ALIBABA CLOUD

Alibaba Cloud

Apsara Stack Enterprise

Security Whitepaper

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Document conventions

Style	Description	Example
Danger	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.
Warning	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.
Notice	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.
Note	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 `cd /d C:/window` command to enter the Windows system folder.
Italic	Italic formatting is used for parameters and variables.	`bae log list --instanceid` *Instance_ID*
[] or [a|b]	This format is used for an optional value, where only one item can be selected.	`ipconfig [-all|-t]`
{} or {a|b}	This format is used for a required value, where only one item can be selected.	`switch {active|stand}`

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1.Security of Apsara Stack products

1.1. Elastic Compute Service (ECS)

1.1.1. Security Whitepaper

1.1.1.1. Platform security

1.1.1.1.1. 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.

1.1.1.1.2. Authentication

1.1.1.1.2.1. Identity authentication

Account authentication uses identity credentials to verify the identities of users. An identity credential typically refers to a logon password or an AccessKey pair. You can obtain your AccessKey pair from the User Information page in the Apsara Uni-manager Management Console. An AccessKey pair consists of an AccessKey ID and an AccessKey secret. The AccessKey ID is public and used to identify users. The AccessKey secret is a secret key used to encrypt the signature strings and verify the signature strings on a server. It is used to authenticate users and must be kept confidential.

ECS performs identity verification on each access request. Therefore, both HTTP and HTTPS requests must contain signature information. ECS performs symmetric encryption to verify the identity of the request sender by using the AccessKey ID and AccessKey secret.

1.1.1.1.2.2. Access control

Resource Access Management (RAM) is a centralized user management and resource access control service provided by Apsara Stack. You can use RAM to create independent user accounts for your employees, systems, or applications and control their access to your cloud resources. Each RAM user can log on to the Apsara Uni-manager Management Console or call service APIs by using an independent logon password or AccessKey pair. By default, RAM users do not have any permissions on resources when they are created. Only an authorized RAM user can operate resources on behalf of the corresponding Apsara Stack tenant account.

You can use RAM to grant permissions based on the least privilege principle to reduce data security risks and avoid sharing your AccessKey pairs with other users. RAM enables an Alibaba Cloud account to have multiple independent RAM users. RAM also supports features such as multi-factor authentication (MFA), strong password policies, separation of console users from API users, custom fine-grained authorization policies, grouped authorization, and temporary authorization tokens, and temporary account disabling. RAM can be used to define fine-grained authorization at the API operation or resource ID level. RAM also supports various restrictive conditions on permission granting, such as constraints on source IP address, required SSL/TLS channel, access time period, and MFA.

We strongly recommend that you access and manage the operating systems in your ECS instances in a secure manner. You can use the SSH public key and private key pairs and properly maintain the private key. You must at least use a complex password, which can be set when you create the instance. In addition, you must use SSHv2 for remote logons and use the sudo commands to temporarily escalate permissions.

You can create RAM users and groups to manage access to cloud resources.

RAM can help you configure fine-grained access control on cloud resources. For example, you can enhance network security by attaching a policy to a RAM user group. If an access request does not originate from a corporate internal network specified in the policy, the access request is rejected.

Different permissions can be granted to RAM user groups to manage ECS resources. The following section describes two example groups.

- SysAdmins: This group requires permissions to create and manage ECS images, instances, snapshots, and security groups. A policy with full ECS management permissions can be attached to the SysAdmins group.
- Developers: This group requires permissions to use ECS instances. A policy that authorizes group members to call the DescribeInstances, StartInstance, StopInstance, CreateInstance, and DeleteInstance API operations can be attached to the Developers group.

If a developer becomes a system administrator, you can move the developer account from the Developers group to the SysAdmins group.

ECS allows you to attach RAM roles to ECS instances to access cloud resources by using temporary Security Token Service (STS) credentials. Instance RAM roles allow ECS instances to assume RAM roles with specific access permissions.

Each RAM role can be assigned to an ECS instance, which can then access other cloud resources by using a temporary STS credential. This ensures the security of AccessKey pairs and allows you to implement fine-grained access control.

1.1.1.1.3. Data security

1.1.1.1.3.1. 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.

1.1.1.1.3.2. Triplicate storage technology

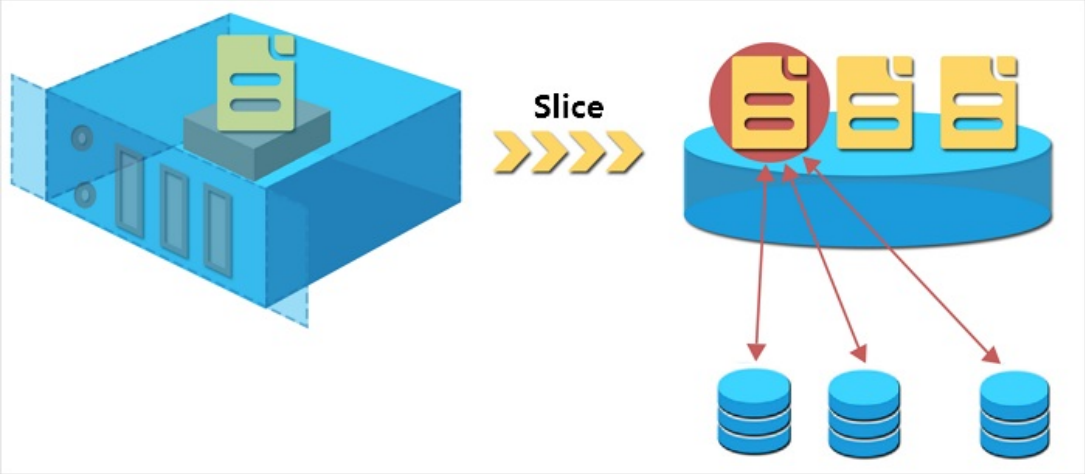
When ECS users read or write data from or to virtual disks, the operations are translated into reads or writes from or to the files stored in the Apsara Stack data system. Apsara Stack uses a flat design in which a linear address space is divided into slices, also called chunks. For each chunk, three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

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.

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.

1.1.1.1.3.3. ECS disk encryption

Elastic Compute Service (ECS) disk encryption is a simple and secure encryption method that can be used to encrypt new disks.

ECS disk encryption eliminates the need to create or maintain your own key management infrastructure, change existing applications and maintenance procedures, or perform additional encryption operations. Disk encryption does not have negative impacts on your business processes. The following types of data can be encrypted:

- Data stored on disks.
- Data transmitted between disks and instances. Data within the instance operating system is not encrypted.
- All snapshots created from encrypted disks. These snapshots are encrypted snapshots.

Data transmitted from instances to disks is encrypted on the hosts where the instances are deployed.

In Apsara Stack ECS, only ultra disks and standard SSDs can be encrypted.

1.1.1.1.4. Encrypted transmission

Apsara Stack uses the HTTPS protocol to ensure data transmission security. The Apsara Uni-manager Management Console uses HTTPS encryption for data transmission. All Apsara Stack services provide API access points that have HTTPS encryption enabled and allow users to use AccessKey pairs to call Apsara Stack service APIs. Apsara Stack uses standard SSL/TLS protocols for transmission and provides keys up to 256 bits in length to ensure that sensitive data can be encrypted and transmitted securely.

1.1.1.1.5. 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.

1.1.1.2. Tenant security

1.1.1.2.1. 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.

1.1.1.2.2. 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.

1.1.1.2.3. 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.

1.2. Container Service for Kubernetes

1.2.1. Security Whitepaper

1.2.1.1. Platform security

1.2.1.1.1. Security isolation

Container Service provides multiple security isolation methods to ensure cluster security.

Exclusive Kubernetes clusters

Kubernetes clusters you created through the Container Service console belong to you. Resources for deploying Kubernetes clusters, such as ECS and SLB instances, can be used only by the current Kubernetes clusters and are not shared with other users. Strong isolation at the physical level can avoid potential security risks arising from resource sharing.

ECS security group

The ECS instance used by each Kubernetes cluster belongs to the same ECS security group. Based on the least privilege principle, a security group contains only the following network access rules:

- Allow access to ECS instances over ICMP
- Allow access to ECS instances through pod CIDR blocks

Container network policies

In a Kubernetes cluster, pods on different nodes can communicate with each other by default. In some scenarios, the network intercommunication between different businesses is not allowed, and network policies must be introduced to reduce risks. In Kubernetes clusters, you can use the Canal network driver to implement the support for network policies.

1.2.1.1.2. Account authentication

You can use the Container Service account authentication function to secure your containerized applications.

RAM user authorization is supported for Kubernetes clusters. You can perform RAM authorization to grant permissions on Kubernetes clusters to specific RAM users. This reduces the risk of exposing Apsara Stack tenant account data.

Role-Based Access Control (RBAC)

RBAC uses the Kubernetes built-in API group for authentication management, allowing you to manage pods corresponding to different roles and role access permissions.

1.2.1.1.3. Link security

Container Service supports TLS certificate verification for link security.

The following communication links in Container Service Kubernetes clusters are verified by TLS certificates to prevent data tampering and eavesdropping on communications:

- kubelet on worker nodes actively communicates with apiserver on master nodes.
- apiserver on master nodes actively communicates with kubelet on worker nodes.

During initialization, a master node uses SSH tunnels to connect to the SSH service of other nodes (port 22).

1.2.1.2. Tenant security

1.2.1.2.1. Application security

Container Service for Kubernetes supports a wide range of application security policies.

Application security policies

Security policy	Description
Run a container as a non-root user	You can run applications in a container as a non-root user. This avoids container escapes and prevents attackers from obtaining host permissions.
Use secure base images	You can customize base images as required and enforce the use of approved base images within your organization. You can also use secure third-party images. We recommend that you use base images based on Alpine Linux. All Docker images are based on Alpine Linux.
Include minimal resources in images	Only resources necessary to run applications are included in images.
Configure Transport Layer Security (TLS) authentication for Docker daemons	TLS authentication is configured for Docker daemons and Docker Swarm API operations.
Prioritize CPU usage for containers	You can use the CPU sharing feature of Docker to prioritize CPU usage for containers. The feature allows a container to have priority over another for CPU usage and avoids high CPU usage by containers with a lower priority. This ensures expected performance of high-priority containers and prevents resource exhaustion attacks.
Limit container memory usage	By default, a container can consume all available memory resources on the Docker host. You can use the memory limit mechanism to prevent denial-of-service (DoS) attacks that may arise if a single container consumes all host resources. Specifically, you can add the -m or -memory option to the docker run command to run containers.

Security policy	Description
Limit container disk usage	By default, Docker images, container rootfs, and volumes are stored in the */var/lib/docker* directory. They share the same file system with the host. The directory size varies depending on the content. You can mount the */var/lib/docker* directory to the cloud storage, such as disks and Object Storage Service (OSS) buckets. This minimizes the impact on the root file system of the host.
Implement identity authentication	• Username-password pairs and certificates are used for user authentication. • A logon failure processing mechanism can be used to limit the number of unauthorized logon attempts. If the number of failed logon attempts within a session exceeds the specified threshold, the session terminates. • A session is automatically locked after the session stays in the idle state for a specified period of time. • You must change the initial password when you log on to the system for the first time. • The password must meet requirements. The new password cannot be the same as the last password. You are periodically prompted to change your password.
Implement the security audit feature	• The system supports the account security audit feature. You can use this feature to create audit logs for system account modifications. These logs cannot be modified. • All operations on the system platform are recorded in clear log entries, including the event date, time, initiator information, type, description, and result. Audit logs are periodically backed up and retained for at least six months.
Ensure communication security and confidentiality	• TLS encryption is used in communication between system components. • Confidential data is encrypted in the system. The data is sent to specific nodes only when required.

Security policy	Description
Manage roles and permissions	• The system uses a built-in multi-tenant permission management model. The model allows you to set different permissions based on teams and roles and manage fine-grained permissions on clusters and applications. • You can manage access to cluster resources for external account systems by using methods such as Lightweight Directory Access Protocol (LDAP). • Each image repository supports access control based on multiple permissions, such as multi-tenant and read-only permissions.

1.2.1.2.2. Host security

OS account requirements

An OS password must be at least 8 characters in length, and must contain at least three types of the following characters: uppercase letters, lowercase letters, numbers, and special characters. Weak passwords (such as regular or consecutive characters, employee IDs, and domain account prefixes) are not allowed. Your OS password is set to expire every 90 days by default.

A mechanism to limit unauthorized logon attempts

A logon failure processing mechanism can be used to limit the number of unauthorized logon attempts. When the number of failed logon attempts exceeds the specified threshold, the session terminates and exits.

Access control

Access control can be used to control user access to resources based on configured security policies.

- *passwd* file permission: 644
- *shadow* file permission: 000
- *rc3.d* file permission: 755
- *profile* file permission: 644
- *profile.d* folder permission: 755

Disabling and deletion of default accounts

You can delete redundant and expired accounts to prevent accounts from being shared. You can disable the following default accounts: sync, shutdown, and halt.

1.3. Auto Scaling (ESS)

1.3.1. Security Whitepaper

1.3.1.1. Platform security

1.3.1.1.1. Security isolation

ESS implements user account-based isolation. You can manage scaling groups, configurations, and rules in your account, such as performing create, modify, and delete operations. ESS can use ECS instance resources only in your account for automatic scaling. ESS performs symmetric encryption by using AccessKey pairs to authenticate users who manage ECS instance resources. It authenticates each access request to ensure security isolation.

1.3.1.1.2. Authentication

1.3.1.1.2.1. Authentication

You can create an AccessKey pair in the Apsara Uni-manager Management 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 a key used to encrypt signature strings and verify those signature strings on the server. The AccessKey secret is used to authenticate the identities of users and must be kept confidential.

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

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

1.3.1.1.2.2. 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.

1.3.1.2. Tenant security

1.3.1.2.1. Log audit

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

The states of a scaling activity include Rejected, In Progress, Successful, Warning, and Failed. Status information includes the status details. Reason for activity includes the results of scaling activities executed in a scaling group. Details include information about instances involved in a scaling activity.

1.4. Resource Orchestration Service (ROS)

1.4.1. Security Whitepaper

1.4.1.1. Platform security

1.4.1.1.1. Data security

None

1.4.1.2. Tenant security

1.4.1.2.1. Log audit

ROS displays detailed information about historical events, including event logs for stacks. The information includes the resource name, associated resource ID, resource type, resource status, status description, and event occurrence time. Event logs provide the information about changes to stacks.

1.5. Object Storage Service (OSS)

1.5.1. Security Whitepaper

1.5.1.1. Platform security

1.5.1.1.1. 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 uses symmetric AccessKey pairs to authenticate users and verifies the signature in each HTTP request sent by users. If verification is successful, OSS reassembles the distributed data. This way, OSS implements data storage isolation between multiple tenants.

1.5.1.1.2. Authentication and access control

1.5.1.1.2.1. Authentication

You can create an AccessKey pair on Apsara Uni-manager Management Console. An AccessKey pair consists of an AccessKey ID and an AccessKey secret. The AccessKey ID is a public ID that uniquely identifies a user. The AccessKey secret is private and used to authenticate a user.

Before you send a request, you must generate a signature string for the request in the format specified by OSS. Then, you must encrypt the signature string by using your AccessKey secret to generate a verification code based on the HMAC algorithm. The verification code is timestamped to prevent replay attacks. After receiving the request, OSS finds the AccessKey secret based on your AccessKey ID, and uses the AccessKey secret to decrypt the signature string and verification code. Then, OSS calculates a verification code and compares it with the decrypted verification code. If the two verification codes are the same, OSS determines that the request is valid. Otherwise, OSS rejects the request and returns HTTP 403.

1.5.1.1.2.2. Access control

OSS supports access control list (ACL) to control access permissions. An ACL is set based on resources. You can specify ACLs for buckets or objects. You can specify an ACL for a bucket when you create the bucket or for an object when you upload the object to OSS. You can also modify the ACLs of uploaded objects and created buckets.

Access to OSS resources can be initiated by the bucket owner or third party users. An owner owns a bucket. Third-party users are other users who access resources in the bucket. Access can be either anonymous or signed. If the access is initiated with an OSS request that does not contain identification information, the access is considered to be anonymous. A signed access is a request that contains signature information in the header or a URL that contains signature information as defined in OSS API documentation.

OSS provides access control for buckets and objects.

You can configure one of the following ACLs for a bucket:

- Public read/write: All users (including anonymous users) can perform write (PutObject, GetObject, and DeleteObject) operations on objects in the bucket.
- Public read: Only the bucket owner or authorized users can perform write operations (PutObject and DeleteObject) on objects in the bucket. Other users, including anonymous users, can only perform read operations (GetObject) from the objects in the bucket.
- Only the bucket owner or authorized users can perform read and write operations (PutObject, GetObject, and DeleteObject) on objects in the bucket. Other users cannot access the objects in the bucket without authorization.

> **Note** If you do not configure the ACL of a bucket when you create the bucket, OSS sets the ACL of the bucket to private.

You can configure one of the following ACLs for an object:

- 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 ACL of the bucket.

> **Note** If you do not configure the ACL of an object when you upload the object, OSS sets the ACL of the object to default.

1.5.1.1.2.3. 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 Apsara Stack. RAM allows you to create RAM users under an Apsara Stack tenant account. The Apsara Stack tenant account can grant access permissions on resources to RAM users.

STS is service that provides temporary access credentials. You can use STS to generate a temporary access credential for a user and specify the permission and validity period of the credential. A credential becomes invalid after it expires.

1.5.1.1.3. 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.

1.5.1.1.4. Data encryption

1.5.1.1.4.1. Server-side encryption

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

To encrypt an object on the OSS server when you upload the object, you only need to add the x-oss-server-side-encryption header in the PutObject request and set its value to AES256.

1.5.1.1.4.2. Client-side encryption

OSS allows you to use client-side encryption to encrypt data before the data is sent to the 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 provided by SDKs to encrypt the data on local clients before the data is uploaded to the OSS bucket.

1.5.1.2. Tenant security

1.5.1.2.1. Key management

Apsara Stack Key Management Service (KMS) is a secure and highly available service that integrates hardware and software, and provides a key management system that can be extended to the cloud. KMS uses customer master keys (CMKs) to encrypt OSS objects and uses KMS API operations 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.

1.5.1.2.2. 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.

1.5.1.2.3. Hotlink protection

To prevent additional fees caused by unauthorized access to the resources in your bucket, you can configure hotlink protection for your buckets on the Apsara Uni-manager Management Console or by using API operations.

You can set the following parameters to configure hotlink protection:

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

For example, if you add http://www.aliyun.com/ to the Referer whitelist of a bucket named oss-example, requests in which the Referer field is http://www.aliyun.com/ can access the objects in the bucket.

1.6. Apsara File Storage NAS

1.6.1. Security Whitepaper

1.6.1.1. Platform security

1.6.1.1.1. Security isolation

Network isolation

NAS provides the permission group mechanism to control the networks over which NAS instances can be accessed. You can add rules to a permission group of a NAS instance to allow users from specified IP addresses or address segments to access the NAS instance with different permissions. In this way, networks are isolated from each other.

Storage isolation

In NAS, each mount point instance of a file system is mapped to a storage unit in the server storage pool. The storage units corresponding to different mount point instances are isolated from each other.

The access control module on the NAS server verifies the I/O requests of users based on the mapping between VPCs and NAS mount point instances. The module checks the storage unit information carried by each request against the storage unit information on the server for consistency. This ensures storage isolation on the server.

1.6.1.1.2. Authentication

Permission control

NAS allows you to perform standard directory or file permission operations on a NAS instance. You can also configure read, write, or execution permissions for a user or user group. NAS supports two types of mount points: VPC and classic network. If you configure a VPC mount point for a NAS instance, only the ECS instances within the same VPC as the mount point can access the NAS instance. If you configure a classic network mount point, only the ECS instances under the same account as the mount point can access the NAS instance.

In NAS, the permission group acts as an IP address whitelist. You can add rules to the permission group of a NAS instance to allow users from specified IP addresses or address segments to access the NAS instance with different permissions.

VPC Default Permission Group is automatically generated for each account by default. This permission group allows all IP addresses in the VPC to access the mount point with full permissions. Full permissions include read and write permissions with no restrictions on the root user.

> **Note**
>
> - Mount points in a classic network do not have a default permission group.
> - When you add a permission group rule for a mount point in a classic network, you can only set the authorized IP address to a single IP address. You cannot set the authorized IP address to an IP address segment.

A permission group rule has four attributes, as listed in the following table.

Permission group rule attributes

Attribute	Value	Definition
Authorized IP Address	An IP address or IP address segment (You must specify an IP address for a permission group rule of a mount point in a classic network.)	The IP address or IP address segment of the authorized object.
Read and Write Permission	• Read Only • Read/Write	The operation permissions of the authorized object on the NAS instance.

Attribute	Value	Definition
User Permission	• Do Not Limit root User • Limit root User • Limit All Users	Whether to restrict the permissions of the authorized object's Linux system users on the NAS instance. Description: • Do Not Limit root User allows the root user to access the NAS instance. • Limit root User considers the root user as nobody. • Limit All Users considers all users including root as nobody.
Priority	Valid values: 1 to 100. 1 indicates the highest priority.	When an authorized object matches multiple rules, the rule with the highest priority takes effect.

Access control

NAS can work with RAM. You can make RAM settings in the NAS console to complete RAM authorization.

RAM allows you to grant the permissions on NAS instances to RAM users.

NAS operation permissions that can be granted to RAM users

Action	Description
DescriptFileSystems	Lists NAS instances.
DescriptMountTargets	Lists the mount points of a NAS instance.
DescriptAccessGroup	Lists the permission groups of a NAS instance.
DescriptAccessRule	Lists permission group rules.
CreateFileSystem	Creates a NAS instance.
CreateMountTarget	Adds a mount point to a NAS instance.
CreateAccessGroup	Creates a permission group.
CreateAccessRule	Adds a permission group rule.
DeleteFileSystem	Deletes a NAS instance.
DeleteMountTarget	Deletes a mount point.
DeleteAccessGroup	Deletes a permission group.
DeleteAccessRule	Deletes a permission group rule.

Action	Description
ModifyMountTargetStatus	Disables or enables a mount point.
ModifyMountTargetAccessGroup	Modifies the permission group of a mount point.
ModifyAccessGroup	Modifies a permission group.
ModifyAccessRule	Modifies a permission group rule.

1.6.1.1.3. Data security

Multi-copy data storage

NAS maintains multiple data copies to ensure data security.

User data: The NAS server stores three copies of user data. Services can continue running even when two copies are lost. The server monitors the number of copies in real time. When a data node is corrupted or a hard drive on a data node fails, the number of valid copies of some data in the cluster becomes less than 3. In this case, the server activates the replication mechanism to replicate data. This mechanism ensures that there are always three valid copies of each piece of data in the cluster.

The server prevents accidental silent errors by verifying that the stored data matches the check data. When the server detects a silent error, it replicates healthy copies to ensure the availability of three valid copies. This improves data reliability.

Data reclamation

The server reclaims the storage space that is released by the Delete operation. This reclaimed storage space is inaccessible to all users. The data stored in the storage space is erased before the space is reused. This fully guarantees data security.

1.6.1.2. Tenant security

1.6.1.2.1. Log audit

The NAS management system logs NAS instance operations, including creating and deleting NAS instances.

NAS logs are generated in real time and automatically stored on the server. A log contains detailed information about an operation, such as the executor and execution time. This information can be used for failure investigation and analysis.

1.6.1.2.2. Directory-level ACLs

This topic describes how to configure directory-level access control lists (ACLs). Only directory-level ACLs are available for Apsara File Storage NAS file systems.

Prerequisites

- You must mount NFSv4 file systems on all clients.
- You must use the alinas-acl tool to configure ACLs. We recommend that you do not change the file

mode creation mask or use commands such as `chmod` to change file permissions. Otherwise, you may not obtain the expected results.

Procedure

1. The syntax of the mount command is **sudo mount -t nfs -o vers=4.0 <the domain name of a mount target>:<the directory of an NAS file system> <a local directory>**. For example, you can use **mount -t nfs -o vers=4.0 014544bbf6-wdt41.cn-hangzhou.nas.aliyuncs.com:/ /mnt** to mount an NFSv4 file system.

   > **Note**
   > - The value of the vers parameter changes based on the client version. If an error occurs when you set vers to 4.0, set vers to 4 instead.
   > - In some cases, ACLs are not enabled for a file system by default. To ensure ACLs are available for the file system, you can mount the file system again to enable ACLs.

2. Install the `nfs4-acl-tools` tool in CentOS.

   ```
   sudo yum -y install nfs4-acl-tools
   ```

3. Make sure that Python 2.7 is installed.

   ```
   python --version Python 2.7.5
   ```

4. Use the alinas-acl tool to configure an ACL.

   ```
   ./alinas_acl set ./foo --add --user Alice --rule r #Grant the Alice user the read-only access to the foo file.
   ./alinas_acl set ./foo -a -u Alice -r r #You can use the command to perform the same operation as the pre ceding command.
   ./alinas_acl set ./dir --add --group Staff --rule rwx #Grant the Staff group the read, write, and execute acc ess to the dir directory.
   ./alinas_acl set ./foo --add --user EVERYONE@ --rule none #Grant the EVERYONE@ principal no access to the foo file.
   ./alinas_acl set ./foo --add --user 1001 --rule none #Grant the 1001 user principal no access to the foo file
   .
   ./alinas_acl set ./dir -d -u Bob #Revoke the Bob user access to the dir directory.
   ```

   > **Note**
   > - To avoid a decrease in performance, we recommend that you configure an ACL for a directory rather than each file in the directory.
   > - We recommend that you add a maximum of 10 access control entries (ACEs) to an ACL.

5. View the ACL.

   ```
   ./alinas_acl get ./foo #View the permissions on the foo file. # file: foo/ # owner:
           root # group: root OWNER@::rw- GROUP@::r-- EVERYONE@::--- Alice::r-- Staff:g:rwx
           1001::---
   ```

> **Note** When you configure an ACL, three special principals named OWNER@, GROUP@, and EVERYONE@ are automatically generated. These principals correspond to the user, group, and others classes of a file mode creation mask, respectively. The permissions that you specify for the file mode creation mask can be different from the permissions that you specify for an ACL. The actual permissions change based on the client version.

1.7. Tablestore

1.7.1. Security Whitepaper

1.7.1.1. Platform security

1.7.1.1.1. Security isolation

This topic describes the security isolation methods of Tablestore, including network and storage isolation.

Network isolation

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

- Allows all network access: Access from the Internet and VPCs bound to the instance is allowed.
- Allows access from specific VPCs: Only access from VPCs bound to the instance is allowed.
- Allows access from the console and specific VPCs: Only access from VPCs bound to the instance and the Tablestore console is allowed. Access from other sources is denied.

Storage isolation

Tablestore uses a shared storage mechanism. This mechanism allows the instances of different users to share the same cluster resource. Tablestore 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.

1.7.1.1.2. Authentication

This topic describes the authentication methods of Tablestore, including authentication and access control.

Authentication

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

Access control

Tablestore supports Security Token Service (STS), which allows you to control access of RAM users. STS is a temporary access credential service provided by Apsara Stack. It provides temporary access control. You can use STS to generate a temporary access credential. You can specify the permissions and validity period of the credential. The credential becomes invalid when it expires.

Tablestore supports authorization based on tables and API operations.

1.7.1.1.3. Data security

This topic describes the data security policies of Tablestore.

Tablestore is built on the Apsara Distributed File System and provides linear storage space. Linear addresses are sliced into chunks. For each chunk, three replicas are created and stored in different nodes in the cluster to ensure data reliability.

In Tablestore, data is serialized before it is written to the disks. Each data block is written to one or more 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 a disk fault occurs on a data node, the chunk replica number becomes smaller than three. The Apsara Distributed File System starts the automatic replication process to replicate data among different service nodes when the replica number is smaller than three. This ensures that each chunk in the cluster has three valid replicas.

Write operations in Tablestore can be returned only after all three replicas are written to the disks. This ensures strong data consistency.

1.7.1.2. Tenant security

1.7.1.2.1. Key management

This topic describes how to manage keys. You can use keys to protect data stored in Tablestore.

Apsara Stack Key Management Service (KMS) is a secure and high-availability service that integrates hardware and software and provides a key management system that can be extended to the cloud.

KMS uses customer master keys (CMKs) to encrypt Tablestore tables 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 CMKs to protect data stored in Tablestore.

1.8. ApsaraDB RDS

1.8.1. Security Whitepaper

1.8.1.1. Platform security

1.8.1.1.1. Secure isolation

Tenant isolation

Tenant isolation

ApsaraDB RDS uses virtualization technology to isolate tenants. Each tenant can maintain their own database permissions independently. Apsara Stack also enhances security for servers that run databases. For example, users cannot use the databases to read or write operating system files. This prevents other users from accessing your data.

1.8.1.1.2. Authentication

ApsaraDB RDS uses authentication to ensure data security.

Identity authentication

Account authentication uses your logon password or AccessKey pair to verify your identity. You can create an AccessKey pair from the Apsara Uni-manager Management Console. An AccessKey pair consists of an AccessKey ID and an AccessKey secret. The AccessKey ID is a public key used for identification. The 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.

ApsaraDB RDS authenticates each access request. Therefore, a request must contain signature information regardless of whether it is sent over HTTP or HTTPS. ApsaraDB RDS uses the AccessKey ID and AccessKey secret to implement symmetric encryption and authenticate the identity of a request sender. AccessKey pairs can be applied for and managed from Apsara Stack. The AccessKey secret must be kept strictly confidential.

Permission control

When an ApsaraDB RDS instance is created, the system does not create an initial database account. You can create standard database accounts by using the console or an API operation and configure read and write permissions for the databases. To implement fine-grained permission control, such as table-, view-, or field-based permissions, you can create a privileged database account by using the console or an API operation. You can then use the database client and privileged database account to create standard database accounts. A privileged database account can configure table-based read and write permissions for standard database accounts.

Access control

All ApsaraDB RDS instances that are created by an Apsara Stack tenant account are managed as resources of that account. By default, Apsara Stack tenant accounts have full access permissions on their resources.

ApsaraDB RDS supports Resource Access Management (RAM). You can use RAM to allow RAM users to access and manage ApsaraDB RDS resources in your account. ApsaraDB RDS can also use STS to offer temporary credentials for short-term access.

1.8.1.1.3. Data security

ApsaraDB RDS ensures data security by using hot standby, data backup, and log backup.

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

Automatic backups at regular intervals are required to ensure the integrity, reliability, and restorability of databases. ApsaraDB RDS provides data backup and log backup.

1.8.1.1.4. Data encryption

SSL

ApsaraDB RDS provides Secure Sockets Layer (SSL) for MySQL, SQL Server, PolarDB, and PostgreSQL. You can use the server root certificate to verify whether the destination database is an ApsaraDB RDS instance. This prevents man-in-the-middle attacks. ApsaraDB RDS also allows you to enable and update SSL certificates for servers to ensure security and validity.

Although ApsaraDB 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.

1.8.1.1.5. DDoS attack prevention

ApsaraDB RDS prevents DDoS attacks by using the traffic scrubbing and blackhole filtering features.

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

Traffic scrubbing and blackhole filtering must meet the following triggering conditions:

- **Traffic scrubbing**

  Traffic scrubbing targets traffic only from the Internet. Traffic is redirected from an IP address to the scrubbing device. Then, the scrubbing device checks whether the traffic is normal. The scrubbing device discards abnormal traffic and limits the traffic to the server. These operations mitigate damage on the server but have an impact on normal traffic.

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

- **Blackhole filtering**

  Blackhole filtering targets traffic only from the Internet. If an ApsaraDB RDS instance is undergoing blackhole filtering, the instance cannot be accessed from the Internet, and connected applications are unavailable. Blackhole filtering is triggered for a single ApsaraDB RDS instance if one of the following conditions is met:

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

  Blackhole filtering is automatically stopped 2.5 hours after it is triggered. Then, the instance undergoes traffic scrubbing. If a DDoS attack is still occurring, blackhole filtering is triggered again. Otherwise, the system restores the normal state.

1.8.1.2. Tenant security

1.8.1.2.1. Log audit

ApsaraDB RDS can audit logs to identify security issues.

ApsaraDB RDS allows you to view SQL transactions. You can audit SQL statements on a regular basis to identify and resolve issues. RDS Proxy records all SQL statements sent to ApsaraDB RDS, including the IP address, database name, user account used for execution, SQL statement, execution duration, number of returned records, and execution time of each statement.

1.8.1.2.2. IP address whitelist

ApsaraDB RDS uses IP address whitelists to prevent access from invalid IP addresses.

By default, ApsaraDB RDS instances are accessible from all IP addresses. Therefore, the default IP address whitelist contains only 0.0.0.0/0. You can add IP address whitelist rules by using the data security module in the console or calling an API operation. IP address whitelists can be updated without the need to restart ApsaraDB RDS instances. Whitelist updates do not affect the normal operation of instances. Multiple IP address whitelists can be configured for each instance. Each whitelist can contain up to 1,000 IP addresses or CIDR blocks.

1.8.1.2.3. Software update

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

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

In rare cases such as critical bugs and security vulnerabilities, ApsaraDB RDS forces the database to update within the maintenance window of the instance. Such mandatory updates only result in temporary database disconnections, without adverse impact on the application if the database connection pool is correctly configured.

You can change the maintenance window by using the console or an API operation. This prevents mandatory updates during peak hours.

1.9. Cloud Native Distributed Database PolarDB-X

1.9.1. Security Whitepaper

1.9.1.1. Platform security

1.9.1.1.1. Security isolation

Network isolation

PolarDB-X supports advanced control of network access by using a Virtual Private Cloud (VPC).

A VPC is a private network environment that you set. It strictly isolates network packets through underlying network protocols, and it controls access at the network layer. The VPC and IP address whitelist together greatly improve the security of PolarDB-X instances.

1.9.1.1.2. Authentication

PolarDB-X provides a system to manage accounts and permissions. This system is similar to the account and permission system of MySQL. This system supports statements and features such as GRANT, REVOKE, SHOW GRANTS, CREATE USER, DROP USER, and SET PASSWORD.

When you create a PolarDB-X database, you can specify an account that is granted all permissions on the database by default. You can use this account to create one or more accounts.

- Permissions at the database and table levels can be granted. Global permissions and column-level permissions are not supported in this version.
- The following eight basic statements can be executed: CREATE, DROP, ALTER, INDEX, INSERT, DELETE, UPDATE, and SELECT.
- You can use the `user@'host'` format to match and verify the accounts that are used to access a host.

> **Note** If the host is connected to a virtual private cloud (VPC), the IP address cannot be obtained. In this case, we recommend that you change the format to `user@'%'`.

1.9.1.2. Tenant security

1.9.1.2.1. IP address whitelist

PolarDB-X provides IP address whitelists to ensure secure access. You can configure an IP address whitelist for each PolarDB-X database.

The default setting of PolarDB-X instances allows access from any IP address. You can add IP addresses to the whitelist on the **Whitelist Settings** page in the console. You are required to restart PolarDB-X instance after you update the IP address whitelist, and your operations on the instance are not affected. You can set IP addresses or CIDR blocks in the IP address whitelist.

> **Note** If the business host is in a Virtual Private Cloud (VPC) network, the IP address cannot be obtained due to technical restrictions. We recommend that you remove the IP address whitelist.

1.9.1.2.2. Protection against high-risk SQL operations

PolarDB-X prohibits high-risk operations such as full table deletion and full table update by default. You can temporarily skip this restriction by adding a hint. The following statements are prohibited by default:

- DELETE statements that do not contain the WHERE or LIMIT conditions.
- UPDATE statements that do not contain the WHERE or LIMIT conditions.

For example, the following statement is prohibited:

```
mysql> delete from tt;
ERR-CODE: [TDDL-4620][ERR_FORBID_EXECUTE_DML_ALL] Forbid execute DELETE ALL or UPDATE ALL sql. M
ore: [http://middleware.alibaba-inc.com/faq/faqByFaqCode.html?faqCode=TDDL-4620]
```

After a hint is added, the statement is successfully executed.

```
mysql> /*TDDL:FORBID_EXECUTE_DML_ALL=false*/delete from tt;
Query OK, 10 row affected (0.21 sec)
```

1.9.1.2.3. Slow SQL audit

In the PolarDB-X console, you can query the slow SQL statements that a client sends to PolarDB-X. Slow SQL statements increase the response time (RT) of the entire link and reduce the throughput of PolarDB-X.

The details about slow SQL statements include the database name, SQL statement, and client IP address. The details also include the start time at which SQL statements are executed and the amount of time that is consumed to execute SQL statements. In the PolarDB-X console, you can query details about slow SQL queries to help you optimize and adjust slow SQL statements.

1.9.1.2.4. Performance monitoring

The PolarDB-X console provides monitoring metrics in different dimensions. You can perform related operations based on the monitoring information.

There are two types of PolarDB-X monitoring information:

- Monitoring information about resources, including the CPU, memory, and network.
- Monitoring information about engines, including the logical queries per second (QPS), physical QPS, logical response time (RT) in milliseconds, physical RT in milliseconds, number of connections, and number of active threads.

The QPS and CPU performance of a PolarDB-X instance are in positive correlation. When PolarDB-X encounters a performance bottleneck, the CPU utilization of the PolarDB-X instance remains high. If the CPU utilization exceeds 90% or remains above 80%, the PolarDB-X instance faces a performance bottleneck. If there is no bottleneck in the PolarDB-X instance, the curent type of the PolarDB-Xinstance cannot meet the QPS performance requirements of the business. In this case, upgrade the instance.

1.10. AnalyticDB for PostgreSQL

1.10.1. Security Whitepaper

1.10.1.1. Platform security

1.10.1.1.1. 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. It strictly isolates network packets by using underlying network protocols and controls access at the network layer.

By default, AnalyticDB for PostgreSQL instances in 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. This method is not recommended. The requests include but are not limited to:

- Access requests from ECS elastic IP addresses (EIPs).
- Access requests from the Internet egress of your data center.

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

Tenant isolation

AnalyticDB for PostgreSQL uses virtualization technology to isolate tenants. Each tenant can maintain their own database permissions independently. Apsara Stack also enhances security for servers that run databases. For example, users cannot use the databases to read or write operating system files. This prevents other users from accessing your data.

1.10.1.1.2. Authentication

The AnalyticDB for PostgreSQL instances that you create by using your Apsara Stack tenant account are owned by the account. By default, Apsara Stack 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.

1.10.1.1.3. Primary and secondary nodes

Each AnalyticDB for PostgreSQL instance consists of a coordinator node and multiple compute nodes. Each node uses 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.

1.10.1.2. Tenant security

1.10.1.2.1. 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.

1.10.1.2.2. IP address whitelists

By default, AnalyticDB for PostgreSQL instances block access from all IP addresses. The default IP address whitelist contains only `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. The IP address whitelist can be updated without restarting the AnalyticDB for PostgreSQL instance. Whitelist updates do not affect the normal operation of the instance. You can configure multiple IP address whitelists. Each whitelist can contain up to 1,000 IP addresses or CIDR blocks.

1.10.1.2.3. SQL audit

AnalyticDB for PostgreSQL allows you to view SQL details. You can audit SQL operations on a regular basis to identify problems in a timely manner. The Proxy module records the information of all SQL statements that are sent to AnalyticDB for PostgreSQL, including the connected IP addresses, names of the accessed databases, accounts used for statement execution, SQL statements, execution duration, number of returned records, and execution time points.

1.10.1.2.4. Backup and restoration

For 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.

1.10.1.2.5. Software upgrade

- AnalyticDB for PostgreSQL provides new versions of database software on a regular basis.
- Software upgrade is optional. It is carried out only upon your request.
- If the current database version that you are using has critical security risks, the AnalyticDB for PostgreSQL team will notify you and recommend that you schedule the upgrade. The AnalyticDB for PostgreSQL team provides full support throughout the upgrade.
- The update of AnalyticDB for PostgreSQL is typically completed within five minutes. During the upgrade, network interruptions may occur and the database may become read-only for about one minute. If the database reconnection settings or connection pools are properly configured, the upgrade has minimal impact on applications.

1.11. KVStore for Redis

1.11.1. Security Whitepaper

1.11.1.1. Security Whitepaper

1.11.1.1.1. Platform security protections

1.11.1.1.1.1. 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.

1.11.1.1.1.2. Authentication

The KVStore for Redis instances that you create by using your Apsara Stack tenant account are owned by the account. By default, Apsara Stack tenant accounts have full access permissions on their resources.

KVStore for Redis supports Resource Access Management (RAM) and Security Token Service (STS). RAM allows you to create and manage RAM users. You can grant RAM users access and management permissions on KVStore for Redis resources that belong to your Apsara Stack tenant account. STS allows you to manage short-term access permissions that can be granted to temporary users.

1.11.1.1.1.3. Transmission encryption

KVStore 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 Redis to verify that KVStore for Redis provides database services based on the destination IP address and port. This can prevent man-in-the-middle (MITM) attacks . KVStore for Redis also allows you to enable and update SSL and TLS certificates for servers. You can update SSL or TLS certificates based on your business requirements to ensure security.

> **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 impact depends on the number of connections and the frequency of data transfer.

1.11.1.1.2. Tenant security protections

1.11.1.1.2.1. Account management

To connect to KVStore for Redis instances, you must pass password authentication. Accounts and passwords are credentials to access KVStore for Redis instances. KVStore for Redis optimizes the performance of short-lived connections. Therefore, after you enable password authentication, the performance of KVStore for Redis instances is not affected.

1.11.1.1.2.2. IP address whitelist

To ensure secure access, KVStore for Redis provides the IP address whitelist feature. You can configure IP address whitelists for each KVStore for Redis instance.

By default, KVStore for Redis instances block access from all IP addresses. The default IP address whitelist contains only `127.0.0.1`. To add an IP address or CIDR block to the whitelist, in the KVStore for Redis console, choose **Instance Information** > **Modify 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 configure multiple IP address whitelists. Each whitelist can contain a maximum of 1,000 IP addresses or CIDR blocks.

1.11.1.1.2.3. Backup and restoration

To ensure data integrity and reliability, KVStore for Redis automatically backs up instances on a regular basis. KVStore for Redis allows you to restore instances by using backup sets.

1.11.1.1.2.4. Upgrade management

- KVStore for Redis regularly provides new versions.
- Version upgrade is optional. It is carried out only upon your request.
- If the KVStore for Redis version that you are using has critical security risks, the KVStore for Redis team sends you a notification and recommends that you schedule an upgrade. The KVStore for Redis team provides full support throughout the upgrade.
- An upgrade of KVStore for Redis is typically completed within 5 minutes. During the upgrade, transient connections may occur and your instances may stay in the read-only state for approximately 1 minute. If reconnection mechanisms are configured on your application, an upgrade has minimal impact on your application.

1.12. ApsaraDB for MongoDB

1.12.1. Security Whitepaper

1.12.1.1. Security Whitepaper

1.12.1.1.1. Platform security

1.12.1.1.1.1. Isolation

Network isolation

ApsaraDB for MongoDB allows you to use a VPC for higher-level network isolation.

A VPC is a private network that you configure on Apsara Stack. It strictly isolates your network packets by using underlying network protocols to implement access control at the network layer.

Tenant isolation

ApsaraDB for MongoDB uses virtualization technologies to isolate tenants. Each tenant has separate database permissions. Apsara Stack also enhances the security of database servers. For example, Apsara Stack prohibits read and write operations on system files by using a database. This ensures that you cannot access the data of other users.

1.12.1.1.1.2. Authentication

Identity authentication

Account authentication uses an identity credential to verify the real identity of a user. An identity credential usually refers to a logon password or AccessKey pair. You can create AccessKey pairs in the ApsaraDB for MongoDB console. An AccessKey pair contains an AccessKey ID and an AccessKey secret. The AccessKey ID is public and represents the user identity. The AssessKey secret is used to encrypt the signature string. The server also uses the AccessKey secret to verify the signature string. Make sure that you keep the AccessKey secret confidential.

ApsaraDB for MongoDB performs identity authentication on each access request. Therefore, all HTTP and HTTPS requests must contain the signature information. ApsaraDB for MongoDB implements symmetric encryption through the Access Key ID and Access Key secret to authenticate the request sender. You can apply for an AccessKey ID and an AccessKey secret in the Apsara Uni-manager Operations Console. The AccessKey ID represents the user identity. The AssessKey secret is used to encrypt the signature string. The server also uses the AccessKey secret to verify the signature string. Make sure that you keep the AccessKey secret confidential.

Permission management

To log on to an ApsaraDB for MongoDB instance, you must pass the username and password authentication. After an ApsaraDB for MongoDB instance is created, a root account is created by default. You can either specify the password for the root account when you create an instance or reset the password after you create an instance.

The root account has all management permissions on an ApsaraDB for MongoDB instance. You can log on to the database as the root user to add or delete accounts, and grant permissions to other accounts.

Access control

ApsaraDB for MongoDB instances that you create by using your Alibaba Cloud tenant account are considered resources under this account. An Alibaba Cloud tenant account has full operation permissions on its resources by default.

ApsaraDB for MongoDB supports Resource Access Management (RAM). RAM allows you to grant access and management permissions on the ApsaraDB for MongoDB resources under your account to RAM users.

1.12.1.1.1.3. Data security

ApsaraDB for MongoDB uses a high-availability architecture that features a three-node replica set. The three data nodes are located on different physical servers. The secondary and standby nodes automatically synchronize data from the primary node. Services are provided by the primary and secondary nodes. When the primary node fails, the system automatically selects a new primary node. When the secondary node fails, the standby node takes over the services.

ApsaraDB for MongoDB can automatically create backups. You can quickly restore data to ensure data integrity and reliability.

You can set the frequency to create full physical backups during one week (at least twice per week) and the start time and end time of the backups. In addition, you can perform full physical backups in the ApsaraDB for MongoDB console, or through APIs at any time based on your O&M requirements.

The system automatically backs up incremental logs generated by an ApsaraDB for MongoDB instance. The combination of full backups and incremental logs enables you to restore data to a specific second in time within the backup retention period.

1.12.1.1.1.4. Data encryption

SSL

ApsaraDB for MongoDB provides SSL. You can use the server root certificate to verify whether the destination database is an ApsaraDB for MongoDB instance and prevent man-in-the-middle attacks. ApsaraDB for MongoDB also allows you to enable and update SSL certificates for servers to ensure data security and validity.

TDE

ApsaraDB for MongoDB provides Transparent Data Encryption (TDE). TDE uses the Advanced Encryption Standard (AES) algorithm that is popular around the globe. The key for TDE is encrypted and stored by Key Management Service (KMS). ApsaraDB for MongoDB dynamically reads the key once when the instance is started or migrated. You can log on to the Key Management Service console and replace the key.

After TDE is enabled for an ApsaraDB for MongoDB instance, the data of the newly-created database or collection is encrypted before it is written to a device such as an HDD, SSD, or PCIe card, or to a service such as Object Storage Service (OSS). Data files and backup files of the instance are all stored as ciphertext.

1.12.1.1.1.5. Anti-DDoS

This feature monitors inbound network traffic in real time. When large volumes of malicious traffic is identified, it scrubs traffic through IP filtering. If traffic scrubbing fails, it triggers the black hole threshold.

1.12.1.1.2. Tenant security

1.12.1.1.2.1. Log audit

This feature records all operations that a client performs on a connected database. It provides references for fault analysis, behavior analysis, and security audit. This feature helps you obtain data execution information for analysis. Audit logs will gradually become an essential regulatory requirement of Finance Cloud and other core businesses.

1.12.1.1.2.2. IP address whitelists

ApsaraDB for MongoDB allows you to configure IP address whitelists for each ApsaraDB for MongoDB instance to implement network access control.

The default whitelist of an ApsaraDB for MongoDB instance contains 0.0.0.0/0, which indicates that the instance is accessible from all IP addresses. You can use OpenAPI Explorer or the ApsaraDB for MongoDB console to configure an IP address whitelist. Updating an IP address whitelist does not restart the instance, so your business is not affected.

1.13. Data Management (DMS)

1.13.1. Security Whitepaper

1.13.1.1. Platform security

1.13.1.1.1. Security isolation

DMS controls access at the following four levels: Apsara Stack tenant accounts, users, IP whitelists, and permissions.

- Required. DMS uses RAM users or Apsara Stack tenant accounts as the first-level authentication.
- Required. Users are grouped into different enterprises. These enterprises are isolated between each other. A user of an enterprise cannot access the resources of another enterprise even if the user passes the first-level authentication.
- Required. DMS uses IP whitelists to control access from IP addresses over the Internet.
- Required. After a user passes the third-level authentication, the user still cannot query or update databases and tables if the user does not have the required permissions.

1.13.1.1.2. Authentication

- Authentication for Apsara Stack tenant accounts

Before you use Data Management (DMS), you must log on to the Apsara Uni-manager Management Console by using your account and password. If your logon session expires, logon fails, or 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 after you log on to the DMS console with your Alibaba Cloud tenant account.

- Access control over database accounts

  After you log on to the DMS console by using your Alibaba Cloud tenant account, DMS checks your account permissions when you add a database instance to DMS. One of the DMS users must be the owner of a database to be accessed, or the owner of the database has granted permissions to the current logon user. Otherwise, the current user cannot add the database to DMS for subsequent management.

1.13.1.1.3. Data security

Security control over data

Data security for queries in the SQLConsole.

- Fine-grained access control: DMS allows you to control access to databases at the database, table, or field level without the need to use your database accounts and passwords. Field-level access control allows you to manage several sensitive fields, such as the ID card, mobile phone number, and password.
- Maximum number of returned entries in a single query: If the number of returned entries in an SQL query exceeds the limit, only the specified maximum number of entries can be returned. This prevents data transmission on a large scale. This feature applies to all DMS users on a global scale.
- Maximum number of daily returned entries: If the total number of daily returned entries exceeds the limit, you can no longer issue a query. This prevents data transmission on a large scale. This feature applies to all DMS users and can be changed for a single user.
- Maximum number of daily queries: If the total number of daily queries exceeds the limit, you can no longer issue a query. This prevents data transmission on a large scale. This feature applies to all DMS users and can be changed for a single user.
- Maximum timeout period of a single SQL query: If the execution time of an SQL query exceeds the maximum time period, the system stops the SQL query. This prevents business interruption that is caused by compromised database performance. This feature applies to all DMS users and can be changed for a single instance.
- Maximum size of an SQL table to be queried: The system stops an SQL query for a table if the following conditions are true: 1. The size of the table to be queried exceeds the limit. 2. SQL fails to use an index to perform the query and must transverse the entire table to complete the query. This avoids business interruption that is caused by compromised database performance. This feature applies to all DMS users and can be changed at the database level on a global scale.

1.13.1.1.4. Data encryption

- KMS-based encryption

Server-side encryption is used to protect static data. Apsara Stack Key Management Service (KMS) is a secure and high-availability service that integrates hardware and software and provides a key management system that can be extended to the cloud. KMS uses customer master keys (CMKs) to encrypt the database keys, sensitive information, and sensitive settings of DMS. KMS calls the required API operations to generate data encryption keys (DEKs) at a time. You can define policies in KMS to control and monitor key usage.

- Support for HTTPS and SSL

  DMS supports HTTPS and SSL connections between user-side browsers and DMS servers. This ensures that data is not intercepted during data transmission.

1.13.1.1.5. Limits on changes

Limits on data changes

- Approval for changes: If you do not have the required permissions to change a destination database, you cannot submit a ticket to request changes. This avoids unexpected operations from unauthorized operators. This feature applies to all DMS users. After you obtain the required permissions, you can submit a ticket.
- Accuracy for changes: The syntax of all the SQL statements in a ticket that is submitted to request changes must be valid. If one of the SQL statements is invalid, the system rejects the ticket. This avoids unexpected changes that are caused by invalid syntax. This feature applies to all DMS users.
- Number of affected rows: After the syntax of SQL statements in a ticket is verified, the system checks the number of affected rows. If the actual number of affected rows is different from the estimated number of affected rows, a notification is sent. This avoids unexpected changes that are caused by the deviation between the specified SQL logic and the actual results. This feature applies to all DMS users.
- Process of changes: You can configure approval processes based on the number of affected rows or change type. This ensures security and development efficiency. This feature applies to all DMS users and can be changed for instances.
- Change scripts for transactions: You can enable the transaction feature on demand when changes are being executed on relational databases such as MySQL. If all changes are successful, these changes are applied. If one of these changes fails, all the changes roll back. This ensures transaction compliance. This feature applies to all DMS users and can be enabled or disabled on demand. This feature is unavailable for PolarDB-X (previously called DRDS).
- Execution of change scripts on schedule: If you need to execute changes during off-peak hours, you can configure a schedule that runs a change task at a specified time and returns results. This avoids man-made errors. This feature applies to all DMS users and can be enabled on demand.
- Backup of change scripts: Before you execute a change script, you can back up all the rows to be changed by using an insert script. This allows you to roll back all the changes and restore all the rows that are backed up immediately after unexpected changes occur. This feature applies to all DMS users. In each ticket, you can request to back up a maximum of 500,000 rows.
- Risk management prior to the execution of changes: Before you execute a change, the system checks the metadata lock of the destination table. If the system fails to obtain the metadata lock within 10 seconds, the system retries. After three failed retries, the related database is deemed busy and the change task fails. This prevents the system from adding extra workloads to the database. This also prevents business interruption that is caused by compromised database performance. This feature applies to all DMS users.
- Risk management prior to the execution of changes: Before you execute a change, the system checks

the number of active connections to the destination database. If the number exceeds the limit, the system retries. After three failed retries, the database is deemed busy and the change task fails. This prevents the system from adding extra workloads to the database. This also prevents business interruption that is caused by compromised database performance. This feature applies to all DMS users.

- Management during the execution of changes: After an SQL query is completed, the system switches to the sleep mode. The period of time in sleep mode is used to balance integrated workload across multiple periods of time. This ensures smooth changes. This prevents the system from adding extra workloads to the database. This also prevents business interruption that is caused by compromised database performance. This feature applies to all DMS users.

1.13.1.2. Tenant security

1.13.1.2.1. Log audit

DMS allows you to audit all operational logs. To audit these logs across multiple dimensions, choose **System Management > Security > Operation audit**. Each operational log includes several fields, such as the operator, operation time, operation, and execution impact.

1.14. Server Load Balancer (SLB)

1.14.1. Security Whitepaper

1.14.1.1. Platform security

1.14.1.1.1. Authentication

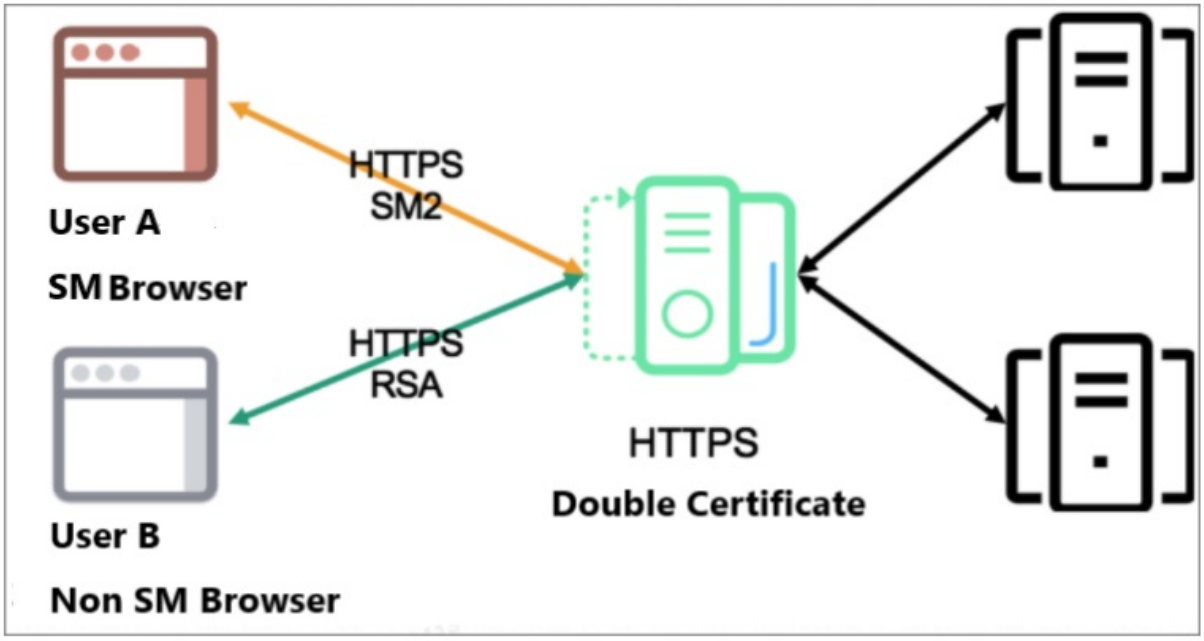
SLB instances created using an Apsara Stack tenant account are owned by the account. By default, the tenant account has full permissions on these resources.

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.

1.14.1.1.2. Encryption in transit

Apsara Stack provides the HTTPS protocol to ensure data security in transit.

The HTTPS service of Apsara Stack supports the RSA and SM encryption algorithms. Systems in fields such as e-government, banking, mobile payment, and e-commerce can use the SM algorithm to enhance security.



In Apsara Stack, both the RSA SSL certificate service and the SM SSL certificate service are deployed on the server. The browser client sends a supported cipher suite when it initiates a request. During the handshake process, the cipher suite is selected based on the internal selection mechanism of the browser and the priority configured in the server. If the browser supports the SM algorithm, the SM Transport Layer Security (TLS) is selected. If the browser does not support the SM algorithm, the RSA TLS is selected.

> **Note** We recommend that you use Chrome Version 69.0.0 and later for the SM algorithm.

1.14.1.2. Tenant security

1.14.1.2.1. 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.

1.14.1.2.2. 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.

1.14.1.2.3. 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.

1.15. Virtual Private Cloud (VPC)

1.15.1. Security Whitepaper

1.15.1.1. Platform security

1.15.1.1.1. 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.

1.15.1.1.2. 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.

1.15.1.2. Tenant security

1.15.1.2.1. Security groups

VPCs use security groups to divide network security domains and implement Layer 3 access control. The security groups act as virtual firewalls and provide stateful inspection and packet filtering features.

VPCs are isolated by default and can be connected to each other through peering connections.

1.16. Log Service

1.16.1. Security Whitepaper

1.16.1.1. Platform security

1.16.1.1.1. Security isolation

Logtail supports multi-tenant isolation. Compared with mainstream open-source collection agents, Logtail has a more refined architecture. A fixed number of threads are used by Logtail to discover events, read data, parse data, and send data. The number of threads does not increase as the number of configurations increases. All configurations operate in the same execution environment. However, Log Service uses multiple technical methods to guarantee processing isolation of configurations, fair scheduling of configurations, reliability and controllability of data collection, and high cost performance of resources.

The characteristics of Logtail multi-tenant isolation are as follows:

- Logtail schedules data collection based on time slices to guarantee isolation and fairness of configuration data endpoints.
- Logtail supports multi-level feedback queues for resource usage to guarantee the isolation and fairness of processing flows and configurations with extremely low resource consumption.
- Logtail supports non-blocking mode of event processing to guarantee high reliability even if log files are rotated when configuration is blocked or data collection is stopped.
- Logtail supports different throttling mechanisms for various configurations, policies of stopping collection, dynamic configuration updates to guarantee a high level of control for data collection.

1.16.1.1.2. Authentication

To ensure the security of log data, this topic describes the authentication method. The process of authentication works the same as that of the identity authentication. This authentication method allows you to delete a Resource Access Management (RAM) user. Each HTTP request of a Log Service API operation must pass security verification to ensure log data security. The security authentication is based on the Alibaba Cloud AccessKey and is done by using the symmetric encryption algorithm.

The following procedure shows how authentication works:

1. The requester generates a signature string based on the API request content (including HTTP header and body).
2. The requester uses Alibaba Cloud AccessKey pair (AccessKey ID and AccessKey secret) to sign the signature string generated in the first step. A digital signature is generated for this API request.
3. The requester sends both the API request content and digital signature to the server.
4. After the server receives the request, the server repeats Step 1 and Step 2 to compute the expected digital signature for this request.

   > **Note** The server retrieves the AccessKey pair used by this request from the background.

5. The server compares the expected digital signature with the digital signature sent from the requester. If they are the same, the request passes security authentication. Otherwise, the request is rejected.

1.16.1.1.3. Data security

The operation of collecting Log Service user data is mapped to reading and writing operations of files which are stored in the Apsara Stack data system.

Apsara Stack uses a flat network in which a linear address space is divided into slices, which are also called chunks. Each chunk is duplicated into three copies. Each copy is stored on different nodes in the cluster to ensure the reliability of data.

The triplicate technology used for the Apsara Stack data system involves three key components: master, chunk server, and client. Each write operation performed by an ECS user undergoes several processes before the client executes the operation. The following section describes how the client executes this operation:

1. The client determines the location of the chunk corresponding to the write operation.
2. The client sends a request to the master to query the storage locations (chunk servers) of all 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 all factors of the entire system into account, such as chunk server disk usage, chunk server distribution across different racks, power distribution conditions, and machine workloads. This strategy ensures that each chunk replica is distributed on different chunk servers across different racks, which effectively prevent data unavailability if a rack or chunk server fails.

In the cases of data node damage or hard disk failures on data nodes, the total number of valid replicas of some chunks become less than three. In these cases, the master replicates data between chunk servers to maintain three valid replicas of all chunks in the cluster.

All user operations including addition, modification, and deletion of data are synchronized to the three copies. This mechanism ensures the reliability and consistency of user data.

Furthermore, when you delete data, the released storage space is reclaimed by Apsara Distributed File System and is not accessible to users. Data erasure is performed before the storage space is reused. This mechanism provides the highest level of data security.

1.16.1.1.4. Encrypted data transmission

Log Service ensures your data security in transmission by using the following methods:

- You use your Alibaba Cloud AccessKey to perform Log Service authentication. To prevent data tampering during data transmission, the Logtail client obtains your Alibaba Cloud AccessKey to sign all log data packets before they are sent. The Logtail client also uses the HMAC SHA1 signature algorithm for authentication.

  > **Note** The Logtail client obtains your Alibaba Cloud AccessKey over HTTPS to ensure the security of your AccessKey.

- The API layer uses the signature authentication mechanism to control access permissions and ensure the security of your data.
- Log Service applies HTTPS and SSL to the network connection between a client and a server to ensure that data is not monitored or stolen during transmission. Log Service communicates with the client over HTTPS to ensure data security.

1.16.1.1.5. Encrypt data

Log Service allows you to use Key Management Service (KMS) to encrypt data for secure storage.

Log Service encrypts data by using KMS. The data encryption mechanism has the following characteristics:

- Log Service supports the Advanced Encryption Standard (AES) encryption algorithm.
- You can create and manage a customer master key (CMK) in the KMS console to ensure the security of the CMK.
- Log Service supports the following encryption types:
  - Service key-based encryption: Log service generates an independent service key for each Logstore. The service key never expires.
  - Bring Your Own Key (BYOK) encryption: You can create a CMK in the KMS console and grant the relevant permissions to Log Service. When Log Service calls a KMS API operation, this CMK is used to create a key for data encryption. If the CMK is deleted or disabled, the BYOK key becomes invalid.

1.16.1.2. Tenant security

1.16.1.2.1. Service monitoring

Log Service monitors machine group status and log collection status of Logtail in real time.

- Machine group status

  Log Service monitors the heartbeat status of all the servers in your machine group in real time. The server status can be **OK** or **Fail**. **Fail** indicates that the machine group is in an abnormal state and cannot collect logs.

- Log collection status

  When you use Logtail to collect logs, Log Service sends alerts through **Collection Error Diagnosis** if errors such as failed regular expression parsing, invalid file path, and insufficient shard capacity occur. Alerts contain information about the errors, such as the time of occurrence, the IP address of the server, the number of errors, and the types of errors.

1.17. Key Management Service (KMS)

1.17.1. Security Whitepaper

1.17.1.1. Platform security

1.17.1.1.1. Security isolation

This topic describes the security isolation of KMS.

> **Note** No instances are deployed in KMS. Therefore, resource isolation caused by instance virtualization do not occur.

CMKs are the only resources in KMS. You can use CMKs by calling API operations but cannot directly access the CMK data. Security isolation is implemented at the network layer of the API.

1.17.1.1.2. Authentication

1.17.1.1.2.1. Authentication

You can create an AccessKey pair in the Apsara Uni-manager Management Console. An AccessKey pair consists of an AccessKey ID and AccessKey secret. The AccessKey ID is public and uniquely identifies a user, whereas the AccessKey secret is private and used to authenticate a user.

Before you send a request to KMS, you must generate a signature string for the request in the format specified by KMS. Then, you must encrypt the signature string by using your AccessKey secret to generate a verification code based on the Hash-based Message Authentication Code (HMAC) algorithm. The verification code carries a timestamp to prevent replay attacks. After KMS receives the request, KMS finds the AccessKey secret based on your AccessKey ID, and uses the AccessKey secret to extract the signature string and verification code. If the generated verification code is the same as that in the request, KMS determines that the request is valid. Otherwise, KMS rejects the request and returns HTTP status code 403.

1.17.1.1.2.2. Access control

Resource Access Management (RAM) is used for access control in KMS. You can use RAM policies to define different identity types and grant RAM users permissions on KMS.

Permissions on KMS have the following basic elements:

- Action: the Action parameter in KMS API requests. For example, you can specify this parameter to create, delete, modify, or query keys, as well as to encrypt or decrypt data by using keys. Each API operation corresponds to an action. You can grant permissions on each action to an identity.
- Resource: Keys are the only resources of KMS. Key IDs are used to identify resources.

1.17.1.1.2.3. RAM authentication and STS authentication

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

RAM is a service provided by Apsara Stack to manage access permissions on resources. You can use an Apsara Stack account to log on to the RAM console, create a RAM user or RAM role, and then grant the access permissions on resources to the RAM user or RAM role.

STS is a service provided by Apsara Stack to manage temporary access credentials. You can use STS to grant temporary access tokens to RAM entities such as RAM users and RAM roles. You can customize the validity period and access permissions of the STS tokens. The STS tokens automatically become invalid upon expiration.

1.17.1.1.3. Data security

KMS uses multiple mechanisms to ensure the security of your data.

Data in KMS refers to the customer master keys (CMKs) that are created and managed in KMS. CMKs are stored in ApsaraDB RDS servers in primary/secondary mode. Each primary or secondary server has its own redundancy and backup mechanism. This way, ApsaraDB RDS implements hierarchical redundancy for CMK data.

The key material of CMKs is encrypted by KMS before the material is stored on disks. KMS provides a hierarchical key architecture and automatically rotates upper-layer keys.

1.17.1.1.4. Transmission encryption

KMS implements end-to-end encryption for data transmission.

When you send a request to KMS, you must use HTTPS to ensure the privacy and integrity of the exchanged information.

1.18. Apsara Stack DNS

1.18.1. Security Whitepaper

1.18.1.1. Tenant security

1.18.1.1.1. 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.

1.18.1.1.2. 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.

1.18.1.1.3. 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.

1.19. API Gateway

1.19.1. Security Whitepaper

1.19.1.1. Platform security

1.19.1.1.1. Security isolation

API Gateway isolates resources by tenant. Resources belong only to the tenant account they are created in. Resources are isolated between different tenants.

1.19.1.1.2. Authentication

1.19.1.1.2.1. Authentication

You can create an app in the API Gateway console. After you create an app, a key pair that consists of an AppKey and an AppSecret is automatically assigned to the app. The AppKey is a public key that is used to identify your identity. The AppSecret is a private key that is used to authenticate your identity.

Before you send a request to API Gateway, you must generate a signature string for the request in the format specified by API Gateway. Then, you must use your AppSecret to encrypt the signature string based on the HMAC algorithm to generate a verification code. The verification code contains a timestamp to prevent replay attacks. After API Gateway receives the request, API Gateway finds the AppSecret that corresponds to the AppKey, and extracts the signature string and verification code in the same way. If the calculated verification code is the same as the one received, the request is valid. Otherwise, API Gateway rejects the request and returns an HTTP 403 error.

1.19.1.1.2.2. API access control

API Gateway users consist of API providers and third-party users (API callers). The provider of an API can request a third-party user to provide an AppId. After the API provider authorizes the application specified by AppId to call the API, the third-party user can immediately initiate an access request to the API by using the AppKey and AppSecret of the application.

An access request must carry the signature of the user who accesses the API. A signature-based access request is a request that contains signature information in the header as stipulated in the API Gateway documentation.

1.19.1.1.2.3. RAM and STS support

API Gateway allows you to manage APIs through RAM and STS.

Resource Access Management (RAM) is a resource access control service provided by Alibaba Cloud. You can use an Apsara Stack tenant account to create RAM user accounts and grant them permissions to access the resources that belong to the tenant account.

Security Token Service (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.

1.19.1.1.3. Data security

API Gateway uses signature authentication to ensure the consistency and integrity of user data when an API is called. In addition, API Gateway provides the data cleansing function. During data cleansing, invalid parameters are cleaned to ensure the security of requests.

API Gateway requires the caller to add user identity information to the API request, and add an encrypted signature to the data for transmission. After receiving an API request, API Gateway verifies the user identity and checks data for integrity and consistency.

In addition, API Gateway can clean invalid parameters that are not preset by users. This ensures that only valid and secure API requests are approved.

1.19.1.1.4. Transmission encryption

API Gateway supports HTTPS to ensure the security of data during transmission.

1.19.1.2. Tenant security

1.19.1.2.1. Log audit

Log Service is a log management service provided by Alibaba Cloud. API Gateway can be used together with Log Service to provide you with access, monitoring, and audit information query and display functions. API Gateway records API requests in real time and synchronizes the logs to Log Service on a regular basis. Request logs contain information such as the request time, source IP address, requested object, returned code, and processing duration.

1.19.1.2.2. IP address-based access control

API Gateway allows you to set a blacklist and a whitelist based on the ClientIP of a caller.

An IP address-based access control policy takes effect immediately after you bind it to an API. This can prevent API requests from unauthorized IP addresses.

- Blacklist: prohibits API requests from the specified IP addresses.
- Whitelist: permits the API requests from only the specified IP addresses.

1.20. Message Queue for Apache RocketMQ

1.20.1. Security Whitepaper

1.20.1.1. Platform security

1.20.1.1.1. Authentication

Identity authentication

Access control for Message Queue for Apache RocketMQ involves the following elements:

- Accessed instance: instance ID
- Accessed resources: topics
- Access object: user accounts, including Apsara Stack tenant accounts and RAM users

The permission types of Message Queue for Apache RocketMQ include:

- Publish permission
- Subscribe permission

When you create a topic in Message Queue for Apache RocketMQ, the system grants you permissions to publish and subscribe to messages within the topic by default. When you create a producer or consumer for the topic, the Message Queue for Apache RocketMQ console automatically authenticates the topic. When you use this topic to send or subscribe to messages, a RocketMQ broker also authenticates the topic.

The Message Queue for Apache RocketMQ console performs authentication and access control on each request. In addition, all service components of Message Queue for Apache RocketMQ, including RocketMQ Name Servers and RocketMQ brokers, provide API-level authentication. The signature and permissions are authenticated for each API request by using the HMAC-SHA1 algorithm to ensure data security.

In the authentication process, your AccessKey ID and AccessKey secret are used to verify the signature and resource permissions.

Authorization

Each resource has only one owner. A resource owner must be an Apsara Stack tenant account. The owner of a resource has full permissions on the resource. The owner of a resource is not necessarily the creator of the resource. Assume that a RAM user is granted management permissions on Message Queue for Apache RocketMQ. The resources that are created by the RAM user still belong to the Apsara Stack tenant account of the RAM user. The RAM user is the resource creator but not the resource owner.

Without authorization by the owner of a resource, other Apsara Stack tenant accounts or RAM users cannot access the resource. A resource owner can grant resource permissions to or revoke resource permissions from other users.

You can use the following two authorization methods:

- As a resource owner, you can use the authorization features in the Message Queue for Apache RocketMQ console, including cross-account and RAM user authorization.
- After you log on to the Apsara Uni-manager Management Console by using your Apsara Stack tenant account, you can grant different permissions to RAM users based on different authorization policies.

Access control

Message Queue for Apache RocketMQ provides two network access modes: Any Tunnel and Single Tunnel. After Message Queue for Apache RocketMQ is deployed, this service provides the Any Tunnel access mode by default. In Any Tunnel mode, Message Queue for Apache RocketMQ can be freely used in all virtual private clouds (VPCs). This access mode can meet the needs of most users. You can change the access mode to Single Tunnel in the Message Queue for Apache RocketMQ console or by calling API operations. In Single Tunnel mode, Message Queue for Apache RocketMQ is used only in a specified VPC.

1.20.1.1.2. Isolation

Message Queue for Apache RocketMQ allows you to obtain advanced network access control by using virtual private clouds (VPCs). A VPC is a private network in Apsara Stack. It strictly isolates your network packets by using the underlying network protocol and implements access control at the data link layer. Using a virtual private network (VPN) or an Express Connect circuit, you can connect servers in your data center to Apsara Stack, use the Classless Inter-Domain Routing (CIDR) block of the VPC to resolve IP address conflicts, and access Message Queue for Apache RocketMQ from both your servers and your Apsara Stack Elastic Compute Service (ECS) instances.

In addition, Message Queue for Apache RocketMQ allows you to deploy multiple VPCs. Different service clusters can be bound to different VPCs to achieve both physical isolation and isolation on the network. This provides fine-grained protection for test, staging, and production environments.

1.20.1.1.3. Transmission encryption

Message Queue for Apache RocketMQ supports Transport Layer Security (TLS) that ensures security and data integrity for the communication among all service components and between RocketMQ clients and service components. In addition, in consideration of the validity period of TLS certificates, Message Queue for Apache RocketMQ also supports dynamic certificates and private key update. This saves you the trouble of a restart for certificate replacement. Private keys are stored in ciphertext and automatically decrypted during use to ensure security.

On the basis of encryption at the transport layer and the access control of Message Queue for Apache RocketMQ, the signature and permissions are authenticated for each API request. This ensures data security and integrity.

Although Message Queue for Apache RocketMQ can encrypt its connection to an application, TLS can work properly only after authentication is enabled on RocketMQ brokers. In addition, TLS consumes extra CPU resources and affects the throughput and response time of Message Queue for Apache RocketMQ. The severity of the impact depends on the number of user connections and the frequency of data transmission.

1.20.1.2. Tenant security

1.20.1.2.1. User blacklist

In addition to authentication, Message Queue for Apache RocketMQ also provides the user blacklist to implement access control for network security.

Message Queue for Apache RocketMQ uses the user blacklist to prevent access from illegal users such as those who perform malicious attacks. This way, malicious attacks on Message Queue for Apache RocketMQ can be prevented.

1.20.1.2.2. Log audit

Log audit is an important part of network security. All manual operations in the Message Queue for Apache RocketMQ console are recorded by using log audit.

Log audit events include the delete, create, and update operations, such as creating and deleting topics and granting and revoking permissions. All logs are provided with audit logs that are retained for a long period.

Audit logs are integrated into the Apsara Uni-manager Operations Console. All data is collected in real time and stored offline so that you can query and audit data offline with ease.

1.21. MaxCompute

1.21.1. Security Whitepaper

1.21.1.1. Platform security

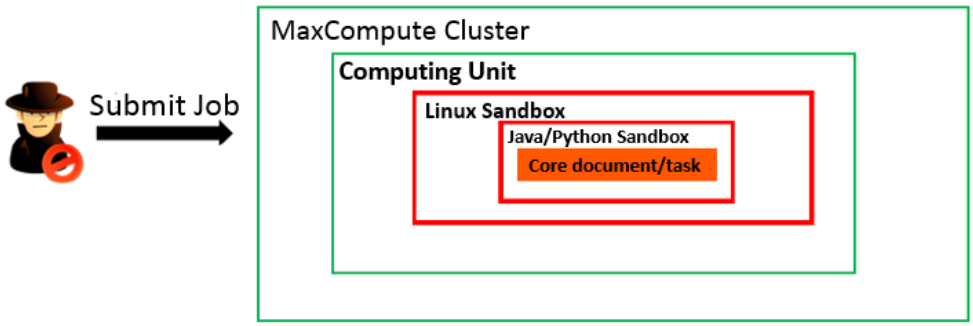
1.21.1.1.1. Security isolation

This topic describes security isolation for MaxCompute platform security.

MaxCompute can be used to handle security issues in multi-tenant scenarios. It integrates the authentication system of Alibaba Cloud to authenticate users by using symmetric AccessKey pairs. MaxCompute verifies the signature in each HTTP request, and discretely stores and isolates data of different users in Apsara Distributed File System. This allows MaxCompute to meet the requirements for multi-tenant collaboration, data sharing, data confidentiality, and data security.

MaxCompute runs all computing jobs in individual sandboxes. The sandbox architecture has multiple layers from the kernel layer to the KVM virtualization layer. The sandboxes use an authentication mechanism to ensure data security and prevent server faults caused by misoperations or malicious operations.

Sandbox-based protection



Network isolation

MaxCompute is a big data platform provided by Alibaba Cloud to process large amounts of data. It complies with isolation standards to ensure data security. MaxCompute supports virtual private clouds (VPCs), which allow you to isolate data. Limits are imposed when you use MaxCompute in VPCs.

Limits:

- The classic network, VPCs, and the Internet are isolated from each other. Users can access only the endpoints and virtual IP addresses (VIPs) of their own networks.
- Domain names that pass the verification on the three types of networks can be used to access the projects that do not have VPC IDs or IP address whitelists configured.
- Projects that have VPC IDs configured are accessible only to the specified VPCs.
- Projects that have IP address whitelists configured are accessible only to the hosts whose IP addresses are added to the IP address whitelists.
- If a request is sent by a proxy server, the request is allowed or denied based on the VPC ID and IP address of the last-hop proxy server.

Elasticsearch on MaxCompute is an enterprise-class full-text retrieval system developed by Alibaba Cloud. It must also comply with isolation standards to ensure data security. Therefore, Elasticsearch on MaxCompute supports VPCs. Limits are imposed when you use Elasticsearch on MaxCompute in VPCs.

Limits:

- The classic network, VPCs, and the Internet are isolated from each other. Users can access only the endpoints and VIPs of their own networks.
- Domain names that pass the verification on the three types of networks can be used to access the projects that do not have VPC IDs or IP address whitelists configured.
- When an Elasticsearch cluster is started in a MaxCompute project, they share the same whitelist of

VPCs.

- By default, if an Elasticsearch cluster is started, the cluster occupies all resources. If you want to start more Elasticsearch clusters, you must scale up the MaxCompute project or scale down the Elasticsearch cluster.

When you deploy MaxCompute in Apsara Stack, a MaxCompute project is automatically created and an Elasticsearch cluster is automatically started in the project. You can start your Elasticsearch cluster in your MaxCompute project. After the cluster is started, you must apply for a domain name and VIP and verify the Elasticsearch cluster deployed in a VPC in the Elasticsearch frontend.

1.21.1.1.2. Authentication

This topic describes authentication for MaxCompute platform security.

Identity authentication

You can create an AccessKey pair in the Apsara Uni-manager Management Console. An AccessKey pair consists of an AccessKey ID and an AccessKey secret. The AccessKey ID is public and used to identify a user, whereas the AccessKey secret is private and used to authenticate the user identity.

Before the client sends a request to MaxCompute, the client generates a string to be signed in the format specified by MaxCompute, uses the AccessKey secret to encrypt the string, and then generates a signature for the request. After MaxCompute receives the request, it identifies the AccessKey secret based on the AccessKey ID and generates a signature. If the signature is the same as that sent by the client, the request is valid. Otherwise, MaxCompute rejects the request and returns an HTTP 403 error.

Access control

You can use an Apsara Stack tenant account or a RAM user to access MaxCompute resources. Different RAM users can be created within one Apsara Stack tenant account. MaxCompute checks the permissions of your Apsara Stack tenant account or RAM user each time you access its resources.

- If you access a resource by using your Apsara Stack tenant account, MaxCompute checks whether the account is the resource owner. A resource is accessible only to its owner.
- If you access a resource as a RAM user, MaxCompute checks whether the Apsara Stack tenant account to which the RAM user belongs is the resource owner and whether the RAM user has been granted permissions on that resource.

> **Note** If an Apsara Stack tenant account other than the resource owner and its RAM users are granted permissions on the resource, they can also access the resource.

MaxCompute supports the following two authorization mechanisms to control access from RAM users:

- ACL-based authorization is an object-based authorization mechanism. An access control list (ACL) contains access permissions on an object. It is a resource of the object. The ACL takes effect only when the object exists. If the object is deleted, the ACL of the object is also deleted. ACL-based authorization is similar to the authorization mechanism that is implemented by using the GRANT and REVOKE statements defined in SQL-92. You can execute these statements to grant or revoke permissions on an object.

> **Note** ACL-based authorization allows you to separately manage field-level permissions. ACL fields and tables are independent authorization objects and contain complete authorization information. You can separately grant permissions on ACL fields and tables and specify expiration time and conditions. You can separately view authorization information and revoke permissions.

- Policy-based authorization is the other authorization mechanism that MaxCompute supports. An access control policy contains access permissions on both 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 or delete policies associated with an object when the object is deleted. MaxCompute uses a custom language to specify access control policies for objects.

Hierarchical authorization of management permissions

MaxCompute supports hierarchical authorization of management permissions. Permission objects and operations are used to define permissions on management operations. You can use existing access control mechanisms, such as policy-based or ACL-based authorization, to control permissions on management operations.

Permission objects include policies, ACLs, project configurations, and projects. Permission operations are the actions that are performed on permission objects, such as the PUT action in a PUT policy and the CREATE action on projects.

Fine-grained management permissions support more complex access control scenarios, such as allowing only specific clients to perform management operations.

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

To implement fine-grained permission management and enhance data security, MaxCompute provides fine-grained column-level authorization based on permission model 2.0.

MaxCompute provides centralized management and query APIs for fine-grained column-level authorization based on permission model 2.0.

- MaxCompute and DataWorks allow for fine-grained tenant authorization and access control on data shared across tenants by using packages.
- MaxCompute allows you to authorize users to access tables and track the queries on those tables.

The following examples show how to configure fine-grained column-level authorization based on permission model 2.0.

> **Note** Fine-grained authorization cannot be implemented by using access control policies because they cannot ensure data security. The following examples show how to implement fine-grained authorization by using ACLs.

Syntax for ACL-based fine-grained authorization

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

```
grant <privileges> on table <name>(<column_list>) to|from USER|ROLE <user|role name>;
-- Grant permissions.
revoke <privileges> on table <name>(<column_list>) to|from USER|ROLE <user|role name>;
-- Revoke permissions.
```

Description:

- If you grant permissions on a table, permissions are granted on all columns in the table, including the added columns and columns whose names are changed.
- If you grant or revoke permissions on columns, permissions on the columns can be differentiated from other permissions or merged with similar permissions.
  - If you grant the SELECT permission on col1 and col2 and grant the DESCRIBE permission on col2 and col3, both authorization statements are valid.
  - If you grant the SELECT permission on col1 and col2 and grant the SELECT permission on col3 and col4, the SELECT permission takes effect on col1, col2, col3, and col4.
- Only project owners and other authorized users can grant permissions.

- Add columns to a package across projects

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

> **Note** If you add the same column to a package multiple times, permissions on the column can be differentiated from other permissions or merged with similar permissions.

Description:

- The syntax to allow the addition of columns to the package remains unchanged.
- The syntax to install or uninstall the package remains unchanged. However, permissions on added columns must be taken into account.
- Only project owners and other authorized users can grant permissions.

- Grant or revoke permissions on columns across projects

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

Description:

- The rules used to grant or revoke permissions within a project take effect for cross-project authorization only when a table is added to multiple packages.
- You can grant or revoke permissions only on columns that are added to the packages. However, permissions on columns in the tables that are added to multiple packages must be taken into account.
- Only project owners and other authorized users can grant permissions.

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

Permission query: You can query permissions within a project, query package permissions, and query permissions across projects.

- 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, permissions only on this 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 commands return 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: Relevant information is included in audit logs.

Access control

MaxCompute supports RAM authorization.

Resource Access Management (RAM) is a resource access control service provided by Alibaba Cloud. You can use your Apsara Stack tenant account to create RAM users and grant them permissions to access specific resources owned by the account.

1.21.1.1.3. Data security

This topic describes data security for MaxCompute platform security.

MaxCompute has passed an independent third-party audit on compliance with the trust services criteria for security, availability, and confidentiality established by American Institute of Certified Public Accountants (AICPA).

Apsara Stack provides a flat storage system in which a linear address space is divided into chunks. Each chunk is replicated into three copies. These copies are stored on different data nodes of the storage cluster to ensure data reliability.

The data storage system for Apsara Stack involves three key components: master, chunk server, and client. Write operations in MaxCompute are processed and executed by the client. Procedure:

1. The client determines the chunk requested by the write operation.
2. The client sends a request to the master to query the chunk servers where the three chunk copies are stored.
3. The master returns the addresses of the chunk servers. Then, the client sends the write request to

the chunk servers.

4. If the write operation succeeds in all three chunk copies, the client returns a success message. Otherwise, the client returns a failure message.

The master takes into account the disk usage of all chunk servers in the cluster, distribution of chunk servers in different server racks, power supply status, and server load. This ensures that the three copies of a chunk are distributed on different chunk servers in different racks. This way, data is still accessible even if a chunk server or rack is faulty.

If a data node or its hard disks are faulty, some chunks may have less than three valid copies. In this case, the master replicates data between chunk servers to ensure that each chunk in the cluster has three valid copies.

All data operations in MaxCompute, such as addition, modification, and deletion, are synchronized to the three copies. This mechanism ensures data reliability and consistency.

After you delete data, the storage space is reclaimed by Apsara Distributed File System. Before the storage space is released, it is inaccessible to all users, and Apsara Distributed File System clears data from it. This provides maximum protection for your data.

1.21.1.1.4. KMS-based storage encryption

This topic describes KMS-based storage encryption for MaxCompute platform security.

Background information

MaxCompute is deployed more and more widely around the world, and its security requirements increase. The need to protect sensitive data, such as user privacy and financial information, becomes more and more crucial. MaxCompute must implement data-at-rest encryption to meet compliance and regulatory requirements.

MaxCompute provides storage encryption. It uses Apsara Distributed File System to encrypt, store, decrypt, and manage user data, and uses Key Management Service (KMS) to ensure the security of user data and keys.

MaxCompute storage encryption provides an additional layer of security and minimizes the damages caused by data loss. Even if encrypted data is lost or stolen, no meaningful content can be extracted from the data.

> **Note**
>
> - MaxCompute storage encryption enables transparent encryption and decryption by using customer master keys (CMKs) to simplify user operations.
> - MaxCompute allows you to configure the storage encryption settings by project. After encryption settings are configured for a project, all data that is subsequently written to the project is encrypted to reduce security risks.
> - MaxCompute storage encryption is backward compatible. It allows unencrypted projects to be encrypted and allows both encrypted and unencrypted data to coexist in a project.

Description

- MaxCompute uses projects as its basic unit and stores the table data of projects in encrypted form. Only full table encryption is supported. Resources and volumes cannot be encrypted.
- The types of tasks that support storage encryption are SQL Task 2.0, including the service mode,

MergeTask, and Tunnel. After storage encryption is enabled for a project, table data written by using these types of tasks is stored in encrypted form.

- AES-CTR, AES-256, RC4, and SM4 encryption algorithms are supported.
- MaxCompute is connected to KMS to ensure key security. You must activate KMS to generate and manage keys for encryption and decryption. After you submit a request to enable storage encryption, MaxCompute automatically connects to KMS to generate the keys required for encryption.

  > **Note** Projects that belong to the same project owner share the same key.

- You can read encrypted and unencrypted data without the need to change task types. Encrypted and unencrypted data can coexist in a project.

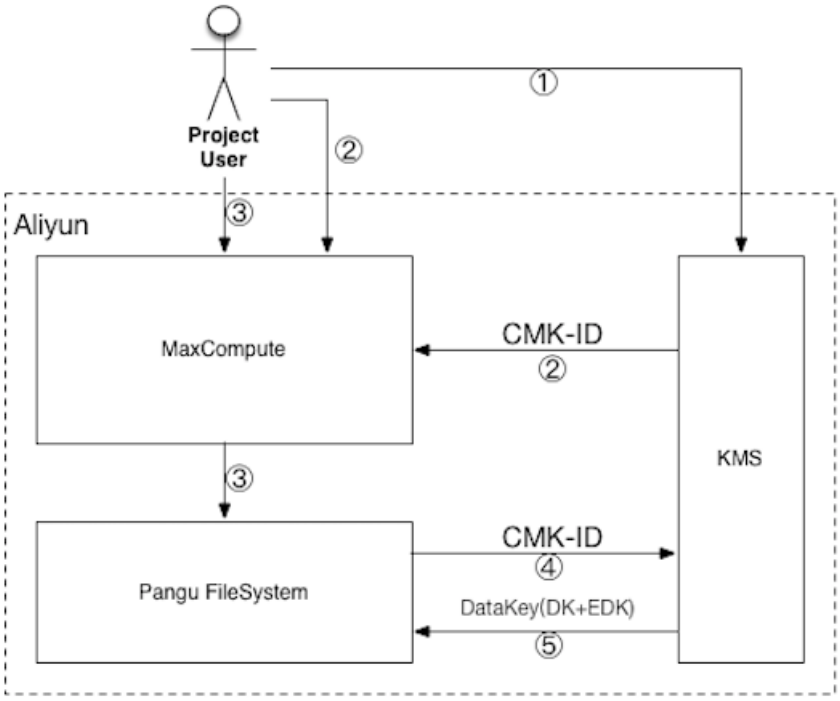
Procedure to encrypt data

1. Activate KMS.
2. Enable MaxCompute storage encryption.

   > **Note** When you enable storage encryption, the system asks KMS to create a CMK. The CMK is used to protect the data key used for encryption.

3. After KMS is activated and storage encryption is enabled, submit jobs in MaxCompute for data computing and processing. After the jobs are complete, MaxCompute uses Apsara Distributed File System to encrypt the data for storage.
4. Apsara Distributed File System provides KMS with the created CMK to obtain the data key used for encryption.
5. The data key obtained from KMS consists of a Data Key (DK) and an Enveloped Data Key (EDK). A DK is a plaintext key used to encrypt data, and an EDK is a ciphertext key generated after envelope encryption is implemented on the DK. After Apsara Distributed File System encrypts data by using the DK, it stores the encrypted data and EDK to complete the data encryption process.

The following figure shows how to encrypt data.



Procedure to process encrypted data

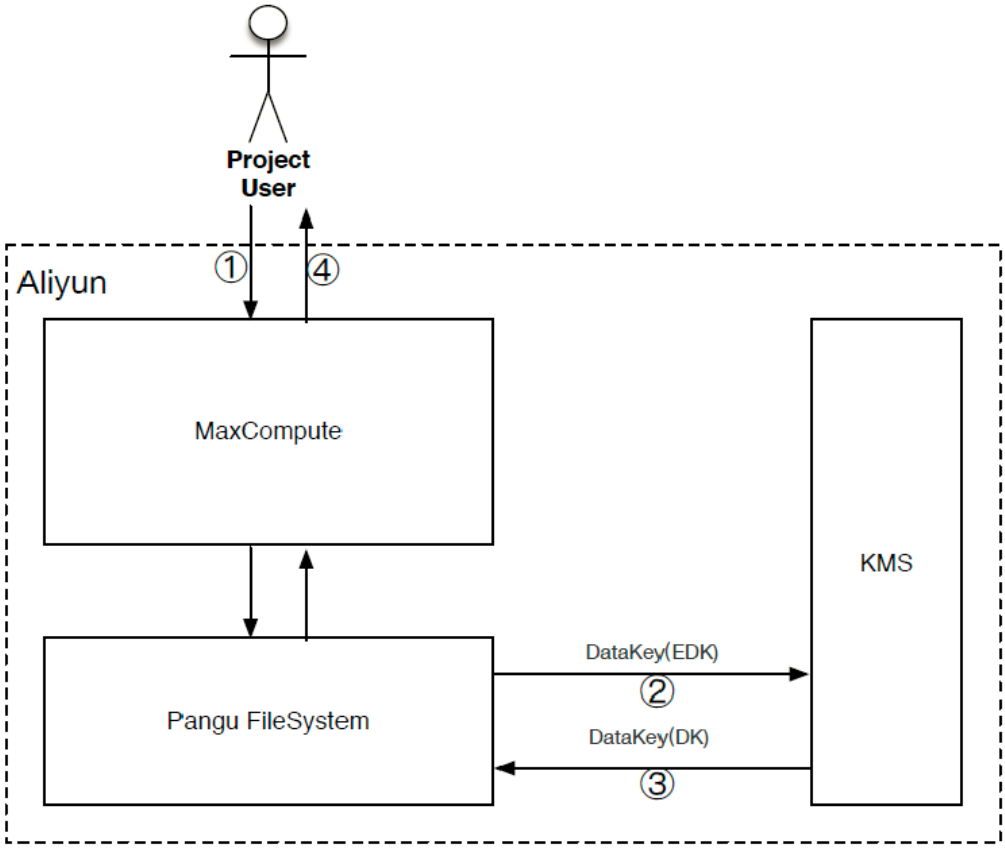
If you use MaxCompute to process encrypted data, the system automatically decrypts the data. You do not need to perform other operations to decrypt data.

1. Submit a MaxCompute job 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 data 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 results.

The following figure shows how to process the encrypted data.



Use of CMKs for storage encryption

MaxCompute supports CMKs to meet your business and security requirements in different scenarios. When you create a project, you can specify a CMK to encrypt data.

Procedure to use a CMK to encrypt and decrypt data:

1. When you create a project, send a request to enable storage encryption.
2. Specify the CMK ID used by the project.

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

   > **Note** If you use the CMK that you created or uploaded in KMS, you must authorize MaxCompute to use the CMK.

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

Usage notes

If you enable storage encryption for a project, take note of the following rules:

- You must activate KMS by using your Apsara Stack tenant account. If KMS is not activated, a message appears, 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. If you do not specify the encryption algorithm, the default algorithm AES-CTR is used.

- A MaxCompute production engineer must enable storage encryption for a project and specify the encryption algorithm by using AdminConsole. Then, AdminConsole automatically accesses KMS to generate the CMK required for encryption.
- After the project configuration takes effect, the table data that is generated or imported by using the tasks that support storage encryption is stored in encrypted form.
- User data stored before storage encryption is enabled cannot be automatically encrypted. If automatic encryption of the data is required, you must write the data again after storage encryption is enabled.

Special notes

- After storage encryption takes effect, MaxCompute automatically encrypts and decrypts data. No additional operations are required to use the data.
- In addition to the supported task types mentioned in the "Description" section, other task types, such as OpenMR, can be used but do not support data encryption.
- After storage encryption takes effect for a project, you can query your keys in KMS. However, you cannot modify the keys or encryption algorithms.
- Storage encryption can be disabled. After storage encryption is disabled, new data is no longer stored in encrypted form. Encrypted data remains encrypted until it is overwritten. The existing encrypted data can still be read in KMS.
- MaxCompute must use an STS token of a Resource Access Management (RAM) role to access your keys. Therefore, you must evaluate the load on RAM.

Additional instructions

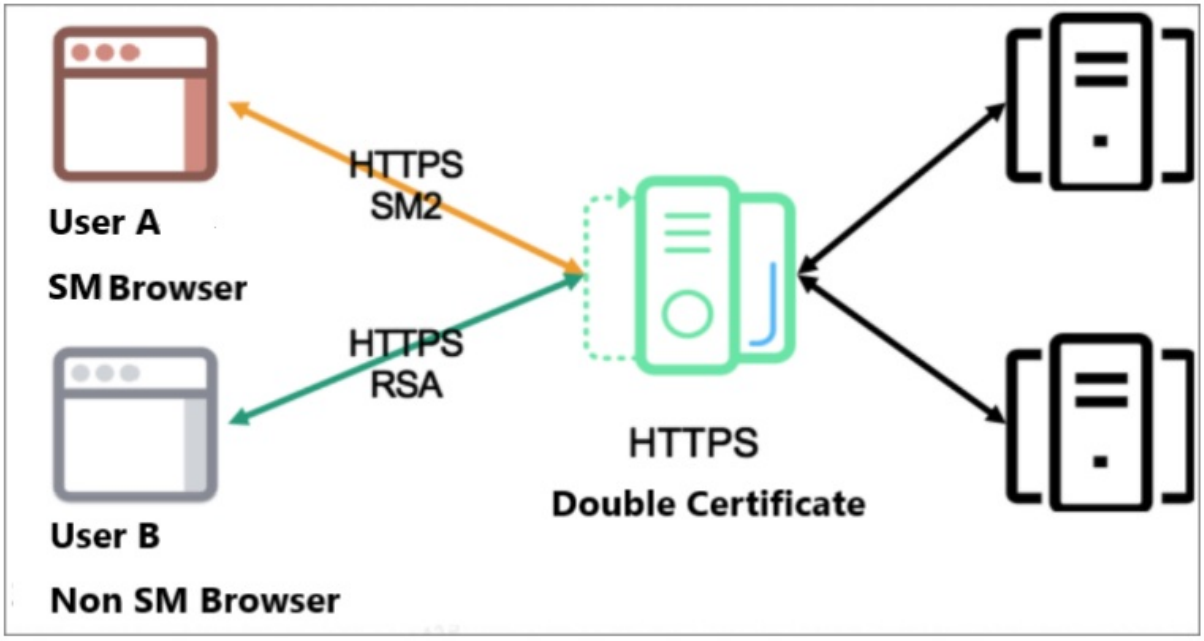
You can configure the storage encryption settings in the Apsara Uni-manager Management Console and Apsara Uni-manager Operations Console. You can enable storage encryption when you create a project in the Apsara Uni-manager Management Console and encrypt data when you manage projects in the Apsara Uni-manager Operations Console.

1.21.1.1.5. Transmission encryption

This topic describes transmission encryption for MaxCompute platform security.

Apsara Stack uses the Hypertext Transfer Protocol Secure (HTTPS) protocol to ensure the security of data transmission.

The HTTPS service of Apsara Stack supports both the Rivest-Shamir-Adleman (RSA) algorithm and the ShangMi (SM) algorithm. The SM algorithm meets the security requirements of various systems, such as e-government systems, bank payment systems, mobile payment systems, and e-commerce systems.



In Apsara Stack, both the RSA and SM SSL certificates are deployed on a server. When a browser client initiates a request, the client includes information about supported cipher suites in the request. During the handshake process, the cipher suite to use is determined based on the internal selection mechanism of the browser and the priority configured in the server.

- If the browser supports the SM algorithm, SM Transport Layer Security (TLS) is selected.
- If the browser does not support the SM algorithm, RSA TLS is selected.

> **Note** To adapt to the SM algorithm, make sure that the kernel version of Google Chrome is 69.0.0 or later.

1.21.1.2. Tenant security

1.21.1.2.1. Cross-project resource sharing

This topic describes cross-project resource sharing for MaxCompute tenant security.

Assume that you are the owner or administrator who assumes the admin role of a project and a user requests to access the resources of your project. If the user belongs to your project team, we recommend that you grant permissions to the user by using the authorization management feature. If the user does not belong to your project team, you can share resources with the user across projects by using packages.

You can share data and resources across projects by using packages.

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. Then, the administrator of Project B installs the package in Project B and determines whether to grant the permissions on the package to other users in Project B.

Examples of operations that can be performed by package creators and users:

- For package creators

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

> **Note**
>
> - Only project owners have the permissions to perform this operation.
> - A package name can be up to 128 characters in length.

```
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 the package.
```

> **Note**
>
> - A project is not a valid object. A project cannot be added to a package.
> - In addition to objects, the operation permissions on the objects are also added to the package. If you do not use [with privileges privileges] to specify permissions, the object is read-only. Only the READ, DESCRIBE, and SELECT permissions are granted on the object. An object and its permissions are inseparable and cannot be changed after you add them to a package. If you want to change them, you must remove the object from the package and add it again.

```
allow project <prjname> to install package <pkgname> [using label <number>];
-- Grant the permissions on the package to another project.
disallow project <prjname> to install package <pkgname>;
-- Revoke the permissions on the package from another project.
```

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

```
show packages;
-- Query the packages.
```

```
describe package <pkgname>;
-- Query details about a package.
```

- For package users

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

> **Note**
>
> - Only project owners have the permissions to perform this operation.
> - To install a package, you must specify pkgname in the following format: <projectName>.<packageName>.

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

> **Note** To uninstall a package, you must specify pkgname in the following format: <projectName>.<packageName>.

```
show packages;
-- Query the packages that have been created and installed.
```

```
describe package <pkgname>;
-- Query details about a package.
```

An installed package is an independent object in MaxCompute. To access resources in a package shared by the user of another project, you must have read permissions on the package. If you do not have the read permissions on the package, you must send a request to the project owner or administrator to apply for the permissions. The project owner or administrator can use ACL-based or policy-based authorization to grant permissions.

Use ACL-based authorization to allow odps_test@aliyun.com to access the resources in the package. Example:

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

Use policy-based authorization to allow users in the prj2 project to access the resources in the package. Example:

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

Note /tmp/policy.txt contains the following data:

```
{
"Version": "1",
"Statement":
[{
"Effect":"Allow",
"Principal":"*",
"Action":"odps:Read",
"Resource":"acs:odps:*:projects/prj2/packages/prj1.testpkg"
}]
}
```

1.21.1.2.2. Column-level access control

This topic describes column-level access control for MaxCompute tenant security.

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

LabelSecurity classifies both data and users who want to access the data into different levels. Data is classified into the following levels based on its sensitivity:

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

MaxCompute adopts the preceding sensitivity levels. Project owners must define their own standards to determine the data sensitivity levels and access permission levels. By default, the data sensitivity level and access permission level of all users are 0.

LabelSecurity allows project administrators to label table columns and views. A table can have columns with different sensitivity levels. By default, the sensitivity level of a new view is 0. The sensitivity levels of views and tables that correspond to the views are independent of each other.

LabelSecurity applies the following default security policies based on the sensitivity levels of data and users:

- No-ReadUp: Users are not allowed to read data that has higher sensitivity levels than their levels, unless they are explicitly authorized.
- Trusted-User: Users are allowed to write data to columns regardless of the sensitivity levels. The default sensitivity level of a new column is 0.

> **Note**
>
> - Traditional MAC systems use complex security policies to prevent unauthorized data operations in projects. For example, the No-WriteDown policy only allows a user to write data to columns that have higher sensitivity levels than the user level. By default, MaxCompute does not support the No-WriteDown policy. This reduces the costs for project owners to manage data sensitivity levels. Project owners can set `SetObjectCreatorHasGrantPermission` to `false` to implement a policy similar to No-WriteDown.
> - If you want to prevent data transfer between projects, you can enable project protection. After the settings take effect, users are able to access data only within their own projects and data cannot be transferred to other projects.

LabelSecurity is disabled for a project by default. Project owners can enable it based on business requirements. After LabelSecurity is enabled, the preceding default security policies take effect. In this case, users must have the SELECT permission and the required level to read sensitive data in the tables.

Run the following command to enable or disable LabelSecurity:

```
Set LabelSecurity=true|false;
-- This command is used to enable or disable LabelSecurity. The default value is false.
--Only project owners can run this command. Other operations can be performed by users who assume the admin role.
```

1.21.1.2.3. Project protection

This topic describes project protection for MaxCompute tenant security.

Users who are authorized to access data in multiple projects can transfer data across these projects. If a project contains highly sensitive data that cannot be shared with other projects, the administrator can set projectProtection to true to **allow only inbound data flows**.

Configuration command:

```
set projectProtection=true
-- This command allows only inbound data flows.
```

> **Note** By default, projectProtection is set to false. You must manually set it to true to enable project protection.

Data transfer across projects after project protection is enabled

After project protection is enabled for your project, you may need to transfer the data of a table to another project and make sure that the table does not contain sensitive data. MaxCompute provides two methods for you to transfer the data:

- Configure an exception policy

  When a project owner enables project protection, the owner can run the following command to configure an exception policy:

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

> **Note** An exception policy is different from policy-based authorization despite the fact that both operations have the same syntax. This exception policy describes an exception in the project protection mechanism. Access requests that meet the description of the exception policy can ignore project protection rules.

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 Alice@aliyun.com user to perform a SELECT operation on the alipay.table_test table and tran
sfer data out of the alipay project.
```

> **Note**
> - The exception policy is not a common authorization method. In this example, if Alice does not have the SELECT permission on the alipay.table_test table, Alice cannot transfer data even if the preceding exception policy is configured.
> - Project protection is a method to control data transfer, not to control data access. Data transfer control is effective only if users can access their desired data.

- Configure trusted projects

  If the current project is protected, data can be transferred to its trusted project. The data transfer does not violate the project protection rules. If multiple projects are specified as trusted projects for each other, they form a trusted project group. Data can be transferred only within the group.

  Commands to manage trusted projects:

```
list trustedprojects;
-- Query all trusted projects added to 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 project protection

MaxCompute supports both package-based resource sharing and project protection. However, their features are mutually exclusive.

Resource sharing takes precedence over project protection. If a data object is shared with users in another project, the data object is not limited by project protection.

More checks to prevent data from being transferred out of projects

To prevent data from being transferred out of projects, set projectProtection to true and verify the following items:

- No trusted projects are added. If a trusted project is added, assess the potential risks.
- No exception policies are configured. If an exception policy is configured, assess the potential risks, especially data leaks caused by time-of-check to time-of-use (TOC2TOU).
- No data is shared by using packages. If a package is used to share data, make sure that the package does not contain sensitive data.

1.21.1.2.4. Log audit

This topic describes log audit for MaxCompute tenant security.

MaxCompute allows you to audit logs generated for different users and stores the logs in metadata warehouses.

In a metadata warehouse, MaxCompute is used to analyze its running status, and metadata stored in MaxCompute is aggregated to a table. This allows you to query and collect statistics on the metadata. The metadata includes static data, operational logs, and security information.

- Static data is permanently written to the data warehouse.
- Operational logs record task processes and are stored only in one partition.
- Security information originates from Tablestore and includes whitelists and ACLs.

1.22. DataWorks

1.22.1. Security Whitepaper

1.22.1.1. Permission isolation for development and production environments

DataWorks manages code and configurations 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 administration expert 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 guarantee 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.

1.22.1.2. Authentication and authorization

1.22.1.2.1. 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.

1.22.1.2.2. 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.

1.22.1.3. 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.

1.22.1.4. 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.

1.23. Realtime Compute

1.23.1. Security Whitepaper

1.23.1.1. Platform security

1.23.1.1.1. 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.

1.23.1.1.2. 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.

1.23.1.1.3. 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.

1.23.1.1.4. 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.

1.24. Machine Learning Platform for AI

1.24.1. Security Whitepaper

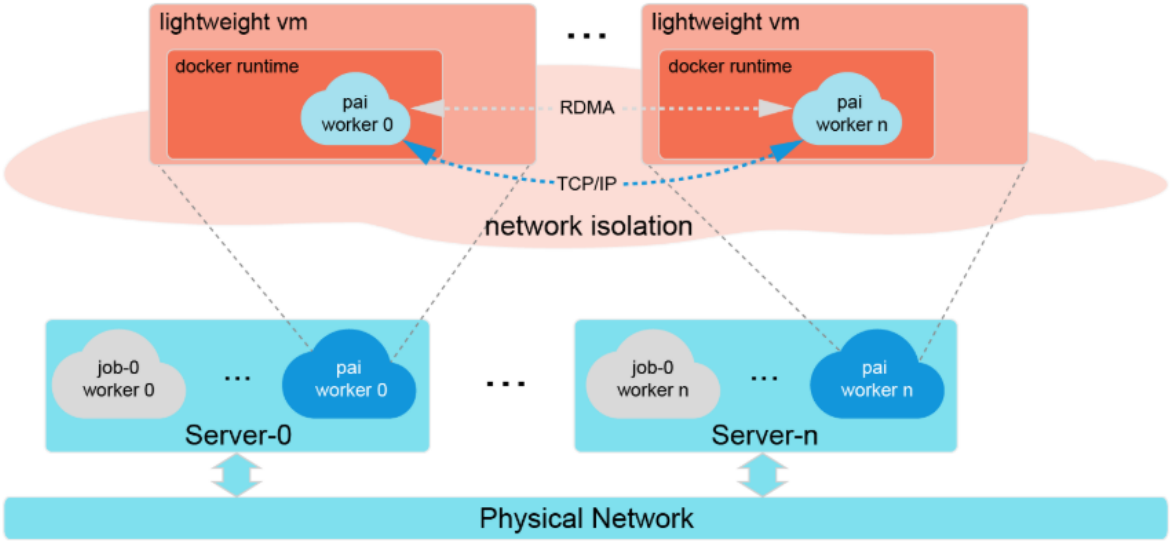
1.24.1.1. Security isolation

This topic describes the security isolation technology of Machine Learning Platform for AI (PAI).

Tenant isolation

When multiple tenants use Apsara Stack PAI, the computing and storage resources assigned to each tenant are isolated and secured by using the multitenancy technology.

- Network virtualization plays a crucial role in tenant isolation. PAI ensures that the computing resources used for the algorithm jobs of a tenant are isolated from those of other tenants based on the virtual network at the upper layer of the physical network. This allows each tenant to independently manage computing and storage resources in a distributed cluster. After a tenant submits a distributed deep learning job, PAI uses the peripheral component interconnect express (PCIe) technology to connect a GPU instance to a Docker instance, as shown in the following figure. This ensures the performance of GPU computing without compromising resource isolation.



- After a tenant activates PAI, DataWorks is also activated. DataWorks creates a dedicated gateway resource group for each tenant based on centralized resource management. The gateway resource group allows tenants to run different types of tasks, such as SQL tasks and MapReduce tasks, in a secure way. This prevents mutual impacts among different tenants.

Service isolation of EAS

Elastic Algorithm Service (EAS) stores the AccessKey pairs of tenants who deploy services. The AccessKey pairs are stored in ApsaraDB RDS. EAS verifies each request and denies requests that fail the verification. EAS uses the container technology to isolate resources. The resources used by a tenant, such as memory and CPU resources, are limited. Therefore, services deployed by different tenants on the same server do not affect each other.

Resource isolation of DSW tenants

Data Science Workshop (DSW) tenants can log on to the PAI console to build their own runtimes for applications in Kubernetes clusters. A cluster functions as a Platform as a Service (PaaS). Each pod or container functions as an independent runtime in the cluster. Kubernetes containers are isolated from each other. This ensures that each tenant can independently manage computing resources, computing tasks, and user data.

1.24.1.2. Authentication

1.24.1.2.1. Identity verification

This topic describes the identity verification mechanism for Elastic Algorithm Service (EAS) and Data Science Workshop (DSW) of Machine Learning Platform for AI (PAI).

Identity verification for PAI

When you access a PAI application from a browser, your identity is verified in the following steps:

1. All requests from the browser are forwarded to LoginFilter. LoginFilter calls the API of the single sign-on (SSO) feature of DataWorks to verify your identity. If you have not logged on to the Apsara Uni-manager Management Console, you are navigated to the logon page. After you log on to the console, the logon information is written to the related cookies.

2. Each request carries a token that is used to prevent Cross-Site Request Forgery (CSRF) attacks.
3. All requests to add, delete, modify, or query resources are verified to ensure that you have permissions to access the resources. This prevents unauthorized actions.
4. When the DataWorks scheduling system or another third-party module calls the APIs in PAI, the token center of DataWorks is used to verify permissions for all requests.

Identity verification for EAS

You can create an AccessKey pair in the Apsara Uni-manager Management 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 AccessKey secret is private and is used to verify the identity of a user.

When you send a request to EAS, your identity is verified in the following steps:

1. You construct a signature string for the request. The signature string must be in the format that is required by EAS.
2. You use your AccessKey secret and the hash-based message authentication code (HMAC) algorithm to encrypt the signature string and then generate a verification code. The verification code carries a timestamp to prevent replay attacks.
3. After EAS receives the request, EAS finds the AccessKey secret that corresponds to the AccessKey ID. Then, EAS generates a signature string and a verification code from the request in the same way.
   - If the verification code generated by EAS is identical to the given one, EAS considers the request valid.
   - If the verification code generated by EAS is different from the given one, EAS denies the request and returns an HTTP 403 error.

Identity verification for DSW

When you use your browser to access DSW in the PAI console, your identity is verified in the following steps:

1. All requests from the browser are forwarded to LoginFilter. LoginFilter calls the API of the SSO feature of DataWorks to verify your identity. This API is used for tenant verification.
2. If you have not logged on to the Apsara Uni-manager Management Console, you are navigated to the logon page. After you log on to the console, the system writes the logon information to the related cookies.
3. All requests to add, delete, modify, or query resources are verified to ensure that you have permissions to access the resources. This prevents unauthorized actions.

When you access JupyterLab or web integrated development environment (Web IDE) from a browser, your identity is verified in the following steps:

1. All requests from the browser are forwarded to the dsw-gateway application. The dsw-gateway application obtains your identity information from the related cookies and forwards the verification request to the pai-notebook application.
2. If you pass the identity verification, the dsw-gateway application forwards the requests to the corresponding Kubernetes pods. If you fail the identity verification, the requests are denied.

1.24.1.2.2. Permission control

This topic describes the permission control policies of Machine Learning Platform for AI (PAI).

After you use Elastic Algorithm Service (EAS) to deploy a service as an API, the system generates a token that is used to call the API. You must provide this token when you call the API. This token is private. Make sure that the token is kept only by the service consumer.

DSW permission control

Data Science Workshop (DSW) regulates permission control in the following ways:

- The server verifies parameters that you specify to ensure that you can read and manage only your own resources.
- You can log on to only your own instances. You cannot manage the computing resources or instances that are owned by other tenants.

1.24.1.2.3. Integration with RAM and STS

Resource Access Management (RAM) is a service provided by Apsara Stack to manage access permissions on resources. When you use RAM, you do not need to share the AccessKey pair of your Apsara Stack tenant account with other tenants. You can grant permissions to RAM users based on the principle of least privilege. You can use your Apsara Stack tenant account to create RAM users and grant resource access permissions to the RAM users. All RAM users that you create and all resources created by the RAM users belong to your Apsara Stack tenant account.

Security Token Service (STS) is a temporary access token service provided by Apsara Stack to manage temporary access permissions. You can use STS to generate temporary access tokens. You can determine the permissions and validity period of the tokens. The access tokens automatically become invalid after the validity period expires.

When you use the deep learning module, you can go to the Object Storage Service (OSS) quick authorization page in the Apsara Uni-manager Management Console to perform quick authorization.

1. OSS quick authorization grants read and write permissions on the OSS bucket that stores your project to the MaxCompute service account odps.aliyuncs.com.
2. After the service account is authorized, the role **AliyunODPSPAIDefaultRole** is created in RAM. Each role has a globally unique resource identifier named **RoleArn** in the `acs:ram::$accountID:role/$roleName` format.
3. After the role is created, Machine Learning Platform for AI (PAI) uses the AccessKey pair of the account odps.aliyuncs.com to call the AssumeRole operation of STS.
4. If the call is successful, you can obtain a temporary AccessKey pair and a temporary STS token. The default validity period is 3,600s. You can read data from and write data to the OSS bucket of your project by using the temporary AccessKey pair and STS token within the validity period.

The role **AliyunODPSPAIDefaultRole** contains the following role information:

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

The following code describes the permissions that are granted to the role:

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

1.24.1.3. Data security

Data security of PAI applications

Machine Learning Platform for AI (PAI) uses MaxCompute to compute and store big data. User data is stored in MaxCompute projects. Projects that belong to different tenants are isolated from each other.

For customers that require high data security, such as financial institutes, MaxCompute provides a mechanism that allows customers to enable or disable data protection for a specific MaxCompute project. You can use this feature to allow or prohibit data exports from a specified project.

Data security of EAS

Elastic Algorithm Service (EAS) uses three types of data:

- EAS metadata: ApsaraDB RDS stores the EAS metadata and ensures data security.
- Kubernetes metadata: The metadata of a Kubernetes cluster is stored in etcd. etcd provides services and runs with three replicas. To access etcd, specific certificates are required. The administrator of the Kubernetes cluster keeps these certificates.
- Monitoring data: The monitoring data is stored in Apsara Stack disks. The type of disk determines the type of data backup.

Data security of DSW

Data Science Workshop (DSW) uses the following types of data:

- Console data: ApsaraDB RDS stores the data that is generated in the PAI console and ensures data security.
- Kubernetes metadata: The metadata of a Kubernetes cluster is stored in etcd. etcd provides services and runs with three replicas. To access etcd, specific certificates are required. The administrator of the Kubernetes cluster keeps these certificates.

1.24.1.4. 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.

1.25. DataHub

1.25.1. Security Whitepaper

1.25.1.1. Platform security

1.25.1.1.1. Data isolation

This topic describes the isolation scheme of DataHub.

DataHub implements symmetric encryption based on AccessKey pairs (AccessKey ID and AccessKey secret) to verify the identity of requesters. Each HTTP request is signed and authenticated. DataHub isolates the data of different users by using the Apsara Distributed File System.

DataHub ensures that user data and metadata are stored in separate storage spaces.

1.25.1.1.2. Authentication

This topic describes the authentication methods of DataHub.

Authentication

You can create AccessKey pairs in the Apsara Uni-manager Management Console. An AccessKey pair consists of an AccessKey ID and an AccessKey secret. The AccessKey ID identifies a user, whereas the AccessKey secret is used to authenticate the user identity. The AccessKey secret must be kept strictly confidential.

Before you send a request to DataHub, you need to create a string to be signed in the format specified by DataHub and then create a signature for the request by using the AccessKey secret. After DataHub receives the request, it identifies the AccessKey secret that corresponds to the AccessKey ID. Then, it extracts the signature string and verification code in the same way. If the extracted verification code is the same as the one received, the request is valid. Otherwise, DataHub rejects the request and returns an HTTP 403 error.

ACL

You can access DataHub resources by using Alibaba Cloud accounts or RAM users. Different RAM users can be created in one Alibaba Cloud account. An Alibaba Cloud account can grant RAM users the permission to access DataHub resources.

- When you access a DataHub resource by using an Alibaba Cloud account, DataHub checks whether the account is the owner of the corresponding resource. Only the resource owner has the permission to access the corresponding resource.
- When you access a DataHub resource as a RAM user, DataHub checks whether you are authorized by the corresponding Alibaba Cloud account to access the resource and whether the Alibaba Cloud account owns the resource. For more information about RAM authorization, see RAM and STS authorization.

> **Note** DataHub does not support resource authorization between Alibaba Cloud accounts.

Configure access control

DataHub supports Resource Access Management (RAM) and Security Token Service (STS) authorization.

RAM is a resource access control service provided by Alibaba Cloud. You can use your Alibaba Cloud account to create RAM users and grant them the permissions to access specific resources that are owned by the account.

STS is an Alibaba Cloud service that provides temporary access credentials. It is used for short-term access control. You can use STS to generate a temporary access credential. You can specify the permissions and validity period of the credential. The credential becomes invalid when it expires.

DataHub resources are authorized by using RAM authorization policies. You must specify Action, Resource, and Effect in a policy. The following script shows a sample policy.

```
{
 "Version": "1",
 "Statement": [
  {
   "Action": [ "dhs:GetRecords"],
   "Resource": "acs:dhs:cn-hangzhou:1001:projects/A/topics/B",
   "Effect": "Allow"
  }
 ]
}
```

> **Note** The format of Resource is `acs:dhs:{Region}:{User}:{DataHubResource}`.

The preceding sample policy indicates the control of access to a DataHub resource that resides in a specific region. The policy grants RAM user 1001 the permission to read data from Topic B of Project A that resides in the China (Hangzhou) region.

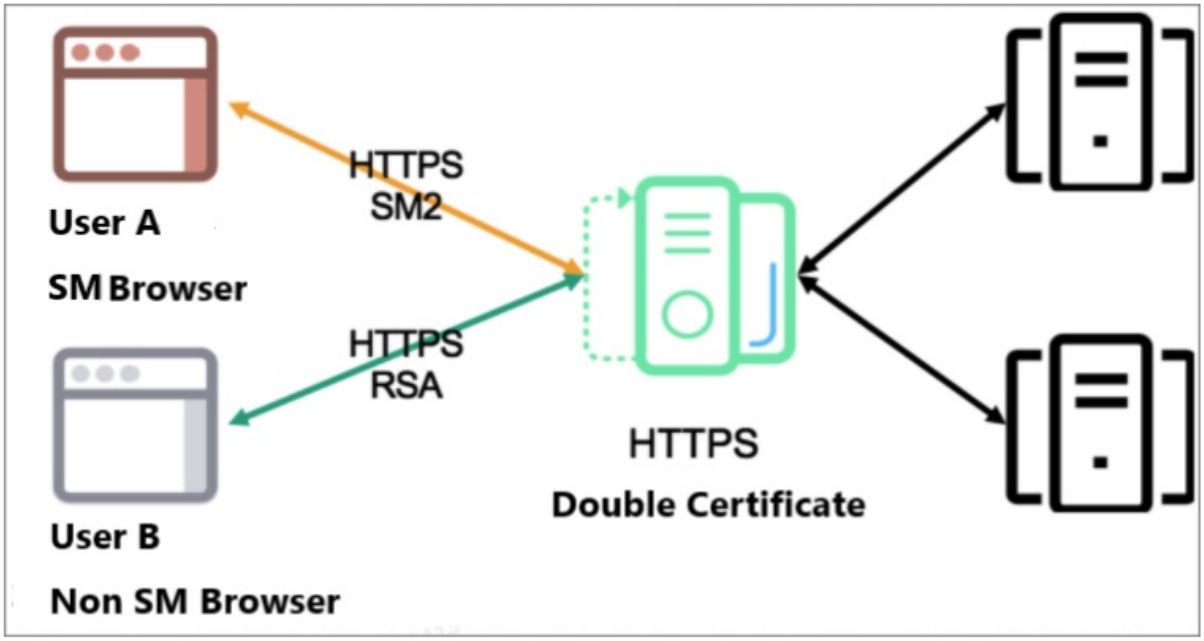
DataHub supports fine-grained permission control policies. You can control resource access based on your needs.

1.25.1.1.3. Data encryption

This topic describes the encryption scheme of DataHub.

Apsara Stack ensures the security of data transmission based on HTTPS.

The HTTPS service of Apsara Stack supports both the Rivest-Shamir-Adleman (RSA) algorithm and the ShangMi (SM) algorithm. The SM algorithm meets the security requirements of various systems, such as e-government systems, bank payment systems, mobile payment systems, and e-commerce systems.



In Apsara Stack, both the RSA and SM SSL certificates are deployed on a server. When a browser client initiates a request, the client includes information about supported cipher suites in the request. During the handshake process, the cipher suite to use is determined based on the internal selection mechanism of the browser and the priority configured in the server.

- If the browser supports the SM algorithm, SM Transport Layer Security (TLS) is selected.
- If the browser does not support the SM algorithm, RSA TLS is selected.

> **Note** To adapt to the SM algorithm, make sure that the kernel version of Google Chrome is 69.0.0 or later.

1.25.1.1.4. Data security

This topic describes the data security scheme of DataHub.

Apsara Stack uses a flat network in which a linear address space is divided into slices. Slices are also called chunks. Each chunk is replicated into three copies. These copies are stored on different data nodes of the storage cluster to ensure data reliability.

The triplicate technology used for the Apsara Stack data system involves three key components: master, chunk server, and client. Each write operation in DataHub is executed by the client. The following steps show the execution process.

1. The client determines the chunk of the write operation.
2. The client sends a request to the master to query the chunk servers where the three chunk copies are stored.
3. The master returns the addresses of the chunk servers. Then, the client sends the write request to the chunk servers.
4. If the write operation succeeds in all three chunk replicas, the client returns a success message. Otherwise, the client returns a failure message.

The master analyzes the following information: the disk usage of all chunk servers in the cluster, distribution of chunk servers in different switch racks, power supply status, and machine load. The master ensures that the three replicas of a chunk are distributed on different chunk servers in different racks. This effectively prevents a single point of failure caused by the failure of a chunk server or rack.

If a data node or its hard disks are faulty, the total number of valid replicas of some chunks may become less than three. In this case, the master replicates data between chunk servers to make sure that each chunk in the cluster has three valid replicas.

All operations on data in DataHub, including inserting, updating, and deleting data, are synchronized to the three replicas. This mechanism guarantees data reliability and consistency.

In addition, when data is deleted, the released storage space is reclaimed by Apsara Distributed File System. During this period, the space is inaccessible for all 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.

1.25.1.2. Tenant security

1.25.1.2.1. Log auditing

This topic describes the log auditing scheme of DataHub.

DataHub logs various types of information for security and troubleshooting purposes. DataHub creates topics to store log data, such as queries per second (QPS), request duration, processing duration, source IP address, and status code. DataHub displays some of the statistics in the console to help you analyze issues.