Hitachi Virtual Storage Platform
Hitachi Universal Replicator User Guide
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Glossary

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Preface

This document describes and provides instructions for using Hitachi Universal Replicator to plan, configure, and perform pair operations on the Hitachi Virtual Storage Platform (VSP) storage system.

Please read this document carefully to understand how to use this product, and maintain a copy for reference purposes.

- Intended audience
- Product version
- Document revision level
- Changes in this revision
- Referenced documents
- Document organization
- Document conventions
- Convention for storage capacity values
- Accessing product documentation
- Getting help
- Comments
**Intended audience**

This document is intended for system administrators, HDS representatives, and authorized service providers who are involved in installing, configuring, and operating the VSP storage system.

This document assumes the following:

- The user has a background in data processing and understands RAID systems and their basic functions.
- The user is familiar with the VSP system and has read the *Hitachi Virtual Storage Platform User and Reference Guide*.
- The user is familiar with the Storage Navigator software for the VSP and has read the *Hitachi Storage Navigator User Guide*.

**Product version**

This document revision applies to VSP microcode 70-06-2x or later.

**Document revision level**

<table>
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<td>October 2010</td>
<td>Initial release</td>
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**Changes in this revision**

- The ShadowImage volume types are updated in [Volume types that can be shared with Universal Replicator on page B-2](#).

**Referenced documents**

Hitachi Virtual Storage Platform:

- *Hitachi TrueCopy® User Guide*, MK-90RD7030
Document organization

The following table provides an overview of the contents and organization of this document. Click the chapter title in the left column to go to that chapter. The first page of each chapter provides links to the sections in that chapter.

<table>
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<th>Chapter</th>
<th>Description</th>
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<tbody>
<tr>
<td>Universal Replicator overview on page 1-1</td>
<td>Provides an overview of Universal Replicator.</td>
</tr>
<tr>
<td>Requirements and specifications on page 2-1</td>
<td>Provides requirements and specifications.</td>
</tr>
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<td>Planning volumes, VSP systems on page 3-1</td>
<td>Provides planning information for pair and journal volumes, the VSP system, previous systems and other key components.</td>
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<td>Planning the data path on page 4-1</td>
<td>Provides planning information for setting up the data path.</td>
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<td>Configuration operations on page 5-1</td>
<td>Provides instructions for configuring the Universal Replicator system.</td>
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<tr>
<td>Pair operations on page 6-1</td>
<td>Provides instructions for performing pair operations.</td>
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<tr>
<td>Monitoring the system on page 7-1</td>
<td>Provides instructions for monitoring pairs.</td>
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<tr>
<td>Maintaining the system on page 8-1</td>
<td>Provides instructions for maintaining the Universal Replicator system.</td>
</tr>
<tr>
<td>Disaster recovery operations on page 9-1</td>
<td>Provides information and instructions for performing disaster recovery operations.</td>
</tr>
<tr>
<td>Troubleshooting on page 10-1</td>
<td>Provides troubleshooting information.</td>
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<tr>
<td>3 UR data-center configurations on page A-1</td>
<td>Provides instructions for 3DC configurations with 3 Universal Replicator sites.</td>
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<td>Sharing volumes on page B-1</td>
<td>Provides instructions for sharing Universal Replicator pair volumes with other software volumes.</td>
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<tr>
<td>Configurations with TrueCopy on page C-1</td>
<td>Provides instructions for sharing Universal Replicator pair volumes with Hitachi TrueCopy® pair volumes.</td>
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<tr>
<td>Configurations with ShadowImage on page D-1</td>
<td>Provides instructions for sharing Universal Replicator pair volumes with Hitachi ShadowImage® pair volumes.</td>
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<tr>
<td>GUI reference on page E-1</td>
<td>Describes the Universal Replicator windows and dialog boxes in Storage Navigator.</td>
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**Document conventions**

This document uses the following typographic conventions:

<table>
<thead>
<tr>
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<th>Description</th>
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<tbody>
<tr>
<td><strong>Bold</strong></td>
<td>Indicates text on a window, other than the window title, including menus, menu options, buttons, fields, and labels. Example: Click <strong>OK</strong>.</td>
</tr>
<tr>
<td><strong>Italic</strong></td>
<td>Indicates a variable, which is a placeholder for actual text provided by the user or system. Example: copy <em>source-file target-file</em></td>
</tr>
<tr>
<td><strong>screen/code</strong></td>
<td>Indicates text that is displayed on screen or entered by the user. Example: # pairdisplay -g <em>oradb</em></td>
</tr>
<tr>
<td><strong>&lt; &gt; angled brackets</strong></td>
<td>Indicates a variable, which is a placeholder for actual text provided by the user or system. Example: # pairdisplay -g <em>&lt;group&gt;</em></td>
</tr>
<tr>
<td><strong>Note:</strong></td>
<td>Italic font is also used to indicate variables.</td>
</tr>
<tr>
<td><strong>[ ] square brackets</strong></td>
<td>Indicates optional values. Example: [ a</td>
</tr>
<tr>
<td><strong>{ } braces</strong></td>
<td>Indicates required or expected values. Example: { a</td>
</tr>
<tr>
<td>**</td>
<td>vertical bar**</td>
</tr>
<tr>
<td><strong>Underline</strong></td>
<td>Indicates the default value. Example: [ a</td>
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This document uses the following icons to draw attention to information:

<table>
<thead>
<tr>
<th>Icon</th>
<th>Meaning</th>
<th>Description</th>
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<tbody>
<tr>
<td><img src="image" alt="Tip" /></td>
<td>Tip</td>
<td>Provides helpful information, guidelines, or suggestions for performing tasks more effectively.</td>
</tr>
<tr>
<td><img src="image" alt="Note" /></td>
<td>Note</td>
<td>Calls attention to important and/or additional information.</td>
</tr>
<tr>
<td><img src="image" alt="Caution" /></td>
<td>Caution</td>
<td>Warns the user of adverse conditions and/or consequences (e.g., disruptive operations).</td>
</tr>
<tr>
<td><img src="image" alt="WARNING" /></td>
<td>WARNING</td>
<td>Warns the user of severe conditions and/or consequences (e.g., destructive operations).</td>
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**Convention for storage capacity values**

Physical storage capacity values (such as, disk drive capacity) are calculated based on the following values:
Logical storage capacity values (such as, logical device capacity) are calculated based on the following values:

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<th>Value</th>
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<tr>
<td>1 KB</td>
<td>1,000 bytes</td>
</tr>
<tr>
<td>1 MB</td>
<td>$1,000^2$ bytes</td>
</tr>
<tr>
<td>1 GB</td>
<td>$1,000^3$ bytes</td>
</tr>
<tr>
<td>1 TB</td>
<td>$1,000^4$ bytes</td>
</tr>
<tr>
<td>1 PB</td>
<td>$1,000^5$ bytes</td>
</tr>
<tr>
<td>1 EB</td>
<td>$1,000^6$ bytes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Logical capacity unit</th>
<th>Value</th>
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<tbody>
<tr>
<td>1 KB</td>
<td>1,024 bytes</td>
</tr>
<tr>
<td>1 MB</td>
<td>1,024 KB or $1,024^2$ bytes</td>
</tr>
<tr>
<td>1 GB</td>
<td>1,024 MB or $1,024^3$ bytes</td>
</tr>
<tr>
<td>1 TB</td>
<td>1,024 GB or $1,024^4$ bytes</td>
</tr>
<tr>
<td>1 PB</td>
<td>1,024 TB or $1,024^5$ bytes</td>
</tr>
<tr>
<td>1 EB</td>
<td>1,024 PB or $1,024^6$ bytes</td>
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<tr>
<td>1 block</td>
<td>512 bytes</td>
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</table>

**Accessing product documentation**

The VSP user documentation is available on the HDS Support Portal: [https://Portal.HDS.com](https://Portal.HDS.com). Please check this site for the most current documentation, including important updates that may have been made after the release of the product.

**Getting help**

The HDS customer support staff is available 24 hours a day, seven days a week. If you need technical support, log on to the HDS Support Portal for contact information: [https://Portal.HDS.com](https://Portal.HDS.com)

**Comments**

Please send us your comments on this document: doc.comments@hds.com. Include the document title, number, and revision. Please refer to specific sections and paragraphs whenever possible.

**Thank you!** (All comments become the property of HDS.)
Universal Replicator overview

With Hitachi Universal Replicator (UR), you create and maintain a remote copy of a data volume on a Hitachi Virtual Storage Platform (VSP) storage system.

This guide provides instructions for planning, configuring, operating, maintaining, and troubleshooting a Universal Replicator system.

- Universal Replicator software
- How Universal Replicator works
- Hardware and software components
- Reference Information
Universal Replicator software

With Universal Replicator, you copy application data to a secondary VSP system at a remote location. The remote volume is an asynchronous block-for-block copy of the local storage volume. The copied data is consistent with local data and therefore available for recovering the local volume if the need arises.

Universal Replicator is designed to support a secondary site hundreds and even thousands of miles from the local site, making recovery from region-wide disasters possible.

Universal Replicator is also designed to limit impact on the local system. Updates sent from a host to the primary production volume on the local system are copied to a local journal volume. The remote system “pulls” data from the journal volume across the communication link to the backup volume, called the secondary volume. The local system is free to perform its role as a transaction processing resource rather than as a replication engine.

**Note:** The “local” system is also referred to as the “primary” system.

The “remote” system is also referred to as the “secondary” system.

The production volume on the primary system receives and stores the data sent from the host. This volume is commonly referred to as the “primary volume”, or “P-VOL”.

The backup volume on the secondary system stores the data copied from the primary system, and is commonly referred to as the “secondary volume”, or “S-VOL”.

How Universal Replicator works

Remote replication occurs using journal volumes on the local and remote systems.

![Figure 1-1 Basic sequence in Universal Replicator operations](image)

- The journal volume on the local system is called the “master journal volume”.

---

1–2

Universal Replicator overview

Hitachi Virtual Storage Platform Hitachi Universal Replicator User Guide
• The journal volume on the remote system is called the “restore journal volume”.

Replication occurs in the following sequence:

1. **Journal obtain** - When the host sends an update to the primary volume (P-VOL), the primary (local) system’s journal-obtain function triggers a copy of the updated data to the master journal volume.
   - The host assigns write-sequence numbers to the data sent to the master journal volume.
   - Write-sequence numbers and other metadata attached to journal data ensure consistency with the data in the P-VOL.

2. **Journal copy** - Data is copied from the master journal to the restore journal.
   - When the master journal has data, the data is transferred to the restore journal. When data transfer is complete, master journal data is discarded.
   - Data copy to the restore journal is initiated by the read-journal command issued by the remote system.
   - Data copy occurs on a continual basis unless there is no data in the master journal. The request for data from the remote system is repeated as soon as the previous read operation is completed.
   - Journal data is removed from the master journal only when the primary system receives sequence numbers for the data from the restore journal.

3. **Journal-restore** - The secondary volume (S-VOL) is updated with changed data from the restore journal.
   - Data is copied to the S-VOL according to the write sequence numbers, ensuring data consistency.
   - When journal-restore is completed, the data in the restore journal is discarded.

Performance is affected because of journal-to-journal copying. Usage rates are also affected. See Read and write I/O during remote copy on page 1-8 for more high level information on Universal Replicator operations.

**Hardware and software components**

A typical configuration consists of a VSP system or externally attached storage system on both local and remote sites, a host or hosts connected to the systems, Universal Replicator software on both systems, data path connections, and interface tools for configuring and managing Universal Replicator.

• The local and remote VSP systems are connected using dedicated fibre-channel data paths that can include fibre-channel switches. Data paths are routed from the fibre-channel ports on the primary system to the ports on the secondary system.

• The host is connected to the VSP using a fibre-channel or fibre-channel-over-Ethernet (FCoE) target port.
• Storage Navigator, whose GUI is used to view and operate Universal Replicator, is connected via a management LAN.

A Universal Replicator system consists of the following:
• P-VOLs and S-VOLs on the local and remote VSP
• Master and restore journal volumes on the local and remote VSP
• Master and restore journals on the local and remote VSP
  o The master journal consists of the primary volumes and master journal volumes.
  o The restore journal consists of the secondary volumes and restore journal volumes.

Management software consists of:
• Storage Navigator graphical user interface (GUI)
• Command Control Interface (CCI)

Universal Replicator components are illustrated in the following figure and described in greater detail in the following topics.

![Universal Replicator components](image)

**Figure 1-2 Universal Replicator components**

**VSP storage systems**

Universal Replicator is operated using two VSP systems, one at the primary site and one at the secondary site. The primary system consists of the main control unit (MCU) and the service processor (SVP). The secondary system consists of the remote control unit (RCU) and the SVP.
• The primary system communicates with the secondary system over dedicated fibre-channel remote copy connections.
• Each VSP system can function simultaneously as a primary and secondary system.

Main and remote control units

The primary and secondary systems are often referred to as the MCU (primary system) and RCU (secondary system). MCU is the main control unit, RCU is the remote control unit.

The MCU control the primary storage volume (P-VOL) and the following operations:
• Host I/O write to the P-VOL
• P-VOL data copy to the master journal
• Initial copy and update copy between the P-VOL and secondary volume (S-VOL).

The RCU control the secondary storage volume (S-VOL) and the following operations:
• Journal commands to the MCU.
• Journal data copy from the master to the restore journal
• Restore journal data copy to the S-VOL
• Pair status management and configuration (for example, rejecting write I/Os to the S-VOLs).

Pair volumes

Original data is stored in the P-VOL and the remote copy is stored in the S-VOL. The pair can be paired, split, re-synchronized, and returned to the unpaired (called “simplex”) state. When synchronized, the volumes are paired; when split, new or changed data sent to the P-VOL is not copied to the S-VOL. When re-synchronized, changed data is copied to the S-VOL. If a disaster occurs, production operations can be transferred to the S-VOL. When the primary site is functional again, operations can be transferred and data can be copied back to the P-VOL.

The P-VOL remains available to the host for read and write I/O operations. The secondary system rejects write I/Os for the S-VOL, unless the write-enable option is specified. Then, write I/O is allowed to the S-VOL while the pair is split. In this instance, S-VOL and P-VOL track maps keep track of differential data and use it to re-synchronize the pair.

Journal volumes

For Universal Replicator operations, journal volumes are required on the primary and secondary systems.
• Updates to the P-VOL are copied to the master journal volume in the primary system. See the illustration in Journals on page 1-6.
- Master journal data is copied to the restore journal volume on the secondary system.
- Journal volumes can have different volume sizes and different RAID configurations.
- Journal data is stored sequentially and separately in each journal volume in the same journal.

For information on planning journal volumes, see Sizing journal volumes on page 3-4.

**Journals**

Journals help you manage data consistency between multiple P-VOLs and S-VOLs. A journal consists of two or more data volumes and journal volumes.

You use journals to create multiple pairs and to split, resynchronize, and release multiple pairs. Journals are required on the primary and secondary systems.

Each data volume and its associated journal volume reside in the same journal.

- The master journal contains master journal volumes and is associated with the P-VOL.
- The restore journal contains restore journal volumes and is associated with the S-VOL.

Each pair relationship between journals is called a "mirror". A mirror ID identifies a pair relationship between journals. When the pair is created, it is assigned a mirror ID.

![Figure 1-3 Journals](image)
**Data path**

The physical transmission link between the local and remote systems is called the data path. Universal Replicator commands and data are transmitted through the fibre-channel data path and switches. The data path is connected to the primary and secondary systems through two types of fibre-channel ports, Initiator and RCU Target ports. Universal Replicator requires paths in both directions. More specifically, it requires paths with Initiator ports in the MCU connected to RCU Target ports in the RCU, and paths with Initiator Ports in the RCU connected to RCU Target ports in the MCU.

One data path connection is required. It is recommended that you use two or more independent connections to provide hardware redundancy. A maximum of eight paths can be used.

For more information, see **Planning the data path on page 4-1**.

**Consistency groups and journals**

Journals are used in Universal Replicator to guarantee data consistency across multiple pairs. Consistency groups are used in other replication software for the same purpose. As a best practice, you can assign CCI consistency group numbers as journal numbers. See “journals” in **System requirements on page 2-2** and **Multiple journals per CCI consistency group on page 3-14** for more information.

**Storage Navigator**

Storage Navigator provides a GUI and command line interface for accessing and managing the storage system, including Universal Replicator.

Storage Navigator communicates with the SVP of each system over defined TCP/IP connections.

**Command Control Interface (CCI)**

CCI provides a command line interface for accessing and managing the storage system, including Universal Replicator. You can perform the same Universal Replicator operations with CCI as you can with Storage Navigator. In addition, you can automate pair operations using scripts.

If you want to use CCI but it is not installed, contact your Hitachi Data Systems account team.

**Reference Information**

The following topics describe UR copy operations and other features.

**Overview of copy operations**

initial and update copy operations including the underlying operations, such as journal processing and differential data management.
Initial copy operation

The initial copy is executed when the primary system copies all the data in sequence from the P-VOL directly to the S-VOL. Though journal volumes are not used during the initial copy, the copy data in this operation is referred to as “base journal data”.

- Creating or resynchronizing two or more pairs within the same journal results in the base journal data being copied to the respective S-VOLs, one at a time. This extends the time required for all the operations to be completed.
- An initial copy operation can be performed to establish the pair — with no data copied between the volumes. This can be done when data in the P-VOLs and S-VOLs are identical.
- Universal Replicator pair data can also be copied using a TrueCopy initial copy operation. Doing this reduces the time to complete the copy operation. See Planning pair volumes on page 3-8 for more information.

Update copy operation

When a host has new or changed information, the following occurs in the primary system:

- The update is written to the P-VOL
- The update is copied to the master journal along with metadata that includes sequence and other consistency information.

The remote system issues the read-journal command (independent of host I/O activity). At this time, the following occurs:

- Any data in the master journal is sent to the restore journal.
- The updated data is copied to the S-VOL.
- Journal data on the primary and secondary systems is discarded when data consistency is established in the copy.

Note: Journal data is transferred using special I/O operations initiated by the secondary system, called RIO (remote I/O). RIO provides the most efficient type of data transfer. Make sure that your channel extenders are capable of supporting RIO. Contact Hitachi Data Systems Support Center for more information.

If an update copy operation fails, the remote system suspends the affected pair or all pairs in the journal, depending on the type of failure. The suspended pair or journal returns to Paired status when the primary and secondary systems are re-synchronized.

Read and write I/O during remote copy

The primary system reads from the P-VOL when it receives a read I/O command. If the read fails, the redundancy provided by RAID-1 or RAID-5 technology recovers the failure. The primary system does not read the S-VOL for recovery.
When a primary system receives a write I/O command for a P-VOL in PAIR status, the system performs the write operation and performs the update copy operation. The write operation completes independently of the update copy operations on the S-VOL.

The secondary system updates the S-VOL according to the write sequence number in the journal data. This maintains data consistency between P-VOL and S-VOL.

If the P-VOL write operation fails, the primary system reports a unit check and does not create the journal data for this operation. As mentioned, if the update copy operation fails, the secondary system suspends either the affected pair or all Universal Replicator pairs in the journal, depending on the type of failure. When the suspended pair or journal is resumed, the primary and secondary systems negotiate the resynchronization of the pairs.

During normal operations, the secondary system does not allow S-VOLs to be online (mounted). Therefore, hosts cannot read from and write to S-VOLs. However, if the S-VOL write option is enabled, write access to an S-VOL is allowed while the pair is split. The pair must be split from the primary system for the option to take effect.

To reduce the overhead associated with remote copy activities and to maximize rate of data transfer, the VSP uses a special write command for initial and update copy operations. This command transfers the control parameters and the fixed-block architecture (FBA) format data for consecutive updated records in a track using a single write operation. It eliminates the overhead required for performing FBA-to-count-key-data (CKD) and CKD-to-FBA conversions.

**Differential data management**

Differential data is the data that is changed in the P-VOL when a pair is split or suspended and that is not reflected in the S-VOL. This data is stored in a track bitmap. When the pair is resynchronized, the primary system merges the P-VOL and S-VOL bitmaps, and the differential data is copied to the S-VOL.

The number of bitmap areas affects the maximum possible number of pairs that can be created in the system.

**S-VOL write option**

When splitting a pair, you can set an option allowing write I/O to the S-VOL. When you resynchronize a split pair whose S-VOL is write-enabled, the secondary system sends the S-VOL track bitmap to the primary system, which merges the P-VOL and S-VOL bitmaps to determine which tracks are out of sync. This ensures proper resynchronization of the pair.
**Pair status**

Every pair operation results in a change in pair status. In addition, when you want to perform an operation, the pair must have a specific status in order to for the operation to run. You will monitor pair status to ensure that you can perform the desired operation, and to ensure that an operation completed successfully.

The following provides a brief description of the pair statuses. For complete details, see [Pair status definitions on page 7-2](#).

- **SMPL**: A volume that is not assigned to a pair is in simplex status, SMPL.
- **COPY**: When copy processing is started, the primary system changes the status of the P-VOL and S-VOL to COPY.
- **PAIR**: When the initial copy processing is complete, the primary system changes the status of both data volumes to PAIR.
- **PSUE**: When a pair is suspended due to an error condition, the primary system changes the P-VOL and S-VOL status to PSUE (if the path status is normal).
- **PSUS**:
  - When a pair is split by the user (pairsplit-r), the primary or secondary system changes the status of the P-VOL and S-VOL to PSUS (if the path status is normal).
  - If a pair is split from the secondary system, it changes the S-VOL status to PSUS. The primary system detects the split (if path status is normal) and changes the P-VOL status to PSUS.
Requirements and specifications

This chapter provides system requirements for Hitachi Universal Replicator.

- System requirements
System requirements

Universal Replicator operations are performed from the primary system to the secondary system, which contain the UR P-VOLs, S-VOLs, and master and restore journal volumes. Copy operations are carried out via the data path.

General requirements for these and all UR components are listed below.

### Table 2-1 General system requirements

<table>
<thead>
<tr>
<th>Item</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of VSP systems</td>
<td>Two—one at the local site, one at the remote site. A maximum of four VSP systems can be used at each site, and any combination — from one to four storage systems on one or both sites — can be used:</td>
</tr>
<tr>
<td>Storage systems at primary and secondary sites</td>
<td>VSP is required at the primary or secondary site. Any of the following can be paired with it:</td>
</tr>
<tr>
<td></td>
<td>• VSP (70-01-01-xx/xx or later)</td>
</tr>
<tr>
<td></td>
<td>• VSP G1000 (80-01-01-xx/xx or later)</td>
</tr>
<tr>
<td></td>
<td>• USP V/VM (60-07-51-xx/xx or later)</td>
</tr>
<tr>
<td></td>
<td>• TagmaStore USP/TagmaStore NSC (50-09-98-xx/xx or later)</td>
</tr>
<tr>
<td></td>
<td>• HUS VM (73-01-31-xx/xx or later)</td>
</tr>
<tr>
<td>Previous model storage systems supported</td>
<td>See previous item; see also Planning for previous models on page 3-16.</td>
</tr>
<tr>
<td>Universal Replicator</td>
<td>• Must be installed on primary and secondary VSP systems.</td>
</tr>
<tr>
<td></td>
<td>• License keys required.</td>
</tr>
<tr>
<td></td>
<td>• UR and URz can coexist in the same storage system.</td>
</tr>
<tr>
<td></td>
<td>• For licensing capacity requirements when UR volumes are shared with other VSP software volumes, see Dynamic Provisioning on page B-5</td>
</tr>
<tr>
<td></td>
<td>• For information on expired licenses or exceeding licensed capacity, see the Hitachi Storage Navigator User Guide.</td>
</tr>
<tr>
<td>Other licenses required</td>
<td>TrueCopy is required. This applies whether or not TC volumes are shared with UR.</td>
</tr>
<tr>
<td>Item</td>
<td>Requirement</td>
</tr>
<tr>
<td>--------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| **Interfaces**     | • **Storage Navigator:**  
  o Must be LAN-attached to the primary system.  
  o Not required on the secondary system, but recommended in order to change UR parameters and access the S-VOL for disaster recovery and maintenance.  
  o The following roles are required:  
    Storage Administrator (Remote Copy), to perform pair operations  
    Storage Administrator (System Resource Management), to configure settings  
• **CCI:**  
  o Optional  
  o Command device required |
| **Data path**      | Fibre channel with either direct and switch connections. When the system is connected to a VSP or VSP G1000, you can use multiple path groups. This is done by registering path groups with multiple path group IDs in the same storage system. But note that only one path group can be specified for a mirror. Up to eight paths can be registered in one path group. |
| **Path group**     | Groups of logical paths, which allows you to configure or change the configuration of multiple paths at the same time.  
  • A maximum of eight logical paths can be registered in a path group  
  • A maximum of 64 path groups can be set in a storage system.  
  • The following Hexadecimal values can be set as the path group ID:  
    o 0-255 when connected to VSP or VSP G1000  
    o 0 only when connected to USP V/VM, HUS VM, TagmaStore USP, or TagmaStore NSC  
  • For a mirror, the same path group ID must be used to connect the primary storage system to the secondary system as is used to connect the systems in the reverse direction.  
  • The path group is specified during the create pair operation. It cannot be changed by the resync pair or swap operation.  
  • Path groups can be created and specified using CCI. See configuration setting commands in [Command Control Interface User and Reference Guide](http://www.hds.com/products/interoperability) and sample configuration definition files in [Command Control Interface Installation and Configuration Guide](http://www.hds.com/products/interoperability).  
  • It is recommended that you specify different paths and path groups for TC and UR secondary systems when using CU Free. |
<table>
<thead>
<tr>
<th>Item</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumes</td>
<td>• A P-VOL may be copied to one S-VOL.</td>
</tr>
<tr>
<td></td>
<td>• P-VOL and S-VOL must be equal in size.</td>
</tr>
<tr>
<td></td>
<td>• P-VOL and S-VOL must be of same emulation type.</td>
</tr>
<tr>
<td></td>
<td>• The maximum volume size of P-VOL and S-VOL is 4,194,304.000 MB (8,589,934,592 blocks). However, when TagmaStore USP or TagmaStore NSC is used as the primary or secondary system, the maximum volume size is 2,949,120.00 MB (6,039,797,760 blocks).</td>
</tr>
<tr>
<td></td>
<td>• The minimum volume size of P-VOL and S-VOL is 26.875MB (96,000 blocks).</td>
</tr>
<tr>
<td></td>
<td>• When TC is cascaded with UR, a data volume may be copied to multiple data centers.</td>
</tr>
<tr>
<td>Maximum number of pairs</td>
<td>Limited per VSP system. See Maximum number of pairs allowed on page 3-8.</td>
</tr>
<tr>
<td>Supported RAID groups</td>
<td>• RAID1, RAID5, and RAID6 are supported for both data and journal volumes.</td>
</tr>
<tr>
<td></td>
<td>• RAID1, RAID5, and RAID6 can co-exist in the same journal.</td>
</tr>
<tr>
<td>Supported volume types</td>
<td><strong>Virtual LUN:</strong></td>
</tr>
<tr>
<td></td>
<td>• Can be used for data and journal volumes.</td>
</tr>
<tr>
<td></td>
<td>• S-VOL capacity must equal P-VOL capacity.</td>
</tr>
<tr>
<td></td>
<td><strong>Cache Residency Manager:</strong></td>
</tr>
<tr>
<td></td>
<td>• Data volume: yes</td>
</tr>
<tr>
<td></td>
<td>• Journal volume: no</td>
</tr>
<tr>
<td></td>
<td><strong>LUN Expansion (LUSE)</strong></td>
</tr>
<tr>
<td>Cache and nonvolatile storage (NVS)</td>
<td>Must be operable for primary and secondary systems to ensure pair creation success. The remote system cache must be configured to adequately support UR remote-copy workloads, as well as local workload activity. In general, increase cache capacity by 25 percent for UR. Also, 1 GB should be added for each journal on the system.</td>
</tr>
<tr>
<td></td>
<td><strong>Note:</strong> When pair status is COPY, neither cache nor shared memory can be added to or removed from the system. When either of these tasks is to be performed, first split any pairs in COPY, status, then resynchronize when the cache or shared memory operation is completed.</td>
</tr>
<tr>
<td>Host failover software</td>
<td>Required for disaster recovery.</td>
</tr>
<tr>
<td>CCI consistency groups when multiple primary and secondary system</td>
<td>• Up to two mirrors can be registered in one journal. One consistency group can be registered in each mirror. If there are four systems, you must create one journal for each system.</td>
</tr>
<tr>
<td></td>
<td>• Up to 8,192 pairs. You can register the total number of pairs in the journals within one CCI consistency group. However, it is recommended that you register only up to 4,096 pairs.</td>
</tr>
<tr>
<td>Item</td>
<td>Requirement</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| Journals   | - Max. number: 256 (0 to 255) per storage system  
             - Recommended number per storage system: Up to 16  
             - Max. number of journal volumes: 64 per journal  
             - Max. number of data volumes: 8,192 per journal  
             See [Planning journal volumes on page 3-7](#) for all requirements and restrictions. |
Planning volumes, VSP systems

This chapter provides information and instructions for planning Universal Replicator volumes, VSP systems, and other important requirements and restrictions.

☐ Plan and design workflow
☐ Assessing business requirements for data recovery
☐ Write-workload
☐ Sizing journal volumes
☐ Planning journals
☐ Data transfer speed considerations
☐ Planning journal volumes
☐ Planning pair volumes
☐ Disaster recovery considerations
☐ Sharing volumes with other VSP software volumes
☐ Planning UR in multiple VSPs using a consistency group
☐ Planning for previous models
☐ Guidelines for preparing systems for UR
Plan and design workflow

Planning the Universal Replicator system is tied to your organization’s business requirements and production system workload. This means defining business requirements for disaster downtime and measuring the amount of changed data your storage system produces over time. With this information, you can calculate the size of journal volumes and the amount of bandwidth required to transfer update data over the data path network.

The plan and design workflow consists of the following:

- Assess your organization’s business requirements to determine recovery requirements.
- Measure your host application’s write-workload in MB per second and write-input/output per second (IOPS) to begin matching actual data loads with the planned UR system.
- Use collected data along with your organization’s recovery point objective (RPO) to size UR journal volumes. Journal volumes must have enough capacity to hold accumulating data over extended periods. The sizing of journal volumes can be influenced by the amount of bandwidth you settle on. Both efforts are interrelated. You may actually adjust journal volume size in conjunction with bandwidth to fit the organization’s needs.
- Use IOPS to determine data transfer speed into and out of the journal volumes. Data transfer speed is determined by the number of Fibre-Channel ports you assign to UR, and by RAID group configuration. You need to know port transfer capacity and the number of ports that your workload data will require.
- Use collected workload data to size bandwidth for the fibre-channel data path. As mentioned, bandwidth and journal volume sizing, along with data transfer speed, are interrelated. Bandwidth may be adjusted with the journal volume capacity and data transfer speed you plan to implement.
- Design the data path network configuration, based on supported configurations, fibre-channel switches, and the number of ports your data transfer requires.
- Plan data volumes (primary and secondary volumes), based on the sizing of P-VOL and S-VOL, RAID group considerations, and so on.
- Understand operating system requirements for data and journal volumes.
- Adjust cache memory capacity for UR.

Some tasks will be handled by HDS’ personnel. The planning information you need to address is provided in the following topics.
Assessing business requirements for data recovery

In a UR system, when the data path continues to transfer changed data to the remote site, journals remain fairly empty. However, if a path failure or a prolonged spike in write-data that is greater than bandwidth occurs, data flow stops. Changed data that is no longer moving to the remote system builds up in the master journal.

To ensure that journals can hold the amount of data that could accumulate, they must be sized according to the following:

- The maximum amount of time that journals could accumulate data. You develop this information by determining your operation’s recovery point objective (RPO).
- The amount of changed data that your application generates. This is done by measuring write-workload.

Determining your RPO

Your operation’s recovery point is the maximum time that can pass after a failure or disaster occurs before data loss is greater than the operation can survive.

For example, if the operation can survive one hour’s worth of lost data, and a disaster occurs at 10:00 am, then the system must be corrected by 11 a.m.

In regards to journal sizing, the journal must have the capacity to hold the data that could accumulated in one hour. If RPO is 4 hours, then the journal must be sized to hold 4-hour’s worth of accumulating data.

To assess RPO, the host application’s write-workload must be known.

With write-workload and IOPS, you or your organization’s decision-makers can analyze the number of transactions write-workload represents, determine the number of transactions the operation could loose and still remain viable, determine the amount of time required to recover lost data from log files or key it in, and so on. The result is your RPO.

Write-workload

Write-workload is the amount of data that changes in your production system in MB per second. As you will see, write-workload varies. according to the time of day, week, month, quarter. That is why workload is measured over an extended period.

With the measurement data, you can calculate workload averages, locate peak workload, and calculate peak rolling averages, which show an elevated average. With one of these base data you will calculate the amount of data that accumulates over your RPO time, for example, 2 hours. This will be a base capacity for your journal volumes or represent a base amount of bandwidth your system requires.
Whether you select average, rolling average, or peak workload is based on the amount of bandwidth you will provide the data path (which is also determined by write-workload). Bandwidth and journal volume capacity work together and depend on your strategy for protecting data.

**Measuring write-workload**

Workload data is collected using Hitachi Performance Monitor or your operating system’s performance-monitoring feature. The number of read/write transactions, or input/output per second (IOPS), is also collected by the software. You will use IOPS to set up a proper data transfer speed, which you ensure through RAID group configuration and by establishing the number of fibre-channel ports your UR system requires. Each RAID group has a maximum transaction throughput; the ports and their microprocessors have an IOPS threshold.

Workload and IOPS collection is best performed during the busiest time of month, quarter, and year. This helps you to collect data that shows your system’s actual workloads during high peaks and spikes, when more data is changing, and when the demands on the system are greatest. Collecting data over these periods ensures that the UR design you develop will support your system in all workload levels.

**To measure write-workload and IOPS**

1. Using your performance monitoring software, collect the following:
   - Disk-write bytes-per-second (MB/s) for every physical volume that will be replicated.
   - Data should be collected over a 3 or 4-week period to cover a normal, full business cycle.
   - Data should be collected at 5 minute intervals. If you use averages, shorter intervals provide more accuracy.
2. At the end of the collection period, convert the data to MB/second, if needed, and import into a spreadsheet tool.

**Sizing journal volumes**

You calculate the size of your journal volumes using write-workload and RPO.

**To calculate journal size**

1. Follow the instructions for Measuring write-workload on page 3-4.
2. Use your system’s peak write-workload and your organization’s RPO to calculate journal size. For example:

   RPO = 2 hours
   Write-workload = 30 MB/sec
   
   Calculate write-workload for the RPO. In the example, write-workload over a two-hour period is calculated as follows:

   30 MB/second \times 60 \text{ seconds} = 1800 \text{ MB/minute}
   1800 \text{ MB/minute} \times 60 \text{ minutes} = 108,000 \text{ MB/hour}
108000 MB/hour x 2 = 416,000 MB/2 hours
Basic journal volume size = 416,000 MB (416 GB)

Journal volume capacity and bandwidth size work together. Also, your strategy for protecting your data may allow you to adjust bandwidth or the size of your journal volumes. For a discussion on sizing strategies, see **Five sizing strategies on page 4-2**.

**Note:** If you are planning for disaster recovery, the remote system must be large enough to handle the production workload, and therefore, must be the same size as master journals. If not planning a disaster recovery solution, remote journal volumes may be smaller than master journal volumes.

### Planning journals

UR manages pair operations for data consistency through the use of journals. UR journals enable update sequence consistency to be maintained across a group of volumes.

Understanding the consistency requirements for an application (or group of applications) and their volumes will indicate how to structure journals.

For example, databases are typically implemented in two sections. The bulk of the data is resident in a central data store, while incoming transactions are written to logs that are subsequently applied to the data store.

If the log volume “gets ahead” of the data store, it is possible that transactions could be lost at recovery time. Therefore, to ensure a valid recovery image on a replication volume, it is important that both the data store and logs are I/O consistent by placing them in the same journal.

The following information about journal volumes and journals will help you plan your journals.

- A journal consists of one or more journal volumes and associated data volumes.
- A journal can have only P-VOLs/master journals, or S-VOLs/restore journals.
- A journal cannot belong to more than one storage system (local or remote).
- All the P-VOLs, or S-VOLs, in a journal must belong to the same storage system.
- Journal numbers of master and restore journals that are paired can be different.
  If using a consistency group number, the consistency group number of the P-VOL and S-VOL must be the same.
- Each pair relationship in a journal is called a "mirror". Each pair is assigned a mirror ID. The maximum number of mirror IDs is 4 (0 to 3) per system.
- When UR and URz are used in the same system, individual journals must be dedicated either to one or the other, not both.
• Master and restore journals are managed according to the journal number.
• Review journal specifications in System requirements on page 2-2.
• A journal can contain up to 64 journal volumes.

Data transfer speed considerations

The previous topics and the topics later in this chapter on bandwidth discuss the amount of data that must be stored temporarily in journals volumes and transferred over the data path network. This topic discusses the speed that data must be transferred in order to maintain the UR system your are designing.

The ability of your UR system to transfer data in a timely manner depends directly on the following two factors:
• RAID group configuration
• Fibre-channel port configuration

Both of these elements must be planned to be able to handle the amount of data and number of transactions your system will move under extreme conditions.

RAID group configuration

A RAID group can consist of physical volumes with a different number of revolutions, physical volumes of different capacities, and physical volumes of different RAID configurations (for example, RAID-1 and RAID-5). The data transfer speed of RAID groups is affected by physical volumes and RAID configurations.

• The data transfer speed of a journal volume depends on the data transfer speed of the RAID group to which it belongs. A RAID group can consist of one or more volumes, including journal volumes.
• Each RAID group has a different throughput rating. The number of MB/sec that volumes in a RAID group are capable of processing is published in UR specifications.
• Journal volumes must be configured in RAID groups according to the group’s throughput specification and your system’s peak write-workload. If write-workload exceeds the RAID group’s throughput rating, then the number of RAID groups must be increased.
• Frequent read/write activity to non-journal volumes in a RAID group results in fewer read/writes by journal volumes in the same RAID group. This can cause a drop in the data transfer speed of journal volumes. To avoid this effect, place journal volumes and frequently accessed non-journal volumes in different RAID groups.
**Fibre-channel port configuration**

The fibre-channel ports on your VSP system have an IOPS threshold. Use the performance monitoring information for the number of IOPS your production system generates to calculate the number of fibre-channel ports the UR system requires.

Please see Planning ports for data transfer on page 4-7 for a full discussion on the type and number of fibre-channel ports required for your system.

**Planning journal volumes**

In addition to sizing journal volumes, you should be aware of the following requirements and restrictions.

- Journal volumes must be registered in a journal before the initial pair-copy operation is performed.
- Journal volumes must be registered on both the local and remote systems.
- Emulation type for journal volumes must be OPEN-V.
- Journal volumes should be sized according to RPO and write-workload. See Sizing journal volumes on page 3-4 for more information.
- If a path is defined from a host to a volume, the volume cannot be registered as a journal volume.
- Journal volumes in a journal can have different capacities.
- A master journal volume and the corresponding restore journal volume can have different capacities.
- A data volume and its associated journal volume can belong to only one journal.
- Do not register a volume to a journal during quick formatting. Doing so stalls the operation.
- Data volumes and journal volumes in the same journal must belong to the same controller.
- The number of journal volumes in the master journal does not have to be equal to the number of volumes in the restore journal.
- Journal volumes consist of two areas: One area is used for storing journal data, and the other area is used for storing metadata for remote copy.
- Journal volumes support all RAID configurations and physical volumes that are supported by VSP.
- Journal volume capacity is not included in accounting capacity.
- Customized volumes can be used for journal volumes.

See the following for more information about journals and journal volumes:

- The “Journals” item in System requirements on page 2-2
- Planning journals on page 3-5
Planning pair volumes

The following information can help you prepare volumes for configuration. Also, see system requirements and specifications in Requirements and specifications on page 2-1 for more information.

- The emulation and capacity for the S-VOL must be the same as for the P-VOL.
- When the S-VOL is connected to the same host as the P-VOL, the S-VOL must be defined to remain offline.
- You can create a UR pair using a TrueCopy initial copy, which takes less time. To do this, system option 474 must be set on the primary and secondary systems. Also, a script is required to perform this operation. For more on system option 474 and how to do this operation, see System option modes on page 3-18.
- UR supports the LUN Expansion (LUSE) feature, which allows you to configure a LUSE volume by using 2 to 36 sequential LDEVs. If two LUSE volumes are assigned to a UR pair, the capacity and configuration of the UR S-VOL must be the same as the UR P-VOL. For example, when the P-VOL is a LUSE volume in which 1-GB, 2-GB, and 3-GB volumes are combined in this order, the S-VOL must be a LUSE volume in which 1-GB, 2-GB, and 3-GB volumes are combined in this order. In addition, RAID1, RAID5, and RAID6 can coexist in the LUSE volume.
- UR supports the Virtual LUN feature, which allows you to configure custom LUs that are smaller than standard LUs. When custom LUs are assigned to a UR pair, the S-VOL must have the same capacity as the P-VOL. For details about Virtual LUN feature, see the Provisioning Guide for Open Systems.
- Identify the volumes that will become the P-VOLs and S-VOLs. Note the port, group ID (GID), and LUN of each volume. This information is used during the initial copy operation.
- You can create multiple pairs at the same time. Review the prerequisites and steps in Creating the initial copy on page 6-2.
- When you create a UR pair, you will have the option to create only the relationship, without copying data from P-VOL to S-VOL. You can use this option only when data in the two volumes is identical.
- When configuring the pair, best practice is to specify different serial numbers for the primary and secondary systems.

Maximum number of pairs allowed

You can create up to 32,768 pairs on a VSP system. The maximum number for your system is limited by:

- The number of cylinders in the volumes.
• The number of bitmap areas required for Universal Replicator data and journal volumes. This is calculated using the number of cylinders.

**Caution:** The bitmap areas that are used for Universal Replicator are also used for Universal Replicator for Mainframe, TrueCopy, TrueCopy for Mainframe, and High Availability Manager. If you use UR with any of these products, use the total number of each pair’s bitmap areas to calculate the maximum number of pairs. In addition, if UR and TC share the same volume, use the total number of both pairs regardless of whether the shared volume is primary or secondary.

**Calculating maximum number of pairs**

**Note:** In the calculations below, note the following:

- ceil () indicates that the value between the parentheses should be rounded up to the nearest integer.
- Number of logical blocks - Volume capacity (in bytes) / 512

**To calculate the number of cylinders**
Use the following formula:

\[
\text{Number of cylinders} = \text{ceil} \left( \text{ceil} \left( \frac{\text{number of logical blocks}}{512} \right) / 15 \right)
\]

**To calculate the number of required bitmap areas:**
Use the following formula

\[
\text{ceil} \left( \frac{\text{number of cylinders} \times 15}{122,752} \right)
\]

where:

- number of cylinders x 15 indicates the number of slots
- 122,752 is the number of slots that a bitmap area can manage

**Note:** Doing this calculation for multiple volumes can result in inaccuracies. Perform the calculation for each volume separately, then total the bitmap areas. The following examples show correct and incorrect calculations. Two volumes are used: one of 10,017 cylinders and another of 32,760 cylinders

Correct calculation

\[
\text{ceil} \left( \frac{10,017 \times 15}{122,752} \right) = 2 \quad \text{ceil} \left( \frac{32,760 \times 15}{122,752} \right) = 5 \quad \text{Total: 7}
\]

Incorrect calculation

\[
10,017 + 32,760 = 42,777 \quad \text{cylinders} \quad \text{ceil} \left( \frac{42,777 \times 15}{122,752} \right) = 6
\]

**Note:** If using LUSE volumes, add 1 to the required number of bitmap areas calculated in the formula above.

**To calculate the maximum number of pairs**
The maximum number of pairs is determined by the following:
The number of bitmap areas required for Universal Replicator (calculated above).

The total number of bitmap areas in the storage system, which is 65,536.

Bitmap areas reside in an additional shared memory, which is required for Universal Replicator.

- Bitmap areas are used not only by Universal Replicator, but also by Universal Replicator for Mainframe, TrueCopy, TrueCopy for Mainframe, and High Availability Manager. Therefore, the number of bitmap areas used by these other program products (if any) must be subtracted from 65,536, with the difference used to calculate the maximum number of pairs for Universal Replicator.

- If TrueCopy and Universal Replicator share the same volume, you must use the total number of bitmap areas for both pairs regardless of whether the shared volume is main or remote.

- The maximum number of pairs supported per storage system, which is 32,768. If CCI is used, it is 32,767.

Calculate the maximum number of pairs using the following formula.

\[
\text{Maximum number of pairs} = \text{floor}( \frac{\text{Number of bitmap areas}}{\text{required number of bitmap areas}} )
\]

If the calculated maximum number of pairs exceeds the total number of LDEVs, and the total LDEVs are less than 32,768, then the total LDEV number is the maximum number of pairs that can be created.

### Maximum initial copy operations and priorities

During configuration, you specify the maximum number of initial copies that can be run at one time. The system allows up to 128 initial copies to run concurrently. You do this for performance reasons (the more initial copies running concurrently, the slower the performance).

You will also specify the priority for each initial copy during the create pair operation. Priority is used when you are creating multiple initial copies during an operation. Creating multiple initial copies in one operation is possible because you can specify multiple P-VOLs and S-VOLs in the Paircreate dialog box. The pair with priority 1 runs first, and so on up to 256.

When you create more pairs than the maximum initial copy setting, the pairs with priorities within the maximum number specified run concurrently, while the pairs with priorities higher than the maximum number wait. When one pair completes, a waiting pair begins, and so on.

If you perform a pair operation for multiple pairs (for a specific kind of data, for example), and then perform another operation for multiple pairs (for another specific kind of data, for example), the pairs in the first operation are completed in the order of their assigned priorities. The system begins processing pairs in the second set when the number of pairs left in the first set drops below the maximum number of initial copy-setting. This is shown in the following example.
Disaster recovery considerations

You begin a disaster recovery solution when planning the UR system. The following are the main tasks for preparing for disaster recovery:

- Identify the data volumes that you want to back up for disaster recovery.
- Pair the identified volumes using UR.
- Establish file and database recovery procedures.
- Install and configure host failover software error reporting communications (ERC) between the primary and secondary sites.

For more information on host failover error reporting, see the following topic. Also, review Disaster recovery operations on page 9-1 to become familiar with disaster recovery processes.

Host failover software

Host failover software is a critical component of any disaster recovery effort. When a primary system fails to maintain synchronization of a UR pair, the primary system generates sense information. This information must be
transferred to the remote site using the host failover software for effective disaster recovery. CCI provides failover commands that interface with industry-standard failover products.

Sharing volumes with other VSP software volumes

Universal Replicator volumes can be shared with other product volumes. Sharing pair volumes enhances replication solutions, for example, when Universal Replicator and TrueCopy or ShadowImage volumes are shared.

For planning information, see the following:

- Sharing volumes on page B-1
- Configurations with TrueCopy on page C-1
- Configurations with ShadowImage on page D-1

Planning UR in multiple VSPs using a consistency group

Copy operations can be run simultaneously on multiple UR pairs residing in multiple primary and multiple secondary systems. This is done by placing journals in the primary systems in a CCI consistency group. Data update order in copy processing is guaranteed to the secondary systems.

With multiple systems, the journals in the paired secondary systems are automatically placed in the consistency group.

With multiple systems, you can also place the journals from both OPEN and mainframe systems in the same CCI consistency group. When this configuration is used, URz journals cannot be placed in an EXCTG.

In addition, Universal Replicator volumes in multiple systems can be shared with other UR pairs and with TrueCopy pairs. See the following for more information:

- 3 UR data-center configurations on page A-1
- Configurations with TrueCopy on page C-1

You can register up to four journals in a single consistency group.

Any combination of primary and secondary system journals can be used. For example, you can include journals from four primary systems and four secondary systems, two primary systems and one secondary system, and so on.

An example configuration is shown in the following figure.
When data is sent to the secondary systems, the systems check time stamps, which are added when data is written by the hosts to the P-VOLs. The secondary systems then restore the data to the S-VOLs in chronological order (older data are restored earlier). This ensures that the update sequence is maintained.

Note the following when planning for multiple systems:

- Storage Navigator is required at the primary and secondary sites.
- CCI is required on the host at the primary and secondary sites.
- Journal data is updated in the secondary system based on the time stamp issued from CCI and the sequence number issued by the host with write requests to the primary system. Time and sequence information remain with the data as it moves to the master and restore journals and then to the secondary volume.
- With CCI consistency groups, when a pair is split from the S-VOL side (P-VOL status = PAIR), each storage system copies the latest data from the P-VOLs to the S-VOLs. P-VOL time stamps might differ by storage system, depending on when they were updated.
- Disaster recovery can be performed with multiple storage systems, including those with UR and URz journals, using CCI. See Switching host operations to the secondary site on page 9-3 for information.
- An error in one journal can cause suspension of all journals. See Suspension among journals on page 10-25 for more information.
- Time stamps issued by CCI and the mainframe host are different. The time stamps issued by the mainframe host become invalid when the URz journal is included in a CCI consistency group.
• Restoring data to the secondary system is performed when the time stamp of the copied journal is updated. The recommended interval between time stamps is one second.

Consider the following before setting the interval:

  - I/O response time slows when time stamps are updating among multiple storage systems. If you shorten the interval, more time stamps are issued, resulting in an I/O response time that is slower yet.
  - If the interval is lengthened, the amount of time that journal data can accumulate increases, which results in an increased amount of data to be copied.
  - None of the above is true during the initial copy or resynchronization. During these operations, lengthening the interval between time stamps does not result in more accumulated journal data, because data restoring takes place regardless of time stamp.

• The recommended method for executing CCI commands is the in-band (host-based) method. This prevents I/O response from deteriorating, which may occur with the out-of-band (LAN-based) method.

• Do not register a URz journal in an EXCTG if it is included in a CCI consistency group. A journal is automatically released from the EXCTG when the CCI pair resynchronization operation is performed.

• In a CCI consistency group containing both UR and URz journals, data consistency is maintained in a UR system when its storage system’s microcode is changed to a version previous to 70-03-0x. However, you cannot lower the microcode for the URz storage system.

• It is not possible to register a journal to multiple CCI consistency groups.

**Multiple journals per CCI consistency group**

Normally, only one journal can be registered in a CCI consistency group. With multiple VSP systems, however, up to four journals, including URz and UR journals, can be registered in a CCI consistency group. The following figures show different configurations in which multiple journals are registered in a single CCI consistency group.
3DC configurations using 3 UR sites

With Universal Replicator, you normally use two data centers—the primary and secondary sites.

You can employ a third site to create a 3-data-center (3DC) configuration. Using three sites makes a third copy of production data available in the event of primary and secondary site failure.

You can set up three UR sites in multi-target or cascade configurations. You also have the option of adding a delta resync pair.

For details, see 3 UR data-center configurations on page A-1.

Planning for previous models

Universal Replicator can be used to perform remote copy operations between VSP and USP V/VM or TagmaStore USP.

To perform remote copy between VSP and USP V/VM or TagmaStore USP, observe the following:

- Configure a remote path between LDKC00 of the VSP system and the USP V/VM.
  - More than one USP V/VM can be connected to LDKC00 of VSP.
  - LDKC01 cannot be used.
- Use the configuration instructions in Configuration operations on page 5-1.
- Both systems must be set up as shown in the figure below.
When connecting VSP with TagmaStore USP or USP V/VM, contact your HDS representative for information regarding supported microcode versions.

When connecting VSP with TagmaStore USP, set up the VSP using a CU:LDEV number between 00:00 to 3F:FF, but do not use 40:00 or higher.

When connecting VSP with USP V/VM, set up the VSP volume using a CU:LDEV number between 00:00 to EF:FF. The volume must be on LDKC00.

Up to 32,768 volumes can be used for volume pairs.

VSP and USP V/VM can be set up in 3-data-center (3DC) cascade or multi-target configurations. These configurations are used when combining TrueCopy and Universal Replicator systems. See Configurations with TrueCopy on page C-1 to review these configurations. There are no restrictions for combining primary and secondary sites between VSP and USP V/VM.

**Guidelines for preparing systems for UR**

Use the following guidelines to ensure that your VSP systems are ready for UR:

- Identify the locations where your UR primary and secondary data volumes will be located, then install and configure the VSP systems.

- Make sure that primary and secondary systems are configured for Storage Navigator operations. See *Hitachi Storage Navigator User Guide* for information.

- Make sure that primary and secondary systems are properly configured for UR operations, for example, cache memory considerations. See the entry for Cache and Nonvolatile Storage in the requirements table, System requirements on page 2-2. Also consider the amount of Cache Residency Manager data to be stored in cache when determining the required amount of cache.
• Make sure that primary and secondary systems have the system option modes specified that may be required for your UR configuration. See System option modes on page 3-18, below, for more information.

• Make sure that primary systems are configured to report sense information to the host. Secondary systems should also be attached to a host server to enable reporting of sense information in the event of a problem with an S-VOL or secondary system. If the remote system is not attached to a host, it should be attached to a primary site host server so that monitoring can be performed.

• If power sequence control cables are used, set the power select switch for the cluster to LOCAL to prevent the primary system from being powered off by the host. Make sure the secondary system is not powered off during UR operations.

• Install the UR remote copy connections (cables, switches, and so on) between the primary and secondary systems.

• When setting up data paths, distribute them between different storage clusters and switches to provide maximum flexibility and availability. The remote paths between the primary and secondary systems must be separate from the remote paths between the host and secondary system.

**System option modes**

To provide greater flexibility, the Virtual Storage Platform has additional operational parameters called system option modes (SOMs) that allow you to tailor the VSP to your unique operating requirements. The SOMs are set on the SVP by your Hitachi Data Systems representative.

The system option modes can be used for several kinds of UR customizations, including:

• 2DC configuration
• Delta resync configuration
• Configuring split options for mirrors
• Improving initial copy time

The following table lists and describes the SOMs for Universal Replicator. For a complete list of SOMs for the VSP, see the Hitachi Virtual Storage Platform User and Reference Guide.

| Note: The SOM information may have changed since this document was published. Contact your Hitachi Data Systems representative for the latest SOM information. |
### Table 3-1 System option modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
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</table>
| **448** | When the SVP detects a blocked path:  
Mode 448 ON: An error is assumed and the mirror is immediately suspended.  
Mode 448 OFF: If the path does not recover within a specified period of time, an error is assumed and the mirror is suspended.  
*Note*: Mode 448 setting is available only when mode 449 is set to OFF. |
| **449** | Mode 449 ON: The SVP does not detect blocked paths.  
Mode 449 OFF: The SVP detects blocked paths and monitors the time until the mirrors are suspended. |
| **466** | It is strongly recommended that the path between the main and remote storage systems have a minimum data transfer speed of 100 Mbps. If the data transfer speed falls to 10 Mbps or lower, UR operations cannot be properly processed. As a result, many retries occur and UR pairs may be suspended. This SOM is provided to ensure proper system operation for data transfer speeds of at least 10 Mbps.  
ON: Data transfer speeds of 10 Mbps and higher are supported. The JNL read is performed with 4-multiplexed read size of 256 KB.  
OFF (default): For conventional operations. Data transfer speeds of 100 Mbps and higher are supported. The JNL read is performed with 32-multiplexed read size of 1 MB by default.  
*Note*: The data transfer speed can be changed using the Change JNL Group options. |
With mode 474 set to ON, the initial copy time for a UR pair is improved when using the TC initial copy operation. The procedure requires use of a script, with the following operations:

- UR initial copy operation, with "None" specified for the Initial Copy parameter.
- Split the UR pair.
- TC initial copy operation, using the split UR pair volumes.
- Delete the TC pair.
- Resynchronize the UR pair.

Mode 474 ON: Using CCI improves performance.
Mode 474 OFF: Operations run normally.

If the P-VOL and S-VOL are both DP-VOLs, initial copy performance might not improve with SOM 474 set to ON. This is because with DP-VOLs, not all areas in a volume are allocated for UR; therefore not all areas in the P-VOL are copied to the S-VOL. With less than the full amount of data in the P-VOL being copied, the initial copy completes in a shorter time, which may not be improved with SOM 474.

Notes:

1. Set this mode for both MCU and RCU.
2. When this mode is set to ON:
   - Execute all pair operations from CCI/BCM.
   - Use a dedicated script.
   - Initial copy operation is prioritized over update I/O. Therefore, the processing speed of the update I/O slows down.
   - Version downgrade is disabled.
   - Take Over is not available.
3. If this mode is not set to ON for both sides, the behavior is as follows:
   - With setting on MCU/without setting on RCU: TC Sync pair creation fails.
   - Without setting on MCU/with setting on RCU: The update data for P-VOL is copied to the S-VOL in synchronous manner.
4. This mode cannot be applied to a UR pair that is the second mirror in a URxUR multi-target configuration, URxUR cascade configuration, or 3DC multi-target or cascading configuration of three UR sites. If applied, TC pair creation is rejected with SSB=CBED output.

<table>
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<tr>
<th>Mode</th>
<th>Description</th>
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<tbody>
<tr>
<td>474</td>
<td>With mode 474 set to ON, the initial copy time for a UR pair is improved when using the TC initial copy operation. The procedure requires use of a script, with the following operations: UR initial copy operation, with &quot;None&quot; specified for the Initial Copy parameter. Split the UR pair. TC initial copy operation, using the split UR pair volumes. Delete the TC pair. Resynchronize the UR pair. Mode 474 ON: Using CCI improves performance. Mode 474 OFF: Operations run normally. If the P-VOL and S-VOL are both DP-VOLs, initial copy performance might not improve with SOM 474 set to ON. This is because with DP-VOLs, not all areas in a volume are allocated for UR; therefore not all areas in the P-VOL are copied to the S-VOL. With less than the full amount of data in the P-VOL being copied, the initial copy completes in a shorter time, which may not be improved with SOM 474. Notes: 1. Set this mode for both MCU and RCU. 2. When this mode is set to ON: - Execute all pair operations from CCI/BCM. - Use a dedicated script. - Initial copy operation is prioritized over update I/O. Therefore, the processing speed of the update I/O slows down. - Version downgrade is disabled. - Take Over is not available. 3. If this mode is not set to ON for both sides, the behavior is as follows: - With setting on MCU/without setting on RCU: TC Sync pair creation fails. - Without setting on MCU/with setting on RCU: The update data for P-VOL is copied to the S-VOL in synchronous manner. 4. This mode cannot be applied to a UR pair that is the second mirror in a URxUR multi-target configuration, URxUR cascade configuration, or 3DC multi-target or cascading configuration of three UR sites. If applied, TC pair creation is rejected with SSB=CBED output.</td>
</tr>
<tr>
<td>506</td>
<td>Enables the delta resync operation. Mode 506 ON: The delta resync operation is performed if there are no update I/Os. Mode 506 OFF: The copy processing of all data is performed if there is no update I/Os.</td>
</tr>
<tr>
<td>Mode</td>
<td>Description</td>
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| 690  | Controls whether to prevent Read JNL or JNL Restore when the Write Pending rate on RCU exceeds 60% as follows:  
• When CLPR of JNL-Volume exceeds 60%, Read JNL is prevented.  
• When CLPR of Data (secondary)-Volume exceeds 60%, JNL Restore is prevented.  
MCU/RCU: This SOM applies to only the RCU.  
Mode 690 ON: Read JNL or JNL Restore is prevented when the Write Pending rate on RCU exceeds 60%.  
Mode 690 OFF (default): Read JNL or JNL Restore is not prevented when the Write Pending rate on RCU exceeds 60% (the same as before).  
Notes:  
1. This SOM can be set online.  
2. If the Write Pending status long keeps 60% or more on RCU, it takes extra time for the initial copy to be completed by making up for the prevented copy operation.  
3. If the Write Pending status long keeps 60% or more on RCU, the pair status may become Suspend due to the JNL-VOL being full.  
4. When TagmaStore USP/TagmaStore NSC is used on P-VOL side, this SOM cannot be used. If this SOM is set to ON, SSB=8E08 on P-VOL side and SSB=C8D1 on S-VOL side may frequently be output. |
| 908  | Changes cache memory (CM) capacity allocated to MPBs with different workloads.  
Mode 908 ON: Difference in CM allocation capacity among MPBs with different workloads is large.  
Mode 908 OFF (default): Difference in CM allocation capacity among MPBs with different workloads is small.  
Notes:  
1. Apply this SOM to CLPRs used only for UR JNLGs.  
2. Since CM capacity allocated to MPBs with low workload is small, the performance is affected by a sudden increase in workload.  
3. This SOM is effective for a CLPR. Therefore, when setting this SOM to ON/OFF, select target "LPRXX (XX=00 to 31)". For example, even when CLPR0 is defined (CLPR1 to 31 are not defined), select "LPR00" first and then set the SOM to ON/OFF. |
Planning the data path

A data path must be designed to manage your organization’s throughput to the remote site. The bandwidth, number of ports, and fibre-channel data path configuration that you use help ensure that your update data arrives at the remote site in a time consistent with your organization’s RPO.

This chapter provides instructions for calculating bandwidth and designing the data path network.

- Data path design workflow
- Sizing bandwidth
- Planning ports for data transfer
- Cable length and switch requirements
- Supported data path configurations
Data path design workflow

To set up a data path, you must establish the following:

- The amount of bandwidth to move data generated by your host application under all I/O conditions. See Sizing bandwidth on page 4-2.
- Ports that can send and receive data. See Planning ports for data transfer on page 4-7.
- The type of cable and number of switches required. See Cable length and switch requirements on page 4-8.
- The configuration that works best for your sites. See Supported data path configurations on page 4-10.

This chapter discusses these topics in detail.

Sizing bandwidth

You purchase bandwidth according to the amount of data that will be transferred from the primary to the secondary system within a certain amount of time.

If the data path network cannot keep pace with the flow of data, the data is saved in the journal until additional bandwidth capacity becomes available. If the journal also cannot keep up, the integrity of the pairs is lost and a new initial copy must be created.

In general, bandwidth is expensive. Adding capacity to a journal volume is relatively inexpensive. But the more data that accumulates in the journal, the further the secondary image is from the production volumes. Therefore, sizing bandwidth is a trade-off between expense and keeping your secondary volume as consistent as you need it to be with the primary volume.

Five sizing strategies

The following sizing strategies are provided to help you work out an approach to sizing bandwidth. Be aware that these are not the only strategies you can use.

- **Size bandwidth to peak workload.** This results in the smallest difference between data in the P-VOL and S-VOL. Identify peak workload on the production disks, then add extra capacity to accommodate packet loss and protocol overhead. RPO is at or near zero when bandwidth is sized to peak workload.

- **Size bandwidth to peak workload rolling average.** The rolling average is less than peak but more than average. This guarantees that at some point data will accumulate in the journal, but most of the time it will not. Your system can afford to journal for the amount of time planned for and still maintain RPO.

- **Size bandwidth to typical workload.** When bandwidth is sized to typical write-workload, and an extended peak workload is experienced, excess write-data is written to journal. This excess data is delayed for
subsequent FIFO transmission to the remote site when network capacity becomes available. Differential data is proportional to the amplitude and duration of the workload surge.

- If you cannot determine a “typical” workload, **sizing should be to the average or mean workload**, plus a small compensation for network overhead. In this scenario, excess data in the journals will be completely emptied to the S-VOL only occasionally. If bandwidth is sized below average write-workload, the journals never fully drain and eventually overflow.

- You can size bandwidth and journal size for long-haul data migration, to be used where data consistency is not required. In this strategy, you use **alternate pair status between resync and suspend** in order to “batch copy” point-in-time copies. When pairs are suspended, journals are not used to queue write operations. Rather, a bitmap is used to track which cylinders have changed on the physical disks. For access patterns that favor multiple writes to a relatively small region of disk, this technique can provide especially efficient transfer of data, since multiple writes to one region are not sent each and every time. Only the last update before resync is sent. The disadvantage of this strategy is that it does not guarantee I/O consistency on the secondary system until the resync completes.

**Calculating bandwidth**

To determine bandwidth for Universal Replicator, write-workload must be measured. Production system workload data is collected using performance monitoring software. Please see **Measuring write-workload on page 3-4**.

When you have collected write-workload data, size your bandwidth according to your sizing strategy. In the following procedures, bandwidth is sized for peak and peak rolling average write-workload.

**Sizing bandwidth for peak write-workload**

1. Make sure that write-workload data is imported into a spreadsheet tool. Column C in the figure below shows an example of collected raw data over 10-minute segments.
2. Locate the highest peak. Based on your write-workload measurements, this is the greatest amount of data transferred during the collection period. It indicates the base amount of data that your bandwidth must be able to handle for near 0 RPO.

Though the highest peak is used for determining bandwidth, you should take notice of extremely high peaks. In some cases a batch job, defragmentation, or other process could be driving workload to abnormally high levels. It is sometimes worthwhile to review the processes that are running. After careful analysis, it may be possible to lower or even eliminate some spikes by optimizing or streamlining high-workload processes. Changing the timing of a process may lower workload.

3. With a base bandwidth value established, make adjustments for growth and a safety factor.
   - Projected growth rate accounts for the increase expected in write-workload over a 1, 2, or 3 year period.
   - A safety factor adds extra bandwidth for unusually high spikes that did not occur during write-workload measurement but could.

### Sizing bandwidth for peak rolling average write-workload

1. Using write-workload data imported into a spreadsheet and your RPO, calculate write rolling-averages.

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<tbody>
<tr>
<td>1</td>
<td>Sample #</td>
<td>Time - 10 min. segments</td>
<td>Raw Data - MB/sec collected per 10 min. segment</td>
<td>30 Min Rolling Ave</td>
<td>60 Min Rolling Ave</td>
<td>24 Hour Rolling Ave</td>
<td>Raw Data Project Growth</td>
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For example, if RPO time is 1 hour, then 60-minute rolling averages are calculated. Do this by arranging the values in six 10-minute intervals, as follows:

a. In cell E4 type, =average(b2:b7), and press Enter. (Most spreadsheet tools have an average function.)

This instructs the tool to calculate the average value in cells B2 through B7 (six 10-minute intervals) and populate cell E4 with that data. (The calculations used here are for example purposes only. Base your calculations on your RPO.)

b. Copy the value that displays in E4.

c. Highlight cells E5 to the last E cell of workload data in the spreadsheet.

d. Right-click the highlighted cells and select the Paste option.

Excel maintains the logic and increments the formula values initially entered in E4. It then calculates all the 60-minute averages for every 10-minute increment, and populates the E cells. This is shown in the following figure, which is an example using Microsoft Excel. For comparison, 24-hour rolling averages are also shown.

<table>
<thead>
<tr>
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<tr>
<td></td>
<td>Sample #</td>
<td>Time - 10 min.</td>
<td>Raw Data - MB/sec</td>
<td>30 Min Rolling Ave</td>
<td>60 Min Rolling Ave</td>
<td>24 Hour Rolling Avg</td>
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Figure 4-2 Rolling averages calculated using 60 minute RPO

For another perspective, you can graph the data, as shown in Figure 4-3 60-Minute rolling averages graphed over raw data on page 4-6.
2. From the spreadsheet or graph, locate the largest or highest rolling average value. This is the peak rolling average, which indicates the base amount of data that your bandwidth must be able to handle.

3. With a base bandwidth value established, make adjustments for growth and a safety factor.
   - Projected growth rate accounts for the increase expected in write-workload over a 1, 2, or 3 year period.
   - A safety factor adds extra bandwidth for unusually high spikes that did not occur during write-workload measurement but could.

Other factors that must be taken into consideration because of their effect on bandwidth are latency and packet loss. These are discussed in the following topics.

**Latency**

Network latency affects replication. It is the amount of data that can be present in the data path. In the event of network failure, a certain number of transmitted records will not yet be resident in the secondary system’s journal because they are still in-route within the data path. During periods of low workload, there may be no records in the path, but during periods of heavy workload, the network is fully used. This amount represents the minimum difference between data in the primary and secondary systems.
Packet loss

Packet losses have the effect of reducing overall bandwidth because lost packets must be re-transmitted, which consumes network capacity that would otherwise be occupied by new data traffic. Also, a network can elongate consistency time, since journals are not applied until a contiguous sequence of records has arrived at the secondary site.

Planning ports for data transfer

When new data exists in the P-VOL, informational commands are sent from the primary system initiator port to the secondary system RCU target port.

The secondary system initiator port sends journal query commands to the primary RCU target port. The data is then sent through these ports — that is, from primary side RCU target ports to secondary system initiator ports.

Note the following:

• An initiator port on one side must have an RCU target port on the other side.
• Two or more initiator ports must be configured before you can create the UR relationship with the secondary system and create pairs.
• The amount of data each of port can transmit is limited. Therefore, it is critical to know the amount of data that will be transferred during peak periods. This knowledge will ensure that you can set up a sufficient number of ports as initiator and RCU target ports in order to handle all workloads.
• If your UR system supports a disaster recovery failover/failback environment, initiator and RCU target ports should be sized equivalently on primary and secondary systems.
• Up to eight paths can be established in both directions. It is recommended that you establish at least two independent data paths to provide hardware redundancy.
• Host paths cannot be connected to an initiator port. However, they can be attached to RCU target ports.

Example configuration

• Two initiator ports on the local side, with two matching RCU target ports on the remote side
• Four initiator ports on the remote side, with four matching RCU target ports on the local side.

Port types

The primary and secondary systems require both initiator and RCU target ports. Both systems send and receive traffic during active replication.

• The initiator port on the primary side is connected to the RCU target port on the secondary side.
• The initiator port on the secondary side is connected to the RCU target port on the primary side.

VSP ports are designated as target ports by default. When you determine the number of initiator ports and RCU target ports your UR system requires, you change port attributes from target to initiator and RCU target.

The fibre-channel ports on VSP systems can have the following attributes:

• **Initiator port:** Sends UR commands to the paired system. Initiator ports must be configured on both primary and secondary systems for pair operations.
  Two or more initiator ports must be configured before you can add the secondary systems and create pairs.

• **RCU Target port:** Receives UR commands and data. RCU target ports must be configured on both primary and remote storage systems for pair operations.

• **Target port:** Connects the system and an open systems host. When the host issues a write request, the request is sent via a target port to a volume on the VSP system. Target ports must be configured on primary systems for UR operations.

• **External port:** Required for Universal Volume Manager copy operations. This port is not used for UR copy operations. This port can be changed to a target, initiator, or RCU target port.

**Determining required number of ports**

The data transfer speed of your UR ports must be greater than peak write-IOPS. This means that you must dedicate the number of ports to a UR pair that will be able to handle the peak IOPS generated by your production system. The minimum number of ports for a UR system is two.

To determine the required number of initiator and RCU target ports

1. Measure the write workload you want to replicate on your production system. When you measure write-workload, IOPS is also provided. (See Measuring write-workload on page 3-4 for more information.)

2. Using peak IOPS and the maximum IOPS for a VSP fibre-channel port (70,000), calculate the number of ports your UR system requires.

\[
\text{Peak IOPS} / 70,000
\]

For example: if your performance monitoring software shows peak IOPS at 280,000, then the calculation would be:

\[
280,000 / 70,000 \text{ (max. IOPS per port)} = 4.
\]

This example shows that four ports are required for the measured peak IOPS.

**Cable length and switch requirements**

Multimode or single-mode optical fiber cables are required on primary and secondary systems. The type of cable and number of switches depends on the distance between primary and secondary sites.
• 0 to 0.5 km: multimode optical shortwave fiber cables are required.
• 0.5 km to 1.5 km (1,640 to 4,920 feet): multimode shortwave fibre-channel interface cables are required; one switch is required, two maximum.
• 1.5 km to 10 km: single optical long-wave fiber cables are required.
• 10 km to 30 km (6.2 to 18.6 miles): single-mode long-wave fibre-channel interface cables are required; one switch is required, two maximum.
• Greater than 30 km (18.6 miles): approved third-party channel extender products and telecommunications lines are required.

This information is illustrated in Figure 4-4 Data path types, switches, and distances on page 4-9.

Additional switches

When the initiator port on the primary system sends data to the secondary system, the fibre-channel protocol accommodates a certain number of unacknowledged frames before the sender must stop sending. These are known as buffer credits. As fibre-channel frames are sent out, available buffer credits are exhausted. As acknowledgments come back, the supply of buffer credits is replenished. Because it takes longer for acknowledgments to return as distance increases, exhausting the supply of buffer credits becomes increasingly likely as distance increases.

Adding fibre-channel switches on either end of the replication network provides the additional credits necessary to overcome buffer shortages due to the network latency.
Supported data path configurations

The remote data path can be configured using one of the following connection types. For a switch connection, you must set the port to Fabric on, Point-to-Point (F-port).

- Direct connection, as shown in Figure 4-5 Direct connection configuration on page 4-10. Direct connection (loop only) is a direct link between the local and remote arrays. NL-port (Node Loop) connections are supported for the data path and host-to-system path.

- Switch connection, as shown in Figure 4-6 Switch connection configuration on page 4-11. Switch connections push data from the local switch through a fibre-channel link across a WAN to the remote switch and fibre channel of the remote system. F-port (point-to-point) and FL-port (loop) switch connections are supported.

- Extender connection, as shown in Figure 4-7 Extender connection configuration on page 4-11. Make sure that your channel extenders are can support remote I/O. For further details, contact your HDS account team.

![Figure 4-5 Direct connection configuration](image-url)
Figure 4-6 Switch connection configuration

Figure 4-7 Extender connection configuration

Note: When an MCU and RCU are connected using switches with a channel extender, and multiple data paths are configured, the capacity of data to be transmitted may concentrate on particular switches, depending on the configuration and the settings of switch routing. Contact your Hitachi Data Systems account team for more information.
Configuration operations

This chapter provides instructions for configuring Universal Replicator.

- Configuration workflow
- Defining fibre-channel port attributes
- Configuring local and remote systems for UR
- Configuring additional logical paths
- Specifying number of concurrent initial/resync copies
- Registering journal volumes in a journal
**Configuration workflow**

This workflow and subsequent topics guides you in setting up the primary and secondary systems for Universal Replicator operations using Storage Navigator.

1. Log in to Storage Navigator.
2. Define the fibre-channel port attributes. See Defining fibre-channel port attributes on page 5-2, below.
3. Set up logical paths between the primary and secondary systems. See Configuring local and remote systems for UR on page 5-3
4. Register journal volumes in a journal. See Registering journal volumes in a journal on page 5-10

You may also perform these additional procedures before the initial copy:

- Add more logical paths. See Configuring additional logical paths on page 5-7.
- Specify the number of volumes to copy. See Specifying number of concurrent initial/resync copies on page 5-8.

Be sure to check the prerequisites for each procedure. Some tasks are performed from both local and remote systems. Other tasks are performed from one or the other.

**Defining fibre-channel port attributes**

Initiator, and RCU target ports must be set up on the primary and secondary systems for Universal Replicator command and data transfer.

**Prerequisite information**

- Before a fiber channel target port can be changed to an initiator port, the following must be performed:
  - Disconnect the port from the host.
  - Release all affected pairs.
  - Delete all logical paths from the initiator port to the remote system.
  - Remove all cables to the port.
- Before a fiber channel initiator port can be changed to target or RCU target, the following must be performed:
  - Release all affected pair.
  - Delete all logical paths from the initiator port to the remote system.
  - After logical paths are deleted, remove the cables connecting the local system to the remote system.
- Check that the number of hosts connected to a target port is not more that the maximum of 128 to avoid disconnection.

See Planning ports for data transfer on page 4-7 for information on target, initiator, and RCU target ports and to determine the number of initiator and RCU target ports required by your system.
To define port attributes

1. In the Storage Navigator main window, select **Actions > Remote Copy > Universal Replicator > DKC Operation.**

2. Click ⚙️ to change the mode from View to Modify.

3. In the Display box, select Port.

4. In the list of ports, right-click the port that you want to change and select the desired port type: **Initiator**, **RCU Target**, or **Target**.

5. When you are finished defining ports, review the Preview list.
   - To change a setting, right-click the port in and select the attribute.
   - To delete a setting, right-click the port and select **Delete**.

6. Click **Apply** to save your modifications in the system.

**Configuring local and remote systems for UR**

You associate the primary and secondary systems in the Universal Replicator relationship and define the logical paths between them in one procedure.
Prerequisite information

- This procedure must be performed on both primary and secondary systems.

- The primary and secondary systems must already be configured for Universal Replicator operations. See System requirements on page 2-2 for more information.

- The data path must be set up. See Planning the data path on page 4-1 for more information.

- The port attributes on the primary and secondary systems must be configured for UR. See Defining fibre-channel port attributes on page 5-2.

- The system's serial number, LDKC number, controller ID, Path Gr. ID, and port number will be required during this procedure.

- Logical path settings are required in order to perform Universal Replicator pair operations and check pair status in Storage Navigator. Make sure to complete the procedure. If you cancel logical path settings, you will be unable to perform operations and check status.

Also, operations involving logical paths cannot be performed when changing the microcode. Make sure the microcode change completes before performing operations involving logical paths.

To set up UR, define logical paths

1. In the Storage Navigator main window, select Actions > Remote Copy > Universal Replicator > DKC Operation.

2. In the DKC Operation window, click to change the mode from View to Modify.

3. In the Display box, select DKC.
4. In the remote system list on the right-side, right-click and select **DKC Operation > Add DKC**.
5. In the **S/N** box, enter the remote system’s 5 or 6-digit serial number.

---

**Note:** Virtual storage machine serial numbers used with VSP G1000 must be identified by physical information, not virtual, when accessing the pair from a VSP.

6. In the **LDKC** box, select the remote system’s LDKC number. Currently, all system models’ LDKC is **00**.

7. In the **Controller ID** box, select the remote system’s controller ID.
   - For VSP G1000, the controller ID is **7**.
   - For VSP, the controller ID is **6**.
   - For USP V/VM, the controller ID is **5**.
   - For TagmaStore USP/TagmaStore NSC, the controller ID is **4**.
   - For HUS VM, the controller ID is **19**.

8. In the **Path Gr. ID** box, when connected to a VSP or VSP G1000, select the ID that identifies the path group. If not connected to a VSP, 0 is the only value possible at this time.
   
   For more information, see the Path Group item in System requirements on page 2-2.

9. In the **M-R Path** box, define the fibre-channel port for the logical path between local and remote systems:
   a. In the **Port** column, select a local system initiator port.
   b. In the **Pair-Port** column, select the remote system RCU target port.

   You may enter port numbers using the keyboard. You may abbreviate the number to two characters. For example, “1A” may be entered instead of “CL1-A”. Letters may be uppercase or lowercase.

10. Click **Option**.

   ![DKC Option]

   11. In the DKC Option dialog box, **Minimum Paths** is intended for a future release. Continue to the next step.

   12. In the **RIO MIH Time** box, enter the time interval in seconds that, if exceeded, will cause the data transfer operation to be reported as failed by the system. Valid values range from 10 seconds to 100 seconds, and the default is 15 seconds.
RIO MIH means “remote I/O missing interrupt handler”.

Note: The recommended RIO MIH setting for a 3DC cascade configuration is 20 seconds.

13. Click **Set**.
   - To change a path, right-click it in the Preview list and select **Modify**. Make any changes in the Add Path dialog box then click **Set**.
   - To delete an added logical path, right-click the path in the Preview list and select **Delete**.

14. Click **Apply** to save the configuration.

**Configuring additional logical paths**

You can configure additional logical paths as needed. A maximum of eight logical paths are supported.

**Prerequisite information**

Review the prerequisites for configuring logical paths in Configuring local and remote systems for UR on page 5-3.

**To configure additional logical paths**

1. In the Storage Navigator main window, select **Actions > Remote Copy > Universal Replicator > DKC Operation**.

2. Click **** to change the mode from View to Modify.

3. In the tree, select the remote system. The logical paths display in the full right-side list.

4. Right-click a logical path, and select **Add Path** from the menu.
5. In the M-R Path box, define the fibre-channel port used by the logical path between local and remote systems:
   a. In the Port column, select a local system initiator port.
   b. In the Pair-Port column, select the remote system RCU target port.

   You may enter port numbers using the keyboard. You may abbreviate the number into two characters. For example, "1A" may be entered instead of "CL1-A". Letters may be uppercase or lowercase.

6. Make any changes in the Add Path dialog box, then click Set.

7. Review the logical paths in the Preview list.
   - To make a change, right-click the path in the Preview list and select Modify.
   - To delete an added logical path, right-click the path in the Preview list and select Delete.

8. Click Apply to add the logical paths.

**Specifying number of concurrent initial/resync copies**

You can specify the number of volumes to be copied concurrently during initial copy and resynchronization operations. Doing this allows you to create or resynchronize pairs with similar kinds of data. Make sure that your system resources are adequate for the number of pairs you want to create.
or resynchronize. Concurrent copy requires more resources such as bandwidth and shared memory. See Maximum initial copy operations and priorities on page 3-10 for more information.

To specify number of volumes to copy concurrently
1. In the Storage Navigator main window, select Actions > Remote Copy > Universal Replicator > Optional Operation.

2. Click  to change the mode from View to Modify.
3. Right-click the value in Activities in the right pane, then select Change System Option from the menu. The System Option dialog box displays.
4. In the **Maximum Initial Copy Activities** box, enter the number of volumes that you want to be copied concurrently during initial copy and resynchronization operations. Valid values range from 1 to 128 volumes. The default is 64.
   - This setting can impact performance on the primary system, depending on the number specified and the amount of I/O activity. By using the default, 64 volumes, you limit the impact of initial copy operations on system performance.
   - When you create or resynchronize a greater number of pairs than you define in Maximum Initial Copy Activities, the system processes the specified maximum number, and starts additional pairs after one of the specified number is synchronized.
     
     For example, if you specify 70 for Maximum Initial Copy Activities and then create 75 pairs, the system starts the first 70 pairs but does not start the 71st pair until one of the pairs is synchronized.

5. Click **Set**. Review if needed in the Preview list.
   - To modify the setting, right click and select **Modify**.
   - To cancel, right click and select **Cancel**.

6. Click **Apply** to save the configuration.

**Registering journal volumes in a journal**

You set up journal volumes by registering them in a journal. The procedure in this section allows you to register journal volumes for use in 3 UR DC configurations. You must either enable all journal volumes being registered in the session for use in a 3 UR DC configuration, or specify that all journals registered in the session are not for use in these configurations (disable).

**Prerequisite information**

- Review the following:
  - System requirements on page 2-2
  - Planning journals on page 3-5
  - Planning journal volumes on page 3-7
- The journal’s mirror status must be Initial, Active, Stopped, Hold, Holding, or Hold(Failure).
- The journal cannot be in use.
- Pair operations involving the journal cannot be in progress.
- Cache Residency Manager settings cannot be defined for the volumes.

**To register journal volumes**

1. In Storage Navigator, select **Actions > Remote Copy > Universal Replicator > Journal Operation**.
2. In the Journal Operation window, click ☐ to change the mode from View to Modify.

3. To register journal volumes in an existing journal, select the journal from the **Registered > LDKC00** tree.
   
   To register journal volumes in a new journal, select the journal from the **Free > LDKC00** tree.
   
   The selected journal displays in the table pane.

4. Right-click the selected journal then select **Edit JNL VOLs** from the menu.
5. In the **Edit Journal Volumes** dialog box, in the **Free Volumes** list, select the volumes that you want to register. Each row represents a volume in the list.

**Note:** Only OPEN-V volumes display in **Free Volume**.

If you cannot find the volumes, select one of the following in the PG/CU change area:

- **PG**, then enter a parity group number in the box, and click **Show**. A list of volumes in the specified parity group displays. Select the volumes that you want to register.
- **PG(Ext.)**, then enter the external parity group number in the box, and click **Show**. A list of volumes in the specified external parity group displays. Select the volumes that you want to register.

Though parity group numbers for external volumes start with the letter "E", you do not need to enter "E" in the text boxes. For example, to specify the parity group number "E1-2", you would enter 1 and 2 into the text boxes.

- **CU**, then select a CU number from the list. A list of volumes in the specified CU displays. Select the volumes that you want to register.
6. Use **UR 2DC or 3DC** to assign journals for use in 2-UR DC or 3-UR DC configurations. You must enable or disable this option for all journals being registered. Only unused journals can be specified.

Select one of the following:

- **Enable**: Defines journals for use in 2-UR DC or 3 UR DC configurations.
  
  Note that when a journal is defined for a 3 UR DC configuration, the micro code cannot be downgraded to 70-03-xx or earlier. The journal would have to be deleted to downgrade.

- **Disable**: Specifies that the journals are not for use in a 2-UR DC or 3 UR DC configuration.

7. Click **Add**, then **Set** to close the **Edit Journal Volumes** dialog box.

8. Review the added journal volumes in the Preview list.

   - To add another volume, right-click the desired journal and select **Modify**. In the dialog, add the volume and click **Set**.
   
   - To cancel a path, right-click it in the Preview list and select **Cancel**.

9. Click **Apply** to save the configuration.

After journal volumes are registered to the unused journal, the journals are shown below as **Registered >LDKC00** in the tree. If an error occurs, right-click the item in the **Preview** list and select **Error Detail**.
This chapter provides instructions for performing Universal Replicator pair operations.

- Pair operations workflow
- Checking pair status
- Creating the initial copy
- Splitting pairs
- Splitting mirrors
- Creating point-in-time copies
- Resynchronizing pairs
- Resynchronizing mirrors
- Deleting pairs
- Deleting pairs in a mirror
Pair operations workflow

The basic UR operations consist of the following:

- Check pair status. Each UR operation requires the pair to be in a specific status.
- Create the pair, in which the S-VOL becomes a duplicate of the P-VOL.
- Split the pair, which separates the P-VOL and S-VOL and allows read/write access to the S-VOL if desired.
- Restore the pair so that the S-VOL again mirrors the on-going, current data in the P-VOL.
- Delete a pair, which removes the pair relationship from the volumes.

Note: Pair operations cannot be performed if micro exchange is in progress or if micro exchange is suspended because the Cancel button has been pressed or because errors have occurred. If you start a microcode change, be sure it completes before performing pair operations.

Note: You cannot use Storage Navigator to perform pair operations or check pair status on volumes with LU path settings that have been canceled. Before you perform pair operations or check the pair status, configure the LU path settings to the volume on which you want to perform these actions.

Checking pair status

Every UR operation requires that pairs have a specific status. Before performing any operation, check pair status.

- Find status requirements in the prerequisite information for each operation.
- To view a pair’s current status in the GUI, or to review status definitions, see Monitoring pair activity and status on page 7-2.

Creating the initial copy

The pair is created when you create the initial copy. All data in the P-VOL on the primary system is copied to the S-VOL on the secondary system. The P-VOL remains available to the host for I/O operations.

Prerequisite information

- The initial copy must be performed from the primary system.
- Pair status of both data volumes must be SMPL.
- S-VOLs must be offline to all hosts.
- The primary and secondary systems and logical paths must be defined. See Configuring local and remote systems for UR on page 5-3 for more information.
- Journal volumes must be registered to the journals that are associated with pairs. See Registering journal volumes in a journal on page 5-10 for more information.
• If you are creating multiple pairs at one time, you must specify the number of volumes that initial copy operations can be performed on concurrently. See Specifying number of concurrent initial/resync copies on page 5-8 for more information.

• If you are creating a UR pair for delta resync, see Procedure for creating a delta resync pair on page C-8.

• Make sure Performance Monitor is stopped.

The following additional information may be useful to you before beginning the procedure:

• You will select the volumes you will pair by the volume’s port, GID, and LUN. Make sure to have this information available.

• You will assign master and restore journals to the P-VOL and S-VOL during the operation.

• You will assign a mirror ID to the pair. This identifies the pair within the journal. A mirror refers to the pair within the journal.

To create an initial copy or copies

1. In the Storage Navigator main window, select Actions > Remote Copy > Universal Replicator > Pair Operation.

2. Click to change the mode from View to Modify.

3. In the tree, select the port of the P-VOL or host group (displayed below the ports).
4. From the list of volumes in the right pane, right-click a volume you want to pair select Paircreate from the menu.
   - Volumes with the pair icon are already used as P-VOLs.
   - Volumes with the pair icon are already used as S-VOLs.
   - If you create more than one pair at a time, the S-VOLs must be in the same secondary system.
Data for the selected volume displays in the P-VOL box. The numbers indicate the volume port, GID, LUN, and volume.

One P-VOL displays at a time, even if you selected multiple volumes for pairing. The volume with the lowest number displays first.

5. Specify an S-VOL.

- To create one pair, select the port, GID, and LUN from the three S-VOL boxes. If you selected multiple volumes as P-VOLs, the S-VOL you specify is paired with the P-VOL displayed in P-VOL.
- If you selected multiple volumes as P-VOLs and want to create multiple pairs, do one of the following using the Select Other S-VOL(s) list to assign S-VOLs:
- Select **Increment** to add the secondary system LUN incrementally. Your S-VOL LUN numbers must be numbered incrementally. For example, if you create three pairs and specify 011 on the LUN of **P-VOL**, the LUNs on the secondary system are incremented at 011, 012, and 013.

- Select **Input Next** to specify S-VOL LUNs one at a time for each P-VOL. For example, set the S-VOL LUN for the current P-VOL and click **Set**, then reopen the dialog box to set the next S-VOL, and so on.

- Select **Relative to P-VOL** to add the S-VOL LUN closest to the P-VOL’s LUN. For example, if the LUN of the three P-VOLs are 001, 005, and 006, and you select LUN 002 for the first S-VOL, LUN numbers 006 and 007 are assigned by the system as the next two S-VOLs.

6. In the **Mirror** box, proceed as follows.
   a. Select the master journal from the **M-JNL** list.
   b. Select a mirror ID (0 to 3) from the **Mirror ID** list.
   c. Select a restore journal from the **R-JNL** list. Only journal numbers between 000 and OFF display.

**Note:** The M-JNL list does not display journal numbers used by Universal Replicator for Mainframe.

7. From the **CT Group** list, specify the consistency group number. If possible, assign the consistency group number matching the Universal Replicator journal number (best practice).

8. In the **DKC** list, select the secondary system, which must be the same for all pairs created in the operation. Secondary systems are identified in the list by serial number, LDKC number, controller ID, model name, and ID (Path Gr. ID).

   When the system is not connected to a VSP or VSP G1000, only 0 (default) is available for Path Gr. ID.

   If a pair is already created in the mirror being used, you must select the same secondary system as the existing pair.

9. In the **Initial Copy** list, select one of the following:
   - **Entire**, to create the UR pair relationship and copy the data from primary to secondary volumes immediately.
   - **None**, to create the UR pair relationship but copy no data from primary to secondary volumes. If you select this option, the data in the P-VOL and S-VOL must be identical.
   - **Delta**, to create the UR pair for a delta resync. The initial copy operation does not start and the pair status changes to HOLD or HOLDING.

10. In the **Priority** list, specify the scheduling order for this initial copy operation, if the number of initial copies in the operation is greater than the maximum concurrent copy setting. 1 to 256 can be specified, 32 is the default.

    See **Maximum initial copy operations and priorities on page 3-10** if running more initial copies than previously specified.
If a time-out error occurs during the Paircreate operation, the copy operation might not have been executed in the order that you set with the Priority parameter. The time out error may be caused by the CU configuration or a remote copy path error. Review the error, release the pair with the error, and then retry the Paircreate operation.

11. In the Error Level list, select one of the following options for the action to take if a failure occurs during this operation:
   - Mirror, to split all pairs in the failed pair’s mirror. Mirror is the default.
   - LU, to split only the pair that failed.

12. Click Set to close the Paircreate dialog box.

13. In the Preview list check your settings.
   - To modify a setting, right click and select Modify.

   ! Note: If you right click more than one volume in the Preview list and select Modify, the Select Other S-VOL(s) list in the Paircreate dialog box indicates No Change. To change the setting, select another option from the list.
   - To cancel a setting, right click and select Cancel.

14. Click Apply to apply the settings and create pairs.

15. In the Pair Operation window, verify that the pair status is correct based on the initial copy option:

<table>
<thead>
<tr>
<th>Initial Copy Option</th>
<th>Current Pair Status Should Be</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire or None</td>
<td>COPY or PAIR</td>
</tr>
<tr>
<td>Delta</td>
<td>HOLD, Holding</td>
</tr>
</tbody>
</table>

16. (Optional) You can monitor the progress of the paircreate operation by clicking File > Refresh in the menu bar. This updates the information in the list.

   You can also review current pair activity and pair status in the Detailed Information dialog box. See Monitoring pair activity and status on page 7-2 for more information.

**Splitting pairs**

When you split a pair, write-data is no longer sent to S-VOL and the pair is no longer synchronized. Splitting a pair or mirror gives you a point-in-time copy of the P-VOL.

**Prerequisite information**

- This operation can be performed from the primary or secondary system.
- Pair status must be COPY or PAIR.
- To split multiple pairs at the same time, the pairs must belong to the same mirror. This ensures sequence consistency among S-VOLs in the mirror.
• When splitting pairs in a journal that is in a CCI consistency group consisting of multiple primary and secondary systems, make sure to select **Mirror** in the **Range** field. If you select **LU**, the pair will not be split.

The following additional information may be useful before beginning the procedure:

• Performing the pair split when I/O load is low reduces impact on performance. Operations on multiple pairs in the same consistency group with different statuses may result in suspension during periods of heavy write I/O.

• If you split pairs in PAIR status and other than PAIR status in the same mirror, an unexpected suspension could occur during the operation under heavy I/O load conditions. You can estimate whether the I/O load is heavy or not from the frequency of host I/Os. This operation should be performed under light I/O load conditions.

• During normal operations, the secondary system rejects write operations to an S-VOL. However, you can enable write operations to the S-VOL during the pair split operation. When you do this, then resync the pair, the secondary system sends the S-VOL track bitmap to the primary system to ensure proper resynchronization of the pair. This S-VOL Write option is described in the pair-split procedure.

**To split one or more pairs**

1. In the Storage Navigator main window, select **Actions > Remote Copy > Universal Replicator > Pair Operation**.

2. Click to change the mode from View to Modify.

3. In the tree, select the port or host group for the pair.

4. From the list of volumes in the right pane, select the pairs that you want to split, right-click, and select **Pairsplit-r** from the menu.

5. In the Pairsplit-r dialog box’s **S-VOL Write** list, select one of the following:
   - **Enable**, to permit hosts to write data to the S-VOL.
   - **Disable**, (the default) to prevent hosts from writing to the S-VOL

6. From the **Range** list, select one of the following:
   - **LU**, to split only the selected pairs.
Mirror, to split all pairs in the selected pairs’s mirror.

If you are splitting some pairs in a mirror but not all, you must select LU for each of these pairs. Do not select Mirror in this case, otherwise an error occurs.

7. From the Suspend Mode list, select one of the following:
   - Flush, to copy all update data to the S-VOL before the split operation is completed.
     When the secondary system receives a request for splitting a pair, all update data is written to the S-VOL from the journal. The status of the pair changes from Suspending to PSUS.
   - Purge, to prevent update data from being copied to the S-VOL before the split operation is completed. When you re-synchronize, uncopied update data is then copied to the S-VOL.

8. Click Set.

   - To modify a setting, right click and select Modify.
   - To cancel a setting, right click and select Cancel.

10. Click Apply to commit the settings to the system.

You can verify the PSUS status when the operation is completed.

### Splitting mirrors

A mirror normally has multiple pairs with the same master and restore journals groups. When you split a mirror, you split all the pairs in the mirror. As with a normal pair split, data copying is suspended between primary and secondary journals.

**Prerequisite information**

- A mirror can be split from the primary or secondary system.
- Pair status must be Active.

**To split a mirror**

1. In the Storage Navigator main window, select Actions > Remote Copy > Universal Replicator > Pair Operation.

2. Click to change the mode from View to Modify.

3. In the tree, expand Registered then select the LDKC. Journals display in the tree and mirrors display in the right pane.

4. Select one or more mirrors.

5. Right-click and select Mirror > Pairsplit-r from the menu.

6. In the Pairsplit-r dialog box, follow the steps for the each option in Splitting pairs on page 6-7. Note that Mirror in the Range field cannot be changed for this operation.
You can verify the Stopped status of the mirror when the mirror split operation is completed.

**Creating point-in-time copies**

Universal Replicator allows you to make Point-in-Time (PiT) copies of volumes in the same journal. Point-in-Time describes a copy of data made when you it.

**Prerequisite information**

Review the prerequisite information in [Splitting pairs on page 6-7](#).

**To make PiT copies of the volumes in a journal**

1. Stop all write I/Os from hosts to P-VOLs in the journal.
2. Split the mirror using the Pairsplit-r dialogue box, specifying **Mirror** for Range and **Flush** for Suspend Mode.
3. When the status of all pairs in the journal changed to Suspend, the operation is completed. You can resume write I/Os to the P-VOLs.

**Resynchronizing pairs**

Resynchronizing a pair updates the S-VOL with differential data that accumulated since the pair was split. After the pair is resynchronized, the S-VOL is again updated via the journals.

**Prerequisites for resynchronizing pairs**

- This operation is performed from the primary system only.
- Pair status must be PSUS or PSUE.
- The delta resync operation is performed using this procedure. Make sure to review [Prerequisite information for delta resync operation on page C-9](#), in addition to reviewing the following prerequisites.

**The following additional information** may be useful before beginning the procedure:

- Performing the operation on a pair in HLDE status changes the status to HOLD.
- The primary system does not resynchronize a pair that is suspended due to an error until the cause of error is resolved.
- If P-VOL status is Failure and S-VOL status is SMPL, the pair cannot be recovered by re-synchronizing. It must be deleted and created again.
- Resynchronizing pairs when I/O load is low reduces impact on performance. Operations on multiple pairs in the same mirror with different statuses may results in suspension during periods of heavy write I/O.
- If you resync pairs in PAIR status and other than PAIR status in the same mirror, an unexpected suspension could occur during the operation under heavy I/O load conditions. You can estimate whether the I/O load is heavy or not from frequency of host I/Os. This operation should be performed under light I/O load conditions.
• The secondary system and path group ID cannot be changed during this operation. To change the secondary system, delete the pair and create it again.

To resync a pair
1. In the Storage Navigator main window, select Actions > Remote Copy > Universal Replicator > Pair Operation.

2. Click \(\text{to change the mode from View to Modify.}\)

3. In the tree, select the port or host group for the pair.

4. In the list of associated pair volumes in the right pane, select one or more pairs according to the following:
   - Select pairs for resynchronization in PSUS or PSUE status.
   - Select pairs for the delta resync operation in HOLD or HOLDING status.
   - Select a pair in HLDE status to change the status to HOLD.

5. In the Pairresync dialog box \textbf{Range} list, select one of the following:
   - \textbf{LU}, to resync only the selected pair.
   - \textbf{Mirror}, to resync all pairs in the selected pair’s mirror.

   If you are resynchronizing some pairs in a mirror but not all, you must select \textbf{LU} for each of these pairs. Do not select \textbf{Mirror} in this case, otherwise an error occurs.

6. In the \textbf{Priority} list, specify the scheduling order for resynchronizing selected pairs. If Range is \textbf{Mirror}, the \textbf{Priority} list is disabled.

7. The \textbf{DKC} box displays the following controller information. No action is required.
   - The serial number with the LDKC number
   - The controller ID with the model name
   - Path Gr. ID
   - The path type
8. In the **Resync Mode** box, select the type of operation you want to perform:
   - **Normal**. Pair resynchronization operation.
   - **Delta**. The delta resync operation.
   - **Return to standby**. Pair status change from HLDE to HOLD.

9. In the **Error Level** list, select an option for the action that will take place if a failure occurs during this operation. Note that if the Range option is set to **Mirror**, Error Level options are disabled.
   - **Mirror**, to split all pairs in the failed pair’s mirror.
   - **LU**, to split only the specified pair or pairs that failed.

10. Click **Set**.

   - To modify a setting, right click and select **Modify**.
   - To cancel a setting, right click and select **Cancel**.

12. Click **Apply** to start the operation.

**Resynchronizing mirrors**

When you resynchronize a mirror, all the pairs with the mirror ID are resynchronized.

Use this procedure also to perform the delta resync operation on all pairs in a mirror or to change pair status of all pairs in the mirror from Hold(Failure) to Hold.

**Prerequisite information**

This operation must be performed from the primary system only.

The following additional information may be useful to you before beginning the procedure:

- Storage Navigator does not support multiple primary and secondary systems in a UR system. In this case, use CCI to restore a mirror.
- Use CCI to restore a mirror that is in a CCI consistency group containing multiple journals.
- Resynchronizing a mirror when I/O load is low reduces impact on performance.

**To resynchronize a mirror**

1. In the Storage Navigator main window, select **Actions > Remote Copy > Universal Replicator > Journal Operation**.

2. Click to change the mode from View to Modify.

3. In the tree, expand **Registered** then select the **LDKC**.
4. In the list or mirrors in the right pane, right-click a pair that you want to resync, perform the delta resync operation on, or to change the status from Hold(Failure) to Hold, then select Mirror > Pairresync > and one of the following:
   o **Stopped** to resynchronize the pairs in the mirror.
   o **Hold or Holding** to perform the delta resync operation on all pairs in the mirror.
   o **Hold(Failure)** to change the status of the mirror to Hold.

5. In the Pairsplit-r dialog box, click **Set**.

6. To resynchronize other mirrors, repeat steps 2 through 5.

7. Review settings in the **Preview** list in the Journal Operation window.
   To cancel a setting, right click the mirror and click **Cancel**.

8. Click **Apply** to restore the mirror(s).

## Deleting pairs

When you delete a pair, the UR relationship between the P-VOL and S-VOL is released. Only the relationship is affected, the data volumes and their data remain.

### Prerequisite information

- This operation can be performed from the primary or secondary system.
- When S-VOLs are physically attached to the same host as P-VOLs, take the S-VOLs offline before releasing the pair. Doing this avoids confusion and possible error when the host is restarted.
- When deleting pairs in a journal that is in a CCI consistency group consisting of multiple primary and secondary systems, make sure to select **Mirror** in the **Range** field. If you select **LU**, make sure the pair is suspended; otherwise it will not be deleted.

The following additional information may be useful to you before beginning the procedure:

- When a pair deletion is initiated, differential data is transferred from S-VOL, the pair relationship is deleted, and the volumes’ status becomes SMPL.
- A pair can be deleted regardless of its status. However, data consistency is not guaranteed unless status is Paired.
- If the operation fails, the P-VOL nevertheless becomes SMPL. Transfer of differential data to S-VOL is terminated.
- If you plan to delete all pairs in the journal and then create another pair, be sure to wait at least one minute after deleting the pairs before creating the new pair.
- Perform pair deletion when write I/O load is low to reduce impact on performance. Operations on pairs with different status in the same mirror may result in suspension during periods of heavy write I/O.
• If you delete pairs in PAIR status and other than PAIR status in the same mirror, an unexpected suspension could occur during the operation under heavy I/O load conditions. You can estimate whether the I/O load is heavy or not from frequency of host I/Os. This operation should be performed under light I/O load conditions.

• In a delta resync configuration, if you release the TC pair, the UR delta resync pair is released as well. If you release the UR pair, the UR delta resync S-VOL is released.

**To delete pairs**

1. In the Storage Navigator main window, select Actions > Remote Copy > Universal Replicator > Pair Operation.

2. Click to change the mode from View to Modify.

3. In the tree, the port or host group for the pair.

4. In the list of associated pairs in the right pane, right-click the pair or pairs that you want to delete and select **Pairsplit-S**.

5. In the Pairsplit-S dialog box **Range** list, select one of the following:
   - LU, to delete only the selected pairs.
   - Mirror, (default) to delete all pairs in the same mirror as the selected pair.
     - If you are deleting some pairs in a mirror but not all, you must select LU for each of these pairs. Do not select Mirror in this case, otherwise an error occurs.
     - If the pair’s status is SMPL, the Range field is disabled and automatically set to LU. It is automatically set to Mirror if the pair’s status is Deleting or Suspending.

6. From the **Delete Mode** list, select one of the following:
   - Normal, to delete pairs only if the primary system can change the pair status of both P-VOL and S-VOL to SMPL.
   - Force, to forcibly delete pairs even when the primary system cannot communicate with the secondary system. If the primary system cannot to communicate with the secondary system, specifying Force allows host operations to continue.
     - If you select Force when pair status is other than SMPL, Range is automatically set to Mirror.
If you select Force when Range is set to LU, the other pairs in the same journal are also suspended.

**Caution:** Please note the following:

- Forced deletion in the local system results in data that was not yet sent to the remote system being deleted.
- Forced deletion in the remote system results in data that was not yet restored being deleted.
- If pair status has not changed to SMPL five minutes after you forcibly delete the pair, delete it again.
- Make sure not to recreate the pair in the first five minutes after forcibly deleting it using the same journals (mirrors), even if pair status is SMPL and journal status is Initial: in this case pair creation could fail and the pair might suspend.
- A time-out error can occur at the time of a forced deletion if I/O is sent to another pair in the same journal, and the pair’s status is PAIR or COPY.

7. Click **Set**.

8. Review settings in the **Preview** list in the Journal Operation window.
   - To modify a setting, right click and select **Modify**.
   - To cancel a setting, right click and select **Cancel**.

9. Click **Apply** to delete the pairs.

### Deleting pairs in a mirror

When you delete the pairs in a mirror, data copying between master and restore journals ends.

**Prerequisite information**

This operation can be performed from the primary or secondary system.

The following information may be useful to you before beginning the procedure:

If a journal includes two mirrors:

- If you specify a mirror in Hold, Holding, or Hold(Failure) status, only the UR pairs of the specified mirror are deleted.
- If you specify a mirror that is not in Hold, Holding, or Hold(Failure) status, UR pairs of both mirrors (including the mirror that you did not specify) are deleted.

**To delete pairs in a mirror**

1. In the Storage Navigator main window, select **Actions > Remote Copy > Universal Replicator > Journal Operation**.

2. Click to change the mode from View to Modify.

3. Do one of the following:
In the tree, select a master journal or a restore journal from below Registered > LDKC00.

In the tree, expand Registered and then select a master journal or a restore journal from the list in the right pane.

4. From the list of mirrors in the right pane, select the mirrors from which to delete pairs. Each row in the list represents one mirror.

5. Right-click and select Mirror > Pairsplit-S from the menu.

   - To modify a setting, right click and select Modify.
   - To cancel a setting, right click and select Cancel.

---

**Caution:** If the journal (mirror) status is not Initial—even though you deleted pairs forcibly and five minutes have passed—perform the operation again to delete all pairs registered to the mirror.

Do not create pairs with the same journal for at least five minutes, even if the journal status was Initial; otherwise pair creation could fail and the pair would be suspended.

---

7. Click **Apply** to delete the pairs in the mirror.
Monitoring the system

Monitoring pairs, journals, data paths, I/O, and hardware performance is crucial for ensuring that Universal Replicator pairs continue to function correctly.

This topic provides information and instructions for monitoring a Universal Replicator system.

- Monitoring pair activity and status
- Saving pair information to a text file
- Monitoring copy operations data, I/O with Usage Monitor
- Monitoring I/O and hardware performance with Performance Monitor
- Monitoring journal (mirror) status
- Monitoring logical path status
- History of pair operations
Monitoring pair activity and status

Monitoring the Universal Replicator system is essential for maintaining your pairs.

- Each operation requires a specific status or statuses. Before performing a pair operation, check the pair’s status.
- Pair status changes when an operation is performed. Check status to make sure that pairs are operating correctly and that data is updated from P-VOLs to S-VOLs, and that differential data is managed appropriately.

Frequent monitoring of the system is optional but recommended. You can set up automatic e-mail notification from the SN for problems found during monitoring (see Hitachi Storage Navigator User Guide).

To monitor pair activity

1. In the Storage Navigator main window, click Actions > Remote Copy > Universal Replicator > Pair Operation.
2. In the Pair Operation window, locate the pair whose status you want to review and check its status in the Status column.
3. To filter the list, click Display Filter. Headings are described in Display Filter dialog box on page E-23 and the Help.
4. To export pair information, see Saving pair information to a text file on page 7-10.
5. To view more detailed pair information, right click a pair and then select Pair Status from the menu.

Pair status definitions

Both Storage Navigator and CCI pair status names appear in the Storage Navigator Status columns, except when the names are the same. When they are the same, the CCI status does not appear.

The following table shows both types of status names and their descriptions. In some cases, a particular status has no exact parallel status in the other interface. This is noted.

When checking your pairs’ status, click File/Refresh to make sure the data is current.
<table>
<thead>
<tr>
<th>SN status</th>
<th>CCI status</th>
<th>Description</th>
<th>P-VOL access</th>
<th>S-VOL access</th>
</tr>
</thead>
</table>
| SMPL      | SMPL       | The volume is not assigned to a pair and is not in a journal.  
- When the volume is added to a pair, the status changes to COPY.  
- When a pair is deleted, the volumes’ status changes back to SMPL.  
If a pair is deleted from the secondary system, S-VOL status changes to SMPL; when the primary system detects this, P-VOL status changes to PSUS. The pair must be deleted from the primary system also to change P-VOL status to SMPL. | Read/Write | Read/Write |
| COPY      | COPY       | The initial copy operation is in progress. | Read/Write⁴ | Read Only |
| PAIR      | PAIR       | The pair is synchronized. Updates to the P-VOL are duplicated on the S-VOL. | Read/Write⁴ | Read Only |
| SN displays this status as PAIR | | | | |
| PFUL      | SSUS       | If data in the journal volume exceeds the threshold (80 %), pair status changes to PFUL. The pair is not suspended; the copy operation continues.  
If the journal option, Inflow Control, is set to Yes when status changes to PFUL, host I/O is delayed because update I/O to the journal volume is delayed. | Read/Write⁴ | Read Only |
| PSUS      | SSUS       | The pair has been split by the user and the P-VOL and S-VOL are no longer synchronized.  
- The primary and secondary systems keep track of journal data discarded during the split operation.  
- When the operation is performed on the primary system, the status of both the P-VOL and S-VOL changes to PSUS.  
- When the operation is performed on the secondary system, the status of the S-VOL changes to PSUS; the primary system detects this and changes P-VOL status to PSUS.  
SSUS is the S-VOL's split status name.  
See also PSUS types and behaviors on page 7-7. | Read/Write⁴ | Read Only, unless write option is enabled. |
### Monitoring the system

<table>
<thead>
<tr>
<th>SN status</th>
<th>CCI status</th>
<th>Description</th>
<th>P-VOL access</th>
<th>S-VOL access</th>
</tr>
</thead>
</table>
| PSUE      | PSUE³      | The pair is suspended by the system due to an error; it is not synchronized.  
- The primary and secondary systems keep track of journal data discarded during the suspension operation.  
- The primary system keeps track of P-VOL tracks that are updated while the pair is suspended.  
- When a UR suspension condition is detected, the primary system changes P-VOL and S-VOL status to PSUE. If the secondary system detects the condition, it changes the S-VOL status to PSUE; the primary system detects this and changes P-VOL status to PSUE.  
See also [PSUS types and behaviors on page 7-7](#). | SN: Read/Write⁴ CCI: Read/Write⁴ if no error in P-VOL | Read Only |
| Suspending (No parallel CCI status) | (No parallel CCI status) | The pair is not synchronized and in transition from the PAIR or COPY status to PSUS or PSUE status. | Read/Write | Read Only |
| Deleting (releasing) (No parallel CCI status) | (No parallel CCI status) | The pair relationship is being deleted. When the operation completes, status changes to SMPL. | Read/Write | Read Only |
| HOLD (No parallel CCI status) | (No parallel CCI status) | • The pair or command devices are ready for the delta resync operation. Incoming write data for the TC S-VOL is stored in the master journal volume.  
• Operations allowed:  
  - Delta resync  
  - Pair-delete  
  - Change pair options | Read/Write | Read Only¹ |
| HOLDING² (No parallel CCI status) | (No parallel CCI status) | Pair status is changing to HOLD so that the delta resync pair can be created. Operations allowed on pairs in HOLDING status:  
• Delta resync operation  
• Pair release  
• Change pair options  
If the delta resync operation is run on a pair in HOLDING status, the operation could fail. If you specify Entire for the delta resync Failure field on the Change Journal Option dialog box, differential data is copied to an S-VOL. | Read/Write | - |
### Monitoring the system

#### SN status | CCI status | Description | P-VOL access | S-VOL access
--- | --- | --- | --- | ---
HLDE | (No parallel CCI status) | • An error occurred on a pair in HOLD status.  
• When P-VOL status is HLDE, incoming write data for the TC S-VOL is not stored in the master journal volume.  
• Operations allowed on pairs in HLDE status:  
  - Recover pair status to standby (HOLD)  
  - Pair delete  
  - Change pair options | Read/Write | -

| (No parallel SN status) | PFUS³ | This status results when the journal volume becomes full and suspends. Pair status changes from COPY, PAIR or PFUL to PFUS. The UR pair is suspended and the copy operation stops. Make sure to review configuration of the logical path and journal volume.  
  - If a Dynamic Provisioning virtual volume (DP-VOL) is used as the UR S-VOL, and the capacity of a pool-VOL is nearly full, UR status becomes PFUS and the pair is suspended.  
  - If the journal option Inflow Control is set to Yes when status changes to PFUS, the pair is not suspended for the time set in the Data Overflow Watch field, even when the journal volume becomes full. During the time it takes for the journal data area to clear, the response to host I/O is delayed.  
  See Changing options used by journals on page 8-3 for more information on Data Overflow Watch. | Read / Write⁴ | Read Only, unless write option is enabled.

| (No parallel SN status) | SSWS³ | After Takeover, SSWS is the status of the S-VOL. With this status, data can be written to the S-VOL. | Read Only | Read/Write |
Additional information on pair status

- When a pair is split by the user or suspended by the system, the primary system notifies the host(s) with a service information message (SIM). If SNMP is installed and operational for VSP, this SIM results in an SNMP trap indicating the reason for suspension.
- Transitional states occur when a request is accepted to change pair status to PSUS, PSUE, or SMPL, but is not yet complete. Transition states are not reported to the host.
- The user or the primary or secondary systems can initiate the PSUS/PSUE status change.
- Only the user can delete a pair.
- When you perform an operation, the system reports final status at the end of the operation.
- If an error causes the status to change to PSUE, the status is reported at the beginning of the transition.
• A pair in Flush mode (remaining local update data is flushing to the secondary system) remains in Suspending or Deleting status until data in the master and restore journals is the same and the pair is completely split or released. To calculate the time during which the pair remains in Suspending or Deleting status, use the following equation:

\[
C \times \left(\frac{u}{100}\right) \times 1,024 \div V \text{ (The unit is seconds)}
\]

where:
- \(C\) is total capacity (MB) of the master journal volume.
- \(u\) is the usage rate of data (%) in the master journal volume.
- \(V\) is data transfer speed (MB/sec) between the primary and the secondary systems.

See Usage Monitor window on page E-32 for instructions on viewing the usage rate of a journal volume.

• When pair status is COPY, neither cache nor shared memory can be added to or removed from the system. When either tasks is to be performed, split any pairs in COPY, status, then resynchronize when the cache or shared memory operation is completed.

**PSUS types and behaviors**

The PSUS status can be set by the user or the system, from the primary or secondary systems.

<table>
<thead>
<tr>
<th>PSUS type</th>
<th>Volume PSUS type applies to</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSUS, S-VOL by Operator</td>
<td>P-VOL, S-VOL</td>
<td>The user split the pair from the primary or secondary system, using the S-VOL-writeoption. CCI displays this PSUS type as SSWS.</td>
</tr>
<tr>
<td>PSUS, by MCU</td>
<td>S-VOL</td>
<td>• The secondary system received a request from the primary system to split the pair.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The P-VOL PSUS type is PSUS-S-VOL by Operator.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CCI displays this PSUS type as SSWS.</td>
</tr>
<tr>
<td>PSUS, by RCU</td>
<td>P-VOL, S-VOL</td>
<td>• The primary system suspended the pair after detecting an error condition on the secondary system.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The S-VOL suspend type is PSUE-S-VOL Failure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CCI displays this PSUS type as PSUE.</td>
</tr>
<tr>
<td>PSUS, Pairsplit-S to RCU</td>
<td>P-VOL</td>
<td>The primary system detected that S-VOL status is SMPL after the user released the pair from the secondary system. The pair cannot be resumed.</td>
</tr>
<tr>
<td>PSUS, JNL Cache Overflow</td>
<td>P-VOL, S-VOL</td>
<td>The pair was suspended because the journal volume was near capacity. CCI displays this PSUS type as SSWS.</td>
</tr>
</tbody>
</table>

• A pair can be split after the initial copy is complete.
A pair must be split to perform maintenance on the P-VOL, or to enable write-access on the S-VOL.

After status changes to PSUS, the primary system performs the following tasks:
- Stops journal-obtain operations
- Continues to accept write I/Os from host to P-VOL
- Keeps track of updated P-VOL tracks

If you enable the S-VOL write-option when splitting the pair, the secondary system keeps track of updated S-VOL tracks. When the pair is re-synchronized, the secondary system sends the S-VOL track bitmap to the primary system, which then merges P-VOL and S-VOL bitmaps to synchronize the tracks.

A split or suspended S-VOL has a separate consistency status, which indicates the S-VOL’s update sequence consistency with respect to the other S-VOLS in the associated journal. Consistency status displays on the secondary system only. S-VOL consistency status is described below.

### Table 7-1 S-VOL consistency statuses

<table>
<thead>
<tr>
<th>Consistency status</th>
<th>Description</th>
</tr>
</thead>
</table>
| Volume             | - Only the current pair was split or suspended.  
                   | - Update sequence consistency between this S-VOL and other S-VOLS in the associated journal is not ensured.  
                   | - This S-VOL cannot be used for disaster recovery at the secondary site.  
                   | - This status is indicated when:  
                     - The pair is split by the user using the Suspend Range-Volume (LU) pairsplit option.  
                     - The pair is suspended due to a failure that did not affect the entire journal.  
| Mirror             | - The pair was split or suspended along with the other pairs in the associated mirror.  
                   | - Update sequence consistency between this S-VOL and other S-VOLS in this mirror is ensured.  
                   | - This S-VOL can be used for disaster recovery on the secondary system.  
                   | - This status is indicated when:  
                     - The pair is split by specifying mirror of the pairsplit -r option.  
                     - All pairs in the associated mirror are suspended due to a failure that affects the entire group; for example, path failure.  
                     - One pair in the mirror was suspended due to a failure that did not affect the entire group.  

### PSUE types and behaviors

The primary system suspends a pair and changes its status to PSUE when it detects any of the following:
- The user has released the pair on the secondary system.
• An error condition related to the secondary system, S-VOL, or an update operation.
• The primary system is unable to communicate with the secondary system.
• A Universal Replicator suspension condition is detected by the system.

The following describes the types of PSUE status.

<table>
<thead>
<tr>
<th>PSUE Type</th>
<th>Applies To</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSUE, S-VOL Failure</td>
<td>P-VOL, S-VOL</td>
<td>The primary system detected an error during communication with the secondary system or during update copying. S-VOL PSUE type is usually PSUE-S-VOL Failure.</td>
</tr>
<tr>
<td>PSUE, MCU IMPL</td>
<td>P-VOL, S-VOL</td>
<td>The primary system could not find valid control information in its nonvolatile memory during IMPL (initial microprogram load). This condition occurs if the primary system is without power for more than 48 hours (power failure and fully discharged backup batteries).</td>
</tr>
<tr>
<td>PSUE, Initial Copy Failed</td>
<td>P-VOL, S-VOL</td>
<td>The pair was suspended before the initial copy operation was complete. The data on the S-VOL is not identical to the data on the P-VOL.</td>
</tr>
<tr>
<td>PSUE, MCU P/S OFF</td>
<td>S-VOL</td>
<td>The primary system is powered off.</td>
</tr>
</tbody>
</table>

When a pair is suspended, the primary system stops performing journal-obtain operations for the pair. However, the primary system continues the following operations:
• Continues accepting write I/Os for the suspended P-VOL
• Keeps track of the P-VOL cylinders/tracks that are updated
• Keeps track of journal data discarded during the pair suspension. (Both primary and secondary systems do this.)

A split or suspended S-VOL has a separate consistency status that indicates its update sequence consistency with respect to the other S-VOLs in the associated journal. Consistency status displays on the secondary system only. Table 7-1 S-VOL consistency statuses on page 7-8 describes S-VOL consistency statuses.

When the pair is re-synchronized, the primary and secondary systems perform the following operations:
• The secondary system sends the S-VOL bitmap to the primary system
• The primary system merges the P-VOL and S-VOL bitmaps to synchronize the tracks

These actions ensure that all cylinders/tracks containing journal data discarded on the secondary system are re-synchronized.
Saving pair information to a text file

You can save pair status and other information to a text file using the Export button on the Pair Operation window.

To save pair information
1. You can filter the list columns in the Pair Operation window. Click Display Filter and select the pair and volume data that you want to save.
2. In the Pair Operation window, click Export.
3. Click OK in the message that appears.
4. In the save dialog box, enter the name of the file and then click Save.
   A message appears.
5. Click OK in the message that appears.

The following data can be exported:

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port</td>
<td>Local system port.</td>
</tr>
<tr>
<td>Gr(Name)</td>
<td>Local system host group number and name. (The name is limited to a maximum of 16 characters.)</td>
</tr>
<tr>
<td>LUN</td>
<td>Local system LU number.</td>
</tr>
<tr>
<td>Vol</td>
<td>Local system LDKC number, CU number and LDEV number.</td>
</tr>
<tr>
<td>Status</td>
<td>Status of the pair.</td>
</tr>
<tr>
<td>JNL</td>
<td>Journal number in the local system.</td>
</tr>
<tr>
<td>Mr</td>
<td>Mirror ID.</td>
</tr>
<tr>
<td>S/N(LDKC)</td>
<td>Remote system serial number.</td>
</tr>
<tr>
<td>ID</td>
<td>Remote system path group ID.</td>
</tr>
<tr>
<td>CNTL</td>
<td>Remote system controller ID and model name.</td>
</tr>
<tr>
<td>Port</td>
<td>Remote system port number.</td>
</tr>
<tr>
<td>Gr</td>
<td>Remote system host group number.</td>
</tr>
<tr>
<td>LUN</td>
<td>Remote system LU number in the remote system.</td>
</tr>
<tr>
<td>Vol</td>
<td>Remote system LDKC number, CU number and LDEV.</td>
</tr>
<tr>
<td>JNL</td>
<td>Remote system journal number.</td>
</tr>
<tr>
<td>Type</td>
<td>Type of volumes in the local system.</td>
</tr>
<tr>
<td>CTG</td>
<td>CCI consistency group number.</td>
</tr>
<tr>
<td>ErrLv</td>
<td>Error level.</td>
</tr>
<tr>
<td>Sync</td>
<td>Progress of copy operation. Or, synchronization rate between the data volume before the pair was split and the data volume after the pair was split.</td>
</tr>
<tr>
<td>CLPR</td>
<td>CLPR number and CLPR name.</td>
</tr>
<tr>
<td>CopyTime</td>
<td>Copy time</td>
</tr>
</tbody>
</table>

An LDEV number ending with # indicates the volume is an external volume. For detailed information about external volumes, see Hitachi Universal Volume Manager User Guide.
A device ID ending in X (e.g., 00:00:3C X) indicates the LDEV is a Dynamic Provisioning virtual volume. For details on a virtual volume, see Provisioning Guide for Open Systems.

"00" appears as the LDKC number when the volume is a Universal Storage Platform V/VM, TagmaStore USP, and TagmaStore NSC volume.

**Monitoring copy operations data, I/O with Usage Monitor**

You can monitor and use operations data and I/O statistics in the Usage Monitor window.

This topic shows you how to do the following:

- Selecting data to be graphed on page 7-12
- Manipulating graph, save data on page 7-14

In Storage Navigator, click **Actions > Remote Copy > Universal Replicator > Usage Monitor**.

The Usage Monitor window displays as shown in below. The fields on the Usage Monitoring window are also described below.

You start and stop monitoring in Performance Monitor. See *Performance Guide* for instructions.

![Figure 7-1 Usage Monitor Window](image)
Table 7-2 Fields on the Usage Monitor window

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
</table>
| Monitoring Switch          | • **Enable**: Monitoring is on. Graph displays.  
|                            | • **Disable**: Monitoring is off. Graph is disabled.         |
| Gathering Interval         | The data collection interval.                                 |
| Update                     | The most recent data sample time of data on the graph.        |
| Usage Monitor Graph        | Remote I/O statistics and status of remote copy monitor.      |

Selecting data to be graphed

The usage monitor graph plots the I/O data that you specify. On the graph:
- The x-axis indicates time.
- The y-axis indicates the number of I/Os during the sampling period.
- The legend on the right side shows the data being displayed.

The value on the y-axis varies according to the maximum value of the statistical data appearing in the graph. If the y-axis value exceeds 10,000,000, the value is shown in exponential notation (for example, 1E7 = 1 x 10^7 = 10,000,000; 2E8 = 2 x 10^8 = 200,000,000).

To specify I/O data to be graphed

1. Make sure that usage monitoring is running (Monitoring Switch = Enable). The usage monitor graph can be viewed only when monitoring is on.
   To enable usage monitor, see the Performance Guide.
2. Right-click the graph and select Display Item from the menu that appears. The Display Item dialog box displays.
3. In the Select Volume box, select one of the following:
   - **ALL Volumes**, to view I/O statistics for all LDEVs in the system. When selected, the LDKC number, CU number, and LDEV number appear above the graph.
     - A device ID ending in # (e.g., 00:00:3C #) indicates the LDEV is an external volume (see Hitachi Universal Volume Manager User Guide for more information about external drives).
     - A device ID ending in X (e.g., 00:00:3C X) indicates the LDEV is a Dynamic Provisioning virtual volume (see Provisioning Guide for Open Systems for more information on virtual volumes).
   - **Journal**, to view I/O statistics for a specific journal. Enter a journal number (000-0FF) in the Journal box.
   - **Volume**, to view I/O statistics for a specific LU. Select the LU Port (CL1-A to CLG-R) and enter the GID (00-FE) and LUN (000-7FF).
4. In the Monitor Data boxes, select the I/O statistics data that you want to appear on the graph. You must select at least one box. Table 7-3 Remote copy I/O statistics data on page 7-13 describes the I/O statistics data.
5. Click **Set** to close the Display Item dialog box. The Usage Monitor window now shows a graph of the selected I/O statistics data for the selected LUs.

**Table 7-3 Remote copy I/O statistics data**

<table>
<thead>
<tr>
<th>Data type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Host I/O</strong></td>
<td></td>
</tr>
<tr>
<td>Write Record Count</td>
<td>The number of write I/Os per second</td>
</tr>
<tr>
<td>Write Transfer Rate</td>
<td>The amount of data that are written per second. The unit is kilobytes per second.</td>
</tr>
<tr>
<td><strong>Initial Copy</strong></td>
<td></td>
</tr>
<tr>
<td>Initial Copy Hit Rate</td>
<td>The initial copy hit rate. The unit is percent.</td>
</tr>
<tr>
<td>Average Transfer Rate</td>
<td>The average transfer rate for initial copy operations. The unit is kilobytes per second.</td>
</tr>
<tr>
<td><strong>Asynchronous Copy</strong></td>
<td></td>
</tr>
<tr>
<td>M-JNL Asynchronous RIO count</td>
<td>The number of asynchronous remote I/Os per second at the primary system.</td>
</tr>
</tbody>
</table>
### Monitoring the system

#### Manipulating graph, save data

- To enlarge the graph, right-click it and select **Large Size**.
- To close the graph, right-click it and select **Close**.
- To save monitoring data in text files, use the Performance Monitor Export Tool.

#### Monitoring I/O and hardware performance with Performance Monitor

Performance Monitor software provides detailed information on I/O activity and hardware performance in the VSP systems. Storage system usage and performance data that is collected and displayed by Performance Monitor enables you to:

- Identify the optimum timing for performing Universal Replicator copy operations.
- Determine the best locations for the Universal Replicator S-VOLs (for example; parity groups with less frequently accessed volumes to avoid bottlenecks of back-end activity)
- Monitor system performance during Universal Replicator operations and during testing activities.

<table>
<thead>
<tr>
<th>Data type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-JNL Total Number of Journal</td>
<td>The number of journals at the primary system.</td>
</tr>
<tr>
<td>M-JNL Average Transfer Rate</td>
<td>The average transfer rate for journals in the primary system. The unit is kilobytes per second.</td>
</tr>
<tr>
<td>M-JNL Average RIO Response</td>
<td>The remote I/O process time on the primary system. The unit is milliseconds.</td>
</tr>
<tr>
<td>R-JNL Asynchronous RIO count</td>
<td>The number of asynchronous remote I/Os per second at the secondary system.</td>
</tr>
<tr>
<td>R-JNL Total Number of Journal</td>
<td>The number of journals at the secondary system.</td>
</tr>
<tr>
<td>R-JNL Average Transfer Rate</td>
<td>The average transfer rate for journals in the secondary system. The unit is kilobytes per second.</td>
</tr>
<tr>
<td>R-JNL Average RIO Response</td>
<td>The remote I/O process time on the secondary system. The unit is milliseconds.</td>
</tr>
</tbody>
</table>

**M-JNL**

- **Data Used Rate**
  - Data usage rate for master journals. The unit is percent.
- **Meta Data Used Rate**
  - Metadata usage rate for master journals. The unit is percent.

**R-JNL**

- **Data Used Rate**
  - Data usage rate for restore journals. The unit is percent.
- **Meta Data Used Rate**
  - Metadata usage rate for restore journals. The unit is percent.
Use the following procedure to lessen the impact on Universal Replicator operations while Performance Monitor is collecting data for one or more systems on the same VSP internal LAN:

1. If Performance Monitor is collecting high amounts of LDEV data, disabling this activity, if possible, for one or more systems.

2. If Performance Monitor is collecting data for more than three systems on the VSP internal LAN, disconnect Performance Monitor, if possible, from one or more systems before using Universal Replicator.

3. After you have disabled LDEV data collection and/or disconnected Performance Monitor wherever possible, then connect to the system using Storage Navigator and launch Universal Replicator.

4. When Universal Replicator operations are completed, exit Universal Replicator and Storage Navigator.

5. Re-enable Performance Monitor data collection.

For further information on Performance Monitor, see Performance Guide.

**Monitoring journal (mirror) status**

The status of a mirror associated with a journal relates to the pair operations that are performed on the journal. Monitoring these statuses can help you resolve problems and maintain the Universal Replicator system. Status for journals is viewed on the Journal Operation window.

**To view journal status**

1. In Storage Navigator, click Actions > Remote Copy > Universal Replicator > Journal Operation.

2. In the tree, open the Registered > LDKC00 child-tree, then select a journal. The group’s information displays in the right-hand pane. See the Status column.

The mirror status for both Storage Navigator and CCI appear together in the Status column. However, the definitions are presented separately in the following topics because there is not a one-to-one relationship between them. Numerous CCI mirror statuses can be paired with Storage Navigator statuses. For mirror status definitions, see:

- Storage Navigator mirror status definitions on page 7-15
- CCI mirror status definitions on page 7-16

**Storage Navigator mirror status definitions**

CCI mirror statuses appear beside Storage Navigator statuses in the SN/CCI format. The following describe Storage Navigator statuses.

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>Data volumes are registered in the mirror.</td>
</tr>
</tbody>
</table>
CCI mirror status definitions

CCI mirror statuses appear beside Storage Navigator statuses in the SN/CCI format. The following describe CCI statuses.

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMPL</td>
<td>The mirror is not used.</td>
</tr>
<tr>
<td>PJNN</td>
<td>The primary journal is normal.</td>
</tr>
<tr>
<td>SJNN:</td>
<td>The secondary journal is normal.</td>
</tr>
<tr>
<td>PJSN</td>
<td>The primary journal is in normal split status.</td>
</tr>
<tr>
<td>SJNS</td>
<td>The secondary journal is in normal split status.</td>
</tr>
<tr>
<td>PJNS</td>
<td>The primary journal is in normal split status (Delta resync configuration).</td>
</tr>
<tr>
<td>SJNS</td>
<td>The secondary journal is in normal split status (Delta resync configuration).</td>
</tr>
<tr>
<td>PJNF</td>
<td>The primary journal is full.</td>
</tr>
<tr>
<td>SJNF</td>
<td>The secondary journal is full.</td>
</tr>
<tr>
<td>PJSF</td>
<td>The primary journal is full and split.</td>
</tr>
<tr>
<td>SJSF</td>
<td>The secondary journal is full and split.</td>
</tr>
<tr>
<td>PJSE</td>
<td>The primary journal is split due to an error (including link errors).</td>
</tr>
<tr>
<td>SJSE</td>
<td>The secondary journal is split due to an error (including link errors).</td>
</tr>
<tr>
<td>PJSE</td>
<td>The primary journal is in split status (Delta resync configuration) due to an error.</td>
</tr>
</tbody>
</table>
Monitoring the system

**Monitoring logical path status**

**To view logical path status**

1. In the Storage Navigator main window, select **Actions > Remote Copy > Universal Replicator > DKC Operation**.
2. In the Display box, select **DKC** and select **LDKC**.
3. Locate the remote system in the list on the right side and view the Status column.
4. To see in-depth path status, right-click the remote system and select **DKC Status**.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Number of the row.</td>
</tr>
<tr>
<td>Path Status</td>
<td>Status of a logical path. For status definitions and troubleshooting, see <a href="#">Troubleshooting logical paths on page 10-3</a>.</td>
</tr>
<tr>
<td>Port</td>
<td>Port on the local system.</td>
</tr>
<tr>
<td>Pair-Port</td>
<td>Port on the remote system.</td>
</tr>
<tr>
<td>S/N</td>
<td>Serial number and LDKC number of the remote system.</td>
</tr>
<tr>
<td>Controller ID</td>
<td>Controller ID and model name (in parenthesis) for the remote system.</td>
</tr>
<tr>
<td>Path Gr. ID</td>
<td>Path group ID</td>
</tr>
<tr>
<td>M-R Path</td>
<td>Type of channel interface between local and remote systems. “Fibre” always displays.</td>
</tr>
<tr>
<td>Minimum Paths</td>
<td>Minimum possible number of paths between the local and the remote systems.</td>
</tr>
<tr>
<td>RIO MIH</td>
<td>Remote I/O missing interrupt handler timer value—the wait time for data transfer from the local to remote system to complete.</td>
</tr>
<tr>
<td>DKC Registered</td>
<td>Date and time when local and remote systems were associated to each other</td>
</tr>
<tr>
<td>Last Updated</td>
<td>Date and time the last operation on a logical path to the remote system was performed.</td>
</tr>
<tr>
<td>Refresh the DKC Operation tab after this panel is closed</td>
<td>When clicked, the DKC Operation window refreshes when it re-displays.</td>
</tr>
</tbody>
</table>

**History of pair operations**

The **History** window provides the history of pair operations. For example, the window shows the date and time when data volume pairs are created or released.

To open the **History** window, do either of the following:
If Universal Replicator has not been started:
1. In the Storage Navigator main window, select Actions > Remote Copy > Universal Replicator > History.
   The History window opens. The History window may not show the latest operation history. To view the latest operation history, go to the next step.
2. Select File > Refresh. The operation history is updated.

If Universal Replicator has already been started:
1. Click the History tab to open the History window.
   The History window may not show the latest operation history. To view the latest operation history, go to the next step.
2. Select File > Refresh. The operation history is updated.
Maintaining the system

Some maintenance tasks are a response to behavior discovered during system monitoring. However, you can also change certain settings to keep the system in tune with your changing requirements.

This chapter provides information and instructions for maintaining a Universal Replicator system.

- Pair maintenance—changing the pair-split option
- Journal and mirror maintenance
- Logical path maintenance
- Managing power-off for systems and network devices
Pair maintenance—changing the pair-split option

You can change the option that specifies whether a pair-split operation that is triggered by pair failure is applied to all the pairs in the mirror, or only to the affected pair. This option was first set during the pair create operation.

Prerequisite information

You can change this option only for pairs in PAIR, PSUS, PSUE, HOLD, HOLDING, or HLDE status.

To change the option

1. In the Storage Navigator main window, select Actions > Remote Copy > Universal Replicator > Pair Operation.

2. Click to change the mode from View to Modify.

3. In the tree, select the port that you have configured for the pair, or a host group (displayed below the ports). The volumes for the port or host group display in the right-side list area.

4. In the list, right-click the desired pair, or mirror of pairs, then select Change Pair Option from the menu.

5. In the Change Pair Option dialog box, click the Error Level list and select one of the following:
   - Mirror, to split all pairs in the failed pair’s mirror
   - LU, to split only the pair that failed

6. Click Set when finished.

   - To modify a setting, right click and select Modify.
   - To cancel a setting, right click and select Cancel.

8. Click Apply to apply the settings. If an error occurs, the error code appears in the right-most column of the Preview list. To view detailed information about the error, right click the error code and select Error Detail.

Journal and mirror maintenance

Maintaining journals and mirror consists of the following operations:

- Changing options used by journal
- Changing options used by mirrors on page 8-5
- Deleting journal volumes from a journal on page 8-8
- Deleting journals on page 8-9
Changing options used by journals

Most Universal Replicator pair operations are performed on multiple pairs. This is done using journals. You can change the following options that affect the pairs in journals:

- Inflow Control—allows you to restrict the inflow of data to allow other journals with higher priority data unrestricted inflow
- Data Overflow Watch—establishes a timeout period
- Use of Cache—allows you to store journal data in the cache on the secondary system

Prerequisite information

Please be aware of the following when changing journal options:

- Journal options must be changed on both systems, primary and secondary.
- To change journal options, one of the following conditions must be satisfied:
  - The attribute of the journal is Initial.
  - The status of the journal in the mirror is one of the following:
    - Initial
    - Stopped
    - Hold
    - Hold(Failure)

When one journal uses multiple mirrors, whether you can select Change Journal Option depends on the status of the journal whose mirror is not in Hold, Holding or Hold(Failure) status. For example, if mirrors in the journal are in the Hold and Active status, you can not change the journal option. If mirrors in the journal are in the Hold and Stopped status, you can change the journal option.

- When changing options for multiple journals, you can leave some options unchanged by entering or selecting no value. If you specify a value, it is applied to the selected journals.

To change options for a journal


2. Click to change the mode from View to Modify.

3. In the tree, right click a journal below Registered > LDKC00 and then select Journals > Change JNL Option.
4. For **Inflow Control**, specify whether to restrict inflow of update I/Os to the journal volume (slows delay response to hosts).

For example, you could have a 100 GB-bandwidth data path with three journals using it. If an important database is saved to a primary volume in one of the journals, with data of lesser importance in the other journals, you may decide to restrict the Inflow Control for the less important journals while not restricting control to the important journal.

**Yes** indicates inflow will be restricted. **No** indicates inflow will not be restricted.

If **Yes** is selected and the metadata or the journal data is full, the update I/Os may stop.

5. For **Data Overflow Watch**, specify the number of seconds for the system to monitor write data to the journal volume when the journal volume is full (100%). Range is 0-600 seconds. Default is 60 seconds.

If **Inflow Control** is **No**, **Data Overflow Watch** is disabled.

**Note:** The metadata area is not a candidate for **Data Overflow Watch**. If the metadata area is full, the journal is suspended with an error regardless of the value of **Data Overflow Watch**.

See status definitions for PFUL and PFUS in **Pair status definitions on page 7-2** for additional key information.

In a 3 UR DC multi-target configuration, when two or more mirrors in the primary site are in Active status, if the free space in the journal data area or metadata area decreases to a critical level, one of the mirrors in the journal will be suspended with an error regardless of the value of the **Data Overflow Watch**.
6. For **Use of Cache**, specify whether to store journal data (initial copy or resynchronization data) in the cache memory on the remote side (restore journal).

   - **Use**: Journal data will be stored in the cache. When there is insufficient space in the cache, journal data will also be stored into the journal volume. This setting only takes effect on the journal volumes of RAID-5 or RAID-6.
   - **Not Use**: Journal data is not stored in the cache.
   - **Blank**: The current setting of **Use of Cache** will remain unchanged.

   **Note:** This setting does not effect master journals unless the CCI horctakeover command is used to change a master journal into a restore journal.

7. Click **Set** when finished.

8. Review settings in the **Preview** list in the Journal Operation window.
   - To modify a setting, right click and select **Modify**.
   - To cancel a setting, right click and select **Cancel**.

9. Click **Apply** to apply the settings. If an error occurs, the error code appears in the right-most column of the **Preview** list. To view detailed information about the error, right click the error code and select **Error Detail**.

### Changing options used by mirrors

Most pair operations are performed on multiple pairs. This is done using a journal or mirrors. You can change the following options that affect the pairs in a mirror:

- **Unit of Path Watch Time**—establishes the unit of path watch time.
- **Copy Pace**—establishes the pace at which data is copied
- **Path Watch Time**—establishes the amount of time before a blocked path results in the mirror being split
- **Forward Path Watch Time**—establishes whether to forward the Path Watch Time value of the master journal to the restore journal.
- **Transfer Speed**—which specifies the speed for data transfer
- **Delta Resync Failure**—which specifies the processing that takes place in the event of a failure.

### Prerequisite information

Please be aware of the following when changing mirror options:

- **Mirror options can be changed on both primary and secondary systems.**
- **To change mirror options, the status of the mirror must be one of the following:**
  - Initial
  - Active
  - Stopped
• Hold
• Holding
• Hold(Failure)

• The Transfer Speed option can be changed if the mirror’s status is Active, Hold, or Holding.

• When changing options for multiple mirrors, you can leave some options unchanged by entering or selecting no value. If you specify a value, it is applied to the selected mirrors.

**To change options for a mirror**

1. In the Storage Navigator main window, select **Actions > Remote Copy > Universal Replicator > Journal Operation**. The Journal Operation window displays.

2. Click to change the mode from View to Modify.

3. In the table pane, right-click the desired journal and then select **Mirror > Change Mirror Option**.

4. For **Unit of Path Watch Time**, specify the unit of time for Path Watch Time, **minute**, **hour**, or **day**.

5. For **Path Watch Time**, specify the interval from the time a path becomes blocked to when the mirror is split (suspended). The interval must be the same for master and restore journals in the same mirror (see next item).

**Important**: If you want a mirror to split immediately after a path becomes blocked, ask Hitachi Data Systems Support Center to set system option mode 448 to ON and set system option mode 449 to OFF.
6. For **Forward Path Watch Time**, specify whether to forward the Path Watch Time value of the master journal to the restore journal. If the Path Watch Time value is forwarded from the master journal to the restore journal, the two journals will have the same Path Watch Time value.
   - **Yes**: The Path Watch Time value will be forwarded to the restore journal.
   - **No**: The Path Watch Time value will not be forwarded to the restore journal. No is the default.
   - **Blank**: The current setting of Forward Path Watch Time will remain unchanged.

   **Caution**: This option cannot be specified in the secondary site. For a pair using the delta resync configuration, select **Yes** in the primary site.

7. For **Copy Pace**, specify the pace for initial copy activity per volume. This field cannot be specified on the remote system. **Low** is the default. When specifying **Medium**, ensure that write I/O is 10 MB/s or less per parity group. If it exceeds 10 MB/s, pairs may be suspended. When specifying **High**, ensure that I/O will not occur. If update I/O occurs, pairs may be suspended.

8. For **Transfer Speed**, specify the line speed (in Mbps (megabits per second)) of data transfer. Specify one of the following: **256**, **100**, or **10**. Recommended values are:
   - Use 10 when the transfer speed is 10 to 99 Mbps.
   - Use 100 when the transfer speed is 100 to 255 Mbps.
   - Use 256 when the transfer speed is 256 Mbps or higher.

   **Note**: This setting does not effect master journals unless the CCI horctakeover command is used to change a master journal into a restore journal.

9. For **Delta resync Failure**, specify the processing that takes place when the delta resync operation cannot be performed. This option is specified on the primary site only.
   - **Entire**, the default. The entire P-VOL is copied to the S-VOL.
   - **None**: No processing is performed; the S-VOL is not updated.
     Select **None** if the delta resync S-VOL is shared in one of the following combinations:
     - An SI P-VOL and a DP-VOL
     - An SS P-VOL and a DP-VOL
     - A TI P-VOL and a DP-VOL
     With these combinations, selecting **Entire** results in a failed full copy. With **None**, recover the delta resync S-VOL by deleting the in-system pairs, copying the delta resync P-VOL to the S-VOL, and then recreating the in-system pairs.

10. Click **Set** when finished.

To modify a setting, right click and select **Modify**.
To cancel a setting, right click and select **Cancel**.

12. Click **Apply** to apply the settings. If an error occurs, right click the item in the Preview list and select **Error Detail**.

## Deleting journal volumes from a journal

You can delete journal volumes as needed. This topic provides instructions and important information for doing so.

### Prerequisite information

You can delete a journal volume

- A journal volume can only be deleted if either of the following conditions exist:
  - If the pair belonging to the mirror in the journal is suspended.
  - If the pair belonging to the mirror in the journal is deleted.
- Deleting a journal volume from a journal in which a pair is registered results in the journal volume's LDEVs becoming blockaded. You can release the blockade by formatting the LDEVs. For instructions on formatting volumes, see *Provisioning Guide for Mainframe Systems*
- To delete a journal volume, mirror statuses in the journal must Initial, Stopped, or Hold (Failure).
  - However, if a journal uses multiple mirrors, journal volumes can only be deleted as shown below.

### Table 8-1 Deleting journal volumes with multiple mirror IDs

<table>
<thead>
<tr>
<th>Mirror ID 1</th>
<th>Mirror ID 2</th>
<th>Can the journal volumes be deleted?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>Active</td>
<td>No</td>
</tr>
<tr>
<td>Active</td>
<td>Stopped</td>
<td>No</td>
</tr>
<tr>
<td>Stopped</td>
<td>Stopped</td>
<td>Yes</td>
</tr>
<tr>
<td>Active</td>
<td>Hold/Holding/Hold (Failure)</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status of journal</th>
<th>Can the journal volumes be deleted?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>No</td>
</tr>
<tr>
<td>Active</td>
<td>No</td>
</tr>
<tr>
<td>Stopped</td>
<td>Yes</td>
</tr>
<tr>
<td>Hold/Holding/Hold (Failure)</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Status of journal</th>
<th>Can the journal volumes be deleted?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>No</td>
</tr>
<tr>
<td>Active</td>
<td>No</td>
</tr>
<tr>
<td>Stopped</td>
<td>Yes, if 3 UR/TC DC configuration is used.</td>
</tr>
<tr>
<td>Hold/Holding</td>
<td>No, if 3 UR DC configuration is used.</td>
</tr>
<tr>
<td>Hold (Failure)</td>
<td>Yes, if 3 UR DC configuration is used.</td>
</tr>
</tbody>
</table>

### To delete journal volumes

1. In the Storage Navigator main window, select **Actions > Remote Copy > Universal Replicator > Journal Operation**. The Journal Operation window displays.

2. Click ![image](image.png) to change the mode from View to Modify.

3. From the tree, click **Registered > LDKC00**.
4. Select and right-click the desired journal below Registered > LDKC00 (or from the journal volume list on the right). Only one journal can be selected. Click Edit JNL VOLS from the menu that displays. The Edit Journal Volumes dialog box displays.

5. From the Journal Volumes list, select the volumes that you want to delete.

6. Click the Delete.

7. Click Set when finished.

   - To modify a setting, right click and select Modify.
   - To cancel a setting, right click and select Cancel.
   - If necessary, repeat steps from 2 to 6 to specify volumes that should be deleted from other journals.

9. Click Apply to apply the settings. If an error occurs, right click the item in the Preview list and select Error Detail.

Deleting journals

Journals can be deleted from either system.

Prerequisite information
- Journals can be deleted from the primary or secondary system.
- All mirrors in the journal must be Initial status.
- Master and restore journals cannot be deleted.

To delete a journal

2. Click to change the mode from View to Modify.

3. From the tree, click Registered > LDKC00. Journals display in the list on the right.

4. Select and right-click the desired journal. Only one journal can be selected. Click Journals > Delete JNL from the menu that displays.

5. Review your settings in the Preview list in the Journal Operation window.
   - To modify a setting, right click and select Modify.
   - To cancel a setting, right click and select Cancel.

6. Click Apply to apply the settings. If an error occurs, right click the item in the Preview list and select Error Detail.

Logical path maintenance

This topic provides the following:
• Modifying data-transfer time threshold
• Deleting logical paths on page 8-10
• Deleting the UR relationship on page 8-11

Modifying data-transfer time threshold
You can modify the threshold for data transfer to complete. If the threshold value is reached, the transfer is flagged as failing by the system.

Prerequisite information
• This operation can be performed from the primary or secondary system.
• The setting is made in the RIO MIH field on the DKC Options dialog box (RIO MIH--remote I/O missing interrupt handler).

To change the data-transfer threshold time
1. In the Storage Navigator main window, select Actions > Remote Copy > Universal Replicator > DKC Operation. The DKC Operation window displays.

2. Click to change the mode from View to Modify.

3. Make sure DKC is selected in the Display box. The tree and full list on the right-side display information about the paired secondary systems.

4. Locate the desired remote system, right-click, and select DKC Operation > Change DKC Option. The DKC Option dialog box displays.

5. Minimum Paths is disabled in this release. Please continue.

6. Enter a new RIO MIH Time. This is the amount of time the system waits before a data transfer operation is flagged as failed. The range is from 10-seconds to 100-seconds; 15-seconds is the default.

7. Click Set when finished.

   - To modify a setting, right click and select Modify.
   - To cancel a setting, right click and select Cancel.

9. Click Apply to apply the settings. If an error occurs, right click the item in the Preview list and select Error Detail.

Deleting logical paths
You can delete logical paths from the primary or secondary systems.

Prerequisite information
• Before deleting logical paths, make sure that the remaining number of logical paths will be greater than the minimum number of paths setting. The delete path operation will fail if the number of remaining paths is equal to or less than the minimum number of paths.
• The primary system administrator can delete logical paths between the initiator port of the primary system and the RCU target port of the secondary system. The secondary system administrator can delete logical paths between the initiator port of the secondary system and the RCU target port of the primary system.

**To delete a logical path**
1. In the Storage Navigator main window, select *Actions > Remote Copy > Universal Replicator > DKC Operation*.

2. Click to change the mode from View to Modify.
3. In the Display box, select **DKC**. The tree and full list display information about remote systems.
4. Locate the desired remote system, right-click, and select **Delete Path**. A confirmation message appears.
5. Click **OK**.
6. Review your settings in the **Preview** list in the Journal Operation window.
   - To modify a setting, right click and select **Modify**.
   - To cancel a setting, right click and select **Cancel**.
7. Click **Apply** to apply the settings. If an error occurs, right click the item in the **Preview** list and select **Error Detail**.

**Deleting the UR relationship**

You can remove the Universal Replicator pair relationship between primary and secondary systems.

**Prerequisite information**
- Removing the relationship between the primary and the secondary systems also removes the logical paths between them.
- This operation must be performed on both the primary and secondary VSP systems.

**To delete the Universal Replicator relationship**
1. In the Storage Navigator main window, select *Actions > Remote Copy > Universal Replicator > DKC Operation*. The DKC Operation window displays.

2. Click to change the mode from View to Modify.
3. Make sure **DKC** is selected in the Display box. The tree and full list on the right-side display information about connected remote systems.
4. Locate the associated remote system, right-click, and select **DKC Operation > Delete DKC**. A confirmation message displays.
5. Click **OK**.
6. Review your settings in the **Preview** list in the Journal Operation window.
To modify a setting, right click and select Modify.
To cancel a setting, right click and select Cancel.

7. Click Apply to apply the settings. If an error occurs, right click the item in the Preview list and select Error Detail.

Managing power-off for systems and network devices

This topic explains power management for systems and network relay devices during copy operations. This topic discusses the following:

• How to proceed when power is removed from systems or network relay devices due to some unexpected reason
• How to intentionally power off systems or network relay devices

“Network relay devices” refers to hardware used for connecting the primary and secondary systems, such as channel extenders, and switches.

When power stops unexpectedly

This topic explains what happens when power is removed from systems or network relay devices due to an unexpected reason.

Caution: When a system is powered on, you must wait five (5) minutes before performing Universal Replicator operations; otherwise the pairs could be suspended with a failure.

When power is removed from primary or secondary system

• If power is removed from the primary system during remote copy operations, the primary system assumes that a failure has occurred and splits all pairs. When the primary system splits pairs, the secondary system also assumes that a failure occurs and splits all pairs.
• If power is removed from the secondary system during remote copy operations, the secondary system assumes that a failure has occurred and splits all pairs. When the secondary system splits pairs, the primary system also assumes that a failure occurs and splits all pairs.

When power is removed from network relay devices

If power is removed from a network relay device during remote copy operations, the primary and secondary systems assume that a failure has occurred and split all pairs.

Powering-off systems intentionally

This topic explains what should be noted when you intentionally power off systems or network relay devices.

Note: To intentionally power off the primary or secondary system, contact your HDS account team and ask them to power off the system.
To power off primary and secondary systems at the same time, see Powering-off primary and secondary systems at the same time on page 8-13.

**Powering-off the primary or secondary system**

**To power off during copy operations**

1. Ensure that all pairs or mirrors are split and that the status of all the pairs is PSUS. Otherwise the pairs could be suspended due to failure.
2. Turn power off.
3. When ready, power on the system.

| Caution: Wait five (5) minutes after powering on a system before performing Universal Replicator operations; otherwise the pairs could be suspended with a failure. |

4. When the system is ready to resume copy operations, on the primary site, restore the pairs that have been split.
5. Confirm that the status of the pairs is COPY or PAIR.

**Correcting errors made when powering-off**

If a secondary system remains in Suspending status because you powered-off while the primary system was copying data, delete the pair forcibly in both primary and secondary system and then recreate the pair.

**Powering-off primary and secondary systems at the same time**

The primary system must be powered off before the secondary system is powered off. When you are ready to power the systems on, the secondary system must be powered on before the primary system.

The following is the procedure for powering off the primary and secondary systems at the same time:

1. Split all pairs that will be affected. For example, if two primary systems and one secondary system are connected to each other and you want to power off one of the primary system and the secondary system, you must split the pairs on all three systems since they are all affected.
2. After the pairs are split, confirm that their status is PSUS at the primary system.
3. Power off the primary system.
4. Power off the secondary system.
5. Power on the secondary system.
6. When the secondary system is ready to resume copy operations, power on the primary system.

| Caution: Wait five (5) minutes after powering on a system before performing Universal Replicator operations; otherwise the pairs could be suspended with a failure. |
7. When the primary system is ready to resume copy operations, restore the pairs that have been split at the primary system. Confirm that the status of the pairs is changed to COPY or PAIR.

After turning power on or off for both the primary and secondary system at the same time, if pair status at primary system is PSUS and a status of a pair of secondary system is PAIR, use Storage Navigator to suspend the pair of the secondary system. After confirming that the statuses of the pair on both systems is PSUS, restore the pair at the primary system.

**Powering-off network relay devices**

**To power off a network relay device during copy operations**

1. Ensure that all pairs or mirrors are split and that the status of all the pairs is PSUS.
2. Power off the device.
3. When ready power on the network relay device.
4. When the network relay device is ready for copy operations, from the primary site, restore the pairs that have been split.
5. Confirm that pair status is COPY or PAIR.
Disaster recovery operations

This chapter provides instructions for performing disaster recovery.

In addition to general recovery planning and procedures, detailed instructions are included for recovery when Universal Replicator pairs are configured in 3-data-center (3DC) configurations with three UR sites, and with TrueCopy/UR sites. Recovery when UR pairs are shared with ShadowImage pairs is also included.

- Overview
- General recovery procedures
- Recovery for 3 UR data centers
- Recovery for 3 UR/TC data centers and 3 UR data centers
- Recovery for configurations with UR/ShadowImage
Overview

Recovery is the reason for using Universal Replicator and other replication software. With copies of data at a remote location, you restore lost or damaged information from the backup copy. With copies in multiple remote locations, you increase the level of data security, with more complex recovery procedures.

The following is covered in this chapter;

- General recovery procedures on page 9-2
- Recovery for 3 UR data centers on page 9-5
- Recovery for 3 UR/TC data centers and 3 UR data centers on page 9-10. This includes information for both 3DC and 2DC configurations.
- Recovery for configurations with UR/ShadowImage on page 9-16

General recovery procedures

A recovery workflow consists of the following:

2. Establish file and database recovery procedures before disaster or failure occurs, as part of the UR planning process.
   See Preparing for file and database recovery on page 9-2.
3. After a disaster or failure, switch host operations to the secondary site.
   See Switching host operations to the secondary site on page 9-3.
4. Recover the primary site, then copy data to it from the secondary site.
   See Reversing copy direction from secondary to primary sites on page 9-3.
5. Re-establish the pair and host operations at the primary site.
   See Resuming host operations at the primary site on page 9-4.

Preparing for recovery

The major steps for preparing for disaster recovery are:

- Identify the data volumes that you want to back up for disaster recovery.
- Pair the important volumes using Universal Replicator.
- Establish file and database recovery procedures.
- Install and configure software for host failover between the primary and secondary sites.

Preparing for file and database recovery

File recovery procedures are necessary when the primary or secondary system suspends a pair due to a disaster or failure. When this occurs, the S-VOL may contain in-process data resulting from an open data set or
transactions that could not complete. File recovery procedures in these circumstances are the same as when a data volume becomes inaccessible due to control unit failure.

You detect and re-create lost updates by checking database log files and other current information at the primary site.

Design your recovery plan so that detection and retrieval of lost updates is performed after the application is started at the secondary site. The detection and retrieval process can take some time.

Prepare for file and database recovery using files for file recovery (for example, database log files that have been verified as current).

Remote copy and disaster recovery procedures are inherently complex. Consult your HDS account team about recovery procedures.

Switching host operations to the secondary site

These procedures apply to single UR pairs and UR systems with multiple primary and/or secondary VSP systems.

The first recovery task is to switch host operations to the secondary site using the CCI horctakeover command.

- The horctakeover command checks the pair status of S-VOLs and splits journals. Splitting the pairs in the journals ensures consistency and usability in the S-VOLs.
- The horctakeover command attempts to restore pairs to reverse P-VOLs and S-VOLs.
- If the horctakeover command runs successfully, host operations are taken over by the secondary site using the S-VOLs. For detailed information about CCI and horctakeover, see Command Control Interface User and Reference Guide.

Reversing copy direction from secondary to primary sites

When host operations have been switched to the secondary site, restore the primary site and re-establish the UR system from secondary to primary sites.

1. Restore the primary system and data paths.
2. Bring up the host servers at the primary site.
3. Make sure that all UR components are operational.
4. Do all of the following, as applicable:
   a. At the primary site, locate P-VOLs whose status is COPY or PAIR. Locate corresponding S-VOLs at the secondary site whose status is SSWS, which indicates that data is being written to the S-VOLs. At the primary site, split these pairs.
   b. At the primary site, locate P-VOLs whose status is other than SMPL. Locate corresponding S-VOLs at the secondary site whose status is SMPL. At the primary site, release the pairs.
c. At the primary site, locate pairs whose status is SMPL. At the secondary site, release the pairs.

5. On pairs that were split and in which S-VOL status is now SSWS, run the pairresync -swaps command. This reverses P-VOLs and S-VOLs and resynchronizes the pairs. The replication is from secondary site to original primary site.

Note: When you run the pairresync -swaps command, you can use the -d option to specify a data volume. However, the command is rejected if the restore journal where the data volume belongs is in Active, Halting, or Stopping status.

6. For S-VOLs whose status is SMPL, recreate the UR pairs specifying the S-VOLs as P-VOLs. This creates pairs in which P-VOLs and S-VOLs are reversed.

7. Verify that pair status of all new S-VOLs (which were originally P-VOLs) changes from COPY to PAIR. When the pair status is changed to PAIR, initial copy operations are finished and consistency is maintained.

Data in the secondary site is now reflected on the primary site.

Resuming host operations at the primary site

When UR pairs are established in the reverse direction between the secondary and primary sites, you can return host operations to the original configuration. This means resuming host operations at the primary site and reestablishing the original flow of data from primary to secondary systems. The following procedure explains how to resume normal operations at the primary site.

1. At both sites, make sure that UR components are operational.
2. Make sure that pair status of P-VOLs and S-VOLs in all UR pairs is PAIR.
3. Stop host applications at the secondary site.
4. Issue a request for splitting pairs to master journals (these were originally the restore journals on the remote site); use the Flush option when splitting pairs. If an error occurs when splitting pairs, fix the error, resume host operations at the secondary site, and then go back to step 1.
5. If no errors occur, wait until suspension finishes. After suspension finishes, check for an S-VOL on the local site whose status is not PSUS. If such a pair exists, fix the error and go back to step 1 after resuming your business task at the secondary site.
6. When all S-VOLs at the primary site are in PSUS status, data in P-VOLs and S-VOLs are the same. S-VOLs at the primary site are ready for host read/write activity. Resume applications at the primary site.
7. Run the pairresync -swaps command, which reverses P-VOLs and S-VOLs and resynchronizes the pairs. The replication is from the primary site to the secondary site (disaster recovery site).

**Note:** When you run the pairresync -swaps command, you can use the -d option to specify a data volume. However, the command is rejected if the restore journal where the data volume belongs is in Active, Halting or Stopping status.

---

**Recovery for 3 UR data centers**

UR copies in two remote sites provides better backup protection, but recovery is somewhat more complex. The following topics provide instruction for resuming host operations at a backup site and then restoring the original system and configurations.

Recovery operations for 3 UR data centers depends on your configuration.

- Recovery for 3 UR DC cascade configuration on page 9-5
- Recovery for 3 UR DC multi-target configuration on page 9-8
- Recovery when the primary-intermediate path fails on page 9-7

Use CCI for all procedures.

---

**Recovery for 3 UR DC cascade configuration**

For recovery instructions, see the following:

- Recovery when the primary site fails on page 9-5.
- Recovery when the intermediate site fails on page 9-6

For remote site failure, business operations are not effected since the primary and intermediate sites are still operable. Recover the remote site then set up the cascade pairs again.

---

**Recovery when the primary site fails**

Recovery operations consist of the following when a failure occurs in the primary site:

- Transfer host operations to the intermediate site.
- Restore the primary site failure and restart business operations.

**To recover from primary site failure in a 3DC cascade**

1. Run the horctakeover command on the primary-intermediate site pair.
2. When S-VOL status changes to SSWS status or changes to a P-VOL, start host operations to the volume.
When you remove failures from the primary site, you can transfer business operations back to the primary site.

**To transfer business operations back to the primary site**
1. If the primary-intermediate site pair status is SUSPENDED, resynchronize the pair to reverse the primary and secondary volumes.
2. Stop business tasks at the intermediate site.
3. Run the horctakeover command on the intermediate-remote site pair. The pair is automatically suspended.
4. Resume business operations to the primary volume in the primary site.
5. Resynchronize the intermediate-remote site pair.

**Recovery when the intermediate site fails**

Recovery operations consist of the following when a failure occurs in the intermediate site:
- Redirect production data backup
- Recover the intermediate site
- Re-create the cascade configuration

When an intermediate site fails, you need to perform delta resync for disaster recovery, using the primary-remote site pair as the original pair and the intermediate-remote site pair as the differential resync pair, to change back to the original cascading configuration.

**To redirect production data backup**, perform the delta resync operation between the primary site P-VOL and secondary site S-VOL.
After you remove failures from the intermediate site, you can set up the original cascade configuration.

**To restore the intermediate site and cascade configuration**

1. If the status of the primary-intermediate site pair is SUSPENDED, resynchronize the pair.
2. Delete the primary-secondary site delta resync pair. As a result of this operation, the intermediate-remote site pair is also deleted.
3. Create a pair between the intermediate and secondary sites. Specify **Entire** for **Initial Copy**.
4. Create a delta resync pair between the primary and secondary sites.

**Recovery when the primary-intermediate path fails**

When the data path between the primary and intermediate sites fails, the status of journals in these sites might change to Stopping (with pair status changed to Suspending). Stopping status maintains journal data for a delta resync operation.

You can recover in either of the following ways:

- By correcting the problem then resyncing primary-intermediate sites.
- By performing the delta resync between primary-secondary sites

**To recover by resynchronizing primary and intermediate sites**

1. Delete the delta resync pair between the primary and secondary sites.
2. Confirm that the status of the journal between the primary and intermediate sites is changed to Stop.
3. Remove the path error.
4. Resync the pair between the primary and intermediate sites.

**To recover using the delta resync between primary-secondary sites**
1. Run the delta resync operation on the delta resync pair set up between the primary and secondary sites.
   This changes the journal status between the primary and intermediate sites.

**Recovery for 3 UR DC multi-target configuration**

When the primary site fails, you move business operations to a remote site. When the primary site is recovered, you move operations back.

Both operations are explained below. Use CCI for all procedures.

**To move business operations to the remote site**
1. Run the pairsplit -RS command on the pair at the alternative remote site.
2. Check the execution result of the pairsplit -RS command.
3. Perform the delta resync operation by running the pairresync -swaps command on the delta resync pair. Note pair status before and after the operation in the following table.

<table>
<thead>
<tr>
<th>Pair</th>
<th>Status before pairresync - swaps</th>
<th>Status after pairresync - swaps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary Volume</td>
<td>Secondary Volume</td>
</tr>
<tr>
<td>Primary-remote site pair</td>
<td>PAIR, PSUS, or PSUE</td>
<td>PAIR, PSUS, or PSUE</td>
</tr>
<tr>
<td>Delta resync pair</td>
<td>HOLD</td>
<td>HOLD</td>
</tr>
</tbody>
</table>

4. Check the execution result of the pairresync -swaps command. When the delta resync pair changes to PAIR status, you can move business operations to the alternate remote site.
To transfer business operations back to the primary site

1. When the primary site is restored, check the status of the pair from the remote site (where business operations were moved) to the primary site. If the status PSUE, resynchronize from the remote site to reverse the pair’s primary and secondary volumes.

2. Stop business operations at the remote site.

3. Run the pairsplit -RS command from the remote site, which brings the secondary volume forcibly into SSWS.

4. Run the pairresync -swaps in the primary site, which reverses the primary and the secondary volumes to restore and resynchronize the pair.

5. Run the pairresync -swaps in the primary site on the other multi-target pair.

6. Resume business operations at the primary site.
Disaster recovery operations

Recovery for 3 UR/TC data centers and 3 UR data centers

All procedures described in the following sections apply to both 3 UR/TC data centers and 3 UR data center recovery.

Recovery procedures when UR P-VOLs and S-VOLs are shared with TrueCopy can be more complex than general procedures.

The following topics provide recovery procedures for resuming host operations at a backup site and then restoring the original system and configurations.

- Recovery for 3 UR/TC DC cascade configuration on page 9-11
- Recovery for 3 UR/TC DC multi-target configuration on page 9-11
- Recovery in a delta resync configuration on page 9-14
- Recovery in a 2DC configuration on page 9-15
Use CCI to perform all procedures.

Recovery for 3 UR/TC DC cascade configuration

Host operations are transferred to the TC secondary volume (S-VOL) at the intermediate site when a disaster or failure occurs in the primary site of a 3DC cascade configuration. The primary site failure is corrected and brought back online, then either the cascade configuration is restored or the multi-target configuration is created.

See 3DC cascade configuration on page C-3 or 3 UR DC cascade configuration on page A-2 for information and illustrations on the configuration covered in this procedure.

To recover a 3DC cascade configuration failure
1. Check consistency of the secondary volume in the intermediate site.
2. Run the horctakeover command on the secondary volume.
3. Wait until the secondary volume in the intermediate site is suspended (in SSWS status) or changes to a primary volume, then use the volume to resume host operations.

Recovery for 3 UR/TC DC multi-target configuration

The recovery procedure you perform in a 3DC multi-target configuration depends on the location of the failure:
- For failure in the primary site only — see Recovering from primary site failure on page 9-11.
- For failure in the primary and TrueCopy intermediate sites — see Recovering from primary and secondary site failure (3DC multi-target) on page 9-13.

See 3DC multi-target configuration on page C-4 or 3 UR DC multi-target configuration on page A-6 for information and illustrations on the configuration covered in this procedure.

Recovering from primary site failure

For 3 UR/TC configurations, host operations are transferred to the secondary volume in the intermediate site when disaster or failure occurs in the primary site in a 3DC multi-target configuration. Replication occurs from the intermediate site to the primary site. Alternatively, a temporary UR system can be set up. Meanwhile, you correct the failure at the primary site, then transfer host operations back to it and set up a 3DC configuration.

To recover a primary site failure
1. Release the UR pair.
2. Run the horctakeover command on the primary-remote site pair.
3. Start host operations to the remote site secondary volume.

Running the horctakeover results in one of the following conditions:
• The original copy flow of the primary-remote site pair reverses and flows from the primary-remote secondary volume to the primary volume.
• The original copy flow does not reverse because of failure in the primary site or data path.

Depending on the result, proceed as follows:

**If the original TC data flow reverses**
1. Re-create the UR pair from the TC primary site to the UR remote site. This results in a 3DC cascade configuration, with the original TC S-VOL as the primary volume. See the lower right configuration in Figure 9-2 Recovery scenarios on page 9-13.
2. Restore the primary site or data path, or both. This must be done before proceeding.
3. Stop host operations to the TC intermediate site.
4. Run the horctakeover command on the TC pair.
5. Resume host operations to the TC P-VOL in the primary site.

The system changes back to the original 3DC multi-target configuration.

**If the original TC data flow did not reverse**
1. To back up the data, create a new UR pair from the TC S-VOL in the intermediate site to the UR secondary volume in the remote site. See the upper-right configuration in Figure 9-2 Recovery scenarios on page 9-13.
2. Restore the primary site or data path, or both. This must be done before proceeding.
3. Release the UR pair.
4. Resynchronize the TC pair to start the replication to the primary site.
5. Release the current UR pair, which extends between the TC secondary site and the UR secondary site.
6. Stop host operations at the TC intermediate site.
7. Run the horctakeover command on the TC pair.
8. Resume host operations to the primary site TC volume.
9. Re-create the UR pair from the primary site to the remote site. The system is now changed back to the original 3DC multi-target configuration.
Recovering from primary and secondary site failure (3DC multi-target)

Host operations are transferred to the Universal Replicator S-VOL in the remote site when a disaster or failure occurs in both the primary and TrueCopy intermediate sites in a 3DC multi-target configuration. Failures are corrected at the two sites and then host operations are transferred back to the primary site.

To recover a primary and TC intermediate site failure
1. Run the horctakeover command on the UR pair.
2. Resume host operations at the UR secondary site.
3. Release the TC pair.
4. Make sure the UR pair is resynchronized so that the copy flow is from S-VOL to P-VOL.
5. Stop host operations at the UR secondary site.
6. Run the horctakeover command on the UR pair.
7. Resume host operations at the primary site.
8. Make sure the copy flow of the UR pair is from P-VOL to S-VOL. If it is not, resynchronize the pair.
9. Re-create the TC pair.

The system is now changed back to the original 3DC multi-target configuration.
Recovery in a delta resync configuration

Host operations are transferred to the TrueCopy S-VOL in the intermediate site when a disaster or failure occurs in the primary site in a delta resync configuration. Then you run the delta resync operation. When the failure at the primary site is corrected, host operations are transferred back to the primary site and the delta resync configuration is reestablished.

Prerequisite information

- For information and illustrations on the configuration covered in this procedure, see Delta resync configuration on page C-6.
- You can specify options for recovery in the event that the delta resync operation fails. See the Delta resync Failure step in Changing options used by mirrors on page 8-5. This also provides important information if you share the delta resync S-VOL with ShadowImage, Thin Image, or Copy-on-Write Snapshot and a DP-VOL.

To recover a delta resync configuration failure

1. Run the horctakeover command on the TC pair.
2. Start host operations to the TC S-VOL.
3. Perform the delta resync operation on the volume in the TC intermediate site.
   
   See Prerequisite information for delta resync operation on page C-9.

   Note that pair status must be HOLD before the operation. When the operation completes, pair status is PAIR or COPY.

   | Note: | Pair status also changes for the original UR pair in the primary and UR remote sites, from PAIR or COPY to HOLD.

   However, the status of the original pair may not change to the required state after the delta resync operation. If this occurs, host operations cannot be resumed in the primary site. See Problems with pair status during delta resync recovery on page 9-15 and make the necessary corrections.

4. Restore the problem at the primary site. This must be done before proceeding.
5. If the TC pair is suspended, resynchronize the pair and reverse the copy flow.
6. Stop host operations to the TC intermediate site.
7. Run the horctakeover command on the TC pair.
8. Resume host operations to the TC P-VOL in the primary site.
9. Perform the delta resync operation on the volume in the TC primary site.
   
   Pair status must be HOLD. When the operation completes, pair status is PAIR or COPY.

   Also, pair status changes for the delta resync UR pair from the TC intermediate to the UR remote site, from PAIR, PSUS, or PSUE to HOLD.

The system becomes a delta resync configuration again.
**Problems with pair status during delta resync recovery**

After performing the delta resync, it is necessary for the original UR pair from the primary to UR remote sites to be in HOLD status, in order to resume operations at the primary site. However, the pair may not be in this status.

If pair status is not HOLD, match the pair’s actual statuses in the following table and then perform the corrective action.

<table>
<thead>
<tr>
<th>Current status</th>
<th>Corrective action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary site: PAIR or COPY</td>
<td>1. Make sure that the status of the pair in the primary site is PSUE or PSUS.</td>
</tr>
<tr>
<td>UR secondary site: HOLD</td>
<td>2. Release the UR pair from the primary site.</td>
</tr>
<tr>
<td></td>
<td>3. Make sure that all the pairs belonging to the journal in the primary site are released.</td>
</tr>
<tr>
<td></td>
<td>4. Create a UR delta resync pair that extends from the primary site to the UR secondary site.</td>
</tr>
<tr>
<td>Primary site: PSUE or PSUS</td>
<td>1. Release the UR pair from the primary site.</td>
</tr>
<tr>
<td>UR secondary site: HOLD</td>
<td>2. Make sure that all the pairs belonging to the journal in the primary site are released.</td>
</tr>
<tr>
<td></td>
<td>3. Create a UR delta resync pair that extends from the primary site to the UR secondary site.</td>
</tr>
<tr>
<td>Primary site: HLDE</td>
<td>Change the status of the HLDE pair back to HOLD using pairresync.</td>
</tr>
<tr>
<td>UR secondary site: HOLD</td>
<td></td>
</tr>
<tr>
<td>Primary site: SMPL</td>
<td>1. Release the pair in HOLD status from the UR secondary site.</td>
</tr>
<tr>
<td>UR secondary site: HOLD</td>
<td>2. Create a UR delta resync pair that extends from the primary site to the UR secondary site.</td>
</tr>
</tbody>
</table>

**Recovery in a 2DC configuration**

Host operations are transferred to the Universal Replicator S-VOL in the remote site when a disaster or failure occurs in the primary site in a 2DC configuration. Failures are corrected at the primary site, host operations are transferred back, and the 2DC configuration is reestablished.

See [2 data center configuration on page C-15](#) for information and illustrations on the configuration covered in this procedure.

**To recover a 2DC configuration failure**

1. In the remote site, confirm the consistency of the UR S-VOL.
2. In the intermediate site, release the TC pair using the Pairsplit-S command.
3. In the intermediate and remote sites, release the UR pair using the Pairsplit-S command.
4. Confirm that the UR S-VOL has changed to SMPL status.
5. Resume host operations to the UR S-VOL on the remote site.

**Note:** Be aware of the following:
- The 2DC configuration does not allow host operations on the intermediate site.
- If the intermediate site is not connected to a host, use the remote command device for UR and TC pair operations.

6. On the primary site, if TC pairs exist, release them.

7. On the remote UR site, create a TC pair:
   - Use the UR S-VOL on the remote site as the TC P-VOL. This is the current disaster recovery production volume.
   - Use the primary site volume as the TC S-VOL
   Follow all requirements for creating a TC pair.

8. After the new TC pair is in PAIR status, stop host operations at the remote site, then release the TC pair.

9. On the intermediate site, create a UR pair to the UR remote site, with no data copying (specify None on the Copy Mode option). Specify the intermediate site volume as the UR P-VOL and the remote volume as the UR S-VOL.

10. On the primary site, create a TC pair between the primary site data volume and the intermediate site UR P-VOL, with no data copying.

    When this is done, since host operations have not resumed, all three sites have the same data in their respective volumes.

11. Resume host operations at the primary site. Synchronous copying will resume between the primary site TC P-VOL and the intermediate site S-VOL. UR copying will resume from intermediate site to remote site.

    The system becomes a 2DC configuration again.

**Recovery for configurations with UR/ShadowImage**

See [Configurations with ShadowImage secondary volumes on page D-4](#) for information and illustrations on the configuration covered in this procedure.

You resume host operations to the remote Universal Replicator secondary volume if a disaster or failure occurs at the primary site where the UR P-VOL is shared with the ShadowImage (SI) secondary volume. Then you recover the primary site and then resume host operations.

**To recover from failure in a UR P-VOL/SI S-VOL configuration**

1. Release the SI pair using the pairsplit -S command.
2. Reverse the copy direction and resync the UR pair using the horctakeover command.
3. Reverse the copy direction again on the UR pair using the horctakeover command.
4. Delete the UR pair using the pairsplit -S command.
5. Create a SI pair from the SI S-VOL to perform copying in the reverse direction. Use the paircreate command.
6. Release the SI pair using the pairsplit -S command.
7. Re-create the original SI pair from the original SI P-VOL to perform copying in the original direction. Use the paircreate command.
8. Split the SI pair using the pairsplit -r command.
9. Recreate the UR pair using the paircreate command.

The system becomes the original configuration again.
This chapter provides Universal Replicator troubleshooting information.

- General troubleshooting
- Troubleshooting logical paths
- Troubleshooting by suspension type
- Troubleshooting hardware problems affecting pairs
- Troubleshooting with CCI
- Service information messages (SIMs)
- Miscellaneous troubleshooting
- Calling the Hitachi Data Systems Support Center
**General troubleshooting**

When an error occurs in a Universal Replicator pair operation with Storage Navigator, an error message displays with a four-digit error code and description. An SVP error code may also be included. See *Hitachi Storage Navigator Messages* for details on error codes.

You can download Storage Navigator dump files using the FD Dump tool. If you are unable to resolve an error, use the tool to copy the dump files to a file, and then contact the Hitachi Data Systems Support Center for assistance.

The following describes general troubleshooting problems and solutions for Universal Replicator.

<table>
<thead>
<tr>
<th>Error</th>
<th>Corrective action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Navigator hangs, or UR operations do not function properly.</td>
<td>Make sure that the problem is not being caused by the computer or Ethernet hardware or software, and restart the computer. Restarting the Storage Navigator computer does not affect UR operations in progress. Make sure that all UR requirements and restrictions are met. Make sure that the primary and secondary systems and remote copy connections are powered on, and that NVS and cache are fully operational. Check all the entered values and parameters to make sure that you entered the correct information on the Storage Navigator computer (for example, secondary system S/N, path parameters, P-VOL and S-VOL IDs). If you are using Performance Monitor, refrain from using it.</td>
</tr>
<tr>
<td>An initiator channel-enable LED indicator (on the control window) is off or flashing.</td>
<td>Please call Hitachi Data Systems Support Center for assistance.</td>
</tr>
<tr>
<td>Status of pairs and/or logical paths is not displayed correctly.</td>
<td>Make sure that the correct CU image is selected. Check whether you selected correct items or options in UR windows, such as the DKC Operation window, the Pair Operation window, and the Display Filter dialog box.</td>
</tr>
<tr>
<td>A UR error message appears on the Storage Navigator computer.</td>
<td>Remove the error cause, and then retry the UR operation.</td>
</tr>
<tr>
<td>The status of a logical path is not normal.</td>
<td>Check the path status in the DKC Status dialog box, and see <em>Troubleshooting logical paths on page 10-3</em>.</td>
</tr>
<tr>
<td>The pair status is suspended.</td>
<td>Check the pair status in the Detailed Information dialog box, and see <em>Troubleshooting by suspension type on page 10-6</em> for suspend types and corrective action.</td>
</tr>
<tr>
<td>Error</td>
<td>Corrective action</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| The pair create or pair resync operation resulted in a timeout error. | • If the timeout error was caused by a hardware failure, a SIM is generated. See Service information messages (SIMs) on page 10-23. If necessary, call Hitachi Data Systems Support Center, and retry UR operations after the problem is solved.  
  • If no SIM was generated, wait for a while (5 or 6 minutes), then check the pair status of the pairs being created or resumed. If the pair status changed correctly, the failed operation completed after the timeout message was issued. If the pair status did not change as expected, heavy workload might have prevented the UR operation from being completed. In this case, retry the UR operation when the system has a lighter workload.  
  • If a time-out error occurs during the paircreate operation, the copy operation might not have been executed correctly in the order specified in the Priority field. A time-out error may be caused by the CU configuration or a remote copy path error. Review the error, release the pair with the error, and then retry the paircreate operation. |
| A communication error between Storage Navigator and the SVP occurred. | See Hitachi Storage Navigator User Guide for instructions.                                                                                           |
| Though "Monitoring Switch" is enabled, monitoring data is not updated. | Because the time setting of SVP is changed, the monitoring data might not be updated. To precede, disable then enable again the Monitoring Switch field. For further information on Monitoring Switch, see Performance Guide. |
| Journal volumes are not registered in the journal.                   | The error caused the delete journal operation to suspend. Re-register the journal volumes that belong to the journal, then delete the journal again.   |
| The pairresync operation suspends with a warning message.           | This is caused when the following two conditions exist:  
  • The Preview list contains two or more pairs belonging to the same mirror.  
  • Mirror is defined in the Range column for at least one of the above pairs.  
  To continue processing, do either of the following:  
  • Ensure that the Range column displays LU for all pairs in the same mirror.  
  • In the Preview list, delete all but one pair in the same mirror. |
| An error occurs when Apply is clicked for a pair operation.          | The error code appears in the right-most column of the Preview list. To view detailed information about the error, right click the error code and select Error Detail. |

**Troubleshooting logical paths**

Troubleshooting information for logical paths between storage systems is shown below.
<table>
<thead>
<tr>
<th>Path status</th>
<th>Description</th>
<th>Corrective action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>This path has been successfully established and can be used for UR copy activities.</td>
<td>None required.</td>
</tr>
</tbody>
</table>
| Initialization   | The link initialization procedure to the secondary system failed because the physical path connection was missing between the primary and secondary systems. | • Make sure that the primary and secondary systems are physically and correctly connected.  
• Make sure that you entered the correct secondary system S/N, Controller ID, and primary and secondary system port numbers.  
• Make sure the primary and secondary system ports are configured correctly. |
| Communication     | Communication between the primary and secondary system timed out.         | • Make sure the secondary system is powered on and that NVS and cache are fully functional.  
• Make sure that network relay devices are properly configured and functional. This includes cables, connectors, switches, extender devices, communication lines, and all other devices connected to the extenders. |
| Port Rejected    | The primary system rejected the logical path link control function because all logical path resources in the primary system are being used for other connections. | • Delete all paths and RCUs not in use.  
• Make sure that all primary and secondary system ports are properly configured: ordinary RCU target ports for secondary systems, initiator ports for primary systems. If necessary, connect to the secondary system to delete paths.  
• Reconfigure the ports, then add the paths and RCUs to the MCU again. |
<p>| Pair-Port         | The secondary system rejected the logical path link control function because all logical path resources in the secondary system are being used for other connections. | Follow the same corrective actions in Port Rejected. |</p>
<table>
<thead>
<tr>
<th>Path status</th>
<th>Description</th>
<th>Corrective action</th>
</tr>
</thead>
</table>
| Serial Number Mismatch | The secondary system's S/N does not match the specified S/N.                | • Make sure that you entered the correct secondary system S/N and Controller ID, and primary and secondary system port numbers.  
• Make sure the primary and secondary system ports are configured correctly.  
• Make sure that data path relay equipment is properly configured and functional. This includes cables, connectors, switches, extender devices, communication lines, and all other devices connected to the extenders. |
| Invalid Port Mode      | The specified port is not configured as an initiator port, or this path already exists. | • Make sure the correct port on the primary system is configured as an initiator port.  
• Make sure that no two paths between primary and secondary system ports have the same settings.  
• Make sure that you entered the correct secondary system S/N and Controller ID, and primary and secondary system port numbers.  
• Make sure that the primary and secondary system ports are configured correctly.  
• Make sure that data path relay equipment is properly configured and functional. This includes cables, connectors, switches, extender devices, communication lines, and all other devices connected to the extenders. |
| Pair-Port Number Mismatch | The specified port in the secondary system is physically disconnected from the primary system. | • Make sure that you specified the correct secondary system port number. Correct the port number if necessary.  
• Make sure that the cables between the primary and secondary system ports and between the primary and secondary system switches are connected correctly.  
• Make sure that the topology settings of the primary and secondary system ports are correct. |
| Pair-Port Type Mismatch | The specified secondary system port is not configured as an RCU target port. | Make sure that the secondary system port is configured as an RCU target port. |
Troubleshooting by suspension type

Troubleshooting information for suspended pairs by suspension type is provided in the following table.

<table>
<thead>
<tr>
<th>Path status</th>
<th>Description</th>
<th>Corrective action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>The primary system connected to the secondary system successfully, but logical communication timeout occurred.</td>
<td>• Make sure that the secondary system port and the relay equipment are configured correctly.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Make sure that data path relay equipment is properly configured and functional. This includes cables, connectors, switches, extender devices, communication lines, and all other devices connected to the extenders.</td>
</tr>
<tr>
<td>Failed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Progress</td>
<td>Paths are being created or deleted, or the port attribute is being changed.</td>
<td>Wait until processing is completed.</td>
</tr>
<tr>
<td>Logical Blockade</td>
<td>Blockaded due to continual path or link failure.</td>
<td>See the following.</td>
</tr>
<tr>
<td></td>
<td>The primary system port does not work.</td>
<td>Repair the port on the primary system, then restore the path*.</td>
</tr>
<tr>
<td></td>
<td>The secondary system port does not work.</td>
<td>Repair the port on the secondary system, then restore the path*.</td>
</tr>
<tr>
<td></td>
<td>The path relay equipment does not work.</td>
<td>Repair the path relay equipment, then restore the path*.</td>
</tr>
<tr>
<td></td>
<td>The connection cable is physically broken.</td>
<td>Replace the broken cable, then restore the path*.</td>
</tr>
<tr>
<td>Program Error</td>
<td>A program error is detected.</td>
<td>Restore the path*.</td>
</tr>
<tr>
<td>&lt;blank&gt;</td>
<td>This path was not established.</td>
<td>Restore the path*.</td>
</tr>
</tbody>
</table>

* To restore a path, delete and then add the path again. It may be necessary to delete and then add the RCU again.

To delete the RCU or path, see Deleting the UR relationship on page 8-11 or Deleting logical paths on page 8-10. To re-register, see Configuring local and remote systems for UR on page 5-3. If you cannot restore the path after performing these operations, contact HDS for assistance.
<table>
<thead>
<tr>
<th>Suspend type</th>
<th>Applies to</th>
<th>Description</th>
<th>Corrective action</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSUE, by RCU</td>
<td>P-VOL</td>
<td>The primary system suspended a pair because it detected an error condition in the secondary system. The suspend type for the S-VOL is by MCU.</td>
<td>Clear the error condition at the secondary system or S-VOL. If you need to access the S-VOL, release the pair from the primary system. If data in the S-VOL has been changed, release the pair from the primary system and then re create the pair by using the paircreate dialog box. If data in the S-VOL has not been changed, restore the pair from the primary system.</td>
</tr>
<tr>
<td>PSUE, S-VOL Failure</td>
<td>P-VOL</td>
<td>The primary system detected an error during communication with the secondary system or detected an I/O error during update copy. In this case, the suspend type for the S-VOL is usually by MCU.</td>
<td>Check the path status on the DKC Status dialog box (see Troubleshooting logical paths on page 10-3). Clear any error conditions at the secondary system and the S-VOL. If you need to access the S-VOL, release the pair from the secondary system. If data in the S-VOL has been changed, release the pair from the primary system and then re create the pair by using the paircreate dialog box. If data in the S-VOL has not been changed, restore the pair from the primary system.</td>
</tr>
<tr>
<td>PSUE, MCU IMPL</td>
<td>P-VOL, S-VOL</td>
<td>The primary system could not find valid control information in its nonvolatile memory during the IMPL procedure. This error occurs only if the primary system is without power for more than 48 hours (power failure and fully discharged batteries).</td>
<td>Restore the pair (pairresync) from the primary system. The primary system performs an initial copy operation in response to the pairresync request, so that the entire P-VOL is copied to the S-VOL.</td>
</tr>
<tr>
<td>PSUE, Initial Copy Failed</td>
<td>P-VOL, S-VOL</td>
<td>The primary system suspended this pair during the initial copy operation. The data on the S-VOL is not identical to the data on the P-VOL.</td>
<td>Release the pair from the primary system. Clear all error conditions at the primary system, P-VOL, secondary system, and S-VOL. Restart the initial copy operation by using the paircreate dialog box.</td>
</tr>
<tr>
<td>PSUE, MCU P/S OFF</td>
<td>S-VOL</td>
<td>The primary system suspended all UR pairs because the primary system was powered off.</td>
<td>None. The primary system automatically restores these UR pairs when the primary system is powered on.</td>
</tr>
</tbody>
</table>

**Troubleshooting hardware problems affecting pairs**

Hardware failures affecting Universal Replicator are described in the following table. Note also that, in addition to the problems described below, hardware failures that affect cache memory and shared memory can cause the pairs to be suspended.
<table>
<thead>
<tr>
<th>Classification</th>
<th>Causes of suspension</th>
<th>SIM</th>
<th>Recovery procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary or secondary system hardware</td>
<td>Hardware redundancy has been lost due to some blockade condition. As a result, one of the following could not complete: primary-secondary system communication, journal creation, copy operation, restore operation, staging process, or de-staging process. Journals cannot be retained because some portion of the cache memory or the shared memory has been blocked due to hardware failure. The primary system failed to create and transfer journals due to unrecoverable hardware failure. The secondary system failed to receive and restore journals due to unrecoverable hardware failure. The drive parity group was in correction-access status while the URpair was in COPY status.</td>
<td>DC0x DC1x DC2x</td>
<td>Depending on the SIM, remove the hardware blockade or failure. Restore the failed volume pairs (pairresync) . If a failure occurs during execution of the CCI horctakeover command, secondary volumes in SSWS pair status may remain in the master journal . If these volumes remain, execute the pairresync -swaps command on the secondary volumes whose pair status is SSWS (pairresync is the CCI command for resynchronizing pair and -swaps is a swap option) .This operation changes all volumes in the master journal to primary volumes. After this operation, restore the volume pairs (pairresync).</td>
</tr>
<tr>
<td>Communication between the primary and secondary systems</td>
<td>Communication between the systems failed because the secondary system or network relay devices were not running. Journal volumes remained full even after the timeout period elapsed.</td>
<td>DC0x DC1x</td>
<td>Remove the failure from the primary and secondary systems or the network relay devices. If necessary, increase resources as needed (for example, the amount of cache, the number of paths between primary and secondary systems, the parity groups for journal volumes, etc.). Restore the failed pairs (pairresync).</td>
</tr>
<tr>
<td>RIO overload or RIO failure</td>
<td>An unrecoverable RIO (remote I/O) timeout occurred because the system or network relay devices were overloaded. Or, RIO could not be finished due to a failure in the system.</td>
<td>DC2x</td>
<td>Release failed pairs (pairsplit-S) . If necessary, increase resources as needed (for example, the amount of cache, the number of paths between primary and secondary system, the parity groups for journal volumes, etc.). Re-establish failed pairs (paircreate).</td>
</tr>
<tr>
<td>Planned power outage to the primary system</td>
<td>The UR pairs were temporarily suspended due to a planned power outage to the primary system.</td>
<td>DC8x</td>
<td>No recovery procedure is required. The primary system automatically removes the suspension condition when the system is powered on.</td>
</tr>
</tbody>
</table>
Troubleshooting with CCI

When an error has occurred in Universal Replicator pair operation when using CCI, you can identify the cause of the error by referring to the CCI operation log file. The file is stored in the following directory by default:

/HORCM/log*/curlog/horcmlog_HOST/horcm.log

Where:

* is the instance number.

HOST is the host name.

To identify the error code in the log file, open the CCI log file, and find the error code.

Example: 11:06:03-37897-10413- SSB = 2E31, 3703

Error codes appear on the right of the equal symbol (=). The alphanumeric characters on the left of the comma(,) indicates SSB1 (for example, 2E31), and on the right of the comma (,) indicates SSB2 (for example, 3703).

The following tables describe the CCI error codes for Universal Replicator.

**CCI error codes for UR: SSB1 = 2E31, B901, B9E0, B9E1, B9E2, B9E4, D004**

<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3703</td>
<td>A request of UR Pairresync to change the pair status from HLDE to HOLD was rejected because the PIN data was existed in the journal volume.</td>
</tr>
<tr>
<td>3704</td>
<td>A request of UR Paircreate was rejected because the emulation types of the specified master journal and of the restore journal were different.</td>
</tr>
<tr>
<td>3705</td>
<td>A request of UR Paircreate or UR Pairresync for delta resync was rejected because the version of the secondary system did not support the corresponding command.</td>
</tr>
<tr>
<td>3706</td>
<td>A request of UR Paircreate for delta resync was rejected because the specified P-VOL was used as the S-VOL of TrueCopy, and the pair status was not PAIR.</td>
</tr>
</tbody>
</table>
| 3707              | A request of UR Pairresync for delta resync was rejected because of the one of following reasons.  
  - The specified P-VOL was the P-VOL of TrueCopy, and the UR pair status was not PAIR.  
  - The specified P-VOL was the S-VOL of TrueCopy, and the UR pair status was not SSWS. |
<p>| 3708              | The UR pair cannot be created because the specified P-VOL was being shredded. |
| 3709              | A request of UR Paircreate or UR Pairresync for delta resync was rejected because the specifying of the restore journal was incorrect. |</p>
<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>370B</td>
<td>The UR pair cannot be resynchronized (DELTAJNL parameter specifying), because the specified P-VOL is not in the either of HOLD or HOLDTRANS status. Or, the UR pair cannot be resynchronized (ALLJNL parameter specifying), because the specified P-VOL is not in the either of HOLD, HOLDTRANS, or NODELTA status.</td>
</tr>
<tr>
<td>370C</td>
<td>A request of Paircreate or Pairresync for UR pair or UR pair for delta resync was rejected because the status of the specified master journal or restore journal could not be transited, or the status transition was in progress.</td>
</tr>
<tr>
<td>371C</td>
<td>A request by UR Paircreate or UR Pairresync was rejected because the TrueCopy pair was either in the status other than suspending or was not used in the 2DC configuration.</td>
</tr>
<tr>
<td>371D</td>
<td>The journal was registered when 2DC Cascade set to Enable in the Edit Journal Volumes dialog box. In the 2DC Cascade configuration, the UR pair cannot be created when the TrueCopy is already registered. The 3DC multi-target configuration also cannot be created.</td>
</tr>
<tr>
<td>3720</td>
<td>A request by UR Paircreate or Pairresync was rejected because the journal volume in the specified master journal was blocked.</td>
</tr>
<tr>
<td>3723</td>
<td>The UR pair cannot be created because the version of the DKCMAIN microcode on the remote storage system does not support the LUSE volume.</td>
</tr>
<tr>
<td>3726</td>
<td>The UR pair cannot be created because the volume specified as the P-VOL was the system disk.</td>
</tr>
<tr>
<td>3728</td>
<td>A request of UR Paircreate was rejected because it was connected with the old model and the specified volume was unsupported.</td>
</tr>
<tr>
<td>3729</td>
<td>A request of UR Paircreate was received. However, the pair could not share the volume with TrueCopy because the Disaster Recovery Extended program product was not installed in the primary system.</td>
</tr>
<tr>
<td>372B</td>
<td>A pair cannot be created because the secondary system does not support the combination of multiple primary and secondary systems.</td>
</tr>
<tr>
<td>372C</td>
<td>The volume is inaccessible because the P-VOL is blocked.</td>
</tr>
<tr>
<td>372D</td>
<td>The specified volume is used in the system that consists of multiple primary and secondary systems. Therefore the command was rejected because the delta resync operation cannot be executed.</td>
</tr>
<tr>
<td>372E</td>
<td>A request to create or resynchronize a pair in the system that consists of multiple primary and secondary systems was rejected because the Disaster Recovery Extended program product was not installed in the primary system.</td>
</tr>
<tr>
<td>3737</td>
<td>In a 3 UR DC configuration, the pair could not be created because the pair status of one of the mirrors is not fixed.</td>
</tr>
<tr>
<td>3738</td>
<td>A request for pair creation was rejected because the Disaster Recovery Extended program product was not installed in the primary storage system.</td>
</tr>
<tr>
<td>3739</td>
<td>A request for pair creation in the second mirror of a 3 UR DC configuration was rejected because the journal to which the P-VOL belongs does not allow the 3 UR DC configuration.</td>
</tr>
<tr>
<td>373D</td>
<td>A request for pair creation in a 3 UR DC configuration was received, but the command was rejected because the S-VOL was used by another program product.</td>
</tr>
<tr>
<td>Error code (SSB2)</td>
<td>Description</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>373E</td>
<td>The pair creation failed because the status of a mirror in the journal in which the specified S-VOL belongs is other than Initial or Stopped.</td>
</tr>
<tr>
<td>3744</td>
<td>A request for pair creation in a 3 UR DC configuration was rejected because the P-VOL was used by another program product.</td>
</tr>
<tr>
<td>3745</td>
<td>A request for pair creation in a 3 UR DC cascade configuration between the primary and intermediate sites was rejected because the journal to which the P-VOL belongs does not allow the 3 UR DC configuration.</td>
</tr>
<tr>
<td>3747</td>
<td>In the configuration where three UR sites are combined, a request of UR pair resync (journal resync mode) was received. However, since the volume status was being changed, the command was rejected.</td>
</tr>
<tr>
<td>374B</td>
<td>The pair cannot be created because the specified P-VOL is used for the external volume mapped for online data migration.</td>
</tr>
</tbody>
</table>
| 3752             | The pair cannot be created because of one of the following:  
|                  | • The secondary system's microcode version does not support connection with the primary system.  
|                  | • The specified S-VOL is being used by TrueCopy |
| 3754             | The pair cannot be created because one of the storage systems does not support the 2DC or 3DC UR function. |
| 3755             | The command was rejected because the specified S-VOL is used as an S-VOL in another mirror, and the pair status is not in SSWS status. |
| 3756             | The pair cannot be created because the secondary storage system does not support the Path Gr. ID, which was specified as other than 0. |
| 375B             | The specified primary storage system does not support global virtualization. |
| 375D             | The pair cannot be created because no virtual LDEV ID is set for the volume specified as the S-VOL. |
| 8C13             | Paircreate or Pairresync is not available, because the specified journal is dedicated to a UR-TC combination (2DC), and the MU# is 0. |
| 8C19             | The pair cannot be created because the specified CTG number is out of range of supporting. |
| 8C1A             | The pair cannot be created or resynchronized because the specified journal number is incorrect. |
| 8C1B             | The pair cannot be created because the specified journal number is out of range of supporting. |
| 8C1E             | The pair cannot be created because of one of the following reasons:  
|                  | • The microcode version of the specified primary storage system does not support connection with the specified secondary storage system.  
<p>|                  | • The specified primary storage system does not support connection with the specified secondary storage system |
| 8C1F             | The pair cannot be created because the virtual ID is not set for the specified S-VOL. |
| 8C20             | The request to update options was rejected because the specified journal number or mirror ID is incorrect. |
| 8F00             | The pair cannot be created because the specified volume was an external volume. |
| 8F04             | The command was rejected because an internal logical error occurred. |</p>
<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
</table>
| 8F10             | The pair cannot be created because the specified P-VOL is one of the following:  
|                  | • An SI S-VOL that is not in PSUS status  
|                  | • An SI volume in Reverse Copy status  
|                  | • An SI reserved volume |
| 8F11             | The pair cannot be created. The processing of volume migration could not be stopped because the P-VOL was being migrated by Volume Migration. |
| 8F14             | The pair cannot be created because the specified volume was the reserved volume. |
| 8F17             | The pair cannot be created because the specified volume was in the state of online from the host. |
| 8F18             | The pair cannot be created because the specified volume was used in a pair on another program product. |
| 8F19             | The pair cannot be created because the emulation type of the specified volume was unusable. |
| 8F1B             | The pair cannot be created because the specified P-VOL was not in the SMPL status. |
| 8F1C             | The pair cannot be created because the specified P-VOL was not in the PSUS status. |
| 8F21             | The pair cannot be created or resynchronized because of the one of following reasons.  
|                  | • The specified volume was the P-VOL of the TrueCopy.  
|                  | • The unavailable configuration with the combination of the ShadowImage (including when the mirror ID of the UR was 0).  
|                  | • Unavailable configuration of the status transition. |
| 8F24             | The pair cannot be created because a path between the devices was not created. |
| 8F25             | The pair cannot be created or resynchronized because PIN was existed in the specified volume. |
| 8F28             | The pair cannot be created or resynchronized because it could not access to the specified P-VOL or S-VOL. |
| 8F29             | The pair cannot be created because the specified master journal was unusable. |
| 8F2A             | The pair cannot be created because the specified P-VOL is a Flash Copy S-VOL. |
| 8F2B             | The pair cannot be created because the protect attribute of the Data Retention Utility was set for the specified P-VOL. |
| 8F33             | The pair cannot be created because the specified volume was used in a pair on the TrueCopy or the ShadowImage. |
| 8F35             | The pair cannot be created because the specified volume was blocked. |
| 8F38             | The following programs for OPEN systems might not be installed, or the licenses of them might be expired. Please confirm settings for:  
|                  | • TrueCopy  
<p>|                  | • Universal Replicator |</p>
<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8F39</td>
<td>The pair cannot be created because the program product of UR was not installed.</td>
</tr>
<tr>
<td>8F46</td>
<td>The pair cannot be created because cache CL2 is in abnormal status.</td>
</tr>
<tr>
<td>8F47</td>
<td>The pair cannot be created because cache CL1 is in abnormal status.</td>
</tr>
</tbody>
</table>
| 8F4D             | The pair cannot be created or resynchronized due to the following contributing factors:  
|                  | • A journal is not registered in the secondary storage system.  
|                  | • A volume in the journal which is registered in the secondary storage system is blocked. |
| 8F50             | The pair cannot be created or resynchronized because the load of the processing was high. Wait about 5 minutes, then retry the operation. |
| 8F53             | The pair cannot be created because the status of the configuration could not be transited. |
| 8F58             | The pair cannot be created or resynchronized because of the one of following reasons.  
|                  | • The pair status of the specified S-VOL differed from the one of P-VOL.  
|                  | • The state of restore journal differed from the state of master journal. |
| 8F67             | The pair cannot be created because the specified secondary system did not support the external volume. |
| 8F6D             | The pair cannot be created because the specified volume was a command device. |
| 8FEA             | The pair cannot be created because the P-VOL is used for Thin Image or Copy-on-Write Snapshot. |
| 8FEC             | The pair cannot be created because the P-VOL is used for Thin Image or Copy-on-Write Snapshot. |
| 9100             | The command cannot be executed because user authentication is not performed. |
| B992             | The information of the consistency group cannot be retrieved, because Universal Replicator was not installed. |
| B9C0             | The source of command devise has run out. Set to OFF the command device and to ON again from the LUN Manager. |

**CCI error codes for UR: SSB1 = B9E1**

<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B901</td>
<td>The command was rejected because the specified device is a command device.</td>
</tr>
</tbody>
</table>
### CCI error codes for UR: SSB1 = B901, B9E0, B9E1, B9E2, B9E4, D004

<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B902</td>
<td>The command was rejected because the mirror ID is invalid.</td>
</tr>
<tr>
<td>B907</td>
<td>The command was rejected because the volume status was SMPL.</td>
</tr>
<tr>
<td>B90A</td>
<td>The S-VOL hide mode is not supported.</td>
</tr>
<tr>
<td>B90D</td>
<td>The command was rejected because the UR program product is not installed.</td>
</tr>
<tr>
<td>B909</td>
<td>The command was rejected because the mirror ID is invalid.</td>
</tr>
<tr>
<td>B900</td>
<td>A status of UR pair was acquired at the time of unavailable to use the UR during the power-on. Retry the operation.</td>
</tr>
<tr>
<td>B94B</td>
<td>The command was rejected because the UR configuration was changed. Check the status of the UR pair.</td>
</tr>
<tr>
<td>B90E</td>
<td>The command was rejected because the path is not set between the systems.</td>
</tr>
<tr>
<td>B90F</td>
<td>A request of UR Paircreate on the UR intermediate volume was rejected because either URz or TCz was not installed.</td>
</tr>
<tr>
<td>B910</td>
<td>The settings of the journal option could not be updated.</td>
</tr>
<tr>
<td>B913</td>
<td>The command was rejected because the system configuration does not allow these operations.</td>
</tr>
<tr>
<td>B912/B9F8</td>
<td>The command was rejected because no journal was registered.</td>
</tr>
<tr>
<td>DB02</td>
<td>A request of UR pair status transition was rejected because the status for the request could not be transited. (ex. Status transition other than SMPL when the Paircreate was requested, or other than PSUS when the Pairresync was requested.)</td>
</tr>
<tr>
<td>DB03</td>
<td>A request of UR Pair status transition was rejected because the pair was in the state of Suspending or Deleting.</td>
</tr>
<tr>
<td>DB07</td>
<td>UR pair status cannot be transited during the power-on processing.</td>
</tr>
<tr>
<td>DB08</td>
<td>UR pair status cannot be transited during the power-off processing.</td>
</tr>
<tr>
<td>DB0C</td>
<td>The command was rejected because the specification was volume instead of group.</td>
</tr>
<tr>
<td>E843</td>
<td>The command was rejected because the CLPR number of the specified volume differed from the CLPR number of the journal.</td>
</tr>
<tr>
<td>E846</td>
<td>The command was rejected because the specified volume belongs to the journal that is contained in the UR-TrueCopy combination (2DC) configuration in the intermediate site.</td>
</tr>
<tr>
<td>E847</td>
<td>An operation request for the journal, which was used in the system that consists of single primary and secondary system, was rejected because the specified volume is defined to be used in the system that consists of multiple primary and secondary systems.</td>
</tr>
<tr>
<td>E848</td>
<td>An operation request for the journal, which was used in the system that consists of multiple primary and secondary systems, was rejected because the specified volume is defined to be used in the system that consists of single primary and secondary system.</td>
</tr>
<tr>
<td>E866</td>
<td>The specified consistency group number is already used.</td>
</tr>
<tr>
<td>Error code (SSB2)</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>E869</td>
<td>The operation cannot be performed because the specified restore journal was used in another mirror and the mirror status was Halting or Stopping. Retry the operation after the mirror status is changed to a status other than Halting or Stopping.</td>
</tr>
<tr>
<td>E871</td>
<td>The command was rejected because the path between the storage devices for the both-way was not defined. Check whether the bidirectional normal path was defined or not.</td>
</tr>
<tr>
<td>E878</td>
<td>The command was rejected because the data volumes of 3390-9A and other than 3390-9A coexist in the specified journal.</td>
</tr>
<tr>
<td>E87B</td>
<td>The command was rejected because the specified journal was unregistered.</td>
</tr>
<tr>
<td>E87C</td>
<td>Journal volume is not registered in the specified journal.</td>
</tr>
<tr>
<td>E87D</td>
<td>The command was rejected because the specified volume was not for the UR pair.</td>
</tr>
<tr>
<td>E87E</td>
<td>The command was rejected because the specified P-VOL or S-VOL was a journal volume.</td>
</tr>
<tr>
<td>E880</td>
<td>The command was rejected because the emulation type was different between the specified P-VOL or S-VOL and the journal volume.</td>
</tr>
<tr>
<td>E881</td>
<td>The command was rejected because of the power-on processing.</td>
</tr>
<tr>
<td>E882</td>
<td>The command was rejected because the emulation type of the specified master journal or the restore journal was invalid.</td>
</tr>
<tr>
<td>E883</td>
<td>The specified mirror ID number or the CTG number differs from the registered mirror ID number or the CTG number.</td>
</tr>
<tr>
<td>E888</td>
<td>The command was rejected because the specified master journal was already used for a pair with another restore journal.</td>
</tr>
<tr>
<td>E889</td>
<td>The command was rejected because the specified journal was already used in another UR's mirror ID.</td>
</tr>
</tbody>
</table>
| E890              | The command was rejected because of one of following:  
  - The specified volume is registered in another journal.  
  - The specified volume is registered in the same mirror of the same journal.  
  - The volume specified as the S-VOL is registered in another mirror of the same journal.  
  - A paircreate operation was attempted in a 3 UR DC configuration using a journal that does not allow this configuration. As a result, a second paircreate operation was run in the second mirror of the same journal. |
<p>| E891              | The command was rejected because the number of pairs that are registered in the specified master journal or restore journal was already reached the maximum number. |
| E894              | When creating a pair using journal in the configuration where three UR sites were combined, a request of pair creation of the third mirror was received in the same journal, so the command was rejected. |</p>
<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
</table>
| E897             | The command was rejected because of the one of following reasons.  
|                  | • The specified primary journal and the secondary journal do not permit the configuration combining three UR sites.  
|                  | • The specified secondary journal is already used as a secondary journal of another mirror.  
<p>|                  | • The paired journal of the specified mirror is already used by another mirror. |
| E898             | The command was rejected because the specified secondary journal is already a secondary journal in another mirror. |
| E89A             | The command was rejected because the path between the storage devices for the both-way was not defined. Check whether the bidirectional normal path was defined or not. |
| E89B             | The command was rejected because the specified master journal or the restore journal remembered the state of connection with another system in the past. Specify another journal, or delete the journal once, then retry the registration again. |
| E8A2             | The command was rejected because the Serial Number, Controller ID, or Path Gr. ID of the specified secondary storage system is wrong. |
| E8A6             | The specified journal number is unregistered. |
| E8A7             | Journal volume is unregistered on the specified journal. |
| E8A8             | The command was rejected because the specified volume was not for a UR pair or was a volume of another journal. |
| E8A9             | UR copy pair cannot be suspended because of the power-on processing. |
| E8B6             | The command was rejected because the mirror ID of the specified restore journal was already used. |
| E8F7             | The command was rejected because there are multiple journals in the specified consistency group. |
| E8FB             | A logic error occurred in the system, and the command was rejected. |
| EA00             | The command was rejected because the specified P-VOL was already used as an S-VOL. |
| EA01             | The command was rejected because the specified P-VOL was already used by another UR pair. |
| EA02             | The command was rejected because the specified S-VOL was used as the P-VOL. |
| EA03             | The command was rejected because the specified P-VOL was already used by another UR pair. |
| EA07             | The command was rejected because the number of the UR pair registrations in the primary journal exceeds the upper limit. |
| EA08             | The command was rejected because the number of UR pair registrations in the secondary journal exceeds the upper limit. |
| EA09             | The command was rejected because the state of master journal was other than Initial, Active, or Stopped. |
| EA0A             | The command was rejected because the state of restore journal was invalid. |
| EA12             | The command was rejected because the specified S-VOL was not in SSWS status. |</p>
<table>
<thead>
<tr>
<th>Error code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EA13</td>
<td>The command was rejected because the request was received for the S-VOL as the P-VOL.</td>
</tr>
<tr>
<td>EA15</td>
<td>The command was rejected because the request was received for the P-VOL as the S-VOL.</td>
</tr>
<tr>
<td>EA18</td>
<td>The command was rejected because the pair status was not PSUS.</td>
</tr>
<tr>
<td>EA19</td>
<td>The command was rejected because the state of journal was not Stopped.</td>
</tr>
<tr>
<td>EA1B</td>
<td>The command was rejected because the journal could not execute the suspend transition, that is, the journal was in HLDE or PSUE status.</td>
</tr>
<tr>
<td>EA1C</td>
<td>The command was rejected because the specified secondary journal was not in the Stopped status.</td>
</tr>
<tr>
<td>EA1E</td>
<td>The command was rejected because the request was received for the S-VOL as the P-VOL.</td>
</tr>
<tr>
<td>EA20</td>
<td>The command was rejected because the request was received for the P-VOL as the S-VOL.</td>
</tr>
<tr>
<td>EA22</td>
<td>The command was rejected because the state of journal was not Stopped.</td>
</tr>
<tr>
<td>EA25</td>
<td>The command was rejected because the state of S-VOL was not SSWS.</td>
</tr>
<tr>
<td>EA29</td>
<td>The command was rejected because the state of master journal was other than Active or Stopped.</td>
</tr>
<tr>
<td>EA2C</td>
<td>The command was rejected because the state of restore journal was other than Active or Stopped.</td>
</tr>
<tr>
<td>EA33</td>
<td>The command was rejected because the state of master journal was other than Active.</td>
</tr>
<tr>
<td>EA36</td>
<td>The command was rejected because the state of restore journal was other than Active.</td>
</tr>
<tr>
<td>EA3A</td>
<td>The command was rejected because the specified S-VOL was in the state of status transition.</td>
</tr>
<tr>
<td>EA3B</td>
<td>The command was rejected because the specified S-VOL was in the state of Suspending.</td>
</tr>
<tr>
<td>EA40</td>
<td>The command was rejected because the desired capacity exceeded the charging capacity of the primary system's program product.</td>
</tr>
<tr>
<td>EA41</td>
<td>The command was rejected because the desired capacity exceeded the charging capacity of the secondary system's program product.</td>
</tr>
<tr>
<td>EA46</td>
<td>In the intermediate site in the cascading configuration combining three UR sites, a request of UR pair delete and suspend was received. However, since the journal status of the mirror combined with a mirror in the specified journal was Active, the command was rejected.</td>
</tr>
<tr>
<td>EA8B</td>
<td>The command was rejected because the specified volume is used in the system that consists of multiple primary and secondary systems.</td>
</tr>
<tr>
<td>EA92</td>
<td>The command was rejected because the microcode was being replaced.</td>
</tr>
<tr>
<td>EA95</td>
<td>The command was rejected because the volume specified for the P-VOL was initializing the pool of Dynamic Provisioning.</td>
</tr>
<tr>
<td>EA9F</td>
<td>In the configuration where three UR sites are combined, a request of UR pair resync (journal resync mode) was received. However, since the specified journal did not exist, or no pair existed in the specified journal, the command was rejected.</td>
</tr>
<tr>
<td>Error code (SSB2)</td>
<td>Description</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>EAA2</td>
<td>The command was rejected because the desired capacity exceeded the charging capacity of the primary system's UR. Check the license capacity as well as the related program product.</td>
</tr>
<tr>
<td>EAA3</td>
<td>The command was rejected because the desired capacity exceeded the charging capacity of the secondary system’s TrueCopy. Check the License capacity as well as the related Program product.</td>
</tr>
<tr>
<td>EAA5</td>
<td>The command was rejected because the desired capacity exceeded the charging capacity of the secondary system’s UR. Check the license capacity as well as the related program product.</td>
</tr>
<tr>
<td>EAA6</td>
<td>The command was rejected because the desired capacity exceeded the charging capacity of the primary system’s TrueCopy. Check the license capacity as well as the related program product.</td>
</tr>
<tr>
<td>EAAB</td>
<td>In the configuration where three UR sites are combined, a request of UR pair resync (journal resync mode) was received, but since the specified option was wrong, the command was rejected.</td>
</tr>
</tbody>
</table>
| EAB6             | The paircreate operation failed because the primary system’s differential management area had no free space. 
If no extended shared memory is installed in the primary system, install it and repeat the operation. 
If extended shared memory is installed, the number of pairs that can be created in the system is exceeded. |
| EAB7             | The paircreate operation failed because no extended shared memory is installed in the primary system. Install extended shared memory in the primary system and then repeat the operation. |
| EAB8             | The paircreate operation failed because the secondary system’s differential management area had no free space. 
If no extended shared memory is installed in the secondary system, install it and repeat the operation. 
If extended shared memory is installed, the number of pairs that can be created in the system is exceeded. |
| EAB9             | The paircreate operation failed because no extended shared memory is installed in the secondary system. Install extended shared memory in the secondary system and then repeat the operation. |
| EAD0             | The command was rejected because the delta resync function was unsupported. |
| EAE5             | The command was rejected because the specified P-VOL or S-VOL is in the process of having the capacity changed by Dynamic Provisioning. |
| EAE7             | The UR pair cannot be deleted because the specified UR volume is used as the TrueCopy pair and is working in the journal that was registered when the 2DC Cascade was set to Enable in the Edit Journal Volumes dialog box. |
| EAF6             | The command was rejected because the pair was in the state that was unavailable to transit. |
| EB24             | The UR pair for the delta resync operation cannot be created because the specified UR S-VOL is in either one of the following statuses: 
- UR volume for the delta resync operation. 
- The status of the UR pair is other than PAIR. |
<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
</table>
| EB25             | The UR pair for delta resync operation cannot be created because the specified UR S-VOL is in either one of the following statuses:  
  • The volume cannot be used as the UR volume for the delta resync operation.  
  • The status of the UR pair is the status other than PAIR or SUSPEND. |
| EB28             | The command was rejected because the Disaster Recovery Extended program product was not installed in the secondary system. |
| EB29             | The command was rejected because the delta resync settings are configured to the primary and secondary systems. |
| EB2F             | The command was rejected because the specified UR pair was used in the system that consists of multiple primary and secondary systems. |
| EB30             | The command was rejected because the specified mirror ID was invalid. |
| EB45             | The specified UR pair cannot execute the takeover because the specified UR pair belongs to the journal that dedicated UR and TrueCopy combination (2DC configuration). |
| EB48             | A delta resync pair cannot be created due to one of the following reasons:  
  • P-VOL of the UR pair is different from P-VOL of the TrueCopy pair.  
  • The serial number of the primary system that is recognized by P-VOL and S-VOL is different. |
<p>| EB49             | The command was rejected because the secondary system did not support the delta resync function. |
| EB4C             | A pair cannot be created because the restore journal was not registered. |
| EB4D             | A pair cannot be created because the master journal was not registered. |
| EB4F             | The UR pair cannot be created because the timer type of master journal and restore journal is different. |
| EB50             | The command was rejected because the specified S-VOL was not mounted. |
| EB51             | The command was rejected because PIN data existed in the specified S-VOL. |
| EB52             | The command was rejected because the specified S-VOL cannot be accessed. |
| EB53             | The command was rejected because the specified S-VOL is blocked. |
| EB54             | The command was rejected because the specified S-VOL is used for the external volume which is mapped for the online data migration. |
| EB57             | The command was rejected because the specified S-VOL was online from the host. |
| EB58             | The command was rejected because the specified journal volume or S-VOL was reserved or being used in the storage system. Please check the status of the volume. |
| EB59             | The command was rejected because the specified S-VOL was being migrated by Volume Migration. Please check the status of the volume. |
| EB5B             | The command was rejected because the access attribute was set to the specified P-VOL or S-VOL by the Data Retention Utility. |</p>
<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EB5C</td>
<td>The command was rejected because an internal logical error occurred.</td>
</tr>
<tr>
<td>EB5E</td>
<td>The command was rejected because the state of S-VOL was not SMPL.</td>
</tr>
<tr>
<td>EB5F</td>
<td>The command was rejected because the program product of UR was not installed in the secondary system.</td>
</tr>
</tbody>
</table>
| EB60             | The command was rejected by either of the following reasons:  
                      - The volume capacity of P-VOL was does not conform with the volume capacity of S-VOL.  
                      - Capacities of each volumes that are concatenated in LUSE on the primary site does not conform with capacities of each volumes that are concatenated in LUSE on the secondary site. |
| EB61             | The command was rejected because the path between the primary and the secondary systems was not valid. |
| EB62             | The command was rejected because the specified P-VOL was a command device. |
| EB63             | The command was rejected because the restore journal was already linked with another journal. |
| EB64             | The command was rejected because the desired capacity exceeded the charging capacity of the program product. |
| EB65             | The command was rejected because of the abnormal end which is related to the charging capacity of the program product. |
| EB66             | The command was rejected and the retry processing was ordered because P-VOL SUSPENDING was detected when the CCI horctakeover (resync) command was executed. |
| EB6B             | The command was rejected because a pair is already created with the specified S-VOL by using Compatible FlashCopy® V2. |
| EB6C             | The UR pair create processing was doubly executed:  
                      - There are no problems if the initial copy operation is restarted when the primary storage system is powered off.  
                      - There are no problems if a UR pair is created when the primary storage system is reset. |
<p>| EB6E             | The command was rejected because the UR program product was not installed in the primary system. |
| EB70             | The command was rejected because the specified S-VOL is assigned to a copy pair of other program products. |
| EB73             | The command was rejected because the specified S-VOL is the system disk. |
| EB74             | The command was rejected because all mainframe connection CHAs are blocked. |
| EB78             | The command was rejected because the specified data volume is a command device. |
| EB79             | The command was rejected because the specified data volume is online. |
| EB7A             | The command was rejected because the journal cache of the restore journal was remained. |
| EB7D             | The command was rejected because the specified S-VOL is an external volume. |</p>
<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
</table>
| EB7E             | The command was rejected because the specified S-VOL is in one of the following statuses.  
|                  | • The specified S-VOL is being used for a ShadowImage pair.  
|                  | • The specified S-VOL is a reserved volume.  
|                  | • UR P-VOL and S-VOL are DP-VOL, and the specified S-VOL is being used as ShadowImage P-VOL.  
|                  | • UR P-VOL and S-VOL are DP-VOL, and the specified S-VOL is the source volume of Volume Migration.  
|                  | • UR P-VOL and S-VOL are DP-VOL, and the specified S-VOL is being used as Thin Image or Copy-on-Write Snapshot P-VOL. |
| EB7F             | The command was rejected because the emulation type of the specified S-VOL was unsupported. |
| EB80             | The command was rejected because the specified volume was the V-VOL or the pool-VOL. Please check the status of the volume. |
| EB87             | The command was rejected because the path from the secondary system to the primary system was not set, or the S-VOL was in the SMPL status. |
| EB88             | The command was rejected because of one of the following:  
|                  | • The specified S-VOL was being used as a ShadowImage S-VOL.  
|                  | • The specified S-VOL was Not Ready, which means that the hard disk drive cannot be used. |
| EB89             | The command was rejected because the emulation types of the specified P-VOL and S-VOL were not the same. |
| EB8A             | The command was rejected because the emulation types of the specified master journal and the restore journal were not the same. |
| EB8E             | The command was rejected because the LUSE configuration of the P-VOL is different from the LUSE configuration of S-VOL. |
| EB94             | The command was rejected because the specified pair could not transit the status. |
| EB9F             | The pair creation command was rejected because the specified S-VOL was not mounted on the secondary system. |
| EBA0             | The pair operation command was rejected because the specified S-VOL was not mounted on the secondary system. |
| EBA7             | The command was rejected because the volume specified for the secondary volume was in either one of the following status.  
|                  | • Increasing the capacity by Dynamic Provisioning.  
|                  | • Releasing the page of Dynamic Provisioning.  
<p>|                  | • Initializing the pool of Dynamic Provisioning. |
| EBAF             | The command was rejected because the license capacity of the Data Retention Utility in the secondary system exceeds the setting value. Please check the license capacity setting for Data Retention Utility in the secondary system. |
| EBC6             | The command was rejected because the specified UR S-VOL was used by either ShadowImage or Compatible FlashCopy® V2. |</p>
<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
</table>
| EBCA             | The command was rejected because the journal restore operation is in progress in the UR pair through another mirror ID.  
• If the UR pair with another mirror ID is in Suspending status, reissue the request when the pair status is changed to the Suspend status.  
• If the UR pair with another mirror ID is in the PAIR status, reissue the request after awhile. |
| EBCE             | The command was rejected because un-updated differential data exists in the specified S-VOL. |
| EBCF             | The UR Pairresync (journal resync mode that forcibly copies all data) was received because of the UR Pairresync (delta resync) failed.  
The command was rejected because the UR pair was not in HOLD status. |
| EBD9             | The command was rejected because the desired capacity exceeded the charging capacity of the secondary system’s TrueCopy. Check the license capacity as well as the related program product. |
| EBDB             | The command was rejected because the desired capacity exceeded the charging capacity of the secondary system’s UR.  
Check the license capacity as well as the related program product. |
| EBDC             | The command was rejected because the processing load of the storage system is heavy.  
Please execute the command again after a while. |
| EBE0             | The command was rejected because the specified S-VOL was already used in the UR pair for delta resync. |
| EBE1             | The command was rejected because the all S-VOLs of the specified restore journal were not the another UR’s S-VOLs. |
| EBE2             | The command was rejected because the difference was not ready for the journal resync operation. |

The update data of TrueCopy (master journal of the UR pair for delta resync operation) is inconsistent with the update data of the restore journal of the UR pair.  
Perform UR Pairresync (journal resync mode that forcibly copies all data). |
| EBE5             | The command was rejected because the journal volume of specified restore journal was blocked. |
| EBF2             | The command was rejected because the At-Time Split function is used combining URz with SIz and the split time is restored to the specified restore journal. |
| EBF3             | The command was rejected because the split time of the AT-Time Split function is restored. |
| EBFD             | The command was rejected because the specified restore journal was not registered. |
| F908             | The command was rejected for one of the following reasons:  
• Virtualization access mode is enabled for the P-VOL or S-VOL but disabled for the volume registered in the mirror.  
• Virtualization access mode is enabled for the volume registered in the mirror but disabled for the P-VOL or S-VOL.  
• The specified virtual serial number or virtual controller ID is not correct. |
CCI error codes for UR: SSB1 = B9FE

<table>
<thead>
<tr>
<th>Error code (SSB2)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B902</td>
<td>Journal volumes are not registered in the specified journal.</td>
</tr>
</tbody>
</table>

**Service information messages (SIMs)**

The VSP system generates service information messages (SIMs) when service is required. SIMs can be generated by channel and storage path microprocessors and by the service processor (SVP).

The SVP reports all SIMs related to Universal Replicator processing. Each time a SIM is generated, the amber Message LED on the control window (under the Ready and Alarm LEDs) turns on as an additional alert for the user.

SIMs are classified into four categories according to severity for reporting and logging purposes: service, moderate, serious, or acute.

Universal Replicator SIMs are displayed on Storage Navigator. You can review the SIMs in the Status window of Storage Navigator.

- SIMs generated by the primary system include the device ID of the P-VOL (byte 13).
- SIMs generated by the secondary system include the device ID of the S-VOL (byte 13).

For further information on SIM reporting, contact your HDS representative or Hitachi Data Systems Support Center.

If SNMP is installed and operational for the VSP system, each SIM results in an SNMP trap being sent to the appropriate hosts. For further information on SNMP operations, see Hitachi Storage Navigator User Guide, or call Hitachi Data Systems Support Center for assistance.

The figure below shows a typical 32-byte SIM from the system. The six-digit reference code consists of bytes 22, 23, and 13. The reference code identifies the possible error and determines the severity. The SIM type (byte 28) indicates the component that experienced the error. When the value of byte 22 is 21, the SIM is a control unit SIM. When the value of byte 22 is Dx (where x is an arbitrary character), the SIM is a device SIM.
The following table shows SIM reference codes, and provides useful information for identifying issues and determining the system experiencing the problem. All SIMs are reported to the host, except 21 80, 21 81, and possibly DC EX—depending on the value set for system option mode 598. For more information, see System option modes on page 3-18.

<table>
<thead>
<tr>
<th>Reference code</th>
<th>Severity</th>
<th>Description</th>
<th>System generating the SIM</th>
<th>SVP log file</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Byte 22</strong></td>
<td><strong>Byte 23</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 80</td>
<td>Moderate</td>
<td>A logical path is blocked due to failure.</td>
<td>Primary/Secondary</td>
<td>SIM Log</td>
</tr>
<tr>
<td>21 81</td>
<td>Service</td>
<td>The logical path is restored.</td>
<td>Primary/Secondary</td>
<td>SSB Log</td>
</tr>
<tr>
<td>21 82</td>
<td>Moderate</td>
<td>A line failure is reported by the extender.</td>
<td>Primary/Secondary</td>
<td>SIM Log</td>
</tr>
<tr>
<td>DC 0X</td>
<td>Serious</td>
<td>The P-VOL has been suspended. Path recovery is impossible.</td>
<td>Primary</td>
<td>SIM Log</td>
</tr>
<tr>
<td>DC 1X</td>
<td>Serious</td>
<td>The P-VOL has been suspended. A failure has been detected in the primary system.</td>
<td>Primary</td>
<td>SIM Log</td>
</tr>
<tr>
<td>DC 2X</td>
<td>Serious</td>
<td>The P-VOL has been suspended. A failure has been detected in the secondary system.</td>
<td>Primary</td>
<td>SIM Log</td>
</tr>
<tr>
<td>DC 4X</td>
<td>Serious</td>
<td>The P-VOL has been suspended. The pair has been suspended at the secondary system.</td>
<td>Primary</td>
<td>SIM Log</td>
</tr>
<tr>
<td>DC 5X</td>
<td>Serious</td>
<td>The P-VOL has been suspended. A pair has been released at the secondary system.</td>
<td>Primary</td>
<td>SIM Log</td>
</tr>
<tr>
<td>DC 6X</td>
<td>Serious</td>
<td>The S-VOL has been suspended. Path recovery is impossible.</td>
<td>Primary</td>
<td>SIM Log</td>
</tr>
<tr>
<td>DC 7X</td>
<td>Serious</td>
<td>The S-VOL has been suspended. A failure has been detected in the secondary system.</td>
<td>Secondary</td>
<td>SIM Log</td>
</tr>
<tr>
<td>DC 9X</td>
<td>Serious</td>
<td>A delta resync P-VOL has been suspended. A failure has been detected in the primary system.</td>
<td>Yes, repeatedly.</td>
<td>Primary</td>
</tr>
</tbody>
</table>
Delta resync operation

If the status of the delta resync pair does not change after you performed delta resync operation, some of the requirements and prerequisites may not have been fulfilled. In that case, after checking the status of all pairs including the delta resync pair for clues into the problem, review all prerequisite material in Delta resync configuration on page C-6.

Suspension among journals

All the journals in a consistency group can be suspended when an error occurs in one of the journals in the consistency group. This takes place under the following conditions:

- The communications line between the CCI and all primary systems are normal.
- The status of the failed journal is PJSE or PJSF.
- At least one journal in the consistency group is in normal status.

The following is provided for your information when the circumstances above are present:

- When an error occurs, the status of the journal changes from normal to PJSE (suspended by error).
- For an error caused by overflowing capacity, status changes to PJSF.
- When one journal becomes PJSE or PJSF, all other normal journals in PJNN status also become PJSE status.
- If you use CCI and if a journal is in the normal status, it will be shown as PJNN.
Note that if some pairs in the journal become suspended by error but the whole journal does not become suspended, the status of other journals will not change.

**Calling the Hitachi Data Systems Support Center**

If you need to call the Hitachi Data Systems Support Center, please provide as much information about the problem as possible, including:

- The circumstances surrounding the error or failure.
- The content of any error messages displayed on the host systems.
- The content of any error messages displayed on Storage Navigator.
- The Storage Navigator configuration information (use the FD Dump Tool).
- The service information messages (SIMs), including reference codes and severity levels, displayed by Storage Navigator.

The HDS customer support staff is available 24 hours a day, seven days a week. If you need technical support, log on to the HDS Support Portal for contact information: [https://hdssupport.hds.com](https://hdssupport.hds.com)
3 UR data-center configurations

With Universal Replicator, a volume at the primary site can be backed up to second and third remote UR sites in 3 data center (3DC) configurations.

This appendix provides planning and setup information for 3-Universal Replicator data center configurations.

- Overview
- 3 UR DC cascade configuration
- 3 UR DC multi-target configuration
Overview

You can configure a Universal Replicator system using multiple VSPs in the following configurations for disaster recovery:

- **3-data center cascade (3DC cascade).** Data in the UR P-VOL is paired with an S-VOL in the UR intermediate site; and then the intermediate site S-VOL is paired (becoming a P-VOL) with an S-VOL in the UR remote site. See the figure and information in [3 UR DC cascade configuration on page A-2](#).

- **3-data center multi-target configuration (3DC multi-target).** Data in the UR P-VOL is paired with two S-VOLs—in two remote UR locations. See the figure and information in [3 UR DC multi-target configuration on page A-6](#).

- An additional option for cascade and multi-target configurations is the delta resync, which pairs the local P-VOL and one of the remote S-VOLs. The delta resync provides one more option for maintaining a close copy of production data for use as a backup in the event of failure at the other sites. The delta resync is slightly different for the cascading and multi-target configurations. See the following sections for details.

- **3DC configurations can be set up using TrueCopy and UR also.** See [Sharing volumes with TrueCopy on page C-2](#) for information.

### 3 UR DC cascade configuration

In a multi-target configuration, data is copied from the local site to two remote sites. In a cascading configuration, data is copied from the primary (local) site to an intermediate site and then to a remote site.

The intermediate site volume acts as:

- The S-VOL for the local-intermediate pair
- The P-VOL for with the intermediate-remote pair

In addition, you can create a delta resync pair from the local site to the remote site. Once created, the delta resync pair remains split unless the S-VOL is needed for disaster recovery. Though the pair is split, the S-VOL contains all but the latest production differential data. This is because the volume is also the S-VOL for the pair from the intermediate site and so is updated regularly.
Mirror IDs are assigned to each pair. You assign arbitrary numbers as mirror IDs. For example:

- Local site mirror ID: M
- Intermediate site secondary mirror ID: M; primary mirror ID: N
- Remote site secondary mirror ID: N

Related information

- Failure recovery on page A-3
- Requirements, restrictions, and notes on page A-3
- Problems that can occur with delta resync on page A-5
- Setting up the 3 UR DC cascade configuration on page A-5

Failure recovery

In a 3DC cascading configuration with three UR sites, failure recovery utilizes the pair or volume whose status is normal.

- If a failure occurs at the local site, business operations are moved to the intermediate site.
- If a failure occurs at the primary and intermediate sites, business operations are moved to the remote site.
- When failed sites are restored, data is copied to their pair volumes from the current production site, business operations are returned to the local site, and all pairs are restored.

See Recovery for 3 UR DC cascade configuration on page 9-5 for recovery information and procedures.

Requirements, restrictions, and notes

- Remote command devices must be assigned to two mirror IDs: one for the primary-intermediate pair, and one for the intermediate-remote pair.
• The VSP system at the three sites require registration of two mirrors in one journal (since two pairs use the same volume). This is done using the **Edit Journal Volumes** dialog box in Storage Navigator, and is discussed in the setup procedure.

Alternatively, if microprogram version 70-03-xx or higher is installed, you can use CCI to register the mirrors in the journal. Contact Hitachi Data Systems support to ensure that you have the latest firmware version available.

• Perform one pair operation in a 3 UR DC configuration at a time. Performing pair operations on the two pairs at the same time results in failure. If this occurs, correct the pair statuses then perform the operations one-at-a-time.

• LUSE volumes cannot be used as pair volumes.

• Create the local-intermediate pair first; then create the intermediate-remote pair.

• Make sure that performance for the intermediate-remote data path is the same as performance for the local-intermediate data path. Otherwise, the intermediate site’s journal volume may experience increased usage. If the usage rate reaches the threshold, the pair intermediate-remote pair is suspended.

• To maintain consistency among the pairs in related journals, make sure that all data volumes in the journals are used in pairs (with accompanying registered mirrors). If a data volume in the local site journal, for example, is not used in a pair, the number of data volumes in the journal may not be the same as the number in the secondary journal, and so consistency cannot be maintained.

• When creating the local-intermediate pair, set the mirror status for the intermediate-remote pair to Initial or Stopped.

• When creating the intermediate-remote pair, the P-VOL cannot be in COPY status in its role as the primary-to-intermediate S-VOL, or the pair will not be created.

• When splitting the intermediate-remote pair using flush mode, set the pair’s mirror status to Stopped.

• When splitting the intermediate-remote pair whose S-VOL is also the delta resync S-VOL, host I/O to the S-VOL will not be allowed even when you specify Enable for S-VOL Write in split procedure.

• When restoring the local-intermediate pair, the intermediate-remote pair is split automatically if its mirror status is PAIR.

• The local-intermediate pair cannot be restored when the mirror status for the intermediate-remote pair is COPY.

• When deleting the intermediate-remote pair:
  - If Mirror is specified for Range, set the mirror status for either cascade pair to Stopped.
  - If Volume is specified for Range, set the mirror status for the primary-intermediate pair to Stopped, or set pair status to SUSPEND.

• Required pair and volume statuses for the delta resync operation:
- Delta resync P-VOL and S-VOL: HOLD
- UR P-VOL: PAIR or PSUE
- UR S-VOL: PAIR, PSUS, PSUE

**Note:** The S-VOL uses two mirror IDs because of its dual use in the 3DC cascade and delta resync configurations. The statuses shown above are required for the two mirrors as well as for the journal in which the UR pair for delta resync resides.

- Differential data is stored in the master journal but may not be completely present after a failure. You can avoid delta resync failure by specifying that the entire P-VOL is copied to the delta resync S-VOL in this case. See the Delta resync Failure option in Changing options used by mirrors on page 8-5 for information.
- When you delete either cascading pair, the delta resync pair is also deleted.

**Problems that can occur with delta resync**

Journal data will not exist, and therefore the delta resync operation will not succeed, if the following occurs. Avoid these situations.

- After splitting the intermediate-remote pair, the S-VOL is updated.
- After the intermediate-remote pair is split and the journal volume at the intermediate site then exceeds 70-percent as a result of updates from the primary site.
- When the delta resync P-VOL is updated and then data in the journal volume exceeds 70-percent.

The following provides solutions to other delta resync problems.

- If the delta resync S-VOL status becomes HLDE, you cannot restore it to HOLD by resynchronizing the pair. You must delete the delta resync pair and recreate it.
- If the delta resync pair’s status does not change after the delta resync operation, check that all requirements are fulfilled and that any problems explained in this topic have not occurred. Check the status of the UR pair and UR pair for delta resync operation, and make sure that all pairs are in the required status.

**Setting up the 3 UR DC cascade configuration**

Set up a 3 UR DC cascade configuration using the following procedure. CCI is used to set up the configuration. To set up a 3DC cascade using UR and TrueCopy, see Procedure for setting up 3DC cascade on page C-4.

1. Set up UR at the primary, intermediate, and remote sites and configure ports. See:
   - Configuring local and remote systems for UR on page 5-3
   - Defining fibre-channel port attributes on page 5-2
2. Configure UR journals in the three sites. When you register a journal, **UR 3DC** is automatically enabled in the **Edit Journal Volumes** dialog box. This setting allows registration of two MUs in a journal, as required for the intermediate S-VOL/P-VOL. See [Registering journal volumes in a journal on page 5-10](#) for more information about registering journals.

**Note:** The **Edit Journal Volumes** dialog box setting, **UR 3DC**, cannot be changed in the dialog box. To disable, it is necessary to delete the journal, disable the setting, and then register the journal again.

3. Create the pair in the first mirror, from the primary to the intermediate site. Specify a value from 0 to 3 as the Mirror ID.

4. When pair status becomes PAIR, create the pair in the second mirror, from the intermediate to the remote site. Specify the secondary journal and S-VOL used in the first mirror as the primary journal and P-VOL of the new pair.

   Select a Mirror ID from 0 to 3, though not the one used for the local site pair.

   Make sure pair status changes to PAIR before proceeding.

5. (Optional) Create a delta resync pair using the P-VOL in the local site mirror and the existing S-VOL in the remote site mirror.

   Select a Mirror ID from 0 to 3, though not those used in the other two mirrors in the configuration.

6. Assign remote command devices to the following:

   - Local site’s primary-intermediate pair mirror ID
   - Local site’s delta resync pair mirror ID
   - Intermediate site’s primary-intermediate pair mirror ID
   - Intermediate site’s intermediate-remote pair mirror ID
   - Remote site’s intermediate-remote pair mirror ID
   - Remote site’s delta resync pair mirror ID

### 3 UR DC multi-target configuration

In a multi-target configuration, data is copied from the local site to two remote sites.

The benefit of this configuration is that it provides a third copy of the data, helping to ensure that business can continue in the event of a failure at the other two sites.

You can also create a delta resync pair from one remote site S-VOL to the other remote site S-VOL. Once created, the delta resync pair remains split unless the S-VOL is needed for disaster recovery.
Mirror IDs are assigned to each pair. You assign arbitrary numbers as mirror IDs. For example:

- Remote site1 mirror ID: M
- Remote site2 mirror ID: N

The host issues an update to the production volume and, as with a standalone UR system, the update data is asynchronously written from the primary volume (P-VOL) to the remote S-VOLs.

**Related information**

- Failure recovery on page A-7
- Requirements, restrictions, and notes on page A-8
- Problems that can occur with delta resync on page A-8
- Setting up the 3 UR DC multi-target configuration on page A-9

**Failure recovery**

In a 3DC multi-target configuration with three UR sites, failure recovery proceeds as follows:

- If a failure occurs in the local site, business operations are moved to one of the remote sites. When the failure is corrected at the local site, business operations are transferred back to the local site.

- If a failure occurs between the local site and one of the remote sites, business operations are moved to the pair volume on the healthy remote site. When the failure is corrected, business operations are transferred back to the local site.

See Recovery for 3 UR DC multi-target configuration on page 9-8 for recovery information and procedures.
Requirements, restrictions, and notes

- The VSP system at the three sites require registration of two mirrors in one journal (since two pairs use the same volume). This is done using the **Edit Journal Volumes** dialog box in Storage Navigator, and is discussed in the setup procedure.

  Alternatively, if microprogram version 70-03-xx or higher is installed, you can use CCI to register the mirrors in the journal. Contact Hitachi Data Systems support to ensure that you have the latest firmware version available.

- LUSE volumes cannot be used as pair volumes.

- To maintain consistency among the pairs in related journals, make sure that all data volumes in the journals are used in pairs (with accompanying registered mirrors). If a data volume in the local site journal, for example, is not used in a pair, the number of data volumes in the journal may not be the same as the number in the secondary journal, and so consistency cannot be maintained.

- The P-VOL in the first pair cannot be in COPY status when creating the second pair. In this case, the second pair will not be created.

- When multiple mirrors are registered in the journal, the P-VOL of one of the mirrors cannot be in COPY status when resynchronizing a pair of another mirror. In this case, the second pair will not be resynchronized.

- When splitting the pair whose S-VOL is also the delta resync S-VOL, host I/O to the S-VOL will not be allowed even when you specify **Enable for S-VOL Write** in the split procedure.

- When you delete either multi-target pair, the delta resync pair is also deleted.

- Delta resync operation requirements. These requirements are required for all volumes in the respective journals.
  - Remote command devices are required for the two mirror IDs at the delta resync primary and secondary sites.
  - The data paths must be operational.
  - CCI must be used for the delta resync operation.
  - Required pair and volume statuses for the delta resync operation.
    - Delta resync P-VOL and S-VOL: HOLD
    - UR P-VOL: SSWS
    - UR S-VOL: PAIR, PSUS, PSUE
  - Differential data is stored in the delta resync master journal but may not be completely present after a failure at delta resync primary site.

Problems that can occur with delta resync

Journal data will not exist, and therefore the delta resync operation will not succeed, if the following occurs. Avoid these situations.

- After splitting the intermediate-remote pair, the S-VOL is updated.
• After the intermediate-remote pair is split and the journal volume at the intermediate site then exceeds 70-percent as a result of updates from the primary site.

• When the delta resync P-VOL is updated and then data in the journal volume exceeds 70-percent.

• The Delta resync Failure option in the Change Mirror Options dialog box is disabled for the delta resync in a 3UR DC multi-target configuration.

The following provides solutions to other delta resync problems.

• If the delta resync pair status becomes HLDE, you cannot restore it to HOLD by resynchronizing the pair. You must delete the delta resync pair and recreate it.

• If the delta resync pair’s status does not change after the delta resync operation, some of the requirements explained in this topic may not have been fulfilled. In that case, check the status of the UR pair and UR pair for delta resync operation, and make sure that all pairs are in the required status.

• If the delta resync pair becomes suspended due to failure following the operation, if the problem is related to the P-VOL, resynchronize the pair. If the problem is related to the S-VOL, delete then recreate the pair.

**Setting up the 3 UR DC multi-target configuration**

Set up a 3 UR DC multi-target configuration using the following procedure. CCI is used to set up the configuration.

To set up a 3DC multi-target using UR and TrueCopy, see Procedure for setting up 3DC multi-target on page C-6.

1. Set up UR at the primary and two remote sites, and configure ports. See:
   - Configuring local and remote systems for UR on page 5-3
   - Defining fibre-channel port attributes on page 5-2

2. Configure UR journals in three three sites. When you register a journal, **UR 3DC** is automatically enabled in the Edit Journal Volumes dialog box. This setting allows registration of two MUs in a journal, as required for the intermediate S-VOL/P-VOL. See Registering journal volumes in a journal on page 5-10 for more information about registering journals.

   **Note:** The Edit Journal Volumes setting, **UR 3DC**, cannot be changed in the dialog box. To disable, it is necessary to delete the journal, disable the setting, and then register the journal again.

3. Create a pair in the first mirror, from the local site to a remote site. Specify a value from 0 to 3 as the Mirror ID.

4. When pair status becomes PAIR, create a pair in the second mirror, from the local site to the second remote site. Specify the same primary volume and journal used in the first mirror as the primary volume and journal in the new pair.
   - Select a Mirror ID from 0 to 3, though not the one used for the first pair.
Make sure pair status changes to PAIR before proceeding.

5. (Optional) Create a delta resync pair using the secondary volumes in two remote sites. Make sure to specify the S-VOL in the first remote site (and in the first mirror) as the primary volume. Specify the S-VOL in the second remote site (and in the second mirror) as the secondary volume. Select a Mirror ID from 0 to 3, though not those used in the other two mirrors in the configuration.

6. Assign remote command devices to the mirror IDs of the two pairs on the local site.

7. Assign the remote command device to the mirror IDs on two secondary sites. Additionally, assign the remote command device to the mirror ID of the UR pair for delta resync operation.

8. Assign remote command devices to the following:
   - Mirror IDs of the two multi-target pairs on the local site
   - Mirror IDs of the multi-target pairs on the two remote sites
   - Mirror ID of the delta resync pair on the two remote sites

There should be a total of six remote devices—two each on the three sites.
Sharing volumes

This appendix discusses other Virtual Storage Platform software volumes that can be shared with Universal Replicator volumes.

Because TrueCopy and ShadowImage volumes can be used extensively with Universal Replicator, complete information for these configurations is provided in:

- Configurations with TrueCopy on page C-1
- Configurations with ShadowImage on page D-1.

- Volume types that can be shared with Universal Replicator
- Cache Residency Manager
- Data Retention Utility
- Dynamic Provisioning
- High Availability Manager (HAM)
- LUN Expansion (LUSE)
- LUN Manager
- Thin Image and Copy-on-Write Snapshot
- Virtual LUN
- Volume Migration
Volume types that can be shared with Universal Replicator

The following table shows whether non-Universal Replicator volumes can be used as Universal Replicator P-VOLs, S-VOLs, and journal volumes.

### Table B-1 Volume types that can be shared with UR

<table>
<thead>
<tr>
<th>Volumes types and functions</th>
<th>Used as UR P-VOL?</th>
<th>Used as UR S-VOL?</th>
<th>Used as UR journal volume?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cache Residency Manager</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume set for CRM</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Thin Image and Copy-on-Write Snapshot</strong>&lt;sup&gt;7&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-VOL in all statuses except COPY(RS-R)/RCPY</td>
<td>Yes&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Yes&lt;sup&gt;2&lt;/sup&gt;</td>
<td>No</td>
</tr>
<tr>
<td>P-VOL in COPY(RS-R)/RCPY status</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>V-VOL</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>pool-VOL</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Cross-OS File Exchange</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume usable by both mainframe and open systems</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Data Retention Utility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume with Read/Write attribute</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Volume with Protect attribute</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Volume with Read Only attribute</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Volume that is disabled for use as an S-VOL</td>
<td>Yes</td>
<td>Only when restoring a UR pair.</td>
<td>No</td>
</tr>
<tr>
<td><strong>Dynamic Provisioning</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual volume</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Dynamic Tiering</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual volume</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>High Availability Manager</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-VOL</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in COPY status</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in PAIR status</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in PSUS status</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in SSWS status</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in PSUE status</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Quorum disk</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>LUN Expansion (LUSE)</strong>&lt;sup&gt;7&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LUSE volume</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>LUN Manager</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume to which a path is defined</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Volume to which no path is defined</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Volumes types and functions</td>
<td>Used as UR P-VOL?</td>
<td>Used as UR S-VOL?</td>
<td>Used as UR journal volume?</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------</td>
<td>-------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Volume to which LUN security is applied</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>ShadowImage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-VOL in PSUS status</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>P-VOL in PSUE status</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>P-VOL in COPY(RS-R)/RCPY status</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P-VOL that is also used as a TC P-VOL or S-VOL</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>P-VOL (in a status other than those listed above)</td>
<td>Yes</td>
<td>Yes⁸</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in PSUS status</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in PSUE status</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in a status other than PSUS or PSUE</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Reserved volume</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>TrueCopy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-VOL in COPY status</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P-VOL in PAIR status</td>
<td>Yes⁶</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>P-VOL in PSUS status</td>
<td>Yes⁶</td>
<td>No⁵</td>
<td>No</td>
</tr>
<tr>
<td>P-VOL in PSUE status</td>
<td>Yes⁶</td>
<td>No⁵</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in COPY status</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in PAIR status</td>
<td>Yes⁶</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in PSUS status</td>
<td>Yes⁶</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in SSWS status</td>
<td>Yes⁶</td>
<td>No⁵</td>
<td>No</td>
</tr>
<tr>
<td>S-VOL in PSUE status</td>
<td>Yes⁶</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Virtual LUN</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual LUN volume</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Volume Migration</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source volume (when volume migration is in progress)</td>
<td>Yes⁴</td>
<td>Yes⁴</td>
<td>No</td>
</tr>
<tr>
<td>Source volume (after volume migration is finished)</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Reserved volume to which no path is defined</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
The following topics clarify key information regarding shared volumes.

### Cache Residency Manager

You can perform Cache Residency Manager operations on a Universal Replicator pair’s P-VOL and S-VOL.

### Data Retention Utility

You can create a Universal Replicator pair using volumes that have been assigned the access attribute by the Data Retention Utility. However, you cannot specify a volume with the "S-VOL Disable" attribute as a Universal Replicator S-VOL.

The following table shows whether the access attribute can be changed or referenced.

<table>
<thead>
<tr>
<th>Volumes types and functions</th>
<th>Used as UR P-VOL?</th>
<th>Used as UR S-VOL?</th>
<th>Used as UR journal volume?</th>
</tr>
</thead>
</table>

**Notes**

1. The volume can be used as a UR pair volume for delta resync.
2. UR pair must be created first, otherwise No.
3. For information on Volume Migration, contact Hitachi Data Systems Support Center at [http://support.hds.com](http://support.hds.com).
4. UR pair status must be other than COPY or PAIR to use the P-VOL as a source volume and perform volume migration. The migration operation stops if UR pair status changes to COPY or PAIR.
5. The volume can be used as an S-VOL only when you restore a UR pair or perform the horctakeover operation, though even in these cases, it cannot be used in a pair for a delta resync operation.
6. The volume cannot be used as the UR P-VOL if the specified journal was registered when 2DC Cascade was enabled.
7. A volume shared by two UR pairs in the 3 UR DC multi-target or cascade configuration cannot be used for this function. Also, a volume that is already used for this function cannot be shared by two UR pairs.
8. When a DP-VOL is used as a pair volume shared by ShadowImage and UR, the UR create pair operation can fail. For more information on how to ensure against failure, see the bullet on DP-VOLs and ShadowImage in [Dynamic Provisioning on page B-5](#).

---

**Warning:** TrueCopy and ShadowImage volumes are used extensively with Universal Replicator. See [Configurations with TrueCopy on page C-1](#) and [Configurations with ShadowImage on page D-1](#) for more information.
The following table shows when changes can be made to the access attribute when the Universal Replicator P-VOL status is PAIR or COPY.

**Table B-2 UR pair status and DRU operations**

<table>
<thead>
<tr>
<th>UR volume</th>
<th>UR pair status</th>
<th>DRU access attribute changed?</th>
<th>DRU access attribute referenced?</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-VOL</td>
<td>SMPL</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>COPY</td>
<td>See next table.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>PAIR</td>
<td>See next table.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>PSUS</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>PSUE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>S-VOL</td>
<td>SMPL</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>COPY</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>PAIR</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>PSUS</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>PSUE</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Table B-3 Whether access attribute can be changed when UR P-VOL status is PAIR or COPY**

<table>
<thead>
<tr>
<th>Change access attribute from</th>
<th>Change access attribute to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Read/Write</td>
</tr>
<tr>
<td>Read/Write</td>
<td>No</td>
</tr>
<tr>
<td>Read Only</td>
<td>Yes</td>
</tr>
<tr>
<td>Protect</td>
<td>Yes</td>
</tr>
<tr>
<td>S-VOL Disable.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Dynamic Provisioning**

- You can create a Universal Replicator pair by specifying a DP-VOL (Dynamic Provisioning virtual volume).
- DP-VOLs can be used for either the UR P-VOL or S-VOL, or both P-VOL and S-VOL.
- DP-VOLs cannot be used for UR journal volumes.
- When a DP-VOL is used for a UR P-VOL or S-VOL, the UR of the allocated pages for the DP-VOL is included in the UR licensed capacity. If the actual licensed capacity exceeds the available licensed capacity, you may use UR for 30 days. After 30 days, UR pairs may only be split or released.
- When specifying a DP-VOL that has allocated pages to a UR S-VOL, be aware that used pool capacity will become temporarily larger than the actual capacity, because pages must be reallocated in the DP-VOL. Therefore, before creating the pair:
  - Make sure that DP-VOL pool capacity is sufficient.
• Make sure that the pool-VOLs, which are added to a pool, are not blocked. If the pool-VOLs are blocked, restore the volume status and then create the pair.

• You can use DP-VOLs that are also used by ShadowImage or that are in a Volume Migration migration plan. To do so, proceed as follows:
  a. Delete the ShadowImage pair or disable the Volume Migration setting.
  b. Create the UR pair.
  c. Re-create the ShadowImage pair or the Volume Migration migration plan.

• Be aware that when a DP-VOL is used as the UR S-VOL, you might not be able to update the UR S-VOL because the capacity of the pool-VOL is full. In this instance:
  o The pair is suspended.
  o With CCI, the UR pair status changes to PFUS.
  o In Storage Navigator, the UR pair status changes to PSUS.

**High Availability Manager (HAM)**

You can use the HAM S-VOL as a UR P-VOL. This configuration benefits the HAM pair if data in the P-VOL and S-VOL become inconsistent due to a disaster. In this case, you can recover the data from the split UR S-VOL.

![Figure B-1 Sharing HAM S-VOL with Universal Replicator P-VOL](image)

**LUN Expansion (LUSE)**

• The capacity and configuration of LUSE volumes assigned to a Universal Replicator S-VOL must be the same as the P-VOL. For example, if the P-VOL is a LUSE volume in which 1-GB, 2-GB, 3-GB volumes are combined in this order, the S-VOL must be a LUSE volume in which 1-GB, 2-GB, 3-GB volumes are combined in the same order.
• Universal Replicator-supported RAID groups RAID1, RAID5, and RAID6 can coexist in the LUSE volume.

• To make a Universal Replicator pair’s P-VOL and S-VOL into LUSE volumes, the pair must be deleted and the volumes’ status returned to SMPL. For more information about LUSE, see Provisioning Guide for Open Systems.

LUN Manager

• LUN Manager operations do not affect Universal Replicator operations. Volumes that are under secure ports and/or are assigned to host groups can also be assigned to Universal Replicator pairs. Volumes that are assigned to Universal Replicator pairs can be protected by LUN Manager.

• Universal Replicator S-VOLs cannot be accessed by any UNIX® or PC server host except when the pair is split.

Thin Image and Copy-on-Write Snapshot

Universal Replicator pair volumes can be shared with Thin Image (TI) and Copy-on-Write Snapshot (SS) P-VOLs; however, there are limitations on how they can be used together.

• A UR P-VOL or S-VOL can be used as the TI or SS P-VOL.

• A UR P-VOL or S-VOL that is part of a delta resync configuration with TrueCopy can also be used as a TI or SS P-VOL.

• A TI or SS P-VOL can be used as a UR S-VOL that is in a single UR pair or part of a delta resync configuration; but the UR pair must be created first.

Configuration with TI and SS volumes

The following shows basic UR configurations with TI and SS.

Figure B-2 UR basic configuration with TI or SS

• You can create the UR pair or the local TI or SS pair first.

• The UR pair must be created before the remote TI or SS pair.
Sharing TI and SS volumes in 3DC configurations

TI and SS volumes can be shared in 3DC TC/UR configurations.

![Diagram of 3DC cascade configuration with TI or SS](image)

**Figure B-3 3DC cascade configuration with TI or SS**

- You can create the TC pair or the local TI or SS pair first.
- The TC pair must be created before the intermediate TI or SS pair.
- You can create the UR pair or the intermediate TI or SS pair first.
- The UR pair must be created before the remote TI or SS pair.

**Shared volumes in a 3DC multi-target configuration.**

The following shows shared TI/SS volumes in a 3DC TC/UR multi-target configuration.

Note: TI and SS volumes cannot be shared in 3DC UR/UR configurations.
You can create either the TC pair or the local TI or SS pair first.

The TC pair must be created before the intermediate TI or SS pair.

You can create either the UR pair or the local TI or SS pair first.

The UR pair must be created before the remote TI or SS pair.

**Shared volumes in a delta resync configuration.**

The following shows shared TI/SS volumes in a 3DC TC/UR delta resync configuration.
Sharing volumes

Virtual LUN

- Universal Replicator supports the Virtual LUN feature, which allows you to configure custom-size LU that are smaller than standard-size LUs. When custom-size LUs are assigned to a Universal Replicator pair, the S-VOL must have the same capacity as the P-VOL.
- To perform Virtual LUN operations on a pair’s P-VOL and S-VOL, the pair must be deleted and the volumes’ status returned to SMPL.

Volume Migration

You can specify the Universal Replicator P-VOL or S-VOL as Volume Migration source volumes. However, when UR pair status is COPY or PAIR, do not perform the volume migration operation; otherwise, the operation is stopped.

UR pair volumes and journal volumes cannot be used as Volume Migration target volumes.
Configurations with TrueCopy

Universal Replicator and TrueCopy can share the same data volumes. Using Universal Replicator and TrueCopy can extend disaster recovery options to a third data center.

This appendix provides planning and setup information for sharing Universal Replicator volumes with TrueCopy. It describes four Universal Replicator/TrueCopy configurations.

Note that the term “P-VOL” indicates the primary volume, and “S-VOL” indicates the secondary volume. These terms are used for both Universal Replicator (UR) and TrueCopy (TC).

- Sharing volumes with TrueCopy
- 3DC cascade configuration
- 3DC multi-target configuration
- Delta resync configuration
- 2 data center configuration
Sharing volumes with TrueCopy

Like UR, a TC pair maintains a copy of the production volume in a second location. However, unlike UR, TC’s secondary volume (S-VOL) is synchronous, and the remote system is located within the same general region as the local site.

Creating a UR backup and a TC backup ensures that a copy in a third location is available in the event that the primary site, and possibly one of the secondary sites, fail.

UR and TC can be used and configured in a variety of ways. The following describes four principle configurations. These are covered in detail in this appendix.

- In a 3-data-center cascade configuration (3DC cascade), three data centers are used — the TC production site, the TC/UR intermediate site, and the distant UR remote site. The figure in the 3DC cascade configuration on page C-3 provides an illustration. With this configuration, you can locate the TC synchronous site near the local site to lower I/O response time, while the UR backup provides a disaster recovery solution at a remote site.

- In a 3-data-center multi-target configuration (3DC multi-target), the production volume is shared by the TC and UR. This volume is the primary volume (P-VOL) for both at the local site. The targets of each system are located at different remote sites. They provide the TC solution and the UR asynchronous disaster recovery solution. The TC secondary site is at an intermediate location, the UR secondary site is at a distant location. This is illustrated in 3DC multi-target configuration on page C-4.

- Another use of the 3DC multi-target is the UR Delta Resync pair, which provides a quick way to regain a long distance copy after disaster in the event that the TC/UR P-VOL becomes unusable. In this case, the host continues I/O operations at the intermediate TC S-VOL site. With a second UR pair previously set up between the TC S-VOL and the UR S-VOL, only differential data needs to be copied to the UR S-VOL. Delta resync is illustrated in Delta resync configuration on page C-6.

- In a 2-data-center configuration (2DC), data is copied from the TC P-VOL to an intermediate site, though not to the TC S-VOL. Instead, the data is copied to the UR master journal volume. This results in an asynchronous copy that side-steps the TC S-VOL, and thus enhances overall transfer speed to the UR S-VOL. This is illustrated in 2 data center configuration on page C-15.

Note: Three-data-center (3DC) configurations can also be set up using Universal Replicator at all three sites. See 3 UR data-center configurations on page A-1 for information.
3DC cascade configuration

In a multi-target configuration, data is copied from the local site to two remote sites. As illustrated below, the TC P-VOL is the primary production volume in a 3DC cascade configuration. The TC S-VOL is located at an intermediate site that is near the primary site.

The host issues an update to the TC primary volume (P-VOL), which is copied synchronously to the S-VOL. The UR system copies the synchronous S-VOL data to the UR remote site.

Data in the UR S-VOL is an asynchronous copy of the TC P-VOL. Depending on RPO and bandwidth, UR S-VOL data can be very close to P-VOL data. As always with UR, data consistency is ensured.

Failure recovery occurs as follows:

- If a failure occurs at the TC P-VOL, business continues because data in the UR S-VOL is restored to the production system via the intermediate volume, if needed. Update sequence integrity is ensured.

- If a failure occurs at both TC P-VOL and S-VOL, an implemented disaster recovery plan would re-direct host activities to the UR S-VOL.

See Recovery for 3 UR/TC DC cascade configuration on page 9-11 for recovery information and procedures.

Prerequisite information for 3DC cascade

- VSP must be installed at the local, TC intermediate, and UR remote sites.
- CCI is recommended at all sites.
- Storage Navigator is required at all sites.
  - Host application
  - TC
  - TC primary volume (P-VOL), the primary production volume
  - TC fence level must be Data.
- The intermediate site requires the following:
  - TC
  - UR
  - TC S-VOL = UR P-VOL
- UR master journal volume
- The remote site requires the following:
  - UR
  - UR S-VOL
  - UR remote journal volume
- Differential data is used to re-synchronize a suspended TC or UR pair.
- When the TC pair is recovered, the UR pair in PAIR or COPY status is automatically split by the system.
- The fence level of the TC P-VOL must be Data.
- 3DC cascade is not supported for multiple primary and secondary systems. The UR or TC pair in this configuration would be suspended when the status became PAIR or COPY.
- The response time for host I/Os will be the response time for TC operation plus the creation time of journal data in the intermediate site.
- The utilization rate on the primary site with a 3DC cascade configuration is higher than if UR and a TC systems are used independently.

**Procedure for setting up 3DC cascade**

**To set up a 3DC cascade configuration**
1. Install and set up TC and UR on the required systems.
2. Create the TC pair on the primary system. See *Hitachi TrueCopy® User Guide* for instructions.
3. When TC pair status is PAIR, create the UR pair on the secondary system using the TC S-VOL as the UR P-VOL. The UR operation is rejected by the system if TC pair status is not already PAIR.
   Mirror ID must be set between 1 and 3.

**3DC multi-target configuration**

In a multi-target configuration, data is copied from the local site to two remote sites. As illustrated below, the P-VOL is paired with the TC secondary volume (S-VOL) and the UR S-VOL at separate remote sites in a 3DC multi-target configuration. The TC site is at an intermediate distance; the UR site is located at a greater distance.
The host issues an update to the production volume and, synchronously, to the TC S-VOL. As with a standalone UR system, the update data is asynchronously written from the primary volume (P-VOL) to the UR S-VOL. The benefit of this configuration is that it provides a third copy of the data, helping to ensure that business can continue in the event of a failure at the other two sites.

Failure recovery occurs as follows:

- If a failure occurs in the P-VOL, business is resumed using the TC S-VOL. When the failure is corrected at the primary site, business tasks are transferred back to the primary site.

  In addition, a quick disaster recovery solution can be put in place while the primary site is being restored, using a UR pair for delta resync. In this configuration, the TC S-VOL is paired with the UR S-VOL. See Delta resync configuration on page C-6 for more information.

- If a failure occurs in the TC system (P-VOL and S-VOL), business is resumed using the UR S-VOL. When the failure is corrected, business tasks are transferred back to the primary site.

- If a failure occurs in the UR system (P-VOL and S-VOL), business is resumed using the TC S-VOL.

See Recovery for 3 UR/TC DC multi-target configuration on page 9-11 for recovery information and procedures.

**Prerequisite information for 3DC multi-target**

- VSP must be installed at the local, TC intermediate, and UR remote sites.
- CCI is recommended at all sites.
- Storage Navigator is required at all sites.
- The primary site requires the following:
  - TC
  - UR
• TC P-VOL = UR P-VOL. This is the primary production volume.
• UR master journal volume

• The intermediate site requires the following:
  • TC
  • UR
  • TC S-VOL

• The remote site requires the following:
  • UR
  • UR S-VOL
  • UR remote journal volume

• 3DC multi-target can be used in configurations with multiple primary and secondary systems. However, delta resync configurations are not supported in configurations with multiple primary and secondary systems.

**Procedure for setting up 3DC multi-target**

**To set up a 3DC multi-target configuration**

1. Install and set up TC and UR on the required systems.
2. Create a TC pair on the primary system. See *Hitachi TrueCopy® User Guide* for instructions.
3. When TC pair status is PAIR, create the UR pair on the primary system. The mirror ID must be set between 1 and 3.

**Delta resync configuration**

In a UR delta resync configuration, you create a second UR pair in a 3DC multi-target. The pair is created using the TC secondary volume (S-VOL) and the UR S-VOL.

The delta resync operation requires less time to bring the S-VOL to a consistent state after a failure occurs because only missing differential data is copied. The delta resync operation is performed when the primary site fails, as illustrated in the figure below.

In addition, you can create or re-create the UR pair for delta resync:

• When the UR pair status changes to HOLD after the delta resync operation.
• When you re-create the UR pair for delta resync when recovering the primary site.
Two operations are performed for the delta resync configuration:

- Create the UR delta resync pair
- In a disaster recovery situation, perform the delta resync operation

The delta resync system is created after setting up the main TC and UR pairs in the multi-target configuration.

- Data is not copied at the time you set up the delta resync pair. The primary volume (P-VOL) and S-VOL in this system contain data from their respective TC and UR systems
- If a failure on the primary site occurs, the TC S-VOL is made the primary production volume using the CCI horctakeover command. Differential data stored in the journal volumes is used to synchronize the S-VOL, via the pairresync operation.
Prerequisite information for creating delta resync pairs

- A UR delta resync pair is created in a 3DC multi-target configuration only.
- A 3DC multi-target configuration with multiple primary and secondary systems cannot be used for delta resync.
- Use the TC S-VOL in PAIR status as the delta resync P-VOL.
- Use a UR S-VOL that is in PAIR status as the delta resync S-VOL.
- The mirror ID must be between 1 and 3; however, make sure it is not the same as the mirror ID assigned to the UR pair in the 3DC multi-target configuration.
- The consistency group you use for the delta resync configuration cannot be used by another UR pair.
- Follow volume combinations shown in Volume types that can be shared with Universal Replicator on page B-2.
- System option mode 506 must be ON for delta resync.
- If you create more than one UR pair for delta resync, the delta resync P-VOLs in the same master journal must:
  - Use the same mirror ID
  - Are paired with S-VOLs in the same restore journal
- If you plan to create in-system pairs on the remote site sharing the delta resync S-VOL, make sure to perform the delta resync create-pair operation first, then create in-system pairs.
- You can set a back-up option in the event that the delta resync operation fails. This is done on the Change Mirror Options window (see the Delta resync Failure step in Changing options used by mirrors on page 8-5).

Procedure for creating a delta resync pair

To create a Universal Replicator pair for delta resync pair

1. Install and set up TC and UR on the required systems.
2. Create a TC pair on the primary system, following the information in the following topics:
   - Prerequisite information for 3DC multi-target on page C-5
   - Prerequisite information for creating delta resync pairs on page C-8
3. After the TC pair status is PAIR, create the UR pair on the primary system, following the information in the following topics:
   - **Prerequisite information for 3DC multi-target on page C-5**
   - **Prerequisite information for creating delta resync pairs on page C-8**

4. Create a second UR pair from the TC S-VOL to the UR S-VOL. Specify the Initial Copy option as Delta.

**Prerequisite information for delta resync operation**

You perform the delta resync operation using the Pair Resync operation. After reviewing these prerequisites, see Resynchronizing pairs on page 6-10.

- The delta resync P-VOL must be updated for longer than 5 minutes after the operation is completed and pair status has changed to PAIR. However, a workaround is available that allows you to avoid the 5-minute update requirement. See Assigning remote command devices on page C-10 for details.

- **Required pair and volume statuses:**
  - The TC volume used as the 3DC multi-target P-VOL: PAIR
  - The TC S-VOL used as the delta resync P-VOL: SSWS.
  - Check this status after executing the CCI horctakeover command
  - The UR delta resync pair: HOLD or HOLDING. If the pair status is HLDE, change to HOLD by performing the pairresync operation.
    - This applies to all pairs in the journal in which the UR pair for delta resync resides.
  - The UR volume used as the 3DC multi-target and the delta resync pair S-VOL and uses two mirror IDs — one for the 3DC multi-target pair and one for the delta resync pair:
    - 3DC multi-target S-VOL: PAIR, PSUS, or PSUE
    - Delta resync S-VOL: HOLD.

  **Note:** The UR S-VOL uses two mirror IDs because of its dual use in the 3DC multi-target and delta resync configurations. The statuses shown above are required for the two mirrors as well as for the journal in which the UR pair for delta resync resides.

- If the delta resync S-VOL has been backed up on the remote site using SI, TI, or SS, make sure to review the information for the Delta resync Failure step on the Change Mirror Option window (Changing options used by mirrors on page 8-5).

- Differential data is stored in the master journal but may not be completely present after a failure at the primary site when the pair was being recovered (or after creating the delta resync pair configuration).

- If data in the restore journal exceeds 80% of capacity, old journal data is automatically deleted. This can occur when the suspended pair has not been re-synchronized for a long time.

  In this case, based on journal option settings, the entire P-VOL is copied to the S-VOL. In a delta resync operation, processing is not performed.
• Journal data may also be destroyed in the following cases:
  o When you restore the TC or UR pair in the multi-target configuration, then also update the delta resync pair.
  o When retry-processing occurs because of a delay of the P-VOL update.
  o When the update of a TC S-VOL is delayed.
• The UR pair status in a delta resync configuration could become PSUS or PSUE if you split the pair, or if there is a failure when copying all data from the P-VOL to the S-VOL. If you then run the delta resync operation, all data might be copied from P-VOL to S-VOL regardless of journal option settings.
• If the pair’s mirror is in Halting or Stopping status, the resynchronization command is rejected.

**Problems that can occur**

Journal data will not exist, and therefore the delta resync operation will fail, in the following cases:

• After creating the UR pair, the primary delta resync P-VOL is updated but not the UR P-VOL.
• When the multi-target P-VOL is resynchronized after the TC pair was split.
• When the UR S-VOL is resynchronized after it was split.
• When the UR pair is resynchronized after being split and then the journal volume at the TC secondary site exceeds 70%.
• When the delta resync P-VOL is updated, and then the journal volume at the TC secondary site exceeds 70%.
• When the delta resync pair is created and no volumes (including volumes after failover or failback) in the primary site are updated.
• When the status of the UR pair for delta resync operation becomes HLDE, the journal data necessary for the delta resync operation might be discarded. In this case, all data in the delta resync P-VOL would be copied to the delta resync S-VOL.

**Performing the delta resync operation**

The delta resync operation is performed during disaster recovery. This operation copies differential data from the TC S-VOL to the UR S-VOL.

The delta resync operation is part of the Pair Resync operation. Follow instructions in [Resynchronizing pairs on page 6-10](#) to execute delta resync.

**Assigning remote command devices**

This section provides a workaround using remote command devices for the delta resync update time-limit.
When the delta resync operation has been performed and pair status is changed to PAIR, the delta resync P-VOL must be updated from the host for longer than five minutes. This is required to ensure internal communications between the intermediate and remote sites.

However, you can work around this five-minute-plus update requirement by setting up command devices and remote command devices. With remote command devices set up, communications between the two sites is performed automatically, and the delta resync is ready to use when the operation is run.

This requires setting up two command devices and two remote command devices on each site — the local, intermediate, and remote sites — as explained in the following general guidelines. Consult the Hitachi Universal Volume Manager User Guide for more complete information about remote command devices.

1. Set up four command devices each on the local, intermediate, and remote sites.
2. Set up and dedicate two external ports and two target ports on each site for the command/remote command devices. Configure paths between external ports and target ports. For details about the external ports, see Hitachi Universal Volume Manager User Guide. For instructions on setting paths, see Provisioning Guide for Open Systems.
3. On each site, map a command device via a target port to a device on one of the other sites. The device on the other site should be mapped to as a remote command device, using an external port on that system.
4. Repeat the previous step so that two command devices on each site are mapped to a remote command device on each of the other two sites.

Thus:

- Each site should have two command devices mapped via two target ports to the other two sites.
- Each site should also have two remote command devices mapped to via external ports from the other two sites.

The following illustration shows this command/remote command device configuration.
When mapping to remote command devices on each site is complete, you must assign mirror IDs to the remote command devices. This is required to enable communication for delta resync operations.

**Assigning mirrors to remote command devices**

The use of mirrors with remote command devices allows you to determine whether the delta resync operation can be performed. You assign mirror IDs after setting up remote command devices as described in the previous topic.

**Prerequisites**

- To assign a mirror to a remote command device, the mirror's status must be one of the following:
  - Initial, Active, Halt, Stopped, Hold, Holding, or Holding(Failure)
  - To use a mirror in Initial status, it must have mirror ID 00.
- Perform this operation per journal.
- In a journal, you can assign multiple mirrors to two remote command devices in one operation.
- A maximum of 16 mirrors can be shared with a remote command device. When a remote command device is shared, you can use it to do the following:
  - Assign it to other mirrors
  - Register it to an extended consistency group
  - Use it with CCI
  - When performing these functions with a remote command device, the number of registered journals and instances used by CCI are subtracted from the number of mirrors that can be shared.
- A maximum of 16 remote command devices can be used for the delta resync operation per DKC.
To assign mirror IDs to remote command devices


2. In the tree, select a master or restore journal below **Registered > LDKC00**.

3. In the mirror list, right-click the mirror that you want to assign to the remote command device, and click **Mirror > Assign R-Cmd. Dev** from the menu that displays. The Assign Remote Command Device dialog box displays, as shown below.

4. Assign mirror IDs to remote command devices as follows.
   - **On primary site**:
     - Assign mirror ID 00 to the remote command device that is mapped to on the intermediate site.
     - Assign the mirror ID used for the UR 3DC multi-target pair to the remote command device that is mapped to on the remote site.
   - **On the intermediate site**:
     - Assign mirror ID 00 to the remote command device that is mapped to on the primary site.
     - Assign the mirror ID used for the UR delta resync pair to the remote command device that is mapped to on the remote site.
   - **On the remote site**:
     - Assign the mirror ID used for the UR 3DC multi-target configuration to the remote command device that is mapped to on the primary site.
     - Assign the mirror ID used for the UR delta resync pair to the remote command device that is mapped to on the intermediate site.

When selecting mirror IDs and remote command devices, observe the following:

- Though two mirrors can be assigned to each remote command device, it is not required. Select **Not set** in the **Mirror 2** list if you are assigning only one mirror ID.
- The same mirror ID cannot be specified from both **Mirror ID** lists.
If you will not use a remote command device, select **Not use** in the second (lower) **Remote Command Device** list.

5. Click **Set**

6. Review your settings in the **Preview** list in the Journal Operation window.
   - To modify a setting, right click and select **Modify**.
   - To cancel a setting, right click and select **Cancel**.

7. Check the list in the Journal Operation window. If the remote command device is assigned, the LDEV number is displayed in the column of the remote command device.

8. Click **Apply** to apply the settings. If an error occurs, right click the item in the **Preview** list and select **Error Detail**.

You can release a remote command device by selecting **Journal > Release R-Cmd. Dev** when you right-click the mirror.

**Releasing remote command device assigned to a mirror**

This operation is performed on the mirror.

---

**Note:** A remote command device assigned to a mirror is released automatically when all pairs in a delta resync configuration are deleted.

---

**To release a remote command device**

1. Ensure that the Storage Navigator main window is in Modify mode. For detailed information about how to do this, see *Hitachi Storage Navigator User Guide*.

2. Ensure that the Journal Operation window is open.

3. In the tree, select a master journal or a restore journal from below **Registered > LDKC00**.

4. From the mirrors, select and right-click the mirror that you want to release the assigned remote command device.

5. Select **Mirror > Release R-Cmd Dev** on the pop up menu.

6. Review your settings in the **Preview** list in the Journal Operation window.
   - To modify a setting, right click and select **Modify**.
   - To cancel a setting, right click and select **Delete**.

7. Click **Apply** to release the remote command device from the mirror. If an error occurs, the error code appears in the right-most column of the **Preview** list. To view detailed information about the error, right click the error code and select **Error Detail**.

See the list in the Journal Operation window whether the remote command device is released from the mirror or not. If the remote command device is not assigned, the column of the remote command device is blank.
2 data center configuration

In a 2DC configuration, update data is transferred from the TrueCopy P-VOL to the Universal Replicator master journal volume located in the intermediate site, and then to the UR S-VOL in the remote site.

Though there are three sites, data is not copied to the TC S-VOL in the intermediate site, only the journal volume. Thus it is called, “2 data center”, or 2DC.

![Figure C-6 2 data center (2DC)](image)

The UR S-VOL contains the same data as the TC P-VOL. If failure occurs, business tasks are taken over using the UR S-VOL.

The master journal in the intermediate site is registered with the 2DC Cascade setting enabled. This setting prevents host data from being written to the UR P-VOL.

Drive capacity can be minimized using the virtual volume of Dynamic Provisioning (DP-VOL) as the data volume in the intermediate site. The DP-VOL is associated with the pool volume, which has a smaller capacity and thus lowers drive capacity. For information on DP-VOLs, see Provisioning Guide for Open Systems.

Prerequisite information for 2DC configuration

- VSP must be installed at the local, TC intermediate, and UR remote sites.
- CCI is recommended at all sites. If the intermediate site is not connected to a host, a remote command device is required. See Command Control Interface User and Reference Guide for more information.
- Storage Navigator is required at all sites.
- The primary site requires the following:
  - Host application
  - TC
  - TC P-VOL, the primary production volume.
- The intermediate site requires the following:
  - TC
  - UR
  - TC S-VOL = UR P-VOL
o UR master journal volume

o Use a journal that was registered when **2DC Cascade** was set to **Enable** in the **Edit Journal Volumes** dialog box. With it you specify whether to write TC P-VOL data to a shared TC S-VOL/UR P-VOL, or to write only to the UR master journal.

**Enable** — Data will be written only to UR master journal volume on the intermediate site for use in the 2DC configuration.

**Disable** — Data will be written to the shared TC S-VOL/UR P-VOL on the intermediate site.

o Updates to the TC S-VOL/UR P-VOL is prohibited.

o System option mode 707 must be set to ON. This allows TC P-VOL data to be written directly to the UR master journal and not to the shared TC S-VOL/UR P-VOL.

  - Though it is possible to change option mode 707, the change is not reflected in the system. You need to delete the journal then re-register it with the option mode set to ON.

  - Storage Navigator does not show system option 707. Therefore, it is recommended that all journals in the system have the same system option mode 707 setting.

• The remote site requires the following:
  o UR
  o UR S-VOL
  o UR remote journal volume

**Specifications and restrictions for Universal Replicator pair operations**

• Because the UR pair depends on the TC pair for data, data copying is not executed when the UR pair is created, but when the TC pair is created.

• About resynchronizing a UR pair:
  o The TC S-VOL must be in PSUS or PSUE status (Error Level field = Group).
  o Make sure the UR S-VOL is not in SSWS status when resynchronizing with -swaps or -swapp options.
  o If the UR pair is suspended and in SSWS status, execute the Pairsplit RB command on the UR S-VOL, confirm that status becomes PSUS, then re-synchronize the pair from the primary site.

• If a UR pair is suspended when the TC S-VOL is in PAIR or COPY status, the TC pair becomes suspended by error.

• A UR pair cannot be released if cascaded with a TC pair. To release a UR pair, first release the TC pair, then release the UR pair.

**Specifications and restrictions for TrueCopy pair operations**

• Specify a volume for the TC P-VOL that is not used in a UR pair. In the 2DC configuration, use the journal that was registered when **2DC Cascade** was enabled.
• The UR P-VOL that is specified for the TC S-VOL must be in PAIR status. The only available differential management unit is tracks.
• To re-synchronize the TC pair, the UR P-VOL must be in PAIR status.
• You cannot use the takeover command on the TC S-VOL when suspending the TC pair.
• If you release the TC pair when the UR P-VOL is in COPY status, the UR pair becomes suspended by error.
• For UR, an X at the end of the device ID indicates the LDEV is a Dynamic Provisioning virtual volume. However, the X does not display when both of the following conditions exist:
  o The TC S-VOL is a Dynamic Provisioning virtual volume.
  o The UR S-VOL is not a Dynamic Provisioning virtual volume.

Procedure for a 2DC configuration

To set up a 2DC configuration
1. Install and set up TC and UR on the required systems.
2. When registering the journal on the intermediate site, set 2DC Cascade to Enable in the Edit Journal Volumes dialog box.
3. Create the UR pair on the intermediate system.
4. When UR pair status is PAIR, create the TC pair on the primary system. See Hitachi TrueCopy® User Guide.
5. Confirm that TC pair status becomes PAIR.
Configurations with ShadowImage

Universal Replicator and ShadowImage can share the same data volumes to provide multiple copies of data, at both the primary and secondary sites.

This appendix provides configurations and information for using ShadowImage with Universal Replicator. For details about ShadowImage, see the Hitachi ShadowImage® User Guide.

- Overview
- Configurations with ShadowImage primary volumes
- Configurations with ShadowImage secondary volumes
- Pair status and data currency
Overview

Universal Replicator’s main function is to maintain a copy of the production volume in a remote location. Backing up the local and/or remote Universal Replicator (UR) volumes with ShadowImage (SI), or backing up the SI volumes with UR, provides additional advantages.

- When sharing the primary volume with SI
  - On-site data backup is provided in case of a UR failure.
  - Multiple copies of production data are provided on the local site for secondary purposes, such as data analysis, testing and so on.
- Sharing the SI secondary volume with the UR primary volume on the local site provides a remote copy.
- When SI is cascaded on the remote side, data in the SI secondary volume can be used for testing the UR system and for recovery purposes.
  - The SI secondary volume is available for continuous replication during a test.
  - If a UR problem is encountered during an actual recovery procedure, the SI secondary volume provides a golden copy of the UR secondary volume, which can be used to restore the UR secondary volume.

Note: To split the SI pairs in a consistency group whose volumes are also used in UR pairs, the UR pairs must be in PAIR, PSUS, or PSUE status.

UR data volumes are shared with SI volumes in specific configurations. The following topics discuss these supported configurations.

Configurations with ShadowImage primary volumes

Note: ShadowImage for Mainframe source and target volumes are now referred to in Storage Navigator as “primary” and “secondary” volumes. However, if using the previous version of the GUI, “source volume (S-VOL)” and “target volume (T-VOL)” are still used. Terms in this document correspond to the current GUI terminology.

An SI primary volume can be shared with a UR primary or secondary volume.
- An SI primary volume shared with the UR primary volume is illustrated below. This configuration allows you to use SI for on-site data backup in case of a UR failure, and to use UR to provide remote backup of the SI primary volume in case of an SI failure.
• A UR secondary volume shared with the SI primary volume is illustrated below. With this configuration, multiple backup copies of the UR primary volume can be made on the secondary system.

**Caution:** When you share a UR S-VOL with an SI P-VOL as shown in the following figure, the restore operation to the UR S-VOL takes time. This is especially the case when the SI pair is in the PSUS(SP)/PSUS status because of the time needed to copy the SI pair.

Because of the extra time that may be needed, make sure the UR journal volume is sized with enough capacity to handle the possible increase in I/O. If journal volume capacity is insufficient, the pair will suspend because of failure.

• UR primary and secondary volumes shared with SI primary volumes is illustrated below. This configuration provides multiple copies of the source volume at the local and remote sites.
Configurations with ShadowImage secondary volumes

The following figure shows an SI primary volume used as the production volume. A remote UR backup copy is made of the SI secondary volume. The SI pair must be in PSUS status to perform the UR operation.

Pair status and data currency

The table below shows whether the data in a shared volume is current, given the combined status.
<table>
<thead>
<tr>
<th>UR pair status</th>
<th>SI pair status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>COPY(PD)/COPY</td>
</tr>
<tr>
<td>COPY</td>
<td>Not Current</td>
</tr>
<tr>
<td>PAIR</td>
<td>Not Current</td>
</tr>
<tr>
<td>PSUS/PSUE</td>
<td>Not Current</td>
</tr>
</tbody>
</table>

Check pair status for shared volumes as follows:

- For UR, check status of the primary volume or secondary volume.
- For SI, check status of the primary volume.

SI supports multiple secondary volumes for each primary volume. When you check pair status, the system returns status for only one pair—the pair whose secondary volume has the lowest LDEV ID. To see status for the pairs with a different secondary volume, direct a host query to the specific secondary volume using the secondary volume’s LDEV ID in the host command.
This appendix describes the Universal Replicator windows, dialog boxes, fields, and behaviors.

- Journal Operation window
- Journal Detail window
- Change Journal Option dialog box
- Change Mirror Option dialog box
- Edit Journal Volumes dialog box
- Pair Operation window
- DKC Operation window
- Usage Monitor window
- History window
- Optional Operation window
Journal Operation window

Use this window to view details about journals and volumes.

You can perform these procedures from the window:

- Registering journal volumes in a journal on page 5-10
- Monitoring journal (mirror) status on page 7-15
- Changing options used by journals on page 8-3
- Deleting journal volumes from a journal on page 8-8
- Deleting journals on page 8-9
- Splitting mirrors on page 6-9
- Resynchronizing mirrors on page 6-12
- Deleting pairs in a mirror on page 6-15
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree</td>
<td>Lists journals in the local system. The tree shows journals used with Universal Replicator, though not Universal Replicator for Mainframe.</td>
</tr>
<tr>
<td></td>
<td>• Journals: This item is located at the top of the tree. When selected, the Journal Operation list shows journals in the local system.</td>
</tr>
<tr>
<td></td>
<td>• Registered: When selected, the Journal Operation list shows journals in which journal volumes are registered. Double-clicking this item shows LDKCs in the tree.</td>
</tr>
<tr>
<td></td>
<td>Selecting an LDKC in the tree shows information about the LDKC. Double-clicking the LDKC shows journals in which journal volumes are registered.</td>
</tr>
<tr>
<td></td>
<td>Selecting a journal in the tree shows information about the journal in the Journal Operation list.</td>
</tr>
<tr>
<td></td>
<td>The journal icons under Registered are:</td>
</tr>
<tr>
<td></td>
<td>- Initial: 🎈 A journal in initial status. Journal volumes are registered in this journal, but no data volumes (P-VOLs and S-VOLs) are registered in this journal.</td>
</tr>
<tr>
<td></td>
<td>- Master: 🎈 A master journal. Journal volumes and P-VOLs are registered in this journal.</td>
</tr>
<tr>
<td></td>
<td>- Restore: 🎈 A restore journal. Journal volumes and S-VOLs are registered in this journal. When this column is blank, neither journal volumes nor data volumes are registered in this journal.</td>
</tr>
<tr>
<td></td>
<td>- Master/Restore: 🎈 A journal used as both master and restore journal. Journal volumes, P-VOLs, and S-VOLs are registered in this journal.</td>
</tr>
<tr>
<td></td>
<td>• Free: When selected, the Journal Operation list shows journals in which no journal volumes are registered. Double-clicking this item shows LDKCs in the tree.</td>
</tr>
<tr>
<td></td>
<td>Selecting a journal in the tree shows information about the journal in the Journal Operation list.</td>
</tr>
<tr>
<td></td>
<td>Four mirrors per journal that are included the mirror used by the UR pair and the unused mirror are displayed.</td>
</tr>
<tr>
<td></td>
<td>• JNL (LDKC): Indicates the number of a journal in the local system. The LDKC number is enclosed in the parentheses following the journal number. The journal number ending in [&amp;], indicates the journal is in a 2DC configuration using UR and TC; for example, 01 (00) [&amp;]]. A journal number ending in [M] indicates the journal can be used in a 3 UR DC configuration.</td>
</tr>
<tr>
<td></td>
<td>• Attribute: Indicates the attribute of a mirror in the local system.</td>
</tr>
<tr>
<td>Journal/Mirror list</td>
<td>A list of journals and mirrors displays. A mirror is a combination of a master journal and a restore journal. One row in this list represents one mirror (or one journal). With an unused journal, a row represents one journal.</td>
</tr>
<tr>
<td></td>
<td>If another journal is selected in the tree, the Journal list shows information about the selected journal. Four mirrors per journal that are included the mirror used by the UR pair and the unused mirror are displayed.</td>
</tr>
<tr>
<td></td>
<td>• JNL (LDKC): Indicates the number of a journal in the local system. The LDKC number is enclosed in the parentheses following the journal number. The journal number ending in [&amp;], indicates the journal is in a 2DC configuration using UR and TC; for example, 01 (00) [&amp;]]. A journal number ending in [M] indicates the journal can be used in a 3 UR DC configuration.</td>
</tr>
<tr>
<td></td>
<td>• Attribute: Indicates the attribute of a mirror in the local system.</td>
</tr>
</tbody>
</table>
The data on this window updates when you do one of the following:
• Click **File > Refresh** on the menu bar.
• Click **Apply**
• Select another tab and then reselect the **Journal Operation** tab.
• Select **Modify** mode when you are in **View** mode.

**Journal Detail window**

Use this window to view detailed information about individual journals.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal (LDKC)</td>
<td>The number of a journal and the LDKC number. The LDKC number is enclosed in the parentheses following the number of a journal, for example, 01 (00). A journal number ending in [&amp;], indicates the journal is in a 2DC configuration, for example, 01 (00) [&amp;]. A journal number ending in [M] indicates the journal can be used in a 3 UR DC configuration; for example, 001 (00) [M].</td>
</tr>
<tr>
<td>Attribute</td>
<td>For a master journal, Attribute is Master. For a restore journal, Attribute is Restore. If Attribute is Initial, journal volumes are registered in this journal but no data volumes are registered. When neither journal volumes nor data volumes are registered, Attribute shows no value.</td>
</tr>
<tr>
<td>Number of Journal Volumes</td>
<td>Number of journal volumes registered in the journal.</td>
</tr>
<tr>
<td>Journal Capacity (GB)</td>
<td>Total capacity of all registered journal volumes.</td>
</tr>
<tr>
<td>Data Volumes</td>
<td>Number of data volumes associated with the journal. When one journal uses multiple mirror IDs, this field shows the number of data volumes in the journal whose mirror ID is other than Hold, Holding, or Hold(Failure).</td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Data Capacity(GB)</td>
<td>Total capacity of all data volumes. When one journal uses multiple mirror IDs, this field shows the total capacity of the data volumes in the journal whose mirror ID is other than Hold, Holding, or Hold(Failure).</td>
</tr>
<tr>
<td>Inflow Control</td>
<td>Restrict inflow of update data to the journal volume. Yes restricts inflow, No does not restrict. (slows delay response to hosts).</td>
</tr>
<tr>
<td>Data Overflow Watch(sec)</td>
<td>Sets number of seconds for the system to monitor write data to the journal volume, after the journal volume threshold (80%) is reached. Data Overflow Watch is blank when Inflow Control is No. For additional information, see Changing options used by journals on page 8-3.</td>
</tr>
</tbody>
</table>
| Use of Cache              | Whether journal data in the restore journal can be stored in the cache. Used: Journal data will be stored in cache. When there is insufficient space in cache, journal data is also stored in the journal volume. 
Caution: This setting does not effect master journals unless the CCI horctakeover command is used to change a master journal to a restore journal. |
| Journal Volumes           | Shows a list of registered journal volumes.  
- Parity Group: The parity group where a journal volume belongs.  
- LDKC:CU:LDEV: The LDKC number, the CU number and the LDEV number of a journal volume.  
- Capacity: The capacity of a journal volume in gigabytes.  
- Emulation: The emulation type of a journal volume.  
- CLPR: The number and the name of the CLPR where the journal volume belongs. Journal volumes and data volumes in the same journal can belong to different CLPRs. Journal volumes must belong to the same CLPR. A primary journal and the corresponding secondary journal need not belong to the same CLPR. |
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mirrors</td>
<td>A list of mirrors. Information of four mirrors are displayed. If four mirrors include the mirror used by UR pairs or unused mirrors, information of those mirrors are also displayed.</td>
</tr>
<tr>
<td>- Mirror ID</td>
<td>indicates a mirror ID.</td>
</tr>
<tr>
<td>- Attribute</td>
<td>indicates the attribute of a mirror ID.</td>
</tr>
<tr>
<td>Master</td>
<td>Master indicates a mirror to which P-VOLs of local system are registered. Restore indicates a mirror to which S-VOLs of local system are registered. Initial indicates that no data volumes are registered in the journals of local system.</td>
</tr>
<tr>
<td>- Status</td>
<td>The status of a mirror in the local system. For detailed information about the statuses, see Monitoring journal (mirror) status on page 7-15.</td>
</tr>
<tr>
<td>- CTG</td>
<td>The number of a consistency group to which the mirror belongs. This column is blank if there is no consistency group. A consistency group number shown as 001 indicates that the primary and secondary system share the consistency group.</td>
</tr>
<tr>
<td>- S/N(LDKC)</td>
<td>The serial number of the remote system and the LDKC number. This column is blank if the attribute of the mirror is Initial.</td>
</tr>
<tr>
<td>- ID</td>
<td>Path group ID registered at DKC registration.</td>
</tr>
<tr>
<td>- Pair JNL</td>
<td>The number of a journal in the remote system. This column is blank if the attribute of the mirror is Initial.</td>
</tr>
<tr>
<td>- Controller ID</td>
<td>The controller identifier, which indicates the remote storage system model. Note the following controller IDs: VSP G1000 = 7, VSP = 6, USP V/VM = 5, TagmaStore USP/TagmaStore NSC = 4, HUS VM = 19. The column is blank if the attribute of the mirror is Initial</td>
</tr>
<tr>
<td>- Path Watch Time</td>
<td>The time for monitoring blockade of paths to the remote system. If the status of the mirror in the restore attribute is Hold, this column is blank.</td>
</tr>
<tr>
<td>- Pairs</td>
<td>The number of data volumes registered in the mirror.</td>
</tr>
<tr>
<td>- Capacity</td>
<td>The total capacity of data volumes registered in the mirror.</td>
</tr>
</tbody>
</table>
Mirrors (continued)

- Copy Pace: The pace for an initial copy activity for one volume. One of the following appears: High, Medium, or Low. The default is Low. Copy Pace is blank if the mirror is a restore mirror.
- Delta Resync Failure: The processing that would take place when the delta resync operation cannot be performed.
  [ Entire]: Whole data in the P-VOL is copied to S-VOL when the delta resync operation cannot be performed.
  [ None]: No processing takes place when the delta resync operation cannot be performed. Therefore, the S-VOL will not be updated.
- Transfer Speed: The line speed (in megabits per second) of data transfer. One of the following appears: 256, 100, or 10.
  This setting does not take effect on master journals. However, if the CCI horctakeover command is used to change a master journal into a restore journal, this setting takes effect on the journal.
- EXCTG, DKC/CTRLID: Mainframe only. Displays the following information sequentially if the journal belongs to an extended consistency group:
  - The extended consistency group number
  - The serial number and the LDKC number (the LDKC number is enclosed by parentheses)
  - A slash (/), the controller ID
  - This column is blank if the journal does not belong to any extended consistency group.
- Remote Command Device: Displays LDEV numbers if the mirror is assigned to the remote command device. This column is blank if the mirror is not assigned to the remote command device.

Previous Displays detailed information about the previous journal.
Next Displays detailed information about the next journal.
Close Closes the Journal Detail dialog box.

### Change Journal Option dialog box

Use this dialog box to change the options that affect pairs in a journal.

See [Changing options used by journals on page 8-3](#) for complete information.
**Change Mirror Option dialog box**

Use this dialog box to change a mirror’s options.

See [Changing options used by mirrors on page 8-5](#) for complete information.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit of Path Watch Time</td>
<td>Sets unit of time for Path Watch Time—minute, hour, or day.</td>
</tr>
<tr>
<td>Path Watch Time (1 to 59 min, 1 to 23 hour, 1 to 30 day)</td>
<td>The interval from when a path gets blocked to when a mirror gets split (suspended). This value must be within the range of 1 to 59 minutes, 1 to 23 hours, or 1 to 30 days. You can specify a numeric value in Path Watch Time. Make sure that the same interval is set to both the master and restore journals in the same mirror, unless otherwise required. If the interval differs between the master and restore journals, these journals do not suspend simultaneously. For example, if the interval for the master journal is 5 minutes and the interval for the restore journal is 60 minutes, the master journal suspends in 5 minutes after a path gets blocked, and the restore journal suspends in 60 minutes after a path gets blocked. <strong>Important:</strong> If you want a mirror to get split (suspended) immediately after a path gets blocked, ask Hitachi Data Systems Support Center to set system option 448 to ON and set system option 449 to OFF.</td>
</tr>
<tr>
<td>Forward Path Watch Time</td>
<td>Forwards the Path Watch Time value for the master journal to the restore journal, which results in the same Path Watch Time value for both.</td>
</tr>
<tr>
<td>Copy Pace</td>
<td>Pace for initial copy—Slow, Medium, or Fast.</td>
</tr>
<tr>
<td>Transfer Speed (Mbps)</td>
<td>Line speed of data transfer.</td>
</tr>
<tr>
<td>Delta resync Failure</td>
<td>Sets the processing that takes place when the delta resync operation cannot be performed—entire P-VOL is copied or no processing (S-VOL not updated).</td>
</tr>
<tr>
<td>Set</td>
<td>Applies the settings in the dialog box to the Journal Operation window.</td>
</tr>
</tbody>
</table>
Edit Journal Volumes dialog box

Use this dialog box to register or delete journal volumes from a journal.

For complete information, see:

- Registering journal volumes in a journal on page 5-10
- Deleting journal volumes from a journal on page 8-8
Pair Operation window

Use this window to view the pairs for the selected port or host group:

You can perform these procedures from the window:

- Creating the initial copy on page 6-2
- Splitting pairs on page 6-7
- Resynchronizing pairs on page 6-10
- Deleting pairs on page 6-13
### Item | Description
--- | ---
**Tree** | Lists the ports in the local system, with host groups displaying below each port. Selecting a port or a host group, lists the volumes for the port or the host group. You can select only one port or one host group at one time and cannot select two or more simultaneously.

**Display Filter** | When clicked, opens the Display Filter dialog box where you can filter information in the Pair Operation list. See Display Filter dialog box on page E-23 for more information.

**Export** | Saves information about volume pairs in a text file.

**Previous/Next** | Shows the next or previous listing of pairs.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair Operation</td>
<td>Shows information about the volumes in the local system. One row represents one volume. By default, information in the list is arranged in order of port numbers. For volumes with more than one path, each path appears in a separate row. The maximum number of rows in the list is 2,048. If the number of volumes exceeds the number of rows, click Previous or Next to view information about volumes that do not appear in the list. You can also use the vertical and horizontal scroll bars to view more information.</td>
</tr>
</tbody>
</table>
| VOL: Identifies the volumes in the local system. See the figures at the end of this table for an illustration with identifying callouts. | - A device ID ending in # (e.g., 00:00:3C #), indicates the LDEV is an external volume. For details on an external volume, see Hitachi Universal Volume Manager User Guide.  
- A device ID ending in X (e.g., 00:00:3C X) indicates the LDEV is a Dynamic Provisioning virtual volume.  
- A USP V/VM volume displays “00” for the LDKC. |
| Status: Pair status. For definitions, see Pair status definitions on page 7-2. | To the right of the icon appears information about an LU path (illustration at the end of this table), which is a path from hosts to the volume. The icons are:  
- Not paired with any other volume; neither a P-VOL nor an S-VOL.  
- P-VOL  
- S-VOL |
| JNL-MirrorID: A journal number and a mirror ID. The number on the left of the hyphen (-) is a journal number. The number on the right of the hyphen is a mirror ID. A journal number ending in [M] indicates the journal can be used in a 3 UR DC configuration; for example, 001 (00) [M]. This column is blank if the volume in the local system is neither a P-VOL nor an S-VOL. |  
- A journal number ending in [M] indicates the journal can be used in a 3 UR DC configuration; for example, 001 (00) [M]. This column is blank if the volume in the local system is neither a P-VOL nor an S-VOL. |
| S/N (LDKC): The serial number and the LDKC number of the remote system. This column is blank if the volume of local system is neither a P-VOL nor an S-VOL. This column can be blank while the pair is in transition to the SMPL status. To view the latest information in this column, refresh the screen. |  
- The serial number and the LDKC number of the remote system. This column is blank if the volume of local system is neither a P-VOL nor an S-VOL. This column can be blank while the pair is in transition to the SMPL status. To view the latest information in this column, refresh the screen. |
| ID: Path group ID registered at DKC registration. The ID displays with "*" and 2-digit hexadecimal notation (01 to FF) or "Default". |  
- The serial number and the LDKC number of the remote system. This column is blank if the volume of local system is neither a P-VOL nor an S-VOL. This column can be blank while the pair is in transition to the SMPL status. To view the latest information in this column, refresh the screen. |
| CTRLID (Model Name): The serial number and the controller ID of the remote system. The model name is enclosed by parentheses. Note the following controller IDs: VSP G1000 = 7, VSP = 6, USP V/VM = 5, TagmaStore USP/TagmaStore NSC = 4, HUS VM = 19. The column is blank if the attribute of the mirror is Initial |  
- The serial number and the controller ID of the remote system. The model name is enclosed by parentheses. Note the following controller IDs: VSP G1000 = 7, VSP = 6, USP V/VM = 5, TagmaStore USP/TagmaStore NSC = 4, HUS VM = 19. The column is blank if the attribute of the mirror is Initial |
### Pair Operation (continued)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paired VOL</td>
<td>A data volume in the remote system. See the figures following this table for an example. This column indicates a P-VOL if the remote system is a primary system. This column indicates an S-VOL if the remote system is a secondary system. Do not change or delete the port ID, GID, or LUN specified when creating the pair. This column is blank if the volume in the local system is neither a P-VOL nor S-VOL.</td>
</tr>
<tr>
<td>Pair JNL</td>
<td>The journal number for the remote system. This column is blank if the volume in the local system is neither a P-VOL nor an S-VOL.</td>
</tr>
<tr>
<td>CTG</td>
<td>Consistency group number. Remains blank if the volume in the local system is neither a P-VOL nor an S-VOL.</td>
</tr>
<tr>
<td>Err Lv.</td>
<td>The range of pair split on error.</td>
</tr>
<tr>
<td>Mirror</td>
<td>If an error occurs with this pair, all the pairs in the mirror where this pair belongs will be split.</td>
</tr>
<tr>
<td>LU</td>
<td>If an error occurs with this pair, only this pair will be split.</td>
</tr>
<tr>
<td>Sync.</td>
<td>If the volume in the local system is a P-VOL, this column shows progress of an initial copy operation. If the volume in the local system is an S-VOL, this column shows information in the following ways:</td>
</tr>
<tr>
<td></td>
<td>- If the volume pair is not split, this column shows nothing.</td>
</tr>
<tr>
<td></td>
<td>- If the volume pair is split and therefore is in PSUS or PSUE status, this column usually shows synchronization rate (that is, concordance rate) between the S-VOL before it became split and the S-VOL after it became split.</td>
</tr>
<tr>
<td></td>
<td>For example, the synchronization rate (that is, concordance rate) is 100 percent if the contents of the S-VOL are the same before and after the volume pair became split.</td>
</tr>
</tbody>
</table>

**Caution:** If a failure in the initial copy operation causes the volume pair to be split, this column shows nothing. If a failure occurs in the initial copy operation, the Detailed Information dialog box shows the phrase "Initial copy failed".

- In the following cases, this column will be blank:
  - When the volume in the local system is neither a P-VOL nor an S-VOL.
  - When the status of the volume pair is HOLD or HLDE.
- CLPR: The number and the name of the CLPR where the data volume belongs.
- Pair Copy Time: The time taken for the copy operation (from the start of the operation to the end). The time that is shown in Pair Copy Time differs from the time that is shown in Copy Time on the History window.
  - To create a pair:
    - MCU receives a request to create a pair.
    - MCU receives a request to start the paircreate operation.
    - The paircreate operation is started according to the conditions of initial copy priority and initial copy activities.
  - Pair Copy Time shows the amount of time needed to complete the paircreate operation (i.e., the progress of the paircreate operation reaches 100%). Copy Time on the History window shows the amount of time needed from step a to the completion of the paircreate operation.

### Used Volume

- The size of used volumes, and also indicates the licensed capacity. For example, if 12.34 (15.0) (TB) appears, the licensed capacity for UR is 15.0 terabytes, and 12.34 terabytes of volumes are used. If the licensed capacity is unlimited, the sized of used volume does not appear.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Pairs</td>
<td>The current total number of pairs.</td>
</tr>
<tr>
<td>Preview</td>
<td>The Preview list shows changes that have been made in the window. When you change settings in the window, the changes appear in the Preview list before the changes are applied to systems. If you are sure that information in the Preview list is correct, click Apply to apply the settings that you have made. When the Preview list shows changes that have been made, you can perform only the same type of operation that you have been doing and cannot perform most of other operations (you can only view detailed information about pairs even when the Preview list shows changes). For example, if you are trying to release pairs and the Preview list shows the pairs that you want to release, you are unable to perform any other operations; for example, you are unable to split pairs and restore pairs.</td>
</tr>
<tr>
<td>Operation</td>
<td>The operation that will occur when you click Apply.</td>
</tr>
<tr>
<td>Preview</td>
<td>The Preview list shows changes that have been made in the window. When you change settings in the window, the changes appear in the Preview list before the changes are applied to systems. If you are sure that information in the Preview list is correct, click Apply to apply the settings that you have made. When the Preview list shows changes that have been made, you can perform only the same type of operation that you have been doing and cannot perform most of other operations (you can only view detailed information about pairs even when the Preview list shows changes). For example, if you are trying to release pairs and the Preview list shows the pairs that you want to release, you are unable to perform any other operations; for example, you are unable to split pairs and restore pairs.</td>
</tr>
<tr>
<td>Apply</td>
<td>Applies settings in the Preview list to the systems.</td>
</tr>
<tr>
<td>Cancel</td>
<td>Cancels settings in the Preview list.</td>
</tr>
</tbody>
</table>

### Information in the VOL Column

**CL3-A - 00 - 002 (00:07:02)**

1 Port that receives read and write requests from hosts.
2 In this example, read and write requests will be sent via the CL3-E port to the logical volume.
3 Group number of the host group. A host group is a group of hosts that issue read and write requests.
4 LUN (logical unit number).
5 Logical volume ID. Indicates the number of "UDS : CU : LUN".

### Information in The Paired VOL Column

**CL1-E - 02 - 70D (01:FE:F2)**

1 Port
2 Group number of the host group
3 LUN (logical unit number).
4 Logical volume ID. Indicates the number of "UDS : CU : LUN".
The Pair Operation window updates when you do one of the following:

- Click File > Refresh on the menu bar.
- Click Apply.
- Select another tab and then reselect the Pair Operation tab.
- Update the Display Filter dialog box.
- Click Previous or Next.
- Select Modify mode when you are in View mode.

**Detailed Information dialog box**

Use this dialog box to view details for a selected pair.

![Detailed Information dialog box](image)

**Paircreate dialog box**

Use this dialog box to create a pair.

See [Creating the initial copy on page 6-2](#) for complete information.
**Paircreate**

<table>
<thead>
<tr>
<th>Port-GID-LUN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P-VOL:</strong> CL3-A - 00 - 000 (00:FE:00)</td>
</tr>
<tr>
<td><strong>S-VOL:</strong> CL3-A</td>
</tr>
<tr>
<td><strong>Select Other S-VOL(s):</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mirror</th>
<th>Mirror ID</th>
<th>R-JNL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mirror:</strong> 001 [M]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CT Group:</strong> 000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**S/N, CTRLID, ID, Path**

<table>
<thead>
<tr>
<th>DKC :</th>
</tr>
</thead>
<tbody>
<tr>
<td>64545(00), 6(VSP), Default, Fibre</td>
</tr>
</tbody>
</table>

**Initial Copy:** Entire
**Priority:** 32
**Error Level:** Mirror

**M-JNL Information:**
- Current Mirror(s): 0
- Total Mirror(s): 0

---

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-VOL</td>
<td>Indicates a primary volume (P-VOL). The numbers are the port number, the GID, and the LUN of the primary data volume. Numbers in parentheses indicate the LDKC number, the CU number and the LDEV number. The GID is a group number for a host group. This column displays only one P-VOL even when two or more P-VOLs are selected in the Pair Operation window. P-VOL only displays the P-VOL that has the smallest volume number. A device ID ending with # indicates the volume is an external volume. A device ID ending in X (e.g., 00:00:3C X) indicates the LDEV is a Dynamic Provisioning virtual volume.</td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>S-VOL</td>
<td>Secondary volume. For information on selecting an S-VOL, see <a href="#">Creating the initial copy on page 6-2</a></td>
</tr>
<tr>
<td>Select Other S-VOL(s)</td>
<td>When multiple pairs being created, sets S-VOLs for other P-VOLs. For information on selecting multiple S-VOLs, see <a href="#">Creating the initial copy on page 6-2</a></td>
</tr>
<tr>
<td>Mirror</td>
<td>Mirror for the pair. Consists of the pair’s master and restore journals, and a mirror ID.</td>
</tr>
<tr>
<td></td>
<td>• M-JNL: The pair’s master journal. For a pair in a 3 UR DC multi-target configuration, information for the remote journal displays in the M-JNL field. A journal number ending in [M] indicates the journal can be used in a 3 UR DC configuration; for example, 001 [M].</td>
</tr>
<tr>
<td></td>
<td>• Mirror ID: The identifier for the mirror.</td>
</tr>
<tr>
<td></td>
<td>• R-JNL: The pair’s restore journal. Journal numbers used by URz do not display in M-JNL and R-JNL; only the journal numbers for UR display.</td>
</tr>
<tr>
<td>CT Group</td>
<td>The consistency group number displays. Registered consistency groups have an asterisk (*). An asterisk also displays if the consistency group is in the Preview list.</td>
</tr>
<tr>
<td>DKC</td>
<td>The serial number with the number of LDKC and the controller ID with the model name of the secondary system. This option also allows you to specify the ID (Path Gr. ID) and path type (channel type). The secondary system must be the same for all pairs being created during one operation.</td>
</tr>
<tr>
<td>Initial Copy</td>
<td>Options for starting the initial copy operation. The default is Entire.</td>
</tr>
<tr>
<td></td>
<td>• Entire: Initial copy starts after the pair is created. All data on the P-VOL is copied to the S-VOL.</td>
</tr>
<tr>
<td></td>
<td>• None: Initial copy does not start after the pair is created. P-VOL and S-VOL must be identical.</td>
</tr>
<tr>
<td></td>
<td>• Delta: Initial copy does not start after the pair is created. The status of the pair changes to HOLD or HOLDING (pair is intended for the delta resync). If the pair is created using HUS VM, [Delta] does not display.</td>
</tr>
<tr>
<td>Priority</td>
<td>Priority (scheduling order) of the initial copy operations (1-256), 32 is the default. For the details of the scheduling order of the initial copy for which the Priority is set, refer to <a href="#">Maximum initial copy operations and priorities on page 3-10</a>.</td>
</tr>
<tr>
<td>Error Level</td>
<td>The range used for splitting a pair when a failure occurs. The default is Mirror.</td>
</tr>
<tr>
<td></td>
<td>• Mirror: All pairs in the pair’s mirror are split.</td>
</tr>
<tr>
<td></td>
<td>• LU: Only the pair is split.</td>
</tr>
</tbody>
</table>
**Pairsplit-r dialog box**

Use this dialog box to split a pair.

See [Splitting pairs on page 6-7](#) for complete information.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
</table>
| S-VOL Write | Whether to permit hosts to write data to the S-VOL. The default is Disable (that is, do not permit):  
• Disable: Hosts cannot write data to the S-VOL while the pair is split.  
• Enable: Hosts can write data to the S-VOL while the pair is split. This option is available only when the selected volume is a P-VOL. |
| Range      | The split range for pairs in a consistency group. The default is LU if two or more pairs in the same mirror are selected. Otherwise, the default is Mirror.  
• LU: Splits only the specified pairs.  
• Mirror: Splits all pairs in the specified pair's mirror. |
| Suspend Mode | Options for handling update data that has not been copied to the S-VOL. The default is Flush:  
• Flush: Update data is copied to the S-VOL.  
• Purge: Update data is not copied to the S-VOL. |
| Set        | Applies the settings to the Preview list in the Pair Operation window.                                                                                                                                         |
| Cancel     | Discards the settings and closes the dialog box.                                                                                                                                                             |
**Pairresync dialog box**

Use this dialog box to resynchronize a pair.

See [Resynchronizing pairs on page 6-10](#) for complete information.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>The resynchronization range. The default is LU if two or more pairs in the same mirror are selected. Otherwise, the default is Mirror.</td>
</tr>
<tr>
<td></td>
<td>• LU: Resynchronizes only the specified pairs.</td>
</tr>
<tr>
<td></td>
<td>• Mirror: Resynchronizes all pairs in the specified pairs’ mirror.</td>
</tr>
<tr>
<td>Priority</td>
<td>Specify the desired priority (1-256) (scheduling order) for the pair-restoring operations. If Range is Mirror, you cannot change the Priority option.</td>
</tr>
<tr>
<td>DKC</td>
<td>Indicates the followings about a remote system.</td>
</tr>
<tr>
<td></td>
<td>• The serial number with the LDKC number.</td>
</tr>
<tr>
<td></td>
<td>• The controller ID with the model name.</td>
</tr>
<tr>
<td></td>
<td>• ID (Path Gr. ID)</td>
</tr>
<tr>
<td></td>
<td>• The path type.</td>
</tr>
<tr>
<td>Resync Mode</td>
<td>Indicates the processing after recovery of the pairs.</td>
</tr>
<tr>
<td></td>
<td>• Normal: Split pair whose status is PSUS or PSUE is recovered.</td>
</tr>
<tr>
<td></td>
<td>• Delta: Delta resync operation is performed.</td>
</tr>
<tr>
<td></td>
<td>• Return to standby: The status of pairs is recovered from HLDE to HOLD.</td>
</tr>
<tr>
<td>Error Level</td>
<td>Options for splitting pairs when a failure occurs.</td>
</tr>
<tr>
<td></td>
<td>• Mirror: All pairs in the failed pairs’ mirror are split.</td>
</tr>
<tr>
<td></td>
<td>• LU: Only the failed pair is split.</td>
</tr>
<tr>
<td></td>
<td>If Range is Mirror, Error Level cannot be changed.</td>
</tr>
<tr>
<td>Set</td>
<td>Applies the settings to the Preview list in the Pair Operation window.</td>
</tr>
<tr>
<td>Cancel</td>
<td>Discards the settings and closes the dialog box.</td>
</tr>
</tbody>
</table>

**Pairsplit-S dialog box**

Use this dialog box to delete a pair.
See **Deleting pairs on page 6-13** for complete information.

![Pair split-S dialog box](image)

**Change Pair Option dialog box**

Use this dialog box to change the Error Level, which is used for splitting a pair when a failure occurs.

See **Pair maintenance—changing the pair-split option on page 8-2** for complete instructions.

![Change Pair Option dialog box](image)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
</table>
| Error Level| Options for splitting pairs when failure occurs:  
- Mirror: If a failure occurs with a pair, all pairs in the selected pair’s mirror are split.  
- LU: If a failure occurs with a pair, only the pair is split. |

**Item** | **Description** |
|---------|-----------------|
| Range   | The release range. The default is LU if two or more pairs in the same mirror are selected. Otherwise, the default is Mirror.  
- LU: Deletes only the specified pairs.  
- Mirror: Deletes all pairs in the selected pair’s mirror. |
| Delete Mode | Options for releasing pairs.  
- Force: The pairs are forcibly released even if the primary system cannot communicate with the secondary system.  
  If Force is specified when pair status is other than SMPL, Range is automatically reset to Mirror.  
- Normal: The pairs are released only if the primary system can change the status of both P-VOLs and S-VOLs to SMPL.  
  The default is Force if pair status is SMPL or Deleting. Otherwise, the default is Normal |
| Set     | Applies the settings to the Preview list in the Pair Operation window. |
| Cancel  | Discards the settings and closes the dialog box. |
**Display Filter dialog box**

Use this dialog box to filter pair information shown on the Pair Operation window.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set</td>
<td>Applies the settings to the Preview list in the Pair Operation window.</td>
</tr>
<tr>
<td>Cancel</td>
<td>Discards the settings and closes the dialog box.</td>
</tr>
</tbody>
</table>

### Display Filter

- **GID**
  - ALL

- **Journal**
  - ALL

- **Mirror**
  - ALL

- **P-VOL/S-VOL**
  - ALL

- **CLPR**
  - ALL

- **Internal/External VOL**
  - ALL

- **Status**
  - SMPL
  - COPY
  - PAIR
  - PSUS/PSUE
  - Suspending
  - Deleting
  - HOLD
  - HLDE
  - HOLDING

- **Reset**
- **Set**
- **Cancel**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GID</td>
<td>The host group’s Group ID. All shows all host groups.</td>
</tr>
<tr>
<td>Journal</td>
<td>List of journals. All shows all journals.</td>
</tr>
<tr>
<td>Mirror</td>
<td>List of mirrors. All shows all mirrors.</td>
</tr>
<tr>
<td>P-VOL/S-VOL</td>
<td>The type of pair volume, P-VOL or S-VOL.</td>
</tr>
<tr>
<td>CLPR</td>
<td>The cache logical partition, which is used to segment cache assigned to parity groups. All, shows all CLPRs display.</td>
</tr>
<tr>
<td>Internal/External VOL</td>
<td>Internal volumes or external volumes. All shows both kinds.</td>
</tr>
<tr>
<td>Status</td>
<td>Storage Navigator pair status or statuses. (CCI statuses are not displayed.)</td>
</tr>
<tr>
<td>Reset</td>
<td>Restores all options to the defaults.</td>
</tr>
<tr>
<td>Set</td>
<td>Applies the settings to the Preview list in the Pair Operation window.</td>
</tr>
<tr>
<td>Cancel</td>
<td>Discards the settings and closes the dialog box.</td>
</tr>
</tbody>
</table>
DKC Operation window

Use this window to view details about the remote systems, logical paths between systems, and ports on the local system.

You can perform these procedures from the window:

- Configuring local and remote systems for UR on page 5-3
- Configuring additional logical paths on page 5-7
- View one of the following:
  - Remote systems information on page E-26
  - Logical Path Information on page E-27
  - Port Information for the local system on page E-27

Note: DKC is an acronym for disk controller, which controls an entire system. UR windows use the term "DKC" to indicate a system.

LDKC is an acronym for logical disk controller, and it also may be called logical DKC. LDKC is a controller that controls a logical system that exists in VSP. In the UR window, the term “LDKC” indicates a logical system.

Information on the DKC Operation window is updated when you do one of the following:

- Click File > Refresh on the menu bar.
- Click Apply
- Select another tab and then reselect the DKC Operation tab.
- Close the DKC Status window.
- Select Modify mode when you are in View mode.
### Universal Replicator DKC Operation

#### Display
- **DKC**
- **Port**

- **Description**
  - Display Changes information in the DKC Operation window.
  - DKC shows information about the remote systems and the logical paths.
  - Port shows information about ports on the local system.

- **Tree**
  - Shows either of the following, depending on the selection in Display.
  - Remote systems.
  - Channel adapters on the local system and port attributes.

- **List**
  - Shows information about one of the following, depending on what is selected in Display and Tree:
    - Logical paths. See Logical Path Information on page E-27.
    - Ports on the local system. See Port Information for the local system on page E-27.

- **Preview**
  - Shows changes made in the window before they are applied to the system. You can modify or delete by right-clicking on an item. When the information is correct, click Apply.

- **Operation**
  - Indicates the operation in progress in the DKC Operation window.
Remote systems information

The list area on the DKC Operation window shows information about the remote system when you select DKC in the Display box and the LDKC in the tree.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
</table>
| Tree  | Lists the remote systems of each LDKC in the local system. The following information appears to the right of the remote system’s icon:  
  - Controller ID of the remote system (The model name of the remote system).  
  - Serial number of the remote system.  
  - Path group ID.  
  
  Note: The LDKC#01 cannot be used in this version of the UR software.  
  
  The icon indicates the status of logical paths between the local system and the remote system:  
  - All the logical paths are in normal status.  
  - A failure occurred at some of the logical paths. |
| Operation | Shows information about the selected remote system:  
  - Controller ID: The controller ID and the model name of the system of a remote system. Note the following controller IDs: VSP G1000 = 7, VSP = 6, USP V/VM = 5, TagmaStore USP/TagmaStore NSC = 4, HUS VM = 19.  
  
  The icon indicates the status of logical paths between the local system and the remote system:  
  - All the logical paths are in normal status.  
  - A failure occurred at some of the logical paths.  
  - S/N (LDKC): The 5 or 6-digit serial number and the LDKC number of the remote system. When the remote system is USP V/VM, "00" appears as the LDKC number.  
  - Path Gr. ID: The path group ID.  
  - M-R Path: The channel type of the logical paths between the local system and the remote system. This column always shows Fiber.  
  - Status: Indicates whether logical paths fail.  
  - Normal: No failure occurs to the logical paths  
  - Failed: All the logical paths fail.  
  - Warning: Some of the logical paths fail.  
  - Num of Path: The number of logical paths. |
 Logical Path Information

The list area on the DKC Operation window shows information about logical paths between ports on the local and remote systems when you select DKC in the Display box and the remote system in the tree.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path Gr. ID</td>
<td>The path group ID. The icon indicates the status of the path:</td>
</tr>
<tr>
<td></td>
<td>- The logical path is in normal status</td>
</tr>
<tr>
<td></td>
<td>- A failure occurred at the logical path</td>
</tr>
<tr>
<td>M-R Path</td>
<td>The channel type of the logical paths between the local system and the</td>
</tr>
<tr>
<td></td>
<td>remote system. This column always indicates Fiber.</td>
</tr>
<tr>
<td>Status</td>
<td>Indicates whether the logical path is normal or failed.</td>
</tr>
<tr>
<td></td>
<td>- Normal: The logical path is in normal status. No failure occurs at the</td>
</tr>
<tr>
<td></td>
<td>logical path</td>
</tr>
<tr>
<td></td>
<td>- Failed: A failure occurs at the logical path.</td>
</tr>
<tr>
<td></td>
<td>More in depth status information can be viewed in the DKC Status dialog</td>
</tr>
<tr>
<td></td>
<td>box on page E-29.</td>
</tr>
<tr>
<td>Port</td>
<td>The port number of the local system.</td>
</tr>
<tr>
<td>Pair-Port</td>
<td>The port number of the remote system.</td>
</tr>
</tbody>
</table>

Port Information for the local system

The list area on the DKC Operation window shows port information when you select Port in the Display box and one of the following in the tree.

- Select Storage System. The list shows all the ports on the local system.
- Select a channel adapter. The list shows ports on the channel adapter.
- Select a port attribute. The list shows ports that have the selected port attribute.
### Universal Replicator DKC Operation

#### Display
- DKC
- Port

#### Tree
- Channel adapter (fibre-channel interface)
- Target port
- RCU target port
- Initiator port
- External port
- Port in initiator/external mix mode

#### Operation
- Port: Port number.
- Attribute: Port attribute (i.e., initiator, target, RCU target, or external).

#### Table

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree</td>
<td>The channel adapters and ports on the local system. The following information appears to the right of the icon:</td>
</tr>
<tr>
<td></td>
<td>- Channel adapter (fibre-channel interface)</td>
</tr>
<tr>
<td></td>
<td>- Target port</td>
</tr>
<tr>
<td></td>
<td>- RCU target port</td>
</tr>
<tr>
<td></td>
<td>- Initiator port</td>
</tr>
<tr>
<td></td>
<td>- External port</td>
</tr>
<tr>
<td></td>
<td>- Port in initiator/external mix mode</td>
</tr>
<tr>
<td>Operation</td>
<td>The ports on the local system:</td>
</tr>
<tr>
<td></td>
<td>- Port: Port number.</td>
</tr>
<tr>
<td></td>
<td>- Attribute: Port attribute (i.e., initiator, target, RCU target, or external).</td>
</tr>
</tbody>
</table>

---

Hitachi Virtual Storage Platform Hitachi Universal Replicator User Guide

E–28  GUI reference
**DKC Status dialog box**

Use this dialog box to view status and other information about the logical path.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Number of the row.</td>
</tr>
</tbody>
</table>
### Path Status

Status of a logical path.

- **Normal.** The path is established and ready to use for copy operations.
- **In Progress.** An operation for configuring or deleting the path is in progress.
- **Initialization Failed.** An error occurred when the connection between local and remote systems was initializing. The probable causes are:
  - No cable is connected to the local system.
  - No cable is connected to the remote system.
  - No cable is connected to the network device between the two systems.
- **Communication Time Out.** This status indicates one of the following:
  - A timeout error has occurred between the primary and the secondary systems.
  - A logic error is detected between the primary and the secondary systems.
- **Port Rejected.** The local system rejected configuration of the logical path connection. Logical path resources in the local system might be in use for other connections.
- **Pair Port Rejected.** The remote system rejected configuration of the logical path connection. Logical path resources in the remote system might be in use for other connections.
- **Serial Number Mismatch.** The serial number of the system connected to this logical path does not match the serial number specified by the Add DKC dialog box.
- **Invalid Port Mode.** The port is not an initiator port.
- **Pair-Port Number Mismatch.** Indicates one of the following:
  - The specified port number is incorrect.
  - The port in the remote system is physically disconnected from the local system.
- **Pair-Port Type Mismatch.** The port on the remote system is not an RCU target port.
- **Communication Failed.** A communication timeout error has occurred on the path between the local and remote systems.

### Table

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port</td>
<td>Port on the local system.</td>
</tr>
<tr>
<td>Pair-Port</td>
<td>Port on the remote system.</td>
</tr>
<tr>
<td>S/N</td>
<td>Serial number and LDKC number of the remote system.</td>
</tr>
<tr>
<td>Controller ID</td>
<td>Controller ID and model name (in parenthesis) for the remote system.</td>
</tr>
<tr>
<td>Path Gr. ID</td>
<td>Path group ID</td>
</tr>
<tr>
<td>M-R Path</td>
<td>Type of channel interface between local and remote systems. Always displays column displays “Fibre”.</td>
</tr>
<tr>
<td>Minimum Paths</td>
<td>Minimum possible number of paths between the local and the remote systems.</td>
</tr>
<tr>
<td>RIO MIH</td>
<td>Remote I/O missing interrupt handler timer value—the wait time for data transfer from the local to remote system to complete.</td>
</tr>
</tbody>
</table>
Add DKC dialog box

Use this dialog box to configure local and remote systems for Universal Replicator pairs.

See Configuring local and remote systems for UR on page 5-3 for complete information.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DKC Registered</td>
<td>Date and time when local and remote systems were associated to each other</td>
</tr>
<tr>
<td>Last Updated</td>
<td>Date and time the last operation on a logical path to the remote system was performed.</td>
</tr>
<tr>
<td>Refresh the DKC Operation tab after this panel is closed</td>
<td>When clicked, the DKC Operation window refreshes when it rediscplays.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S/N</td>
<td>Remote system 5 or 6-digit serial number. (Virtual storage machine serial numbers used with VSP G1000 display physical information, not virtual, when viewed from a VSP).</td>
</tr>
<tr>
<td>LDKC</td>
<td>Remote system LDKC number, 00 for USP V/VM.</td>
</tr>
<tr>
<td>Controller ID</td>
<td>Remote system controller ID: 7 for VSP G1000, 6 for VSP, 5 for USP V/VM, 4 for TagmaStore USP/TagmaStore NSC, 19 for HUS VM.</td>
</tr>
</tbody>
</table>
DKC Option dialog box

Use this dialog box to specify data transfer threshold time.

See Modifying data-transfer time threshold on page 8-10 for complete information.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path Gr. ID</td>
<td>ID for the path group, which is a group of multiple logical paths. For more information, see the Path group item in System requirements on page 2-2.</td>
</tr>
<tr>
<td>M-R Path</td>
<td>Logical path between local and remote systems.</td>
</tr>
<tr>
<td></td>
<td>• Port: local system initiator port.</td>
</tr>
<tr>
<td></td>
<td>• Pair-Port: remote system RCU target port.</td>
</tr>
<tr>
<td>Option</td>
<td>Opens DKC Option dialog box.</td>
</tr>
</tbody>
</table>

Usage Monitor window

Use this window to monitor remote copy operations data and I/O statistics.

See Monitoring copy operations data, I/O with Usage Monitor on page 7-11 for complete information.
History window

Use this window to:

- View the history of operations performed on pairs, and the data associated with each operation
- Export operations history on page E-38
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
</table>
| Status             | The current status of operation history:  
  • No history file exists: Operation history does not exist.  
  • Reading a history file failed: An attempt to read operation history failed.  
  • Updating ... n (%): Updating of operation history is now in progress, where "n (%)" indicates the progress (in %). When the updating is in progress, the checking process automatically continues until updating finishes. The updating process is checked at 10-second intervals.  
  • Complete: Updating of operation history has completed.                                                                                                                                                                                                                                                                                             |
| Last Update Time   | The date and time when operation history was last updated.                                                                                                                                                                                                                                                                                     |
| Page               | The number of the current page and the total number of pages. The display format of Page is "the number of current page / total number of pages". If there is no history file, nothing appears.                                                                                                                                                                      |
| Export             | Saves operation history in a CSV file. You cannot save the history file while operation history is being updated. Save operation history in a text file after operation history is updated. For more information, see Export operations history on page E-38.                                                                                                                                  |
Operations in History window

Copy operations have a beginning and end. These parts of the overall operations are detailed in the History window, and described here.

<table>
<thead>
<tr>
<th>Operation Displayed</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair definition</td>
<td>A pair was defined.</td>
</tr>
<tr>
<td>Paircreate Start</td>
<td>Creation of the pair was started.</td>
</tr>
<tr>
<td>Paircreate Complete</td>
<td>Creation of the pair was finished.</td>
</tr>
<tr>
<td>Pairresync Start</td>
<td>Restoring of the pair was started.</td>
</tr>
<tr>
<td>Pairresync Complete</td>
<td>Restoring of the pair was finished.</td>
</tr>
<tr>
<td>Pairsplit-r Start</td>
<td>Splitting (Suspending) of the pair was started.</td>
</tr>
<tr>
<td>Pairsplit-r Complete</td>
<td>Splitting (Suspending) of the pair was finished.</td>
</tr>
</tbody>
</table>

Related Topics

- Information about field behavior is shown in History window notes on page E-37.
- Descriptions of the pair operations seen in the window are provided in Operations in History window on page E-35.
<table>
<thead>
<tr>
<th>Operation Displayed</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pairsplit-r(FAILURE)</td>
<td>The pair was split (suspended) because of a failure.</td>
</tr>
<tr>
<td>Pairsplit-S Start</td>
<td>Release of the pair was started.</td>
</tr>
<tr>
<td>Pairsplit-S Complete</td>
<td>Release of the pair was finished.</td>
</tr>
<tr>
<td>Status Change by MCU(SMPL to COPY)</td>
<td>The status of the pair was changed from SMPL to COPY because of an operation</td>
</tr>
<tr>
<td></td>
<td>from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(SMPL to PAIR)</td>
<td>The status of the pair was changed from SMPL to PAIR because of an operation</td>
</tr>
<tr>
<td></td>
<td>from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(COPY to PAIR)</td>
<td>The status of the pair was changed from COPY to PAIR because of an operation</td>
</tr>
<tr>
<td></td>
<td>from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(COPY to PSUS/PSUE)</td>
<td>The status of the pair was changed from COPY to PSUS or PSUE because of an</td>
</tr>
<tr>
<td></td>
<td>operation from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(PAIR to PSUS/PSUE)</td>
<td>The status of the pair was changed from PAIR to PSUS or PSUE because of an</td>
</tr>
<tr>
<td></td>
<td>operation from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(PAIR to SMPL)</td>
<td>The status of the pair was changed from PAIR to SMPL because of an operation</td>
</tr>
<tr>
<td></td>
<td>from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(COPY to SMPL)</td>
<td>The status of the pair was changed from COPY to SMPL because of an operation</td>
</tr>
<tr>
<td></td>
<td>from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(PSUS/PSUE to SMPL)</td>
<td>The status of the pair was changed from PSUS or PSUE to SMPL because of an</td>
</tr>
<tr>
<td></td>
<td>operation from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(PSUS/PSUE to COPY)</td>
<td>The status of the pair was changed from PSUS or PSUE to COPY because of an</td>
</tr>
<tr>
<td></td>
<td>operation from the primary system.</td>
</tr>
<tr>
<td>Status Change by RCU(Pairsplit-r Start)</td>
<td>The status of the pair was changed because an operation for splitting a pair</td>
</tr>
<tr>
<td></td>
<td>started at the secondary system.</td>
</tr>
<tr>
<td>Status Change by RCU(Pairsplit-r Complete)</td>
<td>The status of the pair was changed because an operation for splitting a pair</td>
</tr>
<tr>
<td></td>
<td>finished at the secondary system.</td>
</tr>
<tr>
<td>Status Change by RCU(PSUS/PSUE to SMPL; Pairsplit-S Start)</td>
<td>An operation for releasing a pair has been started at the secondary system.</td>
</tr>
<tr>
<td></td>
<td>The status of the pair will change from PSUS or PSUE to SMPL.</td>
</tr>
<tr>
<td>Status Change by RCU(COPY to SMPL; Pairsplit-S Start)</td>
<td>An operation for releasing a pair has been started at the secondary system.</td>
</tr>
<tr>
<td></td>
<td>The status of the pair will change from COPY to SMPL.</td>
</tr>
<tr>
<td>Status Change by RCU(PAIR to SMPL; Pairsplit-S Start)</td>
<td>An operation for releasing a pair has been started at the secondary system.</td>
</tr>
<tr>
<td></td>
<td>The status of the pair will change from PAIR to SMPL.</td>
</tr>
</tbody>
</table>
History window notes

- The operation rows may not appear in chronological descending order. To sort the information in descending (or ascending) order, click a heading.
- The history file always contains the most recent operations up to a maximum of 524,288 operations. Information older than seven days is not shown.
- If a failure occurred with two or more pairs at the same time, the number of pairs showing Pairsplit-r(Failure) or Ready for Delta resync(Failure) may not match the actual number of pairs in which the failure occurs.
- If a pair consists of LUSE volumes, the list shows only the top LDEV numbers of the LUSE volumes.
- The copy time might not be shown in the Copy Time column, even though Paircreate Complete or Pairresync Complete is shown in the Operation column. In such case, you can review the copy time in the volume list in the Pair Operation window.

<table>
<thead>
<tr>
<th>Operation Displayed</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status Change by RCU(Pairsplit-S Complete)</td>
<td>The status of the pair was changed because an operation for releasing a pair finished at the secondary system.</td>
</tr>
<tr>
<td>Ready for Delta resync</td>
<td>A pair became ready for delta resync.</td>
</tr>
<tr>
<td>Ready for Delta resync(Failure)</td>
<td>The failure occurred with the pair which was ready for delta resync.</td>
</tr>
<tr>
<td>Status Change for Delta resync</td>
<td>The status of the P-VOL was changed to HOLD because of a delta resync operation.</td>
</tr>
<tr>
<td>Status Change by MCU(SMPL to HOLD)</td>
<td>The status of the pair was changed from SMPL to HOLD because of an operation from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(HOLD to PAIR)</td>
<td>The status of the pair was changed from HOLD to PAIR because of an operation from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(HOLD to COPY)</td>
<td>The status of the pair was changed from HOLD to COPY because of an operation from the primary system.</td>
</tr>
<tr>
<td>Status Change by MCU(HOLD to SMPL)</td>
<td>The status of the pair was changed from HOLD to SMPL because of an operation from the primary system.</td>
</tr>
<tr>
<td>Status Change by RCU(HOLD to SMPL; Pairsplit-S Start)</td>
<td>An operation for releasing a pair has been started at the secondary system. The status of the pair will change from HOLD to SMPL.</td>
</tr>
<tr>
<td>Status Change to HOLD</td>
<td>The status of the S-VOL was changed to HOLD because of a delta resync operation.</td>
</tr>
<tr>
<td>Unknown</td>
<td>The system could not identify the type of the operation.</td>
</tr>
</tbody>
</table>
Export operations history

Use the History window Export function to save operation history to a CSV file.

The following is an example of an exported text file.

| 2007/02/22 09:57:54,Paircreate Complete,01,01,00:02:01,00:02:04,--,-,000:01:08 |
| 2007/02/22 09:56:46,Paircreate Start,01,01,00:02:01,00:02:04,--,-, |
| 2007/02/22 09:56:46,Pair definition,01,01,00:02:01,00:02:04,--,-, |

(1) (2) (3)(4)(5)(6)(7)(8)

(1) Data and time when the operation finished.
(2) Operation.
(3) Journal number
(4) Mirror ID
(5) LDKC number, CU number and LDEV number of the volume in the local system (LDKC : CU : LDEV).
(6) LDKC number, CU number and LDEV number of the volume in the remote system (LDKC : CU : LDEV).
(7) Extended consistency group number (used only with URz). If no EXCTG, hyphens(- -) display.
(8) Time taken for copying (from the start to the end of copying). Time is provided only when the operation (refer to (2)) is Paircreate Complete or Pairresync Complete.

Optional Operation window

In this window you change the number of volumes on which the initial copy operation is performed concurrently.

See Specifying number of concurrent initial/resync copies on page 5-8 for complete information.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree</td>
<td>Provides access to the system. Select Storage System.</td>
</tr>
<tr>
<td>Activities</td>
<td>System option settings.</td>
</tr>
<tr>
<td>Preview</td>
<td>When you change settings in the Optional Operation window, the Preview list shows the changes. Here, the changes have not been applied to the system. Clicking Apply applies the changes to the system.</td>
</tr>
<tr>
<td>Operation</td>
<td>Indicates the operation that will occur when you click Apply.</td>
</tr>
<tr>
<td></td>
<td>• Change System Option: Change system options.</td>
</tr>
<tr>
<td></td>
<td>• Blank: Nothing will occur when you click Apply.</td>
</tr>
<tr>
<td>Preview</td>
<td>The number to the left of the slash (/) indicates the number of items (i.e., rows) appearing in the Preview list. The number to the right of the slash indicates the maximum number of items (i.e., rows) that can appear in the Preview list.</td>
</tr>
<tr>
<td>Apply</td>
<td>Applies settings in the Preview list to the system.</td>
</tr>
<tr>
<td>Cancel</td>
<td>Cancels the settings in the Preview list.</td>
</tr>
</tbody>
</table>
Glossary

This glossary defines the special terms used in this document. Click the letter links below to navigate.

#

2DC
two-data-center. Refers to the local and remote sites, or data centers, in which TrueCopy (TC) and Universal Replicator (UR) combine to form a remote replication configuration.

In a 2DC configuration, data is copied from a TC primary volume at the local site to the UR master journal volume at an intermediate site, then replicated to the UR secondary volume at the remote site. Since this configuration side-steps the TC secondary volume at the intermediate site, the intermediate site is not considered a data center.

3DC
three-data-center. Refers to the local, intermediate, and remote sites, or data centers, in which TrueCopy and Universal Replicator combine to form a remote replication configuration.

In a 3DC configuration, data is copied from a local site to an intermediate site and then to a remote site (3DC cascade configuration), or from a local site to two separate remote sites (3DC multi-target configuration).

A

alternate path
A secondary path (port, target ID, LUN) to a logical volume, in addition to the primary path, that is used as a backup in case the primary path fails.
array
   Another name for a RAID storage system.

array group
   See RAID group.

async
   asynchronous

at-time split
   Consistency group operation that performs multiple pairsplit operations at a pre-determined time.

audit log
   Files that store a history of the operations performed from SN and the service processor (SVP), commands that the storage system received from hosts, and data encryption operations.

B

base emulation type
   Emulation type that is set when drives are installed. Determines the device emulation types that can be set in the RAID group.

BC
   business continuity

BCM
   Business Continuity Manager

blade
   A computer module, generally a single circuit board, used mostly in servers.

BLK, blk
   block

bmp
   bitmap

C

C/T
   See consistency time (C/T).
ca

cache

cache logical partition (CLPR)

Consists of virtual cache memory that is set up to be allocated to different hosts in contention for cache memory.

capacity

The amount of data storage space available on a physical storage device, usually measured in bytes (MB, GB, TB, etc.).

cascade configuration

In a 3DC cascade configuration for remote replication, data is copied from a local site to an intermediate site and then to a remote site using TrueCopy and Universal Replicator. See also 3DC.

In a ShadowImage cascade configuration, two layers of secondary volumes can be defined for a single primary volume. Pairs created in the first and second layer are called cascaded pairs.

cascade function

A ShadowImage function for open systems where a primary volume (P-VOL) can have up to nine secondary volumes (S-VOLs) in a layered configuration. The first cascade layer (L1) is the original ShadowImage pair with one P-VOL and up to three S-VOLs. The second cascade layer (L2) contains ShadowImage pairs in which the L1 S-VOLs are functioning as the P-VOLs of layer-2 ShadowImage pairs that can have up to two S-VOLs for each P-VOL.

See also root volume, node volume, leaf volume, level-1 pair, and level-2 pair.

cascaded pair

A ShadowImage pair in a cascade configuration. See cascade configuration.

shared volume

A volume that is being used by more than one replication function. For example, a volume that is the primary volume of a TrueCopy pair and the primary volume of a ShadowImage pair is a shared volume.

CCI

Command Control Interface

CFL

Configuration File Loader. A SN function for validating and running scripted spreadsheets.
CFW
  cache fast write

CG
  See consistency group (CTG).

CTG
  See consistency group (CTG).

CH
  channel

channel path
  The communication path between a channel and a control unit. A channel path consists of the physical channel path and the logical path.

CHAP
  challenge handshake authentication protocol

CL
  cluster

CLI
  command line interface

CLPR
  cache logical partition

cluster
  Multiple-storage servers working together to respond to multiple read and write requests.

command device
  A dedicated logical volume used only by Command Control Interface and Business Continuity Manager to interface with the storage system. Can be shared by several hosts.

configuration definition file
  Defines the configuration, parameters, and options of Command Control Interface operations. A text file that defines the connected hosts and the volumes and groups known to the Command Control Interface instance.
**consistency group (CG, CTG)**
A group of pairs on which copy operations are performed simultaneously; the pairs’ status changes at the same time. See also *extended consistency group (EXCTG).*

**consistency time (C/T)**
Shows a time stamp to indicate how close the target volume is to the source volume. C/T also shows the time stamp of a journal and extended consistency group.

**controller**
The component in a storage system that manages all storage functions. It is analogous to a computer and contains a processor, I/O devices, RAM, power supplies, cooling fans, and other sub-components as needed to support the operation of the storage system.

**copy-on-write**
Point-in-time snapshot copy of any data volume within a storage system. Snapshots store only changed data blocks, therefore the amount of storage capacity required for each copy is substantially smaller than the source volume.

**copy pair**
A pair of volumes in which one volume contains original data and the other volume contains the copy of the original. Copy operations can be synchronous or asynchronous, and the volumes of the copy pair can be located in the same storage system (local copy) or in different storage systems (remote copy).

A copy pair can also be called a volume pair, or just pair.

**COW**
copy-on-write

**COW Snapshot**
Hitachi Copy-on-Write Snapshot

**CTG**
See *consistency group (CTG).*

**CTL**
controller

**CU**
control unit
currency of data
The synchronization of the volumes in a copy pair. When the data on the secondary volume (S-VOL) is identical to the data on the primary volume (P-VOL), the data on the S-VOL is current. When the data on the S-VOL is not identical to the data on the P-VOL, the data on the S-VOL is not current.

CYL, cyl
cylinder

cylinder bitmap
Indicates the differential data (updated by write I/Os) in a volume of a split or suspended copy pair. The primary and secondary volumes each have their own cylinder bitmap. When the pair is resynchronized, the cylinder bitmaps are merged, and the differential data is copied to the secondary volume.

D

DASD
direct-access storage device

data consistency
When the data on the secondary volume is identical to the data on the primary volume.

data path
The physical paths used by primary storage systems to communicate with secondary storage systems in a remote replication environment.

data pool
One or more logical volumes designated to temporarily store original data. When a snapshot is taken of a primary volume, the data pool is used if a data block in the primary volume is to be updated. The original snapshot of the volume is maintained by storing the to-be-changed data blocks in the data pool.

DB
database

DBMS
database management system
**delta resync**
A disaster recovery solution in which TrueCopy and Universal Replicator systems are configured to provide a quick recovery using only differential data stored at an intermediate site.

**device**
A physical or logical unit with a specific function.

**device emulation**
Indicates the type of logical volume. Mainframe device emulation types provide logical volumes of fixed size, called logical volume images (LVIs), which contain EBCDIC data in CKD format. Typical mainframe device emulation types include 3390-9 and 3390-M. Open-systems device emulation types provide logical volumes of variable size, called logical units (LUs), that contain ASCII data in FBA format. The typical open-systems device emulation type is OPEN-V.

**DEVN**
device number

**DFW**
DASD fast write

**DHCP**
dynamic host configuration protocol

**differential data**
Changed data in the primary volume not yet reflected in the copy.

**disaster recovery**
A set of procedures to recover critical application data and processing after a disaster or other failure.

**disk array**
Disk array, or just array, is another name for a RAID storage system.

**disk controller (DKC)**
The hardware component that manages front-end and back-end storage operations. The term DKC is sometimes used to refer to the entire RAID storage system.

**DKC**
disk controller. Can refer to the RAID storage system or the controller components.
**DKCMAIN**

disk controller main. Refers to the microcode for the RAID storage system.

**DKP**

disk processor. Refers to the microprocessors on the back-end director features of the Universal Storage Platform V.

**DKU**

disk unit. Refers to the cabinet (floor model) or rack-mounted hardware component that contains data drives and no controller components.

**DMP**

Dynamic Multi Pathing

**DRU**

Hitachi Data Retention Utility

**DP-VOL**

Dynamic Provisioning-virtual volume. A virtual volume with no memory space used by Dynamic Provisioning.

**dynamic provisioning**

An approach to managing storage. Instead of “reserving” a fixed amount of storage, it removes capacity from the available pool when data is actually written to disk. Also called thin provisioning.

**E**

**EC**

error code

**emulation**

The operation of the Hitachi RAID storage system to emulate the characteristics of a different storage system. For device emulation the mainframe host “sees” the logical devices on the RAID storage system as 3390-x devices. For controller emulation the mainframe host “sees” the control units (CUs) on the RAID storage system as 2105 or 2107 controllers.

RAID storage system operates the same as the storage system being emulated.

**emulation group**

A set of device emulation types that can be intermixed within a RAID group and treated as a group.
env.
    environment

ERC
    error reporting communications

ESCON
    Enterprise System Connection

EXCTG
    See extended consistency group (ECTG).

EXG
    external volume group

ext.
    external

extended consistency group (EXCTG)
    A set of Universal Replicator for Mainframe journals in which data consistency is guaranteed. When performing copy operations between multiple primary and secondary storage systems, the journals must be registered in an EXCTG.

external application
    A software module that is used by a storage system but runs on a separate platform.

external port
    A fibre-channel port that is configured to be connected to an external storage system for Universal Volume Manager operations.

external volume
    A logical volume whose data resides on drives that are physically located outside the Hitachi storage system.

F

failback
    The process of switching operations from the secondary path or host back to the primary path or host, after the primary path or host has recovered from failure. See also failover.
failover
The process of switching operations from the primary path or host to a secondary path or host when the primary path or host fails.

FBA
fixed-block architecture

FC
fibre channel; FlashCopy

FCA
fibre-channel adapter

FC-AL
fibre-channel arbitrated loop

FCIP
fibre-channel internet protocol

FCP
fibre-channel protocol

FCSP
fibre-channel security protocol

FIBARC
Fibre Connection Architecture

FICON
Fibre Connectivity

FIFO
first in, first out

free capacity
The amount of storage space (in bytes) that is available for use by the host systems.

FSW
fibre switch

FTP
file-transfer protocol
FV
   fixed-size volume

FWD
   fast-wide differential

G

GID
   group ID

GUI
   graphical user interface

H

HA
   high availability

HACMP
   High Availability Cluster Multi-Processing

HAM
   Hitachi High Availability Manager

HDLM
   Hitachi Dynamic Link Manager

HDP
   Hitachi Dynamic Provisioning

HDS
   Hitachi Data Systems

HDT
   Hitachi Dynamic Tiering

HDvM
   Hitachi Device Manager

HGLAM
   Hitachi Global Link Availability Manager
H-LUN
host logical unit

HOMRCF
Hitachi Open Multi-RAID Coupling Feature. Another name for Hitachi ShadowImage.

HORC
Hitachi Open Remote Copy. Another name for Hitachi TrueCopy.

HORCM
Hitachi Open Remote Copy Manager. Another name for Command Control Interface.

host failover
The process of switching operations from one host to another host when the primary host fails.

host group
A group of hosts of the same operating system platform.

host mode
Operational modes that provide enhanced compatibility with supported host platforms. Used with fibre-channel ports on RAID storage systems.

host mode option
Additional options for fibre-channel ports on RAID storage systems. Provide enhanced functionality for host software and middleware.

HRC
Hitachi Remote Copy. Another name for Hitachi TrueCopy for IBM z/OS.

HRpM
Hitachi Replication Manager

HSCS
Hitachi Storage Command Suite. This suite of products is now called the Hitachi Command Suite.

HUR
Hitachi Universal Replicator
**HXRC**

Hitachi Extended Remote Copy. Another name for Hitachi Compatible Replication for IBM XRC.

**I**

**iFCP**

internet fibre-channel protocol

**IML**

initial microcode load; initial microprogram load

**IMPL**

initial microprogram load

**initial copy**

An initial copy operation is performed when a copy pair is created. Data on the primary volume is copied to the secondary volume.

**initiator port**

A fibre-channel port configured to send remote I/Os to an RCU target port on another storage system. See also RCU target port and target port.

**in-system replication**

The original data volume and its copy are located in the same storage system. ShadowImage in-system replication provides duplication of logical volumes; Copy-on-Write Snapshot in-system replication provides “snapshots” of logical volumes that are stored and managed as virtual volumes (V-VOLs).

See also remote replication.

**intermediate site (I-site)**

A site that functions as both a TrueCopy secondary site and a Universal Replicator primary site in a 3-data-center (3DC) cascading configuration.

**internal volume**

A logical volume whose data resides on drives that are physically located within the storage system. See also external volume.

**IO, I/O**

input/output
**IOPS**
I/Os per second

**IP**
internet protocol

**IPL**
initial program load

**J**

**JNL**
journal

**JNLG**
journal group

**journal group (JNLG)**
In a Universal Replicator system, journal groups manage data consistency between multiple primary volumes and secondary volumes. See also consistency group (CTG).

**journal volume**
A volume that records and stores a log of all events that take place in another volume. In the event of a system crash, the journal volume logs are used to restore lost data and maintain data integrity.

In Universal Replicator, differential data is held in journal volumes on until it is copied to the S-VOL.

**JRE**
Java Runtime Environment

**L**

**L1 pair**
See layer-1 (L1) pair.

**L2 pair**
See layer-2 (L2) pair.

**LAN**
local-area network
layer-1 (L1) pair
In a ShadowImage cascade configuration, a layer-1 pair consists of a primary volume and secondary volume in the first cascade layer. An L1 primary volume can be paired with up to three L1 secondary volumes. See also cascade configuration.

layer-2 (L2) pair
In a ShadowImage cascade configuration, a layer-2 (L2) pair consists of a primary volume and secondary volume in the second cascade layer. An L2 primary volume can be paired with up to two L2 secondary volumes. See also cascade configuration.

LBA
logical block address

LCP
local control port; link control processor

LCU
logical control unit

LDEV
logical device

LDKC
See logical disk controller (LDKC).

leaf volume
A level-2 secondary volume in a ShadowImage cascade configuration. The primary volume of a layer-2 pair is called a node volume. See also cascade configuration.

LED
light-emitting diode

license key
A specific set of characters that unlocks a software application so that you can use it.

local copy
See in-system replication.

local site
See primary site.
**logical device (LDEV)**

An individual logical data volume (on multiple drives in a RAID configuration) in the storage system. An LDEV may or may not contain any data and may or may not be defined to any hosts. Each LDEV has a unique identifier or “address” within the storage system composed of the logical disk controller (LDKC) number, control unit (CU) number, and LDEV number. The LDEV IDs within a storage system do not change. An LDEV formatted for use by mainframe hosts is called a logical volume image (LVI). An LDEV formatted for use by open-system hosts is called a logical unit (LU).

**logical disk controller (LDKC)**

A group of 255 control unit (CU) images in the RAID storage system that is controlled by a virtual (logical) storage system within the single physical storage system. For example, the Universal Storage Platform V storage system supports two LDKCs, LDKC 00 and LDKC 01.

**logical unit (LU)**

A logical volume that is configured for use by open-systems hosts (for example, OPEN-V).

**logical unit (LU) path**

The path between an open-systems host and a logical unit.

**logical volume**

See volume.

**logical volume image (LVI)**

A logical volume that is configured for use by mainframe hosts (for example, 3390-9).

**LU**

logical unit

**LUN**

logical unit number

**LUNM**

Hitachi LUN Manager

**LUSE**

Hitachi LUN Expansion; Hitachi LU Size Expansion

**LV**

logical volume
main control unit (MCU)

A storage system at a primary or main site that contains primary volumes of TrueCopy for Mainframe remote replication pairs. The MCU is configured to send remote I/Os to one or more storage systems at the secondary or remote site, called remote control units (RCUs), that contain the secondary volumes of the remote replication pairs. See also remote control unit (RCU).

main site

See primary site.

main volume (M-VOL)

A primary volume on the main storage system in a TrueCopy for Mainframe copy pair. The M-VOL contains the original data that is duplicated on the remote volume (R-VOL). See also remote volume (R-VOL).

master journal (M-JNL)

Holds differential data on the primary Universal Replicator system until it is copied to the restore journal (R-JNL) on the secondary storage system. See also restore journal (R-JNL).

max.

maximum

MB

megabyte

Mb/sec, Mbps

megabits per second

MB/sec, MBps

megabytes per second

MCU

See main control unit (MCU).

MF, M/F

mainframe

MIH

missing interrupt handler
mirror
In Universal Replicator, each pair relationship in and between journals is called a “mirror”. Each pair is assigned a mirror ID when it is created. The mirror ID identifies individual pair relationships between journals.

M-JNL
main journal

modify mode
The mode of operation of SN where you can change the storage system configuration.

MP
microprocessor

MSCS
Microsoft Cluster Server

mto, MTO
mainframe-to-open

MU
mirror unit

multi-pathing
A performance and fault-tolerant technique that uses more than one physical connection between the storage system and host system. Also called multipath I/O.

M-VOL
main volume

N
donode volume
A level-2 primary volume in a ShadowImage cascade configuration. The secondary volume of a layer-2 pair is called a leaf volume. See also cascade configuration.

NUM
number

NVS
nonvolatile storage
O

OPEN-V

A logical unit (LU) of user-defined size that is formatted for use by open-systems hosts.

OPEN-x

A logical unit (LU) of fixed size (for example, OPEN-3 or OPEN-9) that is used primarily for sharing data between mainframe and open-systems hosts using Hitachi Cross-OS File Exchange.

OS

operating system

OS/390

Operating System/390

P

pair

Two logical volumes in a replication relationship in which one volume contains original data to be copied and the other volume contains the copy of the original data. The copy operations can be synchronous or asynchronous, and the pair volumes can be located in the same storage system (in-system replication) or in different storage systems (remote replication).

pair status

Indicates the condition of a copy pair. A pair must have a specific status for specific operations. When an operation completes, the status of the pair changes to the new status.

parity group

See RAID group.

path failover

The ability of a host to switch from using the primary path to a logical volume to the secondary path to the volume when the primary path fails. Path failover ensures continuous host access to the volume in the event the primary path fails.

See also alternate path and failback.

PG

parity group. See RAID group.
physical device
   See device.

PiT
   point-in-time

point-in-time (PiT) copy
   A copy or snapshot of a volume or set of volumes at a specific point in time. A point-in-time copy can be used for backup or mirroring application to run concurrently with the system.

pool
   A set of volumes that are reserved for storing Copy-on-Write Snapshot data or Dynamic Provisioning write data.

pool volume (pool-VOL)
   A logical volume that is reserved for storing snapshot data for Copy-on-Write Snapshot operations or write data for Dynamic Provisioning.

port attribute
   Indicates the type of fibre-channel port: target, RCU target, or initiator.

port block
   A group of four fibre-channel ports that have the same port mode.

port mode
   The operational mode of a fibre-channel port. The three port modes for fibre-channel ports on the Hitachi RAID storage systems are standard, high-speed, and initiator/external MIX.

PPRC
   Peer-to-Peer Remote Copy

Preview list
   The list of requested operations on SN.

primary site
   The physical location of the storage system that contains the original data to be replicated and that is connected to one or more storage systems at the remote or secondary site via remote copy connections. A primary site can also be called a “main site” or “local site”.

   The term “primary site” is also used for host failover operations. In that case, the primary site is the host computer where the production applications are running, and the secondary site is where the backup
applications run when the applications at the primary site fail, or where the primary site itself fails.

**primary volume**
The volume in a copy pair that contains the original data to be replicated. The data in the primary volume is duplicated synchronously or asynchronously on the secondary pairs.

The following Hitachi products use the term P-VOL: SN, Copy-on-Write Snapshot, ShadowImage, ShadowImage for Mainframe, TrueCopy, Universal Replicator, Universal Replicator for Mainframe, and High Availability Manager.

See also secondary volume (S-VOL).

**P-site**
primary site

**P-VOL**
Term used for the primary volume in the earlier version of the SN GUI (still in use). See primary volume.

**Q**

**quick format**
The quick format feature in Virtual LVI/Virtual LUN in which the formatting of the internal volumes is done in the background. Use to configure the system (such as defining a path or creating a TrueCopy pair) before the formatting is completed. To quick format, the volumes must be in blocked status.

**quick restore**
A reverse resynchronization in which no data is actually copied: the primary and secondary volumes are swapped.

**quick split**
A split operation in which the pair becomes split immediately before the differential data is copied to the secondary volume (S-VOL). Any remaining differential data is copied to the S-VOL in the background. The benefit is that the S-VOL becomes immediately available for read and write I/O.

**R**

**R/W, r/w**
read/write
RAID

redundant array of inexpensive disks

RAID group

A redundant array of inexpensive drives (RAID) that have the same capacity and are treated as one group for data storage and recovery. A RAID group contains both user data and parity information, and the storage system can access the user data in the event that one or more of the drives within the RAID group are not available. The RAID level of a RAID group determines the number of data drives and parity drives and how the data is "striped" across the drives. For RAID1, user data is duplicated within the RAID group, so there is no parity data for RAID1 RAID groups.

A RAID group can also be called an array group or a parity group.

RAID level

The type of RAID implementation. RAID levels include RAID0, RAID1, RAID2, RAID3, RAID4, RAID5 and RAID6.

RCP

remote control port

RCU

See remote control unit (RCU).

RD

read

RCU target port

A fibre-channel port that is configured to receive remote I/Os from an initiator port on another storage system.

remote console PC

A previous term for the personal computer (PC) system that is LAN-connected to a RAID storage system. The current term is SN PC.

remote control port (RCP)

A serial-channel (ESCON) port on a TrueCopy main control unit (MCU) that is configured to send remote I/Os to a TrueCopy remote control unit (RCU).

remote control unit (RCU)

A storage system at a secondary or remote site that is configured to receive remote I/Os from one or more storage systems at the primary or main site.
remote copy
See remote replication.

remote copy connections
The physical paths that connect a storage system at the primary site to a storage system at the secondary site. Also called data path.

remote replication
Data replication configuration in which the storage system that contains the original data is at a local site and the storage system that contains the copy of the original data is at a remote site. TrueCopy and Universal Replicator provide remote replication. See also in-system replication.

remote site
See secondary site.

remote volume (R-VOL)
In TrueCopy for Mainframe, a volume at the remote site that contains a copy of the original data on the main volume (M-VOL) at the main site.

restore journal (R-JNL)
Holds differential data on the secondary Universal Replicator system until it is copied to the secondary volume.

resync
“Resync” is short for resynchronize.

RF
record format

RIO
remote I/O

R-JNL
restore journal

RL
record length

RMI
Remote Method Invocation

rnd
random
root volume
A level-1 primary volume in a ShadowImage cascade configuration. The secondary volume of a layer-1 pair is called a node volume. See also cascade configuration.

RPO
recovery point objective

R-SIM
remote service information message

R-site
remote site (used for Universal Replicator)

RTC
real-time clock

RTO
recovery time objective

R-VOL
See remote volume (R-VOL).

R/W
read/write

S

S#
serial number

S/N
serial number

s/w
software

SAID
system adapter ID

SAN
storage-area network
SATA
serial Advanced Technology Attachment

SC
storage control

SCDS
source control dataset

SCI
state change interrupt

scripting
The use of command line scripts, or spreadsheets downloaded by Configuration File Loader, to automate storage management operations.

SCSI
small computer system interface

secondary site
The physical location of the storage system that contains the primary volumes of remote replication pairs at the main or primary site. The storage system at the secondary site is connected to the storage system at the main or primary site via remote copy connections. The secondary site can also be called the “remote site”. See also primary site.

secondary volume
The volume in a copy pair that is the copy. The following Hitachi products use the term “secondary volume”: SN, Copy-on-Write Snapshot, ShadowImage, ShadowImage for Mainframe, TrueCopy, Universal Replicator, Universal Replicator for Mainframe, and High Availability Manager.
See also primary volume.

seq.
sequential

service information message (SIM)
SIMs are generated by a RAID storage system when it detects an error or service requirement. SIMs are reported to hosts and displayed on SN.

service processor (SVP)
The computer inside a RAID storage system that hosts the SN software and is used by service personnel for configuration and maintenance of the storage system.
severity level
Applies to service information messages (SIMs) and SN error codes.

SI
Hitachi ShadowImage

SIZ
Hitachi ShadowImage for Mainframe

sidefile
An area of cache memory that is used to store updated data for later integration into the copied data.

SIM
service information message

size
Generally refers to the storage capacity of a memory module or cache. Not usually used for storage of data on disk or flash drives.

SM
shared memory

SMTP
simple mail transfer protocol

SN
serial number shown in SN

snapshot
A point-in-time virtual copy of a Copy-on-Write Snapshot primary volume (P-VOL). The snapshot is maintained when the P-VOL is updated by storing pre-updated data (snapshot data) in a data pool.

SNMP
simple network management protocol

SOM
system option mode

source volume (S-VOL)
The volume in a copy pair containing the original data. The term is used only in the earlier version of the SN GUI (still in use), for the following
Hitachi products: ShadowImage for Mainframe, Dataset Replication, IBM FlashCopy.

**space**
Generally refers to the data storage capacity of a disk drive or flash drive.

**SRM**
Storage Replication Manager

**SS**
snapshot

**SSB**
sense byte

**SSID**
(storage) subsystem identifier. SSIDs are used as an additional way to identify a control unit on mainframe operating systems. Each group of 64 or 256 volumes requires one SSID, therefore there can be one or four SSIDs per CU image. For VSP, one SSID is associated with 256 volumes.

**SSL**
secure socket layer

**steady split**
In ShadowImage, a typical pair split operation in which any remaining differential data from the P-VOL is copied to the S-VOL and then the pair is split.

**S-VOL**
See *secondary volume* or *source volume* (*S-VOL*). When used for secondary volume, S-VOL is only seen in the earlier version of the SN GUI (still in use).

**SVP**
See *service processor* (*SVP*).

**sync**
synchronous

**system option mode (SOM)**
Additional operational parameters for the RAID storage systems that enable the storage system to be tailored to unique customer operating requirements. SOMs are set on the service processor.
target port
A fibre-channel port that is configured to receive and process host I/Os.

target volume (T-VOL)
The volume in a mainframe copy pair that is the copy. The term is used only in the earlier version of the SN GUI (still in use), for the following Hitachi products: ShadowImage for Mainframe, Dataset Replication, Compatible FlashCopy(R).
See also source volume (S-VOL).

TB
terabyte

TC
Hitachi TrueCopy

TCz
Hitachi TrueCopy for Mainframe

TDEVN
target device number

TGT
target; target port

THD
threshold

TID
target ID

total capacity
The aggregate amount of storage space in a data storage system.

T-VOL
See target volume (T-VOL).
update copy
An operation that copies differential data on the primary volume of a copy pair to the secondary volume. Update copy operations are performed in response to write I/Os on the primary volume after the initial copy operation is completed.

UR
Hitachi Universal Replicator

URz
Hitachi Universal Replicator for Mainframe

USP
Hitachi TagmaStore® Universal Storage Platform

USP V
Hitachi Universal Storage Platform V

USP VM
Hitachi Universal Storage Platform VM

UT
Universal Time

UTC
Universal Time-coordinated

V

version; variable length and de-blocking (mainframe record format)

VB
variable length and blocking (mainframe record format)

view mode
The mode of operation of SN where you can only view the storage system configuration.

virtual device (VDEV)
A group of logical devices (LDEVs) in a RAID group. A VDEV typically consists of some fixed volumes (FVs) and some free space. The number
of fixed volumes is determined by the RAID level and device emulation type.

**Virtual LVI/LUN volume**

A custom-size volume whose size is defined by the user using Virtual LVI/Virtual LUN. Also called a custom volume (CV).

**virtual volume (V-VOL)**

The secondary volume in a Copy-on-Write Snapshot pair. When in PAIR status, the V-VOL is an up-to-date virtual copy of the primary volume (P-VOL). When in SPLIT status, the V-VOL points to data in the P-VOL and to replaced data in the pool, maintaining the point-in-time copy of the P-VOL at the time of the split operation.

When a V-VOL is used with Dynamic Provisioning, it is called a DP-VOL.

**VLL**

Hitachi Virtual LVI/LUN

**VLVI**

Hitachi Virtual LVI

**VM**

volume migration; volume manager

**VOL, vol**

volume

**VOLID**

volume ID

**volser**

volume serial number

**volume**

A logical device (LDEV), or a set of concatenated LDEVs in the case of LUSE, that has been defined to one or more hosts as a single data storage unit. A mainframe volume is called a logical volume image (LVI), and an open-systems volume is called a logical unit (LU).

**volume pair**

See copy pair.

**V-VOL**

virtual volume
V-VOL management area

Contains the pool management block and pool association information for Copy-on-Write Snapshot operations. The V-VOL management area is created automatically when additional shared memory is installed and is required for Copy-on-Write Snapshot operations.
Glossary–32

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