Alibaba Cloud
Elastic Compute Service
Block Storage

Issue: 20200304
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## Document conventions

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

Block Storage is a high-performance, low latency block storage service for Alibaba Cloud ECS. It supports random or sequential read and write operations. Block Storage is similar to a physical disk. You can format a Block Storage device and create a file system on it to meet the data storage needs of your business.

Block Storage devices

Alibaba Cloud provides a variety of Block Storage devices for ECS instances, such as disks and Share Block Storage devices based on a distributed storage architecture, and local disks located on the physical servers where the ECS instances are hosted.

<table>
<thead>
<tr>
<th>Block Storage device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk</td>
<td>Disks are block-level storage devices provided by Alibaba Cloud for ECS instances. Disks use a triplicate distributed mechanism and feature low latency, high performance, durability, and high reliability. Disks can be created, resized, and released at any time. For more information, see <a href="#">Cloud disk overview</a>.</td>
</tr>
<tr>
<td>Shared Block Storage</td>
<td>Shared Block Storage devices are block-level storage devices to which multiple ECS instances can perform concurrent reads and writes. Similar to disks, Shared Block Storage devices use a triplicate distributed mechanism. They allow multiple instances to perform concurrent access to them, and feature low latency, high performance, and high reliability. Shared Block Storage devices are ideal for the scenarios where shared access to storage resources are required in a shared-everything environment. For more information, see <a href="#">Shared Block Storage</a>.</td>
</tr>
<tr>
<td>Local disk</td>
<td>Local disks are physical disks attached to physical servers that host the ECS instances. They provide local storage access capability for ECS instances. They are designed for business scenarios that require high storage I/O performance, massive storage, and high cost-effective performance. Local disks feature low latency, high random IOPS and throughput, and excellent cost-effective performance. For more information, see <a href="#">Local disks</a>.</td>
</tr>
</tbody>
</table>

Service performance

For information about the performance of each type of Block Storage devices, see [Block Storage performance](#).
Data security

Note:
Except for the data erasure mechanism, only disks and Shared Block Storage devices have the following features.

- Data reliability during read and write operations

  Three copies of your business data are stored in the Block Storage cluster in the same zone to ensure 99.9999999% data reliability during read and write operations. For more information, see Triplicate technology.

- Proactive backup

  You can create snapshots at regular intervals to enhance your data security. Snapshots are backup services provided by Alibaba Cloud. They provide data backup capabilities for disks and Shared Block Storage devices, ensuring that information such as logs and customer transactions are backed up. For more information, see #unique_9.

- Data erasure mechanism

  When you delete a piece of data from disks and Share Block Storage devices, it is completely erased from the distributed Block Storage system and can no longer be accessed by other users in any way. The following measures are used to ensure all data is erased:

  - To make full use of the high bandwidth and low latency features of sequential write to a physical disk, the storage system appends data to an existing file at the underlayer of a disk in sequence. Based on the features of appending data to an existing file, deleting the logical space of a disk is recorded as metadata. The storage system returns only zero for all requests of reading data from the logical space. Similarly, when you overwrite the data in the logical space of a disk or a Shared Block Storage device, the storage system does not directly overwrite the data in the logical space, but modifies the mapping between the logical space and the physical space. This ensures that data that has been overwritten can no longer be read. Data fragments that result from
delete or overwrite operations are forcibly and permanently deleted from the underlying physical disks.

- When a block storage device (disk) is released, the storage system destroys the metadata immediately to ensure that the data can no longer be accessed. At the same time, the physical storage space corresponding to the disk is recycled. The physical space must be cleared before it is re-assigned to store data. Before data is written to a new disk, the system returns only zero for all read requests.

- Data encryption

For data-sensitive applications, we recommend that you encrypt the storage devices that you use. Disks and their snapshots are encrypted with keys based on the industry-standard AES-256 algorithm. Data is automatically encrypted when it is transmitted from ECS instances to disks and automatically decrypted when the data is read. For more information, see #unique_10.

Billing

For more information about the billing methods and pricing of Block Storage devices, see #unique_11.

Limits

For information about the limits and quotas of Block Storage devices, see the "Block Storage limits" section in Limits.

Differences among Alibaba Cloud storage services

Alibaba Cloud provides the following three data storage services: Block Storage, Object Storage Service (OSS), and Apsara File Storage NAS. The following table lists the differences among the three data storage services.

<table>
<thead>
<tr>
<th>Data storage service</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block Storage</td>
<td>A high-performance and low-latency block-level storage device provided by Alibaba Cloud for ECS instances. It supports random read and write operations, and can be attached to ECS instances as a system disk or data disk. You can partition and format a Block Storage device and create file systems on it as you would with a physical disk. Block Storage can meet the data storage needs of most business scenarios.</td>
</tr>
<tr>
<td>Data storage service</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>OSS</strong></td>
<td>A huge storage space designed to store unstructured data on the Internet, such as images, audios, and videos. You can access the data stored in OSS anytime and anywhere by using APIs. OSS is applicable to the business scenarios such as website construction, separation of dynamic and static resources, and the acceleration of domain name access by using CDN. For more information, see #unique_13.</td>
</tr>
<tr>
<td><strong>Apsara File Storage NAS</strong></td>
<td>A storage space designed for storing massive unstructured data that can be accessed by using standard file access protocols, such as the Network File System (NFS) protocol for Linux, and the Server Message Block (SMB, also called Common Internet File System (CIFS)) protocol for Windows. You can set permissions to allow different clients to access the same file at the same time. Apsara File Storage NAS is suitable for the business scenarios such as file sharing across departments in an enterprise, non-linear editing in radio and television industries, high-performance computing, and containerization. For more information, see #unique_14.</td>
</tr>
</tbody>
</table>
2 Performance

2.1 Block Storage performance

This topic describes the performance metrics and specifications of various Block Storage devices, including disks, Shared Block Storage devices, and local disks.

Performance metrics

The key metrics for measuring Block Storage performance are IOPS, throughput, and latency. Some Block Storage devices also have requirements on the capacity. For example, enhanced SSDs of different performance levels (PLs) have different capacity ranges.

- Input/output operations per second (IOPS)

The IOPS metric measures the number of write/read operations that can be performed each second. The metric indicates the performance of transaction-intensive applications, such as databases. A standard SSD can achieve the committed IOPS performance only when it is attached to an I/O optimized instance. Common IOPS performance metrics that are measured include sequential and random operations. The following table describes these performance metrics.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
<th>Data access method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total IOPS</td>
<td>The total number of I/O operations per second</td>
<td>Randomly and sequentially access locations in storage devices</td>
</tr>
<tr>
<td>Random read IOPS</td>
<td>The average number of random read I/O operations per second</td>
<td>Randomly access locations in storage devices</td>
</tr>
<tr>
<td>Random write IOPS</td>
<td>The average number of random write I/O operations per second</td>
<td></td>
</tr>
<tr>
<td>Sequential read IOPS</td>
<td>The average number of sequential read I/O operations per second</td>
<td>Sequentially access locations in storage devices</td>
</tr>
</tbody>
</table>
### Elastic Compute Service

Block Storage / 2 Performance

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
<th>Data access method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequential write IOPS</td>
<td>The average number of sequential write I/O operations per second</td>
<td></td>
</tr>
</tbody>
</table>

- **Throughput**

  The throughput metric measures the size of data transferred per second. Unit: MB/s. The metric indicates the performance of applications that require a large number of sequential read/write operations, such as Hadoop offline computing applications.

- **Latency**

  Latency is the period of time required for a Block Storage device to process an I/O request. Unit: s, ms, or μs. High latency may cause performance deterioration or errors in applications with requirements for low latency, such as databases.

  - For latency-sensitive applications, we recommend that you use enhanced SSDs, standard SSDs, Shared SSD Block Storage, or local SSDs.
  
  - For applications that require high throughput but do not require low latency, such as Hadoop offline computing applications, we recommend that you use ECS instances attached with local SATA HDDs in the d1 or d1ne instance family.

- **Capacity**

  You cannot use capacity as a metric to measure the performance of Block Storage, but the performance of Block Storage devices varies with capacity. The larger the capacity of a Block Storage device, the stronger the data processing capability of the device. Block Storage devices of the same type have the same I/O performance per unit capacity. However, the performance of each disk increases with capacity until the upper limit performance for that single disk is reached.

**Note:**

Block Storage capacity is measured in binary units, such as kibibyte (KiB), mebibyte (MiB), gibibyte (GiB), or tebibyte (TiB). 1 KiB equals 1,024 bytes. 1 MiB equals 1,024 KiB. 1 GiB equals 1,024 MiB. 1 TiB equals 1,024 GiB.
For information about how to test the performance of different types of Block Storage devices, see *Performance tests on Block Storage* or *Test the IOPS performance of an enhanced SSD*.

**Disk performance**

The following table lists the performance and typical scenarios of different types of disks.

<table>
<thead>
<tr>
<th>Performance category</th>
<th>Enhanced SSD</th>
<th>Standard SSD</th>
<th>Ultra disk</th>
<th>Basic disk***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance level (PL)</td>
<td>PL3, PL2, PL1</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Maximum capacity of a single disk</td>
<td>1,261-32,768 GiB, 461-32,768 GiB</td>
<td>20-32,768 GiB</td>
<td>32,768 GiB</td>
<td>32,768 GiB, 2,000 GiB</td>
</tr>
<tr>
<td>Maximum IOPS</td>
<td>1,000,000, 100,000</td>
<td>50,000</td>
<td>25,000*, 5,000</td>
<td>Several hundreds</td>
</tr>
<tr>
<td>Maximum throughput</td>
<td>4,000 MB/s, 750 MB/s</td>
<td>350 MB/s</td>
<td>300 MB/s*, 140 MB/s</td>
<td>30–40 MB/s</td>
</tr>
<tr>
<td>Formula for calculating IOPS of a single disk**</td>
<td>min{1,800 + 50 × Capacity, 1,000,000}, min{1,800 + 50 × Capacity, 100,000}</td>
<td>min{1,800 + 30 × Capacity, 50,000}</td>
<td>min{1,800 + 30 × Capacity, 25,000}</td>
<td>None</td>
</tr>
<tr>
<td>Formula for calculating throughput of a single disk**</td>
<td>min{120 + 0.5 × Capacity, 4,000} MB/s, min{120 + 0.5 × Capacity, 750} MB/s</td>
<td>min{120 + 0.5 × Capacity, 350} MB/s</td>
<td>min{120 + 0.5 × Capacity, 300} MB/s</td>
<td>min{100 + 0.15 × Capacity, 140} MB/s</td>
</tr>
<tr>
<td>Data reliability</td>
<td>99.9999999%</td>
<td>99.9999999%</td>
<td>99.9999999%</td>
<td>99.9999999%</td>
</tr>
</tbody>
</table>

Note: * indicates cost-sensitive scenarios; ** indicates formulas for calculating performance.
### Performance category

<table>
<thead>
<tr>
<th>Enhanced SSD</th>
<th>Standard SSD</th>
<th>Ultra disk</th>
<th>Basic disk***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-channel random write access latency</td>
<td>0.2 ms</td>
<td>0.5−2 ms</td>
<td>1−3 ms</td>
</tr>
</tbody>
</table>

### API parameter value

| cloud_essd | cloud_ssd | cloud_efficiency | cloud |

### Scenario

- **OLTP databases**: relational databases such as MySQL, PostgreSQL, Oracle, and SQL Server databases
- **NoSQL databases**: non-relational databases such as MongoDB, HBase, and Cassandra databases
- **Elasticsearch distributed logs**: Elasticsearch, Logstash, and Kibana (ELK) log analysis

- **Small and medium-sized development and test applications** that require high data reliability
- **Development and test applications**
- **System disks**
- **Applications that are not frequently accessed or have low I/O loads**
- **Applications that require low costs and random I/O operations**

---

* The performance of standard SSDs varies with the sizes of data blocks. Smaller data blocks result in lower throughput and higher IOPS, as described in the following table.

<table>
<thead>
<tr>
<th>Data block size (KiB)</th>
<th>Maximum IOPS</th>
<th>Throughput (MB/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Approximately 25,000</td>
<td>Approximately 100</td>
</tr>
<tr>
<td>16</td>
<td>Approximately 17,200</td>
<td>Approximately 260</td>
</tr>
<tr>
<td>32</td>
<td>Approximately 9,600</td>
<td>Approximately 300</td>
</tr>
<tr>
<td>64</td>
<td>Approximately 4,800</td>
<td>Approximately 300</td>
</tr>
</tbody>
</table>
** A standard SSD is used as an example to describe how to calculate the performance of a single disk:

- **Maximum IOPS:** The baseline is 1,800 IOPS. It increases by 30 IOPS per GiB of storage. The maximum IOPS is 25,000.
- **Maximum throughput:** The baseline is 120 MB/s. It increases by 0.5 MB/s per GiB of storage. The maximum throughput is 300 MB/s.

*** Basic disks are the previous generation of disks and are no longer available for purchase.

Shared Block Storage performance

The following table lists the performance and typical scenarios of different types of Shared Block Storage.

<table>
<thead>
<tr>
<th>Performance category</th>
<th>Shared SSD Block Storage</th>
<th>Shared Ultra Block Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum capacity of a single disk</td>
<td>32,768 GiB</td>
<td>32,768 GiB</td>
</tr>
<tr>
<td>Maximum capacity of a single instance</td>
<td>128 TiB</td>
<td>128 TiB</td>
</tr>
<tr>
<td>Maximum random read/write IOPS*</td>
<td>30,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Maximum sequential read/write throughput*</td>
<td>512 MB/s</td>
<td>160 MB/s</td>
</tr>
</tbody>
</table>
| Formula for calculating the IOPS of a single disk** | \[
min\{1,600 + 40 \times \text{Capacity}, 30,000\}\] | \[
min\{1,000 + 6 \times \text{Capacity}, 5,000\}\] |
| Formula for calculating the throughput of a single disk** | \[
min\{100 + 0.5 \times \text{Capacity}, 512\}\] MB/s | \[
min\{50 + 0.15 \times \text{Capacity}, 160\}\] MB/s |
| Single-channel access latency            | 0.5–2 ms                 | 1–3 ms                    |
| Scenario                                 |                          |                           |
|                                          | · Oracle RAC             | High-availability         |
|                                          | · Failover cluster       | architecture of servers   |
|                                          | · High-availability      |                           |
|                                          | servers                  |                           |
* The maximum IOPS and throughput listed in the preceding table are the maximum performance of a bare Shared Block Storage device that is attached to two or more instances at the same time during stress tests.

** A Shared SSD Block Storage device is used as an example to describe how to calculate the performance of a single disk:

- **Maximum IOPS:** The baseline is 1,600 IOPS. It increases by 40 IOPS per GiB of storage. The maximum IOPS is 30,000.
- **Maximum throughput:** The baseline is 100 MB/s. It increases by 0.5 MB/s per GiB of storage. The maximum throughput is 512 MB/s.

Local disks

For information about the performance of local NVMe SSDs and SATA HDDs, see *Local disks*.

2.2 Storage I/O performance

Storage I/O performance, also known as storage read/write performance, is the performance that is implemented when disks are attached to different ECS instance types. Metrics of storage I/O performance include IOPS and throughput.

I/O size

I/O (inputs/outputs or reads/writes) are random or sequential data requests initiated by an application. The volume of I/O requests is also known as the I/O size in KiB, such as 4 KiB, 256 KiB, and 1,024 KiB.

When designing the underlying storage architecture or selecting the instance type, you must consider metrics such as IOPS, I/O size, and throughput. IOPS × I/O size = Throughput. You can select different Block Storage devices and instance types based on the I/O request features of the application to achieve the best results:

- If the application, such as offline analysis and data warehousing, requires a large amount of I/O, we recommend that you select the big data instance families with higher throughput.
- If the application requires low-latency, random, and small-sized I/O, such as OLTP databases and enterprise-grade applications like SAP, we recommend that you select enhanced SSDs and standard SSDs with high IOPS.

For information about IOPS and throughput, see *Block Storage performance*. 
Storage I/O performance of instances

Note:
This section and subsequent sections are applicable only to the new generation of enterprise-grade instance families, including g6, c6, r6, g5se, hfg6, hfc6, and hfr6. They are not applicable to local disks.

The new generation of enterprise-grade instance families for Alibaba Cloud elastic compute features storage I/O performance isolation. Dedicated storage bandwidths are assigned to ECS instances and disks to avoid the storage I/O preemption among ECS instances. The new generation of enterprise-grade instance families ensures consistent storage I/O performance of applications even during peak hours.

For example, if your business application is one of the following applications that are I/O-sensitive and require stable storage I/O performance, we recommend that you select a new generation instance family that features storage I/O performance isolation:

• Large and medium-sized database loads, such as Oracle, MySQL, SQL Server, PostgreSQL, Cassandra, and MongoDB databases.
• Enterprise-grade applications, such as ERP and CRM.

Relationship between instance types and storage I/O performance

The storage I/O performance of an ECS instance varies with instance families and disk-attached instance types. The storage I/O performance of an instance depends on the instance type. A higher instance type provides higher storage I/O performance (IOPS and throughput).

After you create an ECS instance and attach disks to it, the final storage I/O performance of the ECS instance is determined as described in the following section:

• Scenario 1: If the total storage performance of the attached disks exceeds the maximum storage I/O performance that the instance type can deliver, the final storage I/O performance of the instance is limited to the maximum storage I/O performance of that instance type.
• Scenario 2: If the total storage performance of the attached disks does not exceed the maximum storage I/O performance that the instance type can deliver, the
final storage I/O performance of the instance is limited to the maximum storage I/O performance of the disks.

For example, the ecs.g6.8xlarge instance type features 60,000 IOPS. If a 1,600 GiB enhanced SSD PL2 is attached to an instance of the instance type and the IOPS of the enhanced SSD PL2 is 81,800, the maximum storage IOPS of the instance is 60,000 instead of 81,800. For information about the performance levels of enhanced SSDs, see Enhanced SSDs.

After you understand the relationship between instance storage performance and disk storage performance, you can choose instance types and Block Storage devices based on the performance data of instances and disks that meets your business needs. This prevents performance bottlenecks caused by using improper configurations.

Storage I/O performance of new generation of enterprise-grade instance families

The following table lists the storage I/O performance of the new generation of enterprise-grade instance families. For information about other metrics of the instance families, see #unique_20.

Note:

In this table, the maximum IOPS is measured at 4 KiB I/O size and the maximum throughput is measured at 1,024 KiB I/O size. For information about the test method, see Performance tests on Block Storage.

<table>
<thead>
<tr>
<th>Instance type</th>
<th>Maximum IOPS (K, 4 KiB I/O)</th>
<th>Maximum storage bandwidth (Gbit/s)</th>
<th>Maximum throughput (MB/s, 1, 024 KiB I/O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ecs.g6.large</td>
<td>10</td>
<td>1.0</td>
<td>125</td>
</tr>
<tr>
<td>ecs.g6.xlarge</td>
<td>20</td>
<td>1.5</td>
<td>187.5</td>
</tr>
<tr>
<td>Instance type</td>
<td>Maximum IOPS (K, 4 KiB I/O)</td>
<td>Maximum storage bandwidth (Gbit/s)</td>
<td>Maximum throughput (MB/s, 1,024 KiB I/O)</td>
</tr>
<tr>
<td>----------------</td>
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</tr>
<tr>
<td>ecs.g6. 2xlarge</td>
<td>25</td>
<td>2.0</td>
<td>250</td>
</tr>
<tr>
<td>ecs.g6. 3xlarge</td>
<td>30</td>
<td>2.5</td>
<td>312.5</td>
</tr>
<tr>
<td>ecs.g6. 4xlarge</td>
<td>40</td>
<td>3.0</td>
<td>375</td>
</tr>
<tr>
<td>ecs.g6. 6xlarge</td>
<td>50</td>
<td>4.0</td>
<td>500</td>
</tr>
<tr>
<td>ecs.g6. 8xlarge</td>
<td>60</td>
<td>5.0</td>
<td>625</td>
</tr>
<tr>
<td>ecs.g6. 13xlarge</td>
<td>100</td>
<td>8.0</td>
<td>1,000</td>
</tr>
<tr>
<td>ecs.g6. 26xlarge</td>
<td>200</td>
<td>16.0</td>
<td>2,000</td>
</tr>
<tr>
<td>ecs.c6.large</td>
<td>10</td>
<td>1.0</td>
<td>125</td>
</tr>
<tr>
<td>ecs.c6. xlarge</td>
<td>20</td>
<td>1.5</td>
<td>187.5</td>
</tr>
<tr>
<td>ecs.c6. 2xlarge</td>
<td>25</td>
<td>2.0</td>
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<td>5.0</td>
<td>625</td>
</tr>
<tr>
<td>ecs.c6. 13xlarge</td>
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<td>8.0</td>
<td>1,000</td>
</tr>
<tr>
<td>ecs.c6. 26xlarge</td>
<td>200</td>
<td>16.0</td>
<td>2,000</td>
</tr>
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<td>ecs.r6.large</td>
<td>10</td>
<td>1.0</td>
<td>125</td>
</tr>
<tr>
<td>Instance type</td>
<td>Maximum IOPS (K, 4 KiB I/O)</td>
<td>Maximum storage bandwidth (Gbit/s)</td>
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</tr>
<tr>
<td>---------------</td>
<td>-----------------------------</td>
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<td>-----------------------------------------</td>
</tr>
<tr>
<td>ecs.r6. xlarge</td>
<td>20</td>
<td>1.5</td>
<td>187.5</td>
</tr>
<tr>
<td>ecs.r6. 2xlarge</td>
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<td>2.0</td>
<td>250</td>
</tr>
<tr>
<td>ecs.r6. 3xlarge</td>
<td>30</td>
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<td>ecs.r6. 4xlarge</td>
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<td>5.0</td>
<td>625</td>
</tr>
<tr>
<td>ecs.r6. 13xlarge</td>
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<td>8.0</td>
<td>1,000</td>
</tr>
<tr>
<td>ecs.r6. 26xlarge</td>
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<td>2,000</td>
</tr>
<tr>
<td>ecs.g5se. large</td>
<td>30</td>
<td>1.0</td>
<td>125</td>
</tr>
<tr>
<td>ecs.g5se. xlarge</td>
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<td>2.0</td>
<td>250</td>
</tr>
<tr>
<td>ecs.g5se. 2xlarge</td>
<td>120</td>
<td>4.0</td>
<td>500</td>
</tr>
<tr>
<td>ecs.g5se. 4xlarge</td>
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<td>1,000</td>
</tr>
<tr>
<td>ecs.g5se. 6xlarge</td>
<td>340</td>
<td>12.0</td>
<td>1,500</td>
</tr>
<tr>
<td>ecs.g5se. 8xlarge</td>
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<td>15.0</td>
<td>1,875</td>
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<td>ecs.g5se. 16xlarge</td>
<td>900</td>
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<td>3,750</td>
</tr>
<tr>
<td>ecs.g5se. 18xlarge</td>
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<td>32.0</td>
<td>4,000</td>
</tr>
<tr>
<td>Instance type</td>
<td>Maximum IOPS (K, 4 KiB I/O)</td>
<td>Maximum storage bandwidth (Gbit/s)</td>
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</tr>
<tr>
<td>---------------</td>
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<tr>
<td>ecs.hfc6. large</td>
<td>10</td>
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<td>125</td>
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<td>ecs.hfr6. 20xlarge</td>
<td>200</td>
<td>16.0</td>
<td>2,000</td>
</tr>
</tbody>
</table>
2.3 Performance tests on Block Storage

This topic describes how to use the fio tool on a Linux instance to test performance of cloud disks and local disks, including IOPS, throughput, and latency.

Prerequisites

A Block Storage device is created and attached to an ECS instance.

Note:

If you only want to test the performance of a Block Storage device of a specific type, we recommend that you use a newly created pay-as-you-go data disk. You can release the disk at any time after the test is completed.

Context

You can use other tools to test the performance of Block Storage devices, but the benchmark you obtain may be different. For example, tools such as dd, sysbench, and iometer may be affected by test parameter settings and file systems, which causes inaccurate results. The performance results in this topic are that of a Linux instance tested by using fio. These results are used as performance references for Alibaba Cloud Block Storage products. We recommend that you use the fio tool to test the performance of Block Storage for both Linux and Windows instances.

Warning:

You can obtain accurate test results by testing raw disk partitions. However, you may destroy the file system structure in a raw disk partition if you test the partition directly. Before you perform such a test, you must create a snapshot of the disk to back up your data. For more information about how to create a snapshot, see #unique_21. We recommend that you use newly purchased ECS instances that contain no data for the test to prevent data loss.

Procedure

1. Remotely connect to an ECS instance. For more information, see #unique_22.
2. Before you test a Block Storage device, ensure that it is 4 KiB aligned.

```
sudo fdisk -lu
```

If the value of `Start` in the command output is divisible by 8, the device is 4 KiB aligned. Otherwise, perform 4 KiB alignment before you continue the performance test.

```
Device     Boot Start      End   Sectors Size Id Type
/dev/vda1  *     2048 83886046 83883999  40G 83 Linux
```

3. Run the following commands to install the libaio and fio tools:

```
sudo yum install libaio -y
sudo yum install libaio-devel -y
sudo yum install fio -y
```

4. Switch the directory.

```
cd /tmp
```

5. Run the performance test commands. For more information about the commands, see the following section.

Commands used to test the performance of cloud disks

For more information about the IOPS test methods regarding the enhanced SSD, see

*Test the IOPS performance of an enhanced SSD.*
• Random write IOPS:

```
fio -direct=1 -iodepth=128 -rw=randwrite -ioengine=libaio -bs=4k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Rand_Write_Testing
```

• Random read IOPS:

```
fio -direct=1 -iodepth=128 -rw=randread -ioengine=libaio -bs=4k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Rand_Read_Testing
```

• Sequential write throughput (write bandwidth):

```
fio -direct=1 -iodepth=64 -rw=write -ioengine=libaio -bs=1024k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Write_PPS_Testing
```

• Sequential read throughput (read bandwidth):

```
fio -direct=1 -iodepth=64 -rw=read -ioengine=libaio -bs=1024k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Read_PPS_Testing
```

• Random write latency:

```
fio -direct=1 -iodepth=1 -rw=randwrite -ioengine=libaio -bs=4k -size=1G -numjobs=1 -group_reporting -filename=iotest -name=Rand_Write_Latency_Testing
```

• Random read latency:

```
fio -direct=1 -iodepth=1 -rw=randread -ioengine=libaio -bs=4k -size=1G -numjobs=1 -group_reporting -filename=iotest -name=Rand_Write_Latency_Testing
```

Commands used to test the performance of local disks

The following test commands are only applicable to local NVMe SSD disks.
• Random write IOPS:

```
fio -direct=1 -iodepth=32 -rw=randwrite -ioengine=libaio -bs=4k -numjobs=4 -time_based=1 -runtime=1000 -group_reporting -filename=/dev/vdx -name=test
```

• Random read IOPS:

```
fio -direct=1 -iodepth=32 -rw=randread -ioengine=libaio -bs=4k -numjobs=4 -time_based=1 -runtime=1000 -group_reporting -filename=/dev/vdx -name=test
```

• Sequential write throughput (write bandwidth):

```
fio -direct=1 -iodepth=128 -rw=write -ioengine=libaio -bs=128k -numjobs=1 -time_based=1 -runtime=1000 -group_reporting -filename=/dev/vdx -name=test
```

• Sequential read throughput (read bandwidth):

```
fio -direct=1 -iodepth=128 -rw=read -ioengine=libaio -bs=128k -numjobs=1 -time_based=1 -runtime=1000 -group_reporting -filename=/dev/vdx -name=test
```

• Random write latency:

```
fio -direct=1 -iodepth=1 -rw=randwrite -ioengine=libaio -bs=4k -numjobs=1 -time_based=1 -runtime=1000 -group_reporting -filename=/dev/vdx -name=test
```

• Random read latency:

```
fio -direct=1 -iodepth=1 -rw=randread -ioengine=libaio -bs=4k -numjobs=1 -time_based=1 -runtime=1000 -group_reporting -filename=/dev/vdx -name=test
```

• Sequential write latency:

```
fio -direct=1 -iodepth=1 -rw=write -ioengine=libaio -bs=4k -numjobs=1 -time_based=1 -runtime=1000 -group_reporting -filename=/dev/vdx -name=test
```

• Sequential read latency:

```
fio -direct=1 -iodepth=1 -rw=read -ioengine=libaio -bs=4k -numjobs=1 -time_based=1 -runtime=1000 -group_reporting -filename=/dev/vdx -name=test
```

fio parameter values

The following table uses the command for testing random write IOPS (randwrite) as an example to describe the parameter settings in fio commands.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-direct=1</td>
<td>Indicates that the I/O buffer is ignored during the test and data is written directly.</td>
</tr>
<tr>
<td>-iodepth=128</td>
<td>Indicates that when you use asynchronous I/O, a maximum of 128 I/O requests can be made at the same time.</td>
</tr>
<tr>
<td>-rw=randwrite</td>
<td>Indicates that the read/write policy is random writes. Other valid values for rw:</td>
</tr>
<tr>
<td></td>
<td>- randread (random reads)</td>
</tr>
<tr>
<td></td>
<td>- read (sequential reads)</td>
</tr>
<tr>
<td></td>
<td>- write (sequential writes)</td>
</tr>
<tr>
<td></td>
<td>- randrw (random reads and writes)</td>
</tr>
<tr>
<td>-ioengine=libaio</td>
<td>Indicates that libaio (the Linux-native asynchronous I/O facility) is used as the testing method. There are two ways for an application to use I/O:</td>
</tr>
<tr>
<td></td>
<td>- Synchronous</td>
</tr>
<tr>
<td></td>
<td>In synchronous I/O mode, a thread sends only one I/O request at a time and waits until the I/O request is completed. In this case, the iodepth value is always smaller than 1 for a single thread. You can increase the iodepth value by using multiple concurrent threads. The iodepth value will reach its upper limit when there are 16 to 32 threads running concurrently.</td>
</tr>
<tr>
<td></td>
<td>- Asynchronous</td>
</tr>
<tr>
<td></td>
<td>In asynchronous I/O mode, a thread uses libaio to send multiple I/O requests at a time and waits until all these I/O requests are completed. Asynchronous I/O reduces the number of interactions and increases interaction efficiency.</td>
</tr>
</tbody>
</table>
### Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-bs=4k</td>
<td>Indicates that the size of each block for one I/O is 4 KB. If this parameter is not specified, the default value 4 KB is used.</td>
</tr>
<tr>
<td></td>
<td>· When IOPS is tested, we recommend that you set bs to a small value, such as 4k in this example command.</td>
</tr>
<tr>
<td></td>
<td>· When throughput is tested, we recommend that you set bs to a large value, such as 1024k in other example commands.</td>
</tr>
<tr>
<td>-size=1G</td>
<td>Indicates that the size of the testing file is 1 GiB.</td>
</tr>
<tr>
<td>-numjobs=1</td>
<td>Indicates that the number of testing threads is 1.</td>
</tr>
<tr>
<td>-runtime=1000</td>
<td>Indicates that the test duration is 1,000 seconds. If this parameter is not specified, the file of the size specified by -size is written in blocks of the size specified by -bs.</td>
</tr>
<tr>
<td>-group_reporting</td>
<td>Indicates that in the testing results, the statistics are displayed for a group of threads, not for each individual thread.</td>
</tr>
<tr>
<td>-filename=iotest</td>
<td>Indicates that the name of the test file is iotest.</td>
</tr>
<tr>
<td>-name=Rand_Write _Testing</td>
<td>Indicates that the name of the test task is Rand_Write _Testing. You can specify any name you want.</td>
</tr>
</tbody>
</table>

### 2.4 Test the IOPS performance of an enhanced SSD

The disk configuration and actual environment used will affect the test result. You can configure the environment to perform a performance stress test on an enhanced SSD and obtain the one million IOPS result as shown in this example.

**Context**

**Testing conditions:**

- **Sample operation:** random write (randwrite).
- **Image:** We recommend that you use the latest version of a Linux image provided by Alibaba Cloud, such as CentOS 7.4 64-bit, CentOS 7.3 64-bit, CentOS 7.2 64-bit, or Aliyun Linux 2.1903 64-bit.
- **Tool:** We recommend that you use fio.
- **Instance type:** We recommend that you use ecs.g5se.18xlarge.
- ESSD: We recommend that you use a PL3 enhanced SSD. In this example, the device name of the enhanced SSD is /dev/vdb. For more information, see Enhanced SSDs.

⚠️ Warning:
You can obtain accurate test results by testing raw disk partitions. However, you may destroy the file system structure in a raw disk partition if you test the partition directly. Before you perform such a test, you must create a snapshot of the disk to back up your data. For more information about how to create a snapshot, see #unique_21. We recommend that you use newly purchased ECS instances that contain no data for the test to prevent data loss.

Procedure

1. Remotely connect to an ECS instance. For more information, see #unique_22.

2. Run the following commands to install the libaio and fio tools:

   ```bash
   sudo yum install libaio -y
   sudo yum install libaio-devel -y
   sudo yum install fio -y
   ```

3. Switch the directory.

   ```bash
   cd /tmp
   ```

4. Create the test100w.sh script.

   ```bash
   vim test100w.sh
   ```

5. Paste the following code to the test100w.sh script.

   ```bash
   function RunFio
   {
   numjobs=$1   # The number of the threads to be tested. In this example, the value is 10.
   iodepth=$2   # The maximum number of concurrent I/O requests. In this example, the value is 64.
   bs=$3        # The size of the data block per I/O. In this example, the value is 4k.
   rw=$4        # The read and write policy. In this example, the value is randwrite.
   filename=$5  # The name of the file to be tested. In this example, the value is /dev/vdb.
   nr_cpus=`cat /proc/cpuinfo |grep "processor" |wc -l`
   if [ $nr_cpus -lt $numjobs ];then
       echo "Numjobs is more than cpu cores, exit!"
       exit -1
   fi
   let nu=$numjobs+1
   cpulist=""
   ```
for ((i=1;i<10;i++))
do
    list=`cat /sys/block/vdb/mq/*/cpu_list | awk '{if(i<=NF) print $i;}' i="$i" | tr -d ',' | tr '\n' ','`
    if [ -z $list ];then
        break
    fi
cpulist=${cpulist}$list
done
spincpu=`echo $cpulist | cut -d ',' -f 2-${nu}`
echo $spincpu
fio --ioengine=libaio --runtime=30s --numjobs=${numjobs} --iodepth=${iodepth} --bs=${bs} --rw=${rw} --filename=${filename} --time_based=1 --direct=1 --name=test --group_reporting --cpus_allowed=$spincpu --cpus_allowed_policy=split
} echo 2 > /sys/block/vdb/queue/rq_affinity
sleep 5
RunFio 10 64 4k randwrite /dev/vdb

6. You need to modify the parameter settings in the test100w.sh script based on your environment.

- Set **vdb** to the actual device name of the enhanced SSD.
- Modify **10, 64, 4k, randwrite, and** /dev/vdb in RunFio 10 64 4k randwrite /dev/vdb.
- If you choose to proceed with this operation, set **filename** to a device name such as [/dev/vdb]. If you do not want to risk data loss, set **filename** to a file path such as [/mnt/test.image].

7. Test the performance of the enhanced SSD.

```
sh test100w.sh
```

When the **IOPS=*** appears, it indicates that the performance test of the enhanced SSD is completed.

```
{root}@{host} # sh test100w.sh
4,8,12,16,20,24,28
Starting 8 processes
000: 8 (f=8): \(w(0.0%)\)[r=0Kb/s,w=3965Kib/s][r=0,w=1015K IOPS][eta 00m00s]
write: IOPS=1006k, DM=3931MB/s (412MB/s) [115616/30047ms]
clat (usec) min=82, max=642396, avg=508.05, stdev=81.37
lat (usec) min=95, max=642300, avg=504.46, stdev=81.43
clat percentiles (usec):
  1.000%= 174.5, 95.000%= 210.5, 90.000%= 255.9, 80.000%= 335.8, 70.000%= 414.2, 60.000%= 441.0, 50.000%= 495.9, 40.000%= 584.5, 30.000%= 800.4, 20.000%= 1031.3
  10.000%= 1156.0, 99.000%= 1291.2, 99.500%= 1705.7
bw [ KiB/s ] min=338916, max=526437, per=12.53%, avg=504445.98, stdev=33239.37, samples=400
```
Details of the test100w.sh script

- **In the script, the following command sets the** \texttt{rq\_affinity} **parameter to 2:**

  ```bash
echo 2 > /sys/block/vdb/queue/rq\_affinity
  ```

<table>
<thead>
<tr>
<th>Value of \texttt{rq_affinity}</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Indicates that the block device forwards the received I/O Completion events to the vCPU group that submits the corresponding I/O requests. When multiple threads concurrently process I/O requests, the I/O Completion events may run on the same vCPU, which results in a performance bottleneck.</td>
</tr>
<tr>
<td>2</td>
<td>Indicates that the block device forwards the received I/O Completion events to the vCPU that submits the corresponding I/O requests. The performance of each vCPU is fully delivered when multiple threads concurrently process I/O requests.</td>
</tr>
</tbody>
</table>

- **The following command attaches** \texttt{jobs} **to different CPU cores.**

  ```bash
  fio -ioengine=libaio -runtime=30s -numjobs=${\texttt{numjobs}} -iodepth=${\texttt{iodepth}} -bs=${\texttt{bs}} -rw=${\texttt{rw}} -filename=${\texttt{filename}} -time_based=1 -direct=1 -name=test -group\_reporting -cpus\_allowed=${\texttt{spincpu}} -cpus\_allowed\_policy=split
  ```

**Note:**

Typically, a device has only one request queue. This unique request queue becomes a performance bottleneck when multiple threads concurrently process I/O requests. In Multi-Queue mode, one device can have multiple request queues that process I/O requests, delivering full performance of the backend storage service. If you have four I/O threads, you must attach them to the CPU cores that correspond to different request queues. This allows you to leverage the full capabilities of the Multi-Queue mode to improve storage performance.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>numjobs</td>
<td>The number of I/O threads.</td>
<td>10</td>
</tr>
<tr>
<td>/dev/vdb</td>
<td>The device name of the enhanced SSD.</td>
<td>/dev/vdb</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
<td>Example</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>cpus_allowed_policy</td>
<td><code>fio</code> provides the <code>cpus_allowed_policy</code> and <code>cpus_allowed</code> parameters to bind vCPUs.</td>
<td>split</td>
</tr>
</tbody>
</table>

The preceding command runs multiple jobs that are bound to different CPU cores and correspond to different queue IDs. To view the value of `cpu_core_id` that is bound to a queue ID, perform the following steps:

- Run the `ls /sys/block/vd*/mq/` command to view the queue ID of the enhanced SSD whose device name is in `/dev/vd*` format.
- Run the `cat /sys/block/vd*/mq/cpu_list` command to view the `cpu_core_id` corresponding to the queue ID of the enhanced SSD whose device name is in `/dev/vd*` format.
3 Cloud disks

3.1 Disk overview

Disks are block-level data storage products provided by Alibaba Cloud for ECS. They feature low latency, high performance, durability, and reliability. Disks use a distributed triplicate mechanism to ensure 99.9999999% data durability for ECS instances. This means that if service disruptions occur (for example, due to hardware failure), data within the target zone is copied to an unaffected disk to help ensure data availability.

Category of disks

As with hard disks, you can partition, format, create file systems on, and persistently store data on disks that are attached to ECS instances. The following table lists the disk categories by performance.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced SSD (ESSD)</td>
<td>The ultra-high performance disks provided by Alibaba Cloud. ESSDs are based on the next-generation distributed block storage architecture, a 25 GE network, and remote direct memory access (RDMA) technology. Each ESSD can deliver up to 1 million of random IOPS and has low latency. For more information, see Enhanced SSDs.</td>
</tr>
<tr>
<td>Standard SSD</td>
<td>High-performance disks that feature consistent and high random IOPS performance and high data durability.</td>
</tr>
<tr>
<td>Ultra disk</td>
<td>Disks that feature high cost-effectiveness, medium random IOPS performance, and high data durability.</td>
</tr>
<tr>
<td>Basic disk</td>
<td>Disks that feature high data durability and standard random IOPS performance.</td>
</tr>
</tbody>
</table>

Creation methods

A disk can be used as a system disk or a data disk based on the type of the stored data and the creation method of the disk.
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Create separately</th>
<th>Maximum number of disks per instance</th>
<th>Capacity</th>
</tr>
</thead>
</table>
| System disk | Shared access to a system disk is not allowed. When a system disk is initialized, the operating system type and application data are determined by the image. Only cloud disks can be used as system disks. | No. A system disk must be created with an instance. The lifecycle of the system disk is the same as that of the instance. | 1        | Depends on the image of the instance:  
  • FreeBSD and CoreOS: 30 to 500 GiB  
  • Other Linux: 20 to 500 GiB  
  • Windows Server: 40 to 500 GiB |
| Data disk   | A data disk is often used to store application data. It can be created separately or together with an ECS instance. A disk or a Block Storage device of other types can be used as a data disk. | Yes.              | 16                                  | A maximum of 32 TiB. For more information, see Block Storage performance. |

**Limits**

A disk can be attached to only one ECS instance that is in the same zone as the disk. For more information, see the "Block Storage limits" section in *Limits*.

**Billing methods**

Disks can be billed on a subscription or a pay-as-you-go basis. For more information, see #unique_24 and #unique_25.

- Disks that are created with subscription instances or created separately for subscription instances are billed on a subscription basis.
· Disks that are created with pay-as-you-go instances or created separately for pay-as-you-go instances are billed on a pay-as-you-go basis.

After a disk is created, you can change its billing method as needed. For more information, see *Convert billing methods of cloud disks*.

**Related operations**

You can perform the following operations on a disk as needed:

<table>
<thead>
<tr>
<th>Business requirement</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attach an idle pay-as-you-go disk to an ECS instance</td>
<td>• <em>Attach a cloud disk</em></td>
</tr>
<tr>
<td></td>
<td>• <em>Format a data disk for a Linux-based ECS instance</em></td>
</tr>
<tr>
<td></td>
<td>• <em>Format a data disk for a Windows-based ECS instance</em></td>
</tr>
<tr>
<td>Purchase a subscription data disk</td>
<td><em>Create a subscription disk</em></td>
</tr>
<tr>
<td>Purchase a data disk separately</td>
<td>• <em>Create a pay-as-you-go disk</em></td>
</tr>
<tr>
<td></td>
<td>• <em>Create a disk from a snapshot</em></td>
</tr>
<tr>
<td>Encrypt the data stored on a disk</td>
<td><em>#unique_10</em></td>
</tr>
<tr>
<td>Resize a system disk</td>
<td><em>Overview</em></td>
</tr>
<tr>
<td>Resize a data disk</td>
<td><em>Overview</em></td>
</tr>
<tr>
<td>Change the operating system</td>
<td><em>Replace the system disk by using a public image</em></td>
</tr>
<tr>
<td>Back up disk data</td>
<td>• <em>#unique_21</em></td>
</tr>
<tr>
<td></td>
<td>• <em>#unique_35</em></td>
</tr>
<tr>
<td>Replicate the operating system and application data of another ECS instance</td>
<td><em>#unique_36</em></td>
</tr>
<tr>
<td>Restore a disk to its initial status</td>
<td><em>Reinitialize a cloud disk</em></td>
</tr>
<tr>
<td>Restore a disk to its status at a specific point in time</td>
<td><em>Roll back a disk</em></td>
</tr>
<tr>
<td>Release idle subscription disks to reduce costs</td>
<td>1. <em>Convert billing methods of cloud disks</em></td>
</tr>
<tr>
<td></td>
<td>2. <em>Detach a cloud disk</em></td>
</tr>
<tr>
<td></td>
<td>3. <em>Release a disk</em></td>
</tr>
<tr>
<td>Release idle pay-as-you-go disks to reduce costs</td>
<td>1. <em>Detach a cloud disk</em></td>
</tr>
<tr>
<td></td>
<td>2. <em>Release a disk</em></td>
</tr>
</tbody>
</table>
3.2 Enhanced SSDs

This topic provides general information about Alibaba Cloud enhanced SSDs (ESSDs), such as performance levels, use scenarios, and performance specifications. ESSDs are provisioned on a 25 GE network and remote direct memory access (RDMA) technology. They deliver a maximum random IOPS of 1 million per disk and low one-way latency.

Scenarios

ESSDs feature low latency, fast response, and high data throughput. They are ideal for latency-sensitive applications or I/O-intensive business scenarios. For example:

- Online transaction processing (OLTP) databases: relational databases, such as MySQL, PostgreSQL, Oracle, and SQL Server databases.
- NoSQL databases: non-relational databases, such as MongoDB, HBase, and Cassandra databases.
- Real-time analysis applications: Elasticsearch distributed log analysis, Elasticsearch, Logstash, and Kibana (ELK) log analysis.

Specifications

The API parameter value of ESSDs is `cloud_essd`. ESSDs are divided into three performance levels (PLs) based on the maximum performance per disk.

<table>
<thead>
<tr>
<th>ESSD attribute</th>
<th>Performance level 3</th>
<th>Performance level 2</th>
<th>Performance level 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance level</td>
<td>PL3</td>
<td>PL2</td>
<td>PL1</td>
</tr>
<tr>
<td>Performance description</td>
<td>Ultra high concurrent I/O performance and ultra low I/O latency</td>
<td>High concurrent I/O performance and low I/O latency</td>
<td>Moderate concurrent I/O performance and low I/O latency</td>
</tr>
<tr>
<td>Capacity (GiB)</td>
<td>1,261–32,768</td>
<td>461–32,768</td>
<td>20–32,768</td>
</tr>
<tr>
<td>Data reliability</td>
<td>99.99999999%</td>
<td>99.99999999%</td>
<td>99.99999999%</td>
</tr>
<tr>
<td>Maximum IOPS per disk</td>
<td>1,000,000</td>
<td>100,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Maximum throughput per disk (Mbit/s)</td>
<td>4,000</td>
<td>750</td>
<td>350</td>
</tr>
</tbody>
</table>
### ESSD attribute

<table>
<thead>
<tr>
<th>Performance level 3</th>
<th>Performance level 2</th>
<th>Performance level 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculate disk IOPS</td>
<td>Min{1800 + 50 \times \text{Capacity}, 100000}</td>
<td>Min{1800 + 50 \times \text{Capacity}, 10000}</td>
</tr>
<tr>
<td>Calculate disk throughput (Mbit/s)</td>
<td>Min{120 + 0.5 \times \text{Capacity}, 4000}</td>
<td>Min{120 + 0.5 \times \text{Capacity}, 750}</td>
</tr>
<tr>
<td>Applicable to the following products</td>
<td>Instance families with local SSDs and 16 or more vCPUs (i1, i2, and i2g)</td>
<td>SSDs and instance families with local SSDs (i1, i2, and i2g)</td>
</tr>
<tr>
<td>Scenario example</td>
<td>Large and medium-sized relational databases for core businesses and NoSQL databases, and large SAP and Oracle databases</td>
<td>Medium-sized relational databases, NoSQL databases, medium-sized ELK log clusters, and enterprise-grade commercial software such as SAP and Oracle</td>
</tr>
</tbody>
</table>

#### Billing

ESSDs support pay-as-you-go and subscription billing methods. For more information, see Create a pay-as-you-go disk and Create a subscription disk.

For information about the pricing for different ESSD performance levels, click the Pricing tab of the Elastic Compute Service page.

### ESSD capacity and performance levels

The performance of a storage device is closely related to the capacity of the device. A storage device with larger capacity provides more powerful data processing capabilities. All ESSDs have the same I/O performance per unit capacity. However, the performance of ESSDs increases linearly with its capacity until the maximum performance per disk for that performance level is reached.
### Performance level | ESSD capacity (GiB) | Maximum IOPS | Maximum throughput (MB/s)
---|---|---|---
PL1 | 20-32,768 | 50,000 | 350
PL2 | 461-32,768 | 100,000 | 750
PL3 | 1,261-32,768 | 1,000,000 | 4,000

- **Example 1:** If Alex selects 20 GiB memory when he creates an ESSD in the ECS console, PL1 is the only available option. PL1 ESSDs have a maximum IOPS of 50,000.

- **Example 2:** If Alex selects 32,000 GiB memory, all performance levels are available. The maximum IOPS for PL1 is 50,000, PL2 is 100,000, and PL3 is 1,000,000.

### Storage I/O performance of instance types

The storage I/O performance of some new-generation instance families is proportional to the specifications of the instance types.

The following examples show you how instance types affect the maximum IOPS and throughput of an ESSD.

- **Example 1:** Alex creates a 16 GiB instance of the ecs.g5se.xlarge instance type. The maximum IOPS of this instance type is 60,000. Alex then attaches an ESSD whose capacity is 1,800 GiB and the maximum IOPS is 100,000 to the instance. The maximum IOPS of the instance is 60,000, because it is limited by the maximum IOPS of the instance type.

- **Example 2:** Alex creates a 64 GiB instance of the ecs.g5se.4xlarge instance type. The maximum IOPS of this instance type is 230,000. Alex then attaches an ESSD whose capacity is 1,800 GiB and the maximum IOPS is 100,000 to the instance. The maximum IOPS of the instance is 100,000, because it is no longer limited by the maximum IOPS of the instance type, but is instead limited by the maximum IOPS of the ESSD.
### Related operations

<table>
<thead>
<tr>
<th>Business need</th>
<th>Reference</th>
<th>API operation</th>
</tr>
</thead>
</table>
| Create an ESSD separately and use it as a data disk | • Create a pay-as-you-go disk  
• Create a subscription disk  
• Create a disk from a snapshot                      | #unique_41    |
| Change billing methods                             | Convert billing methods of cloud disks         | #unique_42    |
| Attach a pay-as-you-go data disk to an ECS instance | Attach a cloud disk                            | #unique_43    |
| Create a normal or local snapshot                  | #unique_21                                    | #unique_44    |
| Increase the capacity of an ESSD                   | Overview                                      | #unique_45    |
| Resize an ESSD to improve performance              | • Overview  
• Modify the performance level of an ESSD     | • #unique_45  
• #unique_47  |
| Detach a pay-as-you-go data disk                    | Detach a cloud disk                           | #unique_48    |
| Release a data disk                                | Release a disk                                | #unique_49    |

### 3.3 Triplicate technology

The Alibaba Cloud Distributed File System provides stable and efficient data access and reliability for ECS. Triplicate technology, that is, the process of making and distributing three copies of data, is the principle concept implemented in the Alibaba Cloud Distributed File System.

When you perform read and write operations on cloud disks, the operations are translated into the corresponding processes on the files stored in Alibaba Cloud data storage system. The Distributed File System of Alibaba Cloud uses a flat design in which a linear address space is divided into slices, also called chunks. Each chunk has three copies stored on different server nodes on different racks. This guarantees data reliability.
How triplicate technology works

Triplicate technology involves three key components: Master, Chunk Server, and Client. To demonstrate how triplicate technology works, in this example, the write operation of an ECS user undergoes several conversions before being executed by the Client. The process is as follows:

1. The Client determines the location of a chunk corresponding to a write operation.
2. The Client sends a request to the Master to query the storage locations (that is, the Chunk Servers) of the three copies of the chunk.
3. The Client sends write requests to the corresponding three Chunk Servers according to the results returned from the Master.
4. The Client returns a message that indicates whether the operation was successful.

This strategy guarantees that all the copies of a chunk are distributed on different Chunk Servers on different racks, effectively reducing the potential of total data loss caused by failure of a Chunk Server or a rack.

Data protection

If a system failure occurs because of a corrupted node or hard drive failure, some chunks may lose one or more of the three valid chunk copies associated with them. If this occurs and triplicate technology is enabled, the Master replicates data between Chunk Servers to replace the missing chunk copies across different nodes.
To summarize, all your operations (additions, modifications, or deletions) on cloud disk data are synchronized to the three chunk copies at the bottom layer. This mode ensures the reliability and consistency of your data.

Furthermore, we recommend you implement appropriate backup strategies, snapshots, and other precautionary actions to restore and protect your data and guarantee its availability against other types of failures, such as viruses, human error, or malicious activity on your account. No single technology can solve all the problems, so you must choose appropriate data protection measures to establish a solid defense line for your valuable business data.

### 3.4 Create a cloud disk

#### 3.4.1 Create a pay-as-you-go disk

This topic describes how to create an empty pay-as-you-go disk in the ECS console. You can increase the storage space of an instance by attaching a pay-as-you-go disk to it. You cannot create a separate system disk in the ECS console.

**Context**

You can use either of the following methods to create a pay-as-you-go disk:

- Log on to the ECS console. In the left-side navigation pane, choose Storage & Snapshots > Disks to create a pay-as-you-go disk.
- When you create an ECS instance, set its billing method to pay-as-you-go and create disks for the instance. All the disks created together with this instance use the pay-as-you-go billing method. For more information, see *Create an instance*.

Note the following limits on creating pay-as-you-go disks:
In each region, the number of pay-as-you-go data disks that you create cannot be more than five times the number of pay-as-you-go instances under your account. For more information, see Limits.

You cannot merge multiple disks by formatting them because they are independent of each other. Therefore, we recommend that you determine the number and capacity of disks that you need before you create them.

We recommend that you do not use Logical Volume Manager (LVM) to create logical volumes on multiple disks. This is because a snapshot can only back up data of a single disk. If you create a logical volume on several disks by using LVM, data discrepancies will occur when you roll back these disks.

For information about the pay-as-you-go billing method, see #unique_25.

Procedure

1. Log on to the ECS console.
2. In the left-side navigation pane, choose Storage & Snapshots > Disks.
3. In the upper-right corner of the Disks page, click Create Disk.
4. Select the region and zone of the instance to which you want to attach the disk.
5. Select a disk category and specify the disk capacity. Select Disk Encryption if required and set the Quantity parameter to specify the number of disks you want to purchase.

   ![Disk Creation Interface](image)

   - Quantity: Specify the number of disks you want to purchase.
   - Disk Name: Enter a disk name. The name must be 2 to 128 characters in length and can contain letters, Chinese characters, digits, and the following special characters: 
   - Description: Enter a disk description.

   Note:

   - Select Apply Automatic Snapshot Policy and then select or create an automatic snapshot policy to create automatic snapshots of the disk based on the policy. For details about how to create an automatic snapshot policy, see #unique_52.
   - To check whether a disk needs to be encrypted, see ECS disk encryption.
· You can also create the disk from a snapshot. For more information, see Create a disk from a snapshot.

· For information about how to select enhanced SSDs (ESSDs), see ESSD cloud disk.

6. Select the terms of services in the Terms of Service section.

7. Confirm your settings and the Total value displayed.

8. Click Preview. In the dialog box that appears, click Create.

Result

After the disk is created, go back to the Disks page and refresh the disk list.

Unattached is displayed in the Status column corresponding to the new disk.

What's next

· To attach the disk to an ECS instance, see Attach a cloud disk.

· To convert the disk to a subscription disk, see Convert billing methods of cloud disks.

Related topics

#unique_41
#unique_53
#unique_54

3.4.2 Create a subscription disk

This topic describes how to create an empty subscription disk in the ECS console. You can increase the storage space of an instance by attaching a subscription disk to it.

Context

You can use either of the following methods to create a subscription disk:

· Create a subscription disk and attach it to an ECS instance in the ECS console.

· When you create an ECS instance, set its billing method to subscription and create disks for the instance. All the disks created together with this instance use the subscription billing method. For more information, see Create an instance.

Note the following limits on creating subscription disks:

· You cannot merge multiple disks by formatting them because they are independent of each other. Therefore, we recommend that you determine the number and capacity of disks that you need before you create them.
• We recommend that you do not use Logical Volume Manager (LVM) to create logical volumes on multiple disks. This is because a snapshot can only back up data of a single disk. If you create a logical volume on several disks by using LVM, data discrepancies will occur when you roll back these disks.

• Subscription disks cannot be detached. They are released along with the instances to which they are attached. If you want to release a subscription disk, you can convert it to a pay-as-you-go disk, and then detach and release it.

For information about the subscription billing method, see #unique_24.

Procedure

1. Log on to the ECS console.

2. In the left-side navigation pane, choose Instances & Images > Instances.

3. In the top navigation bar, select a region.

4. On the Instances page, find the subscription instance for which you want to create a subscription disk. In the Actions column, choose More > Configuration Change > Add Subscription Disk.
5. In the Disk section on the page that appears, complete the following settings:

- **Disk category**: Select a disk category from the drop-down list. For information about how to select enhanced SSDs (ESSDs), see *ESSD cloud disk*.
- **Disk capacity**: Enter a capacity for the disk. The allowed capacity ranges from 20 GiB to 32,768 GiB.
- **Disk encryption**: Select Disk Encryption if required. For information about the disk encryption feature, see *ECS disk encryption*.
- **(Optional) Select Apply Automatic Snapshot Policy** and then select an existing automatic snapshot policy.
  
  You can also create an automatic snapshot policy. For details about how to create an automatic snapshot policy, see #unique_52.
- **Quantity**: Enter the number of disks you want to purchase.

**Note:**
You can create a total of 16 data disks for a single instance. Disks and Shared Block Storage devices used as data disks count towards this total.

- **(Optional) Disk Name**: Enter a name for the disk.
- **(Optional) Description**: Enter a description for the disk.
- **To create a disk from a snapshot**, click Create from Snapshot. For more information, see *Create a disk from a snapshot*.

6. **Select ECS Terms of Service**.

7. **Click Preview**.

8. **In the dialog box that appears**, confirm the parameter settings and click Create.

9. **Select a payment method** and click Confirm to Pay to make payment.
10. Click Console and go to the Instances page. Click the name of the instance to which the new subscription disk is attached.

11. Click Disks in the left-side navigation pane. In the disk list, find the subscription disk that you created.

The disk is attached to the instance and is in the In use state.

What's next

- To format and partition the disk, see *Format a data disk of a Linux instance* or *Format a data disk for a Windows instance*.
- To convert the disk to a pay-as-you-go disk, see *Convert the billing methods of cloud disks*.

Related topics

### 3.4.3 Create a disk from a snapshot

This topic describes how to create a disk in the ECS console by using a system disk snapshot or a data disk snapshot. After you create a disk, you can attach it to any instance in the same region and zone as the disk.

**Prerequisites**

You have created a system disk snapshot or a data disk snapshot, and obtained the snapshot ID. For details about how to create a snapshot, see *Create a snapshot*.

**Context**

We recommend that you create a disk from a snapshot in either of the following scenarios:

- If you need to obtain data from a snapshot but you do not want to roll back the corresponding disk, you can create a disk from the snapshot and access the data that you need in the new disk.
- If your ECS instance encounters problems due to a system disk failure, you can use a snapshot of the system disk to create a disk. Then attach the new disk as a data disk to a healthy ECS instance so that you can continue to read the data of the system disk.

Note the following limits on creating disks from snapshots:
By default, a disk created from a snapshot uses the pay-as-you-go billing method, and can only be used as a data disk. However, you can convert the billing method of the disk.

When you access a disk created from a snapshot for the first time, you may experience a decrease in the disk performance because it takes some time for ECS to read data from OSS and write the data to the disk. We recommend that you do not use the disk until ECS finishes reading data from OSS and writing the data to the disk.

In each region, the number of pay-as-you-go data disks that you create cannot be more than five times the number of pay-as-you-go instances under your account. For more information, see Limits.

You cannot merge multiple disks by formatting them because they are independent of each other. Therefore, we recommend that you determine the number and capacity of disks that you need before you create them.

We recommend that you do not use Logical Volume Manager (LVM) to create logical volumes on multiple disks. This is because a snapshot can only back up data of a single disk. If you create a logical volume on several disks by using LVM, data discrepancies will occur when you roll back these disks.

By default, disks created from snapshots use the pay-as-you-go billing method. After you create a disk from a snapshot, you can convert the billing method of the disk to subscription:

- If the disk is attached to a subscription instance, you can convert the disk billing method to subscription by upgrading the instance. For more information about how to upgrade a subscription instance, see Upgrade configurations of Subscription instances.

- If the disk is attached to a pay-as-you-go instance, you can convert the disk billing method to subscription by converting the instance to a subscription instance. For more information about how to convert a pay-as-you-go instance to a subscription instance, see #unique_57.

You can also create a disk from a system disk snapshot or a data disk snapshot when you create an ECS instance. The disks created together with an ECS instance use the same billing method as the ECS instance.

Procedure
1. Log on to the *ECS console*.

2. In the left-side navigation pane, choose Storage & Snapshots > Disks.

3. In the upper-right corner of the Disks page, click Create Disk.

4. Select a region and zone.

   **Note:**
   
   If you want to attach the disk to an ECS instance, they must be in the same region and zone.

5. Complete the following settings:

   a) Select a disk category: Ultra Disk, Enhanced SSD (ESSD), or Standard SSD.

   b) Click Create from Snapshot and then select a snapshot.

   c) (Optional) Select Apply Automatic Snapshot Policy and then select an existing automatic snapshot policy.

      You can also create an automatic snapshot policy. For details about how to create an automatic snapshot policy, see #unique_52.

   d) Set the disk capacity. It must be greater than 20 GiB but less than 32,768 GiB.

      **Note:**
      
      - If you do not set the capacity, the system automatically sets the capacity of the new disk to the snapshot size (source disk capacity of the snapshot).
      - If the disk capacity you set is greater than the snapshot size, you must repartition the disk to guarantee that you can use the excess capacity.
      - If the snapshot size is less than 2,048 GiB and you want to set the disk capacity to a value greater than 2,048 GiB, make sure that the snapshot' source disk uses the Globally Unique Identifier Partition Table (GPT). If the source disk does not use GPT, we recommend that you set the disk capacity to a value less than 2,048 GiB to avoid data loss that may occur during partitioning. For more information, see *Partition and format data disks larger than 2 TiB*.

   e) Set the Quantity parameter.

   f) Select ECS Terms of Service.

6. Confirm your settings and the Total value displayed.
7. Click Preview. Then, follow the on-screen tips to create the disk.

After the disk is created, go back to the Disks page and refresh the disk list. Find the new disk. Unattached is displayed in the Status column corresponding to the disk.

What's next

After creating a disk from a snapshot, you must attach the disk to an ECS instance to restore the snapshot data. For a Linux instance, log on to the instance and run the `mount` command to mount the disk. For more information about how to attach a disk, see Attach a cloud disk.

Related topics

#unique_55
#unique_53
#unique_54

3.5 Encrypt a disk

3.5.1 Encryption overview

This topic introduces the basic concepts of encryption. Encryption can help you secure your data stored in Alibaba Cloud ECS and comply with security standards. You can protect the privacy, autonomy, and security of your data without the need to build or maintain key management infrastructure. Both the system disk and the data disk can be encrypted.

Feature description

ECS uses the industry-standard AES-256 algorithm to encrypt disks, and the key for disk encryption can be a service key or a common key (BYOK). Encryption and decryption have minimal impacts on ECS disk performance.

- When you create an ECS instance from an encrypted image, data in the operating system of the ECS instance is encrypted automatically and decrypted when its data is read. For detailed instructions, see Encrypt a system disk.
- The following types of data on an encrypted data disk is encrypted and is automatically decrypted when it is read. For detailed instructions, see *Encrypt a data disk*.

- Static data stored on the encrypted disk.
- Data transmitted between the encrypted disk and the instance. Data in the operating system is not encrypted again.
- Data transmitted between the encrypted disk and the backend storage clusters.
- All snapshots that are created from encrypted disk, by using the same key as the one from the encrypted disk.
- All disks that are created from encrypted snapshots.

**Keys**

A Customer Master Key (CMK) includes metadata, such as the key ID, creation date, description, rotation plan, lifecycle status, and the key material that is used to encrypt and decrypt data. After a disk is encrypted by using a CMK, all disk data will be encrypted using this CMK. The CMK is also associated with all snapshots and the disks that are created from these snapshots. The CMK is used only in the memory of the host running your ECS instance. It is not stored on any storage media in plaintext. CMKs are stored in the key management infrastructure provided by Key Management Service (KMS) to implement strong physical and logical security protection. Unauthorized access is prohibited. The KMS infrastructure of Alibaba Cloud conforms to the recommendations in NIST SP 800-57 and uses cryptographic algorithms that comply with FIPS Publication 140-2. You can select the following types of CMKs to encrypt disks.
### Elastic Compute Service

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<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Source</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Service key</strong> (See the first key in the following figure.)</td>
<td>When you activate KMS and use encryption for the first time within a region, KMS automatically creates a dedicated CMK for the ECS service in this region. The alias of the CMK is <code>acs/ecs</code>. Service keys cannot be deleted or disabled.</td>
<td>The default service CMK provided by KMS.</td>
<td>This CMK can be used in the scenarios where you want to enhance efficiency and convenience. For more information, see #unique_63</td>
</tr>
</tbody>
</table>
| **Common key** (See the second key in the following figure.) | You can specify a symmetric customer managed CMK (BYOK) that you created as the default key for disk encryption. You have full management permissions to create, rotate, and disable keys, and define access control. | • Source 1: The key that is created in KMS.  
• Source 2: The key that is created in KMS from imported key material (BYOK). | The common key can be used in the scenarios where you want to improve operation flexibility and increase the number of keys. |

### Billing

The billing information of encryption features and operations is described in the following table. Ensure that your billing method has sufficient balance. Otherwise, operations that involve billing items may fail.

<table>
<thead>
<tr>
<th>Feature or operation</th>
<th>Billing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encrypt the system and data disks</td>
<td>No</td>
</tr>
<tr>
<td>Feature or operation</td>
<td>Billing</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Use service keys that are provided by KMS</td>
<td>No</td>
</tr>
<tr>
<td>CMKs that you create on your own in KMS, including BYOK</td>
<td>Yes</td>
</tr>
<tr>
<td>Read and write operations on disk, such as mounting (mount) and unmounting (unmount) of disks, creation of partitions, and formatting of file systems.</td>
<td>No</td>
</tr>
</tbody>
</table>

Limits

- You can encrypt data disks, such as the enhanced SSD, standard SSD, ultra disk, basic disk, and Shared Block Storage.
- You can encrypt system disks, such as the enhanced SSD, standard SSD and ultra disk.
- Products or packets that cannot be encrypted include the local disk and ECS Bare Metal Instance.
- You can encrypt system disks only when you copy their custom image. After the system disk is encrypted, you cannot perform the following operations:
  - Convert encrypted images to unencrypted images.
  - Copy encrypted images across regions.
  - Share encrypted images.
  - Export encrypted images.
- You cannot convert unencrypted disks to encrypted disks.
- You cannot convert encrypted disks to unencrypted disks.

3.5.2 Encrypt a system disk

This topic describes how to encrypt a system disk. You can select to use disk encryption when you copy a custom image. After you select this option, system disks and data disks that are created from the image are automatically encrypted. The key that you use for image encryption becomes the encryption key for the system disks and data disks, and the key can be a service key or a common key (BYOK).

Context

You can encrypt a system disk only by copying a custom image. For more information about disk encryption, see Encryption overview.
Encrypt a system disk when copying a custom image in the ECS console.

1. Log on to the **ECS console**.
2. In the left-side navigation pane, choose Instances & Images > Images.
3. In the top navigation bar, select a region.
4. On the Images page, click the Custom Images tab.
5. Select the custom image that you want to copy and click Copy Image in the Actions column.

   **Note:**
   If the size of your custom image is greater than 500 GiB, you are directed to open a ticket to complete the operation when you click Copy Image.

6. In the Copy Image dialog box, select Encrypt.

   ECS uses the default key (Default CMK) generated by Key Management Service (KMS) for encryption. Alternatively, by selecting a key from the drop-down list, you can choose the custom keys that you created or imported in the KMS console. We recommend that you use custom keys for encryption.

   **Note:**
   If this is the first time that you select Encrypt, click Go to Authorize and select AliyunECSDiskEncryptDefaultRole to allow ECS to access your KMS resources.

   This procedure only describes how to configure encryption items when you copy a custom image. For more information about other configurations, see #unique_64.

7. Click OK.

Encrypt a system disk by calling CopyImage

The following example uses Alibaba Cloud CLI to call the #unique_65 operation to specify a KMSKeyId to encrypt the system disk.

```bash
aliyun ecs CopyImage --RegionId cn-hongkong --ImageId m-bp155shrycg3s0****** --DestinationRegionId cn-shenzhen --Encrypted true --KmsKeyId e522b26d-abf6-4e0d-b5da-04b7*****3c --Tag.N.Key EcsDocumentation
```

Convert the encryption status

To determine the encryption status of the system disk and whether you need to change or select a new CMK, refer to the following points:
• If you do not select a CMK when copying an unencrypted disk, the encryption status of the system disk that is created from the target image is unencrypted.

• When you copy an unencrypted image and select a CMK, the target image is encrypted. You must make sure to use this same CMK when you try to access ECS instances that are created from the image.
• When you copy an encrypted image and do not select a new CMK, the target image is encrypted. You can use the original key to access the ECS instance that is created from the target image.

• When you copy an encrypted image and select a new CMK, the target image is encrypted. You must make sure to use this new CMK when you try to access ECS instances that are created from the image.

What's next
You can use the copied image to create an instance or change the system disk:

• Replace the system disk (non-public image)

Related topics
#unique_68
#unique_69
3.5.3 Encrypt a data disk

This topic describes how to encrypt a data disk. After you enable encryption on a data disk, both dynamic data in transmission and static data on the data disk are encrypted.

Context

In this topic, data disks in Shared Block Storage and common disks are collectively referred to as disks.

Encrypt a data disk when creating an instance

1. Log on to the ECS console.
2. In the left-side navigation pane, choose Instances & Images > Instances.
3. Click Create Instance.
4. On the Basic Configurations page, find the Storage section and perform the following steps.

   ![Note]

   This procedure only describes how to configure encryption items during instance creation. For more information about other configurations, see #unique_51.

   a) Click Add Disk.
   b) Specify the disk type and capacity of the data disk.
   c) Select Disk Encryption and then select a key from the drop-down list.
Encrypt a data disk during disk creation

1. Log on to the ECS console.
2. In the left-side navigation pane, choose Storage & Snapshots > Disks.
3. In the upper-right corner of the Disks page, click Create Disk.
4. Select the region and zone of the instance to which you want to attach the disk.
5. In the Disk section, select Disk Encryption and then select a key from the drop-down list.

Note:
This procedure only describes how to configure encryption items during disk creation. For more information about other configurations, see Create a pay-as-you-go disk or Create a subscription disk.

Convert the encryption status

After a data disk is created, you cannot convert the encryption status of the data disk. The following table describes the operations to convert the encryption status.
<table>
<thead>
<tr>
<th>Conversion of states</th>
<th>Method</th>
<th>Windows Server</th>
<th>Linux</th>
</tr>
</thead>
</table>
| From unencrypted to encrypted | 1. Log on to the operating system of the ECS instance.  
2. Manually copy data on the unencrypted disk to a newly created encrypted disk. | Enter the `robocopy` command in Command Prompt. | Enter the `rsync` command in shell. |
| From encrypted to unencrypted | 1. Log on to the operating system of the ECS instance.  
2. Manually copy data on the encrypted disk to a newly created unencrypted disk. | | |

### Related topics

- #unique_53
- #unique_54
- #unique_41

### 3.6 Attach a cloud disk

This topic describes how to attach a cloud disk. You can create a cloud disk and attach it to an ECS instance as a data disk.

#### Limits

Before you attach a cloud disk to an ECS instance, consider the following:

- You can attach a cloud disk as a data disk only. You cannot attach a cloud disk as a system disk.
To attach a cloud disk to an ECS instance, the instance must meet the following requirements:

- The instance must be in the Running or Stopped state, but not in the Locked state.
- The instance must not have any overdue payments.

The disk to be attached must be in the Unmounted state.

The cloud disk and the ECS instance must be in the same region and the same zone.

Up to 16 cloud disks can be attached to an ECS instance to work as data disks. One cloud disk cannot be attached to multiple instances simultaneously.

If a cloud disk is created independently on the Disks page in the ECS console, it can be attached to any ECS instance in the same region and the same zone, regardless of the billing method of the instance.

Prerequisites

You have created an ECS instance and a cloud disk in the same region and zone. For more information, see #unique_51 and Create a pay-as-you-go disk.

Attach a cloud disk on the Instances page

If you want to attach multiple cloud disks to one ECS instance, we recommend that you do so on the Instances page. To attach cloud disks to a specified ECS instance, follow these steps:

1. Find the target ECS instance and click its ID to go to the Instance Details page.
2. In the left-side navigation pane, click Disks. Then on the displayed page, click Mount in the upper-right corner.
3. In the dialog box, complete the following configurations:

   - Target Disk: Select a cloud disk in the Unmounted state in the same zone.
   - Release Disk with Instance: If you select this option, the disk is released when you release the corresponding instance.
   - Delete Automatic Snapshots While Releasing Disk: If you select this option, all the automatic snapshots of the selected disk are deleted when you release the disk. However, all the manual snapshots are retained. To keep a complete data backup history, we recommend that you do not select this option.

   Click OK, and then Mount.
4. Refresh the Disks page.

   When the cloud disk is in the In Use state, the attachment is successful.

5. According to the content of the cloud disk and the operating system of the ECS instance, perform appropriate operations to make the disk ready for use. The following table details the different follow-up operations.

<table>
<thead>
<tr>
<th>Disk content</th>
<th>Operating system of the ECS instance</th>
<th>Follow-up operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>A new empty cloud disk</td>
<td>Linux</td>
<td><em>Format a data disk for a Linux-based ECS instance.</em> If the cloud disk is larger than 2 TiB, see <em>Partition and format data disks larger than 2 TiB.</em></td>
</tr>
<tr>
<td>Windows</td>
<td></td>
<td><em>Format a data disk for a Windows-based ECS instance.</em> If the cloud disk is larger than 2 TiB, see <em>Partition and format data disks larger than 2 TiB.</em></td>
</tr>
<tr>
<td>A cloud disk created from a snapshot</td>
<td>Linux</td>
<td><em>Connect to the Linux instance and run the mount <code>&lt;partition&gt;</code> <code>&lt;mount point&gt;</code> command to mount the partitions to the target mount points make the disk ready for use.</em></td>
</tr>
<tr>
<td>Windows</td>
<td></td>
<td><em>No follow-up operations are required. The cloud disk is ready for use.</em></td>
</tr>
</tbody>
</table>

Attach a cloud disk on the Disks page

If you want to attach multiple cloud disks to different ECS instances, we recommend that you do so on the Disks page. To attach a cloud disk to an ECS instance, follow these steps:

1. Find a cloud disk in the Unmounted state. Then in the Actions column, select More > Mount.
2. In the dialog box, complete the following configurations:

- Target Instance: Select an ECS instance in the same zone.
- Release Disk with Instance: If you select this option, the disk is released when you release the corresponding instance.
- Delete Automatic Snapshots While Releasing Disk: If you select this option, all the automatic snapshots of the selected disk are deleted when you release the disk. However, all the manual snapshots are retained. To keep a complete data backup history, we recommend that you do not select this option.

Click Mount.

3. Refresh the Disks page.

When the cloud disk is in the In Use state, the attachment is successful.

4. According to the content of the cloud disk and the operating system of the ECS instance, perform appropriate operations to make the disk ready for use. The following table details different follow-up operations.

<table>
<thead>
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<th>Disk content</th>
<th>Operating system of the ECS instance</th>
<th>Follow-up operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>A new empty cloud disk</td>
<td>Linux</td>
<td>* Format a data disk for a Linux-based ECS instance. If the cloud disk is larger than 2 TiB, see Partition and format data disks larger than 2 TiB.</td>
</tr>
<tr>
<td>A cloud disk created from a snapshot</td>
<td>Linux</td>
<td>Connect to the Linux instance and run the mount command to mount the partitions to make the disk ready for use.</td>
</tr>
<tr>
<td>Windows</td>
<td></td>
<td>No follow-up operations are required. The cloud disk is ready for use.</td>
</tr>
</tbody>
</table>

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What to do next

After a cloud disk is attached to an ECS instance, you can perform any of the following operations as needed:

- You can **reinitialize a cloud disk** to restore its initial status.
- You can **increase the size of a cloud disk**. For more information, see *Extend the file system of a Linux data disk* or *Extend a Windows file system*.
- You can **create a snapshot** of a cloud disk to back up its data. Alternatively, you can use **automatic snapshot policies** to create automatic snapshots.
- You can use a snapshot to **roll back a cloud disk** to restore the cloud disk to a previous state.
- You can **detach a cloud disk** and **release a cloud disk** when you no longer require the cloud disk, thus reducing the costs.

Related APIs

*AttachDisk*

3.7 Format a data disk

3.7.1 Format a data disk for a Windows-based ECS instance

This topic describes how to create a partition of the Master Boot Record (MBR) format for a new data disk attached to an ECS instance that runs the Windows system. Then, it describes how to mount an NTFS file system onto the partition. You can create multiple partitions for a data disk based on your business needs.

Context

The following section describes the risks of formatting a data disk:

- Disk partitioning and formatting are high-risk operations. Proceed with caution. This topic describes how to format a new data disk. If you have stored data on the data disk, you must create a snapshot for the data disk to avoid data loss. For more information, see *Create a snapshot*.
- You can only partition data disks that are attached to ECS instances. You cannot perform this operation on the system disk. If you forcibly use a third-party tool to partition the system disk, unknown risks such as system failure and data loss may occur. You are only allowed to expand partitions or add new partitions.
for the system disk that has been expanded. For more information, see *Extend a Windows file system*.

**Procedure**

The following procedure only applies to data disks with a size of less than 2 TiB. For more information about instructions for data disks with a size of greater than 2 TiB, see *Partition and format data disks larger than 2 TiB*. In this example, a 20 GiB data disk is attached to an ECS instance that runs the Windows Server 2012 R2 64-bit operating system. A single Master Boot Record (MBR) partition is created for the data disk.

1. **Connect to the instance**.

2. On the Windows Server desktop, right-click the Start icon, and select Disk Management.

3. Find the unformatted data disk (Disk 2 in this example), which is in the Offline state.

4. Right-click the blank space in Disk 2, and select Online.

   After Disk 2 goes online, Disk 2 enters the Not Initialized state.

5. Right-click the blank space in Disk 2, and select Initialize Disk.

6. In the Initialize Disk dialog box, select Disk 2, and select either of the following partition formats:

   - Currently, MBR is most frequently used. This format only supports data disks less than 2 TiB and a maximum of four primary partitions. If you want to divide a disk into more than four partitions, you need to use a primary partition as an extended partition and create logical partitions in it.
   - GUID Partition Table (GPT) is a new partition format, which cannot be recognized by earlier versions of Windows. The data disk size that GPT supports is determined by the operating system and the file system. In Windows, GPT supports a maximum of 128 primary partitions.

   In this example, select MBR, and click OK.

7. In the Disk Management window, right-click the Unallocated section of Disk 2, and then select New Simple Volume.
8. In the New Simple Volume wizard, perform the following operations:
   a) Click Next.
   b) Specify the size of the simple volume. If you want to create only one primary partition, use the default value. Click Next.
   c) Select a drive letter. In this example, select F. Click Next.
   d) Specify the formatting settings, including file system, allocation unit size, and volume label. Confirm whether to enable Quick Formatting and File and Folder Compression. In this example, use the default settings. Click Next.
   e) Start creating a simple volume. When the information shown in the following figure appears in the wizard, a new simple volume is created. Click Finish to close the New Simple Volume wizard.

Result

After Disk 2 is partitioned and formatted, its status is displayed in the Disk Management window.

In This PC, you can view a new drive named New Volume (F:). The data disk is ready for you to use.

3.7.2 Format a data disk for a Linux-based ECS instance

This topic describes how to create a single partition on a data disk attached to an Elastic Compute Service (ECS) instance that runs the Linux system and mount a file system onto the partition. You can create multiple partitions for a data disk based on your business needs.

Prerequisites

Before formatting a data disk for an ECS instance that runs the Linux system, you must make sure that you meet the following prerequisites:

- Data disks that you have purchased separately are attached to ECS instances. If data disks are purchased with ECS instances, skip this operation. For more information about how to attach data disks to ECS instances, see Attach a cloud disk.
- The device name of the data disk is obtained. You can view the device name of the data disk on the Disks page in the ECS console by choosing More > Modify Disk Property.

Note:
By default, device names are assigned by the system. The device names for I/O optimized instances start from `/dev/vdb` to `/dev/vdz`. If the device name is `dev/xvd*` where `*` indicates a lowercase letter, the instance in use is not I/O optimized.

**Context**

The following procedure only applies to data disks with a size of less than 2 TiB. For more information about instructions for data disks with a size of greater than 2 TiB, see *Partition and format data disks larger than 2 TiB*.

This example uses a new 20 GiB data disk with a device name of `/dev/vdb` attached to an I/O optimized instance that runs the CentOS 7.6 operating system. A single Master Boot Record (MBR) partition is created and the ext4 file system is mounted onto the partition.

**Note:**

You can also use the GUID Partition Table (GPT) format. For more information, see *Partition and format data disks larger than 2 TiB*.

The following section describes the risks of formatting:

- Disk partitioning and formatting are high-risk operations. Proceed with caution. This topic describes how to format a new data disk. If you have stored data on the data disk, you must create a snapshot for the data disk to avoid data loss. For more information about how to create a snapshot, see #unique_21.
- You can only partition data disks attached to ECS instances. You cannot perform this operation on the system disk. If you forcibly use a third-party tool to partition the system disk, unknown risks such as system failure and data loss may occur. You are only allowed to extend partitions or add new partitions for the system disk that has been expanded. For more information, see *Resize partitions and file systems of Linux system disks*.

**Procedure**

1. Connect to the ECS instance. For more information, see #unique_76.
2. Run the `fdisk -l` command to view all data disks attached to the ECS instance.

**Note:**
If /dev/vdb is not displayed in the command results, the ECS instance does not have a data disk. Check whether the data disk is attached to the ECS instance.

3. Run the following commands to create a single partition for the data disk.
   a) Run the fdisk -u /dev/vdb command to partition the data disk.
   b) Enter p to view the partition information of the data disk. In this example, the data disk is not partitioned.
   c) Enter n to create a new partition.
   d) Enter p to set the partition as the primary partition.

   ![Note:](image)
   In this example, you only need to create a primary partition for the data disk.
   If you want to create more than four partitions, enter e(extended) to create at least one extended partition.

   e) Enter the partition number and press Enter. In this example, you can enter 1 to create one partition.
   f) Enter the number of the first available sector, or press Enter to use the default value 2048.
   g) Enter the number of the last sector. In this example, press Enter to use the default value.
   h) Enter p to view the intended partitions of the data disk.
   i) Enter w to start partitioning and exit after partitioning is complete.

```bash
[root@ecshost~ ]# fdisk -u /dev/vdb
Welcome to fdisk (util-linux 2.23.2).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.
Device does not contain a recognized partition table
Building a new DOS disklabel with disk identifier 0x3e60020e.

Command (m for help): p
Disk /dev/vdb: 21.5 GB, 21474836480 bytes, 41943040 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: dos
Disk identifier: 0x3e60020e

Command (m for help): n
Partition type:
p primary (0 primary, 0 extended, 4 free)
e extended
Select (default p): p
Partition number (1-4, default 1): 1
```
First sector (2048-41943039, default 2048):
Using default value 2048
Last sector, +sectors or +size{K,M,G} (2048-41943039, default
41943039):
Using default value 41943039
Partition 1 of type Linux and of size 20 GiB is set

Command (m for help): p

Disk /dev/vdb: 21.5 GB, 21474836480 bytes, 41943040 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: dos
Disk identifier: 0x3e60020e
Device Boot Start End Blocks Id System
/dev/vdb1 2048 41943039 20970496 83 Linux

Command (m for help): w
The partition table has been altered!
Calling ioctl() to re-read partition table.
Syncing disks.

4. Run the `fdisk -u /dev/vdb` command to view the new partition.

If the following information appears, the new partition has been created.

```
[root@ecshost~ ]# fdisk -lu /dev/vdb
Disk /dev/vdb: 21.5 GB, 21474836480 bytes, 41943040 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: dos
Disk identifier: 0x3e60020e
Device Boot Start End Blocks Id System
/dev/vdb1 2048 41943039 20970496 83 Linux
```

5. Run the `mkfs.ext4 /dev/vdb1` command to create a file system in the new partition.

In this example, an ext4 file system is created. You can also create other file systems based on your needs. For example, if you want to share files between the Linux, Windows, and Mac systems, you can run the `mkfs.vfat` command to create a Virtual File Allocation Table (VFAT) file system.

Note:
The time required to create a file system depends on the size of the data disk.

```
[root@ecshost~ ]# mkfs.ext4 /dev/vdb1
mke2fs 1.42.9 (28-Dec-2013)
Filesystem label=
OS type: Linux
6. Optional: Run the `cp /etc/fstab /etc/fstab.bak` command to back up the `etc/fstab` file.

7. Run the `echo /dev/vdb1 /mnt ext4 defaults 0 0 >> /etc/fstab` command to write the information of the new partition into the `/etc/fstab` file.

   You can separately mount the data disk as a folder to store webpages. In this case, the `/mnt` portion in the command must be replaced with the intended mount point folder path.

   **Note:**

   The Ubuntu 12.04 operating system does not support barriers. You need to run the `echo '/dev/vdb1 /mnt ext4 barrier=0 0 0' >> /etc/fstab` command to write the information of the new partition into the file.

8. Run the `cat /etc/fstab` command to view the information of the new partition in the `/etc/fstab` file.

```
[root@ecshost~ ]# cat /etc/fstab
# /etc/fstab
# Created by anaconda on Wed Dec 12 07:53:08 2018
# Accessible filesystems, by reference, are maintained under '/dev/disk'
# See man pages fstab(5), findfs(8), mount(8) and/or blkid(8) for more info
# UUID=d67c3b17-255b-4687-be04-f29190d37396 / ext4 defaults 1 1
/dev/vdb1 /mnt ext4 defaults 0 0
```

9. Run the `mount /dev/vdb1/mnt` command to mount the file system.
10. Run the `df -h` command to view the current disk space and usage.

If the new file system information appears, mounting is successful. You can use the new file system without restarting the instance.

```
[root@ecshost~ ]# df -h
Filesystem Size Used Avail Use% Mounted on
/dev/vda1 40G 1.6G 36G 5% /
devtmpfs 234M 0 234M 0% /dev
tmpfs 244M 0 244M 0% /dev/shm
tmpfs 244M 484K 244M 1% /run
tmpfs 244M 0 244M 0% /sys/fs/cgroup
tmpfs 49M 0 49M 0% /run/user/0
/dev/vdb1 20G 45M 19G 1% /mnt
```

3.7.3 Partition and format data disks larger than 2 TiB

This topic describes how to partition and format data disks larger than 2 TiB in different operating systems.

**Precautions**

- The time required for creating a snapshot of a data disk is proportional to the volume of data on the data disk. The larger the volume of data, the longer time it takes to create a snapshot.

- Alibaba Cloud Block Storage supports Master Boot Record (MBR) and GUID Partition Table (GPT) partition formats. MBR is applicable to data disks no larger than 2 TiB, and allows you to create up to four primary partitions. To partition a data disk larger than 2 TiB, use the GPT format.

**Note:**

Conversion between MBR and GPT may cause data loss. If the resulting disk size when you create a disk by using a snapshot or resize a disk exceeds 2 TiB, we recommend that you first check whether the disk uses the MBR partition format. If the MBR partition format is used and you want to retain disk data on your instance, we recommend that you create another data disk and attach it to the instance. Then format a GPT partition and copy the data from the MBR partition to the GPT partition.
For data disks larger than 2 TiB, use the following partition tools, partition formats, and file systems.

<table>
<thead>
<tr>
<th>Operating system</th>
<th>Partition tool</th>
<th>Partition format</th>
<th>File system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows</td>
<td>Disk Management</td>
<td>GPT</td>
<td>NTFS</td>
</tr>
<tr>
<td>Linux</td>
<td>parted</td>
<td>GPT</td>
<td>Ext4 or XFS</td>
</tr>
</tbody>
</table>

Prerequisites

1. The data disk has been attached to your instance. For more information, see Attach a cloud disk.
2. You have established a remote connection to the ECS instance. For more information about how to remotely connect to an ECS instance, see #unique_78.

Partition and format a data disk on a Windows instance

The section describes how to partition and format a data disk larger than 2 TiB on a Windows instance running the Windows Server 2008 R2 64-bit operating system.

1. On the taskbar, click Server Manager.
2. In the left-side navigation pane of Server Manager, choose Storage > Disk Management.
3. Find the disk to be partitioned and formatted. This example uses Disk 4. The disk is in the Offline state.
4. Right-click the space next to Disk 4, and click Online.
   After it comes online, Disk 4 enters the Not Initialized state.
5. Right-click the space next to Disk 4, and choose Initialize Disk from the shortcut menu.
6. In the Initialize Disk dialog box, select Disk 4 and select GPT as the disk partition method.
7. In the Disk Management window, right-click the Unallocated section of Disk 4, and then choose New Simple Volume from the shortcut menu to create a 4 TiB volume in the NTFS format.
8. In the New Simple Volume Wizard window, click Next, and follow these steps:

   a. Specify Volume Size: Specify the size of the simple volume to create. If you want to create only one primary partition, use the default value. Click Next. You can also divide Disk 4 into multiple partitions.

   Note:
   Theoretically, the maximum NTFS volume is the maximum volume of NTFS containing $2^{64} - 1$ clusters. However, in Windows XP Pro, the maximum volume of NTFS is $2^{32} - 1$ clusters. For example, NTFS can support a volume up to 256 TiB when the cluster size is 64 KiB. If the cluster size is 4 KiB, then the maximum volume is 16 TiB. NTFS selects the size of a cluster automatically based on the disk capacity.

   b. Assign Drive Letter or Path: Select a drive letter. This example uses G. Click Next.

   c. Format Partition: Select the formatting settings including file system, allocation unit size, and volume label, and then select Perform a quick format and Enable file and folder compression as needed. In this example, Perform a quick format is selected. Click Next.

   d. After the new simple volume is created, click Finish to close the New Simple Volume Wizard window.

   After the partition is formatted, the status of Disk 4 in the Disk Management window is shown in the following figure.

Convert the partition format of a data disk on a Windows instance

   Note:
   Converting between partition formats may cause data loss. Ensure that you have backed up the data on the disk before you convert to a different partition format.

This section describes how to convert the partition format on a 3 TiB data disk on a Windows instance running the Windows Server 2012 R2 64-bit operating system.

1. On the Windows Server desktop, right-click the Start icon, and select Disk Management.

2. Find the disk to be partitioned and formatted. This example uses Disk 2.
3. Right-click a simple volume, and then choose Delete Volume from the shortcut menu.

4. Right-click the space next to Disk 2, and then choose Convert to GPT Disk from the shortcut menu.

5. In the Disk Management window, right-click the Unallocated section of Disk 2, and then choose New Simple Volume from the shortcut menu to create a 3 TiB volume in the NTFS format.

6. In the New Simple Volume Wizard window, click Next and follow these steps:
   a. Specify Volume Size: Specify the size of the simple volume to create. If you want to create only one primary partition, use the default value. Click Next. You can also divide Disk 2 into multiple partitions.

   Note: Theoretically, the maximum NTFS volume is the maximum volume of NTFS containing \(2^{64}-1\) clusters. However, in Windows XP Pro, the maximum volume of NTFS is \(2^{32}-1\) clusters. For example, NTFS can support a volume up to 256 TiB when the cluster size is 64 KiB. If the cluster size is 4 KiB, then the maximum volume is 16 TiB. NTFS selects the size of a cluster automatically based on the disk capacity.

   b. Assign Drive Letter or Path: Select a drive letter. This example uses F. Click Next.

   c. Format Partition: Select the formatting settings including file system, allocation unit size, and volume label, and then select Perform a quick format and Enable file and folder compression as needed. In this example, Perform a quick format is selected. Click Next.

   d. After a new simple volume is created, click Finish to close the New Simple Volume Wizard window.

   After the partition is formatted, the status of Disk 2 in the Disk Management window is shown in the following figure.

Partition and format a data disk on a Linux instance

This section describes how to use the `parted` and `e2fsprogs` tools to partition and format a data disk larger than 2 TiB on a Linux instance running the CentOS 7.4
64-bit operating system. In the example, the data disk to be processed is a newly-created 3 TiB empty disk and its device name is /dev/vdd.

Prerequisites
The parted and e2fsprogs tools have been installed on your Linux instance.

```
[root@ecshost~ ]# yum install -y parted
[root@ecshost~ ]# yum install -y e2fsprogs
```

Procedure
To partition and format a data disk larger than 2 TiB and mount the file system, follow these steps:

1. Run the fdisk -l command to check whether the data disk exists. The expected command output is as follows. If different information is returned, the data disk is not mounted to the instance.

```
[root@ecshost~ ]# fdisk -l
Disk /dev/vdd: 3221.2 GB, 3221225472000 bytes, 6291456000 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
```

2. Run the parted /dev/vdd command to start partitioning.
   a. Run the mklabel gpt command to convert the partition format from MBR to GPT.
   b. Run the mkpart primary 1 100% command to create a primary partition, and specify the starting and ending sectors for the partition.
   c. Run the align-check optimal 1 command to check the partition alignment.

   **Note:**
   If not aligned is returned, the partition is not aligned. We recommend that you run the following commands and use the formula \((<\text{optimal\_io\_size}>+<\text{alignment\_offset}>)/<\text{physical\_block\_size}>\) to obtain the starting sector number to align partitions for optimal performance. For example, if the starting sector number is 1024, you can then run the mkpart primary 1024s 100% command to create a new primary partition.

```
[root@ecshost~ ]# cat /sys/block/vdd/queue/optimal_io_size
[root@ecshost~ ]# cat /sys/block/vdd/queue/minimum_io_size
[root@ecshost~ ]# cat /sys/block/vdd/alignment_offset
```
d. Run the `print` command to view the partition table.

```
(parted) mklabel gpt
(parted) mkpart primary 1 100%
(parted) align-check optimal 1
1 aligned
(parted) print
Model: Virtio Block Device (virtblk)
Disk /dev/vdd: 3221GB
Sector size (logical/physical): 512B/512B
Partition Table: gpt
Disk Flags:
   Number Start End Size File system Name Flags
1 17.4kB 3221GB 3221GB primary
```

e. Run the `quit` command to exit the `parted` tool.

3. Run the `partprobe` command to make the system re-read the partition table.

4. Run one of the following commands to create a file system for the `/dev/vdd1` partition.

   - Create an Ext4 file system.
     ```
     [root@ecshost~ ]# mkfs -t ext4 /dev/vdd1
     ```

   - Create an XFS file system.
     ```
     [root@ecshost~ ]# mkfs -t xfs /dev/vdd1
     ```

**Note:**

- If the capacity of the data disk is 16 TiB, you must format it by using the correct version of e2fsprogs. For more information, see Appendix 1: Update e2fsprogs on a Linux instance.

- If you want to disable the lazy init function of an Ext4 file system to avoid its impact on data disk I/O performance, see Appendix 2: Disable the lazy init function on a Linux instance.

5. Run the `mkdir /test` command to create a mount point named `/test`.

6. Run the `mount /dev/vdd1 /test` command to mount partition `/dev/vdd1` to mount point `/test`.

7. Run the `df -h` command to view the current disk space and usage.

   If the command output shows information about the newly created file system, the mount operation was successful, and the new file system can be used.

```
[root@ecshost~ ]# df -h
```
Filesystem Size Used Avail Use% Mounted on
/dev/vda1 40G 6.4G 31G 18% /
devtmpfs 487M 0 487M 0% /dev
tmpfs 497M 0 497M 0% /dev/shm
tmpfs 497M 364K 496M 1% /run
tmpfs 497M 0 497M 0% /sys/fs/cgroup
tmpfs 100M 0 100M 0% /run/user/0
/dev/vdd1 2.9T 89M 2.8T 1% /test

8. (Optional) Write new partition information to /etc/fstab to enable automatic partition mounting when the instance is started.

a. (Optional) Run the `cp /etc/fstab /etc/fstab.bak` command to back up etc/fstab.

b. Run the `echo /dev/vdd1 /test ext4 defaults 0 0 >> /etc/fstab` command to write new partition information to /etc/fstab.

c. Run the `cat /etc/fstab` command to check /etc/fstab information.

If the new partition information appears in the command output, the write operation was successful.

You have now partitioned and formatted a 3 TiB data disk.

Appendix 1: Update e2fsprogs on a Linux instance

If the disk capacity is 16 TiB, you must use e2fsprogs 1.42 or later to format its partitions to an Ext4 file system. If e2fsprogs of a version earlier than 1.42 is used, the following error occurs:

```
mkfs.ext4: Size of device /dev/vdd too big to be expressed in 32 bits using a blocksize of 4096.
```

To install a later version of e2fsprogs, such as 1.42.8, follow these steps:

1. Run the `rpm -qa | grep e2fsprogs` command to check the current e2fsprogs version.

   ![sudo rpm -qa | grep e2fsprogs]

   If the version is earlier than 1.42, perform the following steps to update the software.
2. Run the following command to download e2fsprogs 1.42.8. You can go to e2fsprogs to obtain the latest software package.

```bash
wget https://www.kernel.org/pub/linux/kernel/people/tytso/e2fsprogs/v1.42.8/e2fsprogs-1.42.8.tar.gz
```

3. Run the following commands to compile the tool of a later version.

```bash
tar xzvf e2fsprogs-1.42.8.tar.gz
   cd e2fsprogs-1.42.8
   ./configure
   make
   make install
```

4. Run the following command to check whether e2fsprogs is updated.

```bash
rpm -qa | grep e2fsprogs
```

Appendix 2: Disable the lazy init function on a Linux instance

The lazy init function of an Ext4 file system is enabled by default. While this function is enabled, the instance will initiate a thread to continuously initialize the metadata of the Ext4 file system. Therefore, right after you partition and format a data disk, the test of disk IOPS performance will be affected, resulting in a lower IOPS.

If you need to test the data disk performance immediately after partitioning and formatting the disk, run the following command to disable the lazy init function when you initialize the file system.

```bash
mke2fs -O 64bit,has_journal,extents,huge_file,flex_bg,uninit_bg,
   dir_nlink,extra_isize -E lazy_itable_init=0,lazy_journal_init=0   /dev/vdd1
```

**Note:**

If the lazy init function is disabled, it may take a longer time to initialize the file system. For example, it may take 10 to 30 minutes to initialize the file system of a 32 TiB data disk. Enable or disable the lazy init function based on your needs.

3.7.4 Create a file system on a raw data disk

This topic uses an ECS instance running the Ubuntu operating system to show how to create a file system on a raw data disk. You can skip the steps to create a new partition, such as /dev/vdb1 or /dev/vdb2, and directly create a file system if no
A cloud disk has been created and attached to an ECS instance. For more information, see Create a pay-as-you-go disk and Attach a cloud disk.

Procedure

1. Remotely connect to an ECS instance as a root user. For more information, see #unique_78.

2. Run the following command to view the name of the attached cloud disk.

```
fdisk -l
```

If the following output is displayed, it indicates that the ECS instance has two cloud disks: /dev/vda as the system disk and /dev/vdb as a data disk.
3. Create a file system for the `/dev/vdb` data disk. Example:

   - Create an ext4 file system
     ```bash
     mkfs.ext4 /dev/vdb
     ```
   - Create an ext3 file system
     ```bash
     mkfs.ext3 /dev/vdb
     ```
   - Create an xfs file system
     ```bash
     mkfs.xfs /dev/vdb
     ```
   - Create a btrfs file system
     ```bash
     mkfs.btrfs /dev/vdb
     ```

4. Optional: Create a mount directory, such as `/media/vdb`. If this step is omitted, you can also attach the disk to an existing directory.

   ```bash
   mkdir /media/vdb
   ```

5. Attach the disk to the mount directory.

   ```bash
   mount /dev/vdb /media/vdb
   ```

6. Run the `df` command to view the data disk information.

   The mount directory information of the disk is displayed, indicating that the operation was successful.

   ```bash
   [root@ecshost ~]# df -h
   Filesystem  Size  Used  Avail  Use%  Mounted on
   udev        3.9G   0  3.9G    0%   /dev
   tmpfs      798M   2.9M  795M    1%   /run
   /dev/vda1   40G   3.2G  35G    9%   /
   tmpfs       3.9G   0  3.9G    0%   /dev/shm
   tmpfs       5.0M   0  5.0G    0%   /run/lock
   tmpfs       3.9G   0  3.9G    0%   /sys/fs/cgroup
   tmpfs      798M   0  798M    0%   /run/user/0
   /dev/vdb    98G   61M  93G    1%   /media/vdb
   ```

Related tasks

- **Format a data disk for a Windows-based ECS instance**
  This topic describes how to create a partition of the Master Boot Record (MBR) format for a new data disk attached to an ECS instance that runs the Windows system. Then, it describes how to mount an NTFS file system onto the partition. You can create multiple partitions for a data disk based on your business needs.

- **Format a data disk for a Linux-based ECS instance**
This topic describes how to create a single partition on a data disk attached to an Elastic Compute Service (ECS) instance that runs the Linux system and mount a file system onto the partition. You can create multiple partitions for a data disk based on your business needs.

3.8 Change the operating system

3.8.1 Replace the system disk (non-public image)

Replacing the system disk refers to the allocation of a new system disk for the instance. The original system disk is released and the system disk ID is updated. You can replace the system disk in the following scenarios: 1. You selected an incorrect operating system when you created an ECS instance and need to change the operating system. 2. When your business expands, you want to upgrade the system disk capacity or use another operating system.

Prerequisites

Before you change the image of a system disk to a non-public image, follow these steps:

- For custom images:
  - To use an image captured from an existing ECS instance, you must create a system disk snapshot of this instance and use the snapshot to create a custom image. For more information, see #unique_21 and #unique_36. You must make a copy of the image if the captured image and the instance with the system disk that you want to replace are in different regions. For more information, see #unique_64.
  - To use a local image file, you must import the image in the console or use Packer to create and import the image. The image must be in the same region as your instance. For more information, see #unique_83 and #unique_84.
  - If you want to use an image from another region, you must first make a copy of the image. For more information, see #unique_64.

Note:

Images created by using this method appear in the Custom Image list when you change the system disk.
• To use images owned by another Alibaba Cloud account, you must first let the other account share the images. Then, you can obtain the shared images. For more information, see #unique_85.

• If you want to change to a Linux operating system and use an SSH key pair for authentication, you must first create an SSH key pair. For more information, see #unique_86.

• Replacing a system disk is a high-risk operation that may cause data loss or service interruptions. To minimize the impact of replacing the system disk on your business, we recommend that you create a snapshot of the current system disk before replacing the system disk. For more information, see #unique_21.

• If you want to replace the system disk of a Windows Server instance, make sure that the system disk has sufficient available space. We recommend that you reserve 1 GiB of available space. Otherwise, the system may fail to restart after the system disk is changed.

**Note:**
Create snapshots during off-peak hours to minimize the impact on your business. The first time you create a 40 GiB snapshot requires about 40 minutes. Therefore, you must allocate sufficient time to create the snapshot. Creating a snapshot may temporarily reduce the I/O performance of a block storage device by about 10% and cause a temporary slowdown.

**Context**
You can select a public image, shared image, custom image, or an image from the marketplace for the ECS instance when you change the system disk. This topic describes how to replace an image of a system disk with a non-public image. For more information about how to replace an image of a system disk with a public image, see Replace the system disk by using a public image.

**Note:**
Microsoft no longer offers support for Windows Server 2003. To make sure the safety of your data, we recommend that you stop using Windows Server 2003 for your ECS instances. Alibaba Cloud no longer provides images based on Windows Server 2003. For more information, see Discontinuation of Windows Server 2003 system image.
Replacing a system disk is a high-risk operation that may cause data loss or service interruptions. When you replace a system disk, you must carefully read the following:

- **Before you replace the system disk**
  - The original system disk is released after you replace the system disk. We recommend that you create a snapshot to back up the data before the replacement. For more information, see #unique_21.
  - Your workloads are interrupted because you must stop the instance to replace the system disk. For more information, see #unique_87.
  - Make sure that you have enough snapshot quota to use the automatic snapshot policy for the new system disk. You can delete outdated system disk snapshots that you no longer require. For more information, see #unique_88.
  - You cannot change the category of the system disk for your ECS instance.

- **After you replace the system disk**
  - The IP address and the MAC address of the ECS instance remain unchanged.
  - A new system disk with a new disk ID is allocated to your instance, and the original system disk is released.
  - Snapshots of the outdated system disk cannot be used to restore the new system disk.
  - Manually created snapshots are not released. You can still use the outdated system disk snapshots to create custom images.
  - If the outdated system disk has automatic snapshot policies with Delete Automatic Snapshots While Releasing Disk enabled, the automatic snapshots of the outdated system disk are automatically deleted. The outdated automatic snapshot policies are no longer applicable to new system disks. You must reset the policies.
  - You must redeploy the service environment on the new system disk, which may cause a long interruption to your business.

- **Cross-OS system disk replacement**

  ![Note:](image)

  Cross-OS disk replacement refers to switching between Linux and Windows Server systems. After a system disk switches to a different operating system, the ECS instance cannot identify the file system format of the data disk. For regions
outside mainland China, system disk replacement across operating systems is not supported. The system only supports replacement across different Linux distributions or different Windows Server versions.

- If the data disk does not contain important data, you can reinitialize the data disk and create a file system supported by the corresponding system for the data disk. For more information, see Reinitialize a data disk.

- If important data exists on the data disk, follow these steps:
  
  ■ For replacing Windows Server with Linux: Manually install the required file system driver, such as NTFS-3G. Linux is unable to recognize the NTFS file system.
  
  ■ For replacing Linux with Windows Server: Manually install the required file system diver, such as Ext2Read and Ext2Fsd. Windows Server is unable to recognize some file systems, such as ext3, ext4, XFS.
  
  ■ For replacing Windows Server with Linux: You can use either password authentication or SSH key pair authentication.

Procedure

1. Log on to the ECS console.

2. In the left-side navigation pane, choose Instances & Images > Instances.

3. In the top navigation bar, select a region.

4. Find the instance with the system disk that you want to replace. In the Actions column, choose More > Instance Status > Stop.

   When the instance status changes to Stopped, the instance is successfully stopped.

5. In the Actions column, choose More > Disk and Image > Replace System Disk.

6. In the dialog box that appears, read the precautions for replacing the system disk, and click OK.

7. On the Change System Disk page, configure the following parameters.

   a) Image Type: Select Custom Image, Shared Image, or Marketplace Image, and select the image that you want.

   b) System Disk: You cannot change the type of the system disk. However, you can resize the system disk based on your business needs and the new image. The maximum capacity of the new system disk is 500 GiB. The minimum capacity
depends on the current capacity of the system disk and the size of the image. The following table lists the rules.

<table>
<thead>
<tr>
<th>Image</th>
<th>Resized capacity (GiB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux (excluding CoreOS) + FreeBSD</td>
<td>From Max{20 or current system disk capacity} (the greater of the two) to 500</td>
</tr>
<tr>
<td>CoreOS</td>
<td>From Max{30 or current system disk capacity} (the greater of the two) to 500</td>
</tr>
<tr>
<td>Windows Server</td>
<td>From Max{40 or current system disk capacity} (the greater of the two) to 500</td>
</tr>
</tbody>
</table>

Note:

If you have renewed your instance and downgraded the configurations, the system disk capacity cannot be changed until the next billing cycle starts.

c) Security:

- If the new operating system is Windows Server, you can only use password authentication.
- If your instance is an I/O optimized instance and the new operating system is Linux, you can use either password authentication or SSH key pair authentication. You must set a logon password or bind an SSH key pair.

d) Confirm the Instance Cost. The cost includes both the image fee and the system disk fee. For more information about product pricing, see ECS pricing.

e) Click Confirm to Change.

Result

Log on to the ECS console to monitor the instance status. The replacement of the system disk requires about 10 minutes. After the system disk is replaced, the instance automatically restarts.

What's next

After changing the system disk, follow these steps:
Optional. The automatic snapshot policies of the outdated system disk are now invalid. You can set new automatic snapshot policies for the new system disk. For more information, see #unique_35.

If both the new and the outdated operating systems are Linux, the outdated instance has data disks mounted and automatic mounting of the partition at startup enabled: After the system disk is changed, the configuration for the mounting of the data disk partitions from the outdated system disk will be lost. You must configure the new partition in the /etc/fstab file and mount the partition. You do not need to format and partition the data disk. You can perform the following steps. For more information, see Format a data disk for a Linux-based ECS instance.

1. We recommend that you back up the /etc/fstab file.
2. Write the new partition information to the /etc/fstab file.
3. View the new partition information in the /etc/fstab file.
4. Run the mount command to mount the partition.
5. Run the df -h command to check the current disk capacity and utilization.

After the partition is mounted, you can use the new data disk without restarting the ECS instance.

Related topics
#unique_89

3.8.2 Replace the system disk by using a public image

This topic describes how to replace the system disk by using a public image.

Scenarios

We recommend that you replace the system disk in the following scenarios:

- You selected an incorrect OS when creating an ECS instance.
- You need to replace the current OS.

To replace the system disk, you can replace the disk image with a public image, shared image, custom image, or any other image found on the Alibaba Cloud Marketplace. This topic uses a public image as an example. If you need to use an image that is not a public image, see Replace the system disk (non-public image).

After you replace the system disk:
A new system disk with a new ID is allocated to your instance, and the original system disk is released.

The cloud disk type remains unchanged.

The IP address and the MAC address remain unchanged.

We recommend that you delete snapshots or automatic snapshot policies to ensure that you have sufficient snapshots available for the automatic snapshot policies of the new system disk.

Precautions

Note:
Microsoft has ended extended technical support for Windows Server 2003. For data security purposes, we recommend that you discontinue running Windows Server 2003 on your ECS instances, and update the OS running on your instances. Alibaba Cloud no longer provides an image of this OS. For more information, see Offline announcement of Windows Server 2003 system image.

Risks
Replacing the system disk may involve the following risks:

- The original system disk will be released. Therefore, we recommend that you create a snapshot to back up your data before replacing the system disk.
- Your instance will be stopped and your services interrupted.
- You must redeploy the service environment on the new system disk. However, this may result in an interruption to your services.
- The disk ID will be changed. Therefore, snapshots of the original system disk cannot be used to roll back the new system disk.

Note:
After you replace the system disk, the snapshots you have manually created are not affected. You can still use them to create custom images.

If you have configured automatic snapshot policies for the original system disk to allow automatic snapshots to be released along with the disk, the snapshot policies will no longer apply. All automatic snapshots of the original system disk will be automatically deleted.

Precautions during cross-OS disk replacements
Cross-OS disk replacements refer to replacing the system disk from one OS to another, specifically a switch between Linux and Windows.

**Note:**
Regions outside Mainland China do not support disk replacements between Linux and Windows, but they do support disk replacements between different Linux or Windows editions.

During cross-OS disk replacements, the file format of the data disk may be unidentifiable.

- In case no important data exists on the data disk, we recommend that you **reinitialize the disk** and format it to the default file system of your OS.
- In case important data exists in your data disk, perform the following operations as required:
  - For switches from Windows to Linux, you must install a software application, such as NTFS-3G, because Linux cannot identify NTFS.
  - For switches from Linux to Windows, you also must install a software application, such as Ext2Read or Ext2Fsd, because Windows cannot identify ext3, ext4, or XFS.

### Precautions during Windows OS replacements

- Windows OS only supports password authentication.

**Note:**
Linux OS supports password authentication and SSH key pair authentication. As a result, when you replace Windows OS with Linux OS on your instance, you will have more optional authentication methods.

- If you are using a non-I/O-optimized instance, you can only replace your OS with the following Windows Server OSs by calling `ReplaceSystemDisk`.

<table>
<thead>
<tr>
<th>OS version</th>
<th>Image ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows Server 2008 R2 Enterprise Edition (English)</td>
<td>win2008r2_64_ent_sp1_en-us_40G_ali_base_20170915.vhd</td>
</tr>
<tr>
<td>OS version</td>
<td>Image ID</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Windows Server 2012 R2 Datacenter Edition (English)</td>
<td>win2012r2_64_dtc_17196_en-us_40G.ali base_20170915.vhd</td>
</tr>
<tr>
<td>Windows Server 2016 Datacenter Edition (English)</td>
<td>win2016_64_dtc_1607_en-us_40G.ali base_20170915.vhd</td>
</tr>
</tbody>
</table>

**Preparations**

- Make sure that there is sufficient system disk space. We recommend that you reserve 1 GiB. Otherwise, the OS may not properly start after system disk replacement.
- If you want to replace the OS to Linux and use an SSH key pair for authentication, you need to create an SSH key pair first.
- System disk replacement may lead to data loss or service interruption. To minimize the impact on your services, we recommend that you create a snapshot for the original system disk during off-peak hours before starting the replacement process.

**Note:**
Creating a snapshot of 40 GiB takes about 40 minutes the first time. Creating a snapshot may also reduce I/O performance of a block storage device by up to 10%.

**Procedure**

To replace the system disk, follow these steps:

1. In the Actions column of the target instance, choose More > Instance Status > Stop and stop the instance as prompted.

**Note:**
If the instance is a Pay-As-You-Go VPC instance with the No Fees for Stopped Instances function enabled, the instance may not be properly started after system disk replacement. We recommend that you disable this function when you stop the instance.
2. From the Actions column, choose More > Disk and Image > Replace System Disk.
3. In the displayed dialog box, read the precautionary statement about system disk replacement and then click OK.
4. On the Replace System Disk page, set the following parameters:
   a. Image Type: Select Public Image and then select the image version.
   b. System Disk: Unchangeable. However, you can expand the disk space to meet the requirements of your system disk and services. The maximum disk space is 500 GiB. The minimum disk space you can configure depends on the current disk space and image type.

<table>
<thead>
<tr>
<th>Image</th>
<th>Space range (GiB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux (excluding CoreOS) + FreeBSD</td>
<td>[Max{20, current space of the system disk}, 500]</td>
</tr>
<tr>
<td>CoreOS</td>
<td>[Max{30, current space of the system disk}, 500]</td>
</tr>
<tr>
<td>Windows</td>
<td>[Max{40, current space of the system disk}, 500]</td>
</tr>
</tbody>
</table>

Note:
If you have renewed your instance and downgraded the configurations, the system disk space cannot be changed until the next billing cycle starts.

c. Security enhancement:

- If the new OS is Windows, you can only use password authentication.

- If the instance is an I/O optimized instance and the new OS is Linux, you can use a password or an SSH key pair for authentication. In this case, we recommend you set a logon password or bind an SSH key pair.
d. Confirm Instance Cost, which includes the image fee and system disk fee. For more information, see the pricing page of ECS.

e. Check your settings and click Confirm to change.

Replacing the OS and updating the system status take about 10 minutes. After the OS is replaced, the instance automatically starts.

What to do next

After replacing the system disk, perform the following operations as needed:

· (Optional) Apply automatic snapshot policies to disks. Automatic snapshot policies are bound to the disk ID. After the system disk is replaced, automatic snapshot policies applied on the original disk will fail automatically. Therefore, you need to configure automatic snapshot policies for the new system disk.
• Write the new partition information to the /etc/fstab file of the new system disk and mount the partition as follows:

Note:
If the OS before and after disk replacement is Linux, and if a data disk is mounted to the instance and the partition is set to be mounted automatically at instance startup, then all mounting information will be lost. For more information, see Format and mount data disks for Linux instances.

1. Back up the /etc/fstab file.
2. Write information about the new partition to the /etc/fstab file.
3. Check the information in the /etc/fstab file.
4. Run the `mount` command to mount the partition.
5. Run the `df -h` command to check the file system space and usage.

After the data partition is mounted, the data disk is ready for use without the need for instance restart.

Related API

`ReplaceSystemDisk`

3.9 Resize cloud disks

3.9.1 Overview

You can resize cloud disks as your business and application data grows.

Scenarios

You can resize the storage capacity of a single instance in the following ways:

• *Resize an existing cloud disk.* You need to resize an existing partition or a new partition.

• *Create a new cloud disk,* attach it to the instance as a data disk, and then *partition or format* the disk.

• *Change a system disk* and specify a higher system disk capacity.

This topic describes the thresholds of extended disks and how to resize an existing cloud disk.
Thresholds of extended system disks

The new capacity value must be greater than the existing capacity of the system disk, but equal to or less than 500 GiB. The following table describes the thresholds of extended system disks for different images.

<table>
<thead>
<tr>
<th>Image</th>
<th>Maximum capacity (GiB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux (excluding CoreOS) and FreeBSD</td>
<td>Max {20, current capacity of the system disk} to 500</td>
</tr>
<tr>
<td>CoreOS</td>
<td>Max {30, current capacity of the system disk} to 500</td>
</tr>
<tr>
<td>Windows</td>
<td>Max {40, current capacity of the system disk} to 500</td>
</tr>
</tbody>
</table>

For example, the current capacity of the system disk of a CentOS instance is 35 GiB. After you resize the system disk, its capacity must be equal to or greater than 35 GiB, but equal to or less than 500 GiB.

Thresholds of extended data disks

The new value must be greater than the existing capacity of the data disk. The following table lists the data disk resizing limits for different cloud disk categories.

<table>
<thead>
<tr>
<th>Disk type</th>
<th>Maximum capacity (GiB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic disk</td>
<td>2,000</td>
</tr>
<tr>
<td>Enhanced SSD (ESSD), standard SSD, or ultra disk</td>
<td>32,768</td>
</tr>
</tbody>
</table>

Resize a cloud disk

1. Log on to the console or use the API (ResizeDisk) to resize a cloud disk.
2. Log on to the console or use the API (RebootInstance) to restart an instance.
3. Remote access the instance and resize the partition and file system:

<table>
<thead>
<tr>
<th>Before you resize the cloud disk</th>
<th>After you resize the cloud disk (GiB)</th>
<th>Resize the partition and file system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not partitioned</td>
<td>&lt; 2,048</td>
<td>• Partition or format a Windows data disk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Partition or format a Linux data disk</td>
</tr>
</tbody>
</table>
### 3.9.2 Resize a disk online by extending its capacity

This topic describes how to resize a disk online by extending its capacity. You can resize either system disk or data disk online to meet your storage requirements. After the modification, the new size takes effect immediately, you do not need to restart the instance, create a new disk, or copy the data.

#### Prerequisites

- To prevent data loss caused by errors, create snapshots to back up your data. For more information, see Create a snapshot.

- If your Windows instance was created before March 30, 2019, check whether you need to update the RedHat VirtIO SICI driver for it. For more information, see Update the Red Hat VirtIO SCSI driver of Windows ECS instances.
Context

When you resize a disk online, you can check the status of the disk by using the console or by calling the RebootInstance operation, without restarting its attached instance. The online and offline modes used to resize disks have the following differences:

- **Online mode**: Disks can be resized online when instances are in the Running (Running) state. You do not need to restart instances for the changes to take effect.
- **Offline mode**: Disks can be resized when instances are in the Running (Running) or Stopped (Stopped) state. You must restart instances for the changes to take effect. For more information, see *Resize cloud disks offline*.

The following limits apply when you resize disks online:

- **System limits**
  - For more information about limits of resized system disks and data disks, see *Overview*.
  - When you resize a disk, only its storage capacity is resized. The file systems are not resized. You must manually allocate storage space for the file systems after the disk is resized. For more information, see the *What to do next* section in this topic.
  - You cannot shrink an extended disk by any means, such as by rolling it back.
  - The operating system must meet the following conditions when you resize a system disk:
    - For a Windows instance, the operating system cannot be Windows Server 2003.
    - For a Linux instance, the kernel version displayed in the `uname -a` command output must be 3.6.0 or later.
    - The following table lists the public images that can be used on Linux instances and support the online mode. Other images do not support the online mode.

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Public image version</th>
</tr>
</thead>
<tbody>
<tr>
<td>CentOS 7</td>
<td>CentOS 7.2 and later</td>
</tr>
<tr>
<td>CentOS 6</td>
<td>CentOS 6.8 and later</td>
</tr>
<tr>
<td>Distribution</td>
<td>Public image version</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Ubuntu 16</td>
<td>All Ubuntu 16 versions</td>
</tr>
<tr>
<td>Ubuntu 18</td>
<td>All Ubuntu 18 versions</td>
</tr>
<tr>
<td>Debian 8</td>
<td>Debian 8.9 and later</td>
</tr>
<tr>
<td>Debian 9</td>
<td>All Debian 9 versions</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 7</td>
<td>Red Hat Enterprise Linux 7.4 and later (with SAP)</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 6</td>
<td>Red Hat Enterprise Linux 6.9 and later</td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 8</td>
<td>All Red Hat Enterprise Linux 8 versions</td>
</tr>
<tr>
<td>SUSE 12</td>
<td>SUSE 12 SP2 and later (with SAP)</td>
</tr>
<tr>
<td>OpenSUSE</td>
<td>OpenSUSE 42.3 and later</td>
</tr>
</tbody>
</table>

- What is not supported
  - You cannot resize a disk for which a snapshot is being created.
  - After you renew and downgrade a subscription instance, you cannot resize its subscription disks during the remaining time of the current billing cycle.
  - If a data disk adopts the MBR partition format, you cannot resize the data disk to more than 2 TiB. If you want to resize a data disk to 2 TiB while the MBR partition format is used, we recommend that you create and attach another data disk. Format a GPT partition and copy the data in the MBR partition to the GPT partition.

- What is supported
  - You can resize disks online that are in the In Use state and whose attached instances are in the Running (Running) state.
  - You can resize disks of I/O-optimized instances online.
  - You can resize ultra disks, standard SSDs, and enhanced SSDs online.
  - For Windows instances, you can only resize NTFS file systems.

Procedure

1. Log on to the ECS console.
2. In the left-side navigation pane, choose Storage & Snapshots > Disks.
3. In the top navigation bar, select a region.
4. Find the disk to be resized. In the Actions column, choose More > Resize Disk.

5. Select Resize Online.

6. Set the extended capacity.

7. Confirm the fees, read and confirm the ECS terms of service, and then click Resize.

8. Complete the payment.

Note:
If you do not select Resize Online or the ECS instance does not meet the requirements to be resized online, log on to the console or call the RebootInstance operation to restart the instance for the changes to take effect. For more information, see Restart an instance and RebootInstance.

What's next

After you resize a disk, you can perform the operations listed in the following table as required.
<table>
<thead>
<tr>
<th>Disk status</th>
<th>What to do next</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not attached or partitioned</td>
<td>If the disk is a data disk in the Unattached (Available) state, the extended capacity takes effect immediately after you complete the payment. You can perform the following steps:</td>
</tr>
<tr>
<td></td>
<td>1. Log on to the ECS console or call the AttachDisk operation to attach the disk. For more information, see Attach a disk.</td>
</tr>
<tr>
<td></td>
<td>2. Partition and resize or format the disk:</td>
</tr>
<tr>
<td></td>
<td>• Partition and format a Linux data disk of less than 2 TiB</td>
</tr>
<tr>
<td></td>
<td>• Partition and format a Windows data disk of less than 2 TiB</td>
</tr>
<tr>
<td></td>
<td>• Partition and format a data disk of more than 2 TiB</td>
</tr>
<tr>
<td>Attached but not partitioned</td>
<td>Partition and format the disk:</td>
</tr>
<tr>
<td></td>
<td>• Partition and format a Linux data disk of less than 2 TiB</td>
</tr>
<tr>
<td></td>
<td>• Partition and format a Windows data disk of less than 2 TiB</td>
</tr>
<tr>
<td></td>
<td>• Partition and format a data disk of more than 2 TiB</td>
</tr>
<tr>
<td>Attached and partitioned</td>
<td>Resize disk partitions and file systems:</td>
</tr>
<tr>
<td></td>
<td>• Linux instance: For more information, see  Rewrite partitions and file systems of Linux system disks or Rewrite partitions and file systems of Linux data disks</td>
</tr>
<tr>
<td></td>
<td>• Windows instance: For more information, see Extend a Windows file system</td>
</tr>
</tbody>
</table>

Related topics
#unique_97
#unique_45
#unique_98
3.9.3 Resize cloud disks offline

You can resize both system disks and data disks as described in this topic. The size of the disks is expected to increase as your business and application data grows.

What is offline resizing?

In the offline mode, you can see that cloud disks are extended only after you restart instances by using the console or API (RebootInstance). Instances can be in the running (Running) or stopped (Stopped) state.

Notes

System limits

- For more information about thresholds of extended system disks and data disks, see Overview.
- When you resize cloud disks, only storage capacity is extended, but not file systems. You can allocate your own storage space after resizing. For more information, see Next operations.

What is not supported

- You cannot resize a cloud disk for which a snapshot is being created.
- After you click Renew for Configuration Downgrade for a subscription instance, you cannot resize subscription cloud disks of the instance during the remaining period of the current billing cycle.
- You cannot resize system disks of Windows Server 2003 instances.
- If a data disk adopts the MBR partition format, you cannot resize the data disk to more than 2 TiB. If you want to resize a data disk to 2 TiB while the MBR partition format is used, we recommend that you create and attach another data disk. Format a GPT partition and copy the data in the MBR partition to the GPT partition.

What is supported

- You can resize cloud disks which are in the in use (In Use) state. This occurs when instances to which the disks are attached are in the running (Running) or stopped (Stopped) state.
- You can resize basic disks, ultra disks, standard SSD, and enhanced SSDs (ESSDs).
- For Windows instances, you can only resize the NTFS file system.
Preparations

*Create a snapshot* for data backup, to prevent data loss caused by any errors.

Procedure

Perform the following steps to resize a cloud disk in the ECS console:

1. Locate the cloud disk to be extended. Choose More > Resize Disk in the Actions column.
2. Set the extended capacity, which must be greater than the current capacity.
3. Confirm the fee, read ECS Service Terms and Product Terms of Service, and then click Confirm to Resize.
4. Complete the payment.
5. Restart the instance for the changes to take effect.

Note:

You can see that cloud disks are extended only after you *restart instances* by using the console or API (*RebootInstance*). It does not work if you perform the restart operation in the instance operating system.

Related API: You can also call *ResizeDisk* to perform the resize operation.

Next operations

The following table lists the available operations after you resize a cloud disk. However, this depends on whether the cloud disk is attached and partitioned.

<table>
<thead>
<tr>
<th>Disk status</th>
<th>A disk that is not attached or partitioned</th>
<th>A disk that is attached but not partitioned</th>
<th>A disk that is attached and partitioned</th>
</tr>
</thead>
</table>
If a data disk is in the available (Available) state, the extended capacity takes effect after you complete the payment. Then you can perform the following steps:

1. Log on to the console or use the API (AttachDisk) to attach a cloud disk.
2. Resize or format a partition:
   - Partition or format a Linux data disk of less than 2 TiB
   - Partition or format a Windows data disk of less than 2 TiB
   - Partition or format a data disk of more than 2 TiB

You can perform the following steps:
1. Resize or format a partition:
   - Partition or format a Linux data disk of less than 2 TiB
   - Partition or format a Windows data disk of less than 2 TiB
   - Partition or format a data disk of more than 2 TiB
2. Resize a file system:
   - For a Linux instance, see Resize a partition and file system of a Linux data disk or Resize a partition and file system of a Linux system disk
   - For a Windows instance, see Resize a file system of a Windows disk

### 3.9.4 Extend a Windows file system

This topic describes how to extend a Windows file system. Resizing a cloud disk does not extend the file system; it only extends the storage capacity. Therefore, you need to format the new storage capacity after you resize a cloud disk.

#### Limits

The information contained in this topic applies only to disks that are in use and are attached to Running instances. For information on how to attach, partition, or format disks that are in the Available state, see Attach a cloud disk and Partition and format a data disk.
Preparations

1. Use the ECS console or call the API to resize the cloud disk.
2. Create a snapshot to back up your data.
3. Attach the cloud disk to the instance and make sure that the instance is in the Running state. For information about the connection methods, see Overview.
4. Format and partition the data disk. For more information, see Partition and format a data disk.

Extend the system disk partition

After you resize a system disk in the ECS console, you need to connect to the instance to extend the file system of the corresponding system disk partition. In this example, the operating system is Windows Server 2008 R2 Enterprise Edition 64-bit and the system disk is resized from 50 GiB to 72 GiB.

1. Connect to the Windows instance.
2. Open Server Manager.
3. In the left-side navigation pane, choose Storage > Disk Management.
4. Choose Action > Refresh or Action > Rescan Disks.
5. In the Disk Management area, view the unallocated capacity. In this example, Disk 0 is the resized system disk.

6. Right-click the blank space in the Disk 0 area, and then select Extend Volume.

7. Follow the instructions provided by the Extend Volume Wizard to extend the volume.

The new disk space is automatically added to the original volume.

---

**Extend a data disk partition**

After you resize a data disk in the ECS console, you need to connect to the instance to extend the file system of the corresponding data disk partitions. In this example, the operating system is Windows Server 2008 R2 Enterprise Edition 64-bit and the data disk is resized from 20 GiB to 30 GiB.

1. Connect to the Windows instance.
2. Open Server Manager.
3. In the left-side navigation pane, choose Storage > Disk Management.

4. Choose Action > Refresh or Action > Rescan Disks.

5. In the Disk Management area, view the unallocated capacity. In this example, Disk 1 is the resized data disk.

- To use the new disk space to extend the existing partition, follow these steps:
  a. Right-click the blank space in the Disk 1 area, and then select Extend Volume.
  b. Follow the instructions provided by the Extend Volume Wizard to extend the volume.

The new disk space is automatically added to the original volume.

- To use the new disk space to add a new partition, follow these steps:
  a. Right-click the blank space in the Disk 1 area, and then select New Simple Volume.
  b. Follow the instructions provided by the New Simple Volume Wizard to extend the volume.
The new disk space is added to a new partition.

### 3.9.5 Resize partitions and file systems of Linux system disks

This topic describes how to use the `growpart` and `resize2fs` tools to resize the partitions and extend the file systems of Linux system disks.

**Application scope**

The procedures in this topic apply to system disks with the following partition formats and file system formats:

- **Partitions:** MBR and GPT
- **File systems:** `ext*`, XFS, and Btrfs

**Preparations**

1. **Create a snapshot** for data backup, to prevent data loss caused by misoperations.
2. **Use the ECS console or call the API operation to **Resize cloud disks offline**.**
3. **Connect to the ECS instance remotely.** For more information about connection methods, see **Methods to connect to an ECS instance**.
4. **Install the growpart or xfsprogs tool based on your operating system.**
   - In CentOS 7 and Aliyun Linux, run the following commands:
     ```
     yum install cloud-utils-growpart
     yum install xfsprogs
     ```
   - In Ubuntu 14, Ubuntu 16, Ubuntu 18 and Debian 9, run the following commands:
     ```
     apt install cloud-guest-utils
     apt install xfsprogs
     ```
   - In Debian 8, openSUSE 42.3, openSUSE 13.1, and SUSE Linux Enterprise Server 12 SP2, use an upstream version of `growpart` or `xfsprogs`. 
5. Check the kernel version of your instance, for example, by running the `uname -a` command.

- For kernels 3.6.0 or later, see Procedure for instances with kernels 3.6.0 or later.
- For kernels earlier than 3.6.0, see Procedure for instances with kernels earlier than 3.6.0.

If your instance runs a Linux distribution such as CentOS 6, Debian 7, or SUSE Linux Enterprise Server 11 SP4, the instance must be restarted by using the console or an API operation before resizing can be completed.

Procedure for instances with kernels 3.6.0 or later

This procedure uses an instance running CentOS 7 to describe how to resize a system disk partition.

1. Run the `fdisk -l` command to check the size of the disk.

   In this example, the `/dev/vda` disk size is 100 GiB.

   ```
   [root@ecshost ~]# fdisk -l
   Disk /dev/vda: 107.4 GB, 107374182400 bytes, 209715200 sectors
   Units = sectors of 1 * 512 = 512 bytes
   Sector size (logical/physical): 512 bytes / 512 bytes
   I/O size (minimum/optimal): 512 bytes / 512 bytes
   Disk label type: dos
   Disk identifier: 0x0008d73a

   Device  Boot  Start  End   Blocks   Id  System
   /dev/vda1  *   2048 41943039 20970496   83  Linux
   ```

2. Run the `df -h` command to check the disk partition size.

   In this example, the `/dev/vda1` partition size is 20 GiB.

   ```
   [root@ecshost ~]# df -h
   Filesystem  Size  Used   Avail Use% Mounted on
   /dev/vda1   20G   1.5G   18G   8% /
   devtmpfs    7.8G    0   7.8G    0% /dev
tmpfs       7.8G    0   7.8G    0% /dev/shm
tmpfs       7.8G 344K  7.8G    1% /run
tmpfs       7.8G    0   7.8G    0% /sys/fs/cgroup
tmpfs       1.6G    0  1.6G    0% /run/user/0
   ```

3. Run the `growpart<DeviceName><PartitionNumber>` command to use the growpart tool to resize the specified system disk and partition.

   In this example, the first partition of the system disk is resized.

   ```
   [root@ecshost ~]# growpart /dev/vda 1
   ```
4. Run the `resize2fs <PartitionName>` command to use the resize2fs tool to extend the file system.

In this example, the file system of the /dev/vda1 partition is extended.

```
[root@ecshost ~]# resize2fs /dev/vda1
resize2fs 1.42.9 (28-Dec-2013)
Filesystem at /dev/vda1 is mounted on /; on-line resizing required
old_desc_blocks = 2, new_desc_blocks = 7
The filesystem on /dev/vda1 is now 26213807 blocks long.
```

**Note:**
If an XFS file system is used, run the `xfs_growfs /dev/vda1` command.

5. Run the `df -h` command to check the size of the disk partition.

In this example, the /dev/vda1 partition size is 100 GiB, which means that the partition is resized.

```
[root@ecshost ~]# df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/vda1        99G  1.6G   93G   2% /
devtmpfs        7.8G     0  7.8G   0% /dev
tmpfs           7.8G     0  7.8G   0% /dev/shm
tmpfs           7.8G  500K  7.8G   1% /run
tmpfs           7.8G     0  7.8G   0% /sys/fs/cgroup
tmpfs           1.6G     0  1.6G   0% /run/user/0
```

**Procedure for instances with kernels earlier than 3.6.0**

This procedure uses an instance running CentOS 6 to describe how to resize a system disk partition.

1. Install the `dracut-modules-growroot` tool.

```
[root@ecshost ~]# yum install -y dracut-modules-growroot
```

If a package manager other than yum is used, change `yum` to the corresponding command.

2. Run the following command to overwrite the existing initramfs file.

```
[root@ecshost ~]# dracut -f
```

3. Run the `fdisk -l` command to check the current disk size.

In this example, the /dev/vda disk size is 100 GiB.

```
[root@ecshost ~]# fdisk -l
```
4. Run the `df -h` command to check the disk partition size.

   In this example, the `/dev/vda1` partition size is 20 GiB.

   
   ```
   [root@ecshost ~]# df -h
   Filesystem      Size  Used Avail Use% Mounted on
   /dev/vda1        20G  1.1G   18G   6% /
   tmpfs           7.8G     0  7.8G   0% /dev/shm
   ```

5. Run the `growpart<DeviceName><PartitionNumber>` command to use the `growpart` tool to resize the specified system disk and partition.

   In this example, the first partition of the system disk is resized.

   ```
   [root@ecshost ~]# growpart /dev/vda 1
   CHANGED: partition=1 start=2048 old: size=41940992 end=41943040 new: size=209710462,end=209712510
   ```

6. **Reboot the instance** in the console or call the `RebootInstance` operation to restart the instance.

7. Remotely connect to the instance.

8. Run the `resize2fs <PartitionName>` command to use the `resize2fs` tool to extend the file system.

   In this example, the file system of the `/dev/vda1` partition is extended.

   ```
   [root@ecshost ~]# resize2fs /dev/vda1
   resize2fs 1.41.12 (17-May-2010)
   Filesystem at /dev/vda1 is mounted on /; on-line resizing required
   old desc_blocks = 2, new desc_blocks = 7
   Performing an on-line resize of /dev/vda1 to 26213807 (4k) blocks.
   The filesystem on /dev/vda1 is now 26213807 blocks long.
   ```

   **Note:**

   If an XFS file system is used, run the `xfs_growfs /dev/vda1` command.

9. Run the `df -h` command to check the size of the disk partition.

   In this example, the `/dev/vda1` partition size is 100 GiB, which means that the partition is resized.

   ```
   [root@ecshost ~]# df -h
   ```
3.9.6 Resize partitions and file systems of Linux data disks

When cloud disks are resized, the storage capacity increases but the file system is not affected. To resize the file system and increase the storage capacity of ECS instances, follow the steps in this topic.

Preparations

Before you resize partitions and file systems of a data disk, you must complete the following operations.

1. Create a snapshot for data backup, to prevent data loss caused by misoperations.
2. Use the ECS console or call the API operation to Resize cloud disks offline.
3. Connect to the ECS instance remotely. For more information about connection methods, see Methods to connect to an ECS instance.

Check the partition format and the file system type

In the following example, the data disk is an ultra disk, the ECS instance operating system is CentOS 7.5 64-bit, and the data disk name is /dev/vdb.

1. Run the `fdisk -lu <DeviceName>` command to check whether the disk is partitioned.

In the example, the disk has a partition called `/dev/vdb1`. The partition scheme of the disk is MBR. If the partition scheme of the disk is GPT, it indicates that the partition scheme of the disk is GPT.
2. **Run the `blkid <PartionName>` command to check the file system type.**

In the example, the file system of `/dev/vdb1` is `ext4`.

```
[root@ecshost ~]# blkid /dev/vdb1
/dev/vdb1: UUID="e97bf1e2-fc84-4c11-9652-73********24" TYPE="ext4"
```

Note:
No results are returned if a data disk does not have partitions or file systems, or if a data disk has partitions, but not file systems.

3. Run the following command to check the status of the file system.

- For the ext* file system: `e2fsck -n <dst_dev_part_path>`
- For the xfs file system: `xfs_repair -n <dst_dev_part_path>`

**Warning:**
In the example, the file system is in the **clean** state. If the file system is not in the **clean** state, troubleshoot the file system.

```
[root@ecshost ~]# e2fsck -n /dev/vdb1
e2fsck 1.42.9 (28-Dec-2013)
Warning! /dev/vdb1 is mounted.
Warning: skipping journal recovery because doing a read-only filesystem check.
/dev/vdb1: clean, 11/1310720 files, 126322/5242624 blocks
```

Select a method to resize partitions or file systems

**Select proper operations based on the partition format and file system conditions.**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Operation</th>
</tr>
</thead>
</table>
| The data disk has partitions and file systems. | - To resize the existing MBR partitions of the data disk, see **Option 1: Resize existing MBR partitions**.  
- If the new disk space is used to add new MBR partitions, see **Option 2: Add and format MBR partitions**.  
- To resize the existing GPT partitions of the data disk, see **Option 3: Resize existing GPT partitions**.  
- If the new disk space is used to add new GPT partitions, see **Option 4: Add and format GPT partitions**. |
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The new data disk does not have partitions or file systems.</td>
<td>Partition and format a data disk or Partition and format data disks larger than 2 TiB after you resize the disk space in the console.</td>
</tr>
<tr>
<td>The raw data disk has file systems, but not partitions.</td>
<td>After you resize the disk space in the console, see Option 5: Resize the file system of a raw data disk.</td>
</tr>
<tr>
<td>The data disk is not attached to any instance.</td>
<td>Attach the data disk to an instance and then perform the steps in this topic to resize the data disk.</td>
</tr>
</tbody>
</table>

**Note:**

If the data disk contains an MBR partition, you cannot resize the data disk to greater than or equal to 2 TiB. To prevent data loss, we recommend that you create a cloud disk larger than 2 TiB. Format a GPT partition as specified in Partition and format data disks larger than 2 TiB and copy the data from the MBR partition to the GPT partition.

**Option 1: Resize existing MBR partitions**

**Note:**

To prevent data loss, we do not recommend that you resize partitions and file systems when they are attached to ECS instances. Detach the attached partitions (unmount) first. After you resize the partitions and they can be normally used, attach the partitions (mount) again. The following operation methods are recommended for different Linux kernel versions:

- If the instance kernel is earlier than version 3.6, detach the partition, modify the partition table, and then resize the file system.
- If the instance kernel is version 3.6 or later, modify the partition table, notify the kernel of updating the partition table, and then resize the file system.

To resize an existing MBR partition, perform the following steps:

**Step 1: Modify the partition table**
1. **Run the `fdisk -lu /dev/vdb` command and record the start and end sectors of the existing partition.**

   In this example, the start sector of `/dev/vdb1` is **2048** and the end sector is **41943039**.

   ```bash
   [root@ecshost ~]# fdisk -lu /dev/vdb
   Disk /dev/vdb: 42.9 GB, 42949672960 bytes, 83886080 sectors
   Units = sectors of 1 * 512 = 512 bytes
   Sector size (logical/physical): 512 bytes / 512 bytes
   I/O size (minimum/optimal): 512 bytes / 512 bytes
   Disk label type: dos
   Disk identifier: 0x9277b47b
   
   Device Boot Start End Blocks Id System
   /dev/vdb1 2048 41943039 20970496 83 Linux
   ```

2. **View the mount path of the data disk. Detach the partition based on the returned file path and wait until the partition is fully detached.**

   ```bash
   [root@ecshost ~]# mount | grep "/dev/vdb"
   /dev/vdb1 on /mnt type ext4 (rw,relatime,data=ordered)
   [root@ecshost ~]# umount /dev/vdb1
   [root@ecshost ~]# mount | grep "/dev/vdb"
   ```

3. **Run the `fdisk` command to delete the existing partition.**

   a. **Run the `fdisk -u /dev/vdb` command to partition the data disk.**

   b. **Enter `p` to display the partition table.**

   c. **Enter `d` to delete the partition.**

   d. **Enter `p` to confirm that the partition has been deleted.**

   e. **Enter `w` to save changes and exit.**

   ```bash
   [root@ecshost ~]# fdisk -u /dev/vdb
   Welcome to fdisk (util-linux 2.23.2).
   Changes will remain in memory only, until you decide to write them.
   Be careful before using the write command.
   Command (m for help): p
   Disk /dev/vdb: 42.9 GB, 42949672960 bytes, 83886080 sectors
   Units = sectors of 1 * 512 = 512 bytes
   Sector size (logical/physical): 512 bytes / 512 bytes
   I/O size (minimum/optimal): 512 bytes / 512 bytes
   Disk label type: dos
   Disk identifier: 0x9277b47b
   
   Device Boot Start End Blocks Id System
   /dev/vdb1 2048 41943039 20970496 83 Linux
   Command (m for help): d
   Selected partition 1
   Partition 1 is deleted
   Command (m for help): p
   Disk /dev/vdb: 42.9 GB, 42949672960 bytes, 83886080 sectors
   Units = sectors of 1 * 512 = 512 bytes
   Sector size (logical/physical): 512 bytes / 512 bytes
   I/O size (minimum/optimal): 512 bytes / 512 bytes
   ```
Disk label type: dos
Disk identifier: 0x9277b47b
Device Boot Start End Blocks Id System
Command (m for help): w
The partition table has been altered!
Calling ioctl() to re-read partition table.
WARNING: Re-reading the partition table failed with error 16: Device or resource busy.
The kernel still uses the old table. The new table will be used at the next reboot or after you run partprobe(8) or kpartx(8)
Syncing disks.

4. Run the fdisk command to create a partition.
   a. Run the fdisk -u /dev/vdb command to partition the data disk.
   b. Enter p to display the partition table.
   c. Enter n to create a partition.
   d. Enter p to set the partition as the primary partition.
   e. Enter <partition number> to select a partition number. 1 is selected in the example.

   Warning:
   The start sector of the new partition must be equal to that of the existing partition. The end sector must be greater than that of the existing partition. Otherwise, the resize operation may fail.

   f. Enter w to save changes and exit.

In the example, /dev/vdb1 is extended from 20 GiB to 40 GiB.

[root@ecshost ~]# fdisk -u /dev/vdb
Welcome to fdisk (util-linux 2.23.2).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.
Command (m for help): p
Disk /dev/vdb: 42.9 GB, 42949672960 bytes, 83886080 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: dos
Disk identifier: 0x9277b47b
Device Boot Start End Blocks Id System
Command (m for help): n
Partition type:
p primary (0 primary, 0 extended, 4 free)
e extended
Select (default p): p
Partition number (1-4, default 1): 1
First sector (2048-83886079, default 2048):
Using default value 2048
Last sector, +sectors or +size{K,M,G} (2048-83886079, default 83886079):
Partition 1 of type Linux and of size 30 GiB is set
Command (m for help): p
Disk /dev/vdb: 42.9 GB, 42949672960 bytes, 83886080 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: dos
Disk identifier: 0x9277b47b
Device Boot Start End Blocks Id System
/dev/vdb1 2048 62916607 31457280 83 Linux
Command (m for help): w
The partition table has been altered!
Calling ioctl() to re-read partition table.
Syncing disks.

5. Run the `lsblk /dev/vdb` command to confirm that the partition table has been added.

6. Run the `e2fsck -n /dev/vdb1` command to confirm that the file system after the resize operation is in the clean state.

Step 2: Notify the kernel of updating the partition table

Run the `partprobe <dst_dev_path>` or `partx -u <dst_dev_path>` command to notify kernel that the partition table has been modified and needs to be synchronized.

Step 3: Resize the file system

- For the ext* file system (such as ext3 and ext4), run the `resize2fs /dev/vdb1` command and attach the partition again.

```
[root@ecshost ~]# resize2fs /dev/vdb1
resize2fs 1.42.9 (28-Dec-2013)
Resizing the filesystem on /dev/vdb1 to 7864320 (4k) blocks.
The filesystem on /dev/vdb1 is now 7864320 blocks long.
[root@ecshost ~]# mount /dev/vdb1 /mnt
```

- For the xfs file system, run the `mount /dev/vdb1 /mnt/` command first, and then the `xfs_growfs /dev/vdb1` command.

```
[root@ecshost ~]# mount /dev/vdb1 /mnt/
[root@ecshost ~]# xfs_growfs /dev/vdb1
meta-data=/dev/vdb1 isize=512 agcount=4, agsize=1310720 blks
  = sectsz=512 attr=2, projid32bit=1
  = crc=1 finobt=0 spinodes=0
data = bsize=4096 blocks=5242880, imaxpct=25
  = sunit=0 shost=0 bentsh=0
datausi
  = sunit64=0 shrinkgr=0
naming =version 2 bsize=4096 ascii-ci=0 ftype=1
log = internal bsize=4096 blocks=2560, version=2
  = sectsz=512 maxflex 0 IX noextents=0
```
Option 2: Add and format MBR partitions

If the new disk space is used to add a new MBR partition, perform the following steps:

1. Run the `fdisk -u /dev/vdb` command to create a partition.

   In the example, partition `/dev/vdb2` is created for the newly added 20 GiB disk space.

   ```bash
   [root@ecshost ~]# fdisk -u /dev/vdb
   Welcome to fdisk (util-linux 2.23.2).
   Changes will remain in memory only, until you decide to write them. Be careful before using the write command.
   Command (m for help): p
   Disk /dev/vdb: 42.9 GB, 42949672960 bytes, 83886080 sectors
   Units = sectors of 1 * 512 = 512 bytes
   Sector size (logical/physical): 512 bytes / 512 bytes
   I/O size (minimum/optimal): 512 bytes / 512 bytes
   Disk label type: dos
   Disk identifier: 0x2b31a2a3
   
   Device Boot Start End Blocks Id System
   /dev/vdb1 2048 41943039 20970496 83 Linux
   
   Command (m for help): n
   Partition type:
   p  primary (1 primary, 0 extended, 3 free)
   e  extended
   Select (default p): p
   Partition number (2-4, default 2): 2
   First sector (41943040-83886079, default 41943040):
   Using default value 41943040
   Last sector, +sectors or +size{K,M,G} (41943040-83886079, default 83886079):
   Using default value 83886079
   Partition 2 of type Linux and of size 20 GiB is set
   
   Command (m for help): w
   The partition table has been altered!
   Calling ioctl() to re-read partition table.
   Syncing disks.
   
   2. Run the `lsblk /dev/vdb` command to view the partition.

   ```bash
   [root@ecshost ~]# lsblk /dev/vdb
   NAME MAJ:MIN RM SIZE RO TYPE MOUNTPOINT
   vdb 253:16 0 40G 0 disk
   └─vdb1 253:17 0 20G 0 part
   ```
3. Format the new partition.

- To create an ext4 file system, run the `mkfs.ext4 /dev/vdb2` command.

```
[root@ecshost ~]# mkfs.ext4 /dev/vdb2
mke2fs 1.42.9 (28-Dec-2013)
Filesystem label=
OS type: Linux
Block size=4096 (log=2)
Fragment size=4096 (log=2)
Stride=0 blocks, Stripe width=0 blocks
1310720 inodes, 5242880 blocks
262144 blocks (5.00%) reserved for the super user
First data block=0
Maximum filesystem blocks=2153775104
160 block groups
32768 blocks per group, 32768 fragments per group
8192 inodes per group
Superblock backups stored on blocks:
    32768, 98304, 163840, 229376, 294912, 819200, 884736,
    1605632, 2654208,
    4096000
Allocating group tables: done
Writing inode tables: done
Creating journal (32768 blocks): done
Writing superblocks and filesystem accounting information: done
```

- To create an ext3 file system, run the `mkfs.ext3 /dev/vdb2` command.

```
[root@ecshost ~]# mkfs.ext3 /dev/vdb2
mke2fs 1.42.9 (28-Dec-2013)
Filesystem label=
OS type: Linux
Block size=4096 (log=2)
Fragment size=4096 (log=2)
Stride=0 blocks, Stripe width=0 blocks
1310720 inodes, 5242880 blocks
262144 blocks (5.00%) reserved for the super user
First data block=0
Maximum filesystem blocks=4294967296
160 block groups
32768 blocks per group, 32768 fragments per group
8192 inodes per group
Superblock backups stored on blocks:
    32768, 98304, 163840, 229376, 294912, 819200, 884736,
    1605632, 2654208,
    4096000
Allocating group tables: done
Writing inode tables: done
Creating journal (32768 blocks): done
Writing superblocks and filesystem accounting information: done
[root@ecshost ~]# blkid /dev/vdb2
```
To create an xfs file system, run the `mkfs.xfs -f /dev/vdb2` command.

```
[root@ecshost ~]# mkfs.xfs -f /dev/vdb2
meta-data=/dev/vdb2 isize=512 agcount=4, agsize=1310720 blks
            = sectsz=512 attr=2, projid32bit=1
data = crc=1 finobt=0, sparse=0 imaxpct=25
        = sunit=0 swidth=0 blks
naming = version 2 bsize=4096 ascii-ci=0 ftype=1
log = internal log bsize=4096 blocks=2560, version=2
        = sectsz=512 sunit=0 blks, lazy-crc=0
realtime = none extsz=4096 blocks=0, rtextents=0
```

To create a btrfs file system, run the `mkfs.btrfs /dev/vdb2` command.

```
[root@ecshost ~]# mkfs.btrfs /dev/vdb2
btrfs-progs v4.9.1
Label:              (null)
UUID:               6fb5779b-57d7-4aaf-bf09-82b46f54a429
Node size:          16384
Sector size:        4096
Filesystem size:    20.00GiB
Block group profiles:
  Data:             single            8.00MiB
  Metadata:         DUP               1.00GiB
  System:           DUP               8.00MiB
SSD detected:       no
Incompat features:  extref, skinny-metadata
Number of devices:  1
Devices:
  ID        SIZE    PATH
1    20.00GiB  /dev/vdb2
```

4. Run the `mount /dev/vdb2 /mnt` command to attach the file system to the data disk.

5. Run the `df -h` command to check the current capacity and usage of the data disk.

If information about the new file system is displayed, it indicates that the attach operation is successful.

```
[root@ecshost ~]# df -h
Filesystem Size Used Avail Use% Mounted on
/dev/vda1 40G 1.6G 36G 5% /
```
Option 3: Resize existing GPT partitions

To resize an existing GPT partition, perform the following steps: In the example, a data disk of 1 TiB is extended to 32 TiB. The existing partition is /dev/vdb1.

1. Run the `fdisk` command to view information about the partition to be extended.

   ```bash
   [root@ecshost ~]# fdisk -l
   Disk /dev/vda: 42.9 GB, 42949672960 bytes, 83886080 sectors
   Units = sectors of 1 * 512 = 512 bytes
   Sector size (logical/physical): 512 bytes / 512 bytes
   I/O size (minimum/optimal): 512 bytes / 512 bytes
   Disk label type: dos
   Disk identifier: 0x000b1b45
   
   Device Boot      Start         End      Blocks   Id  System
   /dev/vda1   *        2048    83875364    41936658+  83  Linux
   WARNING: fdisk GPT support is currently new, and therefore in an experimental phase. Use at your own discretion.
   
   Disk /dev/vdb: 35184.4 GB, 35184372088832 bytes, 68719476736 sectors
   Units = sectors of 1 * 512 = 512 bytes
   Sector size (logical/physical): 512 bytes / 512 bytes
   I/O size (minimum/optimal): 512 bytes / 512 bytes
   Disk label type: gpt
   Disk identifier: BCE92401-F427-45CC-8B0D-B30EDF279C2F
   
   #         Start          End    Size  Type            Name
   1         2048   2147483647   1024G  Microsoft basic mnt
   ```

2. View the mount path of the data disk. Detach the partition based on the returned file path and wait until the partition is fully detached.

   ```bash
   [root@ecshost ~]# mount | grep "/dev/vdb"
   /dev/vdb1 on /mnt type ext4 (rw,relatime,data=ordered)
   [root@ecshost ~]# unmount /dev/vdb1
   ```
3. Use the `parted` tool to allocate space for the partition.

   a. Run the `parted /dev/vdb` command to start the `parted` tool.

   b. (Optional) Run the `help` command to view the help information.

   c. Run the `print` command to view the number (Number) and capacity (Size) of the partition to be extended.

      In the example, partition 1 is to be extended and its existing capacity is 1100 GiB. The new capacity will be allocated to partition 1.

   d. Run the `resizepart <partition number> <capacity allocation percentage>` command to resize the partition.

      `resizepart 1 100%` is used in the example.

   e. Run the `print` command to check whether the number (Number) and capacity (Size) of the partition has been changed.

4. Run the `fsck -f /dev/vdb1` command to check whether the file system is consistent.
5. Resize the file system and attach the partition again.

- For the ext\* file system (such as ext3 and ext4), run the `resize2fs /dev/vdb1` command and attach the partition again.

  ```bash
  [root@ecshost ~]# resize2fs /dev/vdb1
  resize2fs 1.42.9 (28-Dec-2013)
  Resizing the filesystem on /dev/vdb1 to 8589934331 (4k) blocks.
  The filesystem on /dev/vdb1 is now 8589934331 blocks long.
  [root@ecshost ~]# mount /dev/vdb1 /mnt
  ```

- For the xfs file system, run the `mount /dev/vdb1 /mnt/` command first, and then the `xfs_growfs /dev/vdb1` command.

  ```bash
  [root@ecshost ~]# mount /dev/vdb1 /mnt/
  [root@ecshost ~]# xfs_growfs /dev/vdb1
  ```

Option 4: Add and format GPT partitions

If the newly added disk space is used to add a new GPT partition, perform the following steps: In the example, a data disk of 32 TiB is used. The existing partition `/dev/vdb1` has a 4.8 TiB capacity. The `/dev/vdb2` partition is to be created.

1. Run the `fdisk` command to view information about the existing partition.

  ```bash
  [root@ecshost ~]# fdisk -l
  Disk /dev/vda: 42.9 GB, 42949672960 bytes, 83886080 sectors
  Units = sectors of 1 * 512 = 512 bytes
  Sector size (logical/physical): 512 bytes / 512 bytes
  I/O size (minimum/optimal): 512 bytes / 512 bytes
  Disk label type: dos
  Disk identifier: 0x000b1b45

  Device Boot Start End Blocks Id System
  /dev/vda1 * 2048 83875364 41936658+ 83 Linux
  WARNING: fdisk GPT support is currently new, and therefore in an experimental phase. Use at your own discretion.

  Disk /dev/vdb: 35184.4 GB, 35184372088832 bytes, 68719476736 sectors
  Units = sectors of 1 * 512 = 512 bytes
  Sector size (logical/physical): 512 bytes / 512 bytes
  I/O size (minimum/optimal): 512 bytes / 512 bytes
  Disk label type: gpt
  Disk identifier: BCE92401-F427-45CC-8B0D-B30EDF279C2F

  # Start End Size Type Name
  ```
2. **Use the parted tool to create a new partition and allocate space for it.**

   a. **Run the parted /dev/vdb command to start the parted tool.**

   b. **Run the print free command to view the disk space to be allocated. Record the start and end sectors and capacity of the existing partition.**

   In the example, the start sector of /dev/vdb1 is 1,049 KB, the end sector is 5,278 GB, and the capacity is 5,278 GiB.

   ```
   (parted) print free
   Model: Virtio Block Device (virtblk)
   Disk /dev/vdb: 35.2TB
   Sector size (logical/physical): 512B/512B
   Partition Table: gpt
   Disk Flags:

   Number  Start   End     Size    File system  Name  Flags
   17.4kB  1049kB  1031kB  Free Space
   1      1049kB  5278GB  5278GB  ext4         mnt
   5278GB  35.2TB  29.9TB  Free Space
   ```

   c. **Run the mkpart <partition name> <start sector> <capacity allocation percentage> command.**

   In the example, the /dev/vdb2 partition named test is created. The start sector of the new partition is the end sector of the existing partition. The new capacity is allocated to the new partition.

   ```
   (parted) mkpart test 5278GB 100%
   (parted) print
   Model: Virtio Block Device (virtblk)
   Disk /dev/vdb: 35.2TB
   Sector size (logical/physical): 512B/512B
   Partition Table: gpt
   Disk Flags:

   Number  Start   End     Size    File system  Name  Flags
   1      1049kB  5278GB  5278GB  ext4         mnt
   2      5278GB  35.2TB  29.9TB  Free Space  test
   ```

   d. **Run the print command to check whether the capacity (Size) of the partition has changed.**

   ```
   (parted) mkpart test 5278GB 100%
   (parted) print
   Model: Virtio Block Device (virtblk)
   Disk /dev/vdb: 35.2TB
   Sector size (logical/physical): 512B/512B
   Partition Table: gpt
   Disk Flags:

   Number  Start   End     Size    File system  Name  Flags
   1      1049kB  5278GB  5278GB  ext4         mnt
   2      5278GB  35.2TB  29.9TB  Free Space  test
   ```

   e. **Run the quit command to exit the parted tool.**
3. Create a file system for the new partition.

- To create an ext4 file system, run the `mkfs.ext4 /dev/vdb2` command.
- To create an ext3 file system, run the `mkfs.ext3 /dev/vdb2` command.
- To create an xfs file system, run the `mkfs.xfs -f /dev/vdb2` command.
- To create a btrfs file system, run the `mkfs.btrfs /dev/vdb2` command.

In the example, an xfs file system is created.

```
[root@ecshost ~]# mkfs -t xfs /dev/vdb2
meta-data=/dev/vdb2 isize=512 agcount=28, agsize=268435455 blks
  = sectsz=512 attr=2, projid32bit=1
  = crc=1 finobt=0, sparse=0
data = bsize=4096 blocks=730144096,
imaxpct=5
  = sunit=0 swidth=0 blks
naming = version 2 bsize=4096 ascii-ci=0 ftype=1
log = internal log bsize=4096 blocks=521728,
  version=2
  = sectsz=512 sunit=0 blks, lazy-
  count=1
realtime =none extsz=4096 blocks=0, rtextents=0
```

4. Run the `fdisk -l` command to view partition capacity changes.

```
[root@ecshost ~]# fdisk -l
Disk /dev/vda: 42.9 GB, 42949672960 bytes, 83886080 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: dos
Disk identifier: 0x000b1b45

Device Boot      Start        End    Size  Type            Name
/dev/vda1   *       2048  83875364    4.8T  Microsoft basic mnt

WARNING: fdisk GPT support is currently new, and therefore in an experimental phase. Use at your own discretion.

Disk /dev/vdb: 35184.4 GB, 35184372088832 bytes, 68719476736 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: gpt
Disk identifier: BCE92401-F427-45CC-8B0D-B30EDF279C2F

#   Start   End    Size   Type  Name
1  2048 10307921919  4.8T Microsoft basic mnt
2 10307921920  6871947687    27.2T Microsoft basic test
```

5. Run the `blkid` command to view the file system types.

```
[root@ecshost ~]# blkid
/dev/vda1: UUID="ed95c595-4813-480e-****-85b1347842e8" TYPE="ext4"
/dev/vdb1: UUID="21e91bbc-7bca-4c08-****-88d5b3a2303d" TYPE="ext4"
PARTLABEL="mnt" PARTUUID="576235e0-5e04-4b76-****-741cbc7e98cb"
```
6. Attach the new partition.

```bash
[root@ecshost ~]# mount /dev/vdb2 /mnt
```

Option 5: Resize the file system of a raw data disk

If a raw data disk contains a file system, but not a partition, you can perform the following steps to directly resize the file system.

1. Run different commands based on the file system type.

   - For the ext* file system, run the `resize2fs` command using the root permissions to resize the file system. Example:
     ```bash
     resize2fs /dev/vdb
     ```
   
   - For the xfs file system, run the `xfs_growfs` command using the root permissions to resize the file system. Example:
     ```bash
     xfs_growfs /dev/vdb
     ```

2. Run the `df -h` command to view the data disk information.

   The file system has a larger capacity, indicating that the operation was successful.

   ```bash
   [root@ecshost ~]# df -h
   Filesystem  Size  Used  Avail  Use%  Mounted on
   /dev/vda1   40G   1.6G   36G    5%  /
   devtmpfs   3.9G    0   3.9G    0%  /dev
   tmpfs     3.9G    0   3.9G    0%  /dev/shm
   tmpfs     3.9G  460K   3.9G    1%  /run
   tmpfs     3.9G    0   3.9G    0%  /sys/fs/cgroup
   /dev/vdb 98G   37G   61G   37%  /mnt
   tmpfs    783M    0   783M    0%  /run/user/0
   ```

Related operations

- **Resize partitions and file systems of Linux system disks**
- **Extend a Windows file system**

3.9.7 Update the Red Hat VirtIO SCSI driver of Windows ECS instances

You can resize Alibaba Cloud disks online without having to restart their ECS instances. If the ECS instances that you want to resize were created before March
30, 2019, follow the procedure described in this topic to check whether the Red Hat VirtIO SCSI driver of these instances needs to be updated.

Context

- The Red Hat VirtIO SCSI driver is only supported on Windows Server 2008 and later versions.
- If an ECS instance has multiple data disks attached, the driver update process may take a few minutes to complete.

Procedure

The procedure to update the Red Hat VirtIO SCSI driver of Windows ECS instances is as follows:

1. Step 1: Check the driver version
2. Step 2: Download the driver
3. Step 3: Update the Red Hat VirtIO SCSI driver

Step 1: Check the driver version

You can check the driver version using one of the following methods:
Method 1: Use the PowerShell script to check the driver version

1. Connect to the Windows ECS instance. For more information, see #unique_106.
2. Open Command Prompt.
3. Enter powershell to access the PowerShell interactive interface.
4. Enter and run the following command to check the driver version and determine based on the command output whether the ECS instance supports online disk resizing:

```powershell
[System.Diagnostics.FileVersionInfo]::GetVersionInfo("C:\Windows\System32\drivers\viostor.sys")
```

- If the version of the Red Hat VirtIO SCSI driver of the Windows ECS instance is 58011 or later, the disks attached to the instance support online resizing.
  For information about how to resize disks online, see Resize cloud disks online.
- If the version of the Red Hat VirtIO SCSI driver is earlier than 58011, proceed to the next step.
Method 2: Manually check the driver version

1. Connect to the Windows ECS instance.
2. Go to the system directory \C:\Windows\System32\drivers\.
3. Right-click the viostor.sys file, choose Properties from the shortcut menu, and view the file version on the Details tab.

- If the version of the Red Hat VirtIO SCSI driver of the Windows ECS instance is 58011 or later, the disks attached to the instance support online resizing. For information about how to resize disks online, see Resize cloud disks online.
- If the version of the Red Hat VirtIO SCSI driver is earlier than 58011, proceed to the next step.

Step 2: Download the driver

Download and decompress the VirtIO driver package. The subsequent steps in this topic are based on the assumption that the decompressed driver package is located at \C:\Users\Administrator\Desktop\virtioDriver. The following table lists the extracted folders corresponding to ECS instances of different operating system versions.

<table>
<thead>
<tr>
<th>Driver file (folder) name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>win7</td>
<td>Windows Server 2008 R2 and Windows 7</td>
</tr>
<tr>
<td>W1h</td>
<td>Windows Server 2008</td>
</tr>
</tbody>
</table>
Step 3: Update the Red Hat VirtIO SCSI driver

You can update the Red Hat VirtIO SCSI driver using one of the following methods:

- Method 1: Use pnputil to add and install the driver

  1. Open Command Prompt.
  2. Run the following command to add the driver package:

     `pnputil -i -a <path to virtio driver inf>`

     **Note:**
     Make sure that you have extracted the .inf target file to the specified directory (`<path to virtio driver inf>`, for example, `C:\Users\Administrator\Desktop\virtioDriver\Wlh\amd64\*.inf`).

  3. Restart the operating system of the ECS instance for the driver update to take effect.
Method 2: Manually add the driver

1. Open Device Manager.

2. Right-click Red Hat VirtIO SCSI controller under Storage controllers and choose Update Driver Software... from the shortcut menu.

Note:
If multiple Red Hat VirtIO SCSI controller devices appear, you only need to update one of them.

3. Select Browse my computer for driver software.

4. Select Let me pick from a list of device drivers on my computer.

5. Click Have Disk.

6. Select the driver file `viostor` in the corresponding folder, and follow the wizard to update the driver.

7. Restart the operating system of the ECS instance for the driver update to take effect.

What's next

Resize cloud disks online
3.10 Roll back a disk

If you have created snapshots from a disk, you can roll back the disk to restore it to its state at a specific point in time. The operations described in this topic apply to system disks and data disks.

Prerequisites

Before you roll back a disk, make sure that:

• You have an existing snapshot of the disk, and you are not in the process of creating a snapshot of the disk.
• The disk has not been released.
• If you have changed the system disk, snapshots of the previous system disk cannot be used to roll back the new system disk.
• The disk has been attached to an ECS instance, and the instance is in the Stopped state.

Notice:

If the feature of No fees for stopped instances (VPC-Connected) is enabled for your pay-as-you-go instance, set the Stop Mode in the Stop Instance dialog box to Retain Instance and Continue Charging After Instance is Stopped when you stop the instance. If you do not do this, you may not be able to restart the instance after the disk is rolled back. For more information, see #unique_111.

Context

Before you roll back a disk, take note of the following items:

• The rollback operation is irreversible. After rollback is completed, the data before the rollback cannot be restored. Use caution when you perform this operation.
• After a disk is rolled back, the data from the time when the snapshot is created to the time when the rollback is performed is lost.
• After a system disk is rolled back, the SSH key pair or password used by the instance is automatically bound to the new system disk.

Procedure

1. Log on to the ECS console.
2. In the left-side navigation pane, choose Instances & Images > Instances.
3. In the top navigation bar, select a region.
4. Find the ECS instance that is in the Stopped state and click the instance ID to access the Instance Details page.
5. In the left-side navigation pane, click Snapshots.
6. Select the target snapshot and click Rollback Disk in the Actions column.
7. In the message that appears, click OK.

What's next

- If you resize a disk after you create a snapshot of the disk, the size of the disk is also rolled back after you roll back the disk. To make the disk revert to the size before the rollback, you must log on to the instance to resize the file system again. For more information, see the following topics:
  - Resize partitions and file systems of Linux data disks
  - Extend a Windows file system

- To retain important or partial data generated from the time when the snapshot is created to the time when the rollback is performed, you can create a data disk from the latest snapshot generated during that period, attach the new data disk to the ECS instance, and then synchronize the data you want to the ECS instance.

Related topics

#unique_112
3.11 Reinitialize a cloud disk

3.11.1 Reinitialize a cloud disk

When a cloud disk is attached to an ECS instance, you can reinitialize the disk to restore the system disk or the data disks to the status when they were created. After a cloud disk is reinitialized:

- The system disk is restored to the initial status when it was created. For example, if you select a public image to create an ECS instance, after the system disk is reinitialized, the operating system is retained, but all other applications that were installed after the instance creation are deleted.

**Note:**

After you change the operating system or resize the system disk, the instance is not fully restored to the status at which it was created, but only to the status of the new system disk when it was created.

- Depending on how the data disk was created, it is restored to the following initial status:
  - Restored to an empty disk if it was an empty disk
  - Restored to a disk with only the data of the source snapshot if it was created from a snapshot

- If an automatic snapshot policy is applied to a cloud disk, the policy is retained and does not need to be applied again after reinitialization.

- After a cloud disk is reinitialized, all the snapshots, both automatically and manually created, are retained. You can use them to roll back a cloud disk.

**Warning:**

- Because you must stop your ECS instance to reinitialize a cloud disk, your business services may be disrupted. Exercise caution when performing this action
- After a cloud disk is reinitialized, its data is lost. Therefore, we recommend you back up the data. To do so, you can create snapshots.

Reinitialize a system disk

Prerequisites
If an SSH key pair is used as the authentication method, check that you have created an SSH key pair or imported an SSH key pair.

Procedure

To reinitialize a system disk, follow these steps:

1. Log on to the ECS console.
2. In the left-side navigation pane, choose Instances & Images > Instances.
3. In the top navigation bar, select a region.
4. Find the target ECS instance and click its ID to go to the Instance Details page.
5. Click Stop.

Note:
For a Pay-As-You-Go VPC-Connected ECS instance, if the feature is enabled, in the Notice dialog box, click OK, and then in the Stop Instance dialog box, select Retain Instance and Continue Charging After Instance Is Stopped. If you select the No Charges After Instance Is Stopped, you may not be able to start the instance successfully after you reinitialize the system disk.
6. After the instance is stopped, click Disks in the left-side navigation pane.

7. Find the system disk and then, in the Actions column, click Reinitialize Disk.
8. In the Reinitialize Disk dialog box, complete the following configuration:

a. Authentication method:
   - For a Windows instance, you must specify a logon password. You can either use a previous password or specify a new one.
For a Linux instance, select Set SSH Key or Set Password as the security setting. If Key Pair is selected, bind a key pair. If Password is selected, specify a logon password.

b. (Optional) Security Enhancement: Select Activate. After the security enhancement feature is enabled, ECS security components are loaded. These components provide security features such as backdoor detection, remote logon reminders, brute-force cracking prevention mechanisms, and more.
c. (Optional) Instance Startup: Select Start Instance Resetting Disk.
d. Click Confirm.

9. For Linux instances: If you have attached a data disk to the instance, connect to the instance and create a mounting point for the partitions of data disks, because the mounting points are lost after the system disk is reinitialized.

Note:
For a Windows instance, both the system disk and the data disks are ready for use. No additional operations are needed.

After the system disk is reinitialized, you must deploy all applications to restore your business operations.

Reinitialize a data disk

Once reinitialized, a data disk is in a different status according to its original status and the operating system of the instance:

- For a Windows instance, the data disk is ready to use without any additional operations required.
- For a Linux instance:
  - If the data disk was an empty disk after it was created, then all the data and partitions on the disk are lost. You must partition and format the disk, and mount the partitions again.

  Note:
  If you configured the `/etc/fstab` file to automatically mount the disk partitions at startup of the instance, you must comment out the lines from the `/etc/fstab` file before reinitializing a data disk. Otherwise, your instance will fail to start.

  - If the data disk was created from a snapshot, then the data disk is recovered to the point in time at which the snapshot was generated. You do not have to mount the partitions again, but all the data generated after the disk creation is lost.

In this section, `/dev/vdb1` is the example partition and `/InitTest` is the example mounting point. Replace these details with your actual information.

Prerequisites

The data disk to be reinitialized must be attached to an ECS instance. For more information, see Attach a cloud disk.

Procedure

To reinitialize a data disk, follow these steps:

1. For Linux instances: If the data disk was an empty disk after it was created, and the mounting configuration was added to the `/etc/fstab` file, you must comment
out the mounting configuration from the `/etc/fstab` file. To do so, follow these steps:

a. Connect to the Linux instance.

b. Run `vim /etc/fstab`.

c. Press the `i` key to enter the Insert mode.

d. Locate the mounting configuration lines and type `#` before the lines. For example:

```
# /dev/vdb1 /InitTest ext3 defaults 0 0
```

e. Press the `Esc` key to exit the Insert mode, and then run `:wq` to save and exit.

2. Log on to the ECS console.

3. In the left-side navigation pane, choose Instances & Images > Instances.

4. In the top navigation bar, select a region.

5. Find the target ECS instance and click its ID to go to the Instance Details page.

6. Click Stop.

**Note:**

For a Pay-As-You-Go VPC-Connected ECS instance, if the `#unique_111` feature is enabled, in the Notice dialog box, click OK, and then in the Stop Instance dialog box, select Retain Instance and Continue Charging After Instance Is Stopped. If you select the No Charges After Instance Is Stopped, you may not be able to start the instance successfully after you reinitialize the system disk.
7. After the instance is Stopped, click Disks in the left-side navigation pane.
8. Find the target data disk and in the Actions column, click Reinitialize Disk.
9. In the Reinitialize Disk dialog box, read the notes and click Confirm.
10. In the left-side navigation pane, click Instance Details.
11. Click Start.
12. For Linux instances: If the data disk was an empty disk after it was created, format and mount data disks for Linux instances.

After the data disk is reinitialized, you may need to deploy applications to restore your business operations.

Related API

ReInitDisk
3.11.2 Reinitialize a data disk

When a data disk is attached to an Elastic Compute Service (ECS) instance, you can reinitialize the disk to restore it to the status when it was created.

Prerequisites

- The data disk has been attached to an instance. For more information about how to attach a data disk to an instance, see Attach a cloud disk.
- For an instance that runs Linux, you can add a command in the /etc/fstab file to mount partitions of a data disk at the startup of the instance. If the data disk was empty when it was created, after you reinitialize the data disk, the command will not be executed and the instance cannot start up as expected. We recommend that you comment out the command in the /etc/fstab file. The procedure is as follows:
  1. Remotely connect to an instance that runs Linux.
  2. Run the `vim /etc/fstab` command.
  3. Press the `i` key to enter the editing mode.
  4. Find the command used to mount data disk partitions and comment it out by using `#`, as shown in the following line.

```bash
# /dev/vdb1 /InitTest ext3 defaults 0 0
```

Note: `/dev/vdb1` is an example partition and `/InitTest` is an example mount point. You can replace them based on your business requirements.

5. Press the `Esc` key to exit the editing mode. Then, enter `:wq` to save any changes and exit the vim editor.

Context

The status of a data disk after being reinitialized varies depending on its original status when it was created and the operating system the instance runs:

- The data disk is restored to the initial status when it was created:
  - It becomes an empty disk if it was originally an empty disk.
  - It stores the data recorded in the source snapshot if it was created from a snapshot.
• For an instance that runs Windows, after you reinitialize its data disk, the data disk is ready for use without any additional operations regardless of its original status.

• For an instance that runs Linux:
  - If the data disk was created from a snapshot, it stores only the data recorded in the source snapshot after being reinitialized. You do not need to mount the partitions again, but all the data generated after the disk creation is lost.
  - If the data disk was created as an empty disk, all the data and partitions on the disk are lost. You must partition and format the disk, and mount the partitions again.

Procedure

1. Log on to the ECS console.

2. In the left-side navigation pane, choose Instances & Images > Instances.

3. In the top navigation bar, select a region.

4. Find the ECS instance where you need to reinitialize a data disk, and click the instance ID to go to the Instance Details page.

5. Click Stop in the upper-right corner of the page to stop the instance.

6. After the instance is Stopped, click Disks in the left-side navigation pane.

7. Find the target data disk, and click Reinitialize Disk in the Actions column.

8. In the Reinitialize Disk dialog box, read the notes and click Confirm.

9. In the left-side navigation pane, click Instance Details.

10. Click Start in the upper-right corner of the page to start the instance and complete the reinitialization of the data disk.

What's next

• If a data disk is mounted to an instance running Linux and the data disk was created as an empty disk, you must format the disk after you reinitialize it. For more information, see Format a data disk for a Linux-based ECS instance.

• After the data disk is reinitialized, you need to deploy and configure applications to restore your business as soon as possible.

Related concepts

Reinitialize a cloud disk

Related topics

#unique_117
3.12 Modify the performance level of an ESSD

This topic describes how to modify the performance level of a running ESSD in the ECS console. After the modification, the new performance level takes effect immediately, you don't need to restart the instance, create a new ESSD disk, or copy the data.

Prerequisites

You can follow the steps in this guide if your ESSD meets the following requirements:

- Your account does not have overdue payment.
- If you attach an ESSD to a Pay-As-You-Go ECS instance, make sure that the instance is not in the Expired state.
- You can change the performance level of a new ESSD only after it enters the Unattached (Available) state.

Context

When you create an ECS instance, you can set the ESSD as the system disk or data disk. You can also create a separate ESSD. For information about how to create an ESSD, see Create an instance by using the wizard and Create a Pay-As-You-Go cloud disk. For information about ESSDs, see Enhanced SSDs.

After the performance level is modified, the ESSD is billed according to the new performance level.

You can also call the API action #unique_47 to complete this task.

Procedure

1. Log on to the ECS console.
2. In the left-side navigation pane, choose Storage & Snapshots > Disks.
3. In the top navigation bar, select a region.
4. Find the target ESSD. In the Actions column, choose More > Modify Performance Level.

![](image1)

5. In the Modify Performance Level dialog box, select a higher performance level and click OK.

![](image2)

The performance level you can select for an ESSD is determined by its storage capacity. If the performance level of an ESSD cannot be upgraded, resize the ESSD and then modify its performance level.

3.13 Monitor a cloud disk

You can monitor the IOPS and throughput of a cloud disk in the ECS console or, if you have installed the CloudMonitor agent, you can monitor the disk in the CloudMonitor console.

To monitor the IOPS and throughput of a cloud disk in the ECS console, follow these steps:
1. Find a cloud disk and click its ID to go to the Details page.
2. In the left-side navigation pane, click Disk Monitoring.
3. On the Monitoring Information page, click the icon and set the start time and end time for monitoring information. You can check the monitoring information of a cloud disk for up to 15 days.

4. View the IOPS and throughput of the cloud disk.

Note:
3.14 Convert billing methods of cloud disks

The billing method of a cloud disk depends on how it is created:

- For cloud disks created with Subscription instances, prepayment of the service fee is required for it to be available for use. For more information, see Subscription.
- For cloud disks created jointly with Pay-As-You-Go instances, or created separately the billing is on a Pay-As-You-Go basis. For more information, see Pay-As-You-Go.

You can change the billing method of a cloud disk, as shown in the following table.
<table>
<thead>
<tr>
<th>Conversion of billing methods</th>
<th>Conversion method</th>
<th>Suitable for</th>
<th>Effective date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscription —&gt; Pay-As-You-Go</td>
<td>Renew for configuration downgrade</td>
<td>Subscription cloud disks attached to Subscription instances. The billing method of the system disk cannot be changed.</td>
<td>Effective from the next billing cycle</td>
</tr>
<tr>
<td>Pay-As-You-Go —&gt; Subscription</td>
<td>Upgrade configurations</td>
<td>Pay-As-You-Go data disks attached to Subscription instances. The billing method of the system disk cannot be changed.</td>
<td>Effective immediately</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The system disks and data disks attached to the Pay-As-You-Go instances.</td>
<td></td>
</tr>
</tbody>
</table>

### 3.15 Detach a cloud disk

If a Pay-As-You-Go cloud disk is attached to an ECS instance as a data disk, you can detach it from the instance and release it. However, if the disk is used as a system disk, you cannot detach it.

When detaching a cloud disk, consider the following:

- Only the Pay-As-You-Go cloud disks in the In Use state and used as a Data Disk can be detached.
- You cannot detach a local disk.
- For a Windows instance:
  - To guarantee data integrity, we recommend that you stop writing or reading the files on the cloud disk. Otherwise, data may be lost.
  - Before detaching a cloud disk in the ECS console, you must connect to the instance and set its status to Offline in Disk Management.
• For a Linux instance:
  - Before detaching a cloud disk in the ECS console, you must connect to the instance and run `umount` to unmount the partitions.
  - If you have configured the `/etc/fstab` file to automatically mount the partitions at the startup of the instance, before detaching it, you must delete the configurations from the `/etc/fstab` file. Otherwise, you cannot connect to the instance after the instance is restarted.

The following table describes the actions available for you to detach a cloud disk in the ECS console.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>You want to detach one or more cloud disks from one instance.</td>
<td>Detach cloud disks on the Instance Disk page.</td>
</tr>
<tr>
<td>You want to detach one specific cloud disk.</td>
<td>Detach a cloud disks on the Disk List page.</td>
</tr>
</tbody>
</table>

Detach cloud disks on the Instance Disk page

On the Instance Disks page, you can delete one or more cloud disks that are attached to the instance.

Prerequisites

The cloud disks are attached to the instance and its status is In Use.

If you are detaching a cloud disk from a Linux instance, and you have configured the `/etc/fstab` file to mount the partitions at the startup of the instance, you must first delete the configurations.

Procedure

To detach a cloud disk from the Instance Disks page, follow these steps:

1. Connect to the instance and unmount its partitions. According to the operating system, follow the recommended steps detailed in the following table.

<table>
<thead>
<tr>
<th>Operating system</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux</td>
<td>Run <code>umount [partition]</code>. For example, <code>umount /dev/vdb1</code>.</td>
</tr>
<tr>
<td>Operating system</td>
<td>Steps</td>
</tr>
<tr>
<td>------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Windows</td>
<td>Start Disk Management, right-click the disk name (for example, Disk 2) and then click Offline.</td>
</tr>
</tbody>
</table>

2. Log on to the *ECS console*.

3. In the left-side navigation pane, choose Instances & Images > Instances.

4. In the top navigation bar, select a region.

5. Find the target instance and click its ID to go to the Instance Details page.

6. In the left-side navigation pane, click Disks.

7. Find the target cloud disk and then, in the Actions column, select More > Unmount.

Only cloud disks that have the following attributes can be detached:

- Status must be In Use.
- Detachable must be Yes.
- Type must be Data Disk.

8. In the dialog box, click Confirm.

9. Optional. If you want to detach multiple cloud disks, repeat steps 7 and 8 as required.

When the status of the cloud disk becomes Unattached, the disk is detached.

**Detach a cloud disk on the Disks page**

On the Disk List page, you can detach a specific cloud disk from an ECS instance.

**Prerequisites**

The cloud disk is *attached to the instance* and is in the In Use state.

If you are detaching a cloud disk from a Linux instance, and you have configured the `/etc/fstab` file to mount the partitions at the startup of the instance, delete the configurations.

**Procedure**

To detach a cloud disk on the Disk List page, follow these steps:
1. Connect to the instance and unmount the partitions. According to the operating system, follow the recommended steps detailed in the following table.

<table>
<thead>
<tr>
<th>Operating system</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux</td>
<td>Run <code>umount [partition]</code>. For example, <code>umount /dev/vdb1</code>.</td>
</tr>
<tr>
<td>Windows</td>
<td>Start Disk Management, right-click the disk name (for example, Disk 2) and then click Offline.</td>
</tr>
</tbody>
</table>

2. Log on to the *ECS console*.

3. In the left-side navigation pane, choose Storage & Snapshots > Disks.

4. In the top navigation bar, select a region.

5. Find the target cloud disk and then, in the Actions column, select More > Unmount.

   Only cloud disks that have the following attributes can be detached:
   
   - Status must be In Use.
   - Detachable must be Yes.
   - Type must be Data Disk.

6. In the dialog box, click Confirm.

   When the status of the cloud disk becomes Unattached, the disk is detached.

Related API

*DetachDisk*

What to do next

If you no longer need the disk, you can *release it*.

3.16 Release a disk

You can release disks that you no longer need. When a disk is released, all the data stored on the disk is released, and billing is stopped. This topic describes how to release a disk by using the ECS console and how to enable or disable the Release Disk with Instance feature.

Prerequisites
· If important data is stored on a disk, we recommend that you create a snapshot to back up the data. For more information, see #unique_21.

· Before you manually release a disk or enable or disable the Release Disk with Instance feature for a pay-as-you-go data disk, make sure that the disk is in the Unattached state. For more information, see Detach a cloud disk.

Context

· If the Delete Automatic Snapshots While Releasing Disk feature is enabled for a disk, the automatic snapshots of this disk are released as well when the disk is released. However, its manual snapshots are not affected. You can disable the Delete Automatic Snapshots While Releasing Disk feature for a disk when you attach the disk. For more information, see #unique_120.

· You can manually release a disk or enable the Release Disk with Instance feature for the disk. The following table describes the releasing methods that different types of disks support.

<table>
<thead>
<tr>
<th>Disk type</th>
<th>Subscription</th>
<th>Pay-as-you-go</th>
</tr>
</thead>
<tbody>
<tr>
<td>System disk</td>
<td>By default, the Release Disk with Instance feature is enabled for subscription system disks. Subscription system disks can only be released together with instances.</td>
<td>By default, the Release Disk with Instance feature is enabled for pay-as-you-go system disks. Pay-as-you-go system disks can only be released together with instances.</td>
</tr>
</tbody>
</table>
| Data disk | - By default, the Release Disk with Instance feature is enabled for subscription data disks. Subscription data disks can be released together with instances.  
- After subscription data disks are converted to pay-as-you-go data disks, they can be manually released. | - Pay-as-you-go data disks can be released together with instances. By default, the Release Disk with Instance feature is enabled for all pay-as-you-go data disks, except pay-as-you-go data disks that are separately created. For separately created pay-as-you-go data disks, you need to manually enable the feature.  
- Pay-as-you-go data disks can also be manually released. |
Consider the following items when you enable or disable the Release Disk with Instance feature for a system disk or a data disk:

- With the Release Disk with Instance feature enabled, a disk is automatically released at the release of its attached instance.
- With the Release Disk with Instance feature disabled, a disk is retained as a pay-as-you-go data disk three days after a payment becomes overdue for its attached instance, three days after the instance expires, or when the instance is manually released.

Note:
The retained data disk is billed on a pay-as-you-go basis. You can log to the Billing Management console and search for the disk ID to view the consumption details.

Manually release a disk

You can perform the following steps to manually release a pay-as-you-go data disk:

1. Log on to the ECS console.
2. In the left-side navigation pane, choose Storage & Snapshots > Disks.
3. In the top navigation bar, select a region.
4. Find the disk that you want to release. In the Actions column, click More, and choose Release from the shortcut menu.
5. In the message that appears, confirm the information and click Confirm Release.

Enable or disable the Release Disk with Instance feature for disks when creating an ECS instance

You can perform the following steps to enable or disable the Release Disk with Instance feature for data disks or the system disk when creating an ECS instance in the ECS console:

1. Log on to the ECS console.
2. In the left-side navigation pane, choose Instances & Images > Instances.
3. Click Create Instance.
4. On the Basic Configurations page that appears, scroll down to the Storage section and select or clear Release with Instance for data disks or the system disk.

For more information about how to create an ECS instance, see #unique_51.

Enable or disable the Release Disk with Instance feature for a disk on the Disks page

You can perform the following steps to enable or disable the Release Disk with Instance feature for a pay-as-you-go data disk on the Disks page in the ECS console:

1. Log on to the ECS console.
2. In the left-side navigation pane, choose Storage & Snapshots > Disks.
3. In the top navigation bar, select a region.
4. Find the disk for which you want to enable or disable the feature. In the Actions column, click More, and choose Modify Disk Property from the shortcut menu.
5. In the Modify Disk Property dialog box that appears, select or clear Release Disk with Instance and click OK.

Modify Disk Property

- Disk Category: SSD
- Release Mode: Release Disk with Instance

Related topics

#unique_49
4 Shared Block Storage

Shared Block Storage is a block-level data storage service that features high concurrency, high performance, and high reliability. It supports concurrent reads and writes on multiple ECS instances, and provides data reliability of up to 99.9999999%.

Benefits

Shared Block Storage stores three copies of each piece of data, and distributes the copies across different servers. This achieves 99.9999999% data reliability for ECS instances. Shared Block Storage automatically copies your data within a zone to ensure data availability and prevent service disruptions, for example, due to a hardware failure.

Scenarios

In a traditional cluster architecture, multiple computing nodes access the same copy of data to provide services. To prevent service disruptions due to single point of failures, you can use Shared Block Storage to ensure access to the data, achieving high availability. We recommend that you store business data in Shared Block Storage devices and use a cluster file system to manage these devices. Data consistency can be guaranteed between multiple front-end computing nodes during concurrent read/write operations.

The high availability architecture of Shared Block Storage is suitable for enterprise -level applications. It provides shared access to block storage devices in a shared -everything architecture, such as the high availability server cluster architectu re and Oracle Real Application Clusters (RAC). Oracle RAC is common among government departments, enterprises, and financial customers.

Types

Shared Block Storage can be divided into the following types based on performance:

- Shared SSD Block Storage

  Shared SSD Block Storage uses SSDs as storage media to provide stable and high-performance storage with enhanced random I/O and data reliability.
- **Shared Ultra Block Storage**

  Shared Ultra Block Storage uses a combination of SSDs and HDDs as storage media.

**Performance**

For more information about the performance of Shared Block Storage, see *Block storage performance*.

**Pricing**

Shared Block Storage is free and under public preview.

**Operations**

- You can create, attach, detach, and release Shared Block Storage devices in a similar manner as disks.
- Shared Block Storage devices can only be created separately and used only as data disks.
- A single Shared Block Storage device can be attached to a maximum of eight ECS instances in the same zone and region at the same time.
- When attached to an ECS instance, Shared Block Storage devices share the data disk quota with disks, that is, up to 16 data disks can be attached to each ECS instance.
- You can allocate the capacity of Shared Block Storage devices in a similar manner as hard disks. You can format and partition Shared Block Storage devices that are attached to an ECS instance and create a file system.

**File system**

Shared Block Storage devices are not pre-installed with a cluster file system. However, you can install cluster file systems such as Google File System (GFS) and General Parallel File System (GPFS) to manage these devices. If Oracle RAC is deployed, we recommend that you use Automatic Storage Management (ASM) to manage storage volumes and file systems.

We recommend that you do not use a traditional file system to manage Shared Block Storage devices because the following two errors may occur:
• Disk space allocation conflict

If a Shared Block Storage device is attached to multiple instances and one of these instances (for example, instance A) writes data to a file, instance A checks the file system and available disk space. After the write operation is complete, the space allocation record is changed in instance A, but the records in other instances are not updated. In this case, when another instance (for example, instance B) tries to write data to the file, this instance may allocate the disk space that has been already allocated by instance A, resulting in a disk space allocation conflict.

• Data file inconsistency

After an instance (for example, instance A) reads and caches data, another process that accesses the same data will directly read the data from the cache. However, if a copy of the same data that is stored on another instance (for example, instance B) is modified during this period, and instance A does not update according to the latest data change, instance A still reads the data from the cache. Data inconsistency occurs as a result.
5 Local disks

Local disks are disks that are attached to the same physical machine that hosts their ECS instance. Local disks provide local storage and access for ECS instances. Local disks are cost-effective and provide high random IOPS, high throughput, and low latency.

Disk types

Note:
This topic provides information of local disks that are sold together with ECS instances. For more information about the performance of instance families using local SSDs and big data instance families, see Instance families.

Local disks are ideal for I/O-intensive workloads that require high cost-effectiveness. Alibaba Cloud provides the following two types of local disks:

- NVMe SSD: This type of disks is ideal for instance families such as i2, i2g, i1, ga1, and gn5. i1 and i2 instance families are suitable for the following scenarios:
  - Services such as online gaming, e-commerce, live streaming, and media services that run I/O-intensive applications and require high I/O performance and low latency.
  - Services that require high I/O performance and a high-availability architecture at the application layer, such as NoSQL databases (including Cassandra, MongoDB, and HBase), MPP data warehouses, and distributed file systems.
- SATA HDD: This type of disks is ideal for instance families such as d1ne and d1. These disks are the preferred storage media for industries with high requirements for big data computing, storage, and analysis, such as Internet and financial industries. The disks can fulfill the requirements of distributed computing services such as Hadoop, which have high requirements for storage performance, storage capacity, and internal bandwidth.

NVMe SSD performance

To obtain the standard performance data and measure the Quality of Service (QoS) of Alibaba Cloud local disks, you can test the bandwidth, IOPS, and latency of NVMe SSDs based on the performance metrics described in this topic. For more
information about performance tests of NVMe SSDs, see Performance tests on Block Storage.

- The following table describes the performance metrics of NVMe SSDs that i2 instances use.

<table>
<thead>
<tr>
<th>NVMe SSD performance metric</th>
<th>Single disk performance</th>
<th>Overall instance performance*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ecs.i2.xlarge</td>
<td>Other i2 instances</td>
</tr>
<tr>
<td>Maximum capacity</td>
<td>894 GiB</td>
<td>1,788 GiB</td>
</tr>
<tr>
<td>Maximum read IOPS</td>
<td>150,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Maximum read throughput</td>
<td>1 GB/s</td>
<td>2 GB/s</td>
</tr>
<tr>
<td>Maximum write throughput</td>
<td>0.5 GB/s</td>
<td>1 GB/s</td>
</tr>
<tr>
<td>Access latency</td>
<td>Microsecond (μs)</td>
<td></td>
</tr>
</tbody>
</table>

*Overall instance performance in the table applies only to ecs.i2.16xlarge. This performance represents the highest performance level for local storage in the i2 instance family.

- The following table describes the performance metrics of NVMe SSDs that i1 instances use.

<table>
<thead>
<tr>
<th>NVMe SSD performance metric</th>
<th>Single disk performance</th>
<th>Overall instance performance***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum capacity</td>
<td>1,456 GiB</td>
<td>2,912 GiB</td>
</tr>
<tr>
<td>Maximum IOPS</td>
<td>240,000</td>
<td>480,000</td>
</tr>
<tr>
<td>Write IOPS**</td>
<td>min{165 × Capacity, 240,000}</td>
<td>2 × min{165 × Capacity, 240,000}</td>
</tr>
<tr>
<td>Read IOPS**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum read throughput</td>
<td>2 GB/s</td>
<td>4 GB/s</td>
</tr>
</tbody>
</table>
The performance of a single NVMe SSD is calculated as follows:

- Write IOPS: 165 IOPS per GiB, up to 240,000 IOPS
- Write throughput: 0.85 MB/s per GiB, up to 1,200 MB/s

Overall instance performance in the table applies only to ecs.i1.14xlarge. This performance represents the highest performance level for local storage in the i1 instance family.

SATA HDD performance

The following table describes the performance metrics of SATA HDDs.

<table>
<thead>
<tr>
<th>SATA HDD performance metric</th>
<th>Single disk performance</th>
<th>Overall instance performance****</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum capacity</td>
<td>5,500 GiB</td>
<td>154,000 GiB</td>
</tr>
<tr>
<td>Maximum throughput</td>
<td>190 MB/s</td>
<td>5,320 MB/s</td>
</tr>
<tr>
<td>Access latency</td>
<td>Millisecond (ms)</td>
<td></td>
</tr>
</tbody>
</table>

**** Overall instance performance in the table applies only to ecs.d1.14xlarge and ecs.d1ne.14xlarge instances. This performance represents the highest performance level for local storage in the d1 and d1ne instance families.

Billing methods

Local disks are billed along with the instances to which they are attached. For more information about ECS instance billing methods, see #unique_24 and #unique_25.
Instructions

- Local disks are attached to a single physical server, which increases the risk of single point of failure (SPOF). The reliability of data stored on local disks depends on the reliability of the physical server. To ensure data availability, we recommend that you implement data redundancy at the application layer. You can use deployment sets to distribute ECS instances across multiple physical machines to achieve high availability and disaster recovery. For more information, see #unique_125.

⚠️ Warning:
Data stored on local disks may be lost, for example, when a hardware failure occurs. We recommend that you do not use local disks for long-term data storage. If your applications do not have data reliability architecture, we recommend that you use cloud disks in your ECS instances for data reliability.

- After you purchase an ECS instance that is equipped with a local disk, you must log on to the instance to partition and format the local disk. For more information, see Partition and format the local disk.

- The following operations are not supported on a local disk:
  - Create a separate local disk
  - Use a snapshot to create a local disk
  - Attach a local disk
  - Detach and release a local disk separately
  - Resize a local disk
  - Reinitialize a local disk
  - Create a snapshot for a local disk
  - Use a snapshot to roll back a local disk

Disk initialization sequence

When you create an ECS instance that is equipped with local disks, all disks are initialized based on the following rules:

- Rule 1: If the specified image does not have data disk snapshots, the local disks are initialized prior to the cloud disks that are created along with the ECS instance.
- Rule 2: If the specified image has data disk snapshots, the initialization sequence of the data disks corresponds to what the snapshots have retained. The initialization sequence of the remaining disks is subject to Rule 1.

For example, for a Linux image that contains snapshots of two data disks, the disks are initialized in the following sequence.

- If the original device names of the two data disks are `/dev/xvdb` and `/dev/xvdc`, Alibaba Cloud first allocates `/dev/xvdb` and `/dev/xvdc` to specified data disks in the image. The system disk is initialized first. Then, the initialization proceeds in the following sequence: data disk 1 specified in the image, data disk 2 specified in the image, local disk 1, local disk 2, cloud disk 1, cloud disk 2, and cloud disk N. This is shown in the following figure.

![Diagram 1]

- If the original device names of the two data disks are `/dev/xvdc` and `/dev/xvdd`, Alibaba Cloud first allocates `/dev/xvdc` and `/dev/xvdd` to specified data disks in the image. The remaining device names are preferentially allocated to the local disks. The system disk is initialized first. Then, the initialization proceeds in the following sequence: local disk 1, data disk 1 specified in the image, data disk 2 specified in the image, local disk 2, cloud disk 1, cloud disk 2, and cloud disk N. This is shown in the following figure.

![Diagram 2]

**Lifecycle**

A local disk has the same lifecycle as the instance to which it is attached. For more information, see *ECS instance lifecycle.*
Impact of instance operations on the data stored on local disks

The following table describes the impact of instance operations on the data stored on local disks.

<table>
<thead>
<tr>
<th>Instance operation</th>
<th>Data stored on the local disk</th>
<th>Local disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restart the operating system, restart the instance by using the ECS console, or forcibly restart the instance.</td>
<td>Retained</td>
<td>Retained</td>
</tr>
<tr>
<td>Shut down the operating system, stop the instance by using the ECS console, or forcibly stop the instance.</td>
<td>Retained</td>
<td>Retained</td>
</tr>
<tr>
<td>Automatically restore the instance.</td>
<td>Erased</td>
<td>Released</td>
</tr>
<tr>
<td>Release the instance.</td>
<td>Erased</td>
<td>Released</td>
</tr>
<tr>
<td>A subscription instance is stopped when it expires or a pay-as-you-go instance is stopped when there is an overdue payment. However, the instance has not been released.</td>
<td>Retained</td>
<td>Retained</td>
</tr>
<tr>
<td>A subscription instance is stopped when it expires or a pay-as-you-go instance is stopped when there is an overdue payment. After that, the instance is released.</td>
<td>Erased</td>
<td>Released</td>
</tr>
<tr>
<td>Renew an expired subscription instance.</td>
<td>Retained</td>
<td>Retained</td>
</tr>
<tr>
<td>Reactivate a pay-as-you-go instance that is stopped due to an overdue payment.</td>
<td>Retained</td>
<td>Retained</td>
</tr>
</tbody>
</table>

References

For more information about phased-out local SSDs, see Ephemeral SSDs.
6 Block Storage FAQ

This topic provides answers to commonly asked questions about using Block Storage.

- **ESSD FAQ**
  - What is an enhanced SSD (ESSD)?
  - What specifications do ESSDs have?
  - What are the similarities and differences between ESSDs, standard SSDs, and ultra disks?
  - How is the performance level of an ESSD measured?
  - How do I test the performance of an ESSD and obtain the 1 million IOPS result?
  - What is the relationship between the storage performance of ESSDs and storage performance of the instance to which the ESSDs are attached?
  - How are ESSDs billed?
  - In which regions and zones are ESSDs available?
  - Which instance families can be attached with ESSDs?

- **Common FAQ**
  - What must I consider when I select zones to create disk and then attach the disks to ECS instances?
  - What are the common operations that can be performed on a disk?
  - How do I query the usage and free space of Block Storage devices?
  - Can I shrink a disk or a Shared Block Storage device?
  - How do I release a subscription disk that has not expired?
  - What is I/O optimization? Can I upgrade an existing ECS instance to an I/O optimized instance?

- **Performance testing FAQ**
  - What tools can I use to test the performance of Block Storage devices?
  - Why did my instance shut down when I used fio to test the I/O performance of the instance?
  - How do I test the performance of Shared Block Storage?
  - How do I test the performance of an ESSD and obtain the 1 million IOPS result?
• Standard SSD FAQ
  - What is the I/O performance of a standard SSD?
  - What scenarios are ideal for standard SSDs?
  - Can I replace a basic disk with a standard SSD?
  - How do I purchase a standard SSD? What are the pricing options for I/O optimized instances and standard SSDs?
  - Can I upgrade a standard SSD after I purchase it?
  - Why is an error reported when I attempt to mount the partitions of a standard SSD to an I/O optimized Linux instance?
  - What must I be aware of before I add mount information of basic disks or standard SSDs to Linux instances?

• Shared Block Storage FAQ
  - What is Shared Block Storage?
  - When can I purchase a Shared Block Storage device?
  - What are the ideal scenarios for Shared Block Storage?
  - Can I attach a Shared Block Storage device to ECS instances in different regions?
  - How many Shared Block Storage devices can be attached to one ECS instance?
  - What are the types and performance of Shared Block Storage?
  - How do I test the performance of Shared Block Storage?

• FAQ about attaching and detaching disks
  - What is a device name (mount point)?
  - What is an independent disk?
  - Can I attach one disk to multiple ECS instances at the same time?
  - Do I need to partition and format a pay-as-you-go disk after I purchase it and attach it to an ECS instance?
  - Why am I unable to find the data disk that I purchased for a Linux instance?
  - How many disks can be attached to one ECS instance?
  - Why am I unable to find the desired ECS instance when I attempt to attach a disk to it?
  - Can I attach a disk to an ECS instance that is in a different zone?
  - Will data in a data disk be lost when I detach the disk?
  - Can I detach a system disk?
• Independent disk FAQ
  - How is a separately purchased pay-as-you-go data disk billed?
  - I attached a disk that I created separately to an ECS instance. Why is the disk released when the instance is released?
  - Can I attach a separately purchased pay-as-you-go data disk to a subscription instance?
  - Can I detach a data disk from a subscription instance?
  - I changed the configurations of a disk when I renewed it. Can I convert the billing method of the disk from subscription to pay-as-you-go within the remaining time of the current subscription?
• Disk snapshot FAQ
  - When I delete a disk, will its snapshots also be deleted?
  - Why are some automatic snapshots on my disk missing?
  - Can I use a snapshot to create an independent disk?
• FAQ about reinitializing disks
  - I cannot access the data in a Linux data disk because an error occurred when I attached the disk. What can I do?
  - Are my snapshots retained if I reinitialize a disk?
  - Data disks of a Linux instance cannot be found after I restarted the instance or reinitialized the system disk. What can I do?
  - How do I re-mount data disks after I reinitialize the system disk of a Linux instance?
• FAQ about extending disks
  - Are my snapshots retained if I replace a system disk?
  - What must I be aware of before I replace a system disk?
  - How do I extend a system disk?
  - Can I shrink a system disk after I extend it?
  - What Block Storage devices can be extended when they are used as system disks? Do any regional limits apply to this operation?
  - Can the system disks of both subscription ECS instances and pay-as-you-go ECS instances be extended?
  - What is the storage capacity range of a system disk?
  - I changed the configurations of an instance when I renewed it. Can I specify a new size for the system disk when I replace the system disk?
  - How do I create a disk from a snapshot of a data disk to extend the data disk without risking data loss?
  - What can I do if the error message "Bad magic number in super-block while trying to open /dev/xvdb1" is returned when I extend a disk of a Linux instance?

• Partition FAQ
  - Can I partition a data disk for data storage?
  - For a disk with multiple partitions, are snapshots created for the entire disk or only for a specific partition?
  - What must I be aware of before I re-partition a disk?
  - What is the relationship between writing data and partitioning and formatting?

• FAQ about rolling back disks
  - I rolled back a data disk by using a snapshot after I re-partitioned the disk. How many partitions are available in the disk?
  - An error message similar to the following is returned when I attempt to roll back a disk: "A disk can be rolled back only when the associated instance has been stopped and the disk has no snapshots being created. If the operating system of an ECS instance has been replaced, the snapshot taken before the replacement cannot be used to roll back the new system disk." What can I do?

• Other FAQ
  - How do I migrate data from the system disk of a Linux instance?
  - How do I copy data across instances?
What is an enhanced SSD (ESSD)?

An ESSD is an ultra-high performance disk provided by Alibaba Cloud. ESSDs use 25 GE networks and the remote direct memory access (RDMA) technology to deliver up to 1 million random IOPS with low one-way latency. For more information, see Enhanced SSDs.

What specifications do ESSDs have?

ESSDs have three specifications based on their maximum performance. For the latest information about ESSD performance, see Enhanced SSDs.

The performance of a storage device is closely related to the capacity of the device. A storage device with larger capacity provides more powerful data processing capabilities. All ESSDs have the same I/O performance per unit capacity. However, the performance of ESSDs increases linearly with its capacity until the maximum performance per disk for that performance level is reached.

<table>
<thead>
<tr>
<th>Performance level</th>
<th>ESSD capacity (GiB)</th>
<th>Maximum IOPS</th>
<th>Maximum throughput (MB/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL1</td>
<td>20-32,768</td>
<td>50,000</td>
<td>350</td>
</tr>
<tr>
<td>PL2</td>
<td>461-32,768</td>
<td>100,000</td>
<td>750</td>
</tr>
<tr>
<td>PL3</td>
<td>1,261-32,768</td>
<td>1,000,000</td>
<td>4,000</td>
</tr>
</tbody>
</table>

What are the similarities and differences between ESSDs, standard SSDs, and ultra disks?

- Similarities: All three types of disks are based on a distributed Block Storage architecture, provide high reliability and scalability, and support snapshots and data encryption.

- Differences: ESSDs have the best performance among the three categories of disks. For more information, see Enhanced SSDs and Block Storage performance.

How is the performance level of an ESSD measured?

The performance level of an ESSD is proportional to its storage capacity. An ESSD that has a larger storage capacity delivers higher performance. Compared with standard SSDs, ESSDs have much better performance. For more information, see Enhanced SSDs.
How do I test the performance of an ESSD and obtain the 1 million IOPS result?

We recommend that you use fio (flexible IO tester) to perform a stress test on an ESSD. For more information, see Test the IOPS performance of an enhanced SSD.

What is the relationship between the storage performance of ESSDs and storage performance of the instance to which the ESSDs are attached?

Instance type specifications impact the performance of instance-level storage. The higher specifications an instance type has, the higher IOPS and throughput it delivers.

For example, when you create an instance of the g5se storage optimized instance family with enhanced performance and attach ESSDs to the instance:

- If the total storage performance of the attached ESSDs does not exceed the maximum storage performance that the instance type can deliver, the instance delivers the total storage performance of the ESSDs.
- If the total storage performance of the attached ESSDs exceeds the maximum storage performance that the instance type can deliver, the storage performance of the instance is limited to the maximum storage performance that the instance type can deliver.

For example, you create a 16 GiB instance of the ecs.g5se.xlarge instance type that can deliver up to 60,000 IOPS. If you attach an ESSD to the instance and the ESSD has a storage capacity of 2 TiB with a maximum IOPS of 101,800, the maximum IOPS of the instance is 60,000, instead of 101,800.

For information about the performance and specifications of the g5se instance family, see #unique_20.

How are ESSDs billed?

ESSDs support both subscription and pay-as-you-go billing methods. For more information, visit the Pricing page.

In which regions and zones are ESSDs available?

ESSDs are available in the following regions and zones:

- China (Hangzhou): Zone G, Zone H, and Zone I
- China (Shanghai): Zone E, Zone F, and Zone G
- China (Beijing): Zone F, Zone G, and Zone H
- China (Zhangjiakou-Beijing Winter Olympics): Zone A and Zone B
- China (Shenzhen): Zone D and Zone E
- China (Chengdu): Zone A
- China (Hong Kong): Zone C
- India (Mumbai): Zone B
- UK (London): Zone B
- Australia (Sydney): Zone B

Which instance families can be attached with ESSDs?

ESSDs can be attached only to instances from the instance families that support 25 GE networks (g6, g5, ic5, c6, c5, r6, r5, and g5se), ECS Bare Metal Instance families (ebmhnfg5, ebmc4, ebnmg5, ebmgn6v, ebnmg5i, ebmc5s, ebmg5s, ebmnr5s, and sccgn6), and enterprise-level heterogeneous computing instance families (vgn5i, gn6i, gn6v, gn5, gn5i, gn4, ga1, f1, and f3). For more information, see #unique_20.

What tools can I use to test the performance of Block Storage devices?

For details, see Block Storage performance.

Why did my instance shut down when I used fio to test the I/O performance of the instance?

You can use fio to test the I/O performance of an instance by testing raw disk partitions or file systems. However, performing this test on raw disk partitions may damage the metadata of the file systems in the raw disk partitions, which prevents you from accessing files in the partitions. This causes the instance to shut down. This problem does not occur when you use fio to test the I/O performance of the instance by testing file systems.

What must I consider when I select zones to create disk and then attach the disks to ECS instances?

A pay-as-you-go disk can be attached only to an ECS instance that is in the same zone as the disk.

- For high-availability applications, we recommend that you create data disks in different zones and attach them to ECS instances.
- For low-latency applications, we recommend that you create data disks in the same zone as the ECS instances and attach them to the instances.
What are the common operations that can be performed on a disk?

For information about the common operations that you can perform on a disk, see the "Related operations" section in Disk overview.

How do I query the usage and free space of Block Storage devices?

You can log on to an ECS instance to query the usage and free space of Block Storage devices in the instance. You cannot query the usage and free space of Block Storage devices by using the ECS console or by calling ECS API operations.

Can I shrink a disk or a Shared Block Storage device?

No, you cannot shrink disks or Shared Block Storage devices. If you want to shrink a disk that you purchased, we recommend that you create a disk of your desired size and attach it to the same instance as the original disk. Then copy the data stored in the original disk to the new disk and release the original disk.

How do I release a subscription disk that has not expired?

Alibaba Cloud subscription data disks cannot be released before they expire. To release a subscription data disk, you must convert it into a pay-as-you-go data disk first. Before you release the resulted pay-as-you-go data disk, ensure that you have backed up all important data stored in it. For more information, see Convert billing methods of cloud disks and Release a disk.

Note:
The disks that have been converted from subscription billing to pay-as-you-go billing is billed by hour. Charges for pay-as-you-go data disks stop one hour after the disks are released. After the disk billing method is changed from subscription to pay-as-you-go, the refund amount is displayed in the ECS console. The coupons that have been used are not refundable.

What is I/O optimization? Can I upgrade an existing ECS instance to an I/O optimized instance?

I/O optimization provides better network capabilities and storage performance for instances and disks. For example, you can optimize the storage performance of a standard SSD by attaching it to an I/O optimized instance.

You can call the #unique_132 and #unique_133 operations to upgrade your non-I/O optimized instances to I/O optimized instances.
What is the I/O performance of a standard SSD?

For details, see Block Storage performance.

What scenarios are ideal for standard SSDs?

Standard SSDs provide high performance and high reliability. They are ideal for I/O-intensive applications, such as MySQL, SQL Server, Oracle, PostgreSQL, and other small and medium-sized relational databases. They are also ideal for small and medium-sized development and testing environments which require high data reliability.

Can I replace a basic disk with a standard SSD?

No, standard SSDs cannot be used to replace basic disks because standard SSDs use SSDs as the physical storage media.

How do I purchase a standard SSD? What are the pricing options for I/O optimized instances and standard SSDs?

For the pricing details, visit the Pricing page.

Can I upgrade a standard SSD after I purchase it?

Yes, you can upgrade and scale up your standard SSDs. For more information, see Overview.

Why is an error reported when I attempt to mount the partitions of a standard SSD to an I/O optimized Linux instance?

In the Linux operating system, the mount points for standard SSDs are in format of /dev/vd*, and the mount points for basic disks are in format of /dev/xvd*. If you specify the mount point in format of /dev/xvd* in a command to mount a standard SSD partition, an error is reported. Specify a mount point in format of /dev/vd* in the command to mount a partition of the standard SSD.

What must I be aware of before I add mount information of basic disks or standard SSDs to Linux instances?

To mount a data disk to a Linux instance, you must format and partition the disk. When you perform this operation, note that /dev/xvdb1 is the mount point for a basic disk, and /dev/vdb1 is the mount point for an ultra disk, a standard SDD, or an ESSD. If the information specified in the mount -a command is incorrect, the disk fails to be mounted. To avoid this problem, perform the following steps:
1. Run the `fdisk -l` command to view information about the data disk.

2. Check whether the information of the data disk added to `/etc/fstab` is the same as that in step 1.

   **Note:**
   Do not add duplicate mount information because it will cause a system startup failure.

3. Run the `vim` command to modify the `/etc/fstab` file.

4. Comment out or delete incorrect information and add correct mount information.

5. Run the `mount -a` command to check whether the disk is mounted.

   For more information, see *Format a data disk for a Linux-based ECS instance*.

What is Shared Block Storage?

Shared Block Storage is a block-level data storage service that features high concurrency, high performance, and high reliability. It supports concurrent reads from and writes to multiple ECS instances. For more information, see *Shared Block Storage*.

Each Shared Block Storage device can be attached to a maximum of eight ECS instances in the same zone as the Shared Block Storage device. If you want to attach a Shared Block Storage device to more than eight ECS instances, submit a ticket to raise the quota.

When can I purchase a Shared Block Storage device?

Shared Block Storage is under invitational preview. During the invitational preview, Shared Block Storage is provided for free in all regions. After the invitational preview ends, Shared Block Storage supports both the subscription and pay-as-you-go billing methods.

What are the ideal scenarios for Shared Block Storage?

The high availability architecture of Shared Block Storage is suitable for enterprise-level applications. It provides shared access to block storage devices in a shared-everything architecture, such as the high availability server cluster architecture and Oracle Real Application Clusters (RAC). Oracle RAC is common among government departments, enterprises, and financial customers.
Can I attach a Shared Block Storage device to ECS instances in different regions?

No, you can attach a Shared Block Storage device to only ECS instances in the same zone as the Shared Block Storage device.

How many Shared Block Storage devices can be attached to one ECS instance?

When used as data disks, Shared Block Storage devices share the data disk quota with other disks. A maximum of 16 data disks can be attached to an instance.

What are the types and performance of Shared Block Storage?

Shared Block Storage is classified into Shared SSD Block Storage and Shared Ultra Block Storage. For more information about their specifications and performance, see Block Storage performance.

How do I test the performance of Shared Block Storage?

You can use fio to perform a performance stress test. When you perform the test, the total iodepth value of all clients cannot exceed 384. For example, if the test is conducted on four instances at the same time, we recommend that the iodepth value of each client does not exceed 96.
• When you perform a performance stress test on two ECS instances at the same time:

- Run the following command to test random write IOPS:

  FIO -direct=1 -iodepth=128 -rw=randwrite -ioengine=libaio -bs=4k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Rand_Write_Testing

- Run the following command to test random read IOPS:

  FIO -direct=1 -iodepth=128 -rw=randread -ioengine=libaio -bs=4k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Rand_Read_Testing

- Run the following command to test write throughput:

  FIO -direct=1 -iodepth=64 -rw=write -ioengine=libaio -bs=64k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Write_PPS_Testing

- Run the following command to test read throughput:

  FIO -direct=1 -iodepth=64 -rw=read -ioengine=libaio -bs=64k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Read_PPS_Testing

• When you perform a performance stress test on four ECS instances at the same time:
- Run the following command to test random write IOPS:

```bash
FIO -direct=1 -iodepth=96 -rw=randwrite -ioengine=libaio -bs=4k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Rand_Write_Testing
```

- Run the following command to test random read IOPS:

```bash
FIO -direct=1 -iodepth=96 -rw=randread -ioengine=libaio -bs=4k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Rand_Read_Testing
```

- Run the following command to test write throughput:

```bash
FIO -direct=1 -iodepth=64 -rw=write -ioengine=libaio -bs=64k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Write_PPS_Testing
```

- Run the following command to test read throughput:

```bash
FIO -direct=1 -iodepth=64 -rw=read -ioengine=libaio -bs=64k -size=1G -numjobs=1 -runtime=1000 -group_reporting -filename=iotest -name=Read_PPS_Testing
```

What is a device name (mount point)?

A device name (mount point) is the location of an ECS disk on the disk controller bus. The selected device name matches the disk device number in Linux and matches the disk sequence number in the disk manager in Windows.

What is an independent disk?

An independent disk is a pay-as-you-go data disk that you purchase separately. An independent disk can be attached to or detached from any ECS instance in the same zone as the disk. You must attach an independent disk to an instance and partition and format the disk before you can use it. For more information, see Create a pay-as-you-go disk.

Can I attach one disk to multiple ECS instances at the same time?

No, a data disk can be attached only to one ECS instance in the same zone as the disk.

Do I need to partition and format a pay-as-you-go disk after I purchase it and attach it to an ECS instance?

Yes. After you purchase a pay-as-you-go data disk separately, you must attach it to an ECS instance and then partition and format the disk. For more information, see
Format a data disk for a Linux-based ECS instance and Format a data disk for a Windows-based ECS instance.

Why am I unable to find the data disk that I purchased for a Linux instance?

If you purchase a pay-as-you-go data disk separately, you must attach it to the instance and partition it. Before you can view and use its storage space, you must format the disk. For more information, see Format a data disk for a Linux-based ECS instance and Attach a cloud disk.

How many disks can be attached to one ECS instance?

When used as data disks, disks share the data disk quota with Shared Block Storage devices. A maximum of 16 data disks can be attached to one ECS instance.

Why am I unable to find the desired ECS instance when I attempt to attach a disk to it?

Check whether the ECS instance has been released. If no, ensure that it is in the same zone as the disk.

Can I attach a disk to an ECS instance that is in a different zone?

No, a pay-as-you-go disk can be attached only to an ECS instance in the same zone as the disk.

Will data in a data disk be lost when I detach the disk?

- In Windows, we recommend that you stop all read and write operations on all file systems of the disk to ensure data integrity. Otherwise, the data that is being read or written will be lost.
- In Linux, you must log on to the ECS instance and run the umount command on the disk. After the command is executed, log on to the ECS console to detach the disk.

Can I detach a system disk?

No, system disks cannot be detached but can be replaced. For more information, see Replace the system disk (non-public image).

How is a separately purchased pay-as-you-go data disk billed?

A pay-as-you-go data disk is billed by the hour. Note that if your account balance is insufficient, the services of the data disk will be suspended.
I attached a disk that I created separately to an ECS instance. Why is the disk released when the instance is released?

This is because you have configured the disk to be released along with the instance. You can change this configuration in the ECS console or by calling an API operation. For more information, see Release a disk.

Can I attach a separately purchased pay-as-you-go data disk to a subscription instance?

Yes, you can attach a separately purchased pay-as-you-go data disk to a subscription instance.

Can I detach a data disk from a subscription instance?

No, you cannot detach data disks from subscription instances. Data disks expire at the same time as the subscription instances to which they are attached, and are released together with the instances. To release a subscription data disk, convert it into a pay-as-you-go data disk first. Then detach and release the data disk. For information about how to change the billing method of disks, see Convert billing methods of cloud disks.

I changed the configurations of a disk when I renewed it. Can I convert the billing method of the disk from subscription to pay-as-you-go within the remaining time of the current subscription?

No, you can convert the billing method of the disk from subscription to pay-as-you-go only by changing the configurations of the instance after the current subscription period ends.

When I delete a disk, will its snapshots also be deleted?

If you have enabled the Delete Automatic Snapshots While Releasing Disk feature for the disk, the automatic snapshots of the disk are also deleted when you delete the disk. However, the manual snapshots are retained. You can change this setting at any time. For more information, see #unique_120.

Why are some automatic snapshots on my disk missing?

When the number of snapshots reaches the upper limit, the earliest automatic snapshots are automatically deleted but manual snapshots are not affected.

Note:
The automatic snapshot policy that is applied to a disk can be executed only after the disk is attached to an instance.
Can I use a snapshot to create an independent disk?

Yes, you can use an existing snapshot to create an independent pay-as-you-go disk. For more information, see Create a disk from a snapshot.

I cannot access the data in a Linux data disk because an error occurred when I attached the disk. What can I do?

Perform the following steps to fix the error:

1. Find the data disk and use one of the following methods to check whether it is attached to the corresponding ECS instance:
   - Perform the check in the ECS console. For more information, see Monitor a cloud disk.
   - Log on to the instance, and run the `fdisk -l` command to check whether the data disk partition information is correct. Run the `df -h` and `mount | grep "< devpath>"` commands to view the mount information.

2. Run the `cat` command to view the `/etc/fstab` file and check whether you have mounted two disks to the same directory.
   - If two disks are mounted to the same directory, the second disk will replace the first disk, causing data of the first disk to become inaccessible. Mount the second disk to a different directory.
   - If they are mounted to different directories but the mount information shows that they are in the same directory, run the `ll` command to check whether a connection exists between the two directories. If a connection exists between the two directories, run the `mkdir` command to create a new directory, and mount one of the disks to the new directory. Then check whether the data can be accessed.

What can I do if data is lost after I restart an ECS Linux instance?

- **Problem description:** All data in a directory such as `/alidata` is lost after you restart an ECS Linux instance.
- **Cause:** After you run the `df -h` command, the command output shows that none of the data disk partitions is mounted to the directory.
• Solution: This solution uses an I/O-optimized instance as an example. If your ECS instance is a non-I/O optimized instance, enter the device names of the disk partitions in format of /dev/xvd*1 in the mount command.

1. Run the `fdisk -l` command to view the data disk partitions that are not mounted.
2. Run the `mount /dev/vdb1 /alidata` command to mount the data disk partitions to the preceding directory.
3. Run the `df -h` command to check whether the data disk partitions are mounted to the directory.
4. (Optional) Configure the `/etc/fstab` file for the system to automatically mount the disk partitions during next system startup to avoid this problem.

Are my snapshots retained if I reinitialize a disk?

Yes, both manual and automatic snapshots in the disk are retained.

Data disks of a Linux instance cannot be found after I restarted the instance or reinitialized the system disk. What can I do?

• Problem description: After restarting a Linux instance or reinitializing the system disk, you log on to the instance and run the `df -h` command. The command output shows that no data disks are found.

• Cause:
  - Restarting an instance: Mount information was not written to the `/etc/fstab` file before you restart the instance. As a result, data disks are not automatically mounted after the instance restarts.
  - Reinitializing the system disk: The `/etc/fstab` file is reset after the system disk is reinitialized. As a result, data disks are not automatically mounted during system startup.
Solution:

1. Run the `mount /dev/xvdb1` command to re-mount the data disk partitions.
2. Run the `mount` command to check the file system of the `/dev/xvdb1` partition.
3. Assume that the file system of the `/dev/xvdb1` partition is ext3. Run the following command to write the partition mount information to the `/etc/fstab` file:
   ```bash
   echo '/dev/xvdb1 /data ext3 defaults 0 0' >> /etc/fstab
   ```
4. Restart the instance in the ECS console.

How do I re-mount data disks after I reinitialize the system disk of a Linux instance?

After you reinitialize the system disk of a Linux instance, data in the data disks that are attached to the instance remains unchanged, but the mount information of the data disks is lost. As a result, all the data disks become unmounted. Assume that before the system disk is reinitialized, a data disk partition attached to the instance is named `/dev/vdb1`, and its mount point is named `/InitTest`. Run the following commands to re-mount the data disk partition after you restart the Linux instance:

1. Run the `mount` command to view the mount information of the data disk.
   
   The command output does not contain information of `/dev/vdb1`.

2. Run the `fdisk -l` command to view information about data disk partitions.

3. Run the `cat /etc/fstab` command to view the original mount point name of the `/dev/vdb1` data disk partition.

4. Run the `mkdir /InitTest` command to re-create the mount point for the data disk partition.

   For the `/dev/vdb1` data disk partition, the new mount point name must be the same as the original one.

5. Run the `mount /dev/vdb1 /InitTest` command to re-mount the data disk partition.

6. Run the `df -h` command to check whether the data disk partition is mounted.
7. Perform the following steps to check whether the /dev/vdb1 data disk partition can be mounted automatically:

   a. Run the `umount /dev/vdb1` command to unmount the /dev/vdb1 data disk partition.
   b. Run the `mount` command to check whether the partition is unmounted.
      
      If the command output does not contain information of /dev/vdb1, the partition is unmounted.
   c. Run the `mount -a` command to automatically mount /dev/vdb1.
   d. Run the `mount` command to check whether the partition is mounted.
      
      If the command output shows information of /dev/vdb1, the partition is mounted.

Are my snapshots retained if I replace a system disk?

This depends on how the snapshots are created. Manual snapshots are retained, but automatic snapshots are deleted if the Delete Automatic Snapshots While Releasing Disk feature is enabled.

Note:

After a system disk is replaced, the disk ID changes. You cannot use the snapshots of the original system disk to roll back the new system disk.

What must I be aware of before I replace a system disk?

We recommend that you create snapshots of the current system disk before you replace it. Make sure that the new system disk has enough space available. The recommended available disk space is 1 GiB or larger. If disk space is insufficient, the instance may not start properly after you replace the system disk.

How do I extend a system disk?

You can extend a system disk in the ECS console or by calling the operation.

Can I shrink a system disk after I extend it?

No, you cannot shrink a system disk after you extend it. We recommend that you extend the system disk reasonably based on your needs.
What Block Storage devices can be extended when they are used as system disks? Do any regional limits apply to this operation?

Ultra disks, standard SSDs, and ESSDs can be extended when they are used as system disks. You can extend system disks in all regions.

Can the system disks of both subscription ECS instances and pay-as-you-go ECS instances be extended?

Yes, the system disks of both subscription ECS instances and pay-as-you-go ECS instances can be extended.

What is the storage capacity range of a system disk?

The capacity range of a system disk varies with the operating system. For more information, see Overview.

I changed the configurations of an instance when I renewed it. Can I specify a new size for the system disk when I replace the system disk?

After you downgrade the configurations of a subscription instance when renewing it, you can extend its system disk only when the new subscription starts.

How do I create a disk from a snapshot of a data disk to extend the data disk without risking data loss?

If a data disk cannot be extended without data loss due to a disk error, you can purchase a pay-as-you-go disk to temporarily store data from the original data disk, and then format the original data disk. To do so, perform the following steps:

1. Create a snapshot of the current data disk (original data disk). For more information, see #unique_21.

2. Go to the disk purchase page. Select the region and zone of the ECS instance to purchase a pay-as-you-go disk. Click Create from Snapshot. In the dialog box that appears, select the snapshot created in the previous step.

3. Log on to the ECS console and then attach the new data disk you purchased in the previous step to the ECS instance.

4. Log on to the ECS instance and run the mount command to mount the new data disk. For more information about how to mount a disk created from a snapshot, see Create a disk from a snapshot.

5. Check whether files in the new data disk are the same as those in the original data disk.
6. Run the `fdisk` command to delete the original partition table. Then run commands such as `fdisk` and `mkfs.ext3` to re-partition and re-format the new data disk, extending it to the target capacity. For more information, see Resize partitions and file systems of Linux data disks.

7. Run the `cp -R` command to copy all the data in the new data disk back to the original data disk.
   
   You can add the `--preserve=all` setting to retain the file properties when copying the files.

8. Run the `umount` command to unmount the new data disk.

9. In the ECS console, detach the new data disk from the ECS instance, and release the disk.

What can I do if the error message "Bad magic number in super-block while trying to open /dev/xvdb1" is returned when I extend a disk of a Linux instance?

   • **Problem description:** When you run the `e2fsck -f /dev/xvdb` command to extend a disk of an ECS Linux instance, the error message "Bad magic number in super-block while trying to open /dev/xvdb1" is returned.

   • **Cause:** The disk to be extended is not partitioned.

   • **Solution:** Run the `e2fsck -f /dev/xvdb` and `resize2fs /dev/xvdb` commands to extend the disk. Then run the `mount` command to mount the disk.

Can I partition a data disk for data storage?

   Yes, you can split a data disk into multiple partitions as needed. We recommend that you use the system tool for partitioning.

For a disk with multiple partitions, are snapshots created for the entire disk or only for a specific partition?

   Snapshots are created for the entire disk, instead of for a specific partition.

What must I be aware of before I re-partition a disk?

   To ensure data security, we recommend that you create a snapshot of a disk before re-partitioning the disk. This way, you can roll back the disk if you perform a misoperation. For more information, see Create a snapshot and #unique_134.
What is the relationship between writing data and partitioning and formatting?

A new disk or disk partition can be used only after it is initialized and has its data structure recorded on the disk. The goal of formatting is to create file systems. Therefore, when a file system is created on a disk, data of the file system is written to the disk. The amount of data written to disks during formatting varies based on the file system.

- In a Windows instance, you can use one of the following methods to format a data disk:
  - Quick format: This method allows you to allocate only file systems to partitions and rewrite the directory table. Quick format takes up less space.
  - Full format: This method allows you to allocate file systems to partitions, rewrite the directory table, and scan for and mark damaged sectors. In addition, during the formatting process, empty data blocks on the disk are filled in, which is equivalent to writing the entire disk. In this case, the size of the first full snapshot is approximately equal to the disk size.

- In a Linux instance, if no data is written to a disk after you format the disk, the size of the first snapshot depends on the format of file systems on the disk.

I rolled back a data disk by using a snapshot after I re-partitioned the disk. How many partitions are available in the disk?

When you roll back a data disk by using a snapshot, the disk returns to the status it was in when the snapshot was taken. If the disk has not been re-partitioned when the snapshot was taken, only one partition is available in the disk.

An error message similar to the following is returned when I attempt to roll back a disk: "A disk can be rolled back only when the associated instance has been stopped and the disk has no snapshots being created. If the operating system of an ECS instance has been replaced, the snapshot taken before the replacement cannot be used to roll back the new system disk." What can I do?

- Problem description: When you attempt to roll back a disk by using a snapshot, an error message similar to the following is returned: "A disk can be rolled back only when the associated instance has been stopped and the disk has no snapshots being created. If the operating system of an ECS instance has been replaced, the snapshot taken before the replacement cannot be used to roll back the new system disk."

- Cause: The problem may be caused by an incorrect disk property or disk state.
• Solution: You can troubleshoot the problem based on the instance status or snapshot status.

- Check whether the instance to which the disk is attached has been stopped.

  You can roll back disks only when the instances to which the disks are attached are in the Stopped state. You can log on to the ECS console and check the status of the instance on the Instances page.

- Check whether the system disk of the instance associated with the snapshot has been replaced.

  If you selected a new image to replace the system disk, a new system disk is automatically re-created from the new image and the system disk ID changes. Therefore, you cannot use the snapshots taken for the original system disk to roll back the new system disk. However, you can create a custom image from one of these snapshots and then use the custom image to replace the system disk of the instance. In this way, the instance returns to the status it was in when the snapshot was taken. For more information, see Replace the system disk (non-public image).

- Check whether the disk to be rolled back has a snapshot being created.

  To ensure data consistency, Alibaba Cloud does not allow users to roll back a disk when a snapshot is being created from the disk. You can go to the Instance Details page. Click Instance Snapshots in the left-side navigation pane. Check the status of snapshots. A snapshot is being created if the Progress value is not 100% and the Status value is Progressing.

  If you need to forcibly terminate the creation process of a snapshot to roll back the disk, select the snapshot and click Delete.

How do I migrate data from the system disk of a Linux instance?

Assume that you purchase an ECS Linux instance without attaching any data disks to it. After the instance is used for a period of time, its system disk usage approaches 100% and can no longer meet your business needs. To solve this problem, you can purchase a data disk and attach it to the instance. Then, run the `mv` command to migrate data from the system disk to the data disk.

How do I copy data across instances?

You can choose data copy methods based on the operating system:
- **Copy data between Linux instances**
  - **Use the lrzsz tool**
    
    Log on to the Linux instances, install the lrzsz tool, run the `rz` command to upload files to one Linux instance, and run the `sz` command to download the files to the other Linux instance.
    
    You can also first run the `sz` command to download files to your local PC and then run the `rz` command to upload these files to the other Linux instance.
  - **Use the FTP tool**
    
    If you use the SFTP tool, we recommend that you use the root account to log on to instances and to upload or download files.
  - **Use the wget command**
    
    On one instance, compress a file or a folder and then save it to the web directory to generate a download URL. Then run the `wget` command on the other Linux instance to download the file or folder.

- **Copy data between a Linux instance and a Windows instance**
  
  We recommend that you use the SFTP tool to download files from the Linux instance to your local PC and then use the FTP tool to upload the files to the Windows instance.

- **Copy data between Windows instances**
  - **Use the FTP tool**
  - **Use TradeManager**