured the database reconnection or connection pool for your application, the upgrade does not affect your application.**

5.8 Data Transmission Service (DTS)

5.8.1 Platform security

5.8.1.1 Security isolation

DTS uses independent processes and files to isolate instances and data between tenants. For example, users are not allowed to read/write OS files of instances so that users cannot access data of other users.

5.8.1.2 Authentication

You can use your Alibaba Cloud account to create a DTS instance. The resources of the DTS instance are owned by the Alibaba Cloud account. The account has full access permissions on its DTS resources by default.

DTS supports RAM for Alibaba Cloud. You can assign permissions to access and manage DTS resources to RAM users. RAM enables you to assign permissions as needed and helps enterprises minimize information security risks.

5.8.1.3 Transmission security

To enhance data transmission security, DTS-defined log formats are used.

In DTS, data is encrypted for secure transmission. For example, data is encrypted during incremental data synchronization between the data reading module and the data synchronization module.

DTS also supports HTTPS to effectively improve access security.

5.8.1.4 Data security

When you use DTS to synchronize or subscribe to incremental data, many pieces of incremental data are stored on the DTS server. The incremental data is serialized and stored based on the storage format defined in DTS. The DTS-defined storage format helps to enhance data security.



Note:

After data is written to the DTS server, it is stored for seven days and automatically deleted after this period of time expires.

5.9 Data Management (DMS)

5.9.1 Platform security

5.9.1.1 Security isolation

VPCs are isolated from each other, and are suitable for scenarios which require high security. Therefore, VPCs are used as the infrastructure for database instances .

DMS supports access to instances in VPCs. This ensures network security and data operation convenience.

5.9.1.2 Authentication

Authentication of Apsara Stack tenant accounts and database accounts

Before using DMS, you must log on to the Apsara Stack console or other Apsara Stack consoles with your Apsara Stack tenant account and password. If your login session expires, or if you switch to another account, you can no longer access DMS. You must use your Apsara Stack tenant account to log on to DMS again. You can use DMS only after you are logged on with your Apsara Stack tenant account.

Database account permission control

When you are logged on with your Apsara Stack tenant account and attempt to connect to a database through DMS, DMS will check the permissions of your account. To access resources within the database, you must be the owner of the database resources or be authorized to access the database.

5.9.1.3 Transmission security

HTTPS and SSL support

DMS supports HTTPS and SSL connections between user-side browsers and DMS servers, which prevents interception and data thefts during data transmission.

5.9.2 Tenant security

5.9.2.1 ActionTrail

Operation audit

DMS provides an audit function, which records operations such as user logon, logoff, SQL operations, table structure changes, table data changes, import, export, and operation results. Additionally, you can use the log audit function (Monitoring System) of Apsara Infrastructure Management Framework to query user operation logs. The logs record details such the access, operations, and SQL statements of a user in a specific instance.

5.10 Server Load Balancer (SLB)

5.10.1 Platform security

5.10.1.1 Authentication

SLB instances created using an Apsara Stack tenant account are owned by the account. By default, the tenant account has full permissions on these resources.

You can manage SLB instances by using RAM. You can authorize a RAM user to access and manage SLB resources owned by the tenant account. SLB also supports STS, which enables temporary access to SLB resources.

5.10.2 Tenant security

5.10.2.1 HTTPS

SLB supports HTTPS load balancing to forward HTTPS requests.

SLB supports HTTPS, SSL, and TLS load balancing:

- SLB provides centralized certificate and key management for services that require certificate authentication. This eliminates the need to deploy certificate management systems on individual ECS instances.
- All decryption operations are performed on SLB, reducing the CPU usage of backend ECS instances.

SLB provides centralized certificate management that allows you to store certificates and keys. All private keys uploaded to the certificate management system are encrypted.

5.10.2.2 IP address whitelists

SLB masks the IP addresses of backend servers and provides only the IP address of the SLB instance for external use.

SLB also provides the whitelist function. By adding a whitelist, you can control which IP addresses can access the SLB service.

5.10.2.3 Log management

Server Load Balancer (SLB) provides the log management feature that allows you to view the operation and health check logs of an SLB instance.

5.11 Virtual Private Cloud (VPC)

5.11.1 Platform security

5.11.1.1 Security isolation

VPCs are isolated through tunneling technology. The isolation effect between VPCs is the same as that of the traditional VLANs. Broadcast domain isolation can be achieved on ECS instances and NICs. VPCs, like VLANs, are isolated at the network layer. Meanwhile, VPCs divide different security domains for access control.

Each VPC is identified by a unique tunnel ID.

A unique tunnel ID is generated when tunnel encapsulation is performed on each data packet transmitted between the ECS instances within a VPC. Then, the data packet is transmitted over the physical network.

ECS instances in different VPCs cannot communicate with each other. They have different tunnel IDs and therefore are on different routing planes.

5.11.1.2 Access control

VPCs support RAM. RAM allows you to grant access and management permissions on your VPC resources to RAM users.

VPCs also support STS, which issues temporary credentials to grant temporary access permissions.

5.11.2 Tenant security

5.11.2.1 Security groups

VPCs divide network security domains by using security group rules as firewalls that perform stateful inspection (also known as dynamic packet filtering). This way, network access control at Layer 3 is implemented based on security groups.

VPCs are isolated by default and can be connected to each other through router interfaces.

5.12 Apsara Stack DNS

5.12.1 Tenant security

5.12.1.1 Tenant isolation

Apsara Stack DNS isolates data by tenant. After receiving a DNS request, Apsara Stack DNS determines whether the request is authorized based on the AccessKey pair contained in the request. If it is, Apsara Stack DNS processes the data. Tunnel IDs are used to associate VPCs with zones. The backend DNS server responds to the users' DNS requests based on tunnel IDs. This helps isolate data among tenants.

5.12.1.2 Network security hardening

Apsara Stack DNS provides recursive resolution. To protect against potential security risks from the Internet, Apsara Stack DNS reinforces the security of

domain name resolution. Specifically, only outbound traffic is allowed, and all inbound traffic from the Internet is discarded.

5.12.1.3 Log audit

Log audit is an essential step to ensure security. Apsara Stack DNS provides you with detailed log information. All operations are logged in real time. If a security breach occurs, you can query log entries to trace the activities of the attacker and analyze the security breach.

5.13 MaxCompute

5.13.1 Platform security

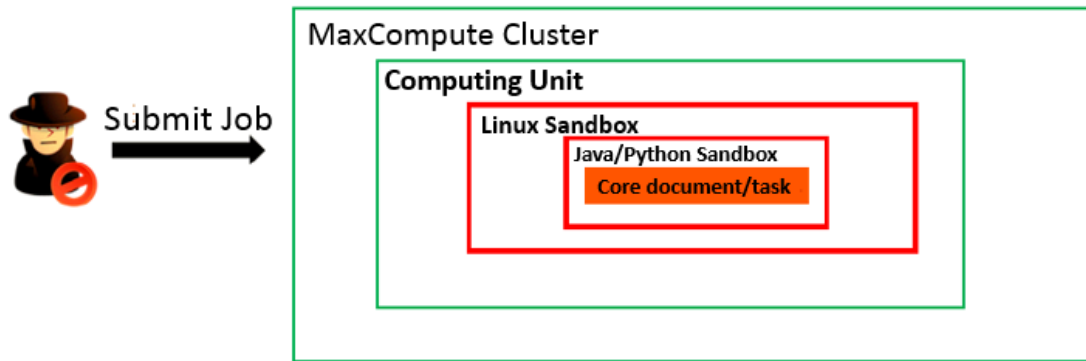
5.13.1.1 Security isolation

MaxCompute is designed to handle security issues in multi-tenant scenarios. It uses the Alibaba Cloud account authentication system, which authenticates users based on symmetric AccessKey pairs. It also verifies the signature information in each HTTP request. MaxCompute stores user data separately in Apsara Distributed File System to achieve data isolation between users. This allows MaxCompute to meet the requirements for multi-user collaboration, data sharing, data confidentiality, and data security, implementing true resource isolation between tenants.

MaxCompute executes all computing tasks in individual sandboxes. The sandboxes are multi-layered, starting at the kernel level. System sandboxes are combined with

an authentication management mechanism to ensure data security and prevent server failures caused by human error or malicious operations.

Figure 5-3: Sandbox protection



Network isolation

MaxCompute is a big data platform provided by Alibaba Cloud to process massive amounts of data. Because MaxCompute processes and stores large amounts of user data, it must comply with security isolation standards to ensure the security of user data. MaxCompute is designed with the support for Virtual Private Cloud (VPC) and configured with limits for MaxCompute, that is, restrictions on VPC-capable MaxCompute.

At present, MaxCompute supports VPCs in the following ways:

- Classic networks, VPC networks, and the Internet are isolated from each other. Each network can only access endpoints and virtual IP addresses (VIPs) within themselves.
- Projects that do not have VPC IDs or IP address whitelist configured do not have any access restrictions. These projects can be accessed by their domain names over all three networks.
- Projects that have VPC IDs configured are only accessible from the VPC with the same ID.
- Projects that have IP address whitelists configured are accessible from the machines whose IP addresses are in the whitelist.
- If a proxy is used to send an access request, the request will be granted or denied based on the IP address or VPC ID of the last-hop proxy server.

Elasticsearch on MaxCompute is an enterprise-level massive data retrieval system developed by Alibaba Cloud. It also needs to meet security isolation requirements. Therefore, the MaxCompute team added VPC-capable Elasticsearch on MaxCompute based on the original VPC-capable MaxCompute, and configured limits for Elasticsearch on MaxCompute, that is, restrictions on VPC-capable Elasticsearch.

At present, Elasticsearch on MaxCompute supports VPCs in the following ways:

- Classic networks, VPC, and the Internet are isolated from each other. Users can access only the endpoints and VIPs on their networks.
- Projects without a VPC ID whitelist or IP address whitelist are accessible to users from valid domains over the three types of networks.
- To start an Elasticsearch service instance, MaxCompute must use the same VPC list as the instance. They share a VPC whitelist and have the same VPC restrictions.
- Starting an Elasticsearch instance occupies all resources by default. You must scale up the MaxCompute instance or scale down the Elasticsearch instance if you start more Elasticsearch instances.

Specific usage scenario: An Elasticsearch instance is started for each project by default when a MaxCompute is deployed in the Apsara Stack environment. You can start your Elasticsearch instance in your project, apply for a domain name and VIP after the instance is started, and verify VPC settings in the Elasticsearch frontend.

5.13.1.2 Authentication and authorization

Authentication

You can generate an AccessKey pair in the Apsara Stack console. The AccessKey pair consists of an AccessKey ID and an AccessKey Secret. The AccessKey ID identifies a user, while the AccessKey Secret is used to authenticate the user identity. The AccessKey Secret must be kept strictly confidential.

Before a request is sent to MaxCompute, a signature string is generated in the format specified by MaxCompute. The signature string is then encrypted using the AccessKey Secret to generate a verification code. After receiving the request, MaxCompute locates the AccessKey Secret that corresponds to the AccessKey ID, and uses the same method to extract the signature string and verification code. If

the verification code matches the code that you provided, the request is considered valid. Otherwise, MaxCompute rejects the request and returns an HTTP 403 error.

Authorization

You can use an Apsara Stack tenant account or RAM user account to access MaxCompute resources. You can use an Apsara Stack tenant account to create different RAM user accounts for use in different scenarios. MaxCompute applies permission-based access policies when you access resources with an Apsara Stack tenant account or RAM user account.

- When you attempt to access a resource by using an Apsara Stack tenant account, MaxCompute verifies whether the tenant account is the resource owner. The resource owner is the only tenant account that can access the resource.
- When you attempt to access a resource by using a RAM user account, the RAM user authorization policy is triggered. MaxCompute first verifies whether the Apsara Stack tenant account is the resource owner, and then verifies whether the RAM user account has been granted access permissions on the resource by the resource owner.



Note:

The preceding description only applies to an unauthorized Apsara Stack tenant account and RAM user account. If the Apsara Stack tenant account and RAM user account have been granted permissions on a resource, they can both access the resource which otherwise can only be accessed by the resource owner.

The two authorization mechanisms used by MaxCompute are described as follows:

- **ACL-based authorization:** an object-based authorization mechanism. An access control list (ACL) contains the access permission data of an object. It is a resource of the object. ACL authorization can only be performed on objects that exist. When an object is deleted, the ACL of the object is automatically deleted. The ACL authorization mechanism is similar to the GRANT and REVOKE statements defined in SQL-92. You must execute statements to grant or revoke permissions on existing project objects.
- **Policy-based authorization:** a policy-based authorization mechanism. An access policy contains the access permission data of an object and a subject. It is a resource of the subject. Policy-based authorization can be performed on objects and subjects that do not exist or are uncertain. The system does not

automatically change policies related to an object when the object is deleted.

MaxCompute uses a custom language to authorize access policies for objects.

MaxCompute also supports various other access control mechanisms.

Column-level access control

Label-based security (LabelSecurity) is a mandatory access control (MAC) policy at the project level. It allows project administrators to control user access to sensitive data at the column level.

LabelSecurity assigns security levels to data and the users who access the data.

MaxCompute can classify data into four sensitivity levels:

- **Level 0: unclassified data**
- **Level 1: confidential data**
- **Level 2: sensitive data**
- **Level 3: highly sensitive data**

Project owners must define their own standards to determine which level data is classified to and what level of access each level is permitted. The default sensitivity level of data is 0. The default access level of all users is also 0.

LabelSecurity can label entire columns in a table with individual sensitivity levels. Administrators can label columns in a table with sensitivity levels. Administrators can also label columns in views with sensitivity levels. The sensitivity labels of views and base tables are independent from each other. The default sensitivity level of a new view is 0.

After data and users are labeled with security levels, LabelSecurity applies the following default security policies:

- **No-ReadUp: Users are not allowed to read data that has a sensitivity level higher than their own, unless the users are given explicit authorization.**
- **Trusted-User: Users are allowed to write data of all sensitivity levels. The default sensitivity level of newly written data is 0.**



Note:

- **In some traditional MAC systems, other complex security policies are implemented to prohibit unauthorized data operations in a project. For example, the No-WriteDown policy prohibits users from writing data with a sensitivit**

y level lower than the user level. No-WriteDown is not included as a default security policy in MaxCompute to reduce management costs for data sensitivity levels. Project administrators can set the SetObjectCreatorHasGrantPermission project security parameter to false to implement a policy similar to No-WriteDown.

- If you want to prevent data flow between projects, you can enable the ProjectProtection parameter. After the setting takes effect, users will only be able to access data within their own projects and data cannot flow to other projects.

By default, LabelSecurity is disabled. Project owners can enable it as needed. After LabelSecurity is enabled, the preceding default security policies take effect. After the policies have taken effect, users must have the select permission and required access level to read sensitive data in tables.

Run the following command to enable or disable LabelSecurity:

```
Set LabelSecurity=true|false;
-- This command enables or disables the LabelSecurity mechanism.
The default value is false.
-- This operation must be completed by project owners. Other
operations can be performed by project administrators.
```

Fine-grained column-level authorization and authentication based on permission model 2.0

To allow more fine-grained management of MaxCompute permissions and enhance the security protection capabilities of the service, MaxCompute provides column-level authorization and authentication.

Based on permission model 2.0, MaxCompute provides unified operations and query interfaces for permissions to implement column-level authorization and authentication.

- MaxCompute and DataWorks allow for fine-grained tenant authorization and access control over shared package resources across tenants.
- MaxCompute can authorize users to access tables and track user table queries.

The following example describes fine-grained column-level authorization by using column-based table operations. The method used is based on permission model 2.0.



Note:

Fine-grained authorization cannot be implemented through authorization policies as they cannot ensure security. The following examples all implement fine-grained authorization through ACLs.

Syntax for ACL-based fine-grained authorization

- Grant or revoke permissions on columns in a table within a project.

```
grant/revoke <privileges> on table <name>(<column_list>) to|from
USER/ROLE <user/role name>;
```

Description:

1. When you grant permissions on a table, permissions are granted on all columns in the table, including:
 - a. Added columns
 - b. Renamed columns
 2. When you grant or revoke permissions on columns, permissions on the columns can be differentiated from other permissions or merged with similar permissions.
 - a. When you grant SELECT permissions on col1 and col2 and grant DESCRIBE permissions on col2 and col3, both authorization statements are valid.
 - b. When you grant SELECT permissions on col1 and col2 and then grant SELECT permissions on col3 and col4, the SELECT permissions will take effect on col1, col2, col3, and col4.
 3. Permissions for a project must be granted by the project owner or a user who is authorized to grant permissions.
- Add columns to a package across projects.

```
add table <name>(<column list>) to package pkgdel1 with privileges <
privilege list>;
```



Note:

When you add columns to a package multiple times, permissions on the columns can be differentiated from other permissions or merged with similar permissions.

Description:

1. The syntax does not change when others install the package.
2. The syntax does not change when you install or uninstall the package.
However, permissions on columns added to the package must be taken into account.
3. Permissions for a project must be granted by the project owner or a user who is authorized to grant permissions.

- Grant or revoke permissions on columns in a table across projects.

```
grant/revoke <privileges> on table <name>(<column_list>) to|from
USER|ROLE <user/role name>
PRIVILEGEPROPERTIES("refobject"="true", "refproject"="<project_name>", "package"="<package name>");
```

Description:

1. The same principles for granting or revoking permissions on a table within a single project apply to granting or revoking permissions across different projects.
2. When granting cross-project permissions on columns, do not grant any permissions beyond the scope of columns necessary for the projects. You must consider all of the permissions that have been granted on the same table in all packages.
3. Permissions for a project must be granted by the project owner or a user who is authorized to grant permissions.

Authentication policy: Policy-based authentication uses the same logic as ACL-based authentication. Make sure to consider how these policies interact with column-level permissions.

Query permissions

- Query permissions within a project.

```
show grants for <user|role name>; #The syntax does not change.
However, the result is displayed at the column level.
show grants for table <name>(columns);
```

```
show grants on table <name>(columns) for user|role <name>;
```

**Note:**

If a column is specified, only permissions on that column are displayed.

- **Query package permissions.**

```
describe package <pkg name>;
describe package <pkg name> PRIVILEGEPROPERTIES ("allowedonly"="true");
describe package <pkg name> PRIVILEGEPROPERTIES ("contentonly"="true");
```

**Note:**

The preceding describe package commands all display results at the column level.

- **Query permissions across projects.**

```
show grants for <user|role name> PRIVILEGEPROPERTIES ("refobject"="true", "refproject"="<project>"); #The syntax does not change.
However, the result is displayed at the column level.
show grants for table <name>(columns) PRIVILEGEPROPERTIES("refobject"="true", "refproject"="<project>");
show grants on table <name>(columns) for user|role <name> PRIVILEGEPROPERTIES ("refobject"="true", "refproject"="<project>");
```

Audit policy: The relevant information will be recorded in audit logs.

Access control

MaxCompute supports RAM authentication.

Resource Access Management (RAM) is a resource access control service provided by Alibaba Cloud. With an Apsara Stack tenant account, you can create RAM user accounts and grant them permissions to access specific resources owned by the tenant account.

5.13.1.3 Data security

Apsara Stack uses a flat design in which a linear address space is divided into slices, also called chunks. Each chunk is replicated into three copies. Each copy is stored on a different node in the cluster, which ensures data reliability.

Triplicate technology used for Apsara Stack data storage involves three key components: master, chunk server, and client. Write operations on MaxCompute undergo several processes before the client executes the operation. The processes are described as follows:

1. The client determines the location of a chunk corresponding to the write operation.
2. The client sends a request to the master to query the storage locations (chunk servers) of the three chunk replicas.
3. The client sends write requests to the chunk servers that are returned from the master.
4. If the write operation succeeds on all three chunk replicas, the client returns a success message. Otherwise, the client returns a failure message.

The distribution strategy of the master takes factors of the entire system into account, such as chunk server disk usage, chunk server distribution across racks, power distribution conditions, and machine workloads. This strategy ensures that each chunk replica is distributed to different chunk servers on different racks. This effectively prevents data unavailability caused by the failure of a chunk server or rack.

When a data node is damaged or disk faults occur on a data node, the total number of valid replicas of some chunks in a cluster becomes less than three. In these cases, the master replicates data between chunk servers to ensure that the number of valid replicas of all chunks in the cluster is three.

In short, all data operations in MaxCompute (add, modify, and delete operations) are synchronized to three replicas. This approach ensures user data reliability and consistency.

Furthermore, when data is deleted, the released storage space is reclaimed by Apsara Distributed File System. During this period, the space is not accessible from any users. Data erasure is performed on the space before it is released for further usage. This mechanism provides a high level of protection for user data.

5.13.1.4 Storage encryption with KMS

Background information

As MaxCompute continues to be deployed around the world, its security requirements increase and sensitive user data such as financial information must remain secure and protected. MaxCompute must also implement data-at-rest encryption to comply with security regulations.

Because of this, MaxCompute provides data storage encryption. It uses Apsara Distributed File System to encrypt, store, and decrypt user data, and uses Key Management Service (KMS) to secure user data and keys.

The MaxCompute storage encryption function provides an added layer of security and minimizes damage caused by data loss. Even if encrypted data is lost or stolen, it is impossible to extract meaningful content from it.



Note:

- The MaxCompute storage encryption function enables transparent encryption and decryption of data through customer master keys (CMKs) to minimize user operations.
- MaxCompute configures storage encryption settings by project. After encryption settings are configured for a project, all subsequent data written to the project will be encrypted to reduce security risks.
- The MaxCompute storage encryption function is backward compatible. It allows unencrypted projects to be encrypted and allows both encrypted and unencrypted data to coexist in a project.

Features

The related features are described as follows:

- MaxCompute uses projects as the basic unit of operation and stores project table data in encrypted form. Only full table encryption is supported. Resources and volumes cannot be encrypted.
- The types of tasks that support data storage encryption are SQL Task 2.0 (including the service mode), MergeTask, and Tunnel. After the storage encryption function is enabled for a project, table data written through these types of tasks is stored in encrypted form.
- You can select from the following encryption algorithms: AES 128, AES 256, and RC4.
- MaxCompute is connected to KMS to ensure the security of keys. You must activate KMS to generate and manage keys for encryption and decryption.

After you submit a request to enable storage encryption, MaxCompute will automatically access KMS to generate the keys required for encryption.



Note:

Projects that belong to the same project owner share the same keys.

- **You can read encrypted and unencrypted data without having to change between task types.**

Data encryption process

- 1. Send a request to activate KMS.**
- 2. Send a request to enable the storage encryption function of MaxCompute.**



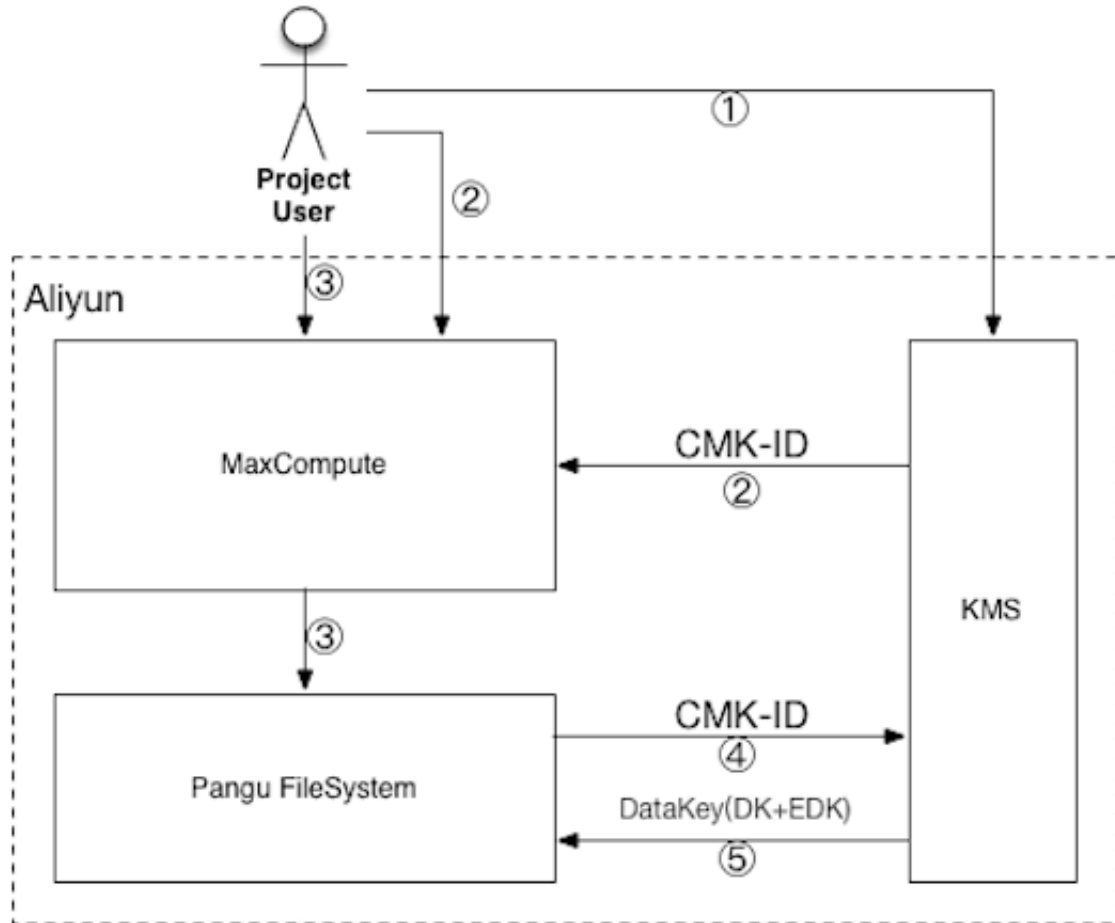
Note:

When you enable the storage encryption function, the system will ask KMS to create a CMK. The CMK is used to protect the data keys used for encryption.

- 3. After KMS is activated and storage encryption is enabled, you can submit jobs in MaxCompute for processing. After the jobs are processed, MaxCompute uses Apsara Distributed File System to encrypt stored data.**
- 4. Apsara Distributed File System provides KMS with the created CMK to obtain the data keys used for encryption.**
- 5. The data keys obtained from KMS consist of a Data Key (DK) and an Enveloped Data Key (EDK). DK is the plaintext key used to encrypt data and EDK is the ciphertext key generated by using envelope encryption on the DK. After you use the DK to encrypt data, the encrypted data and EDK are stored, completing the data encryption process.**

The following figure shows the data encryption flowchart.

Figure 5-4: Data encryption process



Procedure to process encrypted data

When you use MaxCompute to process encrypted data, the data is automatically decrypted by the system. You do not need to perform any other operations to decrypt data. The procedure is as follows:

1. Submit a MaxCompute task to process encrypted data.
2. Apsara Distributed File System reads the EDK of the encrypted data and sends it to KMS to obtain the DK.



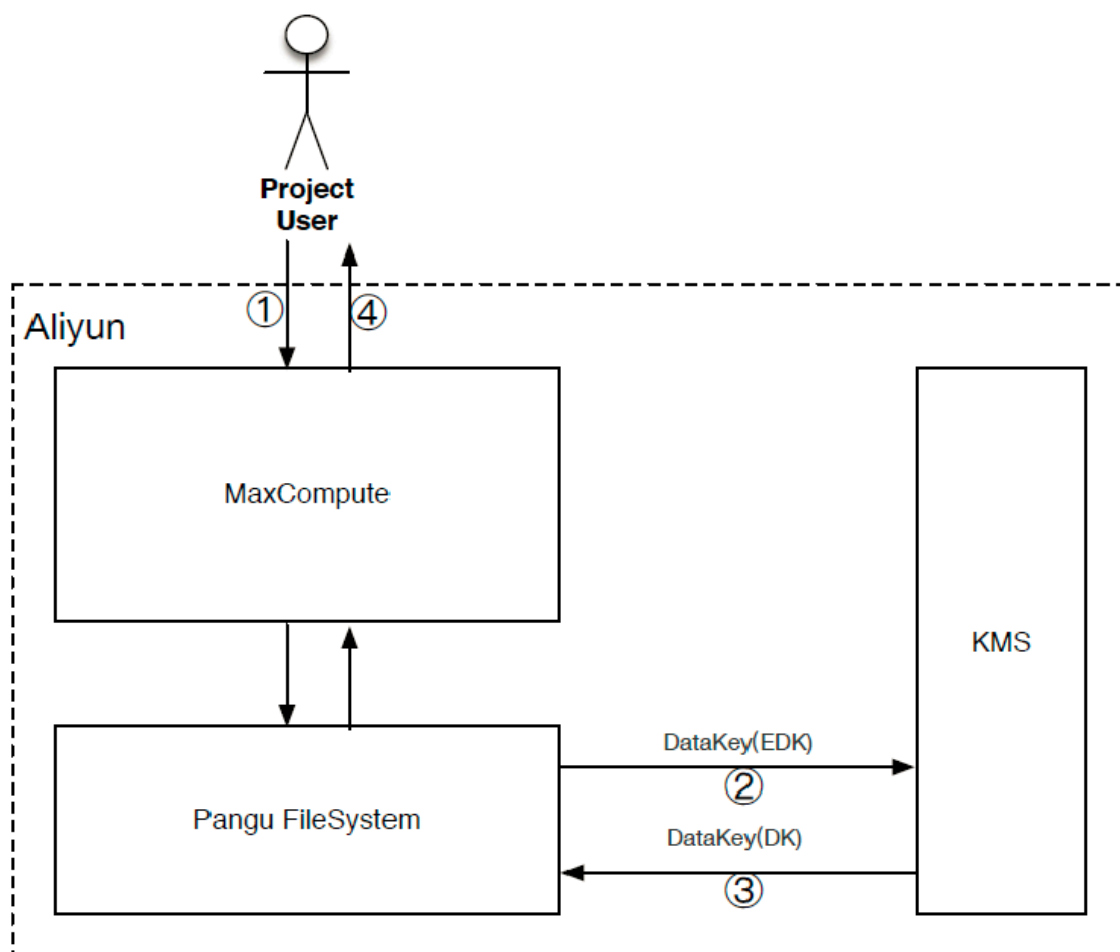
Note:

To ensure security, you cannot directly use the EDK to decrypt data.

3. Apsara Distributed File System decrypts data based on the received DK.
4. MaxCompute processes the decrypted data and returns the result.

The following figure shows the flowchart for processing encrypted data.

Figure 5-5: Procedure to process encrypted data



Use of custom keys for storage encryption

MaxCompute supports custom keys to suit your business and security requirements in different scenarios. When creating a project, you can specify a specific CMK to encrypt data.

The procedure for using a custom key for encryption and decryption is as follows:

- 1. When creating a project, you can apply for the storage encryption function.**
- 2. When enabling storage encryption, specify the CMK ID used by the project.**

You can use MaxCompute to create a CMK or use the CMK that you have created or uploaded in KMS.

If you use a CMK that you have created or uploaded in KMS, you must authorize MaxCompute so that MaxCompute can use the CMK and create and use the corresponding DK to encrypt and decrypt data.

3. Select an encryption algorithm.
4. Complete the other configurations required to create the project.
5. After the project is created, the storage encryption function takes effect. Data written to MaxCompute through SQL and Tunnel tasks is stored in encrypted form.

Precautions

When enabling storage encryption for a project, pay attention to the following rules:

- KMS must be activated in your Apsara Stack tenant account. If KMS is not activated, a message will be displayed, indicating that storage encryption cannot be enabled.
- When you submit a request to enable storage encryption for a project, you must specify an encryption algorithm. The default encryption algorithm is AES 128.
- A MaxCompute production engineer must enable storage encryption for the project and set the encryption algorithm through the AdminConsole. The AdminConsole will then access KMS to generate the CMK required for encryption.
- After the project configuration takes effect, table data that was generated or imported through storage encryption-enabled tasks is stored in encrypted form.
- User data will not be automatically decrypted unless storage encryption is enabled. If existing data must be decrypted, it must be overwritten in encrypted mode.

Special notes

- After storage encryption takes effect, data encryption and decryption operations are performed automatically. No additional operations are required during data use.
- In addition to the supported task types mentioned in the "Features" section, other task types such as OpenMR can be used but are not available for data encryption.
- After storage encryption takes effect for a project, you can query your keys through KMS. However, you cannot modify the keys and encryption algorithm.

- Storage encryption can be disabled. After the function is disabled, new data is no longer stored in encrypted mode. Encrypted data remains encrypted until it is overwritten. The existing encrypted data can still be read through KMS.
- MaxCompute needs to use a temporary STS token of a RAM role to access your keys. Because of this, you must evaluate the load on RAM.

5.13.1.5 Transmission encryption

MaxCompute provides RESTful APIs for transmission and uses HTTPS to ensure security.

5.13.2 Tenant security

5.13.2.1 Cross-project resource sharing

Assume that you are the owner or administrator (admin role) of a project, and you receive a resource access application from a user to use resources in your project. If the applicant belongs to your project, we recommend that you grant permissions by using the user authorization management function. If the applicant does not belong to your project, you can use the package-based resource sharing function to grant cross-project access to the applicant.

A package is a mechanism to share data and resources across projects. It is used to solve cross-project user authorization problems.

The administrator of project A can create a package that includes all objects required by project B. Then, the administrator of project A can grant project B the permissions to install the package. After the package is installed in project B, the administrator of project B can determine whether to grant the permissions on the package to the users of project B.

The following section describes how to use packages:

- A package creator can run the following commands to perform package-related operations:

```
create package <pkgname>  
-- Create a package
```



Notice:

- Only project owners have the permissions to perform this operation.

- **A package name cannot exceed 128 characters.**

```
add project_object to package package_name [with privileges
privileges]
remove project_object from package package_name
project_object ::= table table_name |
instance inst_name |
function func_name |
resource res_name
privileges ::= action_item1, action_item2, ...
-- Add resources to a package
```



Note:

- **A project is not a valid object. A project cannot be added to a package.**
- **When an object is added to a package, the permissions on the object are also added to the package. If you do not include [with privileges privileges] to specify permissions when you add an object to the package, the read-only permissions are granted on the object by default. Read-only permissions allow you to perform read, describe, and select operations on resources . Objects and their permissions are processed as a whole and cannot be changed after being added to a package. If you want to change the permissions on an object, you must delete the object from the package and add it again.**

```
allow project <prjname> to install package <pkgname> [using label <
number>]
-- Grant access permissions to other projects
```

```
disallow project <prjname> to install package <pkgname>
-- Revoke access permissions for other projects
```

```
delete package <pkgname>
-- Delete a package
```

```
show packages
-- View the list of packages
```

```
describe package <pkgname>
-- View details of a package
```

- **A package user can run the following commands to perform package-related operations:**

```
install package <pkgname>
-- Install a package
```



Note:

- **Only project owners have the permissions to perform this operation.**
- **To install a package, you need to enter pkgName in the following format:**
`<projectName>.<packageName>.`

```
uninstall package <pkgname>
-- Uninstall a package
```

**Note:**

To uninstall a package, you need to enter pkgName in the following format:
`<projectName>.<packageName>.`

```
show packages
-- View the list of packages that have been created and installed
```

```
describe package <pkgname>
-- View details of a package
```

An installed package is an independent object in MaxCompute. To access resources in a package (resources shared by other projects), you must have the read permissions on the package. If you do not have the read permissions on a package, you can submit an application for the permissions to the project owner or administrator. The project owner or administrator can grant permissions to you by using the ACL or policy authorization method.

Example: You can use ACL authorization to allow a user (odps_test@aliyun.com) to access resources in a package.

```
use prj2;
install package prj1.testpkg;
grant read on package prj1.testpackage to user
aliyun$odps_test@aliyun.com;
```

You can use policy authorization to allow any user in project prj2 to access resources in the package.

```
use prj2;
install package prj1.testpkg;
put policy /tmp/policy.txt;
```

**Note:**

/tmp/policy.txt content is as follows:

```
{
  "Version": "1",
  "Statement":
```

```
[{
  "Effect": "Allow",
  "Principal": "*",
  "Action": "odps:Read",
  "Resource": "acs:odps:*:projects/prj2/packages/prj1.testpkg"
}]
```

5.13.2.2 Data protection mechanism (Project Protection)

Users authorized to access multiple projects can perform cross-project data access operations to transfer project data. If a project contains highly sensitive data that cannot be shared with other projects, the administrator can enable Project Protection to only allow inbound data.

You can enable Project Protection as follows:

```
set projectProtection=true
-- Set the Project Protection rule to allow only inbound data flow.
```



Note:

The Project Protection parameter is set to false by default. You need to manually enable Project Protection by setting this parameter to true.

Outbound data flow after Project Protection is enabled

After you enable Project Protection for a project, you may encounter this situation : A user requests to export data from a table in the project. The table is evaluated, and verified that it does not contain any sensitive data. MaxCompute provides two methods to export data after Project Protection is enabled.

Configure an exception policy

A project owner can configure an exception policy when enabling Project Protection. The command is as follows:

```
SET ProjectProtection=true WITH EXCEPTION <policyFile>
```



Note:

An exception policy is different from authorization despite the fact that both operations have the same syntax. This exception policy implements an exception in the Project Protection mechanism. Any access requests that meet the description of the exception policy can ignore Project Protection rules.

Exception policy example:

```
{
  "Version": "1",
  "Statement": [
    {
      "Effect": "Allow",
      "Principal": "ALIYUN$Alice@aliyun.com",
      "Action": ["odps:Select"],
      "Resource": "acs:odps:*:projects/alipay/tables/table_test",
      "Condition": {
        "StringEquals": {
          "odps:TaskType": ["DT", "SQL"]
        }
      }
    }
  ]
}
```

-- Allow the user Alice@aliyun.com to perform a select operation on the alipay.table_test table through an SQL task and transfer data from the alipay project.

**Note:**

- An exception policy is different from typical authorization. Assume that the user Alice in the preceding example does not have the permissions to perform select operations on the alipay.table_test table. Although the exception policy is configured, Alice cannot export data from the table.
- Project Protection is a method to control the flow of data, not a method to control the access to data. Data flow control is effective only when users can access the data in question.

Set Trusted Projects

Assume that there is a protected source project and a destination project. The destination project is set as the Trusted Project of the source project. Data flow from the source project to the destination project does not break the Project Protection rules. If any two projects are mutually set as Trusted Projects, these projects then form a Trusted Project Group. Data flow within this group is allowed, but data flow out of the group is prohibited.

You can run the following commands to manage Trusted Projects:

```
list trustedprojects;
-- View all Trusted Projects in the current project.
add trustedproject <projectname>;
-- Add a Trusted Project to the current project.
remove trustedproject <projectname>;
```

```
-- Remove a Trusted Project from the current project.
```

Resource sharing and data protection

In MaxCompute, package-based resource sharing and project protection are mutually independent mechanisms that take effect at the same time, but their functions are mutually restrictive.

MaxCompute gives priority to resource sharing over data protection. If a data object is made accessible from users from other projects through resource sharing, the object is not subject to Project Protection rules.

Prevent data flow out of projects

To prevent outbound data flow from projects, you must enable Project Protection and verify the following settings:

- **Make sure that no Trusted Projects are added. If any Trusted Projects are added, you must assess the potential risks.**
- **Make sure that no exception policies are configured. If any exception policies are configured, you must assess the potential risks, especially data leakage due to TOC2TOU.**
- **Make sure that no data sharing packages are used. If any data sharing packages are used, you must ensure that no sensitive data exists in the package.**

5.13.2.3 Log audit

MaxCompute allows you to audit various kinds of log data generated for different users. Log data (such as static data, running records, and security information) is stored in a metadata warehouse in MaxCompute.

- **Static data:** data that is not automatically deleted after it is generated.
- **Running record:** records of the process of a running task. The records exist in only one partition.
- **Security information:** data that originates from Table Store, such as whitelists and ACL tables.

Metadata warehouse: When you use MaxCompute to analyze its running status, the metadata stored in MaxCompute is aggregated into this table for convenient analysis.

5.14 DataWorks

5.14.1 Permission isolation for development and production environments

DataWorks supports code and configuration management by workspace. Two workspace modes are available, which are Basic Mode and Standard Mode.

A workspace created in Standard Mode can isolate the development and production environments. Take the MaxCompute engine as an example. A workspace created in Standard Mode requires two MaxCompute projects: one for the development environment and the other for the production environment. Data in the two environments is completely isolated from each other.

Developers can only operate development environment data on the DataStudio page of DataWorks. Changes to production environment data take effect only after an O & M engineer publishes the changes. A workspace created in Standard Mode allows you to strictly control table permissions. Developers are prohibited from arbitrarily operating tables in the production environment to ensure data security.

The development and production environments are integrated for a workspace created in Basic Mode. This type of workspace features fast iteration. Code takes effect immediately after being submitted, without requiring you to publish it. However, permissions of the development and production environments are not isolated.

5.14.2 Authentication and authorization

5.14.2.1 Access control

Logon control

You can use your Alibaba Cloud account to log on to the Resource Access Management (RAM) console and create multiple RAM users. By creating policies and attaching them to RAM users, you can enable RAM users who meet specified conditions to access DataWorks. For example, you can specify that only RAM users who use the specified IP address or Classless Inter-Domain Routing (CIDR) block, enable multi-factor authentication (MFA), and use the HTTPS access protocol can access DataWorks.

By specifying the IP addresses or CIDR blocks that have access to DataWorks, you can further prevent unauthorized access and ensure data and business security. For example, when your AccessKey is inadvertently lost or stolen, DataWorks can prevent access from unauthorized IP addresses (such as IP addresses that are not in your internal network) before you create a new AccessKey.

Sandbox isolation

A workspace is a basic unit for isolating user data in DataWorks. All nodes in the workspace run in the sandbox to prevent data leakage. Sandbox isolation also prevents developers from jeopardizing third-party data stores on the public network due to unauthorized use of external resources. By default, DataWorks only allows the following access scenarios:

- In DataStudio, developers can only access a specified compute engine.
- In Data Integration, developers can only access data stores that have been registered.

If developers need to access external resources outside the workspace in addition to the above two scenarios, the workspace administrator must add the resources to the sandbox whitelist in advance.

5.14.2.2 Permission management

Role management

DataWorks defines seven roles in permission management, including owner, administrator, developer, O&M engineer, deployment engineer, security administrator, and guest.

Role	Permission description
Owner	Indicates the user who owns a workspace. The owner has all permissions of a workspace.
Administrator	Indicates an administrative user entrusted by the owner. An administrator has all permissions of a workspace except for deleting the workspace.

Role	Permission description
Developer	Indicates a user who operates the development environment. A developer has the permissions to develop nodes and workflows and operate data in the development environment.
O&M engineer	Indicates a user who operates the production environment. An O&M engineer has the permissions to terminate, rerun, and deploy nodes in the production environment.
Deployment engineer	Indicates a user who connects the development and production environments. A deployment engineer has the permissions to publish code from the development environment to the production environment.
Security administrator	Indicates a data security manager . A security administrator has the permissions to manage the configuration in the Data Protection module.
Guest	Indicates a user with the minimum permission. A guest can only view code instead of performing any other operations.

Permission management

DataWorks allows you to manage data permissions on a workspace. You can authorize permissions by table or field and view and audit permissions.

Data download control

DataWorks gives you full control over configuration data download to reduce the risk of data leakage and ensure data security.

5.14.3 Data encryption

All underlying data of DataWorks is encrypted for storage and transmission, including user code, workflow configuration, and data store connection information. Only authorized users can view, use, and modify the data.

5.14.4 Sensitive data protection

DataWorks supports data identification, sensitive data discovery, data classification and grading, desensitization, access monitoring, risk discovery and alerting, and audit.

- **Data identification:** automatically identifies sensitive data in a workspace based on preset rules.
- **Data classification and grading:** allows you to define different levels of data confidentiality and provide separate access control permissions for each level.
- **Desensitization:** desensitizes sensitive data by masking, aliases, and hashing.
- **Access monitoring:** monitors the access to and export of sensitive data.
- **Risk discovery:** monitors sensitive data access behavior in specific scenarios.

5.15 Realtime Compute

5.15.1 Platform security

5.15.1.1 Resource isolation

Realtime Compute projects are isolated based on permissions. Only authorized users can access or perform operations on a project and its sub-products.

Realtime Compute allows you to isolate resources at the project level. For example, if a sharp increase in streaming data inputs results in a higher CPU usage for the job of a user's project, the CPU usage of your job is not impacted. This is enabled by the application of virtualization technologies at the underlying layer of Realtime Compute.

5.15.1.2 Authentication and authorization

Realtime Compute accounts

You can only log on to the Realtime Compute console using Alibaba Cloud accounts, which are managed based on the username, password, and signature key. The accounts comply with the existing security system of Alibaba Cloud. To ensure the security of accounts, the HTTPS protocol is used for transmission.

Data store accounts

In Realtime Compute, the accounts of data stores are required to create source and result tables. We provide Resource Access Management (RAM) and Security Token

Service (STS) to prevent your business data from leaking due to the loss of account information.

5.15.1.3 Data security

Realtime Compute ensures the security of Realtime Compute system data and business data.

System data security

The security of system data is ensured by Realtime Compute. The following measures have been taken to ensure the security of system data:

- **The HTTPS protocol is used for transmission.**
- **The Advanced Encryption Standard (AES) is used to encrypt the information about the connection with data stores. This helps to prevent sensitive information from leaking.**
- **Comprehensive attack tests have been performed to ensure high-level security.**

Business data security

Realtime Compute does not store business data of users. The security of business data is ensured by external Alibaba Cloud data stores. For more information, see security models and best security practices of Alibaba Cloud data stores.

5.15.1.4 Business process

Business process security

Realtime Compute defines a strict development process for streaming data analysis, and provides separate pages for data development and administration in its console. This guarantees a complete and secure business process while minimizing adverse effects on user experience.

- **Code versions**

Realtime Compute allows you to compare code versions and roll back to an earlier version. This helps you trace the code and troubleshoot faults.

- **Standalone debugging tool in the IDE**

Realtime Compute offers a debugging tool in the integrated development environment (IDE), which allows you to debug the code without affecting online data. With this tool, you can specify data for source tables, dimension tables, and

result tables to create a job, and then debug the data offline. This ensures that running jobs are not affected.

- **Job publishing process**

Realtime Compute offers a job publishing process that prevents running jobs from being affected by the changes of offline code. After you debug the new code, you can publish the job and view it on the Administration page of the Realtime Compute platform. The running job does not automatically use the new code. Instead, you must confirm the changes, terminate the running job, and start the job again using the new code. In this way, you can exercise a complete control over the code that is used for the job to be published.

5.16 Machine Learning Platform for AI

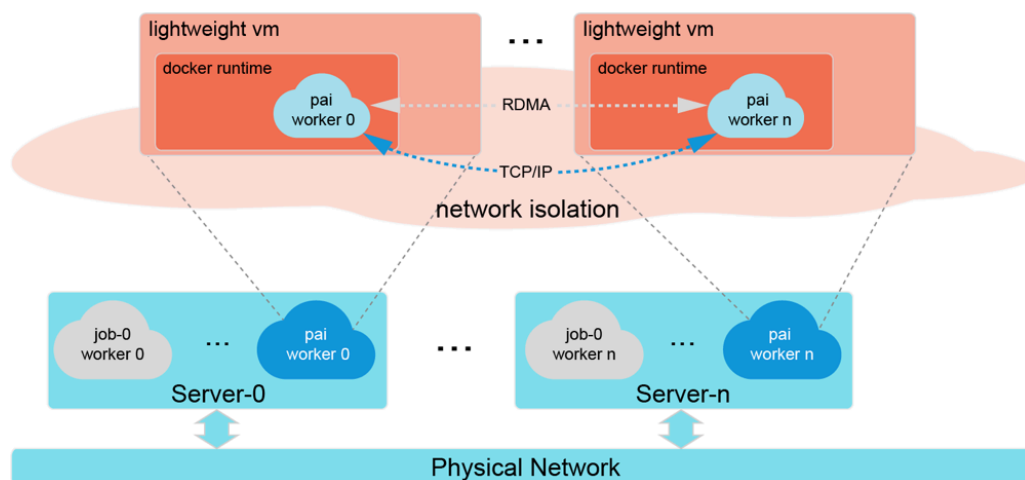
5.16.1 Security isolation

Tenant isolation

When users use Apsara Stack Machine Learning Platform for AI, the computing and storage resources assigned to each user are isolated and secured with the multi-tenancy technology.

- **Network virtualization plays a crucial role in tenant isolation.** Based on the virtual network established at the upper layer of the physical network, Machine Learning Platform for AI isolates the algorithm jobs of different users. This allows each job to manage its own computing and storage resources in the distributed cluster. When running a distributed deep learning job, the system

uses the PCIe technology to connect a GPU instance to a Docker instance. This guarantees GPU computing performance while isolating resources for security.



- When you activate Machine Learning Platform for AI, the DataWorks service is also activated. Based on centralized resource management, DataWorks creates a dedicated gateway resource group for each user. The gateway resource group allows the user to run SQL, MapReduce, and other types of tasks securely. Tasks performed by the user do not affect other users.

Secure isolation for online model service

The online model service stores the AccessKey pair of the user who deploys the service in ApsaraDB for RDS. It verifies each request and rejects if it fails the authentication. The online model service uses the container technology to isolate tenant resources, including memory and CPU resources. This way, other services deployed on the same server are not affected.

5.16.2 Authentication

5.16.2.1 Identity authentication

Machine Learning Platform for AI authentication

When a user accesses a machine learning application from a browser, the following identity authentication procedure is performed:

1. All requests from the browser are transmitted to LoginFilter. LoginFilter calls the API of the DataWorks SSO module to perform identity authentication. If the user has not logged on to the system, the user is redirected to the Apsara Stack logon page. Related cookies are written to the system after logon.

2. All requests contain a token to prevent Cross-Site Request Forgery (CSRF) attacks.
3. All requests to add, delete, modify, or query resources are verified to ensure that the user has permissions to access the resources. This prevents unauthorized actions.
4. When the DataWorks scheduling module or other third-party modules call the API of Machine Learning Platform for AI, the token center of DataWorks is used to verify permissions in all requests.

Identity authentication for online model service

A user can obtain an AccessKey pair in the Apsara Stack console. An AccessKey pair consists of an AccessKey ID and an AccessKey Secret. The AccessKey ID is public and is used to identify a user. The AccessKeySecret is private and is used to authenticate a user.

When a user sends a request to the online model service, the online model service authenticates the user as follows:

1. Convert the request into a signature string in the format specified by the online model service.
2. Use the AccessKey Secret and the HMAC algorithm to encrypt the signature string and generates a verification code. The verification code is time stamped to prevent replay attacks.
3. After the online model service receives the request, it locates the AccessKey Secret based on the AccessKey ID, uses the AccessKey Secret to decrypt the signature string, and generates a verification code.
 - If the generated verification code is the same as the one in the request, the online model service considers the request to be valid.
 - If the generated verification code is different from the one in the request, the online model service rejects the request and returns an HTTP 403 error message.

5.16.2.2 Access control

After your machine learning application has been deployed using the online model service, the system generates a token for accessing the prediction API. This token is required when you access the deployed application. This token is private. You must ensure that it is kept by the application user.

5.16.2.3 RAM and STS

Resource Access Management (RAM) is a resource access control service provided by Apsara Stack. With RAM, you can avoid sharing the AccessKey pair of your Apsara Stack account with other users, and assign minimum operation permissions to different RAM users based on the least privilege principle. RAM allows you to use the primary account to create RAM user accounts. The primary account can assign resource access permissions to RAM users.

Security Token Service (STS) is a temporary access token service provided by Apsara Stack to manage temporary access permissions. STS can generate a temporary access token for the user. The access permission and expiration date of the token are defined by the user. The access token expires automatically upon the expiration date.

When using the deep learning module, you can go to the OSS quick authorization page in the Apsara Stack console to perform quick authorization:

1. OSS quick authorization grants an OSS bucket read and write permissions to MaxCompute service account `odps.aliyuncs.com`.
2. After the authorization, role `AliyunODPSPAIDefaultRole` is created in RAM. Each role has a globally unique resource descriptor called `RoleArn`. The format is `acs:ram:::$accountID:role/$roleName`.
3. After the role is created, Machine Learning Platform for AI uses the AccessKey pair of account `odps.aliyuncs.com` to call the `AssumeRole` operation of STS.
4. If the call is successful, you will obtain a temporary AccessKey pair (`AccessKeyId` and `AccessKeySecret`) and a temporary STS token (`SecurityToken`). The default validity period is 3,600 seconds. With the temporary AccessKey pair and STS token, you can read and write the OSS bucket in the corresponding project.

The role information contained in `AliyunODPSPAIDefaultRole` is as follows:

```
{
  "Statement": [
    {
      "Action": "sts:AssumeRole",
      "Effect": "Allow",
      "Principal": {
        "Service": [
          "odps.aliyuncs.com"
        ]
      }
    }
  ],
  "Version": "1"
```

```
}
```

The role authorization policy is as follows:

```
{
  "Version": "1",
  "Statement": [
    {
      "Action": [
        "oss:GetObject",
        "oss:ListObjects",
        "oss:DeleteObject",
        "oss:ListParts",
        "oss:PutObject",
        "oss:AbortMultipartUpload"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }
  ]
}
```

5.16.3 Data security

Data security of Machine Learning Platform for AI applications

Machine Learning Platform for AI uses MaxCompute for big data computing and storage. MaxCompute projects are used to store data of different users to ensure that the users cannot access one another's data.

For financial institutes and other scenarios that require higher data security, MaxCompute allows you to enable or disable protection for data stored in projects. You can use this feature to allow or prohibit the export of data. For more information, see [Project data protection](#).

Data security of online model service

The online model service uses three types of data:

- **Online model service metadata:** The metadata is stored in and secured by ApsaraDB for RDS.
- **Kubernetes (K8s) metadata:** The metadata is stored in etcd, which provides services and data backup with three replicas. To access etcd, you need certificates kept by the K8s cluster administrator.
- **Monitoring data:** The monitoring data is stored in Alibaba Cloud disks, the type of which decides the type of data backup.

5.16.4 Log audit

Machine Learning Platform for AI provides a request log. User access records are automatically written into a designated file in the specified format based on the frequency of user access. The user access log is used for auditing or action analysis . The request log contains information such as the request time, source IP address, request method, request URL, request user ID, processing duration, and error code.

6 Apsara Stack Security

Apsara Stack Security, integrated with the strong data analysis ability of the Alibaba Cloud computing platform, is an achievement of Alibaba Group after many years of research on security technologies. It provides you with a variety of one-stop security services, including DDoS Traffic Scrubbing, Server Intrusion Detection, Web Application Firewall (WAF), and Threat Detection Service (TDS).

For more information about Apsara Stack Security, see the *Apsara Stack Security Technical Whitepaper* .

6.1 Overview

Apsara Stack Security, integrated with the strong data analysis ability of the Alibaba Cloud computing platform, is an achievement of Alibaba Group after many years of research on security technologies.

Apsara Stack Security Standard Edition

Apsara Stack Security Standard Edition provides various security modules and on-premises security operations services, such as Traffic Security Monitoring, Server Guard, Server Intrusion Detection, Web Application Firewall (WAF), and Threat Detection Service (TDS). It ensures the availability, confidentiality, and integrity of business systems and data in Apsara Stack.

Apsara Stack Security Standard Edition makes full use of the security features of Apsara Stack products and Apsara Stack Security to provide Apsara Stack users with one-stop security assurance that covers intrusion protection, threat detection, and centralized management. Apsara Stack Security Standard Edition enhances the security of the Apsara Stack environment in terms of technology and management, effectively protecting your Apsara Stack platform.

Optional security services

Apsara Stack Security provides a wide range of optional services for you to choose from based on the business scenarios on the Apsara Stack platform.

For more information about Apsara Stack Security, see the *Apsara Stack Security Technical Whitepaper* .

6.2 Apsara Stack Security Standard Edition

6.2.1 Threat Detection Service

Threat Detection Service (TDS) detects possible intrusions or attacks by means of machine learning and data modeling. It detects zero-day vulnerabilities and potential virus attacks. TDS also provides you with up-to-date information about ongoing attacks, so that you can better monitor the security of your business systems. This prevents data leaks caused by network attacks and allows you to track hacker identities.

The following table describes features of TDS.

Feature	Description
Security overview	Provides a comprehensive security overview, including statistics on protected assets, attack trends, and traffic trends.
Screens	Displays security information on the following screens: <ul style="list-style-type: none">• Map-based traffic screen• Server security screen
Security alert management	Allows you to view and handle security events, such as abnormal logons, abnormal accounts, webshells, malicious processes, abnormal process behavior, sensitive file tampering, and abnormal network connections.
Attack analysis	Protects against common attacks on web applications and brute-force attacks. <ul style="list-style-type: none">• Brute-force attacks: An attacker logs on to a server by using brute-force attacks.• Common attacks on web applications: SQL injection, code execution, command execution, script Trojans, file inclusion, upload vulnerability exploitation, and common content management system (CMS) vulnerability exploitation

Best practices

TDS provides features such as asset management, security monitoring, intrusion backtracking, attacker tracking, and intelligence warning. We recommend that you use TDS in the following scenarios to help visualize your cloud security:

- **Security status awareness**

You can be fully aware of your cloud security, such as attacks, vulnerabilities, intrusions, protection effectiveness, business weaknesses, and the security status of services available for external use. TDS detects network- and server-layer attacks, advanced persistent threat (APT) attacks, and business security threats. It also identifies abnormal network connections and generates daily security reports.

- **Countermeasures against intrusions**

Your business systems in the cloud may be attacked. For example, during a sudden surge of the server load, you receive an SMS message indicating that your Elastic Compute Service (ECS) instances are being attacked. Your instances may be controlled to launch attacks, malicious advertisement links may appear on your web pages, or your data may be encrypted by a hacker by using ransomware. You can use the following features of TDS to defend against these types of intrusions:

- **Intrusion detection:** TDS detects dozens of intrusion types, such as WannaCry ransomware attacks, intrusions through webshells, one-line Trojans, software viruses, and connections between internal servers and command-and-control (C&C) servers.
- **Intrusion behavior analysis:** TDS analyzes the causes and processes of intrusions and collects evidence of hacker behavior during the intrusions.
- **Details of security events:** You can view webshell addresses, protocol analysis results of DDoS attacks, process addresses, and attack prevention effectiveness.

- **Real-time monitoring on screens**

TDS displays your cloud security status on visual screens. This improves teamwork efficiency and allows you to monitor the cloud security in real time.

6.2.2 Traffic Security Monitoring

Developed by Alibaba Cloud Security, the Traffic Security Monitoring module is able to monitor attacks within milliseconds. By performing in-depth analysis on the traffic packets mirrored from the Apsara Stack portal, this module can detect various attacks and abnormal behaviors in real time and coordinate with other protection modules to implement defenses. Throughout the Apsara Stack Security

defense process, the Traffic Security Monitoring module provides a wealth of information and basic data support.

The following table describes the features provided by the Traffic Security Monitoring module.

Feature	Description
Traffic data collection and analysis	Uses a bypass in traffic mirroring mode to collect inbound and outbound traffic through the interconnection switch (ISW) and generates a traffic diagram.
Unusual traffic detection	Uses a bypass in traffic mirroring mode to detect the unusual traffic that has exceeded the scrubbing threshold and reroutes the traffic to the DDoS Traffic Scrubbing module. The traffic rate (Unit: Mbit/s), packet rate (Unit: PPS), HTTP request rate (Unit: QPS), or number of new connections can be set as the threshold.
Malicious server detection	Detects attacks that are launched by malicious servers within the Apsara Stack network.
Web application protection	Uses a bypass to block common Web attacks at the network layer based on default Web attack detection rules. The attacks that can be blocked include Structured Query Language (SQL) injections, code and command execution, Trojan scripts, file inclusion attacks, and exploitation of upload vulnerabilities and common content management system (CMS) vulnerabilities.
Suspicious TCP connection blocking	Uses a bypass to send TCP RST packets to the server and the client to block layer-4 TCP connections.
Network log recording	Records UDP and TCP traffic logs and the Request and Response logs of HTTP queries. These logs are used by Threat Detection Service (TDS) for big data analysis.

Best practices


By checking the traffic at different times, in different regions, and from each IP address, you can identify the traffic peak and trough periods and view traffic distribution by rate or region. You can also check the top five IP addresses that generate the most traffic to block access from malicious IP addresses.

6.2.3 Server Guard

Server Guard provides security protection measures such as vulnerability management, baseline check, intrusion detection, and asset management for Elastic Compute Service (ECS) instances by means of log monitoring, file analysis, and feature scanning.

Server Guard uses the client-server model. To protect the security of ECS instances in real time, Server Guard clients work with the Server Guard server to monitor attacks, vulnerabilities, and baseline configurations at the system layer and the application layer on the ECS instances.

The following table describes the features provided by Server Guard.

Category	Feature	Description
Vulnerability management	Linux software vulnerability detection and fixes	Detects vulnerabilities recorded in the official database of Common Vulnerabilities and Exposures (CVE) in software such as SSH, OpenSSL, and MySQL based on the software versions, and provides vulnerability information and solutions.
	Windows vulnerability detection and fixes	Detects critical Windows vulnerabilities on your ECS instances based on the latest vulnerability information released by Microsoft, and provides Windows patches to fix the vulnerabilities, such as the Server Message Block (SMB) remote code execution vulnerability.
		 Note: By default, only critical vulnerabilities are reported. You can manually check for security updates and detect low-risk vulnerabilities.

Category	Feature	Description
	Web CMS vulnerability detection and fixes	Detects Web content management system (CMS) vulnerabilities based on the security intelligence provided by Alibaba Cloud by scanning directories and files. This feature also provides patches developed by Apsara Stack Security to fix vulnerabilities in software such as WordPress and Discuz!, and allows you to undo vulnerability fixes.
	Configuration and component vulnerability detection	Detects vulnerabilities that cannot be detected by software version comparison or file vulnerability scanning, and identifies critical configuration vulnerabilities in software, such as configuration and component vulnerabilities including unauthorized access to Redis and ImageMagick vulnerabilities.
Baseline check	Account security baseline check	<ul style="list-style-type: none"> • Detects SSH, RDP, FTP, MySQL, PostgreSQL, and SQL Server accounts with weak passwords. • Detects the at-risk accounts of your ECS instances, such as suspicious hidden accounts and cloned accounts • Checks the compliance of the password policy of Linux servers. • Detects accounts without passwords on the ECS instances.

Category	Feature	Description
	System configuration check	<p>Checks the system group policies, baseline logon policies, and registry configuration risks, including:</p> <ul style="list-style-type: none"> • Suspicious auto-startup items in the scheduled tasks of Linux servers. • Auto-startup items on Windows servers. • Sharing configurations of the system. • SSH logon security policies of Linux servers. • Account-related security policies on Windows servers.
	Database security baseline check	Checks whether the Redis service on an ECS instance is exposed to the public network, whether unauthorized access vulnerabilities exist, and whether suspicious data is written to important system files.
	Benchmark compliance check	Checks whether the system baseline complies with the latest Center for Internet Security (CIS) CentOS Linux 7 Benchmark.
Intrusion detection - unusual logons	Disapproved logon location alerts	Automatically records all logons, and determines the approved logon cities based on the usual logon locations . It also generates alerts on logons in disapproved locations. You can customize the approved logon cities.
	Disapproved logon IP alerts	Generates alerts on logons through IP addresses that are not whitelisted after a logon IP whitelist is created.
	Disapproved logon time alerts	Generates alerts on logons within disapproved time ranges after the approved logon time range is set.
	Disapproved logon account alerts	Generates alerts on logons with disapproved accounts after the approved logon account list is created.

Category	Feature	Description
	Brute-force attack detection and blocking	Detects and blocks brute-force attacks in real time. Both SSH and RDP brute-force attacks can be detected.
Intrusion detection - webshells	Webshell detection	Uses an Alibaba-developed webshell detection engine to detect and remove webshells on your ECS instances. Both scheduled and real-time scans are supported. It detects webshells written in Active Server Pages (ASP), Hypertext Preprocessor (PHP), and Java Server Pages (JSP), and allows you to manually quarantine these webshell files.
Intrusion detection - suspicious processes	Suspicious process activity detection	Detects suspicious process activities such as reverse shells, Java processes running CMD commands, and unusual file downloads using bash.
Asset management	Asset grouping	Allows you to group your ECS instances into a maximum of four layers, filter assets by region, online status, or other features, and manage the asset tags.
	Asset fingerprints	<ul style="list-style-type: none"> • Listening port: collects and displays the listening port information and records changes. This allows you to easily check the listening port status. • Account: collects the account and permission information to discover privileged accounts and detect privilege escalations. • Process: collects and displays the information about the processes through snapshots to list normal processes and detect suspicious processes. • Software: lists the software installation information so that the affected assets can be quickly located when a critical vulnerability is exploited.

Category	Feature	Description
Server logs	Log retrieval	<ul style="list-style-type: none"> • Previous logon logs: records successful system logons. • Brute-force attack logs: records failed system logons. • Process snapshot logs: records the information about the running processes on the server at a specific time. • Listening port snapshot logs: records the listening port information on the server at a specific time. • Account snapshot logs: records the information about logon accounts on the server at a specific time. • Process startup logs: records the process startup information on the server. • Network connection logs: records the network connections started by the server.

Best practices

You can use the features of Server Guard to periodically perform baseline check for ECS instances, detect security threats and vulnerabilities on ECS instances, and fix them promptly for higher server security.

6.2.4 Web Application Firewall

Based on the intelligent semantic analysis engine, Web Application Firewall (WAF) defends against common attacks defined by Open Web Application Security Project (OWASP), including Structured Query Language (SQL) injections, cross-site scripting (XSS) attacks, common web server plug-in vulnerabilities, Trojan uploads, and unauthorized access to core resources. WAF filters out massive malicious access attempts to prevent leakage of website assets and data, and to safeguard website security and availability.

The following table describes the features provided by WAF.

Feature	Description
Protection against common Web attacks	<p>Detects SQL injections, XSS, intelligence, cross-site request forgery (CSRF), server-side request forgery (SSRF), Hypertext Preprocessor (PHP) deserialization, Java deserialization, Active Server Pages (ASP) code injections, file inclusion attacks, file upload attacks, PHP code injections, command injections, crawlers, and server responses.</p> <p>WAF provides five built-in protection templates, including the template with default protection policies, monitoring mode template, anti-DDoS template, template for financial customers, and template for Internet customers. WAF allows you to customize the decoding algorithms in the templates, enable or disable each attack detection module separately, and set the detection granularity.</p>
HTTP flood mitigation	<p>Allows you to set access frequency control rules for domain names and URLs to restrict the access frequency of IP addresses or sessions that meet the criteria or block these IP addresses or sessions.</p> <p>Restricts the access frequency of known IP addresses or sessions or block these IP addresses or sessions.</p> <p>The HTTP flood mitigation rules do not apply to IP addresses or sessions that have been added to the whitelist.</p>
Custom and precise access control	<p>Supports precise access control based on the following HTTP contents or their combinations: URI, GET parameters, decoded path, HOST header, complete cookie, POST parameters, complete body, HTTP status code, and response content.</p>

Best practices

- Use WAF to prevent the leakage of sensitive information

WAF effectively defends against security threats such as accesses from unauthorized URLs, accesses to the unauthorized content, and malicious crawling of sensitive information on websites.

- Use WAF to prevent WordPress reflection attacks

WAF effectively prevents WordPress reflection attacks with custom HTTP-based access control list (ACL) rules.

6.2.5 On-premises security operations services

On-premises security operations services help you make better use of the features of Apsara Stack products and Apsara Stack Security to ensure your application security.

Security operations services include pre-release security assessment, access control policy management, periodic security check, routine security inspection , and urgent event handling. These services cover the entire lifecycle of your businesses in Apsara Stack. On-premises security operations services help you create a security operations system for cloud businesses. This system enhances the security of application systems and ensures the security and stability of your businesses.

6.3 Optional security services

6.3.1 DDoS Traffic Scrubbing

Backed by its large-scale and distributed operating system and more than a decade of experience in defending against security attacks, Alibaba Cloud has designed and developed the DDoS Traffic Scrubbing module based on the cloud computing architecture to protect the Apsara Stack platform against large amounts of distributed denial of service (DDoS) attacks.

The following table describes the features provided by the DDoS Traffic Scrubbing module.

Feature	Description
Traffic scrubbing against DDoS attacks	Detects and prevents attacks such as SYN flood, ACK flood, ICMP flood, UDP flood, NTP flood, DNS flood, and HTTP flood.
DDoS attack display	Allows you to view DDoS attacks in the console and search for DDoS attacks by IP address, status, and event information.
DDoS traffic analysis	Allows you to monitor and analyze the traffic of a DDoS attack, and view the attack traffic protocol and the top 10 IP addresses that have launched most attacks.

**Note:**

Apsara Stack Security cannot scrub the traffic between internal networks.

Best practices

The DDoS Traffic Scrubbing module automatically detects and protects against DDoS attacks targeted at public IP addresses on the Apsara Stack platform. When the platform is subjected to a DDoS attack, the DDoS Traffic Scrubbing module redirects, scrubs, and reinjects network traffic that is detected and scheduled by the Traffic Security Monitoring module. In addition, you can view the detailed information about a DDoS attack event to understand the traffic elements of the attack and analyze the attack source.

6.3.2 Sensitive Data Discovery and Protection

Sensitive Data Discovery and Protection (SDDP) is a data security service used to detect and protect sensitive data in Apsara Stack big data services.

SDDP uses Alibaba Cloud's big data analytics capabilities and artificial intelligence (AI) technologies to detect and classify sensitive data based on your business requirements. It can also mask sensitive data both in transit and at rest, monitor dataflows, and detect abnormal activities. It provides visible, controllable, and industry-compliant security protection for your sensitive data by using precise detection and analysis. SDDP can detect and protect sensitive data in a variety of Apsara Stack big data services, such as MaxCompute, Object Storage Service (OSS), and Table Store.

The following table describes features of SDDP.

Feature		Description
Classification and detection of sensitive data	Detection of new data	A department administrator can authorize SDDP to scan and protect data assets based on business requirements. SDDP only scans and monitors authorized data assets.
	Sensitive data classification	SDDP can classify sensitive data detected in big data services, such as MaxCompute, OSS, Table Store, and ApsaraDB for RDS. You can define classification rules for sensitive data by using keywords, regular expressions, or other methods.

Feature		Description
	Sensitive data detection	SDDP has built-in algorithms for detecting sensitive data, and uses file clustering, deep neural networks, and machine learning to detect sensitive images, text, and fields.
Management of sensitive data permissions	Asset permissions detection	SDDP can redirect you to pages that display the permissions of data assets and allows you to view the accounts that have permissions to access those assets. The data assets include MaxCompute projects, MaxCompute tables, MaxCompute columns, MaxCompute packages, OSS buckets, Table Store instances, and Table Store tables.
	Account permissions detection	SDDP allows you to view all accounts in a department and search for departments or accounts in fuzzy search mode. SDDP displays relationships between departments and accounts in a hierarchical and visible layout.
	Abnormal permissions usage detection	SDDP automatically detects abnormal permissions usage in big data services, such as MaxCompute, OSS, and Table Store.
Monitoring of dataflows and operations	Dataflow monitoring	SDDP monitors dataflows among entities, including data storage services (such as MaxCompute, OSS, and Table Store), data transmission services (such as Datahub and CDP), the data stream processing service Blink, external databases, and external files. It displays dataflows and abnormal activities on dynamic graphs. This way, you can click an abnormal activity on a graph to redirect to the page for handling the abnormal activity.
	Abnormal data operation detection	SDDP detects abnormal operations in big data services, such as MaxCompute, OSS, and Table Store.
	Abnormal dataflow detection	SDDP detects abnormal dataflows (including abnormal downloads) in big data services, such as MaxCompute, OSS, and Table Store.
	Detection rule customization	SDDP allows you to customize rules for detecting abnormal dataflows and operations based on algorithms.

Feature		Description
Abnormal activity processing	Configuration for abnormal activity detection	SDDP allows you to configure thresholds and rules for detecting abnormal activities, such as abnormal dataflows, permissions usage, and data operations.
	Abnormal activity processing	SDDP processes abnormal activities with a built-in console. You can search for abnormal activities by department, event type, account, processing status, or time of occurrence.
	Abnormal activity statistics	SDDP collects statistics on the processing status of abnormal activities, including abnormal dataflows, permissions usage, and data operations, and then dynamically displays these statistics.
Static data masking	Static data masking	<p>SDDP statically masks sensitive data in big data services, such as MaxCompute, OSS, Table Store, and ApsaraDB for RDS.</p> <p>It supports the following masking algorithms : hash masking, shield masking, substitution masking, conversion masking, encryption masking, and shuffle masking.</p>
Intelligent audit	Intelligent audit	SDDP collects and audits the operation logs of big data services, such as MaxCompute, OSS, and ApsaraDB for RDS.

Best practices

- Complies with laws and regulations on personal information protection.

SDDP detects personal information in large amounts of data, automatically marks risk levels for personal information, and effectively detects data leaks. Enterprises can use SDDP to ensure that their systems comply with laws and regulations on personal information protection.

- Classifies and protects sensitive data of enterprises.

SDDP classifies and detects sensitive data, manages data permissions, and identifies abnormal activities (such as abnormal dataflows, permission usage, and data operations) based on specified rules. This way, enterprises can properly protect their sensitive data of diverse classifications.

- **Handles data leaks.**

SDDP detects abnormal activities based on specific rules and allows you to centrally summarize and handle these activities. This helps enterprises process data leaks online and provides effective support for security O&M.