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1 Overview

With the digitalization in various industries, data has become the operation core of enterprises and institutions, and users' requirements on the stability of storage systems become higher and higher. Although many vendors can produce storage devices with high stability, they cannot evade irrecoverable damage to production systems caused by natural disasters. To ensure the consistency, recoverability, and high reliability of data, remote disaster recovery solutions have emerged. Remote replication is one of the key technologies used in remote disaster recovery solutions.

The remote replication function provided by OceanStor enterprise unified storage systems is called HyperReplication. HyperReplication can implement data migration, remote disaster recovery, and data restoration after a disaster. HyperReplication requires at least two OceanStor enterprise unified storage systems, which serve as the primary and secondary storage systems. The two storage systems can be deployed in the same equipment room, same city, or two cities thousands of kilometers apart.

HyperReplication supports two replication modes:

1. Synchronous remote replication: In this mode, data is synchronized in real time to achieve full protection for data consistency and to minimize data loss in the event of a disaster.
2. Asynchronous remote replication: Data is synchronized periodically to minimize the adverse impact on service performance caused by the long latency of long-distance data transfer.

Other vendors in the industry use logs, periodic data set replication, or periodic snapshot replication to achieve asynchronous remote replication. Logs have a slight impact on primary LUN I/Os but occupy the most replication bandwidth and logs because data with repeated addresses is not merged. Periodic snapshot replication, on the contrary, has a serious impact on primary LUN I/Os but occupies the least replication bandwidth and logs. Periodic data set replication is a balance between the previous two modes.
Based on the multi-time-point cache technology, HyperReplication employs periodic snapshot replication to shorten the synchronization period and reduce the impact of I/O suspension and copy-on-write (COW) on primary LUN performance, optimizing the performance of asynchronous remote replication.

### Table 1-1 Terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery point objective (RPO)</td>
<td>RPO refers to the maximum tolerable amount of data lost during backup and disaster recovery. It is expressed in a period of time. A shorter RPO means less data lost.</td>
</tr>
<tr>
<td>Consistency group (CG)</td>
<td>A CG is a group of LUNs. It is used to ensure the consistency of related written data.</td>
</tr>
</tbody>
</table>
2 Working Principle

2.1 Design Principle

The following are principles for designing a remote replication solution using HyperReplication:

1. Synchronization between the primary and secondary LUNs is as frequent as possible to reduce the amount of lost data upon a disaster.
2. The latency in responding to front-end applications' write requests is as short as possible so that the system throughput and performance are improved.
3. Data at the primary and secondary sites is available when an exception or a disaster happens.

Due to the inevitable latency on communication links, the synchronization frequency and write latency (previous two principles) cannot reach their optimal values at the same time. In the case that the synchronization frequency reaches its optimal value, the primary site sends data to the secondary site immediately after it receives a local write I/O. After the I/O is written to both the primary and secondary LUNs, the primary site sends a write success acknowledgement to the host. This is called synchronous remote replication.

In the case that the write latency reaches its optimal value, the primary site records the difference between the primary and secondary LUNs caused by received write I/Os, and returns a write success acknowledgement to the host right after the data is written to the primary LUN. When the different data between the two LUNs reaches a certain amount or after a fixed period of time, the primary site writes all the different data to the secondary LUN. This is called asynchronous remote replication. Both synchronous and asynchronous remote replication must meet the third requirement: data availability at any time.

2.2 Working Principle of HyperReplication/S

Based on a log principle, HyperReplication/S of OceanStor enterprise unified storage systems maintains data consistency between a primary LUN and its secondary LUN. The working principle of HyperReplication/S is as follows:

1. After a synchronous remote replication relationship is set up between a primary LUN at the primary site and a secondary LUN at the secondary site, an initial synchronization is implemented to replicate all the data from the primary LUN to the secondary LUN by default.
2. If the primary LUN receives a write request from a production host during initial synchronization, the new data is written to the primary and secondary LUNs. If the original data block to be replaced is being copied, the new data is written to the primary and secondary LUNs after the data copy is complete.

3. After initial synchronization, data on the primary LUN is the same as that on the secondary LUN. The following shows how I/Os are processed in synchronous remote replication.

- The primary LUN receives a write request from the production host and sets the differential log value to "differential" for the data block corresponding to the I/O.
- The primary site writes the data of the request to the cache and sends the write request to the secondary site through the configured replication link. Meanwhile, data in the cache is flushed onto disks.
- The secondary site receives the write I/O from the primary site, writes the data to the cache, and returns the data write result. Meanwhile, data in the cache is flushed onto disks. If data is successfully written to the cache at the primary and secondary sites, the corresponding differential log value is changed to "non-differential". Otherwise, the value remains "differential", and the data block will be copied again in the next synchronization.
- The primary site sends a write success response to the host.

2.3 Functions of HyperReplication/S

Zero Data Loss

HyperReplication/S of OceanStor enterprise unified storage systems updates data on the primary and secondary LUN at the same time, ensuring zero RPO. A disaster recovery system constructed based on HyperReplication/S implements data-level disaster recovery with a high disaster recovery level (level 6 — zero data loss and remote cluster support).

Split Mode

HyperReplication/S supports the split mode. In this mode, write requests of production hosts go only to the primary LUN, and the difference between the primary and secondary LUNs is recorded by the differential log. If users want to achieve data consistency between the primary
and secondary LUNs again, they can start a manual synchronization process, during which data blocks marked as differential in the log are copied from the primary LUN to the secondary LUN. The I/O processing process is similar to the initial synchronization process. This mode meets some user requirements such as temporary link maintenance, network bandwidth expansion, and saving data at a certain point in time on the secondary LUN.

Quick Response and Disaster Recovery

HyperReplication/S immediately enters the **Interrupted** state when a system fault such as a link down failure or an I/O error due to faults of the primary or secondary LUN. In the **Interrupted** state, I/Os are processed in a way similar to the scenario where a remote replication pair is split. That is, data is written only to the primary LUN and the data difference is recorded.

If the primary LUN fails, it cannot receive I/O requests from the production host. After the fault is resolved, the synchronous remote replication pair is recovered based on the specified recovery policy. If the policy is automatic recovery, the pair automatically enters the synchronizing state, and incremental data is synchronized to the secondary LUN. If the policy is manual recovery, the pair enters the to be recovered state. A user needs to manually initiate a synchronization process. Incremental synchronization greatly reduces the fault or disaster recovery time of HyperReplication/S.

Writable Secondary LUN

The writable secondary LUN function enables the secondary LUN to receive data from hosts. HyperReplication/S supports this function. That is, production hosts can directly access data on the secondary LUN. This function is used in the following scenarios:

1. Users want to use data on the secondary LUN for data analysis and mining without affecting services supported by the primary LUN.
2. The production storage system at the primary site is faulty and the disaster recovery storage system at the secondary site needs to take over services from the production storage system. However, a primary/secondary switchover fails or the secondary site cannot communicate with the production storage system correctly.

Usually, the secondary LUN of a remote replication pair is read-only. If the primary LUN is faulty, the administrator can cancel secondary LUN write protection to set the secondary LUN writable. Then the disaster recovery storage system can take over host services to ensure business continuity.

The secondary LUN of a synchronous remote replication pair can be set to writable only when the following two conditions are met:
1. The remote replication pair is in the split or abnormally interrupted state.
2. Data on the secondary LUN is complete (when data on the secondary LUN is incomplete, the data is unavailable, and the secondary LUN cannot be set to writable).

OceanStor enterprise unified storage systems can record difference between the primary and secondary LUNs after host data is written to the secondary LUN. After the production storage system at the primary site recovers, users can perform incremental synchronization to quickly switch services back.

**Primary/Secondary Switchover**

A primary/secondary switchover is the process where the primary and secondary LUNs in a remote replication pair exchange roles. HyperReplication/S allows users to perform primary/secondary switcheovers.

Primary/Secondary switchovers are affected by the secondary LUN data state, which indicates the availability of data on the secondary LUN. There are two secondary LUN data states:

3. **Consistent**: Data on the secondary LUN is a duplicate of the data on the primary LUN (at the time the previous synchronization ended). In this state, data on the secondary LUN is available but not necessarily the same as the current data on the primary LUN.
4. **Inconsistent**: Data on the secondary LUN is not a duplicate of the data on the primary LUN (at the time the previous synchronization ended). In this state, data on the secondary LUN is available.

As shown in the previous figure, the primary LUN at the primary site becomes the new secondary LUN after the switchover, and the secondary LUN at the secondary site becomes the new primary LUN. After users perform some simple operations on the host side (the major operation is to map the new primary LUN to the secondary production hosts, which can be performed in advance), the secondary production hosts at the secondary site take over services and issue new read and write requests to the new primary LUN. A primary/secondary switchover can be performed only when data on the secondary LUN is in the **Consistent** state. Synchronization after a primary/secondary switchover is incremental synchronization.
The following must be noted before a primary/secondary switchover is performed for a synchronous remote replication pair:

5. When the pair is in a normal state, a primary/secondary switchover can be performed.
6. In the split state, a primary/secondary switchover can be performed only when the secondary LUN is set to writable.

**Consistency Group Functions**

In medium- and large-sized database applications, data, logs, and modification information are stored on different LUNs. If data on one of the LUNs is unavailable, data on the other LUNs is also invalid. How to keep consistency between multiple remote replication pairs must be considered if remote disaster recovery must be implemented for these LUNs simultaneously. HyperReplication/S provides the consistency group function to maintain the same synchronization pace among multiple remote replication pairs.

A consistency group is a set of multiple remote replication sessions, ensuring data consistency in the scenario where a host writes data to multiple LUNs on a single storage system. After data is written to a consistency group at the primary site, all data in the consistency group is simultaneously copied to the secondary LUN using the synchronization function of the consistency group, ensuring integrity and availability of the data used for backup and disaster recovery.

HyperReplication/S allows users to add multiple remote replication pairs to a consistency group. When users perform splitting, synchronization, or a primary/secondary switchover or set secondary LUNs to writable for a consistency group, the operation applies to all members in the consistency group. When a link fault occurs, all members of the consistency group enter the abnormally interrupted state together. After the fault is rectified, data synchronization is performed again to ensure availability of the data on the secondary storage system.

Primary LUNs in a consistency group can belong to different working controllers. The same applies to secondary LUNs. This allows users to configure LUNs flexibly.

### 2.4 Disaster Recovery Process of HyperReplication/S

1. In normal cases, the primary site provides services, and data on the primary LUN at the primary site is synchronously copied to the secondary LUN at the secondary site.
2. When a disaster occurs at the primary site, the remote replication link is down (the pair between the primary and secondary LUNs is interrupted). At this time, set the secondary LUN at the secondary site to writable so that the secondary host can read data from the secondary LUN.
3. The secondary site takes over services from the primary site to ensure service continuity (together with the failover software on the host side, HyperReplication/S can achieve failover upon a disaster, improving the disaster recovery level).
4. After the takeover, a primary/secondary switchover is performed and the secondary LUN is set to read-only. Then a synchronization process is performed to copy data on the new primary LUN at the secondary site to the new secondary LUN at the primary site.
5. Stop services at the secondary site, perform a primary/secondary switchover, and restore the pre-disaster pair.
6. Set the secondary LUN to read-only. The primary site resumes services. The disaster recovery process is complete.
2.5 Working Principle of HyperReplication/A

HyperReplication/A of OceanStor enterprise unified storage systems adopts the multi-time-segment caching technology (patent number: PCT/CN2013/080203). The working principle of the technology is as follows:

1. After an asynchronous remote replication relationship is set up between a primary LUN at the primary site and a secondary LUN at the secondary site, an initial synchronization is implemented to fully copy data from the primary LUN to the secondary LUN.

2. When the initial synchronization is complete, the secondary LUN data status becomes Consistent (data on the secondary LUN is a copy of data on the primary LUN at a certain past point in time). Then the I/O process shown in the following figure starts.

- Incremental data is automatically synchronized from the primary site to the secondary site based on the user-defined synchronization period that ranges from 3 seconds to 1440 minutes. If the synchronization type is Manual, a user needs to manually trigger the synchronization. When a replication period starts, new time segments (TP_{N+1} and TP_{X+1}) are respectively generated in the caches of the primary LUN (LUN A) and the secondary LUN (LUN B).
  - The primary site receives a write request from a production host.
  - The primary site writes data of the write request to cache time segment TP_{N+1} and sends a write success response to the host immediately.
  - During data synchronization, the storage system reads data in cache time segment TP_X of the primary LUN in the previous synchronization period, transmits the data to the secondary LUN, and then writes the data to cache time segment TP_{X+1} of the secondary LUN. The process is repeated until the synchronization period ends.
the secondary site, and writes the data to cache time segment $TP_{X+1}$ of the secondary LUN. When the write cache of the primary site reaches the high watermark, data in the cache is automatically flushed to disks. In this case, a snapshot is generated for data of time segment $TP_N$. During synchronization, such data is read from the snapshot and copied to the secondary LUN.

- When the synchronization is complete, the storage system flushes data of time segments $TP_N$ and $TP_{X+1}$ in the caches of the primary and secondary LUNs onto disks (the corresponding snapshots are deleted automatically), and waits for the next synchronization period.

**NOTE**
- Time segment: logical space in a cache that manages new data received during a specific period of time (data size is not restricted).
- In scenarios of a low RPO and short replication period, the caches of the primary and secondary LUNs can store all data in multiple time segments. However, if the host bandwidth or disaster recovery bandwidth is abnormal and the replication period is prolonged or interrupted, data in the caches is flushed onto disks in the primary and secondary storage systems for consistency protection. Upon replication, the data is read from the disks.

---

**2.6 Functions of HyperReplication/A**

**Second-Level RPO**

As HyperReplication/A employs the innovative multi-time-segment caching technology, data in caches and I/Os interacts with the caches that carry time information. During replication and synchronization, the storage system directly reads data of corresponding time segments from the primary LUN cache and copies the data to the secondary LUN. This lowers the latency and eliminates the impact of traditional asynchronous remote replication snapshots on system performance. Therefore, the synchronization period can be shortened to seconds.

HyperReplication/A does not copy data updates from the primary LUN to the secondary LUN in real time. Therefore, the RPO is determined by the user-defined synchronization period (from 3 seconds to 1440 minutes).

**Quick Response to Host Write Requests**

HyperReplication/A rapidly responds to write requests of application hosts. The primary site returns a write success response to the host immediately after data of a host write request to the primary LUN is written to the cache but not after the data is written to the secondary LUN. Moreover, data synchronization between the primary and secondary LUNs is performed in the background. Therefore, the synchronization has a very slight impact on host performance.

**2.6.1 Split Mode and Quick Disaster Recovery**

Similar to HyperReplication/S, HyperReplication/A also allows users to split and resume replication pairs.

A split asynchronous remote replication session will not be periodically synchronized. Users can manually start synchronization. Then the session is synchronized based on preset synchronization policies (manual or automatic).

HyperReplication/A provides three data synchronization types:
• Manual: Users need to manually synchronize data from a primary LUN to a secondary LUN. If this mode is adopted, users can update data to the primary LUN as desired. That is, users can determine that the data of the secondary LUN is the copy of the primary LUN at a desired point in time.

• Timed wait when synchronization begins: When a data synchronization process starts, the system starts timing. After one synchronization period, the system starts synchronization and timing again. After a specified period of time since the start of the latest synchronization process, the system automatically copies data from the primary LUN to the secondary LUN.

• Timed wait when synchronization ends: The system starts timing for the next synchronization session after the last synchronization session ends. In this mode, when a data synchronization session ends, the system waits for the duration preset by users. When the duration elapses, the system automatically synchronizes data from the primary LUN to the secondary LUN again.

You can choose a synchronization type that best fits your needs.

Full Protection for Data on the Secondary LUN

HyperReplication/A provides full protection for data on the secondary LUN. At the secondary site, hosts’ permission to read and write the secondary LUN is under control. When a synchronization process is interrupted or data on the secondary LUN becomes unavailable, data of the previous period TP_X can be recovered to the secondary LUN to overwrite data of the current period TP_{X+1}. Then the secondary LUN stores available data of the point in time before the latest synchronization process.

Writable Secondary LUN

Similar to HyperReplication/S, HyperReplication/A also supports the writable secondary LUN function.

By default, the secondary LUN of an asynchronous remote replication pair is read-only. The secondary LUN of an asynchronous remote replication pair can be set to writable only when the following two conditions are met:

1. The remote replication pair is in the split or abnormally interrupted state.
2. Data on the secondary LUN is complete (when data on the secondary LUN is incomplete, the data is unavailable, and the secondary LUN cannot be set to writable).

When the secondary LUN of an asynchronous remote replication pair is set to writable and has protection time point TP_x, a rollback will be triggered to roll the data on the secondary LUN back to the latest available data at time point TP_x.

OceanStor enterprise unified storage systems can record difference between the primary and secondary LUNs after host data is written to the secondary LUN. After the production storage system at the primary site recovers, users can perform incremental synchronization to quickly switch services back.

Primary/Secondary Switchover

Similar to HyperReplication/S, HyperReplication/A also supports primary/secondary switchovers. For the working principle of a primary/secondary switchover, see section 2.3.

A primary/secondary switchover is performed for an asynchronous remote replication pair when the following conditions are met:
3. Asynchronous remote replication is in the split state.
4. In split mode, the secondary LUN is set to writable.
5. The secondary LUN of the pair is not in the rollback state.

2.6.1.2 Consistency Group

Similar to HyperReplication/S, HyperReplication/A supports consistency group functions. Users can create or delete a consistency group or members of the group.

2.7 Disaster Recovery Process of HyperReplication/A

1. In normal cases, the primary site provides services, and data on the primary LUN at the primary site is synchronously copied to the secondary LUN at the secondary site.
2. When a disaster occurs at the primary site, the remote replication link is down (the pair between the primary and secondary LUNs is interrupted). At this time, set the secondary LUN at the secondary site to writable so that the secondary host can read data from the secondary LUN.
3. The secondary site takes over services from the primary site to ensure service continuity (together with the failover software on the host side, HyperReplication/A can also achieve failover upon a disaster).
4. After the takeover, perform a primary/secondary switchover and set the secondary LUN to read-only. When host services are not busy, perform synchronization multiple times to copy data from the new primary LUN at the secondary site to the new secondary LUN at the primary site to minimize the data difference between the two LUNs.
5. Stop services at the secondary site.
6. Perform synchronization again so that data on the new primary LUN is consistent with that on the new secondary LUN. (This synchronization aims at eliminating data difference caused by the previous writes of hosts.)
7. Split the pair and set the secondary LUN to writable. Then perform a primary/secondary switchover to restore the pre-disaster pair.
8. Set the secondary LUN to read-only. The primary site resumes services. The disaster recovery process is complete.

### NOTE

In an asynchronous remote replication scenario, the storage system performs data synchronization multiple times until the data difference between the primary and secondary LUN is comparatively small. Then, the storage system stops services and performs the last synchronization. This prevents data loss and minimizes the downtime.
3 Technical Features

3.1 Multi-Time-Point Cache Technology

OceanStor enterprise unified storage systems are based on the multi-time-point cache technology. When snapshots exist on LUNs and an I/O is written to the cache, a write success acknowledgement is immediately returned to the host. Users do not need to implement COW in real time to update the data nor flush data from the cache to disks when a snapshot is activated. Second-level intensive snapshots are supported.

HyperReplication/A is based on the multi-time-point cache technology. COW must be implemented for the primary site so that a write success acknowledgement is immediately returned after an I/O is written to the cache. In this way, the impact of COW on host performance is reduced, and the impact of data synchronization on host performance is significantly migrated. In data copying, the primary site directly reads data from the cache, shortening the copy latency and ensuring second-level RPO in remote replication.
3.2 Block I/Os

In specific scenarios, remote replication consistency groups must suspend host I/Os to ensure data consistency among members in the consistency groups.

OceanStor enterprise unified storage systems are based on block I/Os. I/Os can be suspended even when some I/Os are not returned. It takes microseconds to suspend host I/Os when multiple controllers are deployed, whereas seconds are required in the industry on average. Block I/Os reduce the impact of remote replication on host I/O performance and improve the efficiency of process control.

3.3 Flexible Networking

HyperReplication supports flexible networks. Users can set up a desired network based on site requirements.

Each Controller Allocated One Replication Link

The following uses OceanStor 18000 series storage systems with multiple controllers as an example to illustrate that HyperReplication supports each controller allocated one replication link on the primary and secondary storage systems.

Each Engine Allocated One Replication Link

The following uses OceanStor 18000 series storage systems with multiple controllers as an example to illustrate that HyperReplication supports each engine allocated one replication link on the primary and secondary storage systems.
Each Two Engines Allocated One Replication Link

The following uses OceanStor 18000 series storage systems with multiple controllers as an example to illustrate that HyperReplication supports every two engines allocated one replication link on the primary and secondary storage systems.
3.4 Changeable Network Connections

HyperReplication supports Fibre Channel and iSCSI network connections, and can adapt to various network environments such as direct inter-array connections and connections through a Fibre Channel switch, an IP switch, and an IP WAN network.

3.5 Dynamic Adjustment of the Copy Speed

HyperReplication allows users to manually change the copy speed to prevent a conflict between a copy task and a production task. If a storage system detects that the service load is heavy, a user can manually lower the copy speed to make system resources available to services. When the service load is light, the copy speed can be increased dynamically, mitigating service conflicts in peak hours.

HyperReplication supports four copy speeds: low, medium, high, and highest. When the physical bandwidth between storage systems is sufficient for replication, the low copy speed ranges from 0 MB/s to 5 MB/s, the medium copy speed ranges from 10 MB/s to 20 MB/s, the high copy speed ranges from 50 MB/s to 70 MB/s, and the highest copy speed is higher than 100 MB/s. Users can select a copy speed based on service requirements.

3.6 High Specifications

HyperReplication supports high-specification remote replication configurations, meeting configuration requirements in various scenarios. For example, OceanStor 18000 series storage systems support a maximum of 64,000 remote replications. Each consistency group supports a maximum of 8000 members.

3.7 High Fan-Out Replication Ratio

HyperReplication supports data replication from 32 storage systems to one storage system for central backup (32:1 replication ratio, which is four to eight times that of a piece of peer software from another vendor). This realizes disaster recovery resource sharing and greatly reduces the cost in deploying disaster recovery devices.

Figure 3-1 Multiple interconnected storage systems — Fan-out
3.8 Mutual Mirroring

HyperReplication enables users to implement mutual mirroring between two OceanStor enterprise unified storage systems, as shown in the following figure.
4 Application Scenarios

HyperReplication is used for data backup and disaster recovery. Different remote replication modes apply to different application scenarios:

- Synchronous remote replication applies to backup and disaster recovery scenarios where the primary site is close to the secondary site, for example, in the same city (same data center or campus).
- Asynchronous remote replication applies to backup and disaster recovery scenarios where the primary site is far from the secondary site (for example, across countries or regions) or the network bandwidth is limited.

In a specific application scenario, determine the replication mode based on the distance and available bandwidth between sites. Typical application scenarios include central backup and disaster recovery, and active-active continuous service support.

4.1 Central Backup and Disaster Recovery

In a central backup and disaster recovery scenario, service data distributed in different places is backed up to the same site for centralized management. Service data at multiple service sites is centrally backed up to and managed at the central backup site. When a disaster occurs at any service site, the central backup site can take over services and recover data. Service data at multiple service sites is centrally backed up to and managed at the central backup site. When a disaster occurs at any service site, the central backup site can take over services from the service site and recover data.
Scenario description:

- Backup data is managed centrally so that data analysis and mining can be performed without affecting services.
- When any of the service sites suffers a disaster, the central backup site can quickly take over services from the site and recover data, achieving unified management of service switchovers.
- HyperReplication allows users to construct a central backup site that backs up data from a maximum of 32 service sites.
- A remote replication mode can be selected for a service site based on the distance between the service site and the central backup site.

4.2 Active-Active Continuous Service Support

In an active-active continuous service support scenario, services run at multiple sites simultaneously. Service data is scattered at different sites. If there are demanding requirements for service continuity, the service sites need to serve as backup sites mutually, and service switchovers can be performed between sites. When a disaster occurs, a functional service site takes over services from the failed service site and recovers data.

Scenario description:

- The two service sites run services independently without affecting each other.
- The two service sites mutually back up data for each other and do not need a dedicated disaster recovery site. This makes the entire disaster recovery system cost-effective.
- When one service site is attacked by a disaster, the other service site can take over services immediately.
- A remote replication mode can be selected based on the service characteristics and the distance between sites.
5 Technical Requirements for Disaster Recovery Solution Implementation

For HyperReplication/S, a write success response is returned only after the data in each write request is written to the primary and secondary sites. If the primary site is far away from the secondary site, the write latency of foreground applications is quite long, affecting foreground services. Therefore, HyperReplication/S is usually implemented in a situation where the primary site is close to the secondary site, for example, intra-city disaster recovery. The following lists the requirements imposed by HyperReplication/S:

- Distance between the primary and secondary sites < 200 km
- Minimum link bandwidth ≥ 64 Mbit/s
- Unidirectional transmission latency < 1 ms
- Actual network bandwidth > Peak write I/O bandwidth

For HyperReplication/A, the write latency of foreground applications is independent of the distance between the primary and secondary sites. Therefore, HyperReplication/A applies to disaster recovery scenarios where the primary and secondary sites are far away from each other, or the network bandwidth is limited. The following lists the requirements imposed by HyperReplication/A:

- No explicit limit on the WAN distance between the primary and secondary sites
- Minimum link bandwidth (bidirectional) ≥ 10 Mbit/s
- Unidirectional transmission latency < 50 ms
- Actual network bandwidth > Average write I/O bandwidth

The following table lists the maximum transmission distance supported by HyperReplication in different network environments.
### Networking Mode

<table>
<thead>
<tr>
<th>Networking Mode</th>
<th>Maximum Transmission Distance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct connection through iSCSI</td>
<td>100 m to 150 m</td>
<td>The maximum supported transmission distance varies with transmission media.</td>
</tr>
<tr>
<td>Direct connection through multimode optical fibers</td>
<td>500 mª</td>
<td></td>
</tr>
<tr>
<td>Long-distance transmission through switches, trunk devices, DWDM, and Fibre Channel/IP gateways</td>
<td>200 km</td>
<td>No restriction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE**

For the transmission distance of multimode optical fibers, see the following table:

<table>
<thead>
<tr>
<th>Transmission Rate</th>
<th>Optical Fiber Type</th>
<th>OM1</th>
<th>OM2</th>
<th>OM3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Gbit/s</td>
<td>OM1</td>
<td>150 m</td>
<td>300 m</td>
<td>500 m</td>
</tr>
<tr>
<td>4 Gbit/s</td>
<td>OM2</td>
<td>70 m</td>
<td>150 m</td>
<td>380 m</td>
</tr>
<tr>
<td>8 Gbit/s</td>
<td>OM3</td>
<td>21 m</td>
<td>50 m</td>
<td>150 m</td>
</tr>
</tbody>
</table>
HyperReplication Configuration Process

Start

1. Verify availability of asynchronous remote replication.
   - Check the remote replication license file.

2. Establish a connection between the primary and secondary arrays.
   - Add routes.
     - You must add routes if the primary and secondary arrays connect to each other through iSCSI host ports and reside on different network segments.
   - Add a remote device.

3. Create a remote replication.
   - Create an asynchronous remote replication.

4. Create a consistency group.
   - Create a consistency group.
     - If you need to ensure time consistency between LUNs in multiple remote replications, create a consistency group.

End

Legend: Mandatory Optional
Checking the License File

Managing Routes
Adding a Remote Device

![Wizard for Adding Remote Device: Step 3-1](image)

**Set Up a Device Connection**

Please set up the connection to the remote device.

**Link Type:** ISCSI

**Local Device**

- **Controller:** ENG0.A
- **Local Port:** ENG0.A1.P0

**Remote Device**

Please enter the username and password of the super administrator or administrator of the remote device.

- **IP Address:** 129.198.20.31
- **Username:** admin
- **Password:** ********
- **TCP/IP Port:** 3260
Creating a Remote Replication
Setting Remote Replication Properties

- **Speed:** Medium
- **Recovery Policy:** Automatic
- **Synchronization Type:** Timed wait when syn...
  - Interval: 10 minutes
- **Initial Synchronization:**
  - Data is inconsistent between the primary and secondary LUNs. After the remote replication task is created, the system automatically performs data synchronization.
  - Data is inconsistent between the primary and secondary LUNs. After the remote replication task is created, manually perform data synchronization.
  - The primary and secondary LUNs have consistent data and data synchronization is not required.
  - Data is consistent between the primary and secondary LUNs. After the remote replication task is created, the system automatically performs data synchronization to ensure the data consistency.
### 7 Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym and Abbreviation</th>
<th>Full Spelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUN</td>
<td>logical unit number</td>
</tr>
<tr>
<td>COW</td>
<td>copy-on-write</td>
</tr>
<tr>
<td>I/O</td>
<td>Input Output</td>
</tr>
</tbody>
</table>