Installation Guide

Dell R240 / R430 / R440 / R730xd / R740xd
R740xd2 / R7515 / HPE Apollo 4200
Equus D2860

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Installation Process Overview

This document describes the installation and configuration process for a Google Global Cache (GGC) node. Follow these instructions if you’re an ISP deploying GGC in your network.

The installation process has these steps:

1. Hardware installation
2. Network installation
3. IP addressing
4. Software installation
5. BGP configuration

Google may provide a networking device that connects to GGC machines. In some cases it’s managed by the ISP; in others by Google. In this Installation Guide, all references to Google router mean a networking device both provided and managed by Google.

Steps 2 and 5 have two scenarios, depending on whether the GGC node is connected to a Google router or an ISP managed switch.

Follow only the steps applicable to the GGC node type you’re installing.
Follow these instructions to rack mount GGC machines. Some details vary depending on the type of GGC hardware provided. See the appendices for detailed information.

You may rack mount GGC machines as soon as you receive them.

2.1 You Will Need

- Two people to lift the machines into position
- *Dell and HPE machines:* Rack mount installation kit and vendor specific instructions (shipped with machines)
- Phillips (crosshead) screwdriver
- T-15 and T-25 Torx screwdrivers
- Rack space, as listed in Appendix D - Physical Requirements
- Power feeds and cables, as listed in Appendix E - Power Requirements
- Network and power cabling, as listed in Appendix A - Cabling Requirements - Google Router and Appendix B - Cabling Requirements - ISP Managed Switch
## 2.2 Procedure

1. **HPE Apollo 4200 and Equus D2860**: Remove the shipping screws on either side of the chassis, following vendor instructions. If you don't remove the shipping screws you won't be able to open the chassis to maintain the mid-chassis mounted disks in the future.

2. Install provided rails and mounting hardware in your rack.

3. Install the machines in the rack, following vendor instructions.

4. Connect power, **but do not turn the system on yet**.

5. Verify that both Power Supply Units (PSUs) show green indicator lights.

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**NOTE:** For Dell R740xd2 machines, to prevent possible injury, ensure that the thumbscrews located on the front left and right control panels are fastened during racking, so that the machine doesn't slide out of the rack when you pull the front drive bay.

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**GGC equipment is heavy. Use two people to lift it and follow appropriate health and safety procedures to prevent injury and to avoid damage to the GGC equipment.**

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**For redundancy and performance reasons, you must use both PSUs. Google strongly recommends that you connect each power supply to independent power feeds. If a second feed isn't available, you can connect both PSUs to the same feed.**
Network Installation - Google Router

Follow the instructions in this section if Google is providing and managing a GGC router to which the GGC machines are connected. Otherwise, proceed to Network Installation - ISP Managed Switch.

Connect the GGC machines and the router to your network as soon as you receive them. Do this even if you aren't ready to install the GGC software or start GGC traffic.

The GGC router comes preconfigured with uplink interface, LACP (for uplinks with 2+ physical ports). The router is also preconfigured with IP addressing previously provided to Google, as shown on the Configuration tab of the GGC Node's page in the ISP portal (https://isp.google.com/assets/).

Please verify that the IP addressing is what you intended, and are currently able to use. If any IP addressing details need to be changed, please contact ggc@google.com immediately, to avoid unnecessary turn-up delays. Always include the GGC node name in communications with us.

Network diagram of a GGC deployment with GGC router: single interconnect to ISP network (left) and two interconnects (right)
3.1 You Will Need

Equipment supplied by Google:

- GGC router
- Rack mount hardware
- Machine-to-router connectivity components, as listed in Appendix A - Cabling Requirements - Google Router, including some or all of these:
  - SFPs
  - Direct-attach SFP+/QSFP/QSFP28 cables
  - RJ45 ethernet cables
- Uplink connectivity SFPs or QSFPs, as required for number of uplinks

Equipment supplied by ISP:

- Machine-to-router connectivity components, specifically multimode fibers, as listed in Appendix A - Cabling Requirements - Google Router
- Uplink connectivity components, including SFPs or QSFPs, single or multimode fibers, as required for number of uplinks
3.2 Procedure

3.2.1 Install and Connect the Router

Details of cabling and network interfaces vary, depending on the GGC hardware type, the number of machines in the node, and the type and number of uplinks in use. See Appendix A - Cabling Requirements - Google Router.

1. Install the router in the rack.
2. Install SFPs and cabling as described in Appendix A - Cabling Requirements - Google Router.
3. Power on the router.

3.2.2 Configure Your Network

For each uplink bundle, configure LACP on your device as follows:

- Passive mode
- Layer 2 mode
- Load balanced on source/destination layer 3 information

If you’re using a single, non-bundled uplink, don’t enable LACP.

3.2.3 Verify Connectivity

- Check uplink physical status (link lights) on GGC router, and on your device.
- Verify GGC router light levels (Tx and Rx) at your device.
- Verify GGC router LACP status at your device.
Network Installation - ISP Managed Switch

Follow the instructions in this section if you’ll be providing all network connectivity for the GGC machines.

You may connect the GGC machines to your network as soon as you receive them, even if you aren’t ready to install the GGC software or start GGC traffic.

4.1 You Will Need

Equipment supplied by Google:

- SFPs for machine to switch or router links

Equipment supplied by ISP:

- Switch or router
- SFPs for uplinks
- Cabling, as described in Appendix B - Cabling Requirements - ISP Managed Switch

You’ll also need:

- Administrative access to your Ethernet switch
- Switch port numbers facing the GGC machines
4.2 Procedure

Install SFPs and cabling, as described in Appendix B - Cabling Requirements - ISP Managed Switch.

Configure your switch with the following settings:

- **Maximum port speed** (10Gbps for 10Gbps links, 1Gbps for 1Gbps links, etc.)
- **Full duplex**
- **Auto-negotiation enabled**
- **Flow control enabled**
- **Spanning tree**, either:
  - **Disabled on GGC machine-facing ports** or set to Portfast (Cisco IOS), Edge port (JUNOS), or equivalent
- **All GGC machines in a single, dedicated layer 2 broadcast domain (VLAN)**

For GGC machines using a single interface, Link Aggregation Control Protocol (LACP) should be **disabled**.

For GGC machines using multiple interfaces, LACP should be **enabled**, and configured as follows:

- **Passive mode**
- **Layer 2 mode**
- **Load balanced on source / destination layer 3 information**
- **Standalone mode** (aggregated link should remain up, even if a physical port is down)
- **All interfaces for a machine connected to the same switch**
- **Separate LACP bundle for each machine**

You may connect different GGC machines in the same node to different switches, but it isn't required. If you use multiple switches, the VLAN used by the GGC machines must span all switches involved.

Sample switch configurations are provided in Appendix C - Configuration Examples - ISP Managed Switch. Refer to your switch vendor’s documentation for specific configuration commands.
GCG nodes require a dedicated layer 3 subnet. You can configure nodes as dual-stacked (preferred), IPv4 only, or IPv6 only.

For each IP protocol version supported by the GGC node, machines have the following addresses assigned:

- Static maintenance IP address
- Multiple VIPs to serve traffic to users
- BGP VIP (on one machine at any time)

Maintenance IPs are configured statically. VIPs are managed automatically to ensure they move to other machines during failures and machine maintenances. This minimizes disruption of traffic to the users and ensures the BGP sessions with GGC nodes don't remain down for extended periods.
5.1 IP Addressing Requirements for GGC Nodes

GGC nodes require a specific size of allocated public IP subnet, as shown in the table below.

<table>
<thead>
<tr>
<th>Number of machines in the node</th>
<th>IPv4 subnet size</th>
<th>IPv6 subnet size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 to 3</td>
<td>/28</td>
<td>/64</td>
</tr>
<tr>
<td>4 to 8</td>
<td>/27</td>
<td>/64</td>
</tr>
<tr>
<td>9 to 16</td>
<td>/26</td>
<td>/64</td>
</tr>
</tbody>
</table>

5.1.1 IPv4 Addressing Scheme

IPv4 addresses are assigned within the GGC allocated subnet as follows:

- You **must** use the 1st usable address in the subnet for the subnet gateway.
- If required, assign the 2nd and 3rd addresses to an ISP-managed switch (e.g. for HSRP or GLBP).
- The 4th and following IP addresses in the subnet are reserved for GGC machines (management IPs and VIPs).
- Check the Configuration tab of the node’s page in the [ISP Portal](https://isp.google.com/assets/) for the BGP peering IP address previously provided to Google.

Please verify that the IP addressing is what you intended, and are currently able to use. If any IP addressing details need to be changed, please contact ggc@google.com immediately, to avoid unnecessary turn-up delays. Always include the GGC node name in communications with us.

5.1.2 IPv6 Addressing Scheme

IPv6 addresses are assigned within the GGC allocated subnet as follows:

- The ::1 address in the subnet is used as a statically addressed subnet gateway. If your device is configured to send router advertisements, the GGC machines uses this in preference to the static gateway.
- If required, assign the ::2 and ::3 addresses to an ISP-managed switch (e.g. for HSRP or GLBP).
- The ::4 and following IP addresses in the subnet are reserved for GGC machines (management IPs and VIPs).
- Check the Configuration tab of the node’s page in the [ISP Portal](https://isp.google.com/assets/) for the BGP peering IP address previously provided to Google.
5.2 IP Addressing Requirements for Google Routers

GGC nodes that are behind Google routers have additional subnet requirements because of interconnects needed to connect them to your network.

- We support up to 4 interconnects per Google router.
- Each interconnect may be configured with either IPv4, IPv6 or both address types.

Subnet sizes required for each interconnect type are as follows:

- A /31 IPv4 subnet is required for interconnects with standard configuration.
- A /29 IPv4 subnet (or larger) is required for interconnects where redundancy protocol (HSRP, VRRP, etc.) is used at the ISP’s side.
- A /127 IPv6 subnet is required for interconnects.

It’s up to the ISP to decide which IP from the interconnect allocated subnet is configured at either side of the interconnect. Google doesn't have any guidelines or preferences.

Please verify that the IP addressing is what you intended, and are currently able to use. If any IP addressing details need to be changed, please contact ggc@google.com immediately, to avoid unnecessary turn-up delays. Always include the GGC node name in communications with us.
5.3 Enabling IPv6

5.3.1 New Node

You can enable IPv6 prior to installation by specifying the **IPv6 subnet** and **IPv6 Router for BGP Sessions** when you supply the technical information required for node activation in the ISP Portal (https://isp.google.com/assets/) asset pages.

Google *strongly* recommends you enable IPv6 for new nodes, even if you don't yet have significant IPv6 user traffic, provided that IPv6 is globally reachable.

⚠️ Please verify that your IPv6 implementation works properly, as connectivity issues will significantly delay turn-up.

5.3.2 Existing Node

For an existing node that's already serving IPv4 traffic, you can enable IPv6 through the ISP Portal (https://isp.google.com/assets/) asset pages by following these steps:

1. In the 'Configuration' tab, select 'Update Configuration' at the bottom.
2. Select 'Enabled' for IPv6 and supply the IPv6 subnet.
3. Click 'Update' to save the changes.

You'll receive an email when configuration changes are complete.

❓ If you’re enabling IPv6 support for a GGC node that’s connected to a Google router, you’ll need to provide the IPv6 subnet for the interconnect that’s configured with a BGP session over it. Contact ggc@google.com to verify these prerequisites are in place.
Software Installation (Network based)

Network based install is possible on GGC nodes that meet *all* of these requirements:

- Google supplied GGC Router (Cisco NCS 5001/5011)
- IPv4 enabled (Network-based IPv6-only installation is not supported)
- Dell R740xd, Dell R740xd2, HPE Apollo 4200 or Equus D2860 hardware

### 6.1 Procedure

#### 6.1.1 Dell R740xd

1. Install the GGC router and provide connectivity to it.
2. Wire the machines to the GGC router, following the cabling requirements in Appendix A exactly.
3. Connect power to the machines.
4. Wait for the GGC router to complete turn-up. You will receive an email message once this is done. This message will be instructing you to boot the machines. Do this by pressing the front power button. If the machines were already powered on, reboot them at this point.
5. Press F12 to initiate a network boot on all machines.
6. No further action needed. The machines should perform an automated network-based install.

#### 6.1.2 Dell R740xd2, HPE Apollo 4200 and Equus D2860

1. Install the GGC router and provide connectivity to it.
2. Wire the machines to the GGC router, following the cabling requirements in Appendix A exactly.
3. Connect power to the machines.
4. Power on the machines by pressing the front power button.
5. No further action needed. All machines will attempt to boot of the network at regular intervals. Once the GGC Router is fully provisioned and has established BGP session(s), all machines should install over the network without intervention on your side.
6.2 GGC software network-based installation failures

Occasionally GGC network-based installation may fail to start. If this happens, please retry the procedure above. If the failure persists, try the USB-drive installation process.

If the machine can't establish network connectivity, check all cables are properly seated and connected according to requirements in Appendix A.
Software Installation (USB-drive)

This section describes the steps to install the GGC software on the machine. After this step is complete, the installer automatically signals Google to begin the turn-up process or to return this machine to a serving state, in the case of a reinstallation.

The installation steps are:

1. Download the USB image.
2. Create USB boot sticks.
3. Verify IP addressing information.
4. Boot each machine from a USB stick.
5. Enter the network configuration and wait for the installer to complete.
6. Reboot the machines.

It's possible to install a GGC machine without Internet connectivity. In this case, the machine repeatedly tries contacting GGC management systems until it succeeds.

7.1 You Will Need

- A monitor and keyboard
- IP information provided to Google in the [ISP Portal](https://isp.google.com/assets/)
- Labels to mark the IP address on each machine
- A USB stick with at least 1 GB capacity. One USB stick per machine is provided.
- Access to a computer with appropriate permissions to:
  - Download and save the install image file
  - Download, save, and run the tools required to create a bootable USB stick
- GGC machines, mounted in a rack and powered up. A connection to the network with Internet connectivity is preferred but not required.

  You’ll also need to advertise the prefix allocated to the GGC node to your upstream networks.
7.2 Installation Procedure

7.2.1 Download the Install Image


Only the latest version of the setup image is supported. If you use an older installer version we may ask you to reinstall the machine.

7.2.2 Prepare the USB Stick

You’ll need a USB removable media device to store the GGC setup image. This can be the USB stick shipped with GGC servers, or any other USB stick or portable USB drive with at least 1 GB capacity.

Create the USB boot stick on a computer on which you have the permissions described above. You can create multiple boot sticks, to install machines in parallel, or you can make one USB stick and reuse it for multiple machine installations.

For details on how to write the install image to the USB stick on various operating systems, see the ISP Help Center (https://support.google.com/interconnect?p=usb).

7.2.3 Verify IP Addressing Details

The node’s IP addressing details, previously provided to Google, are shown on the Configuration tab of the GGC Node’s page in the ISP portal (https://isp.google.com/assets/).

⚠️ Please verify that the IP addressing is what you intended, and are currently able to use. If any IP addressing details need to be changed, please contact ggc@google.com immediately, to avoid unnecessary turn-up delays. Always include the GGC node name in communications with us.

7.2.4 GGC Software Installation

Repeat the installation steps on each machine in the GGC node.

1. Connect a monitor and a keyboard to the machine.

2. Insert the prepared setup USB stick in any USB port.

   **NOTE:** For Dell R740xd2 machines, use the front ports when installing the GGC software.

3. Power off the machine, if it’s currently running.

4. Power on the machine by pressing the front power switch.
5. Allow some time for the machine to boot from the USB stick.

If you've installed this machine before, it might not automatically boot from the USB stick. If that happens, follow the steps at [Booting the machine from the USB stick](#).

![Helpful Tip]

If there is issues with the machine registering USB devices, try alternative ports on the opposing side of the machine e.g. use the front USB ports instead of the rear ports and vice versa.

The installation displays this screen:

![Installer Start Screen]

1. Press **ENTER** or wait for 10 seconds for the ‘Boot Menu’ to disappear. The machine boots up and starts the installation program.

   The installer examines the hardware. Some modifications applied by the installer may require the machine to reboot.

   If that happens, make sure the machine boots from the USB stick again. The installation program then resumes.

2. The installer detects which network interface has a link. In this example, it’s the first 10GE interface. It prompts you to configure it, as shown in this screen. Press **ENTER** to proceed:
3. Respond to the prompts that appear on the screen. The configuration should match the information provided to Google in the ISP Portal (https://isp.google.com/assets/):

**NOTE:** If you’ve used this USB stick to install any GGC machines before, the fields listed below are pre-populated with previously used values. Verify they’re correct before pressing **ENTER**.

- Enable LACP: Select ‘Y’ if the machine has multiple interfaces connected. Select ‘N’ if it has only a single interface connected.

- Enter GGC node subnet in CIDR format: `x.x.x.x/nn` or `x:x:x:x::/64`.

- Enter the machine number: 1 for the first machine, 2 for the second, and so on.

- Confirm the configuration when prompted.
4. The installer validates IP information and connectivity, then begins software installation onto the local hard drive. This step takes a couple of minutes. Allow it to finish.

5. When the installation process has completed successfully, it prompts you to press ENTER to reboot the machine:

![Successful installation]

If any warnings or error messages are shown on the screen, don’t reboot the machine. See GGC Software Installation Troubleshooting.

6. Remove the USB stick from the machine and press ENTER to reboot.

7. When the machine reboots after a successful installation, it boots from disk. The machine is now ready for remote management. The monitor shows the Machine Health Screen:

![Booted from disk]
8. Label each machine with the name and IP address assigned to it.

If the installation didn't go as described above, follow the steps in the next section, **GGC Software Installation Troubleshooting**.

### 7.3 GGC Software Installation Troubleshooting

Occasionally GGC software installation may fail. This is usually due to either:

- Hardware issues, which prevent the machine from booting, or that prevent the install image from being written to disk
- Network issues, which prevent the machine from connecting to GGC management systems

First, check machine hardware status by attaching a monitor, and viewing the [Machine Health Screen](https://support.google.com/interconnect/answer/9028258?hl=en&ref_topic=7658879). Further information is available in the [ISP Help Center](https://support.google.com/interconnect?p=usb).

If you can't establish network connectivity, check the cables, switch and router configuration, and the IP information you entered during installation. Check IP connectivity to the GGC machines from the GGC switch, from elsewhere in your network, using external Looking Glass utilities.

If you're installing a brand new machine for the first time and the setup process reports an error *before* network connectivity is available, let **ggc@google.com** know what its service tag is when reporting the problem.

If the setup process reports an error *after* network connectivity is established, it automatically uploads logs to Google for investigation. If this happens, leave the machine running with the USB stick inserted so we can gather additional diagnostics, if required.

Don't place transparent proxies, NAT devices, or filters in the path of communications between the GGC Node and the internet, subject to the explicit exceptions in the GGC Agreement. Any filtering of traffic to or from GGC machines is likely to block remote management of machines. This delays turn-up.

In other cases, contact the GGC Operations team: **ggc@google.com**. Always include the GGC node name in communications with us.

**NOTE:** Photos of the fault, including those of the installer and Machine Health Screen, are useful for troubleshooting.
7.4 Boot the Machine from the USB Stick

7.4.1 Dell Hardware

1. Insert the USB stick and reboot the machine. During POST (Power On Self Test phase of PC boot), this menu appears on the screen:

   ![Dell POST screen](image)

   Dell POST screen

2. Press **F11** to enter the Boot Manager.

3. Select the 'BIOS Boot Menu'.


4. From the list of bootable devices, select ‘Hard disk C:’ and then the USB stick, as shown in this screen:

7.4.2 HPE hardware

1. Insert the USB stick and reboot the machine. During POST (Power On Self Test phase of PC boot), this menu appears on the screen:
2. Press **F11** to enter the Boot Menu.

3. Select ‘Legacy BIOS One-Time Boot Menu’ and select ‘ENTER’.

4. Choose ‘One Time Boot to USB DriveKey’.
7.4.3 Equus D2860 hardware

Restart the machine.

- It may take 20 to 30 seconds before the machine's fans start running.
- It may take about two minutes before the machine shows any VGA output.

During POST, hold the “F7” key.

A menu appears on the screen, similar to the following:
Choose the option that shows just the name of the USB stick. Don’t choose any option containing “sSATA” or “UEFI”.

Wait for the machine to finish booting from the USB stick.
In this scenario you establish BGP sessions with the Google-provided router. One session per each interconnect and IP protocol version is required.

### 8.1 You Will Need

- Administrative access to your BGP peer router, or route server
- BGP configuration details from ggc@google.com

### 8.2 Procedure

You can configure your BGP router at any time. The session doesn't come up until Google completes the next steps of the installation. Establishing a BGP session with a Google router and advertising prefixes doesn't cause traffic to flow. We'll contact you to arrange a date and time to start traffic.

We recommend at least one BGP session between your BGP peer(s) and the Google-provided router.

We'll contact you if we have problems establishing the BGP session, or if we detect problems with the prefixes advertised.

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If you’re planning to perform work that may adversely affect GGC nodes, don't disable BGP sessions. Instead, schedule maintenance for it in the ISP Portal (https://isp.google.com/assets/).
BGP Configuration - ISP Managed Switch

In this scenario you establish a BGP session directly with the GGC node.

9.1 You Will Need

- Administrative access to your BGP peer router, or route server
- General BGP instructions from https://support.google.com/interconnect?p=bgp
- BGP configuration details for this node from ISP Portal (https://isp.google.com/assets/)

9.2 Procedure

You can configure your BGP router at any time. The session doesn't come up until Google completes the next steps of the installation. Establishing a BGP session with a new GGC node and advertising prefixes doesn't cause traffic to flow. We'll contact you to arrange a date and time to start traffic.

It's important to understand that the BGP session established with GGC node isn't used for traditional routing purposes. This has two implications:

- Only a single BGP session (for IPv4 and IPv6 each) with a GGC node is supported and necessary.
- There's no need to monitor the session or to notify us if it's down.

We'll contact you if we have problems establishing the BGP session, or if we detect problems with the prefixes advertised.

Disabling the BGP session doesn't stop the node from serving traffic. Our systems continue to use the most recently received BGP feed when the session isn't established.

If you're planning to perform work that may adversely affect GGC nodes, schedule maintenance for it in the ISP Portal (https://isp.google.com/assets/).
Appendix A - Cabling Requirements - Google Router
10.1 Dell R730xd (Cisco NCS 5001)

Each machine requires:

- 2 x 10G SR SFPs: 1 for the machine, 1 for the router
- 1 x 1G copper SFP
- 1 x multi-mode fiber
- 1 x copper Cat5e cable
- LACP disabled in GGC installer

You'll also need:

- Additional SFPs for uplink(s) to your network
- Fiber of correct type for uplink(s)

10.1.1 Procedure

1. Insert 10G SFPs into machine network interface “Port 1”, as shown below.

2. Insert SFPs into GGC router:
   - Machine-facing 10G SFPs, starting from interface #0
   - Machine-facing 1G SFPs, starting from interface #14
   - Uplink SFPs, starting from interface #30 or uplink QSFPs, starting from interface #1/0

3. Connect machines to switch with fiber, as shown:
   - First machine 10G interface “Port 1” to router interface #0
   - Second machine 10G interface “Port 1” to router interface #1, and so on.

4. Connect machines to switch with Cat5e cabling:
   - First machine RJ45 interface #3 to router interface #14
   - Second machine RJ45 interface #3 to router interface #15, and so on.
5. Connect uplinks from GGC router to your router.

6. Verify uplink Tx and Rx light levels from your router.
10.2 Dell R740xd (Cisco NCS 5001, up to 12 machines)

Each machine requires:

- 4 x 10G SR SFPs: 2 for the machine, 2 for the switch or 2 x 10G SFP+ direct attach cables
- 2 x multi-mode fiber (not needed with direct attach cables)
- LACP enabled in GGC installer

You’ll also need:

- Additional 10G SFPs or 100G QSFP28s for uplink to your network
- Fiber of correct type for uplinks

10.2.1 Procedure

1. Insert uplink SFPs into GGC router:
   - If you’re using 10G SFPs, insert up to 16 10G SFPs into the GGC router, starting from interface #24.
   - If you’re using 100G QSFP28s, insert up to 2 100G QSFP28s into the GGC router, starting from interface #1/0.

2. Insert machine-facing 10G SFPs into GGC router, starting from interface #0.

3. Insert 10G SFPs into machine network interfaces #1 and #2.

4. Connect machines to switch, as follows:
   - First machine interface #1 to router interface #0
   - First machine interface #2 to router interface #1
   - Second machine interface #1 to router interface #2
   - Second machine interface #2 to router interface #3, and so on.
10.3 Dell R740xd (Cisco NCS 5001, more than 12 machines)

Each machine requires:

- 4 x 10G SR SFPs: 2 for the machine, 2 for the switch or 2 x 10G SFP+ direct attach cables
- 2 x multi-mode fiber (not needed with direct attach cables)
- LACP enabled in GGC installer

You’ll also need:

- Additional 100G QSFP28s for uplink to your network
- Fiber of correct type for uplinks

10.3.1 Procedure

1. Insert uplink SFPs into GGC router: Insert up to 2 100G QSFP28s into GGC router, starting from interface #1/0. 10G uplinks aren't supported.

2. Insert machine-facing 10G SFPs into GGC router, starting from interface #0.

3. Insert 10G SFPs into machine network interfaces #1 and #2.

4. Connect machines to switch, as follows:
   - First machine interface #1 to router interface #0
   - First machine interface #2 to router interface #1
   - Second machine interface #1 to router interface #2
   - Second machine interface #2 to router interface #3, and so on.
10.4 Dell R7515 (Cisco NCS 5011)

Each machine requires 1 x QSFP28 direct-attach cable.

You’ll also need:

- Additional 100G QSFP28s for uplink to your network
- Fiber of correct type for uplinks

10.4.1 Procedure

1. Connect machines to switch with direct-attach cable, as shown:
   - First machine 50G interface (#1 in the diagram) to GGC router interface #0
   - Second machine 50G interface (#1 in the diagram) to GGC router interface #1, and so on.

2. Insert 100G QSFP28s used for uplinks into GGC router, starting from interface #24.

3. Connect uplinks from GGC router to your router.

4. Verify uplink Tx and Rx light levels from your router.
10.5 Dell R740xd2 (Cisco NCS 5011)

Each machine requires 1 x QSFP28 direct-attach cable.

You’ll also need:

- Additional 100G QSFP28s for uplink to your network
- Fiber of correct type for uplinks

10.5.1 Procedure

1. Connect machines to switch with direct-attach cable, as shown:
   - First machine 50G interface (#1 in the diagram) to GGC router interface #0
   - Second machine 50G interface (#1 in the diagram) to GGC router interface #1, and so on.

2. Insert 100G QSFP28s used for uplinks into GGC router, starting from interface #24.

3. Connect uplinks from GGC router to your router.

4. Verify uplink Tx and Rx light levels from your router.
10.6 HPE Apollo 4200 (Cisco NCS 5001, up to 8 machines)

Each machine requires:

- 4 x 10G SR SFPs: 2 for the machine, 2 for the switch or 2 x 10G SFP+ direct attach cables
- 2 x multi-mode fiber (not needed with direct attach cables)
- 1 x 1G copper SFP (router end)
- 1 x copper Cat5e cable
- LACP enabled in GGC installer

You’ll also need:

- Additional SFPs or QSFPs for uplink to your network
- Fiber of correct type for uplinks

10.6.1 Procedure

1. Insert SFPs into GGC router:
   - Machine-facing 10G SFPs, starting from interface #0
   - Machine-facing 1G SFPs, starting from interface #16
   - Uplink SFPs, starting from interface #24 or QSFPs, starting from interface #1/0

2. Insert 10G SFPs into machine network interfaces #1 and #2, as shown.

3. Connect machines to switch with fiber or direct attach cables, as shown:
   - First machine 10G interfaces #1, #2 to router interface #0, #1
   - Second machine 10G interfaces #1, #2 to router interfaces #2, #3, and so on.

4. Connect machines to switch with Cat5e cabling, as shown:
   - First machine RJ45 interface #1 to router interface #16
   - Second machine RJ45 interface #1 to router interface #17, and so on.
5. Connect uplinks from GGC router to your router.

6. Verify uplink Tx and Rx light levels from your router.
10.7 HPE Apollo 4200 (Cisco NCS 5001, more than 8 machines)

Each machine requires:

- 4 x 10G SR SFPs: 2 for the machine, 2 for the switch or 2 x 10G SFP+ direct attach cables
- 2 x multi-mode fiber (not needed with direct attach cables)
- 1 x 1G copper SFP (router end)
- 1 x copper Cat5e cable
- LACP enabled in GGC installer

You’ll also need:

- Additional 100G QSFP28s for uplink to your network (10G SFP uplinks aren't supported)
- Fiber of correct type for uplinks

10.7.1 Procedure

1. Insert SFPs into GGC router:
   - Machine-facing 10G SFPs, starting from interface #0
   - Machine-facing 1G SFPs, starting from interface #24
   - Uplink QSFPs, starting from interface #1/0

2. Insert 10G SFPs into machine network interfaces #1 and #2, as shown.

3. Connect machines to switch with fiber or direct attach cables, as shown:
   - First machine 10G interfaces #1, #2 to router interface #0, #1
   - Second machine 10G interfaces #1, #2 to router interfaces #2, #3, and so on.

4. Connect machines to switch with Cat5e cabling:
   - First machine RJ45 interface #1 to router interface #24
   - Second machine RJ45 interface #1 to router interface #25, and so on.
5. Connect uplinks from GGC router to your router.

6. Verify uplink Tx and Rx light levels from your router.
10.8 HPE Apollo 4200 (Cisco NCS 5011)

Each machine requires:

- 1 x 40G QSFP direct-attach cable
- LACP disabled in GGC installer

You’ll also need:

- Additional 100G QSFP28s for uplink to your network
- Fiber of correct type for uplinks

10.8.1 Procedure

1. Insert 100G QSFP28s into GGC router, starting from interface #24.

2. Connect machines to switch with direct-attach cable, as shown:
   - First machine 40G interface (#2 in the diagram) to GGC router interface #0
   - Second machine 40G interface (#2 in the diagram) to GGC router interface #1, and so on.

3. Connect uplinks from GGC router to your router.

4. Verify uplink Tx and Rx light levels from your router.
10.9 Equus D2860 (Cisco NCS 5011)

Each machine requires:

- 1 x QSFP direct-attach cable
- LACP disabled in GGC installer

You will also need:

- Additional 100G QSFPs for uplink to your network
- Fiber of correct type for uplinks

10.9.1 Procedure

1. Insert 100G QSFPs into GGC router, starting from interface #24.

2. Connect machines to the switch with direct-attach cable, as shown:
   - First machine network interface (outlined in yellow in the image below) to GGC router interface #0
   - Second machine network interface (outlined in yellow in the image below) to GGC router interface #1, and so on

3. Connect uplinks from GGC router to your router

4. Verify uplink Tx and Rx light levels from your router
Appendix B - Cabling Requirements - ISP Managed Switch

11.1 Dell R240

Each machine requires:

- 2 x copper Cat5e or Cat6 cables
- LACP enabled in GGC installer

11.1.1 Procedure

Connect machine RJ45 network interfaces, indicated by #1 and #2, to your switch.

11.2 Dell R430

Each machine requires:

- 2 x copper Cat5e or Cat6 cables
- LACP enabled in GGC installer

11.2.1 Procedure

Connect machine RJ45 network interfaces #1 and #2, as shown, to your switch.
11.3 Dell R440

Each machine requires:

- 2 x copper Cat5e or Cat6 cables
- LACP enabled in GGC installer

11.3.1 Procedure

Connect machine RJ45 network interfaces #1 and #2, as shown, to your switch.

11.4 Dell R730xd

Each machine requires:

- 2 x 10G SFPs (SR or LR): 1 for the machine, 1 for the switch
- 1 x multi-mode or single-mode fiber, to match SFP type
- LACP disabled in GGC installer

11.4.1 Procedure

1. Insert SFPs into machine network interface #1, as shown.
2. Insert SFPs into your switch.
3. Connect machines to switch.
4. Verify Tx and Rx light levels from your switch.
11.5 Dell R740xd 2x10G

Each machine requires:

- 4 x 10G SFPs (SR or LR); 2 for the machine, 2 for the router
- 2 x multi-mode or single-mode fiber, to match SFP type
- LACP enabled in GGC installer

11.5.1 Procedure

1. Insert two SFPs into machine network interfaces #1 and #2, as shown.

2. Insert SFPs into your switch.

3. Connect machines to switch.

4. Verify Tx and Rx light levels from your switch.

5. On your switch add two ports facing each machine into separate LACP bundle.
11.6 Dell R740xd 1x10G

Each machine requires:

- 2 x 10G SFPs (SR or LR): 1 for the machine, 1 for the switch
- 1 x multi-mode or single-mode fiber, to match SFP type
- LACP disabled in GGC installer

11.6.1 Procedure

1. Insert SFP into machine network interface #1, as shown.

2. Insert SFP into your switch.

3. Connect machines to switch.

4. Verify Tx and Rx light levels from your switch.
Appendix C - Configuration Examples - ISP Managed Switch

These examples are for illustration only; your configuration may vary. Contact your switch vendor for detailed configuration support for your specific equipment.

12.1 Cisco IOS XR Interface Configuration (LACP Disabled)

Replace interface descriptions `mynode-abc101` with the name of the GGC node and the machine number.

```plaintext
interface TenGigE0/0/0/0
    description mynode-abc101
    l2transport

interface TenGigE0/0/0/1
    description mynode-abc102
    l2transport
```
Replace interface descriptions `mynode-abc101-port1` with the name of the GGC node, the machine number, and machine interface name.

```plaintext
interface Bundle-Ether1
  description mynode-abc101
  bundle lACP-fallback timeout 5
  l2transport
  !

interface TenGigE0/0/0/0
  description mynode-abc101-port1
  bundle id 1 mode active
  !

interface TenGigE0/0/0/1
  description mynode-abc101-port2
  bundle id 1 mode active
  !

interface Bundle-Ether2
  description mynode-abc102
  bundle lACP-fallback timeout 5
  l2transport
  !

interface TenGigE0/0/0/2
  description mynode-abc102-port1
  bundle id 2 mode active
  !

interface TenGigE0/0/0/3
  description mynode-abc102-port2
  bundle id 2 mode active
  !
```
Replace interface descriptions `mynode-abc101` with the name of the GGC node and the machine number.

```
!
  interface TenGigabitEthernet1/1
    description mynode-abc101
    switchport mode access
    flowcontrol send off
    spanning-tree portfast
  !
  interface TenGigabitEthernet1/2
    description mynode-abc102
    switchport mode access
    flowcontrol send off
    spanning-tree portfast
  !
  interface TenGigabitEthernet1/3
    description mynode-abc103
    switchport mode access
    flowcontrol send off
    spanning-tree portfast
  !
  interface TenGigabitEthernet1/4
    description mynode-abc104
    switchport mode access
    flowcontrol send off
    spanning-tree portfast
  !
end
```
12.4 Cisco Switch Interface Configuration (LACP Enabled)

Replace interface descriptions `mynode-abc101-Gbl` with the name of the GGC node, the machine number, and machine interface name.
! interface GigabitEthernet1/1
description mynode-abc101-Gb1
switchport mode access
flowcontrol send off
channel-protocol lacp
channel-group 1 mode passive
spanning-tree portfast
!
interface GigabitEthernet1/2
description mynode-abc101-Gb2
switchport mode access
flowcontrol send off
channel-protocol lacp
channel-group 1 mode passive
spanning-tree portfast
!
interface Port-channel1
description mynode-abc101
switchport
switchport mode access
no port-channel standalone-disable
spanning-tree portfast
!
interface GigabitEthernet1/3
description mynode-abc102-Gb1
switchport mode access
flowcontrol send off
channel-protocol lacp
channel-group 2 mode passive
spanning-tree portfast
!
interface GigabitEthernet1/4
description mynode-abc102-Gb2
switchport mode access
flowcontrol send off
channel-protocol lacp
channel-group 2 mode passive
spanning-tree portfast
!
interface Port-channel2
description mynode-abc102
switchport
switchport mode access
no port-channel standalone-disable
spanning-tree portfast
end
12.5 Juniper Switch Interface Configuration (LACP Disabled)

Replace interface descriptions `mynode-abc101` with the name of the GGC node and the machine number.

```plaintext
set interfaces xe-0/0/1 description mynode-abc101-Xe1
set interfaces xe-0/0/1 unit 0 family ethernet-switching port-mode access
set interfaces xe-0/0/2 description mynode-abc101-Xe1
set interfaces xe-0/0/2 unit 0 family ethernet-switching port-mode access
set interfaces xe-0/0/3 description mynode-abc101-Xe1
set interfaces xe-0/0/3 unit 0 family ethernet-switching port-mode access
set interfaces xe-0/0/4 description mynode-abc101-Xe1
set interfaces xe-0/0/4 unit 0 family ethernet-switching port-mode access
# The above may be "interface-mode" access
set interfaces xe-0/0/1 unit 0 family ethernet-switching vlan members vlan10
set interfaces xe-0/0/1 ether-options no-flow-control
set protocols stp interface xe-0/0/1 edge
set interfaces xe-0/0/2 unit 0 family ethernet-switching vlan members vlan10
set interfaces xe-0/0/2 ether-options no-flow-control
set protocols stp interface xe-0/0/2 edge
set interfaces xe-0/0/3 unit 0 family ethernet-switching vlan members vlan10
set interfaces xe-0/0/3 ether-options no-flow-control
set protocols stp interface xe-0/0/3 edge
set interfaces xe-0/0/4 unit 0 family ethernet-switching vlan members vlan10
set interfaces xe-0/0/4 ether-options no-flow-control
set protocols stp interface xe-0/0/4 edge
```
12.6 Juniper Switch Interface Configuration (LACP Enabled)

Replace interface descriptions `mynode-abc101-Xe1` with the name of the GGC node, the machine number, and interface name on your switch.

```
set interfaces ge-0/0/1 description GGHost1-Gb1
set interfaces ge-0/0/1 ether-options 802.3ad lacp force-up
set interfaces ge-0/0/1 ether-options 802.3ad ae0
set interfaces ge-0/0/2 description GGHost1-Gb2
set interfaces ge-0/0/2 ether-options 802.3ad lacp force-up
set interfaces ge-0/0/2 ether-options 802.3ad ae0
set interfaces ge-0/0/3 description GGHost2-Gb1
set interfaces ge-0/0/3 ether-options 802.3ad lacp force-up
set interfaces ge-0/0/3 ether-options 802.3ad ae1
set interfaces ge-0/0/4 description GGHost2-Gb2
set interfaces ge-0/0/4 ether-options 802.3ad lacp force-up
set interfaces ge-0/0/4 ether-options 802.3ad ae1
set interfaces ae0 description GGHost1
set interfaces ae0 aggregated-ether-options no-flow-control
set interfaces ae0 aggregated-ether-options lacp passive
set interfaces ae0 unit 0 family ethernet-switching port-mode access
set interfaces ae0 unit 0 family ethernet-switching vlan members vlan10
set interfaces ae1 description GGHost2
set interfaces ae1 aggregated-ether-options no-flow-control
set interfaces ae1 aggregated-ether-options lacp passive
set interfaces ae1 unit 1 family ethernet-switching port-mode access
set interfaces ae1 unit 1 family ethernet-switching vlan members vlan10
# Use "stp" or "rstp" depending on the spanning-tree protocol in use
set protocols stp interface ae0 edge
set protocols stp interface ae1 edge
```

12.7 Cisco BGP Configuration (Prefix List Based Route Filtering)

```
neighbor <IP address of GGC> remote-as 11344
neighbor <IP address of GGC> transport connection-mode passive
neighbor <IP address of GGC> prefix-list deny-any in
neighbor <IP address of GGC> prefix-list GGC-OUT out

ip prefix-list deny-any deny 0.0.0.0/0 le 32
ip prefix-list GGC-OUT permit <x.y.z/24>
ip prefix-list GGC-OUT permit <a.b.c/24>
```
12.8 Cisco BGP Configuration (AS-PATH Based Route Filtering)

neighbor <IP address of GGC> remote-as 11344
neighbor <IP address of GGC> transport connection-mode passive
neighbor <IP address of GGC> filter-list 1 in
neighbor <IP address of GGC> filter-list 2 out

ip as-path access-list 1 deny .*
ip as-path access-list 2 permit _100_
ip as-path access-list 2 permit _200$
ip as-path access-list 2 permit ^300$

12.9 Juniper BGP Configuration (Prefix Based Policy)

neighbor <IP address of GGC> {
   description "GGC";
   import no-routes;
   export export-filter;
   peer-as 11344;
   passive;
}

policy-statement no-routes {
   term default {
      then reject;
   }
}

12.10 Juniper BGP Configuration (AS-PATH Based Policy)

neighbor <IP address of GGC> {
    description "GGC";
    import no-routes;
    export export-filter;
    peer-as 11344;
    passive;
}

policy-statement no-routes {
    term default {
        then reject;
    }
}

policy-statement export-filter {
    term allow-routes {
        from {
            from as-path-group GGC;
        }
        then accept;
    }
}

as-path-group GGC {
    as-path AS-PATH-NAME-1 "^100.*";
    as-path AS-PATH-NAME-2 "^200.*";
}
### Appendix D - Physical Requirements

#### Physical Dimensions

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Height</th>
<th>Width</th>
<th>Depth</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell R240</td>
<td>1U</td>
<td>19” rack mount</td>
<td>610mm (24”)</td>
<td>12.2kg (26.89lb)</td>
</tr>
<tr>
<td>Dell R430xd</td>
<td>1U</td>
<td>19” rack mount</td>
<td>610mm (24”)</td>
<td>19.9kg (44lb)</td>
</tr>
<tr>
<td>Dell R440</td>
<td>1U</td>
<td>19” rack mount</td>
<td>686mm (27”)</td>
<td>17.5kg (38.6lb)</td>
</tr>
<tr>
<td>Dell R730xd</td>
<td>2U</td>
<td>19” rack mount</td>
<td>686mm (27”)</td>
<td>32.5kg (72lb)</td>
</tr>
<tr>
<td>Dell R740xd</td>
<td>2U</td>
<td>19” rack mount</td>
<td>711mm (28”)</td>
<td>33.1kg (73lb)</td>
</tr>
<tr>
<td>Dell R740xd2</td>
<td>2U</td>
<td>19” rack mount</td>
<td>813mm (32”)</td>
<td>43.2kg (95.2lb)</td>
</tr>
<tr>
<td>Dell R7515</td>
<td>2U</td>
<td>19” rack mount</td>
<td>813mm (32”)</td>
<td>27.3kg (60.2lb)</td>
</tr>
<tr>
<td>HPE Apollo 4200</td>
<td>2U</td>
<td>19” rack mount</td>
<td>813mm (32”)</td>
<td>50kg (110.2lb)</td>
</tr>
<tr>
<td>Equus D2860</td>
<td>2U</td>
<td>19” rack mount</td>
<td>876mm (34.5”)</td>
<td>46.3kg (102lb)</td>
</tr>
<tr>
<td>Cisco NCS 5001</td>
<td>1U</td>
<td>19” rack mount</td>
<td>483mm (19”)</td>
<td>9.3kg (20.5lb)</td>
</tr>
<tr>
<td>Cisco NCS 5011</td>
<td>1U</td>
<td>19” rack mount</td>
<td>572mm (22.5”)</td>
<td>10kg (22.2lb)</td>
</tr>
</tbody>
</table>

Dimensions are vendors data, rounded to the nearest half or whole inch. Please note that mounting rails, and cable-management hardware (if used) can add 3” (76mm) to 6” (152mm) to the overall depth required.

Required operating temperature is 10°C to 35°C (50°F to 95°F), at up to 80% non-condensing humidity. You might see exhaust temperatures of up to 50°C (122°F); this is normal.

See Appendix F - Vendor Hardware Documentation for further environmental and mechanical specifications.
Appendix E - Power Requirements

Each machine requires dual power feeds. Machines are shipped with either 110V/240V PSUs, or 50V DC power PSUs.

Google doesn't provide all power cord types. If your facility requires other types of power cords and they're not listed in the table below, you'll need to provide them.

Per-machine Power Requirements and Google-Provided Power Cords

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Nominal Power</th>
<th>Peak Power</th>
<th>AC Power Cords</th>
<th>DC Power Cords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell R240</td>
<td>161W</td>
<td>255W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Dell R240 (Dense)</td>
<td>170W</td>
<td>267W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Dell R240 (Brazil)</td>
<td>139W</td>
<td>233W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Dell R430xd</td>
<td>250W</td>
<td>270W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Dell R440</td>
<td>166W</td>
<td>307W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Dell R730xd</td>
<td>350W</td>
<td>450W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Dell R740xd</td>
<td>357W</td>
<td>780W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Dell R740xd2</td>
<td>654W</td>
<td>1030W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Dell R7515</td>
<td>410W</td>
<td>835W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>HPE Apollo 4200</td>
<td>372W</td>
<td>800W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Equus D2860 40GE</td>
<td>820W</td>
<td>850W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Equus D2860 50GE</td>
<td>830W</td>
<td>850W</td>
<td>C13/C14</td>
<td>None</td>
</tr>
<tr>
<td>Cisco NCS 5001</td>
<td>200W</td>
<td>275W</td>
<td>C13/C14</td>
<td>CAB-48DC-40A-8AWG</td>
</tr>
<tr>
<td>Cisco NCS 5011</td>
<td>228W</td>
<td>508W</td>
<td>C13/C14</td>
<td>CAB-48DC-40A-8AWG</td>
</tr>
</tbody>
</table>

Google doesn't provide DC power cords for machines; have your electrician connect machines to DC power.

See Appendix F - Vendor Hardware Documentation for further electrical specification information.
Appendix F - Vendor Hardware Documentation

If you have further questions related to hardware delivered by Google and can't find answers in this document, consult the appropriate resource listed below.

### Vendor Hardware Documentation

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell PowerEdge</td>
<td>General Resources (<a href="https://qrl.dell.com/Product/Category/1">https://qrl.dell.com/Product/Category/1</a>)</td>
</tr>
<tr>
<td>(all)</td>
<td></td>
</tr>
</tbody>
</table>

1. Nominal power during regular operation.

2. Dell estimated maximum potential instantaneous power draw of the product under maximum usage conditions. Should only be used for sizing the circuit breaker. Peak power values for other platforms were sourced in-house by running synthetic stress test.