Manage NFS over RDMA

ONTAP 9

NetApp
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Table of Contents

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Learn about NFS over RDMA in ONTAP

NFS over RDMA uses RDMA-capable network adapters, allowing data to be copied directly between storage system memory and host system memory, circumventing CPU interruptions and overhead.

NFS over RDMA configurations are designed for customers with latency sensitive or high-bandwidth workloads such as machine learning and analytics. ONTAP NFS over RDMA can be used for any NFS based workloads. In addition, NVIDIA has extended NFS over RDMA to enable GPU Direct Storage (GDS). GDS further accelerates GPU-enabled workloads by bypassing the CPU and main memory altogether, using RDMA to transfer data between the storage system and GPU memory directly.

Beginning with ONTAP 9.10.1, NFS over RDMA configurations are supported for the NFSv4.0 protocol. Subsequent ONTAP releases introduced support for additional NFS versions.

Requirements

- Ensure you are running the correct version of ONTAP for the NFS version you want to use.

NFS version	ONTAP support
NFSv4.0	ONTAP 9.10.1 and later
NFSv4.1	ONTAP 9.14.1 and later
NFSv3	ONTAP 9.15.1 and later

  - You can configure NFS over RDMA with System Manager beginning with ONTAP 9.12.1. In ONTAP 9.10.1 and 9.11.1, you need to use the CLI to configure NFS over RDMA.
- Both nodes in the high availability (HA) pair must be the same version.
- Storage system controllers must support RDMA:

Beginning with ONTAP…	The following controllers support RDMA…
9.10.1 and later	• AFF A400 • AFF A700 • AFF A800
ONTAP 9.14.1 and later	• AFF C-Series • AFF A900
ONTAP 9.15.1 and later	• AFF A1K • AFF A90 • AFF A70

Beginning with ONTAP…	The following controllers support RDMA…
ONTAP 9.16.1 and later	• AFF A50 • AFF A30 • AFF A20

- Data LIFs must be configured to support RDMA.
- For information about target RNIC support, refer to the NetApp Hardware Universe.
- For information on supported client operating systems for NFS over RDMA, refer to the NetApp Interoperability Matrix (IMT). For RoCE v2 supported RNICs, refer to the respective RNIC vendor documentation.

Interface groups are not supported with NFS over RDMA.

Next steps

- Configure NICs for NFS over RDMA
- Configure LIFs for NFS over RDMA
- NFS settings for NFS over RDMA

Related information

- RDMA
- NFS trunking overview
- RFC 7530: NFS Version 4 Protocol
- RFC 8166: Remote Direct Memory Access Transport for Remote Procedure Call Version 1
- RFC 8167: Bidirectional Remote Procedure Call on RPC-over-RDMA Transports
- RFC 8267: NFS Upper-Layer Binding to RPC-over-RDMA version 1

Configure NICs for NFS over RDMA

NFS over RDMA requires NIC configuration for both the client system and storage platform.

Storage platform configuration

For information about target RNIC support, refer to the NetApp Hardware Universe.

If you are using a high-availability (HA) configuration, both nodes must use the same RNIC to support RDMA failover. The NIC must be RoCE capable.

- Beginning with ONTAP 9.10.1, you can view a list of RDMA offload protocols with the command:

```
network port show -rdma-protocols roce
```

Learn more about `network port show` in the ONTAP command reference.

- Beginning with ONTAP 9.16.1, it is recommended to use priority flow control (PFC). Configure PFC using the `network port modify` command:

```
network port modify -node <nodename> -port <portname> -flowcontrol-admin
pfc -pfc-queues-admin 3
```

- Prior to ONTAP 9.16.1, it is recommended to use the default global flow control (GFC). If the flow-control setting has been changed, configure GFC using the `network port modify` command:

```
network port modify -node <nodename> -port <portname> -flowcontrol-admin
full
```

Learn more about `network port modify` in the ONTAP command reference.

Client system configuration

For information on supported client operating systems for NFS over RDMA, refer to the NetApp Interoperability Matrix (IMT). For RoCE v2 supported RNICs, refer to the respective RNIC vendor documentation.

Although the client and server can be directly connected, the use of switches is recommended for improved failover performance.

The client, server, any switches, and all ports on switches must be configured using jumbo frames. The flow-control configuration on the clients and switches should match ONTAP's flow-control configuration. Beginning with ONTAP 9.16.1, it is best practice to enable and configure priority flow control on ONTAP, the switches, and the clients. Prior to ONTAP 9.16.1, it is recommended to use global flow control.

After this configuration is confirmed, you can mount the NFS export using RDMA.

System Manager

You must be using ONTAP 9.12.1 or later to configure network interfaces with NFS over RDMA using System Manager.

Steps

1. Check if RDMA is supported. Navigate to **Network > Ethernet Ports** and select the appropriate node in the group view. When you expand the node, look at the **RDMA protocols** field for a given port: the value **RoCE** denotes RDMA is supported; a dash (**-**) indicates it's not supported.
2. To add a VLAN, select **+ VLAN**. Select the appropriate node. In the **Port** dropdown menu, the available ports display the text **RoCE Enabled** if they support RDMA. No text is displayed if they do not support RDMA.
3. Follow the workflow in Enable NAS storage for Linux servers using NFS to configure a new NFS server.

   When adding network interfaces, you will have the option to select **Use RoCE ports**. Select this option for any network interfaces that you want to use NFS over RDMA.

CLI

1. Check if RDMA access is enabled on the NFS server with the command:

   ```
   vserver nfs show-vserver <SVM_name>
   ```

   By default, `-rdma` should be enabled. If it is not, enable RDMA access on the NFS server:

   ```
   vserver nfs modify -vserver <SVM_name> -rdma enabled
   ```

2. Mount the client via NFSv4.0 over RDMA:
   a. The input for the proto parameter depends on the server IP protocol version. If it is IPv4, use `proto=rdma`. If it is IPv6, use `proto=rdma6`.
   b. Specify the NFS target port as `port=20049` instead of the standard port 2049:

   ```
   mount -o vers=4,minorversion=0,proto=rdma,port=20049
   <Server_IP_address>:/<volume_path> <mount_point>
   ```

3. **OPTIONAL**: If you need to unmount the client, run the command `unmount <mount_path>`

More information

- Create ONTAP NFS servers
- Enable NAS storage for Linux servers using NFS

Configure LIFs for NFS over RDMA

To use NFS over RDMA, you must configure your LIFs (network interface) to be RDMA compatible. Both the LIF and its failover pair must be capable of supporting RDMA.

Create a new LIF

System Manager

You must be running ONTAP 9.12.1 or later to create a network interface for NFS over RDMA with System Manager.

Steps

1. Select **Network > Overview > Network Interfaces**.
2. Select + Add .
3. When you select **NFS,SMB/CIFS,S3**, you have the option to **Use RoCE ports**. Select the checkbox for **Use RoCE ports**.
4. Select the storage VM and home node. Assign a **Name**, **IP address**, and **Subnet mask**.
5. Once you enter the IP address and subnet mask, System Manager filters the list of broadcast domains to those that have RoCE capable ports. Select a broadcast domain. You can optionally add a gateway.
6. Select **Save**.

CLI

Steps

1. Create a LIF:

```
network interface create -vserver SVM_name -lif lif_name -service-policy
service_policy_name -home-node node_name -home-port port_name {-address
IP_address -netmask netmask_value | -subnet-name subnet_name} -firewall
-policy policy_name -auto-revert {true|false} -rdma-protocols roce
```

   - The service policy must be either default-data-files or a custom policy that includes the data-nfs network interface service.
   - The `-rdma-protocols` parameter accepts a list, which is by default empty. When `roce` is added as a value, the LIF can only be configured on ports supporting RoCE offload, affecting bot LIF migration and failover.

Modify a LIF

System Manager

You must be running ONTAP 9.12.1 or later to create a network interface for NFS over RDMA with System Manager.

Steps

1. Select **Network > Overview > Network Interfaces**.
2. Select **⋮ > Edit** beside the network interface you want to change.
3. Check **Use RoCE Ports** to enable NFS over RDMA or uncheck the box to disable it. If the network interface is on a RoCE capable port, you will see a checkbox next to **Use RoCE ports**.
4. Modify the other settings as needed.
5. Select **Save** to confirm your changes.

CLI

1. You can check the status of your LIFs with the `network interface show` command. The service policy must include the data-nfs network interface service. The `-rdma-protocols` list should include `roce`. If either of these conditions are untrue, modify the LIF.

   Learn more about `network interface show` in the ONTAP command reference.

2. To modify the LIF, run:

   ```
   network interface modify vserver SVM_name -lif lif_name -service-policy
   service_policy_name -home-node node_name -home-port port_name {-address
   IP_address -netmask netmask_value | -subnet-name subnet_name} -firewall
   -policy policy_name -auto-revert {true|false} -rdma-protocols roce
   ```

   Learn more about `network interface modify` in the ONTAP command reference.

ⓘ Modifying a LIF to require a particular offload protocol when the LIF is not currently assigned to a port that supports that protocol will produce an error.

Migrate a LIF

ONTAP also allows you to migrate network interfaces (LIFs) to use NFS over RDMA. When performing this migration, you must ensure the destination port is RoCE capable. Beginning with ONTAP 9.12.1, you can complete this procedure in System Manager. When selecting a destination port for the network interface, System Manager will designate whether ports are RoCE capable.

You can only migrate a LIF to an NFS over RDMA configuration if:

- It is an NFS RDMA network interface (LIF) hosted on a RoCE capable port.
- It is an NFS TCP network interface (LIF) hosted on a RoCE capable port.
- It is an NFS TCP network interface (LIF) hosted on a non-RoCE capable port.

For more information about migrating a network interface, refer to Migrate a LIF.

Related information

- Create a LIF
- Create a LIF
- Modify a LIF
- Migrate a LIF

Modify the NFS configuration

In most cases, you do not need to modify the configuration of the NFS-enabled storage VM for NFS over RDMA.

If you are, however, dealing with issues related to Mellanox chips and LIF migration, you should increase the NFSv4 locking grace period. By default, the grace period is set to 45 seconds. Beginning with ONTAP 9.10.1, the grace period has a maximum value of 180 (seconds).

Steps

1. Set the privilege level to advanced:

   ```
   set -privilege advanced
   ```

2. Enter the following command:

   ```
   vserver nfs modify -vserver SVM_name -v4-grace-seconds number_of_seconds
   ```

For more information about this task, see Specify the NFSv4 locking grace period for ONTAP SVMs.

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