IBM Spectrum Accelerate Family HyperSwap Quorum Witness
Version 1.0.0

User Guide

IBM

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About this guide

This guide describes how to install and configure the IBM®Spectrum Accelerate Family HyperSwap Quorum Witness.

Who should use this guide

This guide is intended for technology officers, enterprise storage managers, and storage administrators who want to learn about quorum witness functionality, as implemented in HyperSwap applications of the Spectrum Accelerate Family storage systems.

Conventions used in this guide

These notices are used in this guide to highlight key information.

Note: These notices provide important tips, guidance, or advice.

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Related information and publications

You can find additional information and publications related to IBM Spectrum Accelerate Family HyperSwap Quorum Witness on the following information sources.

- IBM FlashSystem® A9000R on IBM Knowledge Center (ibm.com/support/knowledgecenter/STJKN5) – on which you can find the following related publications:
  - IBM FlashSystem A9000R – Release Notes
  - IBM FlashSystem A9000R – Deployment Guide
  - IBM FlashSystem A9000R – Command-Line Interface (CLI) Reference Guide
  - IBM FlashSystem A9000 and IBM FlashSystem A9000R – Open API Reference Guide
  - IBM Hyper-Scale Manager – Release Notes
  - IBM Hyper-Scale Manager – User Guide
  - IBM Hyper-Scale Manager – Representational State Transfer (REST) API Specifications
- IBM FlashSystem A9000 on IBM Knowledge Center (ibm.com/support/knowledgecenter/STJKMM) – on which you can find the following related publications:
  - IBM FlashSystem A9000 – Release Notes
  - IBM FlashSystem A9000 – Product Overview

- – IBM FlashSystem A9000 – Deployment Guide
- – IBM FlashSystem A9000 – Command-Line Interface (CLI) Reference Guide
- – IBM FlashSystem A9000 and IBM FlashSystem A9000R – Open API Reference Guide
- IBM Flash Storage and Solutions marketing website (ibm.com/systems/storage/flash)
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Chapter 1. Introduction

The IBM Spectrum Accelerate™ Family HyperSwap® Quorum Witness is a software component that facilitates coordination between two IBM FlashSystem A9000 or A9000R storage systems in a HyperSwap solution.

Note: For your convenience, IBM Spectrum Accelerate Family HyperSwap Quorum Witness is referred to as Quorum Witness throughout this user guide.

IBM HyperSwap provides high availability of host applications running on IBM FlashSystem A9000 and A9000R storage systems. It is designed to guarantee business continuity in case of hardware, power, or connectivity failure, or if a natural or man-made disaster occurs. To enable a non-disruptive automatic failover, the IBM HyperSwap solution includes Quorum Witness software, preferably installed at a separate side (third failure domain).

Note: Full description of the IBM HyperSwap solution appears in the Product Overview of the IBM FlashSystem A9000 and A9000R storage systems. This information is available on IBM Knowledge Center (ibm.com/support/knowledgecenter).

After the Quorum Witness software is installed on a dedicated server or a virtual machine, it is used by the connected IBM FlashSystem A9000 and A9000R storage systems as part of the HyperSwap solution. The Quorum Witness role in the solution is to track and report the systems health, using the storage systems' heartbeat messages, and serve as a tie breaker in split-brain scenarios. If a failure is detected, it resolves a potential contention between the peer storage systems, determining which of them will own the primary volume. The Quorum Witness is critical for complete high-availability functionality. Without a functioning Quorum Witness, automatic failover cannot be performed.

In the solution example illustrated below, data is replicated between two storage systems. The host is connected to a HyperSwap volume through both systems in an active-active configuration. The Quorum Witness is installed at a separate site (third fault domain) and monitors the storage system health, by receiving heartbeat messages from both storage systems.
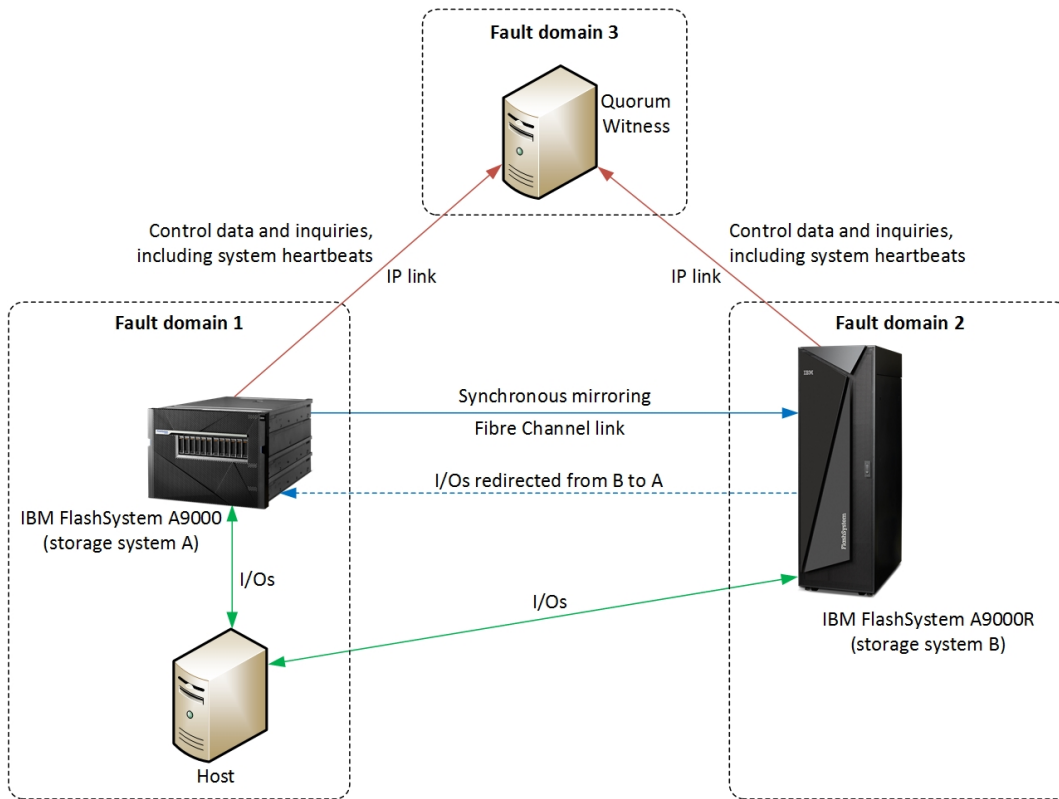
Figure 1. Typical HyperSwap solution with the Quorum Witness

Quorum Witness and storage systems

A minimal IBM HyperSwap high availability configuration consists of two independently located IBM storage systems with configured synchronous replication accessible to the same hosts, and a Quorum Witness at a third site.

After the Quorum Witness is installed, it is registered on both storage systems, participating in the IBM HyperSwap solution. Each storage system can be configured with one Quorum Witness instance, identified by its unique ID.

Note: To ensure that failover is possible at any time, the Quorum Witness can be made more resilient by deploying it on a dedicated highly-available VM. The system robustness can be achieved using VMware HA products, as described in "Highly-available VM deployment" on page 15.

After the Quorum Witness is configured and activated on the storage system, the storage starts sending keepalive messages to be used by the Quorum Witness to monitor the array health. After the HyperSwap relationship is established, it is validated by the storage systems, relying on the information provided by the Quorum Witness. Then each storage system verifies that the Quorum Witness reports the health status of its peer. This ensures that both storage systems are connected to the same Quorum Witness and operate properly.

Chapter 2. Installation

Download and install the Quorum Witness software package as described in the following sections.

- "Compatibility and requirements"
- "Defining Quorum Witness on IBM storage systems" on page 5
- "Performing first-time installation"

For information about uninstallation, see "Uninstalling the Quorum Witness software" on page 7.

Compatibility and requirements

For the complete and up-to-date information about the compatibility and requirements of IBM Spectrum Accelerate Family HyperSwap Quorum Witness, refer to its latest release notes.

You can find the latest release notes on IBM Knowledge Center (www.ibm.com/support/knowledgecenter).

Performing first-time installation

You can install the Quorum Witness software on a bare-metal machine or a dedicated VM, using a compatible version of Red Hat Enterprise Linux (RHEL) or CentOS.

Before you begin

- Verify that the following packages are installed on the Quorum Witness host. These files are also supplied in the package together with the product BIN file. They can be deployed during the installation process, see step 5 on page 4 of the procedure below.
  - RHEL 6.x, CentOS 6.x:
    - `nginx-1.10.3-1.el6.ngx.x86_64.rpm`
    - `postgresql92-9.2.14-1PGDG.rhel6.x86_64.rpm`
    - `postgresql92-contrib-9.2.14-1PGDG.rhel6.x86_64.rpm`
    - `postgresql92-libs-9.2.14-1PGDG.rhel6.x86_64.rpm`
    - `postgresql92-server-9.2.14-1PGDG.rhel6.x86_64.rpm`
    - `uuid-1.6.1-10.el6.x86_64.rpm`
    - `jemalloc-3.6.0-1.el6.x86_64.rpm`
    - `redis-3.2.0-1.el6.x86_64.rpm`
    - `libxslt-1.1.26-2.el6_3.1.x86_64` (CentOS 6.x only)
  - RHEL 7.x, CentOS 7.x:
    - `nginx-1.10.3-1.el7.ngx.x86_64.rpm`
    - `postgresql92-9.2.14-1PGDG.rhel7.x86_64.rpm`
    - `postgresql92-contrib-9.2.14-1PGDG.rhel7.x86_64.rpm`
    - `postgresql92-libs-9.2.14-1PGDG.rhel7.x86_64.rpm`
    - `postgresql92-server-9.2.14-1PGDG.rhel7.x86_64.rpm`
    - `uuid-1.6.2-26.el7.x86_64.rpm`

```
- jemalloc-3.6.0-1.el7.x86_64.rpm
- redis-3.2.5-1.el7.x86_64.rpm
- libxslt-1.1.28-5.el7.x86_64 (CentOS 7.x only)
```

Procedure

Follow these steps to install Quorum Witness.

1. Open the relevant TCP ports for a default Linux firewall.

Note: If you are using a different firewall software, refer to its documentation for the port opening instructions.

- RHEL 6.x:
    - **iptables -I OUTPUT -p tcp --dport 8460 -j ACCEPT**
    - **iptables -I OUTPUT -p tcp --dport 8461 -j ACCEPT**
    - **iptables -I INPUT -p tcp --dport 8460 -j ACCEPT**
    - **iptables -I INPUT -p tcp --dport 8461 -j ACCEPT**
    - **service iptables save**
    - **service iptables restart**

Important: Use the **ip6tables** command to open the relevant ports, if you use IPv6. The "Enabling IPv6 connectivity" on page 11 section explains how to enable IPv6 for the Quorum Witness.

- RHEL 7.x:
    - **firewall-cmd --permanent --add-port=8460/tcp**
    - **firewall-cmd --permanent --add-port=8461/tcp**
    - **firewall-cmd --reload**

2. Download the installation package to a local folder on the Linux host that will be used as Quorum Witness server.

3. Extract the installation package file ('* ' represents the build number) :

```
# tar -xzvf ibm_quorum_witness-1.0.0-*.x86_64.tar.gz
```

The following files are extracted:
- Dependencies (RPM files) per RHEL version.
- `ibm_quorum_witness-1.0.0-*.x86_64.bin` – product BIN file
- `ibm_quorum_witness-1.0.0-xxxx.x86_64.bin.asc`– digital signature file for the BIN file verification

4. Verify that you have relevant permissions on the host.

5. If the complementary RPM files were not deployed before the installation of the Quorum Witness package, go to the extracted directory and use the **rpm -iv *.rpm** command to install them.

6. Enter **./ibm_quorum_witness-1.0.0-*.x86_64.bin** to start the installation.

7. Review and accept the license agreement which is displayed after you run the installation file. After installation the Quorum Witness application is started automatically.

> **Note:** During the installation, a self-signed Secure Sockets Layer (SSL) certificate (`qw.crt`) and certificate key (`qw.key`) files are generated to create a secure communication channel for a storage system and the Quorum Witness host. Likewise, the Quorum Witness trusts the default certificate on the IBM storage system. If you need to replace any of these certificates, see the "Managing SSL certificates" on page 9 section for instructions.

8. Copy the certificate file from the `/opt/ibm/ibm_quorum_witness/settings/ssl_cert` directory to each storage system, participating in the HyperSwap deployment. This certificate must be added to the storage system, when defining the Quorum Witness, using XCLI or IBM Hyper-Scale Manager.

9. In addition, store the **qw.crt** and **qw.key** files in a secure location, different from the Quorum Witness server or VM. These files may be required, when restoring the Quorum Witness database, if it becomes corrupted. Also, take note of the IP address or hostname, used during the installation. The same values must be used during software database restore as well. The Quorum Witness database restoration is detailed in "Restoring Quorum Witness database" on page 15.

10. If you are using SELinux, the program activation can fail. In this case allow `nginx` web server to bind to network interfaces and connect to the Quorum Witness socket.

    * RHEL 6.x: **semodule -i /opt/ibm/ibm_quorum_witness/conf.d/selinux/rhel6/ibmqw.pp**
    * RHEL 7.x: **semodule -i /opt/ibm/ibm_quorum_witness/conf.d/selinux/rhel7/ibmqw.pp**
    * Verify the new configuration by viewing the `ibmqw.te` file. This file presents the changes to the relevant SELinux `*.pp` files in the human-readeable format.
        – RHEL 6.x: **cat /opt/ibm/ibm_quorum_witness/conf.d/selinux/rhel6/ibmqw.te**
        – RHEL 7.x: **cat /opt/ibm/ibm_quorum_witness/conf.d/selinux/rhel7/ibmqw.te**
    * Restart the Quorum Witness service, as explained in "Checking and controlling the Quorum Witness service" on page 10.

Defining Quorum Witness on IBM storage systems

The Quorum Witness instance must be defined on the IBM FlashSystem A9000/A9000R storage systems, participating in the IBM HyperSwap solution.

To ensure proper operation, define the Quorum Witness, using one of the following methods:

* IBM Hyper-Scale Manager, hybrid cloud management application for IBM Spectrum Accelerate Family products. Navigate to **SYSTEMS & DOMAINS VIEWS** > **Quorum Witnesses** and define Quorum Witness instances, according to your application requirements. For the description of the IBM Hyper-Scale Manager operation, refer to its user guide.
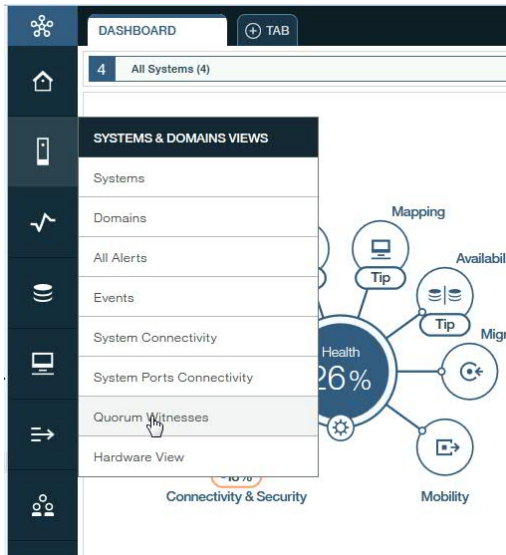
Figure 2. Navigating to Quorum Witness form in IBM Hyper-Scale Manager
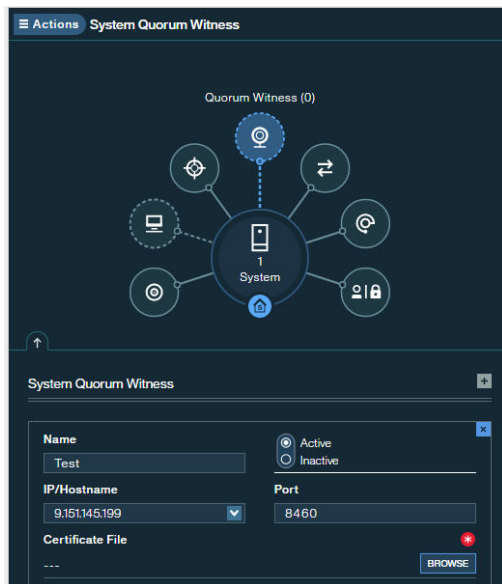
Figure 3. Quorum Witness form in IBM Hyper-Scale Manager

- XCLI utility, command-line user interface for managing IBM Spectrum Accelerate Family storage systems. Use the `quorum_witness_define` command for defining Quorum Witnesses. For details, refer to the IBM FlashSystem A9000/A9000R CLI reference guide.

Communication between the Quorum Witness and storage systems is performed over TCP/IP links. Verify that the TCP ports 8460 and 8461 are open on the external interface of the host. Refer to the installation procedure in see the "Performing first-time installation" on page 3 section for the port opening procedures.

Uninstalling the Quorum Witness software

If you want to completely remove the Quorum Witness software from the Linux host upon which it is installed, follow the steps in the following procedure.

Procedure

To uninstall the Quorum Witness software from the Linux host:

1. Log on to the Linux command prompt environment as a root user.
2. Run the standard Linux uninstallation command for the Quorum Witness software package (`ibm_quorum_witness`).

Chapter 3. Operation

This chapter describes operation tasks of managing SSL certificates and controlling the Quorum Witness service. For the detailed description of the CLI commands for managing and monitoring Quorum Witness from the storage system side, refer to the IBM FlashSystem A9000/A9000R CLI reference guide.

- "Managing SSL certificates"
- "Checking and controlling the Quorum Witness service" on page 10

Managing SSL certificates

The Quorum Witness host uses SSL certificates for maintaining a secure link to a storage system. The expiration time for the certificates is 3650 days. This section describes how to manage the Quorum Witness SSL certificates.

- "Replacing a self-signed certificate"
- "Replacing root CA public key"

Replacing a self-signed certificate

During the installation, a self-signed Secure Sockets Layer (SSL) certificate is generated to create a secure communication channel for a storage system and the Quorum Witness host. If you already have a trusted certificate that you want to use, you can replace the self-signed certificate with an existing trusted certificate.

Procedure

A self-signed certificate file, `qw.crt`, and a certificate key file, `qw.key`, are stored in the following directory: /opt/ibm/ibm_quorum_witness/settings/ssl_cert. The following procedure describes how to replace them.

1. Create new certificate and key files, using a utility of your choice, such as **openssl genrsa**. Make sure to use the same names for both files.
2. Copy the new certificate and key files to the /opt/ibm/ibm_quorum_witness/settings/ssl_cert directory, overwriting the old copies.
3. Restart the `nginx` service, using the **service nginx restart** command.
4. Copy the new certificate file to each storage system, participating in the HyperSwap deployment. This certificate must be added to the storage system, when defining the Quorum Witness, using XCLI or IBM Hyper-Scale Manager.

Replacing root CA public key

If a root CA public key is replaced on a storage system, it must be replaced on a Quorum Witness host as well to ensure a trusted link between the host and the storage system.

Procedure

The IBM root CA public key, **ibm-xiv.crt**, is stored in the following directory: /opt/ibm/ibm_quorum_witness/settings/ssl_cert/client_certificates. The following procedure describes how to revoke the old key, add the new one and list all keys stored on the Quorum Witness host.

1. Revoke the old key by running the following command: **su - ibmqw -c "qw_certificates remove -f ibm-xiv.crt"**.

2. Copy the new root CA public key to any location on the Quorum Witness host and run the following command to add the key: **su - ibmqw -c "qw_certificates add -f <path_to_new_certificate>/ <new_certificate_name>"**. The new root CA public key is added to the database and copied to the /opt/ibm/ibm_quorum_witness/settings/ssl_cert/ client_certificates directory.

3. Display the existing keys to verify that the operation succeeded. Run this command: **su - ibmqw "qw_certificates list"**. The output must be as follows:

```
ibmqw@test-qw2 ~]$ qw_certificates list
qw.crt
ibm-xiv.crt
```

4. Restart the nginx service, using the **service nginx restart** command.

Checking and controlling the Quorum Witness service

At any time, you can check whether the Quorum Witness service runs properly on the Linux host. You can also stop and then start the service if needed.

Procedure

1. Log on to the Linux command prompt environment as a root user.

Important: Only root users can complete service operations.

2. Enter the following command: **ibm_quorum_witness status**. The status of the service is displayed.

```
# service ibm_quorum_witness status
Celery services are running...
Django service is running...
```

What to do next

If you want to stop the Quorum Witness service, use the **stop** command:

Important: Stopping the service makes the Quorum Witness unavailable for storage systems, disrupting the HyperSwap operation.

```
# service ibm_quorum_witness stop
```

To start the service again, use the **start** command:

```
# service ibm_quorum_witness start
```

If you want to stop and then start the Quorum Witness service in one command, use the **restart** command:

```
# service ibm_quorum_witness restart
```

Modifying the Quorum Witness communication port

At any time, you can modify the default communication port used by the Quorum Witness in accordance with your network requirements.

Procedure

1. Log on to the Linux command prompt environment as a root user.
2. Enter the following command: **sed --in-place --copy 's/current_port/ new_port/g' /opt/ibm/ibm_quorum_witness/conf.d/nginx/qw_nginx.conf**.
3. Use the same command to change the current port incremented by 1 to the new port incremented by 1. This port is reserved for log retrieval by storage systems in the HyperSwap solution.
4. Restart the `nginx` service, using the **service nginx restart** command. For example, to change port 8460 to port 8470:

```
sed --in-place --copy 's/8460/8470/g' /opt/ibm/ibm_quorum_witness/conf.d/nginx/qw_nginx.conf
sed --in-place --copy 's/8461/8471/g' /opt/ibm/ibm_quorum_witness/conf.d/nginx/qw_nginx.conf
service nginx restart
```

5. Open the new ports, as explained in the "Performing first-time installation" on page 3 section.

Enabling IPv6 connectivity

By default, the Quorum Witness uses the IPv4 communication method. If required, you can enable IPv6 connectivity.

Procedure

1. Log on to the Linux command prompt environment as a root user.
2. Enter the following command: **sed --in-place --copy 's/#listen \[::\]/listen \[::\]/g' /opt/ibm/ibm_quorum_witness/conf.d/nginx/ qw_nginx.conf**.
3. Restart the `nginx` service, using the **service nginx restart** command.

Chapter 4. Troubleshooting

This chapter can help you detect and solve problems that you might encounter when using the IBM Spectrum Accelerate Family HyperSwap Quorum Witness.

Note:

- For up-to-date information about known issues and possible workarounds, refer to the latest release notes.
- When contacting IBM Support, specify the storage system you are managing, using Quorum Witness.

See the following sections for more information:

- "Checking the log files."

Checking the log files

The IBM Spectrum Accelerate Family HyperSwap Quorum Witness maintains log files that record different types of events.

You can find the following log files in the `/var/log/qw/` directory:

- `events.log` – Records all events according to their type: **Info**, **Error**, or **Warning**. You can use the Rsyslog application, an open source utility for forwarding log messages over IP networks (for more information, see the Rsyslog website). The following example shows different events that might be recorded:

```
Mar 14 14:44:41 qw-rh73-1 INFO 52 | external | quorum_witness | Service started
Mar 15 10:12:53 qw-rh73-1 INFO 53 | external | quorum_witness | Service stopped
Mar 19 08:30:39 qw-rh73-1 INFO 54 | external | 7023804-2 | System 7023804-2 registered
Mar 19 15:13:59 qw-rh73-1 INFO 55 | external | 7023804-2 | System 7023804-2 unregistered
```

- `qw.log` – Records events related to the operation of the Quorum Witness application.
- `celery.log` – Records events regarding the Celery services on the Linux host on which Quorum Witness is installed.
- `django.log` – Records events regarding the Django service on the Linux host on which Quorum Witness is installed.
- `celerybeat.log` – Records events regarding the scheduled tasks of the Celery services on the Linux host.
- `gunicorn.log` – Records application-level events related to the Django service on the Linux host.
- `nginx_access.log` – Records access events of the NGINX service on the Linux host.
- `nginx_error.log` – Records errors of the NGINX service on the Linux host.
- `redis.log` – Records Redis-related events on the Linux host.

Chapter 5. Best practices

Refer to the general guidance and best practices that are described in the following sections.

- "Highly-available VM deployment"
- "Restoring Quorum Witness database"

Highly-available VM deployment

You can utilize vSphere Fault Tolerance (FT) for the Quorum Witness virtual machine to improve the HyperSwap application reliability and decrease the system downtime.

FT provides continuous availability for the Quorum Witness VM by creating and maintaining another VM that is identical and continuously available to replace it in the event of a failover situation. The duplicate virtual machine is created and runs on another host. Its execution is identical to that of the primary VM and it can take over at any point without interruption, thereby providing fault tolerant protection.

The Fault Tolerance is a preferred solution for the Quorum Witness VM protection. It ensures zero downtime and no impact on the operation in case of the Quorum Witness host and/or datastore migration.

Restoring Quorum Witness database

The Quorum Witness database may become corrupted, making it unavailable for the storage systems and disrupting the HyperSwap operation. Database corruption can occur due to the physical failure of the Quorum Witness server hard disk. Also, it may happen during incorrect execution of VM failover, while using vSphere Fault Tolerance protection technique. The database failure is indicated by the **DB Recovery Needed** status of the Quorum Witness in the IBM Hyper-Scale Manger GUI or XCLI and relevant information message stored in the log file.

Procedure

To restore the corrupted Quorum Witness database:

1. Reinstall the Quorum Witness software on a bare-metal machine or a dedicated VM, using the same IP address or hostname as the previous installation. See "Performing first-time installation" on page 3.
2. Copy the previously saved `qw.cert` and `qw.key` files to the `/opt/ibm/ibm_quorum_witness/settings/ssl_cert` directory.
3. Restart the `nginx` service, using the **service nginx restart** command.
4. Activate the Quorum Witness via XCLI or Hyper-Scale Manager.

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