

Paragon Automation Installation Guide

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Paragon Automation Installation Guide

22.1

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About This Guide

Use this guide to install Paragon Automation on a Linux server.

RELATED DOCUMENTATION

[Paragon Automation User Guide](#)

[Paragon Automation Release Notes, Release 22.1](#)

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CHAPTER

Introduction

Paragon Automation Portfolio Installation Overview | 2

Paragon Automation Portfolio Installation Overview

Juniper® Paragon™ Automation Portfolio is a cloud-ready solution for network planning, configuration, provisioning, traffic engineering, monitoring, and life-cycle management. This solution brings advanced visualization capabilities and analytics to network management and monitoring. Paragon Automation offers base platform support for Juniper Networks devices and some third-party devices.

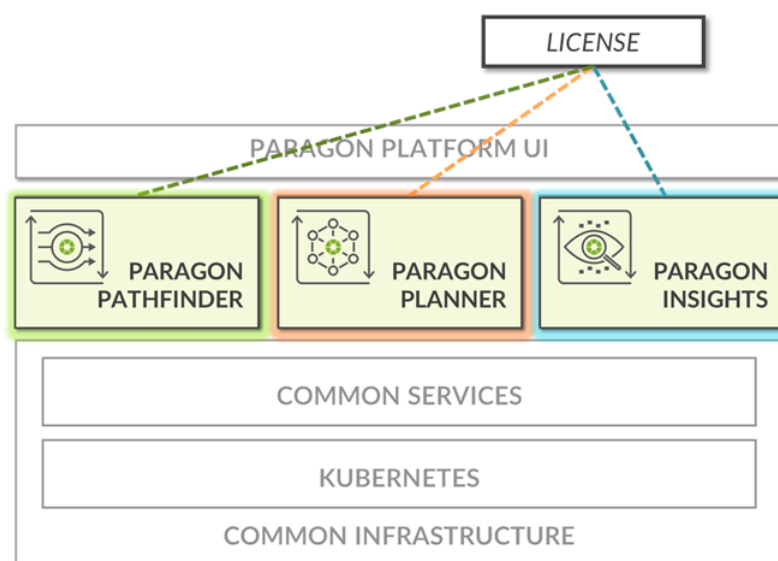
This guide describes how to install Paragon Automation and is intended for network operators and administrators who install, configure, and manage the network infrastructure. You deploy Paragon Automation as the following set of on-premises (customer managed) microservices-based applications:

- Paragon Insights (previously known as HealthBot)
- Paragon Planner (previously known as NorthStar Planner)
- Paragon Pathfinder (previously known as NorthStar Controller)

When you install Paragon Automation, you can install these three applications at the same time. After installation is complete, you can use these applications only if you have the software licenses installed.

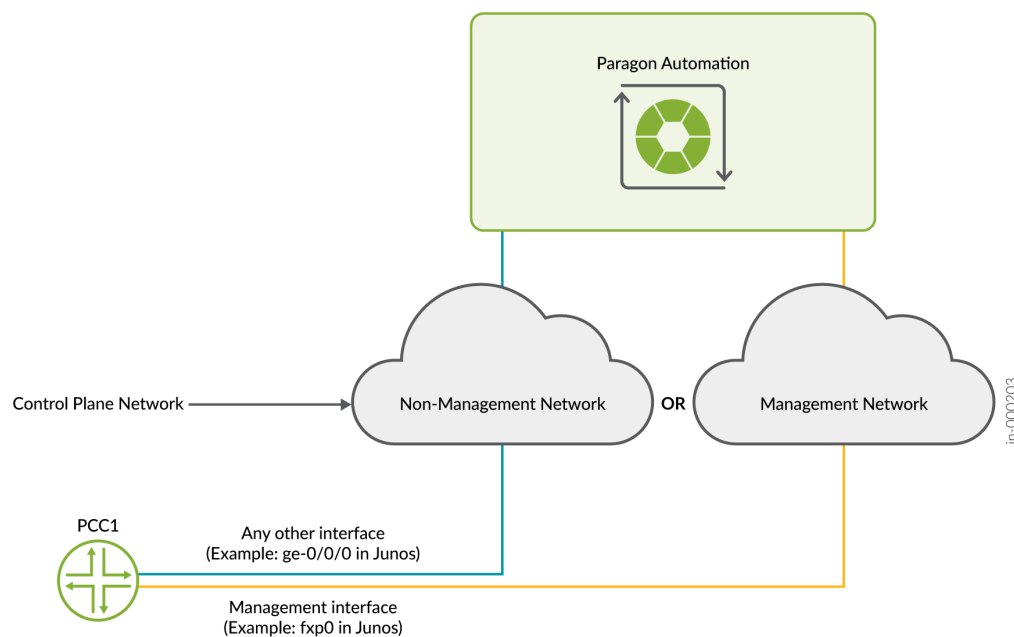
Paragon Automation can integrate with Anuta Networks ATOM platform, which supports EMS capabilities, to provide an improved WAN automation solution. Anuta ATOM is an external application that provides automated WAN assurance for L2VPN and L3VPN services. For more information, see [Integration with Anuta ATOM Overview](#).

Figure 1: Paragon Automation Portfolio



Communication between the different components of Paragon Automation, and between Paragon Automation and the managed devices as well as the network administrator, happens through a control plane network. The control plane network can be the same as the management network (over interfaces such as fxp0 in devices running Junos OS), or any other non-management network (over interfaces such as ge-0/0/0 in devices running Junos OS). This communication includes protocols and services such as Path Computation Element Protocol (PCEP), BGP Link State (BGP-LS), HTTPS (Web UI), system logging (syslog), SNMP, and NETCONF.

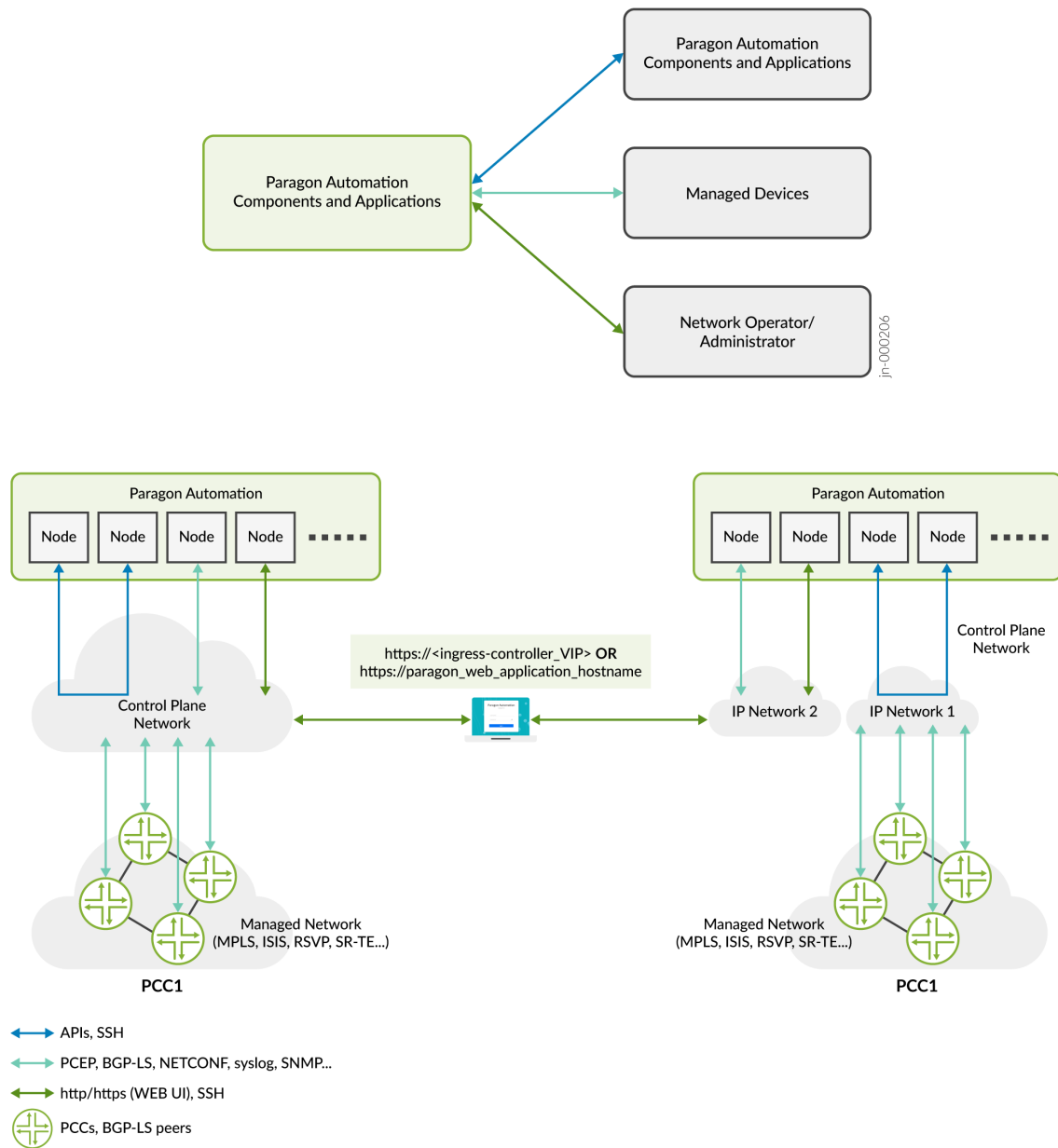
Figure 2: Communication Paths



Paragon Automation Deployment Architecture

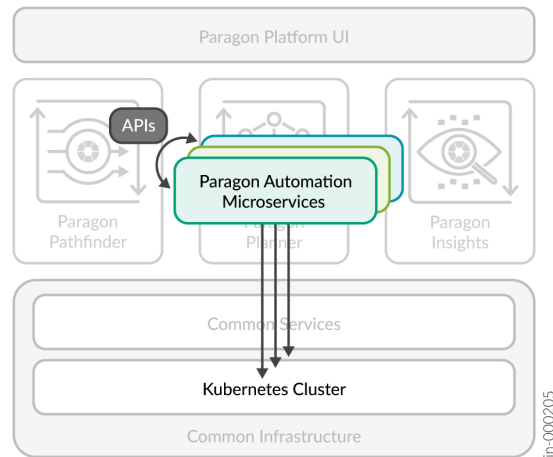
You can install Paragon Automation applications on a Kubernetes cluster, which you can access over a control plane network through a Web UI. [Figure 3 on page 4](#) illustrates typical Paragon Automation Deployment architectures and their communication protocols.

Figure 3: Deployment Architecture



The Paragon Automation Kubernetes cluster is a collection of microservices that interact with one another through APIs. The Kubernetes cluster comprises multiple nodes that are configured with different roles. For more information about roles, see ["Cluster Node Roles" on page 8](#).

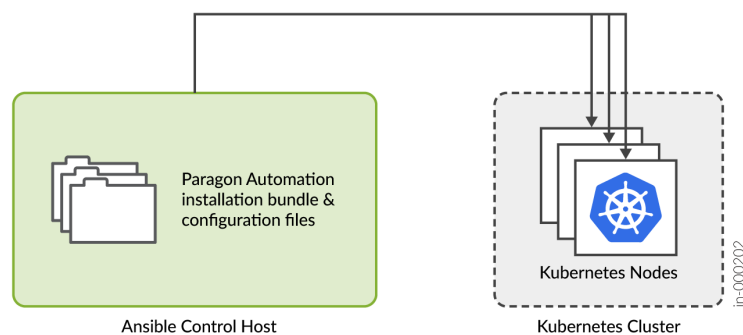
Figure 4: Kubernetes Cluster



Paragon Automation Installation

You use Ansible playbooks to automate the installation of Paragon Automation software. The playbooks install the required software on all the cluster nodes. These Ansible playbooks are packaged in a Docker image, and executed on a separate dedicated host (control host). The control host must have Docker installed and must be able to mount local directories into a Docker container. You must have a dedicated machine functioning as the control host.

Figure 5: Installation Overview



To install Paragon Automation, you:

- Download an installation bundle to the control host.
- Create and customize the required installation and configuration files.

- Run the installer on the control host.

The installation is controlled through several variables that are defined in the installation and configuration files created during the installation process. Based on these files, the Ansible playbooks deploy the Kubernetes cluster.

This guide explains how to:

- Install and upgrade Paragon Automation.
- Uninstall Paragon Automation.
- Add and remove nodes.
- Back up and restore a configuration.
- Migrate data from your existing setup to Paragon Automation.
- Perform common installation troubleshooting tasks.

RELATED DOCUMENTATION

Paragon Automation Overview

[Paragon Automation System Requirements](#) | 8

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CHAPTER

System Requirements

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Paragon Automation System Requirements

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- [Software Requirements | 13](#)
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- [Installation on VMs | 17](#)

Before you install the Paragon Automation software, ensure that your system meets the requirements that we describe in these sections.

To determine the resources required to implement Paragon Automation, you must understand the fundamentals of the Paragon Automation underlying infrastructure.

Paragon Automation is a collection of microservices that interact with one another through APIs and run within containers in a Kubernetes cluster. A Kubernetes cluster is a set of nodes or machines running containerized applications. Each node is a single machine, either physical (bare-metal server) or virtual (virtual machine).

The nodes within the cluster provide the following three different roles or functions depending on how they are configured.

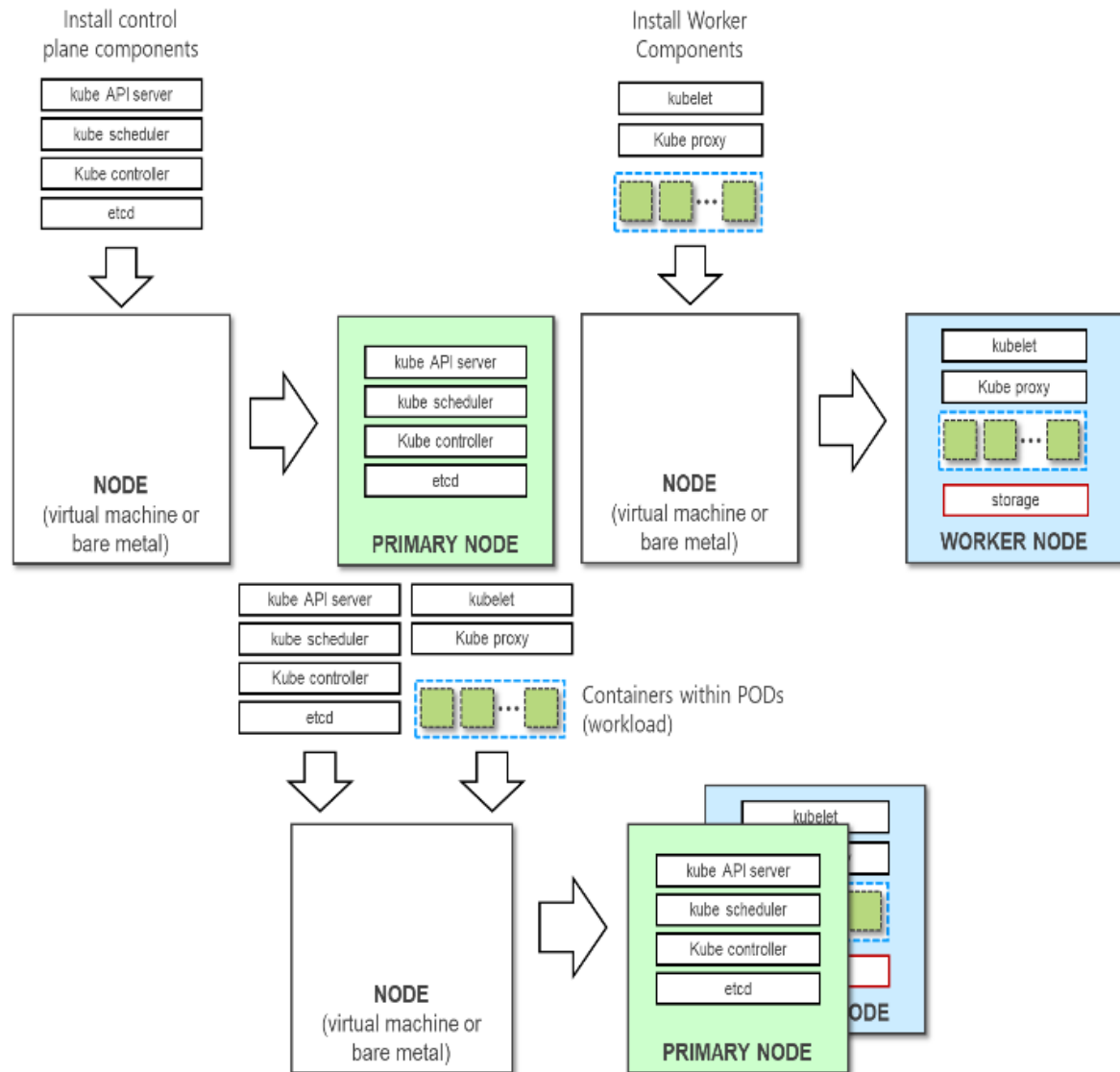
- **Control plane (primary) node**—Implements the control plane, which monitors the state of the cluster, manages the worker nodes, schedules application workloads, and manages the life cycle of the workloads.
- **Compute (worker) node**—Performs tasks that the control plane node assigns, and hosts the pods and containers that execute the application workloads. Each worker node hosts one or more pods that are collections of containers.

A node can function as both primary and worker.

- **Storage node**—Provides storage for objects, blocks, and files within the cluster. In Paragon Automation, Ceph provides storage services in the cluster. A storage node must be in a worker node, although not every worker node needs to provide storage.

For detailed information on minimum configuration for primary, worker, and storage nodes, see "[Paragon Automation Implementation](#)" on page 10 and "[Hardware Requirements](#)" on page 11.

Figure 6: Kubernetes Cluster Nodes and Roles



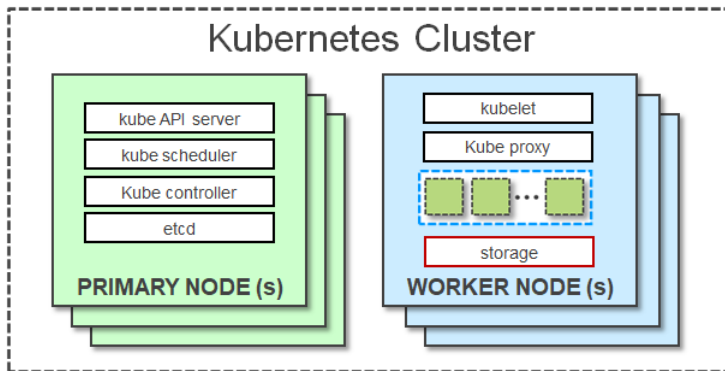
A Kubernetes cluster comprises several primary nodes and worker nodes. A single node can act as both primary and worker.

Information about the system's intended capacity, whether it needs high availability, and its expected performance help you determine the following cluster parameters:

- Total number of nodes (virtual or physical) in the cluster

- Amount of resources on each node (CPU, memory, and disk space)
- Number of nodes acting as primary, worker, and storage nodes

Figure 7: Kubernetes Cluster



Paragon Automation Implementation

You implement Paragon Automation on top of a Kubernetes cluster. A Paragon Automation implementation consists of one or more primary nodes and one or more worker nodes. You require a minimum of one primary node and one worker node for a functional cluster. You can implement Paragon Automation in two different ways:

- **Single-node implementation**—A single-node implementation comprises one node, either a virtual machine (VM) or a bare-metal server (BMS), acting as primary, worker, and storage node. When you install Paragon Automation with a single node, you must configure the node as "master" in the `inventory.yml` file and also select Master Scheduling during installation. For more information see, ["Install Single-Node Cluster on Ubuntu" on page 57](#), ["Install Single-Node Cluster on CentOS" on page 117](#), or ["Install Single-Node Cluster on Red Hat Enterprise Linux" on page 172](#).

NOTE: You must use a single-node setup only as proof of concept (POC) or for lab deployment and not for production deployments.

- **Multinode Implementation**—A multinode implementation comprises multiple nodes, either VMs or BMSs, where at least one node acts as primary and another node acts as worker and provides storage. You can implement high availability with a multinode implementation as follows:
 - **Control plane high availability**—For control plane redundancy, you must have a minimum of three primary nodes. You can add more primary nodes as long as the total number of primary nodes is an **odd** number.

When you install Paragon Automation with multiple primary nodes, you must configure a Kubernetes Master Virtual IP address and select the Install Loadbalancer for Master Virtual IP address option during installation. For more information, see ["Install Multinode Cluster on Ubuntu" on page 36](#), ["Install MultiNode Cluster on CentOS" on page 97](#), or ["Install Multinode Cluster on Red Hat Enterprise Linux" on page 152](#).

- **Workload high availability**—For workload high availability and workload performance, you must have more than one worker. You can add more workers to the cluster as needed.
- **Storage high availability**—For storage high availability, you must have at least three nodes for Ceph storage. You must enable Master Scheduling during installation if you want any of the primary nodes to provide Ceph storage. Enabling master scheduling allows the primary to act as a worker as well.

You could implement a setup that provides redundancy in different ways, as shown in the examples in [Figure 8 on page 11](#).

Figure 8: Multinode Redundant Setups



NOTE: For Paragon Automation production deployments, we recommend that you have a fully redundant setup with a minimum of three primary nodes (multi-primary node setup), and a minimum of three worker nodes providing Ceph storage. You must enable Master Scheduling during the installation process.

Hardware Requirements

This section lists the minimum hardware resources required for the Ansible control host node and the primary and worker nodes of a Paragon Automation cluster.

The compute, memory, and disk requirements of the Ansible control host node are not dependent on the implementation type (single or multinode) of the cluster or the intended capacity of the system. The following table shows the requirements for the Ansible control host node:

Table 1: Minimum Hardware Requirement for the Ansible Control Host Node

Node	Minimum Hardware Requirement	Storage Requirement	Role
Ansible control host	2–4-core CPU, 12-GB RAM, 100-GB HDD	No disk partitions or extra disk space required	Carry out Ansible operations to install the cluster.

In contrast, the compute, memory, and disk requirements of the cluster nodes vary widely based on the implementation type (single-node or multinode) and the intended capacity of the system. The intended capacity includes the number of devices to be monitored, type of sensors, frequency of telemetry messages, and number of playbooks and rules. If you increase the number of device groups, devices, or playbooks, you'll need higher CPU and memory capacities.

The following table summarizes the minimum hardware resources required per node for a successful installation of a multinode cluster.

Table 2: Minimum Hardware Requirements Per Node for Multinode Deployments

Node	Minimum Hardware Requirement	Storage Requirement	Role
Primary or worker node	8-core CPU, 32-GB RAM, 200 GB including Ceph storage Minimum 1000 IOPS for the disks	The cluster must include a minimum of three storage nodes. Each node must have an unformatted disk partition or a separate unformatted disk, with at least 30-GB space, for Ceph storage. See "Disk Requirements" on page 14.	Kubernetes primary or worker node

The following table summarizes the minimum hardware resources required for successful installation of a single-node cluster.

Table 3: Minimum Hardware Requirements Per Node for Single-Node Deployments

Node	Minimum Hardware Requirement	Storage Requirement	Role
Primary or worker node	8-core CPU, 32-GB RAM, 200-GB storage (including Ceph storage) Minimum 1000 IOPS for the disks	The node must have an unformatted disk partition or a separate unformatted disk, with minimum 30-GB space, for Ceph storage. See "Disk Requirements" on page 14.	Kubernetes primary or worker node

NOTE: SSDs are mandatory on bare-metal servers.

Here, we've listed only minimum requirements for small deployments supporting up to two device groups. In such deployments, each device group may comprise two devices and two to three playbooks across all Paragon Automation components. See [Paragon Automation User Guide](#), for information about devices and device groups.

NOTE: To get a scale and size estimate of a production deployment and to discuss detailed dimensioning requirements, contact your Juniper Partner or Juniper Sales Representative.

Software Requirements

- You must install a base OS of Ubuntu version 18.04.04 or later, CentOS version 7.6 or later, or RHEL version 8.3 or later on all nodes. All the nodes must run the same OS (Ubuntu, CentOS, or RHEL) version of Linux.

Paragon Automation Release 22.1 is qualified to work with the following OS versions:

- Ubuntu versions 18.04.05 LTS (Bionic Beaver) and 20.04.4 LTS (Focal Fossa)
- RHEL version 8.4
- You must install Docker on the Ansible control host. The control host is where the installation packages are downloaded and the Ansible installation playbooks are executed. For more information,

see ["Installation Prerequisites on Ubuntu" on page 20](#), ["Installation Prerequisites on CentOS" on page 80](#), or ["Installation Prerequisites on Red Hat Enterprise Linux" on page 137](#).

If you are using Docker CE, we recommend version 18.09 or later.

If you are using Docker EE, we recommend version 18.03.1-ee-1 or later. Also, to use Docker EE, you must install Docker EE on all the cluster nodes acting as primary and worker nodes in addition to the control host.

Docker enables you to run the Paragon Automation installer file, which is packaged with Ansible (version 2.9.5) as well as the roles and playbooks that are required to install the cluster.

NOTE: Installation will fail if you don't have the correct versions. We've described the commands to verify these versions in subsequent sections in this guide.

Disk Requirements

The following disk requirements apply to the primary and worker nodes, in both single-node and multinode deployments:

- Disk must be SSD.
- Required partitions:
 - You must mount the root partition at `/`.

You can create one single root partition with at least 170-GB space.

Alternatively, you can create a root partition with at least 30-GB space and a data partition with at least 140-GB space. You must mount the data partition at `/export`. You must also bind-mount the system directories `/var/local` and `/var/lib/docker` in the same partition. For example:

```
# mkdir -p /export/docker /var/lib/docker /export/local /var/local
# vi /etc/fstab
[...]
/export/docker /var/lib/docker none bind 0 0
/export/local /var/local none bind 0 0
[...]

# mount -a
```

You use the data partition mounted at **/export** for Postgres, ZooKeeper, Kafka, and Elasticsearch.
You use the data partition mounted at **/var/local** for Paragon Insights Influxdb.

- The unformatted partition for Ceph storage must have at least 30-GB space.

NOTE: Instead of using this partition, you can use a separate unformatted disk with at least 30-GB space for Ceph storage.

Network Requirements

- All nodes must run NTP or other time-synchronization at all times.
- An SSH server must be running on all nodes. You need a common SSH username and password for all nodes.
- You must configure DNS on all nodes.
- All nodes need Internet connection. If the cluster nodes do not have Internet connection, you can use the air-gap method for installation. The air-gap method is supported only on nodes with RHEL as the base OS.
- You must allow intercluster communication between the nodes. In particular, you must keep the ports listed in [Table 4 on page 15](#) open for communication. Ensure that you check for any iptables entry on the servers that might be blocking any of these ports.

Table 4: Ports That Firewalls Must Not Block

Port Numbers	Purpose
Enable these ports on all cluster nodes for administrative user access.	
80	HTTP (TCP)
443	HTTPS (TCP)
7000	Paragon Planner communications (TCP)
Enable these ports on all cluster nodes for communication with network elements.	

Table 4: Ports That Firewalls Must Not Block *(Continued)*

Port Numbers	Purpose
67	ztpservicedhcp (UDP)
161	SNMP, for telemetry collection (UDP)
162	ingest-snmp-proxy-udp (UDP)
11111	hb-proxy-syslog-udp (UDP)
4000	ingest-jti-native-proxy-udp (UDP)
830	NETCONF communication (TCP)
7804	NETCONF callback (TCP)
4189	PCEP Server (TCP)
30000-32767	Kubernetes port assignment range (TCP)
Enable communication between cluster nodes on all ports. At the least, open the following ports.	
6443	Communicate with worker nodes in the cluster (TCP)
3300	ceph (TCP)
6789	ceph (TCP)
6800-7300	ceph (TCP)
6666	calico etcd (TCP)
2379	etcd client requests (TCP)
2380	etcd peer communication (TCP)
9080	cephcsi (TCP)
9081	cephcsi (TCP)

Table 4: Ports That Firewalls Must Not Block *(Continued)*

Port Numbers	Purpose
7472	metallb (TCP)
7964	metallb (TCP)
179	calico (TCP)
10250-10256	Kubernetes API communication (TCP)
Enable this port between the control host and the cluster nodes.	
22	TCP

Web Browser Requirements

[Table 5 on page 17](#) lists the 64-bit Web browsers that support Paragon Automation.

Table 5: Supported Web Browsers

Browser	Supported Versions	Supported OS Versions
Chrome	85 and later	Windows 10
Firefox	79 and later	Windows 10
Safari	14.0.3	MacOS 10.15 and later

Installation on VMs

Paragon Automation can be installed on virtual machines (VMs). The VMs can be created on any Hypervisor, but must fulfill all the size, software, and networking requirements described in this topic.

The VMs must have the recommended base OS installed. The installation process for VMs and bare-metal servers is the same.

RELATED DOCUMENTATION

[Installation Prerequisites on CentOS | 80](#)

[Install MultiNode Cluster on CentOS | 97](#)

[Installation Prerequisites on Ubuntu | 20](#)

[Install Multinode Cluster on Ubuntu | 36](#)

3

CHAPTER

Install Paragon Automation On Ubuntu

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[Install Multinode Cluster on Ubuntu | 36](#)

[Install Single-Node Cluster on Ubuntu | 57](#)

[Modify cRPD Configuration | 75](#)

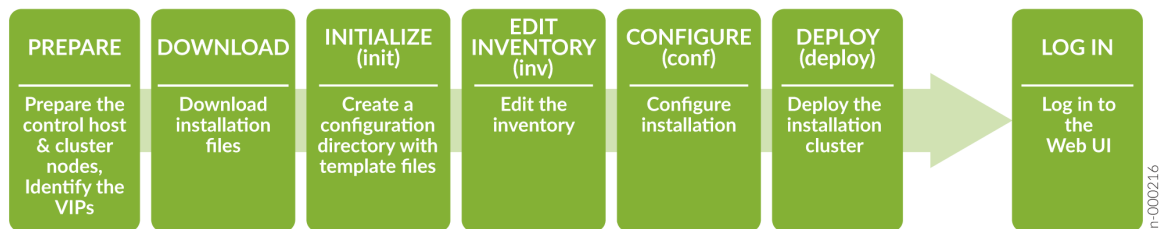
Installation Prerequisites on Ubuntu

IN THIS SECTION

- [Prepare the Control Host | 21](#)
- [Prepare Cluster Nodes | 23](#)
- [Virtual IP Address Considerations | 28](#)
- [Configure DNS Server \(Optional\) | 36](#)

To successfully install and deploy a Paragon Automation cluster, you must have a control host that installs the distribution software on a single node or on multiple cluster nodes. You can download the distribution software on the control host and then create and configure the installation files to run the installation from the control host. You must have **Internet access** to download the packages on the control host. You must also have Internet access on the cluster nodes to download any additional software such as Docker and OS patches. The order of installation tasks is shown at a high level in [Figure 9 on page 20](#).

Figure 9: High-Level Process Flow for Installing Paragon Automation



Before you download and install the distribution software, you must configure the control host and the cluster nodes as described in this topic.

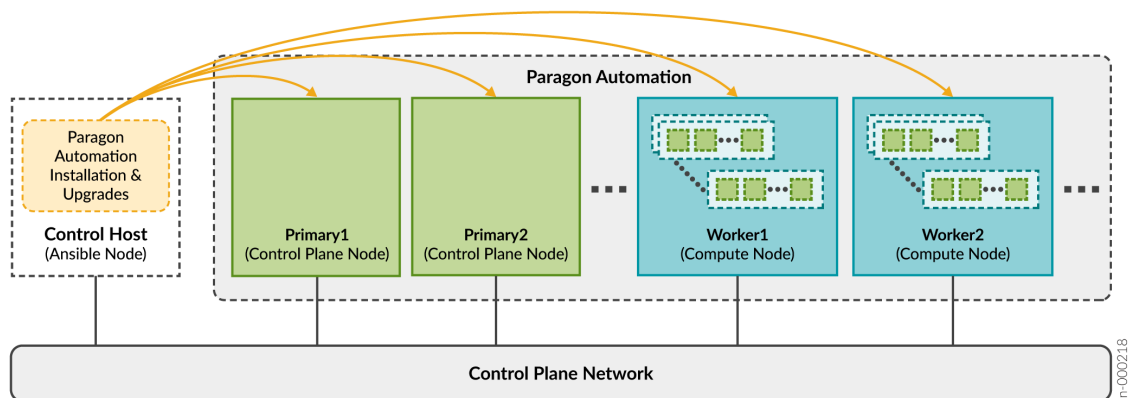
Prepare the Control Host

The control host is a dedicated machine that orchestrates the installation and upgrade of a Paragon Automation cluster. It carries out the Ansible operations that run the software installer and install the software on the cluster nodes as illustrated in [Control Host Functions on page 21](#).

You must download the installer packages on the Ansible control host. As part of the Paragon Automation installation process, the control host installs any additional packages required on the cluster nodes. The packages include optional OS packages, Docker, and Elasticsearch. All microservices, including third-party microservices, are downloaded onto the cluster nodes. The microservices do not access any public registries during installation.

The control host can be on a different broadcast domain from the cluster nodes, but you must ensure that the control host can use SSH to connect to all the nodes.

Figure 10: Control Host Functions



After installation is complete, the control host plays no role in the functioning of the cluster. However, you'll need the control host to update the software or any component, make changes to the cluster, or reinstall the cluster if a node fails. You can also use the control host to archive configuration files. We recommend that you keep the control host available, and not use it for something else, after installation.

Prepare the control host for the installation process as follows:

- 1. Install the base OS**—Install Ubuntu version 18.04.04 (or later). Paragon Automation Release 22.1 is qualified to work with Ubuntu versions 18.04.05 LTS (Bionic Beaver) and 20.04.4 LTS (Focal Fossa).
- 2. Install Docker**—Install and configure Docker on the control host to implement the Linux container environment. Paragon Automation supports Docker CE and Docker EE. The Docker version you choose to install in the control host is independent of the Docker version you plan to use in the cluster nodes.

If you want to install Docker EE, ensure that you have a trial or subscription before installation. For more information about Docker EE, supported systems, and installation instructions, see <https://www.docker.com/blog/docker-enterprise-edition/>.

To download and install Docker CE, perform the following steps:

```
# sudo apt-get install -y apt-transport-https ca-certificates curl gnupg-agent software-properties-common
# curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo apt-key add -
# sudo add-apt-repository "deb [arch=amd64] https://download.docker.com/linux/ubuntu $(lsb_release -cs) stable"
# sudo apt-get update
# sudo apt-get install -y docker-ce docker-ce-cli containerd.io
```

To verify that Docker is installed and running, use the `# docker run hello-world` command.

To verify the Docker version installed, use the `# docker version` or `# docker --version` commands.

For full instructions and more information, see <https://docs.docker.com/engine/install/ubuntu/>.

- 3. Configure SSH client authentication**—The installer running on the control host connects to the cluster nodes using SSH. For SSH authentication, you must use a root or non-root user account with superuser (sudo) privileges. We will refer to this account as the install user account in subsequent steps. You must ensure that the install user account is configured on **all** the nodes in the cluster. The installer will use the inventory file to determine which username to use, and whether the authentication will use SSH keys or a password. See [Customize the Inventory File - Multinode Implementation](#) or [Customize the Inventory File - Single Node Implementation](#).

If you choose the `ssh-key` authentication (recommended) method, generate the SSH key.

```
# cd ~/.ssh
# ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/root/.ssh/id_rsa):    <= ENTER (use default)
Enter passphrase (empty for no passphrase):                <= ENTER (no passphrase)
Enter same passphrase again:                                <= ENTER (no passphrase)
Your identification has been saved in /root/.ssh/id_rsa.
Your public key has been saved in /root/.ssh/id_rsa.pub.
The key fingerprint is:
SHA256:YS8cWopND9RFnpHGqaI1Q8e5ca2fxP/yMVzZtIDINbg root@Control1
The key's randomart image is:
+---[RSA 2048]-----+
|  ..o *==+  |
|  ..= *o*oo  |
|  .o==*+. .  |
```

```
|  =+o0.Eo  ..+|
|  o.++ So.o  oo|
|  .      .o .. . |
|           .+  |
|           . .o |
|           o.  |
+----[SHA256]-----+
```

If you want to protect the SSH key with a passphrase, you can use `ssh-agent` key manager. See <https://www.ssh.com/academy/ssh/agent>.

NOTE: You'll need to copy this key to the nodes as part of the cluster nodes preparation tasks, as described in the next section.

4. **(Optional) Install `wget`**—Install the `wget` utility to download the Paragon Automation distribution software.

```
# apt install wget
```

Alternatively, you can use `rsync` or any other file download software to copy the distribution software.

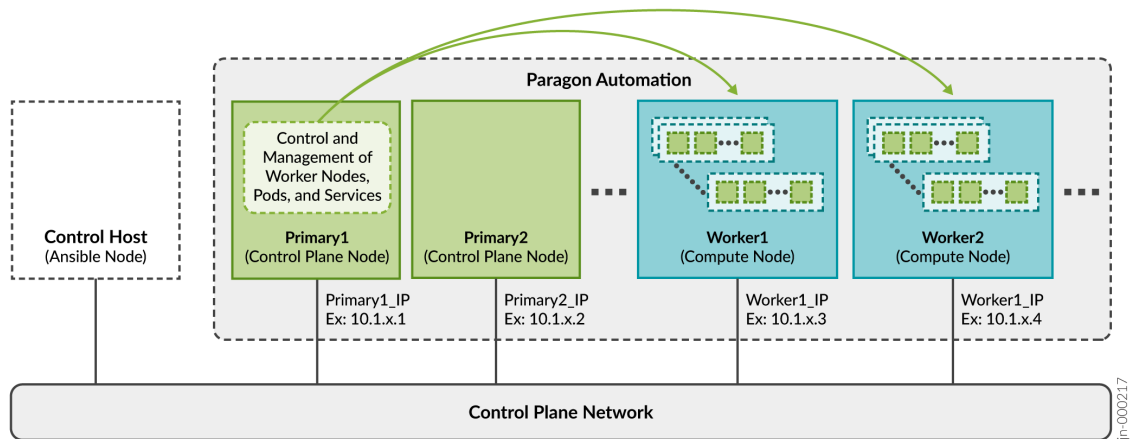
Prepare Cluster Nodes

The primary and worker nodes are collectively called *cluster nodes*. Each cluster node must have at least one unique static IP address, as illustrated in [Figure 11 on page 24](#). When configuring the hostnames, use only lowercase letters, and do not include any special characters other than hyphen (-) or the period (.). If the implementation has a separate IP network to provide communication between the Paragon Automation components, as described in the overview section, the IP addresses in that separate network do not need to be reachable outside the cluster. However, then you must assign a second set of IP addresses to the worker nodes. These IP addresses enable devices outside the cluster to reach the worker nodes and also enable communication between:

- Paragon Automation and the managed devices
- Paragon Automation and the network administrator

We recommend that you place all the nodes in the same broadcast domain. For cluster nodes in different broadcast domains, see ["Configure Load Balancing" on page 35](#) for additional load balancing configuration.

Figure 11: Cluster Node Functions



As described in "[Paragon Automation System Requirements](#)" on page 8, you can install Paragon Automation using a single-node or a multinode deployment. The node installation prerequisites are the same for both multinode and single-node deployments, except for storage requirements.

You need to prepare the cluster nodes for the Paragon Automation installation process as follows:

1. **Configure raw disk storage**—The cluster nodes must have raw storage block devices with unpartitioned disks or unformatted disk partitions attached. You can also partition the nodes such that the root partition and other file systems can use a portion of the disk space available. You must leave the remaining space unformatted, with no file systems, and reserve it for Ceph to use. For more information, see "[Disk Requirements](#)" on page 14.

NOTE: You don't need to install or configure anything to allow Ceph to use the unpartitioned disks or unformatted disk partitions. The Paragon Automation installation process automatically assigns the space for Ceph storage.

For multinode clusters, you must have a minimum of three cluster nodes with storage space attached. For a single-node cluster, the single node must have storage space.

Installation fails if unformatted disks are **not** available.

Ceph requires newer Kernel versions. If your Linux kernel is very old, consider upgrading or reinstalling a new one. For a list of minimum Linux kernel versions supported by Ceph for your OS, see <https://docs.ceph.com/en/latest/start/os-recommendations>. To upgrade your Linux kernel version, see [Upgrade your Ubuntu Linux Kernel Version](#).

NOTE: Ceph does not work on Linux kernel version 4.15.0-55.60.

2. **Install the base OS**—Install Ubuntu version 18.04.04 (or later) on all nodes. Paragon Automation Release 22.1 is qualified to work with Ubuntu versions 18.04.05 LTS (Bionic Beaver) and 20.04.4 LTS (Focal Fossa).
3. **Create install-user account**—The install user is the user that the Ansible playbooks use to log in to the primary and worker nodes and perform all the installation tasks. Ensure that you configure either a root password or an account with superuser (sudo) privileges. You will add this information to the **inventory** file during the installation process.

Set the root user password.

```
# passwd root
New password:
Retype new password:
passwd: password updated successfully
```

4. **Install SSH authentication**—The installer running on the control host connects to the cluster nodes through SSH using the install-user account.

- a. Log in to the cluster nodes. and install the open-ssh server on all nodes.
- b. Edit the **sshd_config** file.

```
# vi /etc/ssh/sshd_config
```

- c. If you are using "root" as the install-user account, then permit root login.

```
PermitRootLogin yes
```

If you chose to use plain text password for authentication, then you must enable password authentication.

```
PasswordAuthentication yes
```

We do not recommend the use of password authentication.

- d. Ensure that the **AllowTcpForwarding** parameter is set to yes.

```
AllowTcpForwarding yes
```

NOTE: Paragon Automation installation fails when the **AllowTcpForwarding** parameter is set to no.

- e. If you changed **/etc/ssh/sshd_config**, restart the SSH daemon.


```
# systemctl restart sshd
```

f. Log in to the control host:

- i. To allow authentication using the SSH key, copy **id_rsa.pub** to the cluster nodes.

```
# ssh-copy-id -i ~/.ssh/id_rsa.pub cluster-node-IP-or-hostname
```

Repeat this step for *all* the nodes in the cluster (primary and workers). *cluster-node-IP* is the unique address of the node as shown in [Figure 11 on page 24](#). If a hostname is used instead, the Ansible control host should be able to resolve the name to its IP address.

- ii. Use SSH authentication to log in to the cluster node using the install-user account. You must not need a password to log in.

You should be able to use SSH to connect to all nodes in the cluster (primary and workers) from the control host using the install-user account. If you are not able to log in, review the previous steps and make sure that you didn't miss anything.

5. **Install Docker**—Select one of the following Docker versions to install.

- Docker CE—If you want to use Docker CE, you do *not* need to install it on the cluster nodes. The deploy script installs Docker CE on the nodes during Paragon Automation installation.
- Docker EE—If you want to use Docker EE, you *must* install Docker EE on *all* the cluster nodes. If you install Docker EE on the nodes, the deploy script uses the installed version and does not attempt to install Docker CE in its place. For more information about Docker EE and supported systems, and for instructions to download and install Docker EE, see <https://www.docker.com/blog/docker-enterprise-edition/>.

The Docker version you choose to install in the cluster nodes is not dependent on the Docker version installed in the control host.

6. **Install Python**—Install Python 3, if it is not preinstalled with your OS, on the cluster nodes:

```
# apt install python3
```

To verify the Python version installed, use the `# python3 -V` or `# python3 --version` command.

7. Use the `# apt list --installed` command and ensure that the following packages are installed:

```
apt-transport-https, bash-completion, gdisk, iptables, lvm2, openssl
```

8. **Install and enable NTP**—All nodes must run Network Time Protocol (NTP) or any other time-synchronization protocol at all times. By default, Paragon Automation installs the Chrony NTP client. If you don't want to use Chrony, you can manually install NTP on all nodes.

- a. Install `ntpd` to synchronize date and time by querying an NTP server.

```
# apt install ntpdate -y
```

- b. Run the following command twice to reduce the offset with the NTP server.

```
# ntpdate ntp-server
```

- c. Install the NTP protocol.

```
# apt install ntp -y
```

- d. Configure the NTP server pools.

```
# vi /etc/ntp.conf
```

- e. Replace the default Ubuntu pools with the NTP server closest to your location in the `ntp.conf` file.

```
server ntp-server prefer iburst
```

Save and exit the file.

- f. Restart the NTP service.

```
# systemctl restart ntp
```

- g. Confirm that the system is in sync with the NTP server.

```
# timedatectl
```

9. **(Optional) Upgrade your Ubuntu Linux kernel version** To upgrade the kernel version of your Ubuntu server to the latest LTS version to meet the requirements for Paragon Automation installation:

- a. Log in as the root user.

- b. Check the existing kernel version.

```
root@server# uname -msr
```

If the Linux kernel version is earlier than 4.15, upgrade the kernel.

- c. Update apt repositories:

```
root@server# apt update
```

- d. Upgrade existing software packages, including kernel upgrades:

```
root@server# apt upgrade -y
```

```
root@server# apt install --install-recommends linux-generic-hwe-xx.xx
```

Here, `xx.xx` is your Ubuntu OS version.

- e. Reboot the server to load the new kernel:

```
root@server# reboot
```

- f. Verify the new kernel version:

```
root@server# uname -msr
```

Virtual IP Address Considerations

IN THIS SECTION

- [VIP Address for Multi-Primary Node Deployment | 34](#)
- [Configure Load Balancing | 35](#)

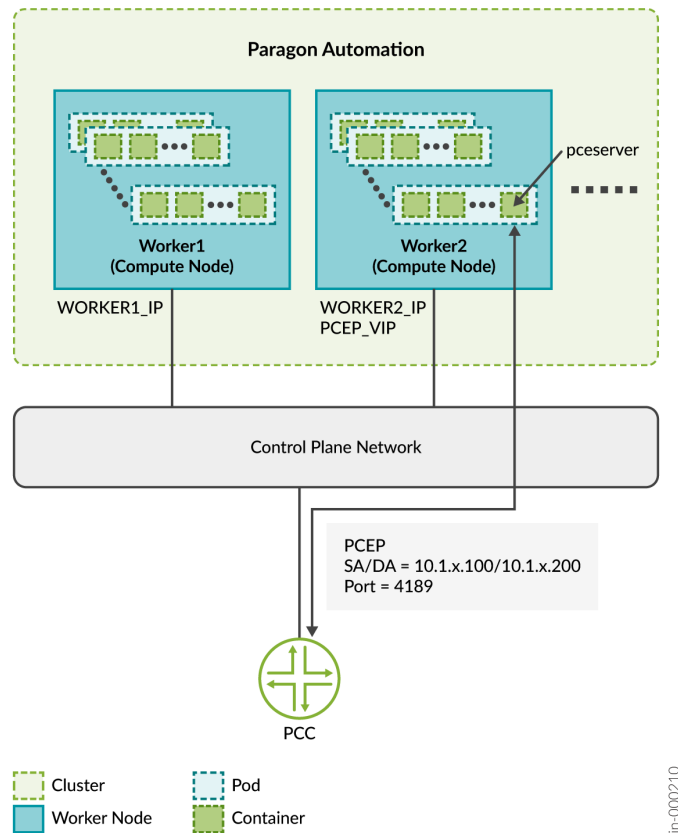
The Kubernetes worker nodes host the pods that handle the workload of the applications.

A pod is the smallest deployable unit of computing created and managed in Kubernetes. A pod contains one or more containers, with shared storage and network resources, and with specific instructions on how to run the applications. Containers are the lowest level of processing, and you execute applications or microservices in containers.

The primary node in the cluster determines which worker node will host a particular pod and containers.

You implement all features of Paragon Automation using a combination of microservices. You need to make some of these microservices accessible from outside the cluster as they provide services to end users (managed devices) and administrators. For example, you must make the pceserver service accessible to establish PCEP sessions between provider edge (PE) routers and Paragon Automation.

You need to expose these services outside of the Kubernetes cluster with specific addresses that are reachable from the external devices. Because a service can be running on any of the worker nodes at a given time, you must use virtual IP addresses (VIPs) as the external addresses. You must not use the address of any given worker node as an external address.



In this example:

- Consider that Worker 1 is 10.1.x.3 and Worker 2 is 10.1.x.4.
- SERVICE IP = PCEP VIP is 10.1.x.200
- PCC_IP is 10.1.x.100

Paragon Automation services use one of two methods of exposing services outside the cluster:

- **Load balancer**—Each load balancer is associated with a specific IP address and routes external traffic to a specific service in the cluster. This is the default method for many Kubernetes installations in the cloud. The load balancer method supports multiple protocols and multiple ports per service. Each service has its own load balancer and IP address.
- Paragon Automation uses the MetalLB load balancer. MetalLB simulates external load balancer by either managing virtual IP addresses in Layer 2 mode, or interacts with external router(s) in Layer 3 mode. MetalLB provides load-balancing infrastructure to the Kubernetes cluster.

Services of type "LoadBalancer" will interact with the Kubernetes load-balancing infrastructure to assign an externally reachable IP address. Some services can share an external IP address.

- **Ingress**—The ingress method acts as a proxy to bring traffic into the cluster, and then uses internal service routing to route the traffic to its destination. Under the hood, this method also uses a load balancer service to expose itself to the world so it can act as that proxy.

Paragon Automation uses the following ingress proxies:

- Ambassador
- Nginx

Devices from outside the cluster need to access the following services and thus these services require a VIP address.

Table 6: Services That Need VIPs

Required VIP Address	Description	Load Balancer/Proxy
Ingress controller	Used for accessing the Paragon Automation GUI over the Web. Paragon Automation provides a common Web server that provides access to the components and applications. Access to the server is managed through the Kubernetes Ingress Controller.	Ambassador MetalLB
Paragon Insights services	Used for Insights services such as syslog, DHCP relay, and JTI.	MetalLB
Paragon Pathfinder PCE server	Used to establish PCEP sessions with devices in the network.	MetalLB
SNMP trap receiver proxy (Optional)	User for the SNMP trap receiver proxy only if this functionality is required.	MetalLB

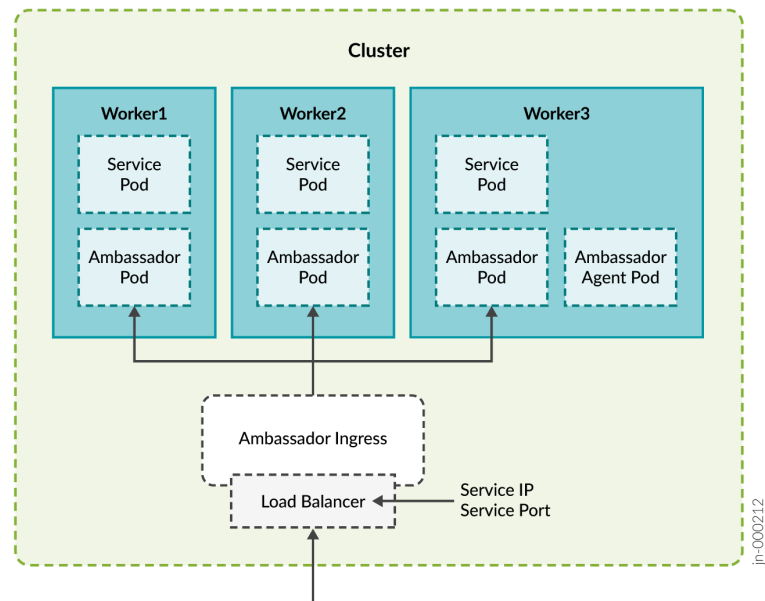
Table 6: Services That Need VIPs *(Continued)*

Required VIP Address	Description	Load Balancer/Proxy
VIP for Infrastructure Nginx Ingress Controller	<p>Used as a proxy for the Paragon Pathfinder netflowd server and, optionally, the Paragon Pathfinder PCE server.</p> <p>The Nginx Ingress Controller needs a VIP within the MetalLB load balancer pool. This means that during the installation process you need to include this address as part of the LoadBalancer IP address ranges that you will be required to include while creating the configuration file.</p>	<p>Nginx</p> <p>MetalLB</p>
Virtual IP address for Pathfinder Netflowd	<p>Used for Paragon Pathfinder netflowd server.</p> <p>Netflowd can use Nginx as proxy, in which case it will not require its own VIP address.</p>	MetalLB

Ports used by Ambassador:

- HTTP 80 (TCP) redirect to HTTPS
- HTTPS 443 (TCP)
- Paragon Planner 7000 (TCP)
- DCS/NETCONF initiated 7804 (TCP)

Figure 12: Ambassador



Ports used by Insights Services, PCE server, and SNMP:

- **Insights Services**

JTI 4000 (UDP)

DHCP (ZTP) 67 (UDP)

SYSLOG 514 (UDP)

SNMP proxy 162 (UDP)

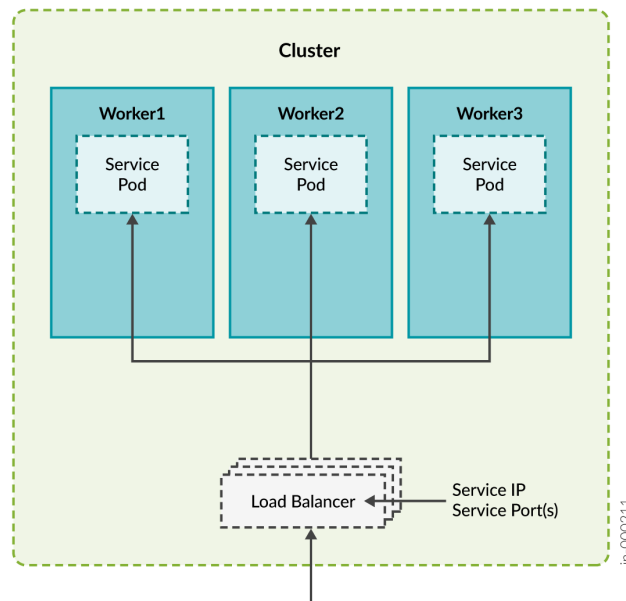
- **PCE Server**

PCEP 4189 (TCP)

- **SNMP**

SNMP Trap Receiver 162 (UDP)

Figure 13: Ports Used by Services



Ports used by Nginx Controller:

- NetFlow 9000 (UDP)
- PCEP 4189 (TCP)

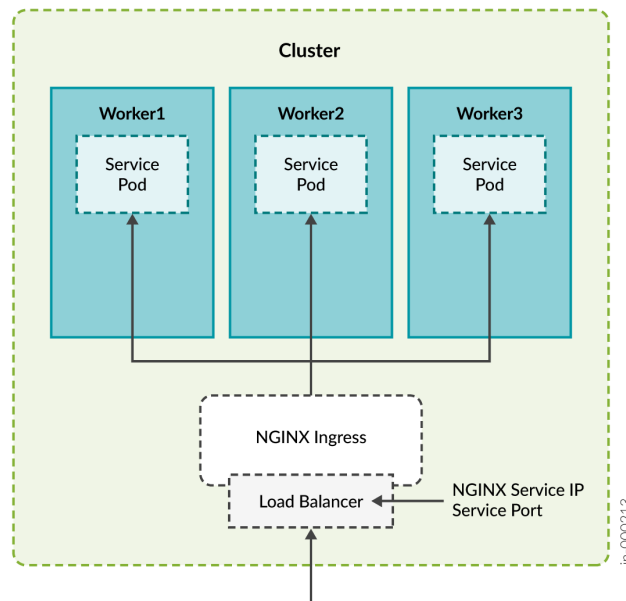
Using Nginx for PCEP

During the installation process, you will be asked whether you want to enable ingress proxy for PCEP. You can select from None or Nginx-Ingress as the proxy for the Path Computation Element (PCE) server.

If you select Nginx-Ingress as the proxy, you do *not* need to configure the VIP for the PCE server described in [Table 6 on page 30](#). In this case, the VIP address for Infrastructure Nginx Ingress Controller is used for the PCE server also. If you choose to not use a netflowd proxy, the VIP for the Infrastructure Nginx Ingress Controller is used for netflowd, as well.

NOTE: The benefit of using Nginx is that you can use a single IP address for multiple services.

Figure 14: Nginx Controller



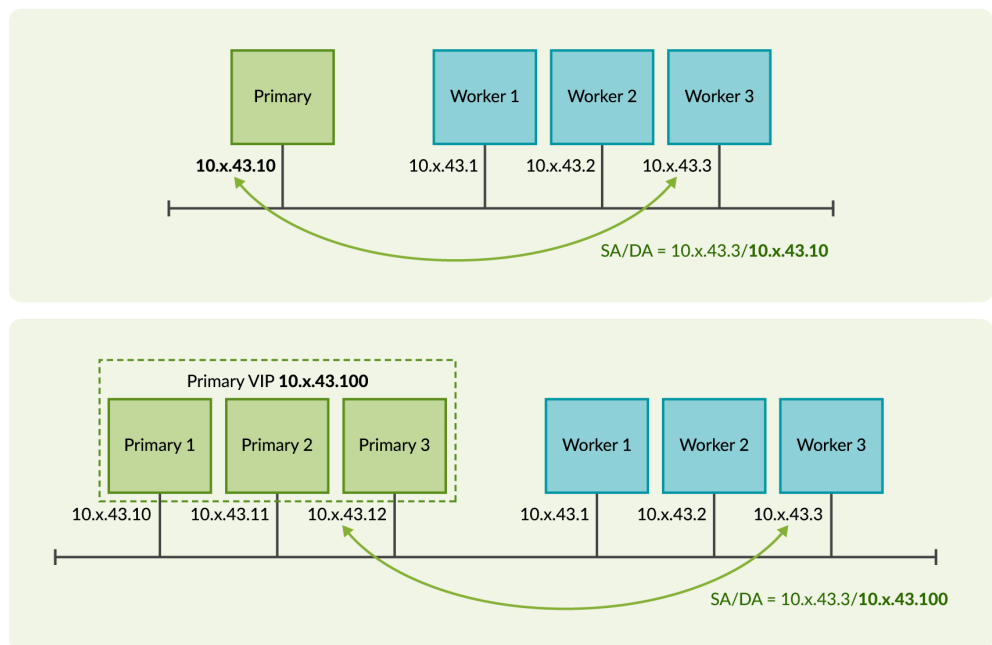
VIP Address for Multi-Primary Node Deployment

If you are deploying a setup with multiple primary nodes, you need an additional VIP address in the same broadcast domain as the cluster nodes. This address will be used for communication between the elected primary node and the worker nodes.

In a multi-primary setup, the worker node communicates with the primary function using the VIP address, instead of the address assigned to any of the nodes acting as primary.

The installation wizard refers to this IP address as the Kubernetes Master Virtual IP address. The VIP address pool of the MetalLB load balancer must *not* contain this VIP address.

In a setup with a single primary node, the worker node communicates with the primary node using the address assigned to that node acting as primary (IP address configured on the interface of the node acting as primary).



NOTE: You must identify all the required VIP addresses before you start the Paragon Automation installation process. You will be asked to enter these addresses as part of the installation process.

Configure Load Balancing

VIPs are managed in Layer 2 by default. When all cluster nodes are in the same broadcast domain, each VIP address is assigned to one cluster node at a time. Layer 2 mode provides fail-over of the VIP and does not provide actual load balancing. For true load balancing between the cluster nodes or if the nodes are in different broadcast domains, you must configure load balancing in Layer 3.

You must configure a BGP router to advertise the VIP address to the network. Make sure that the BGP router uses ECMP to balance TCP/IP sessions between different hosts. Connect the BGP router directly to the cluster nodes.

To configure load balancing on the cluster nodes, edit the **config.yml** file. For example:

```
metallb_config:
  peers:
    - peer-address: 192.x.x.1 ## address of BGP router
      peer-asn: 64501 ## autonomous system number of BGP router
      my-asn: 64500 ## ASN of cluster
```

```
address-pools:
  - name: default
    protocol: bgp
    addresses:
      - 10.x.x.0/24
```

In this example, The BGP router at 192.x.x.1 is responsible for advertising reachability of the VIP addresses with the 10.x.x.0/24 prefix to the rest of the network. The cluster allocates the VIP address of this range and advertises the address for the cluster nodes that can handle the address.

Configure DNS Server (Optional)

You can access the main Web gateway either through the ingress controller's VIP address or through a hostname that is configured in the Domain Name System (DNS) server that resolves to the ingress controller's VIP address. You need to configure the DNS server only if you want to use a hostname to access the Web gateway.

Add the hostname to the DNS as an A, AAAA, or CNAME record. For lab and Proof of Concept (POC) setups, you can add the hostname to the `/etc/hosts` file on the cluster nodes.

RELATED DOCUMENTATION

[Install Multinode Cluster on Ubuntu | 36](#)

[Install Single-Node Cluster on Ubuntu | 57](#)

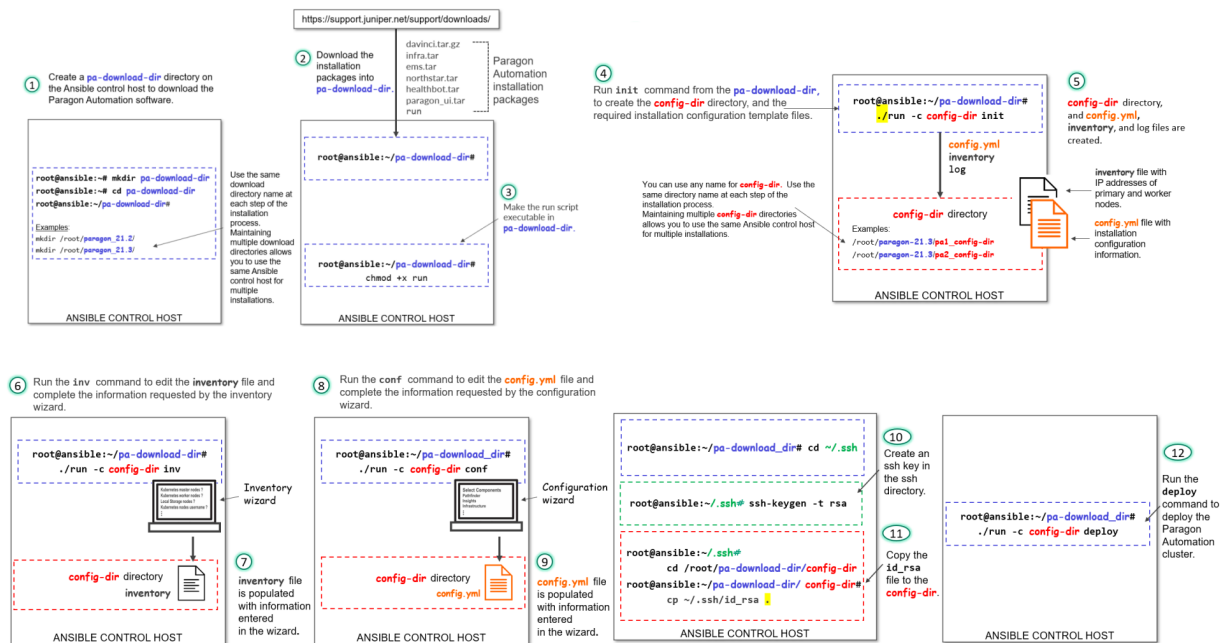
Install Multinode Cluster on Ubuntu

IN THIS SECTION

- [Download the Paragon Automation Software | 37](#)
- [Install Paragon Automation as a Multinode Cluster | 38](#)
- [Log in to the Paragon Automation UI | 56](#)

Read the following topics to learn how to install Paragon Automation on a multinode cluster with Ubuntu host OS. [Figure 15 on page 37](#) shows a summary of installation tasks at a high level. Ensure that you've completed the preconfiguration and preparation steps described in ["Installation Prerequisites on Ubuntu" on page 20](#) before you begin installation.

Figure 15: Installation Sequence - Infographic



To view a higher-resolution image in your Web browser, right-click the image and open in a new tab. To view the image in PDF, use the zoom option to zoom in.

Download the Paragon Automation Software

Prerequisite

- You need a Juniper account to download the Paragon Automation software.

1. Log in to the control host.

2. Create a directory in which you'll download the software.

We refer to this directory as *pa-download-dir* in this guide.

3. Select the version number from the **Version** list on the Paragon Automation software download page at <https://support.juniper.net/support/downloads/?p=pa>.

4. Download the **Paragon Automation Setup** installation files to the download folder using the `wget "http://cdn.juniper.net/software/file-download-uri"` command.

The Paragon Automation setup installation bundle consists of the following scripts and TAR files to install each of the component modules:

- **davinci.tar.gz**, which is the primary installer file.
- **infra.tar**, which installs the Kubernetes infrastructure components including Docker and Helm.
- **ems.tar**, which installs the base platform component.
- **northstar.tar**, which installs the Paragon Pathfinder and Paragon Planner components.
- **healthbot.tar**, which installs the Paragon Insights component.
- **paragon_ui.tar**, which installs the Paragon Automation UI component.
- **addons.tar**, which installs infrastructure components that are not part of the base Kubernetes installation. The infrastructure components include, IAM, Kafka, ZooKeeper, cert-manager, Ambassador, Postgres, Metrics, Kubernetes Dashboard, Open Distro for Elasticsearch, Fluentd, Reloader, ArangoDB, and Argo.
- **rhel-84-airgap.tar.gz**, which installs Paragon Automation using the air-gap method on nodes *only* where the base OS is Red Hat Enterprise Linux (RHEL).
- **run script**, which executes the installer image.

NOTE: The Paragon Automation setup installation bundle comprises of a **foghorn.tar** file. However, Foghorn is not supported in Release 22.1.

Now that you've downloaded the software, you're ready to install Paragon Automation.

Install Paragon Automation as a Multinode Cluster

To install Paragon Automation on a Kubernetes cluster of multiple primary and worker nodes:

1. Make the run script executable in the *pa-download-dir* directory.

```
# chmod +x run
```

2. Use the `run` script to create and initialize a configuration directory with the configuration template files.

```
# ./run -c config-dir init
```

config-dir is a user-defined directory on the control host that contains configuration information for a particular installation. The `init` command automatically creates the directory if it does not exist. Alternatively, you can create the directory before you execute the `init` command.

Ensure that you include the dot and slash (./) with the `run` command.

If you are using the same control host to manage multiple installations of Paragon Automation, you can differentiate between installations by using differently named configuration directories.

3. Ensure that the control host can connect to the cluster nodes through SSH using the `install-user` account.

Copy the private key that you generated in ["Configure SSH client authentication" on page 22](#) to the user-defined ***config-dir*** directory. The installer allows the Docker container to access the ***config-dir*** directory. The SSH key must be available in the directory for the control host to connect to the cluster nodes.

```
# cd config-dir
# cp ~/.ssh/id_rsa .
# cd ..
```

Ensure that you include the dot (.) at the end of the copy command (`cp`).

4. Customize the inventory file, available in the ***config-dir*** directory, with the IP addresses or hostnames of the cluster nodes, as well as the usernames and authentication information that are required to connect to the nodes. The inventory file is in the YAML format and describes the cluster nodes on which Paragon Automation will be installed. You can edit the file using the `inv` command or a Linux text editor such as `vi`.

- a. Customize the inventory file using the `inv` command:

```
# ./run -c config-dir inv
```

The following table lists the configuration options that the `inv` command prompts you to enter.

Table 7: *inv* Command Options

inv Command Prompts	Description
Kubernetes master nodes	Enter IP addresses of the Kubernetes primary nodes.
Kubernetes worker nodes	Enter IP addresses of the Kubernetes worker nodes.
Local storage nodes	<p>Define the nodes that have disk space available for applications. The local storage nodes are prepopulated with the IP addresses of the primary and worker nodes. You can edit these addresses. Enter IP addresses of the nodes on which you want to run applications that require local storage.</p> <p>Services such as Postgres, ZooKeeper, and Kafka use local storage or disk space partitioned inside export/local-volumes. By default, worker nodes have local storage available. If you do not add primary nodes here, you can run only those applications that do not require local storage on the primary nodes.</p> <p>NOTE: Local storage is different from Ceph storage.</p>
Kubernetes nodes' username (for example, root)	Configure the user account and authentication methods to authenticate the installer with the cluster nodes. The user account must be root or, in the case of non-root users, the account must have superuser (sudo) privileges.
SSH private key file (optional)	If you chose ssh-key authentication, for the control host to authenticate with the nodes during the installation process, configure the path to the config-dir directory where the ansible_ssh_private_key_file is located, and the id_rsa file, as config/id_rsa. This is because the path to the config-dir is mounted internally in the installer container at config. Alternatively, you can also use the default {{ inventory_dir }}/id_rsa.

Table 7: *inv* Command Options (Continued)

inv Command Prompts	Description
Kubernetes nodes' password (optional)	<p>If you chose password authentication for the control host to authenticate with the nodes during the installation process, enter the authentication password directly. WARNING: The password is written in plain text.</p> <p>We do <i>not</i> recommend using this option for authentication.</p>
Kubernetes cluster name (optional)	Enter a name for your Kubernetes cluster.
Write inventory file?	Click Yes to save the inventory information.

For example:

```
$ ./run -c config-dir inv
Loaded image: paragonautomation:latest
=====
PO-Runtime installer
=====

Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
  info [-mc]        cluster installation info

Starting now: inv

INVENTORY

This script will prompt for the DNS names or IP addresses of the Kubernetes master and
worker nodes.
Addresses should be provided as comma-delimited lists.

At least three master nodes are recommended. The number of masters should be an odd number.
```


A minimum of four nodes are recommended.

Root access to the Kubernetes nodes is required.

See https://docs.ansible.com/ansible/2.10/user_guide/intro_inventory.html

```
? Kubernetes master nodes 10.12.xx.x3,10.12.xx.x4,10.12.xx.x5
? Kubernetes worker nodes 10.12.xx.x6
? Local storage nodes 10.12.xx.x3,10.12.xx.x4,10.12.xx.x5,10.12.xx.x6
? Kubernetes nodes' username (e.g. root) root
? SSH private key file (optional; e.g. "{{ inventory_dir }}/id_rsa") config/id_rsa
? Kubernetes nodes' password (optional; WARNING - written as plain text)
? Kubernetes cluster name (optional) k8scluster
? Write inventory file? Yes
```

- b. Alternatively, you can customize the inventory file manually using a text editor.

```
# vi config-dir/inventory
```

Edit the following groups in the **inventory** file.

- i. Add the IP addresses of the Kubernetes primary and worker nodes of the cluster.

The `master` group identifies the primary nodes, and the `node` group identifies the worker nodes. You cannot have the same IP address in both `master` and `node` groups.

To create a multi-primary node setup, list the addresses or hostnames of all the nodes that will be acting as primary under the `master` group. Add the addresses or hostnames of the nodes that will be acting as workers under the `node` group.

```
master:
  hosts:
    10.12.xx.x3: {}
    10.12.xx.x4: {}
    10.12.xx.x5: {}
node:
  hosts:
    10.12.xx.x6: {}
```

- ii. Define the nodes that have disk space available for applications under the `local_storage_nodes:children` group.

```
local_storage_nodes:
  children:
    master:
      hosts:
        10.12.xx.x3: {}
        10.12.xx.x4: {}
        10.12.xx.x5: {}
    node:
      hosts:
        10.12.xx.x6: {}
```

- iii. Configure the user account and authentication methods to authenticate the the installer in the Ansible control host with the cluster nodes under the `vars` group.

```
vars:
  ansible_user: root
  ansible_ssh_private_key_file: config/id_rsa
  ansible_password:
```

- iv. (Optional) Specify a name for your Kubernetes cluster in the `kubernetes_cluster_name` group.

```
kubernetes_cluster_name: k8scluster
```

5. Configure the installer using the `conf` command.

```
# ./run -c config-dir conf
```

The `conf` command runs an interactive installation wizard that enables you to choose the components you want to install and configure a basic Paragon Automation setup. The command populates the **config.yml** file with your input configuration. For advanced configuration, you must edit the **config.yml** file manually.

Enter the information as prompted by the wizard. Use the cursor keys to move the cursor, use the space key to select an option, and use the `a` or `i` key to toggle selecting or clearing all options. Press Enter to move to the next configuration option. You can skip configuration options by entering a period (`.`). You can reenter all your choices by exiting the wizard and restarting from the beginning. The installer allows you to exit the wizard after you save the choices that you already made or to

restart from the beginning. You cannot go back and redo the choices that you already made in the current workflow without exiting and restarting the wizard altogether.

The following table lists the configuration options that the `conf` command prompts you to enter :

Table 8: *conf* Command Options

conf Command Prompts	Description/Options
Select components	<p>You can install the Infrastructure, Pathfinder, Insights, and base platform components. By default, all components are selected.</p> <p>You can choose to install Pathfinder based on your requirement. However, you must install all other components, apart from Foghorn.</p> <p>NOTE: Foghorn is not supported in Release 22.1. You <i>must not</i> select the Foghorn option. Installation fails if you select Foghorn.</p>

Table 8: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Infrastructure Options	<p>These options appear only if you selected to install the Infrastructure component at the previous prompt.</p> <ul style="list-style-type: none"> • Install Kubernetes Cluster—Install the required Kubernetes cluster. If you are installing Paragon Automation on an existing cluster, you can clear this selection. • Install MetalLB LoadBalancer—Install an internal load balancer for the Kubernetes cluster. By default, this option is already selected. If you are installing Paragon Automation on an existing cluster with preconfigured load balancing, you can clear this selection. • Install Nginx Ingress Controller—Install Nginx Ingress Controller is a load-balancing proxy for the Pathfinder components. • Install Chrony NTP Client—Install Chrony NTP. You need NTP to synchronize the clocks of the cluster nodes. If NTP is already installed and configured, you need not install Chrony. All nodes must run NTP or some other time-synchronization protocol at all times. • Allow Master Scheduling—Master scheduling determines how the nodes acting as primary nodes are used. <i>Master</i> is another term for a node acting as primary. <p>If you select this option, the primary nodes can also act as worker nodes, which means they not only act as the control plane but can run application workloads as well. If you do not select master scheduling, the primary nodes are used only as the control plane.</p> <p>Master scheduling allows the available resources of the nodes acting as primary to be available for workloads. However, if you select this option, a misbehaving workload might exhaust resources on the primary node and affect the stability of the whole cluster. Without master scheduling, if you have multiple primary nodes with high capacity and disk space, you risk wasting their resources by not utilizing them completely.</p> <p>NOTE: This option is required for Ceph storage redundancy.</p>
List of NTP servers	<p>Enter a comma-separated list of NTP servers. This option is displayed only if you chose to install Chrony NTP.</p>

Table 8: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Kubernetes for Master Virtual IP address	<p>Enter a virtual IP (VIP) address for the Kubernetes API Server for a multi-primary node deployment only. Make sure that the VIP address is in the same Layer 2 domain as the primary nodes. This VIP address is not part of the LoadBalancer pool of VIP addresses.</p> <p>You see this option only if you've configured multiple primary nodes in the inventory file (multi-primary installation).</p>
Install LoadBalancer for Master Virtual IP address	<p>(Optional) Select to install keepalived LoadBalancer for the Master VIP address.</p> <p>You see this option only if you've configured multiple primary nodes in the inventory file (multi-primary installation).</p>
Virtual IP address (es) for ingress controller	Enter a VIP address to be used for Web access of the Kubernetes cluster or the Paragon Automation UI. This must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for Infrastructure Nginx Ingress Controller	Enter a VIP address for the Nginx Ingress Controller. This must be an unused IP address that is managed by the MetalLB load balancer pool. This address is used for NetFlow traffic.
Virtual IP address for Insights services	Enter a VIP address for Paragon Insights services. This must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for SNMP trap receiver (optional)	<p>Enter a VIP address for the SNMP trap receiver proxy only if this functionality is required.</p> <p>If you do not need this option, enter a period (.).</p>
Pathfinder Options	<p>Select to install Netflowd. You can configure a VIP address for netflowd or use a proxy for netflowd (same as the VIP address for the Infrastructure Nginx Ingress Controller).</p> <p>If you choose to not install netflowd, you cannot configure a VIP address for netflowd.</p>

Table 8: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Use netflowd proxy	<p>Enter Y to use a netflowd proxy. This option appears only if you chose to install netflowd.</p> <p>If you chose to use a netflowd proxy, you needn't configure a VIP address for netflowd. The VIP address for the Infrastructure Nginx Ingress Controller is used as the proxy for netflowd.</p>
Virtual IP address for Pathfinder Netflowd	Enter a VIP address to be used for Paragon Pathfinder netflowd. This option appears only if you chose <i>not</i> to use netflowd proxy.
PCE Server Proxy	Select the proxy mode for the PCE server. Select from None and Nginx-Ingress.
Virtual IP address for Pathfinder PCE server	<p>Enter a VIP address to be used for Paragon Pathfinder PCE server access. This address must be an unused IP address that is managed by the load balancer.</p> <p>If you selected Nginx-Ingress, as the PCE Server Proxy, this VIP address is not necessary. The wizard does not prompt you to enter this address and PCEP will use the same address as the VIP address for Infrastructure Nginx Ingress Controller.</p> <p>NOTE: The addresses for ingress controller, Infrastructure Nginx Ingress Controller, Insights services, and PCE server must be unique. You cannot use the same address for all four VIP addresses.</p> <p>All these addresses are listed automatically in the LoadBalancer IP address ranges option.</p>

Table 8: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
LoadBalancer IP address ranges	<p>The LoadBalancer IP addresses are prepopulated from your VIP addresses range. You can edit these addresses. The externally accessible services are handled through MetalLB, which needs one or more IP address ranges that are accessible from outside the cluster. VIPs addresses for the different servers are selected from these ranges of addresses.</p> <p>The address ranges can be (but need not be) in the same broadcast domain as the cluster nodes. For ease of management, because the network topologies need access to Insights services and the PCE server clients, we recommend that you select the VIP addresses from the same range.</p> <p>For more information, see "Virtual IP Address Considerations" on page 28.</p> <p>Addresses can be entered as comma-separated values (CSV), as a range, or as a combination of both. For example:</p> <ul style="list-style-type: none"> • 10.x.x.1, 10.x.x.2, 10.x.x.3 • 10.x.x.1-10.x.x.3 • 10.x.x.1, 10.x.x.3-10.x.x.5 • 10.x.x.1-3 is not a valid format.
Hostname of Main web application	<p>Enter a hostname for the ingress controller. You can configure this value as an IP address or as a fully qualified domain name (FQDN). For example, you can enter 10.12.xx.100 or www.paragon.juniper.net (DNS name). Do not include http:// or https://.</p> <p>NOTE: You will use this hostname to access the Paragon Automation Web UI from your browser. For example, https://<i>hostname</i> or https://<i>IP-address</i>.</p>
BGP autonomous system number of CRPD peer	<p>Set up the Containerized Routing Protocol Daemon (cRPD) autonomous systems and the nodes with which cRPD creates its BGP sessions.</p> <p>You must configure the autonomous system (AS) number of the network to allow cRPD to peer with one or more BGP Link State (BGP-LS) routers in the network. By default, the AS number is 64500.</p> <p>NOTE: While you can configure the AS number at the time of installation, you can also modify the cRPD configuration later. See "Modify cRPD Configuration" on page 75.</p>

Table 8: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Comma separated list of CRPD peers	<p>Configure cRPD to peer with at least one BGP-LS router in the network to import the network topology. For a single autonomous system, configure the address of the BGP-LS routers that will peer with cRPD to provide topology information to Paragon Pathfinder. The cRPD instance running as part of a cluster will initiate a BGP-LS connection to the specified peer routers and import topology data after the session is established. If more than one peer is required, you can add the peers as CSVs, as a range, or as a combination of both, similar to how you add LoadBalancer IP addresses.</p> <p>NOTE: While you can configure the peer IP addresses at the time of installation, you can also modify the cRPD configuration later, as described in "Modify cRPD Configuration" on page 75.</p> <p>You must configure the BGP peer routers to accept BGP connections initiated from cRPD. The BGP session will be initiated from cRPD using the address of the worker where the bmp pod is running as the source address.</p> <p>Because cRPD could be running on any of the worker nodes at a given time, you must allow connections from any of these addresses. You can allow the range of IP addresses that the worker addresses belong to (for example, 10.xx.43.0/24), or the specific IP address of each worker (for example, 10.xx.43.1/32, 10.xx.43.2/32, and 10.xx.43.3). You could also configure this using the <code>neighbor</code> command with the <code>passive</code> option to prevent the router from attempting to initiate the connection.</p> <p>If you chose to enter each individual worker address, either with the <code>allow</code> command or the <code>neighbor</code> command, make sure you include all the workers, because any worker could be running cRPD at a given time. Only one BGP session will be initiated. If the node running cRPD fails, the bmp pod that contains the cRPD container will be created in a different node, and the BGP session will be reinitiated.</p> <p>The sequence of commands in the following example shows the options to configure a Juniper device to allow BGP-LS connections from cRPD.</p> <p>The following commands configure the router to accept BGP-LS sessions from any host in the 10.xx.43.0/24 network, where all the worker nodes are connected.</p> <pre>[edit groups northstar] root@system# show protocols bgp group northstar type internal; family traffic-engineering {</pre>

Table 8: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
	<pre> unicast; } export TE; allow 10.xx.43.0/24; [edit groups northstar] root@system# show policy-options policy-statement TE from family traffic-engineering; then accept; The following commands configure the router to accept BGP-LS sessions from 10.xx.43.1, 10.xx.43.2, and 10.xx.43.3 (the addresses of the three workers in the cluster) only. [edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS allow 10.x.43.1 set protocols bgp group BGP-LS allow 10.x.43.2 set protocols bgp group BGP-LS allow 10.x.43.3 set protocols bgp group BGP-LS export TE cRPD initiates the BGP session. Only one session is established at a time and is initiated using the address of the worker node currently running cRPD. If you choose to configure the specific IP addresses instead of using the allow option, configure the addresses of all the workers nodes for redundancy. The following commands also configure the router to accept BGP-LS sessions from 10.xx.43.1, 10.xx.43.2, and 10.xx.43.3 only (the addresses of the three workers in the cluster). The passive option prevents the router from attempting to initiate a BGP-LS session with cRPD. The router will wait for the session to be initiated by any of these three routers. [edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS neighbor 10.xx.43.1 set protocols bgp group BGP-LS neighbor 10.xx.43.2 set protocols bgp group BGP-LS neighbor 10.xx.43.3 </pre>

Table 8: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
	<pre>set protocols bgp group BGP-LS passive set protocols bgp group BGP-LS export TE</pre> <p>You will also need to enable OSPF/IS-IS and MPLS traffic engineering as shown here:</p> <pre>set protocols rsvp interface <i>interface.unit</i></pre> <pre>set protocols isis interface <i>interface.unit</i> set protocols isis traffic-engineering igp-topology</pre> <p>Or</p> <pre>set protocols ospf area <i>area</i> interface <i>interface.unit</i> set protocols ospf traffic-engineering igp-topology</pre> <pre>set protocols mpls interface <i>interface.unit</i> set protocols mpls traffic-engineering database import igp-topology</pre> <p>For more information, see https://www.juniper.net/documentation/us/en/software/junos/mpls/topics/topic-map/mpls-traffic-engineering-configuration.html.</p>
Finish and write configuration to file	<p>Click Yes to save the configuration information.</p> <p>This action configures a basic setup and saves the information in the config.yml file in the <i>config-dir</i> directory.</p> <p>Click No to restart the wizard without exiting the current session. The previously entered configuration parameters and selections appear preconfigured in the wizard. You can choose to retain them or reenter new values.</p> <p>Click Cancel to exit the wizard without saving the configuration.</p>

For example:

```
$ ./run -c config conf
Loaded image: paragonautomation.latest
=====
PO-Runtime installer
=====
```

Supported command:

```

deploy [-t tags]  deploy runtime
destroy [-t tags] destroy runtime
init              init configuration skeleton
inv              basic inventory editor
conf              basic configuration editor
info [-mc]        cluster installation info

```

Starting now: conf

NOTE: depending on options chosen additional IP addresses may be required for:

```

multi-master      Kubernetes Master Virtual IP address
Infrastructure     Virtual IP address(es) for ingress controller
Infrastructure     Virtual IP address for Infrastructure Nginx Ingress Controller
Insights           Virtual IP address for Insights services
Insights           Virtual IP address for SNMP Trap receiver (optional)
Pathfinder         Virtual IP address for Pathfinder Netflowd
Pathfinder         Virtual IP address for Pathfinder PCE server

```

```

? Select components  done (4 selections)
? Infrastructure Options  done (4 selections)
? List of NTP servers  0.pool.ntp.org
? Virtual IP address(es) for ingress controller  10.12.xx.x7
? Virtual IP address for Infrastructure Nginx Ingress Controller  10.12.xx.x8
? Virtual IP address for Insights services  10.12.xx.x9
? Virtual IP address for SNMP Trap receiver (optional)
? Pathfinder Options  [Install Netflowd]
? Use netflowd proxy?  Yes
? PCEServer proxy  Nginx Ingress
? LoadBalancer IP address ranges  10.12.xx.x7-10.12.xx.x9
? Hostname of Main web application  host.example.net
? BGP autonomous system number of CRPD peer  64500
? Comma separated list of CRPD peers  10.12.xx.11
? Finish and write configuration to file  Yes

```

6. (Optional) For more advanced configuration of the cluster, use a text editor to manually edit the **config.yml** file.

The **config.yml** file consists of an essential section at the beginning of the file that corresponds to the configuration options that the installation wizard prompts you to enter. The file also has an extensive list of sections under the essential section that allows you to enter complex configuration values directly in the file.

You can configure the following options:

- Set the `opendistro_es_admin_password` password to log in to the Kibana application. You use Open Distro to consolidate and index application logs and the visualization tool Kibana to search logs using keywords and filters.

By default, the username is preconfigured as `admin` in `#opendistro_es_admin_user`: `admin` and the `install_opendistro_es` option is set to `true` to replace the Elasticsearch version with Open Distro. Use `admin` as username and this password to log in to Kibana.

By default, data is retained on the disks for seven days, before being purged, in a production deployment. You can edit the number of days to a smaller number in `opendistro_es_retain` if your disk size is low.

```
# install_opendistro_es: true
# opendistro_es_admin_user: admin
# opendistro_es_admin_password: opendistro_password
# opendistro_es_retain: 7d
```

If you do not configure the `opendistro_es_admin_password` password, the installer generates a random password. You can retrieve the password using the command:

```
# kubectl -n kube-system get secret opendistro-es-account -o jsonpath={..password} | base64 -d
```

- Set the `iam_skip_mail_verification` configuration option to `true` for user management without SMTP by Identity and Access Management (IAM). By default, this option is set to `false` for user management with SMTP. You must configure SMTP in Paragon Automation so that you can notify Paragon Automation users when their account is created, activated, or locked, or when their account password is changed.
- Configure the `callback_vip` option with an IP address different from that of the virtual IP (VIP) address of the ingress controller. You can use an IP address from the MetalLB pool of VIP addresses. You configure this IP address to enable segregation of management and data traffic from the southbound and northbound interfaces. By default, `callback_vip` is assigned the same or one of the addresses of the ingress controller.
- If you want to use an interface other than the default interface for intercluster communication, set the `kubernetes_system_interface` variable. The current setting is `"{{ ansible_default_ipv4.interface }}"`, which is the interface that the default route uses. The `kubernetes_system_interface` variable configures the Kubernetes API server and Calico.

To view the default interface, run this command on a primary node:

```
root@primary-node:~# ip r show default
default via 10.12.xx.254 dev ens3 proto dhcp src 10.12.xx.121 metric 100
```

In this example, ens3 is default interface for this machine.

If you want to use an interface different from the default one and the same interface can be used on all cluster nodes, configure `kubernetes_system_interface` in the **config.yml** file. For example:

```
kubernetes_system_interface: ens4
```

If you want to use an interface different from the default one but the interface is different on different nodes, you must remove `kubernetes_system_interface` from the **config.yml** file. Instead, configure the interface names in the inventory file. For example:

```
master:
  hosts:
    10.12.xx.x3:
      kubernetes_system_interface: ens7
    10.12.xx.x4:
      kubernetes_system_interface: ens8
    10.12.xx.x5:
      kubernetes_system_interface: ens9
node:
  hosts:
    10.12.xx.x6:
      kubernetes_system_interface: ens7
```

Note that, `calico_ip_autodetect` is set to `"interface={{ kubernetes_system_interface }}"`, and takes the same value as `kubernetes_system_interface` and does not need to be explicitly changed if the default interface is changed.

Save and exit the file after you finish editing it.

7. (Optional) If you want to deploy custom SSL certificates signed by a recognized certificate authority (CA), store the private key and certificate in the **config-dir** directory. Save the private key as **ambassador.key.pem** and the certificate as **ambassador.cert.pem**.

By default, Ambassador uses a locally generated certificate signed by the Kubernetes cluster-internal CA.

NOTE: If the certificate is about to expire, save the new certificate as **ambassador.cert.pem** in the same directory, and execute the `./run -c config-dir deploy -t ambassador` command.

8. Install the Paragon Automation cluster based on the information that you configured in the **config.yml** and **inventory** files.

```
# ./run -c config-dir deploy
```

The installation time to install the configured cluster depends on the complexity of the cluster. A basic setup installation takes at least 45 minutes to complete.

The installer checks NTP synchronization at the beginning of installation. If clocks are out of sync, installation fails.

For **multi-primary node** deployments only, the installer checks the disk input/output operations per second (IOPS) at the beginning of installation. If the IOPS value is below 300, installation fails. To disable disk IOPS check, use the `# ./run -c config-dir deploy -e ignore_iops_check=yes` command and rerun the deployment. However, we do not recommend that you disable disk IOPS check.

If you are installing Paragon Automation on an existing Kubernetes cluster, the `deploy` command upgrades the currently deployed cluster to the latest Kubernetes version. The command also upgrades the Docker CE version, if required. If Docker EE is already installed on the nodes, the `deploy` command does not overwrite it with Docker CE. When upgrading the Kubernetes version or the Docker version, the command performs the upgrade sequentially on one node at a time. The command cordons off each node and removes it from scheduling. It performs upgrades, restarts Kubernetes on the node, and finally uncordons the node and brings it back into scheduling.

9. After deployment is completed, log in to the worker nodes.

Use a text editor to configure the following recommended information for Paragon Insights in the **limits.conf** and **sysctl.conf** files. These values set the soft and hard memory limits for influx DB memory requirements. If you do not set these limits, you might see errors such as “out of memory” or “too many open files” because of the default system limits.

a.

```
# vi /etc/security/limits.conf

# End of file
*          hard    nofile      1048576
*          soft    nofile      1048576
root       hard    nofile      1048576
root       soft    nofile      1048576
influxdb   hard    nofile      1048576
influxdb   soft    nofile      1048576
```

b.

```
# vi /etc/sysctl.conf

fs.file-max = 2097152
vm.max_map_count=262144
fs.inotify.max_user_watches=524288
fs.inotify.max_user_instances=512
```

Repeat this step for all worker nodes.

Now that you've installed and deployed your Paragon Automation cluster, you're ready to log in to the Paragon Automation UI.

Log in to the Paragon Automation UI

To log in to the Paragon Automation UI:

1. Open a browser, and enter either the hostname of the main Web application or the VIP address of the ingress controller that you entered in the URL field of the installation wizard.

For example, <https://vip-of-ingress-controller-or-hostname-of-main-web-application>. The Paragon Automation login page appears.

2. For first-time access, enter **admin** as username and **Admin123!** as the password to log in. You must change the password immediately.

The **Set Password** page appears. To access the Paragon Automation setup, you must set a new password.

3. Set a new password that meets the password requirements.

Use between 6 and 20 characters and a combination of uppercase letters, lowercase letters, numbers, and special characters. Confirm the new password, and click **OK**.

The **Dashboard** page appears. You have successfully installed and logged in to the Paragon Automation UI.

4. Update the URL to access the Paragon Automation UI in **Administration > Authentication > Portal Settings** to ensure that the activation e-mail sent to users for activating their account contains the correct link to access the GUI. For more information, see *Configure Portal Settings*.

For high-level tasks that you can perform after you log in to the Paragon Automation UI, see [Paragon Automation Getting Started](#).

Install Single-Node Cluster on Ubuntu

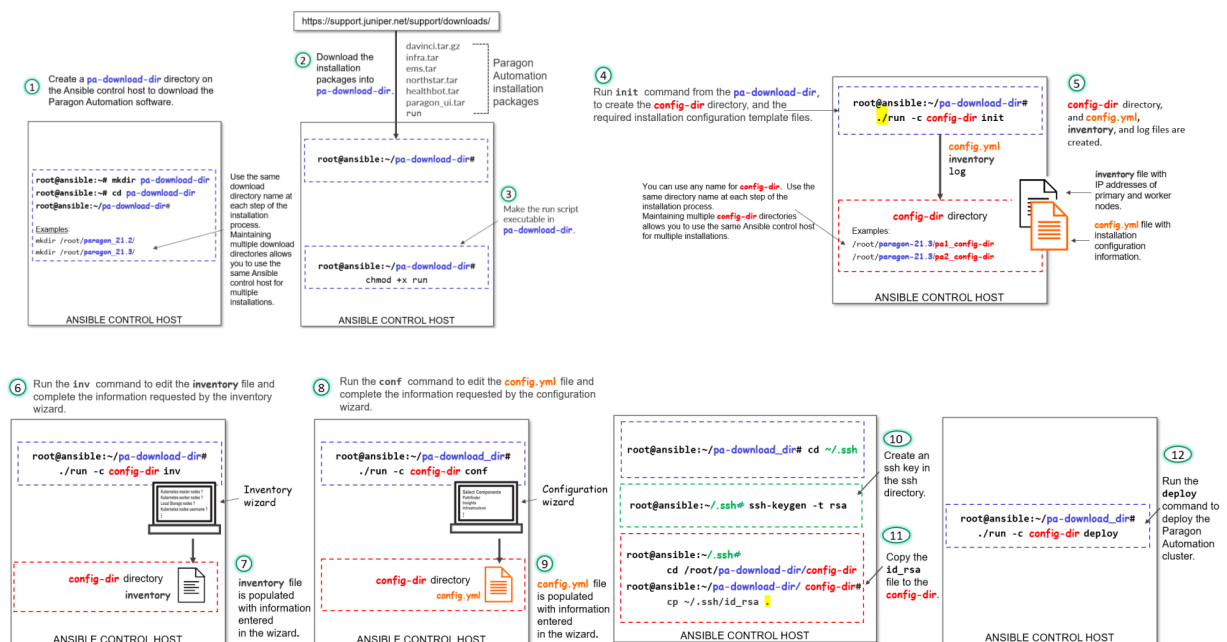
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You can also install Paragon Automation on a single node that acts as both primary node and worker node. Make sure you use a single-node setup *only* as proof of concept (POC) or for lab deployments and not for production deployments.

Read the following topics to learn how to install Paragon Automation on a single node, with Ubuntu as the base OS. [Figure 16 on page 57](#) shows a summary of installation tasks at a high level. Ensure that you've completed all the preconfiguration and preparation steps described in "[Installation Prerequisites on Ubuntu](#)" on page 20 before you begin installation.

Figure 16: Installation Sequence - Infographic



To view a higher-resolution image in your Web browser, right-click the image and open in a new tab. To view the image in PDF, use the zoom option to zoom in.

Download the Software

Prerequisite

- You need a Juniper account to download the Paragon Automation software.
- 1. Log in to the control host.
- 2. Create a directory in which you'll download the software.
We refer to this directory as *pa-download-dir* in this guide.
- 3. Select the version number from the **Version** list on the Paragon Automation software download page at <https://support.juniper.net/support/downloads/?p=pa>.
- 4. Download the **Paragon Automation Setup** installation files to the download folder using the `wget "http://cdn.juniper.net/software/file-download-url"` command.

The Paragon Automation setup installation bundle consists of the following scripts and TAR files to install each of the component modules:

- **davinci.tar.gz**, which is the primary installer file.
- **infra.tar**, which installs the Kubernetes infrastructure components including Docker and Helm.
- **ems.tar**, which installs the base platform component.
- **northstar.tar**, which installs the Paragon Pathfinder and Paragon Planner components.
- **healthbot.tar**, which installs the Paragon Insights component.
- **paragon_ui.tar**, which installs the Paragon Automation UI component.
- **addons.tar**, which installs infrastructure components that are not part of the base Kubernetes installation. The infrastructure components include, IAM, Kafka, ZooKeeper, cert-manager, Ambassador, Postgres, Metrics, Kubernetes Dashboard, Open Distro for Elasticsearch, Fluentd, Reloader, ArangoDB, and Argo.
- **rhel-84-airgap.tar.gz**, which installs Paragon Automation using the air-gap method on nodes *only* where the base OS is Red Hat Enterprise Linux (RHEL).
- **run script**, which executes the installer image.

NOTE: The Paragon Automation setup installation bundle comprises of a **foghorn.tar** file. However, Foghorn is not supported in Release 22.1.

Install Paragon Automation on a Single-Node

1. Make the run script executable in the *pa-download-dir* directory.

```
# chmod +x run
```

2. Use the run script to create and initialize a configuration directory with the configuration template files.

```
# ./run -c config-dir init
```

config-dir is a user-defined directory on the control host that contains configuration information for a particular installation. The `init` command automatically creates the *config-dir* directory if it does not exist. Alternatively, you can create the directory before you execute the `init` command.

Ensure that you include the dot and slash (./) with the `run` command.

If you are using the same control host to manage multiple installations of Paragon Automation, you can differentiate between installations by using differently named configuration directories.

3. Ensure that the control host can connect to the cluster node through SSH using the `install-user` account.

Copy the private key that you generated in ["Configure SSH client authentication" on page 22](#) to the user-defined *config-dir* directory. The installer allows the Docker container to access the *config-dir* directory. The SSH key must be available in the directory for the control host to connect to the cluster nodes.

```
# cd config-dir
# cp ~/.ssh/id_rsa .
# cd ..
```

Ensure that you include the dot "." at the end of the copy command.

4. Customize the inventory file, created under the *config-dir* directory, with the IP address or hostname of the single cluster node, as well as the username and authentication information required to

connect to the node. The inventory file is in the YAML format and describes the cluster nodes on which Paragon Automation will be installed. You can edit the file using the `inv` command or a Linux text editor such as `vi`.

- a. Customize the inventory file using the `inv` command:

```
# ./run -c config-dir inv
```

The following table lists the configuration options that the `inv` command prompts for.

Table 9: *inv* Command Options

inv Command Prompts	Description
Kubernetes master nodes	Enter the IP address of the single Kubernetes cluster node.
Kubernetes worker nodes	Leave this field empty for a single-node cluster.
Local storage nodes	<p>The local storage node is prepopulated with the IP address of the single cluster node.</p> <p>This field defines the node that has disk space available for applications that require local storage. Services such as Postgres, ZooKeeper, and Kafka, use local storage or disk space partitioned inside export/local-volumes.</p> <p>This is different from Ceph storage.</p>
Kubernetes nodes' username (for example, root)	Configure the user account and authentication methods to authenticate the installer with the cluster nodes. The user account must be root or, in case of non-root users, the account must have superuser (sudo) privileges.

Table 9: *inv* Command Options (Continued)

inv Command Prompts	Description
SSH private key file (optional)	If you chose ssh-key authentication, for the control host to authenticate with the nodes during the installation process, configure the path to the <i>config-dir</i> directory where the <i>ansible_ssh_private_key_file</i> is located, and the <i>id_rsa</i> file, as <i>config/id_rsa</i> . This is because the path to the <i>config-dir</i> is mounted internally in the installer container at <i>config</i> . Alternatively, you can also use the default <code>{{ inventory_dir }}/id_rsa</code> .
Kubernetes nodes' password (optional)	If you chose password authentication for the control host to authenticate with the node during the installation process, enter the authentication password directly. Warning: The password is written in plain text. We do not recommend using this option for authentication.
Kubernetes cluster name (optional)	Enter a name for your Kubernetes cluster.
Write inventory file?	Click Yes to save the inventory information.

For example:

```
$ ./run -c config-dir inv
Loaded image: paragonautomation:latest
=====
PO-Runtime installer
=====

Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
  info [-mc]        cluster installation info
```

```
Starting now: inv
```

INVENTORY

This script will prompt for the DNS names or IP addresses of the Kubernetes master and worker nodes.

Addresses should be provided as comma-delimited lists.

At least three master nodes are recommended. The number of masters should be an odd number. A minimum of four nodes are recommended.

Root access to the Kubernetes nodes is required.

See https://docs.ansible.com/ansible/2.10/user_guide/intro_inventory.html

```
? Kubernetes master nodes 10.12.xx.x3
```

```
? Kubernetes worker nodes
```

```
? Local storage nodes 10.12.xx.x3
```

```
? Kubernetes nodes' username (e.g. root) root
```

```
? SSH private key file (optional; e.g. "{ inventory_dir }/id_rsa") config/id_rsa
```

```
? Kubernetes nodes' password (optional; WARNING - written as plain text)
```

```
? Kubernetes cluster name (optional) k8scluster
```

```
? Write inventory file? Yes
```

- b.** Alternatively, you can customize the inventory file manually using a text editor.

```
# vi config-dir/inventory
```

Edit the following groups in the **inventory** file.

- i.** Add the IP address of the single Kubernetes node in the `master` group only.

The `master` group identifies the primary nodes, and the `node` group identifies the worker nodes. You cannot have the same IP address in both `master` and `node` groups.

To create a single-primary-node setup, include the IP address or hostname of the node that will be acting as both primary and worker under the `master` group. Do *not* add any IP address or hostname under the `node` group.

```
master:
  hosts:
    10.12.xx.x3: {}
node:
  hosts:
```

- ii. Add the address or hostname of the single Kubernetes node under the `local_storage_nodes:children` group under `master`. Do not add anything to the `local_storage_nodes:children` group under `node`.

```
local_storage_nodes:
  children:
    master:
      hosts:
        10.12.xx.x3: {}
    node:
      hosts:
```

- iii. Configure the user account and authentication methods to authenticate the installer in the Ansible control host with the cluster node under the `vars` group.

```
vars:
  ansible_user: root
  ansible_ssh_private_key_file: config/id_rsa
  ansible_password:
```

- iv. (Optional) Specify a name for your Kubernetes cluster in the `kubernetes_cluster_name` group.

```
kubernetes_cluster_name: k8scluster
```

5. Configure the installer using the `conf` command.

```
# ./run -c config-dir conf
```

The `conf` command runs an interactive installation wizard that enables you to choose the components to be installed and configure a basic Paragon Automation setup. The command populates the `config.yml` file with your input configuration. For advanced configuration, you must edit the `config.yml` file manually.

Enter the information as prompted by the wizard. Use the cursor keys to move the cursor, use the space key to select an option, and use `a` or `i` to toggle selecting or clearing all options. Press Enter to move to the next configuration option. You can skip configuration options by entering a period (`.`). You can reenter all your choices by exiting the wizard and restarting from the beginning. The installer allows you to exit the wizard after you save the choices that you already made or to restart from the beginning. You cannot go back and redo the choices that you already made in the current workflow without exiting and restarting the wizard altogether.

The following table lists the configuration options that the `conf` command prompts for:

Table 10: `conf` Command Options

conf Command Prompts	Description/Options
Select components	<p>You can install one or more of the Infrastructure, Pathfinder, Insights, and base platform components. By default, all components are selected.</p> <p>You can choose to install Pathfinder based on your requirement. However, you must install all other components, apart from Foghorn.</p> <p>NOTE: Foghorn is not supported in Release 22.1. You <i>must not</i> select the Foghorn option. Installation fails if you select Foghorn.</p>

Table 10: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Infrastructure Options	<p>The wizard displays these options only if you selected to install the Infrastructure component at the preceding prompt.</p> <ul style="list-style-type: none"> • Install Kubernetes Cluster—Install the required single-node Kubernetes cluster. • Install MetalLB LoadBalancer—Install an internal load balancer for the single-node Kubernetes cluster. By default, this option is already selected. • Install Nginx Ingress Controller—Install Nginx Ingress Controller is a load-balancing proxy for the Pathfinder components. • Install Chrony NTP Client—Install the Chrony NTP client. The node must run NTP or some other time-synchronization protocol at all times. If NTP is already installed and configured, you need not install Chrony. • Allow Master Scheduling—Master scheduling determines how the node acting as primary nodes are used. <i>Master</i> is another term for a node acting as primary. <p>If you select this option, the primary nodes can also act as worker nodes, which means they not only act as control plane but can run application workloads as well. If you do not select this option, the primary nodes are used only as the control plane.</p> <p>NOTE: For single-node cluster installations, you <i>must</i> allow master scheduling. If you don't, installation will fail.</p>
List of NTP servers	Enter a comma-separated list of NTP servers. The wizard displays this option only if you chose to install Chrony NTP at the preceding prompt.
Virtual IP address (es) for ingress controller	Enter a VIP address to be used for Web access of the Kubernetes cluster or the Paragon Automation user interface. This address must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for Infrastructure Nginx Ingress Controller	Enter a VIP address for the Nginx Ingress Controller. This address must be an unused IP address that is managed by the MetalLB load balancer pool. This address is used for NetFlow traffic.

Table 10: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Virtual IP address for Insights services	Enter a VIP address for Paragon Insights services. This address must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for SNMP trap receiver (optional)	Enter a VIP address for the SNMP trap receiver proxy only if this functionality is required. If you do not need this option, enter a dot (.).
Pathfinder Options	Select to install Netflowd. You can configure a VIP address for netflowd or use a proxy for netflowd (same as the VIP address for the Infrastructure Nginx Ingress Controller). If you choose to not install netflowd, you cannot configure a VIP address for netflowd.
Use netflowd proxy	Enter Y to use a netflowd proxy. This option appears only if you chose to install netflowd. If you chose to use a netflowd proxy, you needn't configure a VIP address for netflowd. The VIP address for the Infrastructure Nginx Ingress Controller is used as the proxy for netflowd.
Virtual IP address for Pathfinder Netflowd	Enter a VIP address to be used for Paragon Pathfinder netflowd. This option appears only if you chose <i>not</i> to use netflowd proxy.
PCE Server Proxy	Select the proxy mode for the PCE server. Select from None and Nginx-Ingress.

Table 10: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Virtual IP address for Pathfinder PCE server	<p>Enter a VIP address to be used for Paragon Pathfinder PCE server access. This address must be an unused IP address that is managed by the load balancer.</p> <p>If you selected Nginx-Ingress, as the PCE Server Proxy, this VIP address is not necessary. The wizard does not prompt you to enter this address and PCEP will use the same address as the VIP address for Infrastructure Nginx Ingress Controller.</p> <p>NOTE: The addresses for ingress controller, Infrastructure Nginx Ingress Controller, Insights services, and PCE server must be unique. You cannot use the same address for all four VIP addresses.</p> <p>All these addresses are listed automatically in the LoadBalancer IP address ranges option.</p>
LoadBalancer IP address ranges	<p>The LoadBalancer IP addresses are prepopulated from your VIP addresses range. You can edit these addresses. The externally accessible services are handled through MetalLB, which needs one or more IP address ranges that are accessible from outside the cluster. VIPs for the different servers are selected from these ranges of addresses.</p> <p>The address ranges can be (but need not be) in the same broadcast domain as the cluster nodes. For ease of management, because the network topologies need access to Insights services and the PCE server clients, we recommend that you select the VIP addresses from the same range.</p> <p>For more information, see "Virtual IP Address Considerations" on page 28.</p> <p>Addresses can be entered as comma-separated values (CSV), as a range, or as a combination of both. For example:</p> <ul style="list-style-type: none"> • 10.x.x.1, 10.x.x.2, 10.x.x.3 • 10.x.x.1-10.x.x.3 • 10.x.x.1, 10.x.x.3-10.x.x.5 • 10.x.x.1-3 is not a valid format

Table 10: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Hostname of Main web application	<p>Enter a hostname for the ingress controller. You can configure the hostname as an IP address or as a fully qualified domain name (FQDN). For example, you can enter 10.12.xx.100 or www.paragon.juniper.net (DNS name). Do not include http:// or https://.</p> <p>NOTE: You will use this hostname to access the Paragon Automation Web UI from your browser. For example, https:// <i>hostname</i> or https:// <i>IP-address</i>.</p>
BGP autonomous system number of CRPD peer	<p>Set up the Containerized Routing Protocol Daemon (cRPD) autonomous systems and the nodes with which cRPD creates its BGP sessions.</p> <p>You must configure the autonomous system number of the network to allow cRPD to peer with one or more BGP-LS routers in the network. By default, the autonomous system number is 64500.</p> <p>NOTE: While you can configure the autonomous system number at the time of installation, you can also modify the cRPD configuration later. See, No Link Title.</p>

Table 10: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Comma separated list of CRPD peers	<p>You must configure cRPD to peer with at least one BGP-LS router in the network to import the network topology. For a single autonomous system, configure the address of the BGP-LS router(s) that will peer with cRPD to provide topology information to Paragon Pathfinder. The CRPD instance running as part of a cluster will initiate a BGP-LS connection to the specified peer router(s) and import topology data once the session has been established. If more than one peer is required, these can be added as comma separated values, or as a range or as a combination of both, similar to how LoadBalancer IP addresses are added.</p> <p>NOTE: While you can configure the peer IP addresses at the time of installation, you can also modify the cRPD configuration later, as described in No Link Title.</p> <p>You must configure the BGP peer routers to accept BGP connections initiated from cRPD. The BGP session will be initiated from cRPD using the address of the worker where the bmp pod is running, as the source address. In the single node deployment case, cRPD will be running on the only worker configured. If new workers are added to the cluster later, you must allow connections from the addresses of any of the workers (the current worker, and any additional worker).</p> <p>You can allow the range of IP addresses that the worker address belongs to (for example, 10.xx.43.0/24), or the specific IP address of the worker (for example, 10.xx.43.1/32). You could also configure this using the neighbor command combined with the passive option to prevent the router from attempting to initiate the connection.</p> <p>The following example shows the options to configure a Juniper device to allow BGP-LS connections from cRPD.</p> <p>The following commands configure the router to accept BGP-LS sessions from any host in the 10.xx.43.0/24 network, where the worker is connected. This will accommodate any worker that is added to the cluster later.</p> <pre>[edit groups northstar] root@system# show protocols bgp group northstar type internal; family traffic-engineering { unicast; } export TE; allow 10.xx.43.0/24;</pre>

Table 10: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
	<pre>[edit groups northstar] root@system# show policy-options policy-statement TE from family traffic-engineering; then accept;</pre> <p>The following commands configure the router to accept BGP-LS sessions from 10.xx.43.1 only. Additional allow commands can be added later on, if new workers are added to the cluster.</p> <pre>[edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS allow 10.x.43.1 set protocols bgp group BGP-LS export TE</pre> <p>The following commands also configure the router to accept BGP-LS sessions from 10.xx.43.1 only. The passive option was added to prevent the router from attempting to initiate a BGP-LS session with cRPD. The router will wait for the session to be initiated by this BGP cRPD. Additional neighbor commands can be added later on, if new workers are added to the cluster.</p> <pre>[edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS neighbor 10.xx.43.1 set protocols bgp group BGP-LS passive set protocols bgp group BGP-LS export TE</pre> <p>You will also need to enable OSPF/ISIS and MPLS traffic engineering as shown:</p> <pre>set protocols rsvp interface <i>interface.unit</i> set protocols isis interface <i>interface.unit</i> set protocols isis traffic-engineering igp-topology Or set protocols ospf area <i>area</i> interface <i>interface.unit</i></pre>

Table 10: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
	<pre>set protocols ospf traffic-engineering igp-topology</pre> <pre>set protocols mpls interface <i>interface.unit</i></pre> <pre>set protocols mpls traffic-engineering database import igp-topology</pre> <p>For more information, see https://www.juniper.net/documentation/us/en/software/junos/mps/topics/topic-map/mps-traffic-engineering-configuration.html.</p>
Finish and write configuration to file	<p>Click Yes to save the configuration information.</p> <p>This configures a basic setup, and the information is saved in the config.yml file in the <i>config-dir</i> directory.</p>

For example:

```
$ ./run -c config conf
Loaded image: paragonautomation.latest
=====
PO-Runtime installer
=====

Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
  info [-mc]        cluster installation info

Starting now: conf
NOTE: depending on options chosen additional IP addresses may be required for:
    multi-master  Kubernetes Master Virtual IP address
    Infrastructure Virtual IP address(es) for ingress controller
    Infrastructure Virtual IP address for Infrastructure Nginx Ingress Controller
    Insights      Virtual IP address for Insights services
    Insights      Virtual IP address for SNMP Trap receiver (optional)
    Pathfinder     Virtual IP address for Pathfinder Netflowd
    Pathfinder     Virtual IP address for Pathfinder PCE server
```

```

? Select components  done (4 selections)
? Infrastructure Options  done (4 selections)
? List of NTP servers  0.pool.ntp.org
? Virtual IP address(es) for ingress controller  10.12.xx.x7
? Virtual IP address for Infrastructure Nginx Ingress Controller  10.12.xx.x8
? Virtual IP address for Insights services  10.12.xx.x9
? Virtual IP address for SNMP Trap receiver (optional)
? Pathfinder Options  [Install Netflowd]
? Use netflowd proxy?  Yes
? PCEServer proxy  Nginx Ingress
? LoadBalancer IP address ranges  10.12.xx.x7-10.12.xx.x9
? Hostname of Main web application  host.example.net
? BGP autonomous system number of CRPD peer  64500
? Comma separated list of CRPD peers  10.12.xx.11
? Finish and write configuration to file  Yes

```

6. (Optional) For more advanced configuration of the cluster, use a text editor to manually edit the **config.yml** file.

The **config.yml** file consists of an essential section at the beginning of the file that corresponds to the configuration options that the installation wizard prompts you to enter. The file also has an extensive list of sections under the essential section that allows you to enter complex configuration values directly in the file.

The following options are available.

- Set the `opendistro_es_admin_password` password to log in to the Kibana application. Open Distro is used to consolidate and index application logs and Kibana is the visualization tool that enables you to search logs using keywords and filters.

By default, the username is preconfigured as `admin` in `#opendistro_es_admin_user: admin` and `install_opendistro_es` option is set to `true` to replace the Elasticsearch version with Open Distro. Use `admin` as username and this password to log in to Kibana.

By default, data is retained on the disks for seven days, before being purged, in a production deployment. You can edit the number of days to a smaller number in `opendistro_es_retain` if your disk size is low.

```

# install_opendistro_es: true
# opendistro_es_admin_user: admin
# opendistro_es_admin_password: opendistro_password
# opendistro_es_retain: 7d

```

If you do not configure the `opendistro_es_admin_password`, the installer will generate a random password. You can retrieve the password using this command:

```
# kubectl -n kube-system get secret opendistro-es-account -o jsonpath={..password} | base64 -d
```

- Set the `iam_skip_mail_verification` configuration option to `true` for user management without SMTP by Identity Access Management (IAM). By default, this option is set to `false` for user management with SMTP. You must configure SMTP in Paragon Automation so that the Paragon Automation users can be notified when their account is created, activated, locked, or when the password is changed for their account.
- Configure the `callback_vip` option with an IP address different from that of the VIP for the ingress controller. You can configure a separate IP address, which is a part of the MetalLB pool of addresses, to enable segregation of management and data traffic from the southbound and northbound interfaces. By default, `callback_vip` is assigned the same or one of the addresses of the ingress controller.

Save and exit the file after you finish editing it.

7. (Optional) If you want to deploy custom SSL certificates signed by a recognized certificate authority (CA), store the private key and certificate in the `config-dir` directory. Save the private key as **ambassador.key.pem** and the certificate as **ambassador.cert.pem**.

By default, Ambassador uses a locally generated certificate signed by the Kubernetes cluster-internal CA.

NOTE: If the certificate is about to expire, save the new certificate as **ambassador.cert.pem** in the same directory, and execute the `./run -c config-dir deploy -t ambassador` command.

8. Install the Paragon Automation cluster based on the information that you configured in the **config.yml** and **inventory** files.

```
# ./run -c config-dir deploy
```

The installation time to install the configured cluster depends on the complexity of the cluster. A basic setup installation takes at least 45 minutes to complete.

NTP synchronization is checked at the start of deployment. If clocks are out of sync, deployment will fail. If you are installing Paragon Automation on an existing Kubernetes cluster, the `deploy` command upgrades the currently deployed cluster to the latest Kubernetes version. The command also upgrades the Docker CE version, if required. If Docker EE is already installed on the nodes, the `deploy` command will not overwrite it with Docker CE. When upgrading the Kubernetes version or the Docker version, the command performs the upgrade sequentially on one node at a time. Each

node is cordoned off and removed from scheduling and upgrades are performed, Kubernetes is restarted on the node, and the node is finally uncordoned and brought back into scheduling.

9. When deployment is completed, log in to the worker nodes.

Use a text editor to configure the following recommended information for Paragon Insights in the **limits.conf** and **sysctl.conf** files. These values set the soft and hard memory limits for influx DB memory requirements. If you do not set these limits, you might see errors such as “out of memory” or “too many open files” because of default system limits.

a.

```
# vi /etc/security/limits.conf

# End of file
*          hard    nofile      1048576
*          soft    nofile      1048576
root       hard    nofile      1048576
root       soft    nofile      1048576
influxdb   hard    nofile      1048576
influxdb   soft    nofile      1048576
```

b.

```
# vi /etc/sysctl.conf

fs.file-max = 2097152
vm.max_map_count=262144
fs.inotify.max_user_watches=524288
fs.inotify.max_user_instances=512
```

Log in to the Paragon Automation UI

After you install Paragon Automation, log in to the Paragon Automation UI.

1. Open a browser, and enter either the hostname of the main Web application or the VIP address of the ingress controller that you entered in the URL field of the installation wizard.

For example, <https://vip-of-ingress-controller-or-hostname-of-main-web-application>. The Paragon Automation login page appears.

2. For first-time access, enter **admin** as username and **Admin123!** as the password to log in. You must change the password immediately.

The **Set Password** page appears. To access the Paragon Automation setup, you must set a new password.

3. Set a new password that meets the password requirements.

The password should be between 6 to 20 characters and must be a combination of uppercase letters, lowercase letters, numbers, and special characters. Confirm the new password, and click **OK**.

The **Dashboard** page appears. You have successfully installed and logged in to the Paragon Automation UI.

4. Update the URL to access the Paragon Automation UI in **Administration > Authentication > Portal Settings** to ensure that the activation e-mail sent to users for activating their account contains the correct link to access the GUI. For more information, see *Configure Portal Settings*.

For high-level tasks that you can perform after you log in to the Paragon Automation GUI, see [Paragon Automation Getting Started](#).

Modify cRPD Configuration

During the installation of Paragon Automation, you can configure the address of the BGP-LS routers that will peer with cRPD to provide topology information to Paragon Pathfinder. You can also modify the cRPD configuration after installation, in the following ways:

- You can edit the BGP Monitoring Protocol (BMP) configuration file (**kube-cfg.yml**) located in the Paragon Automation primary node **/etc/kubernetes/po/bmp/** directory, and then apply the new configuration.

To edit the BMP configuration file and add a new neighbor:

1. Edit the **kube-cfg.yml** file.

```
root@primary-node:~# vi /etc/kubernetes/po/bmp/kube-cfg.yml

---
apiVersion: v1
kind: ConfigMap
metadata:
  namespace: northstar
  name: crpd-config
data:
  config: |
    protocols {
      bgp {
        group northstar {
          neighbor 10.xx.43.1;
          neighbor 10.xx.43.2;  <= make sure you include the ";"
        }
      }
    }
  }
```

```
}
}
```

2. Apply the changes in the **kube-cfg.yml** file.

```
root@primary-node:~# kubectl apply -f /etc/kubernetes/po/bmp/kube-cfg.yml
deployment.apps/bmp configured
configmap/crpd-config configured
service/bmp-grpc unchanged
service/crpd unchanged
service/bgp unchanged
persistentvolumeclaim/crpd-data unchanged
```

3. Connect to the cRPD container.

```
root@primary-node:/# cd usr/local/bin/

root@primary-node:/usr/local/bin# ./pf-crpd
```

4. Verify that the changes are applied.

```
root@bmp-5888bb7dfd-72v9t> show configuration protocols bgp | display inheritance
group northstar {
---more---
##
## '10.xx.43.1' was inherited from group 'extra'
##
neighbor 10.xx.43.1;
##
## '10.xx.43.2' was inherited from group 'extra'
##
neighbor 10.xx.43.2;
```

NOTE: Any additional neighbor will be added under a configuration group named extra. Use the `| display inheritance` command to see the new neighbor.

- Connect to the cRPD container and edit the configuration like you would on any Junos device.

To connect to cRPD and add a new neighbor or change the autonomous system (AS) number:

1. Connect to the cRPD container and enter configuration mode.

```
root@primary-node:/# cd usr/local/bin/

root@primary-node:/usr/local/bin# ./pf-crpd

root@ bmp-5888bb7dfd-72v9 > edit

[edit]
root@ bmp-5888bb7dfd-72v9t#
```

2. Review the current BGP configuration and AS number.

```
[edit]
root@bmp-5888bb7dfd-72v9t# show protocols bgp | display inheritance
group northstar {
---more--
    ##
    ## '10.xx.43.1' was inherited from group 'extra'
    ##
    neighbor 10.xx.43.1;
    ##
    ## '10.xx.43.2' was inherited from group 'extra'
    ##
    neighbor 10.xx.43.2;

[edit]
root@bmp-5888bb7dfd-72v9t# show routing-options autonomous-system
11;
```

3. Change the AS number.

```
[edit]
root@bmp-5888bb7dfd-72v9t# set routing-options autonomous-system 64500
```

4. Add a new neighbor.

```
[edit]
root@bmp-5f78448d69-f84q7# edit protocols bgp

[edit protocols bgp]
root@bmp-5888bb7dfd-72v9t# set group northstar neighbor 10.xx.43.3

[edit protocols bgp group northstar]
root@bmp-5888bb7dfd-72v9t# show | display inheritance
---more---
neighbor 10.xx.43.3;
  ##
  ## '10.xx.43.1' was inherited from group 'extra'
  ##
  neighbor 10.xx.43.1;
  ##
  ## '10.xx.43.2' was inherited from group 'extra'
  ##
  neighbor 10.xx.43.2;
```

NOTE: You could also add the neighbor under the configuration group `extra`. However, if the pod is restarted, this change will be overwritten by the configuration in the `kube-cfg.yml` file.

5. Commit your configuration changes.

```
[edit]
root@bmp-5f78448d69-f84q7# commit
```

4

CHAPTER

Install Paragon Automation On CentOS

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Installation Prerequisites on CentOS

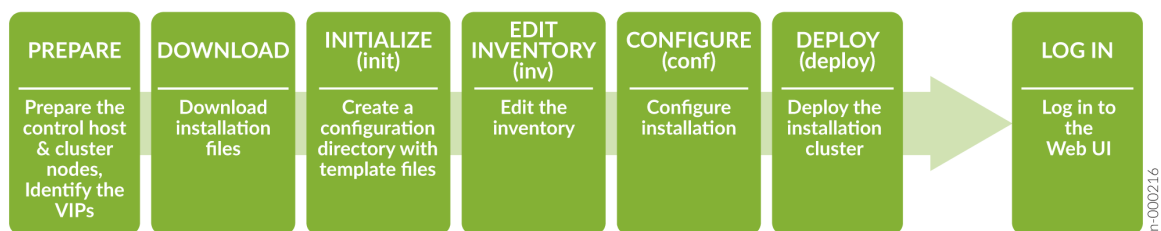
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To successfully install and deploy a Paragon Automation cluster, you must have a control host that installs the distribution software on a single node or on multiple cluster nodes. You can download the distribution software on the control host and then create and configure the installation files to run the installation from the control host. You must have **Internet access** to download the packages on the control host. You must also have Internet access on the cluster nodes to download any additional software such as Docker, and OS patches.

The order of installation tasks is shown at a high level in [Figure 17 on page 80](#).

Figure 17: High-Level Process Flow for Installing Paragon Automation



Before you download and install the distribution software, you must configure the control host and the cluster nodes as described in this topic.

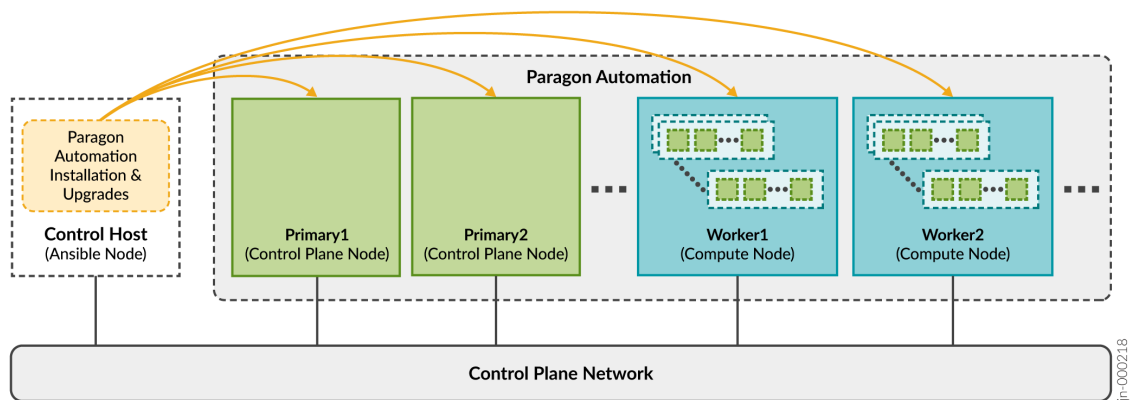
Prepare the Control Host

The control host is a dedicated machine that orchestrates the installation and upgrade of a Paragon Automation cluster. It carries out the Ansible operations that run the software installer and install the software on the cluster nodes as illustrated in [Figure 18 on page 81](#).

You must download the installer packages on the Ansible control host. As part of the Paragon Automation installation process, the control host installs any additional packages required on the cluster nodes. The packages include optional OS packages, Docker, and Elasticsearch. All microservices, including third-party microservices, are downloaded onto the cluster nodes. The microservices do not access any public registries during installation.

The control host can be on a different broadcast domain from the cluster nodes, but you must ensure that the control host can use SSH to connect to all the nodes.

Figure 18: Control Host Functions



After installation is complete, the control host plays no role in the functioning of the cluster. However, you'll need the control host to update the software or any component, make changes to the cluster, or reinstall the cluster if a node fails. You can also use the control host to archive configuration files. We recommend that you keep the control host available, and not use it for something else, after installation.

You need to prepare the control host for the installation process as follows:

- 1. Install Base OS**—Install CentOS version 7.6 (or later).
- 2. Install Docker**—Docker must be installed and configured on the control host to implement the Linux container environment. Paragon Automation supports Docker CE and Docker EE. The Docker version you choose to install in the control host is independent of the Docker version you plan to use in the cluster nodes.

If you want to install Docker EE, ensure that you have a trial or subscription before installation. For more information on Docker EE, supported systems, and installation instructions, see <https://www.docker.com/blog/docker-enterprise-edition/>.

To download and install Docker CE, perform the following steps:

```
$ sudo yum install -y yum-utils \
    device-mapper-persistent-data \
    lvm2
$ sudo yum-config-manager \
    --add-repo \
    https://download.docker.com/linux/centos/docker-ce.repo
$ sudo yum install docker-ce
$ sudo systemctl start docker
```

To verify that Docker is installed and running, use the `$ docker run hello-world` command.

To verify the Docker version installed, use the `$ docker version` or `$ docker --version` commands.

For full instructions and more information, see <https://docs.docker.com/engine/install/centos/>.

3. **Configure SSH client authentication**—The installer running on the control host connects to the cluster nodes using SSH. For SSH authentication, you must use a root or non-root user account with superuser (sudo) privileges. We will refer to this account as the install user account in subsequent steps. You must ensure that the install user account is configured on **all** the nodes in the cluster. The installer will use the inventory file to determine which username to use, and whether the authentication will use SSH keys or a password. See [Customize the Inventory File - Multinode Implementation](#) or [Customize the Inventory File - Single Node Implementation](#).

If you choose the ssh-key authentication (recommended) method, generate the SSH key.

```
# cd ~/.ssh
$ ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/root/.ssh/id_rsa):    <= ENTER (use default)
Enter passphrase (empty for no passphrase):                <= ENTER (no passphrase)
Enter same passphrase again:                                <= ENTER (no passphrase)
Your identification has been saved in /root/.ssh/id_rsa.
Your public key has been saved in /root/.ssh/id_rsa.pub.
The key fingerprint is:
SHA256:YS8cWopND9RFnpHGqaI1Q8e5ca2fxP/yMVzZtIDINbg root@Control1
The key's randomart image is:
+---[RSA 2048]-----+
|    ..O *==+    |
|    ..= *o*oo    |
```

```
| . .o==*+. . . |
| =+o0.Eo . .+|
| o.++ So.o oo|
| . .o . . . |
| .+ |
| . .o |
| o. |
+----[SHA256]-----+
```

If you want to protect the SSH key with a passphrase, you can use ssh-agent key manager. See <https://www.ssh.com/academy/ssh/agent>.

NOTE: You'll need to copy this key to the nodes as part of the cluster nodes preparation tasks, as described in the next section.

4. **(Optional) Install wget**—Install the `wget` utility to download the Paragon Automation distribution software.

```
$ yum install wget
```

Alternatively, you can use `rsync` or any other file download software to copy the distribution software.

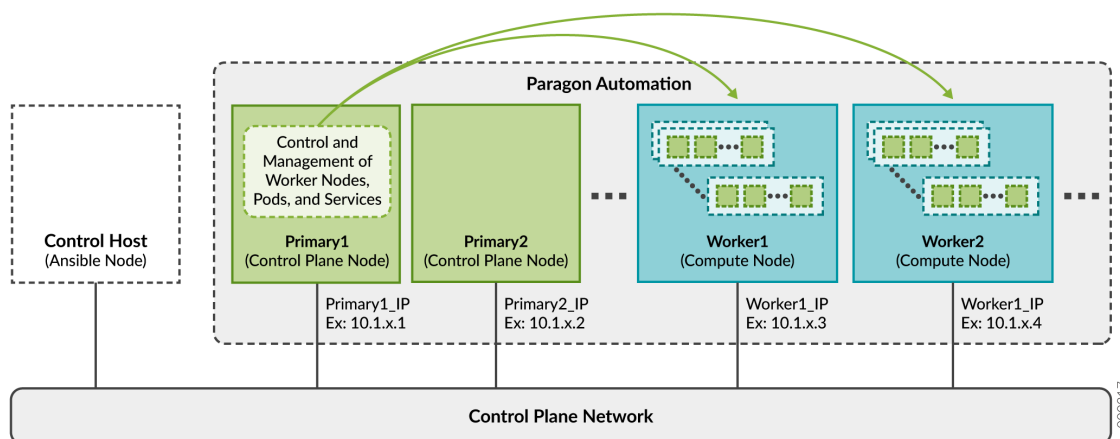
Prepare Cluster Nodes

The primary and worker nodes are collectively called *cluster nodes*. Each cluster node must have at least one unique static IP address, as illustrated in [Cluster Nodes Functions on page 84](#). When configuring the hostnames, use only lowercase letters, and do not include any special characters other than hyphen (-) or the period (.). If the implementation has a separate IP network to provide communication between the Paragon Automation components, as described in the overview section, the IP addresses in that separate network do not need to be reachable outside the cluster. However, then you must assign a second set of IP addresses to the worker nodes. These IP addresses enable devices outside the cluster to reach the worker nodes and also enable communication between:

- Paragon Automation and the managed devices
- Paragon Automation and the network administrator

We recommend that all the nodes be in the same broadcast domain. For cluster nodes in different broadcast domains, see ["Load balancing configuration" on page 96](#) for additional load balancing configuration.

Figure 19: Cluster Nodes Functions



As described in "[Paragon Automation System Requirements](#)" on page 8, you can install Paragon Automation as a single node or a multinode deployment. The node installation prerequisites are the same for both multinode and single-node deployments, except for storage requirements.

You need to prepare the cluster nodes for the Paragon Automation installation process as follows:

1. **Configure Raw Disk Storage**—The cluster nodes must have raw storage block devices with unpartitioned disks or unformatted disk partitions attached. You can also partition the nodes such that the root partition and other file systems can use a portion of the disk space available. You must leave the remaining space unformatted, with no file systems, and reserve it for Ceph to use. For more information, see "[Disk Requirements](#)" on page 14.

NOTE: You don't need to install or configure anything to allow Ceph to use the unpartitioned disks or unformatted disk partitions. The Paragon Automation installation process automatically assigns the space for Ceph storage.

For multinode clusters, you must have a minimum of three cluster nodes with storage space attached.

For a single-node cluster, the single node must have storage space.

Installation fails if unformatted disks are **not** available.

Ceph requires newer Kernel versions. If your Linux kernel is very old, consider upgrading or reinstalling a new one. For a list of minimum Linux kernel versions supported by Ceph for your OS, see <https://docs.ceph.com/en/latest/start/os-recommendations>. To upgrade your Linux kernel version, see [Upgrade your CentOS Linux Kernel Version](#).

2. **Install Base OS**—Install CentOS version 7.6 (or later) that allows installation of Docker CE or Docker EE.
3. **Create Install User Account**—The install user is the user that the Ansible playbooks will use to log in to the primary and worker nodes and perform all the installation tasks. Ensure that either a root password or an account with superuser (sudo) privileges is configured. You will add this information to the **inventory** file during the installation process.

Set the root user password.

```
# passwd root
New password:
Retype new password:
passwd: password updated successfully
```

4. **Configure SSH Authentication**—Install open-ssh server on all nodes. The installer running on the control host connects to the cluster nodes through SSH using the install user account.

- a. Log in to the cluster nodes. and install open-ssh server on all nodes.

- b. After installation, edit the **sshd_config** file.

```
$ vi /etc/ssh/sshd_config
```

- c. If you are using "root" as the install user account, permit root login.

```
PermitRootLogin yes
```

If you chose to use plain text password for authentication, you must enable password authentication.

```
PasswordAuthentication yes
```

We do not recommend the use of password authentication.

- d. Ensure that the **AllowTcpForwarding** parameter is set to yes.

```
AllowTcpForwarding yes
```

NOTE: Paragon Automation installation fails when the **AllowTcpForwarding** parameter is set to no.

- e. If you changed **/etc/ssh/sshd_config**, restart the SSH daemon.

```
$ systemctl restart sshd
```

- f. Log in to the control host:

- i. To allow authentication using the SSH key, copy **id_rsa.pub** to the cluster nodes.

```
$ ssh-copy-id -i ~/.ssh/id_rsa.pub cluster-node-IP-or-hostname
```

Repeat this step for ALL the nodes in the cluster (primary and workers). *cluster-node-IP* is the unique address of the node as shown in [Cluster Nodes Functions on page 84](#). If the hostname is used instead, the Ansible control host should be able to resolve the name to its IP address.

- ii. SSH into the cluster node. You must not require a password to log in.

To verify connectivity. Use the Install User Account to ssh.

You should be able to SSH into all nodes in the cluster (primary and workers) from the control host using the Install User Account. If you are not able to, review the previous steps and make sure you did not miss anything.

5. Install Docker—Select one of the following Docker versions to install.

- Docker CE—If you want to use Docker CE, you do *not* need to install it on the cluster nodes. The deploy script installs Docker CE on the nodes during Paragon Automation installation.
- Docker EE—If you want to use Docker EE, you *must* install Docker EE on *all* the cluster nodes. If you install Docker EE on the nodes, the deploy script uses the installed version and does not attempt to install Docker CE in its place. For more information on Docker EE, supported systems, download, and installation instructions, see <https://www.docker.com/blog/docker-enterprise-edition/>.

The Docker version you choose to install in the cluster nodes is not dependent on the Docker version installed in the control host.

6. Disable Firewall—Disable the local firewall.

```
$ systemctl stop firewalld
```

```
$ systemctl disable firewalld
```

Consider protecting your cluster with an external firewall.

7. Install Python—Install Python 3, if not pre-installed with your OS, on the cluster nodes:

```
$ yum install -y python3
```

To verify the Python version installed, use `$ python3 -V` or `$ python3 --version` commands.

8. Check Installed Packages—Use the `$ yum list installed` command and ensure that the following packages are installed.

```
bash-completion, gdisk, iptables, lvm2, python-six, PyYAML, openssl
```

9. **Install and Enable NTP**—All nodes must run NTP or other time-synchronization at all times. By default, Paragon Automation installs the Chrony NTP client. If you do not want to use Chrony, you can manually install NTP on all nodes.

- a. Install NTP.

```
$ yum install ntp ntpdate -y
```

- b. Run this command twice to reduce the offset with the NTP server.

```
$ ntpdate ntp-server
```

- c. Start the NTP daemon.

```
$ systemctl start ntpd
```

- d. Configure the NTP server pools.

```
$ vi /etc/ntp.conf
```

- e. Replace the default CentOS pools with your desired NTP server.

```
server ntp-server prefer iburst
```

Save and exit the file.

- f. Restart the NTP service.

```
$ systemctl restart ntpd
```

- g. Confirm that the system is in sync with the NTP server.

```
$ timedatectl
```

10. **(Optional) Upgrade your CentOS Linux Kernel Version**To upgrade the kernel version of your CentOS server to the latest LTS version to meet the requirements for Paragon Automation installation.

- a. Log in as root user.

- b. Check the existing kernel version:

```
root@server$ uname -msr
```

If the Linux kernel version is earlier than 4.18, upgrade the kernel.

- c. Update existing software packages to the latest versions

```
root@server$ yum -y update
```

- d. CentOS does not provide the latest available kernel versions in its software repository. Therefore, the ERepo (elrepo) software repository is used. Additionally, CentOS requires all

software to be signed; so you must install the elrepo GPG signature key before installing the elrepo repository.

Installing the elrepo GPG signature key requires a single rpm command which returns no output if successful:

- i. Install GPG Key for ElRepo Software Repository.

```
root@server$ rpm --import https://www.elrepo.org/RPM-GPG-KEY-elrepo.org
```

- ii. Install ElRepo Software Repository.

```
root@server$ rpm -Uvh https://www.elrepo.org/elrepo-release-7.0-4.el7.elrepo.noarch.rpm
```

- iii. Confirm the latest kernel in the ElRepo Repository.

```
root@server$ yum list available --disablerepo='*' --enablerepo=elrepo-kernel
```

- e. Install the latest kernel.

```
root@server$ yum --enablerepo=elrepo-kernel install kernel-lt
```

- f. Reboot the server to load the new kernel.

```
root@server$ reboot
```

- g. Edit GRUB configuration. Use the text editor to edit **/etc/default/grub** file.

```
root@server$ vi /etc/default/grub
```

- h. Set GRUB_DEFAULT=0. Save and exit the file.

- i. Install the GRUB configuration and reboot the server.

```
root@server$ grub2-mkconfig -o /boot/grub2/grub.cfg
```

```
root@server$ reboot
```

- j. Verify the new kernel version.

```
root@server$ uname -msr
```

Virtual IP Address Considerations

IN THIS SECTION

- [VIP for multi-primary node deployment | 95](#)
- [Load balancing configuration | 96](#)

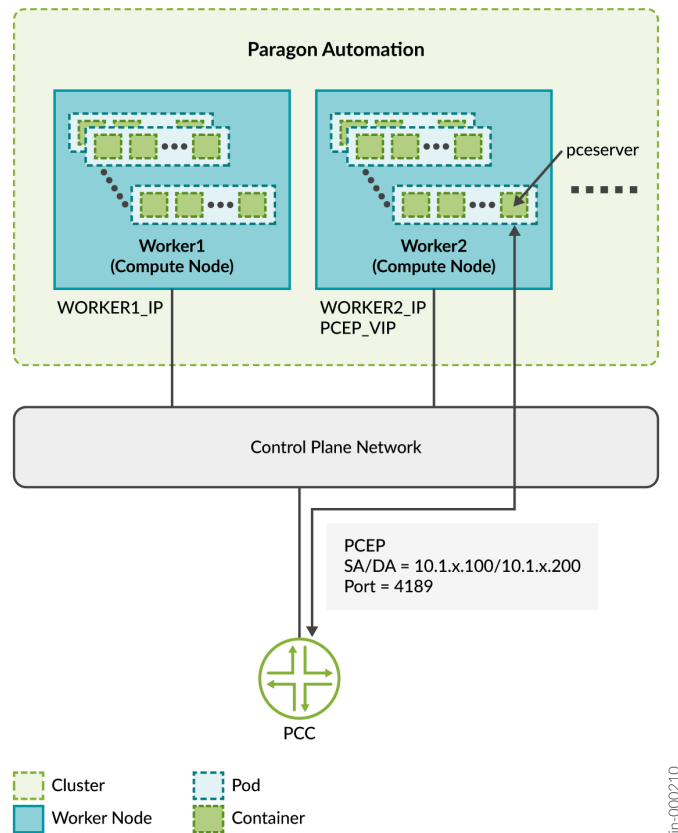
The Kubernetes worker nodes host the pods that handle the workload of the applications.

A pod is the smallest deployable unit of computing created and managed in Kubernetes. A pod contains one or more containers, with shared storage and network resources, and with specific instructions on how to run the applications. Containers are the lowest level of processing, and you execute applications or microservices in containers.

The primary node in the cluster determines which worker node will host a particular pod and containers.

You implement all features of Paragon Automation using a combination of microservices. You need to make some of these microservices accessible from outside the cluster as they provide services to end users (managed devices) and administrators. For example, you must make the pceserver service accessible to establish PCEP sessions between provider edge (PE) routers and Paragon Automation.

You need to expose these services outside of the Kubernetes cluster with specific addresses that are reachable from the external devices. Because a service can be running on any of the worker nodes at a given time, you must use virtual IP addresses (VIPs) as the external addresses. You must not use the address of any given worker node as an external address.



In this example:

Consider that WORKER1_IP = 10.1.x.3 and WORKER2_IP = 10.1.x.4.

SERVICE IP = PCEP VIP = 10.1.x.200

PCC_IP = 10.1.x.100

The services in Paragon Automation are configured to employ one of two methods of exposing services outside the cluster:

- **Load Balancer** Each load balancer is associated with a specific IP address and routes external traffic to a specific service in the cluster. This is the default method for many Kubernetes installations in the cloud. It supports multiple protocols and multiple ports per service. Each service has its own load balancer, and IP address.
- Paragon Automation uses the MetalLB load balancer. MetalLB simulates external load balancer by either managing virtual IP addresses in Layer 2 mode, or interacts with external router(s) in Layer 3 mode. MetalLB provides load-balancing infrastructure to the kubernetes cluster.

Services of type "LoadBalancer" will interact with the Kubernetes load-balancing infrastructure to assign an externally reachable IP address. Some services can share an external IP address.

- **Ingress** Ingress acts as a proxy to bring traffic into the cluster, then uses internal service routing to route the traffic to its destination. Under the hood, Ingress also uses a Load Balancer service to expose itself to the world so it can act as that proxy.

Paragon Automation uses:

- Ambassador
- Nginx

Devices from outside the cluster need to access the following services and thus these services require a VIP address.

Required VIP Address	Description	Load Balancer/Proxy
Ingress controller	<p>Used for Web access of the Paragon Automation GUI.</p> <p>Paragon Automation provides a common Web server that provides access to the components and applications. Access to the server is managed through the Kubernetes Ingress Controller.</p> <p>Ingress Controller also provides access for device initiated NETCONF connections. To allow for separation of network element initiated traffic and management traffic, Ingress Controller can be configured using multiple addresses.</p>	<p>Ambassador</p> <p>MetaLB</p>
Paragon Insights services	Used for Insights services such as syslog, DHCP relay, and JTI.	MetaLB
Paragon Pathfinder PCE server	<p>Used to establish PCEP sessions with devices in the network.</p> <p>PCE server can use Nginx as a proxy, in which case it will not use its own VIP address.</p>	MetaLB

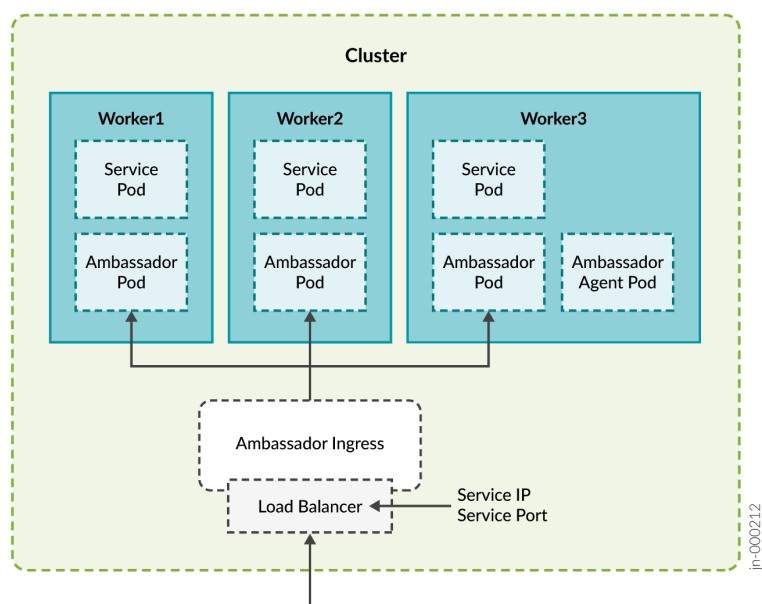
(Continued)

Required VIP Address	Description	Load Balancer/Proxy
SNMP trap receiver proxy (Optional)	User for the SNMP trap receiver proxy only if this functionality is required.	MetalLB
Virtual IP address for Infrastructure Nginx Ingress Controller	<p>Used as a proxy for Paragon Pathfinder netflowd server, and optionally Paragon Pathfinder PCE server.</p> <p>The Nginx Ingress Controller needs a VIP within the MetalLB load balancer pool. This means that during the installation process you need to include this address as part of the LoadBalancer IP address ranges that you will be required to include while creating the configuration file.</p>	<p>Nginx</p> <p>MetalLB</p>
Virtual IP address for Pathfinder Netflowd	<p>Used for Paragon Pathfinder netflowd server.</p> <p>Netflowd can use Nginx as proxy, in which case it will not require its own VIP address.</p>	MetalLB

Ports used by Ambassador:

- HTTP 80 (TCP) redirect to HTTPS
- HTTPS 443 (TCP)
- Paragon Planner 7000 (TCP)
- DCS/NETCONF initiated 7804 (TCP)

Figure 20: Ambassador



Ports used by Insights Services, PCE server, and SNMP.

- **Insights Services**

JTI 4000 (UDP)

DHCP (ZTP) 67 (UDP)

SYSLOG 514 (UDP)

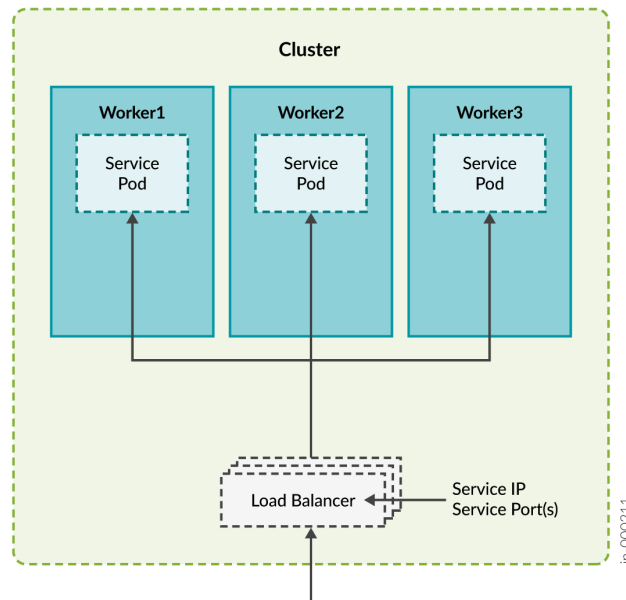
SNMP proxy 162 (UDP)

- **PCE Server**

PCEP 4189 (TCP)

- **SNMP**

SNMP Trap Receiver 162 (UDP)



Ports used by Nginx Controller:

- NetFlow 9000 (UDP)
- PCEP 4189 (TCP)

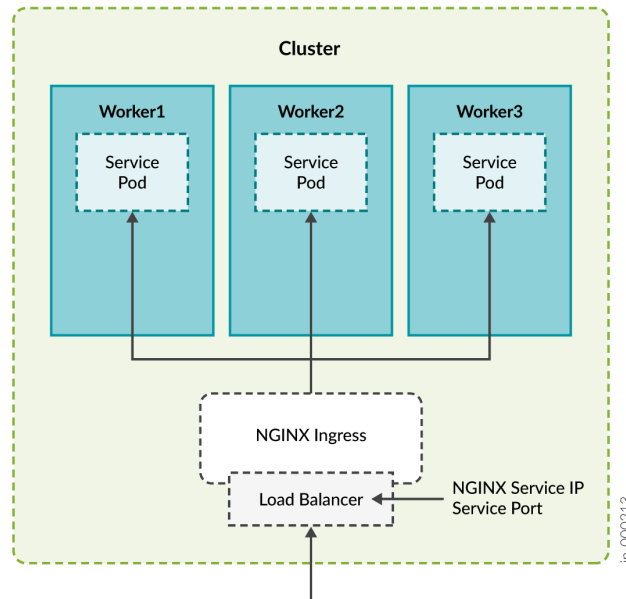
Using Nginx for PCEP

During the installation process, you will be asked whether you want to enable ingress proxy for PCEP. You can select from None or Nginx-Ingress as the proxy for the Path Computation Element (PCE) server.

If you select Nginx-Ingress as the proxy, you do *not* need to configure the VIP for the PCE server described in the table. In this case, the VIP address for Infrastructure Nginx Ingress Controller is used for the PCE server also. If you choose to not use a netflowd proxy, the VIP for the Infrastructure Nginx Ingress Controller is used for netflowd, as well.

NOTE: The benefit of using Nginx is that you can use a single IP address for multiple services.

Figure 21: Nginx Controller



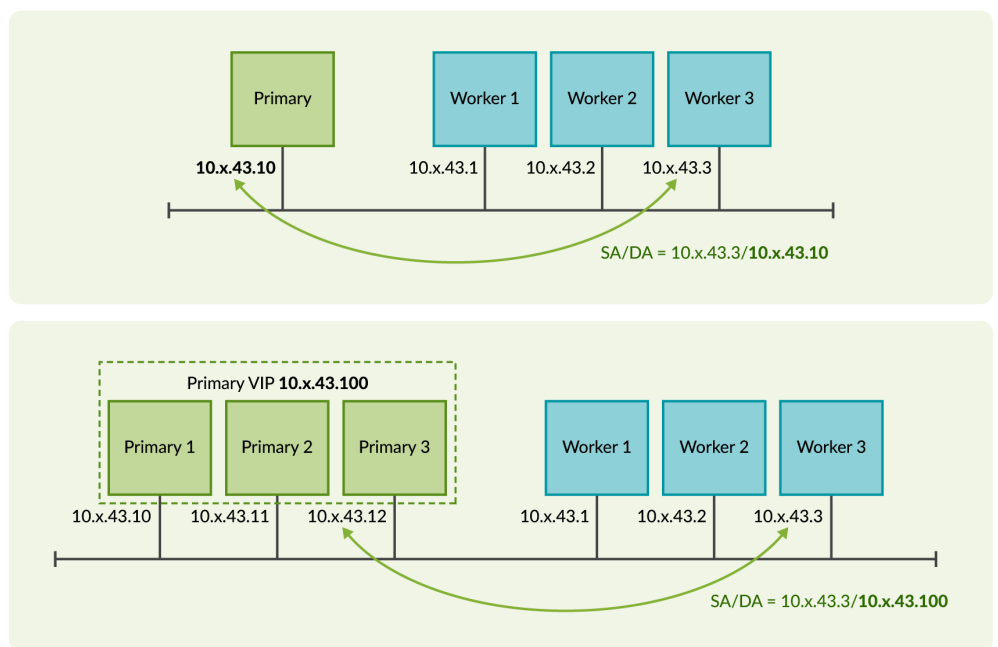
VIP for multi-primary node deployment

If you are deploying a setup with multiple primary nodes, you need an additional VIP address in the same broadcast domain as the cluster nodes. This address will be used for communication between the elected primary node and the worker nodes.

In a multi-primary setup, the worker node communicates with the primary function using the VIP address, instead of the address assigned to any of the nodes acting as primary.

The installation wizard refers to this IP address as the Kubernetes Master Virtual IP address. The VIP address pool of the MetalLB load balancer must *not* contain this VIP address.

In a setup with a single primary node, the worker node communicates with the primary node using the address assigned to that node acting as primary (IP address configured on the interface of the node acting as primary).



NOTE: You must identify all the required VIPs, before you start the Paragon Automation installation process. You will be asked to enter these addresses as part of the installation process.

Load balancing configuration

VIPs are managed in Layer 2 by default. When all cluster nodes are in the same broadcast domain, each VIP is assigned to one cluster node at a time. Layer 2 mode provides fail-over of the VIP and does not provide actual load balancing. For true load balancing between the cluster nodes or if the nodes are in different broadcast domains, you must configure load balancing in Layer 3.

You must configure a BGP router to advertise the VIP to the network. The BGP router should be configured to use ECMP to balance TCP/IP sessions between different hosts. Connect the BGP router directly to the cluster nodes.

To configure load balancing on the cluster nodes, edit the **config.yml** file. For example:

```
metallb_config:
  peers:
    - peer-address: 192.x.x.1 ## address of BGP router
      peer-asn: 64501 ## autonomous system number of BGP router
      my-asn: 64500 ## ASN of cluster
```

```
address-pools:
  - name: default
    protocol: bgp
    addresses:
      - 10.x.x.0/24
```

In this example, The BGP router at 192.x.x.1 is responsible to advertise reachability for the VIPs with the 10.x.x.0/24 prefix to the rest of the network. The cluster allocates the VIP of this range and advertises the address for the cluster nodes that can handle the address.

DNS Server Configuration (Optional)

You can access the main Web gateway either through the ingress controller's VIP address or through a hostname that is configured in the Domain Name System (DNS) server that resolves to the ingress controller's VIP address. You need to configure the DNS server only if you want to use a hostname to access the Web gateway.

Add the hostname to the DNS as an A, AAAA, or CNAME record. For lab and Proof of Concept (POC) setups, you can add the hostname to the `/etc/hosts` file on the cluster nodes.

RELATED DOCUMENTATION

[Install MultiNode Cluster on CentOS | 97](#)

[Install Single-Node Cluster on CentOS | 117](#)

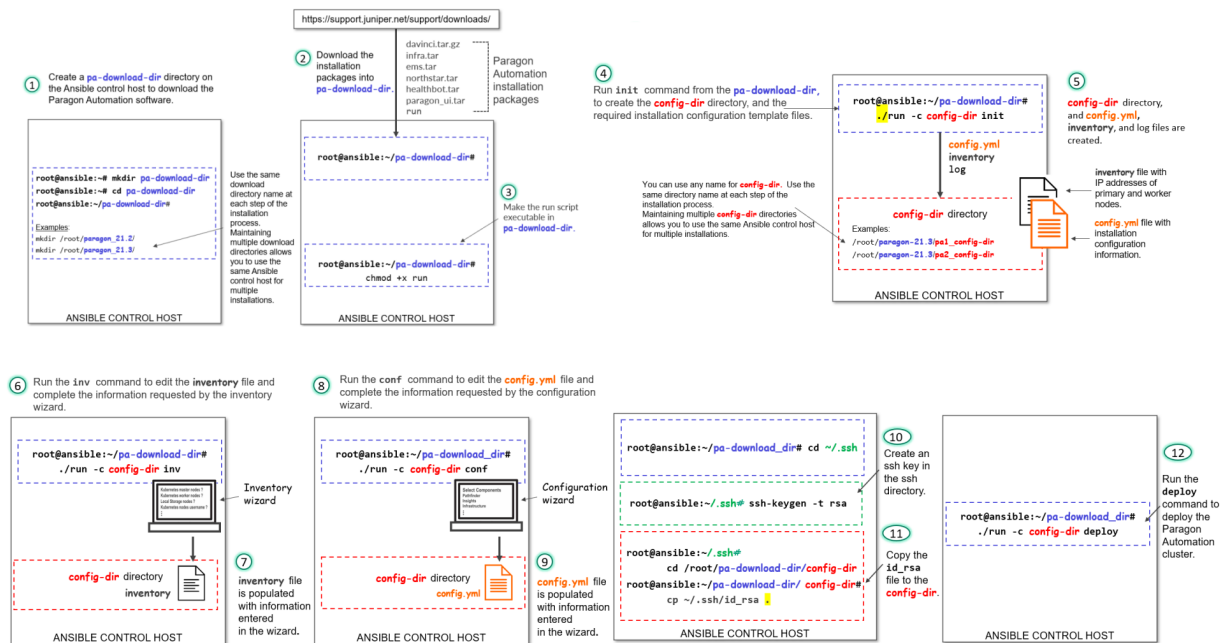
Install MultiNode Cluster on CentOS

IN THIS SECTION

- [Download the Software | 98](#)
- [Install Paragon Automation as a Multinode Cluster | 99](#)
- [Log in to the Paragon Automation UI | 117](#)

This topic describes the installation of the Paragon Automation on a multi-node cluster. The summary of installation tasks is shown at a high level in [Figure 22 on page 98](#). Ensure that you have completed all the preconfiguration and preparation steps described in ["Installation Prerequisites on CentOS" on page 80](#) before you begin installation.

Figure 22: Installation Sequence - Infographic



To view a higher-resolution image in your Web browser, right-click the image and open in a new tab. To view the image in PDF, use the zoom option to zoom in.

Download the Software

Prerequisite

- You need a Juniper account to download the Paragon Automation software.

- Log in to the control host.
- Create a directory in which you download the software.

This directory is referred to as *pa-download-dir* in this guide.

- Select the version number from the **Version** list on the Paragon Automation software download page at <https://support.juniper.net/support/downloads/?p=pa>.

4. Download the **Paragon Automation Setup** installation files to the download folder using the `wget "http://cdn.juniper.net/software/file-download-url"` command.

The Paragon Automation setup installation bundle consists of the following scripts and tar files to install each of the component modules:

- **davinci.tar.gz**, which is the primary installer file.
- **infra.tar**, which installs the Kubernetes infrastructure components including Docker and Helm.
- **ems.tar**, which installs the base platform component.
- **northstar.tar**, which installs the Paragon Pathfinder and Paragon Planner components.
- **healthbot.tar**, which installs the Paragon Insights component.
- **paragon_ui.tar**, which installs the Paragon Automation UI component.
- **addons.tar**, which installs infrastructure components that are not part of the base Kubernetes installation. The infrastructure components include, IAM, Kafka, ZooKeeper, cert-manager, Ambassador, Postgres, Metrics, Kubernetes Dashboard, Open Distro for Elasticsearch, Fluentd, Reloader, ArangoDB, and Argo.
- **rhel-84-airgap.tar.gz**, which installs Paragon Automation using the air-gap method on nodes *only* where the base OS is Red Hat Enterprise Linux (RHEL).
- **run script**, which executes the installer image.

NOTE: The Paragon Automation setup installation bundle comprises of a **foghorn.tar** file. However, Foghorn is not supported in Release 22.1.

Install Paragon Automation as a Multinode Cluster

1. Make the run script executable in the *pa-download-dir* directory.

```
# chmod +x run
```

2. Use the run script to create and initialize a configuration directory with the configuration template files.

```
# ./run -c config-dir init
```

config-dir is a user-defined directory on the control host that contains configuration information for a particular installation. The `init` command automatically creates the directory if it does not exist. Alternatively, you can create the directory before you execute the `init` command.

Ensure that you include the `./` with the `run` command.

If you are using the same control host to manage multiple installations of Paragon Automation, you can differentiate between installations by using differently named configuration directories.

3. Ensure that the control host can connect to the cluster nodes through SSH using the install user account.

Copy the private key that you generated in ["Install SSH Client Authentication" on page 82](#) to the user defined **config-dir** directory. The installer allows the Docker container to access the **config-dir** directory. The SSH key must be available in the directory for the control host to connect to the cluster nodes.

```
# cd config-dir
# cp ~/.ssh/id_rsa .
# cd ..
```

Ensure that you include the dot `.` at the end of the copy command.

4. Customize the inventory file, created under the **config-dir** directory, with the IP addresses or hostnames of the cluster nodes, as well as the usernames and authentication information that are required to connect to the nodes. The inventory file is in the YAML format and describes the cluster nodes on which Paragon Automation will be installed. You can edit the file using the `inv` command or a Linux text editor such as `vi`.

- a. Customize the inventory file using the `inv` command:

```
# ./run -c config-dir inv
```

The configuration options that the `inv` command prompts are listed in the following table.

Table 11: `inv` Command Options

inv Command Prompts	Description
Kubernetes master nodes	Enter IP addresses of the Kubernetes primary nodes.
Kubernetes worker nodes	Enter IP addresses of the Kubernetes worker nodes.

Table 11: *inv* Command Options (*Continued*)

inv Command Prompts	Description
Local storage nodes	<p>Define the nodes that have disk space available for applications. The local storage nodes are prepopulated from the primary and worker node IP addresses. You can edit these addresses. Enter IP addresses of the nodes on which you want to run applications that require local storage.</p> <p>Services such as Postgres, Zookeeper, and Kafka, use local storage or disk space partitioned inside export/local-volumes. By default, worker nodes have local storage available. If you do not add primary nodes here, you can run only applications that do not require local storage on the primary nodes.</p> <p>This is different from Ceph storage.</p>
Kubernetes nodes' username (e.g. root)	<p>Configure the user account and authentication methods to authenticate the installer with the cluster nodes. The user account must be root or in case of non-root users, the account must have superuser (sudo) privileges.</p>
SSH private key file (optional)	<p>If you chose ssh-key authentication, for the control host to authenticate with the nodes during the installation process, configure the path to the config-dir directory where the ansible_ssh_private_key_file is located, and the id_rsa file, as config/id_rsa. This is because the path to the config-dir is mounted internally in the installer container at config. Alternatively, you can also use the default <code>{{ inventory_dir }}/id_rsa</code>.</p>

Table 11: *inv* Command Options (Continued)

inv Command Prompts	Description
Kubernetes nodes' password (optional)	<p>If you chose password authentication for the control host to authenticate with the nodes during the installation process, enter the authentication password directly.</p> <p>Warning: The password is written in plain text. We do not recommend using this option for authentication.</p>
Kubernetes cluster name (optional)	Enter a name for your Kubernetes cluster.
Write inventory file?	Click Yes to save the inventory information.

For example:

```
$ ./run -c config-dir inv
Loaded image: paragonautomation:latest
=====
PO-Runtime installer
=====

Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
  info [-mc]        cluster installation info

Starting now: inv

INVENTORY

This script will prompt for the DNS names or IP addresses of the Kubernetes master and
worker nodes.
Addresses should be provided as comma-delimited lists.

At least three master nodes are recommended. The number of masters should be an odd number.
```

A minimum of four nodes are recommended.

Root access to the Kubernetes nodes is required.

See https://docs.ansible.com/ansible/2.10/user_guide/intro_inventory.html

```
? Kubernetes master nodes 10.12.xx.x3,10.12.xx.x4,10.12.xx.x5
? Kubernetes worker nodes 10.12.xx.x6
? Local storage nodes 10.12.xx.x3,10.12.xx.x4,10.12.xx.x5,10.12.xx.x6
? Kubernetes nodes' username (e.g. root) root
? SSH private key file (optional; e.g. "{{ inventory_dir }}/id_rsa") config/id_rsa
? Kubernetes nodes' password (optional; WARNING - written as plain text)
? Kubernetes cluster name (optional) k8scluster
? Write inventory file? Yes
```

- b. Alternatively, you can customize the inventory file manually using a text editor.

```
# vi config-dir/inventory
```

Edit the following groups in the **inventory** file.

- i. Add the IP addresses of the Kubernetes primary and worker nodes of the cluster.

The `master` group identifies the primary nodes, and the `node` group identifies the worker nodes. You cannot have the same IP address in both `master` and `node` groups.

To create a multi-primary node setup, list the addresses or hostnames of all the nodes that will be acting as primary nodes under the `master` group. Add the addresses or hostnames of the nodes that will be acting as worker nodes under the `node` group.

```
master:
  hosts:
    10.12.xx.x3: {}
    10.12.xx.x4: {}
    10.12.xx.x5: {}
node:
  hosts:
    10.12.xx.x6: {}
```

- ii. Define the nodes that have disk space available for applications under the `local_storage_nodes:children` group.

```
local_storage_nodes:
  children:
    master:
      hosts:
        10.12.xx.x3: {}
        10.12.xx.x4: {}
        10.12.xx.x5: {}
    node:
      hosts:
        10.12.xx.x6: {}
```

- iii. Configure the user account and authentication methods to authenticate the installer in the Ansible control host with the cluster nodes under the `vars` group.

```
vars:
  ansible_user: root
  ansible_ssh_private_key_file: config/id_rsa
  ansible_password:
```

- iv. (Optional) Specify a name for your Kubernetes cluster in the `kubernetes_cluster_name` group.

```
kubernetes_cluster_name: k8scluster
```

5. Configure the installer using the `conf` command.

```
# ./run -c config-dir conf
```

The `conf` command runs an interactive installation wizard that allows you to choose the components to be installed and configure a basic Paragon Automation setup. The command populates the **config.yml** file with your input configuration. For advanced configuration, you must edit the **config.yml** file manually.

Enter the information as prompted by the wizard. Use the cursor keys to move the cursor, use the space key to select an option, and use `a` or `i` to toggle selecting or clearing all options. Press Enter to move to the next configuration option. You can skip configuration options by entering a period (`.`). You can re-enter all your choices by exiting the wizard and restarting from the beginning. The installer allows you to exit the wizard after you save the choices that you already made or to restart

from the beginning. You cannot go back and redo the choices that you already made in the current workflow without exiting and restarting the wizard altogether.

The configuration options that the `conf` command prompts for are listed in the following table:

conf Command Prompts	Description/Options
Select components	<p>You can install one or more of the Infrastructure, Pathfinder, Insights, and base platform components. By default, all components are selected.</p> <p>You can choose to install Pathfinder based on your requirement. However, you must install all other components, apart from Foghorn.</p> <p>NOTE: Foghorn is not supported in Release 22.1. You <i>must not</i> select the Foghorn option. Installation fails if you select Foghorn.</p>

(Continued)

conf Command Prompts	Description/Options
Infrastructure Options	<p>These options are displayed only if you selected to install the Infrastructure component in the previous prompt.</p> <ul style="list-style-type: none"> • Install Kubernetes Cluster—Install the required Kubernetes cluster. If you are installing Paragon Automation on an existing cluster, you can clear this selection. • Install MetalLB LoadBalancer—Install an internal load balancer for the Kubernetes cluster. By default, this option is already selected. If you are installing Paragon Automation on an existing cluster with preconfigured load balancing, you can clear this selection. • Install Nginx Ingress Controller—Install Nginx Ingress Controller is a load-balancing proxy for the Pathfinder components. • Install Chrony NTP Client—Install Chrony NTP. NTP is required to synchronize the clocks of the cluster nodes. If NTP is already installed and configured, you need not install Chrony. All nodes must run NTP or some other time-synchronization at all times. • Allow Master Scheduling—Master scheduling determines how the node acting as primary nodes are used. Master is another term for a node acting as primary. <p>If you select this option, the primary nodes can also act as worker nodes, which means they not only act as control plane but can run application workloads as well. If you do not select master scheduling, the primary nodes are used only as the control plane.</p> <p>Master scheduling allows the available resources of the nodes acting as primary to be available for workloads. However, you run the risk that a misbehaving workload can exhaust resources on the primary node, and affect the stability of the whole cluster. Without master scheduling, if you have multiple primary nodes with high capacity and disk space, you risk wasting their resources by not utilizing them completely.</p> <p>NOTE: This option is required for Ceph storage redundancy.</p>
List of NTP servers	<p>Enter a comma-separated list of NTP servers. This option is displayed only if you chose to install Chrony NTP.</p>

(Continued)

conf Command Prompts	Description/Options
Kubernetes Master Virtual IP address	<p>Enter a VIP for the Kubernetes API Server for a multi-primary node deployment only. The VIP must be in the same Layer 2 domain as the primary nodes. This VIP is not part of the LoadBalancer pool of VIPs.</p> <p>This option is presented only when multiple primary nodes have been configured in the inventory file (multi-primary installation).</p>
Install LoadBalancer for Master Virtual IP address	<p>(Optional) Select to install keepalived LoadBalancer for the Master VIP.</p> <p>This option is presented only when multiple primary nodes have been configured in the inventory file (multi-primary installation).</p>
Virtual IP address (es) for ingress controller	Enter a VIP to be used for Web access of the Kubernetes cluster or the Paragon Automation user interface. This must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for Infrastructure Nginx Ingress Controller	Enter a VIP for the Nginx Ingress Controller. This must be an unused IP address that is managed by the MetalLB load balancer pool. This address is used for NetFlow traffic.
Virtual IP address for Insights services	Enter a VIP for Paragon Insights services. This must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for SNMP trap receiver (optional)	<p>Enter a VIP for the SNMP trap receiver proxy only if this functionality is required.</p> <p>If you do not need this option, enter a dot ".".</p>
Pathfinder Options	<p>Select to install Netflowd. You can configure a VIP address for netflowd or use a proxy for netflowd (same as the VIP address for the Infrastructure Nginx Ingress Controller).</p> <p>If you choose to not install netflowd, you cannot configure a VIP address for netflowd.</p>

(Continued)

conf Command Prompts	Description/Options
Use netflowd proxy	<p>Enter Y to use a netflowd proxy. This option appears only if you chose to install netflowd.</p> <p>If you chose to use a netflowd proxy, you needn't configure a VIP address for netflowd. The VIP address for the Infrastructure Nginx Ingress Controller is used as the proxy for netflowd.</p>
Virtual IP address for Pathfinder Netflowd	<p>Enter a VIP address to be used for Paragon Pathfinder netflowd. This option appears only if you chose <i>not</i> to use netflowd proxy.</p>
PCE Server Proxy	<p>Select the proxy mode for the PCE server. Select from None and Nginx-Ingress.</p>
Virtual IP address for Pathfinder PCE server	<p>Enter a VIP address to be used for Paragon Pathfinder PCE server access. This address must be an unused IP address that is managed by the load balancer.</p> <p>If you selected Nginx-Ingress, as the PCE Server Proxy, this VIP address is not necessary. The wizard does not prompt you to enter this address and PCEP will use the same address as the VIP address for Infrastructure Nginx Ingress Controller.</p> <p>NOTE: The addresses for ingress controller, Infrastructure Nginx Ingress Controller, Insights services, and PCE server must be unique. You cannot use the same address for all four VIP addresses.</p> <p>All these addresses are listed automatically in the LoadBalancer IP address ranges option.</p>

(Continued)

conf Command Prompts	Description/Options
LoadBalancer IP address ranges	<p>The LoadBalancer IP addresses are prepopulated from your VIP addresses range. You can edit these addresses. The externally accessible services are handled through MetalLB, which needs one or more IP address ranges that are accessible from outside the cluster. VIPs for the different servers are selected from these ranges of addresses.</p> <p>The address ranges can be (but need not be) in the same broadcast domain as the cluster nodes. For ease of management, because the network topologies need access to Insights services and the PCE server clients, we recommend that you select the VIP addresses from the same range.</p> <p>For more information, see "Virtual IP Address Considerations" on page 28.</p> <p>Addresses can be entered as comma-separated values (CSV), as a range, or as a combination of both. For example:</p> <ul style="list-style-type: none"> • 10.x.x.1, 10.x.x.2, 10.x.x.3 • 10.x.x.1-10.x.x.3 • 10.x.x.1, 10.x.x.3-10.x.x.5 • 10.x.x.1-3 is not a valid format
Hostname of Main web application	<p>Enter a hostname for the ingress controller. This can be configured as an IP address or as hostname (FQDN). For example, you can enter 10.12.xx.100 or www.paragon.juniper.net (DNS name). Do not include http:// or https://.</p> <p>NOTE: You will use this hostname to access the Paragon Automation Web UI from your browser. For example, https://<i>hostname</i> or https://<i>IP-address</i>.</p>
BGP autonomous system number of CRPD peer	<p>Set up the Containerized Routing Protocol Daemon (cRPD) autonomous systems and the nodes with which cRPD creates its BGP sessions.</p> <p>You must configure the autonomous system (AS) number of the network to allow cRPD to peer with one or more BGP Link State (BGP-LS) routers in the network. By default, the AS number is 64500.</p> <p>NOTE: While you can configure the AS number at the time of installation, you can also modify the cRPD configuration later. See "Modify cRPD Configuration" on page 75.</p>

(Continued)

conf Command Prompts	Description/Options
Comma separated list of CRPD peers	<p>Configure cRPD to peer with at least one BGP-LS router in the network to import the network topology. For a single autonomous system, configure the address of the BGP-LS routers that will peer with cRPD to provide topology information to Paragon Pathfinder. The cRPD instance running as part of a cluster will initiate a BGP-LS connection to the specified peer routers and import topology data after the session is established. If more than one peer is required, you can add the peers as CSVs, as a range, or as a combination of both, similar to how you add LoadBalancer IP addresses.</p> <p>NOTE: While you can configure the peer IP addresses at the time of installation, you can also modify the cRPD configuration later, as described in "Modify cRPD Configuration" on page 75.</p> <p>You must configure the BGP peer routers to accept BGP connections initiated from cRPD. The BGP session will be initiated from cRPD using the address of the worker where the bmp pod is running as the source address.</p> <p>Because cRPD could be running on any of the worker nodes at a given time, you must allow connections from any of these addresses. You can allow the range of IP addresses that the worker addresses belong to (for example, 10.xx.43.0/24), or the specific IP address of each worker (for example, 10.xx.43.1/32, 10.xx.43.2/32, and 10.xx.43.3). You could also configure this using the <code>neighbor</code> command with the <code>passive</code> option to prevent the router from attempting to initiate the connection.</p> <p>If you chose to enter each individual worker address, either with the <code>allow</code> command or the <code>neighbor</code> command, make sure you include all the workers, because any worker could be running cRPD at a given time. Only one BGP session will be initiated. If the node running cRPD fails, the bmp pod that contains the cRPD container will be created in a different node, and the BGP session will be re-initiated.</p> <p>The sequence of commands in the following example shows the options to configure a Juniper device to allow BGP-LS connections from cRPD.</p> <p>The following commands configure the router to accept BGP-LS sessions from any host in the 10.xx.43.0/24 network, where all the worker nodes are connected.</p> <pre>[edit groups northstar] root@system# show protocols bgp group northstar type internal; family traffic-engineering {</pre>

(Continued)

conf Command Prompts	Description/Options
	<pre> unicast; } export TE; allow 10.xx.43.0/24; [edit groups northstar] root@system# show policy-options policy-statement TE from family traffic-engineering; then accept; </pre> <p>The following commands configure the router to accept BGP-LS sessions from 10.xx.43.1, 10.xx.43.2, and 10.xx.43.3 (the addresses of the three workers in the cluster) only.</p> <pre> [edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS allow 10.x.43.1 set protocols bgp group BGP-LS allow 10.x.43.2 set protocols bgp group BGP-LS allow 10.x.43.3 set protocols bgp group BGP-LS export TE </pre> <p>cRPD initiates the BGP session. Only one session is established at a time and is initiated using the address of the worker node currently running cRPD. If you choose to configure the specific IP addresses instead of using the allow option, configure the addresses of all the workers nodes for redundancy.</p> <p>The following commands also configure the router to accept BGP-LS sessions from 10.xx.43.1, 10.xx.43.2, and 10.xx.43.3 only (the addresses of the three workers in the cluster). The passive option prevents the router from attempting to initiate a BGP-LS session with cRPD. The router will wait for the session to be initiated by any of these three routers.</p> <pre> [edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS neighbor 10.xx.43.1 set protocols bgp group BGP-LS neighbor 10.xx.43.2 set protocols bgp group BGP-LS neighbor 10.xx.43.3 </pre>

(Continued)

conf Command Prompts	Description/Options
	<pre>set protocols bgp group BGP-LS passive set protocols bgp group BGP-LS export TE</pre> <p>You will also need to enable OSPF/IS-IS and MPLS traffic engineering as shown here:</p> <pre>set protocols rsvp interface <i>interface.unit</i></pre> <pre>set protocols isis interface <i>interface.unit</i> set protocols isis traffic-engineering igp-topology</pre> <p>Or</p> <pre>set protocols ospf area <i>area</i> interface <i>interface.unit</i> set protocols ospf traffic-engineering igp-topology</pre> <pre>set protocols mpls interface <i>interface.unit</i> set protocols mpls traffic-engineering database import igp-topology</pre> <p>For more information, see https://www.juniper.net/documentation/us/en/software/junos/mpls/topics/topic-map/mpls-traffic-engineering-configuration.html.</p>
Finish and write configuration to file	<p>Click Yes to save the configuration information.</p> <p>This action configures a basic setup and saves the information in the config.yml file in the config-dir directory.</p>

For example:

```
$ ./run -c config conf
Loaded image: paragonautomation.latest
=====
PO-Runtime installer
=====

Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
```

```
info [-mc]          cluster installation info
```

```
Starting now: conf
```

```
NOTE: depending on options chosen additional IP addresses may be required for:
```

```
multi-master    Kubernetes Master Virtual IP address
Infrastructure   Virtual IP address(es) for ingress controller
Infrastructure   Virtual IP address for Infrastructure Nginx Ingress Controller
Insights        Virtual IP address for Insights services
Insights        Virtual IP address for SNMP Trap receiver (optional)
Pathfinder      Virtual IP address for Pathfinder Netflowd
Pathfinder      Virtual IP address for Pathfinder PCE server
```

```
? Select components  done (4 selections)
? Infrastructure Options  done (4 selections)
? List of NTP servers  0.pool.ntp.org
? Virtual IP address(es) for ingress controller  10.12.xx.x7
? Virtual IP address for Infrastructure Nginx Ingress Controller  10.12.xx.x8
? Virtual IP address for Insights services  10.12.xx.x9
? Virtual IP address for SNMP Trap receiver (optional)
? Pathfinder Options  [Install Netflowd]
? Use netflowd proxy?  Yes
? PCEServer proxy  Nginx Ingress
? LoadBalancer IP address ranges  10.12.xx.x7-10.12.xx.x9
? Hostname of Main web application  host.example.net
? BGP autonomous system number of CRPD peer  64500
? Comma separated list of CRPD peers  10.12.xx.11
? Finish and write configuration to file  Yes
```

6. (Optional) For more advanced configuration of the cluster, use a text editor to manually edit the **config.yml** file.

The **config.yml** file consists of an essential section at the beginning of the file that corresponds to the configuration options that the installation wizard prompts you to enter. The file also has an extensive list of sections under the essential section that allows you to enter complex configuration values directly in the file.

The following options are available.

- Set the `opendistro_es_admin_password` password to log in to the Kibana application. Open Distro is used to consolidate and index application logs and Kibana is the visualization tool that enables you to search logs using keywords and filters.

By default, the username is preconfigured as `admin` in `#opendistro_es_admin_user`: `admin` and `install_opendistro_es` option is set to `true` to replace the Elasticsearch version with Open Distro. Use `admin` as username and this password to log in to Kibana.

By default, data is retained on the disks for seven days, before being purged, in a production deployment. You can edit the number of days to a smaller number in `opendistro_es_retain` if your disk size is low.

```
# install_opendistro_es: true
# opendistro_es_admin_user: admin
# opendistro_es_admin_password: opendistro_password
# opendistro_es_retain: 7d
```

If you do not configure the `opendistro_es_admin_password`, the installer will generate a random password. You can retrieve the password using the command:

```
# kubectl -n kube-system get secret opendistro-es-account -o jsonpath={..password} | base64 -d
```

- Set the `iam_skip_mail_verification` configuration option to true for user management without SMTP by Identity Access Management (IAM). By default, this option is set to false for user management with SMTP. You must configure SMTP in Paragon Automation so that the Paragon Automation users can be notified when their account is created, activated, locked, or when the password is changed for their account.
- Configure the `callback_vip` option with an IP address different from that of the VIP for the ingress controller. You can configure a separate IP address, which is a part of the MetalLB pool of addresses, to enable segregation of management and data traffic from the southbound and northbound interfaces. By default, `callback_vip` is assigned the same or one of the addresses of the ingress controller.
- If you want to use an interface other than the default interface for inter-cluster communication, set the `kubernetes_system_interface` variable. The current setting is `"{{ ansible_default_ipv4.interface }}"` which is the interface used by the default route. The `kubernetes_system_interface` variable configures the Kubernetes API server and Calico.

To view the default interface, run this command on a primary node:

```
root@primary-node:~# ip r show default
default via 10.12.xx.254 dev ens3 proto dhcp src 10.12.xx.121 metric 100
```

In this example, `ens3` is default interface for this machine.

If you want to use an interface different from the default one and the same interface can be used on all cluster nodes, configure the `kubernetes_system_interface` in the **config.yml** file. For example:

```
kubernetes_system_interface: ens4
```

If you want to use an interface different from the default one but the interface is different on different nodes, you must remove `kubernetes_system_interface` from the **config.yml** file. Instead, configure the interface names in the inventory file. For example:

```

master:
  hosts:
    10.12.xx.x3:
      kubernetes_system_interface: ens7
    10.12.xx.x4:
      kubernetes_system_interface: ens8
    10.12.xx.x5:
      kubernetes_system_interface: ens9
node:
  hosts:
    10.12.xx.x6:
      kubernetes_system_interface: ens7

```

Note that `calico_ip_autodetect` is set to `"interface={{ kubernetes_system_interface }}"`, and takes on the same value as `kubernetes_system_interface` and does not need to be explicitly changed if the default interface is changed.

Save and exit the file after you finish editing it.

7. (Optional) If you want to deploy custom SSL certificates signed by a recognized certificate authority (CA), store the private key and certificate in the *config-dir* directory. Save the private key as **ambassador.key.pem** and the certificate as **ambassador.cert.pem**.

By default, ambassador uses a locally generated certificate signed by the Kubernetes cluster-internal CA.

NOTE: If the certificate is about to expire, save the new certificate as **ambassador.cert.pem** in the same directory, and execute the `./run -c config-dir deploy -t ambassador` command.

8. Install the Paragon Automation cluster based on the information that you configured in the **config.yml** and **inventory** files.

```
# ./run -c config-dir deploy
```

The installation time to install the configured cluster depends on the complexity of the cluster. A basic setup installation takes at least 45 minutes to complete.

The installer checks NTP synchronization at the beginning of installation. If clocks are out of sync, installation will fail.

For **multi-primary node** deployments only, the installer checks the disk IOPS at the beginning of installation. If the IOPS is below 300, installation will fail. To disable disk IOPS check, use the `# ./run -c config-dir deploy -e ignore_iops_check=yes` command and rerun deployment. However, we do not recommend that you disable the disk IOPS check.

If you are installing Paragon Automation on an existing Kubernetes cluster, the `deploy` command upgrades the currently deployed cluster to the latest Kubernetes version. The command also upgrades the Docker CE version, if required. If Docker EE is already installed on the nodes, the `deploy` command will not overwrite it with Docker CE. When upgrading the Kubernetes version or the Docker version, the command performs the upgrade sequentially on one node at a time. Each node is cordoned off and removed from scheduling and upgrades are performed, Kubernetes is restarted on the node, and the node is finally uncordoned and brought back into scheduling.

9. When deployment is completed, log in to the worker nodes.

Use a text editor to configure the following recommended information for Paragon Insights in the **limits.conf** and **sysctl.conf** files. These values set the soft and hard memory limits for influx DB memory requirements. If you do not set these limits, you might see errors such as “out of memory” or “too many open files” because of default system limits.

a.

```
# vi /etc/security/limits.conf

# End of file
*          hard    nofile      1048576
*          soft    nofile      1048576
root       hard    nofile      1048576
root       soft    nofile      1048576
influxdb   hard    nofile      1048576
influxdb   soft    nofile      1048576
```

b.

```
# vi /etc/sysctl.conf

fs.file-max = 2097152
vm.max_map_count=262144
fs.inotify.max_user_watches=524288
fs.inotify.max_user_instances=512
```

Repeat this step for all worker nodes.

Now that you've installed and deployed your Paragon Automation cluster, you're ready to log in to the Paragon Automation UI.

Log in to the Paragon Automation UI

After you install Paragon Automation, log in to the Paragon Automation UI.

1. Open a browser, and enter either the hostname of the main Web application or the VIP of the ingress controller that you entered in the URL field of the installation wizard.

For example, <https://vip-of-ingress-controller-or-hostname-of-main-web-application>. The Paragon Automation login page appears.

2. For first-time access, enter **admin** as username and **Admin123!** as the password to log in. You must change the password immediately.

The **Set Password** page appears. To access the Paragon Automation setup, you must set a new password.

3. Set a new password that meets the password requirements.

The password should be between 6 to 20 characters and must be a combination of uppercase letters, lowercase letters, numbers, and special characters. Confirm the new password, and click **OK**.

The **Dashboard** page appears. You have successfully installed and logged in to the Paragon Automation UI.

4. Update the URL to access the Paragon Automation UI in **Administration > Authentication > Portal Settings** to ensure that the activation e-mail sent to users for activating their account contains the correct link to access the GUI. For more information, see *Configure Portal Settings*.

For high-level tasks that you can perform after you log in to the Paragon Automation GUI, see [Paragon Automation Getting Started](#).

Install Single-Node Cluster on CentOS

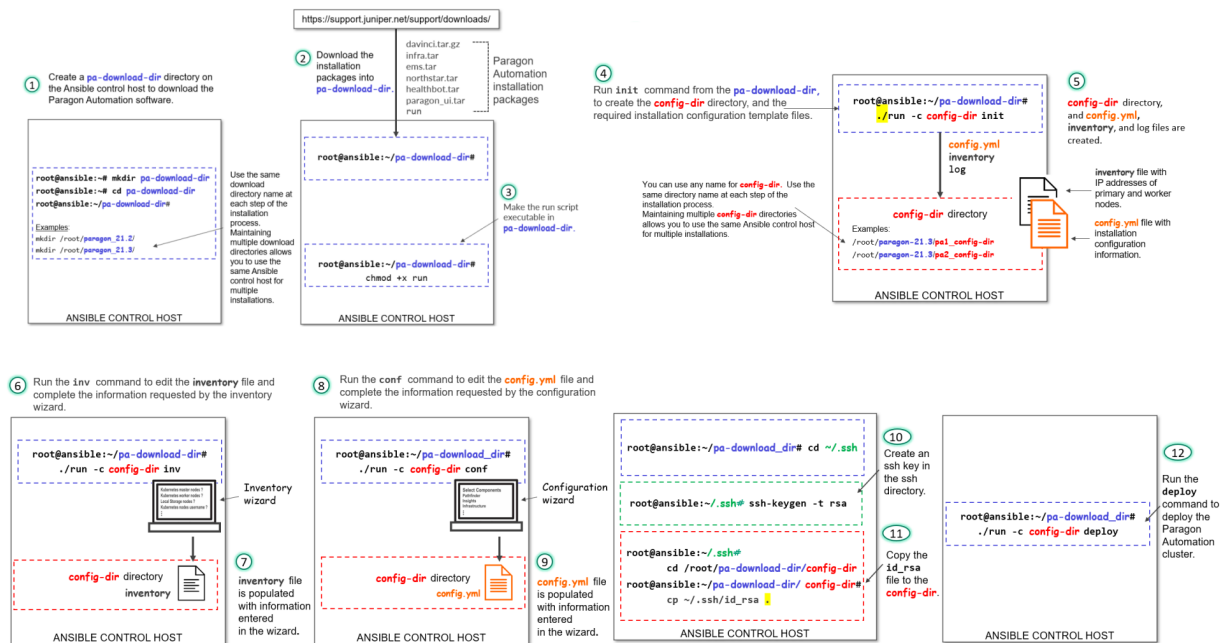
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- [Log in to the Paragon Automation UI | 134](#)

You can also install Paragon Automation on a single node which acts as both primary and worker node. A single node setup must be used *only* as Proof-Of-Concept (POC) or for lab deployment and must not be used for production deployments.

This topic describes the installation of Paragon Automation on a single node. The summary of installation tasks is shown at a high level in [Figure 23 on page 118](#). Ensure that you have completed all the preconfiguration and preparation steps described in ["Installation Prerequisites on CentOS" on page 80](#) before you begin installation.

Figure 23: Installation Sequence - Infographic



To view a higher-resolution image in your Web browser, right-click the image and open in a new tab. To view the image in PDF, use the zoom option to zoom in.

Download the Software

Prerequisite

- You need a Juniper account to download the Paragon Automation software.

- Log in to the control host.
- Create a directory in which you download the software.

This directory is referred to as *pa-download-dir* in this guide.

- From the Version drop-down list on the Paragon Automation software download page at <https://support.juniper.net/support/downloads/?p=pa>, select the version number.

4. Download the **Paragon Automation Setup** installation files to the download folder using the `wget "http://cdn.juniper.net/software/file-download-url"` command.

The Paragon Automation setup installation bundle consists of the following scripts and tar files to install each of the component modules:

- **davinci.tar.gz**, which is the primary installer file.
- **infra.tar**, which installs the Kubernetes infrastructure components including Docker and Helm.
- **ems.tar**, which installs the base platform component.
- **northstar.tar**, which installs the Paragon Pathfinder and Paragon Planner components.
- **healthbot.tar**, which installs the Paragon Insights component.
- **paragon_ui.tar**, which installs the Paragon Automation UI component.
- **addons.tar**, which installs infrastructure components that are not part of the base Kubernetes installation. The infrastructure components include, IAM, Kafka, ZooKeeper, cert-manager, Ambassador, Postgres, Metrics, Kubernetes Dashboard, Open Distro for Elasticsearch, Fluentd, Reloader, ArangoDB, and Argo.
- **rhel-84-airgap.tar.gz**, which installs Paragon Automation using the air-gap method on nodes *only* where the base OS is Red Hat Enterprise Linux (RHEL).
- **run script**, which executes the installer image.

NOTE: The Paragon Automation setup installation bundle comprises of a **foghorn.tar** file. However, Foghorn is not supported in Release 22.1.

Install Paragon Automation on a Single-Node

1. Make the run script executable in the *pa-download-dir* directory.

```
# chmod +x run
```

2. Use the run script to create and initialize a configuration directory with the configuration template files.

```
# ./run -c config-dir init
```

config-dir is a user-defined directory on the control host that contains configuration information for a particular installation. The `init` command automatically creates the *config-dir* directory if it does not exist. Alternatively, you can create the directory before you execute the `init` command.

Ensure that you include the `./` with the `run` command.

If you are using the same control host to manage multiple installations of Paragon Automation, you can differentiate between installations by using differently named configuration directories.

3. Ensure that the control host can connect to the cluster node through SSH using the install user account.

Copy the private key that you generated in ["No Link Title" on page 82](#) to the user defined *config-dir* directory. The installer allows the Docker container to access the *config-dir* directory. The SSH key must be available in the directory for the control host to connect to the cluster nodes.

```
# cd config-dir
# cp ~/.ssh/id_rsa .
# cd ..
```

Ensure that you include the dot `.` at the end of the copy command.

4. Customize the inventory file, created under the *config-dir* directory, with the IP address or hostname of the single cluster node, as well as the username and authentication information required to connect to the node. The inventory file is in the YAML format and describes the cluster nodes on which Paragon Automation will be installed. You can edit the file using the `inv` command or a Linux text editor such as `vi`.

- a. Customize the inventory file using the `inv` command:

```
# ./run -c config-dir inv
```

The configuration options that the `inv` command prompts are listed in the following table.

Table 12: *inv* Command Options

inv Command Prompts	Description
Kubernetes master nodes	Enter IP address of the single Kubernetes cluster node.
Kubernetes worker nodes	Leave this field empty for a single node cluster.

Table 12: *inv* Command Options (*Continued*)

inv Command Prompts	Description
Local storage nodes	<p>The local storage node is prepopulated with the single cluster node IP address.</p> <p>This field defines the node that has disk space available for applications that require local storage. Services such as Postgres, Zookeeper, and Kafka, use local storage or disk space partitioned inside export/local-volumes.</p> <p>This is different from Ceph storage.</p>
Kubernetes nodes' username (e.g. root)	Configure the user account and authentication methods to authenticate the installer with the cluster nodes. The user account must be root or in case of non-root users, the account must have superuser (sudo) privileges.
SSH private key file (optional)	If you chose ssh-key authentication, for the control host to authenticate with the nodes during the installation process, configure the path to the config-dir directory where the ansible_ssh_private_key_file is located, and the id_rsa file, as config/id_rsa. This is because the path to the config-dir is mounted internally in the installer container at config. Alternatively, you can also use the default {{ inventory_dir }}/id_rsa.
Kubernetes nodes' password (optional)	<p>If you chose password authentication for the control host to authenticate with the node during the installation process, enter the authentication password directly.</p> <p>Warning: The password is written in plain text. We do not recommend using this option for authentication.</p>
Kubernetes cluster name (optional)	Enter a name for your Kubernetes cluster.
Write inventory file?	Click Yes to save the inventory information.

For example:

```
$ ./run -c config-dir inv
Loaded image: paragonautomation:latest
=====
PO-Runtime installer
=====

Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
  info [-mc]        cluster installation info

Starting now: inv

INVENTORY

This script will prompt for the DNS names or IP addresses of the Kubernetes master and
worker nodes.
Addresses should be provided as comma-delimited lists.

At least three master nodes are recommended. The number of masters should be an odd number.
A minimum of four nodes are recommended.

Root access to the Kubernetes nodes is required.

See https://docs.ansible.com/ansible/2.10/user\_guide/intro\_inventory.html

? Kubernetes master nodes  10.12.xx.x3
? Kubernetes worker nodes
? Local storage nodes  10.12.xx.x3
? Kubernetes nodes' username (e.g. root)  root
? SSH private key file (optional; e.g. "{{ inventory_dir }}/id_rsa")  config/id_rsa
? Kubernetes nodes' password (optional; WARNING - written as plain text)
? Kubernetes cluster name (optional)  k8scluster
? Write inventory file?  Yes
```

- b. Alternatively, you can customize the inventory file manually using a text editor.

```
# vi config-dir/inventory
```

Edit the following groups in the **inventory** file.

- i. Add the IP address of the single Kubernetes node in the `master` group only.

The `master` group identifies the primary nodes, and the `node` group identifies the worker nodes. The same IP address cannot be in both `master` and `node` groups.

To create a single-master setup, include the IP address or hostname of the node that will be acting as primary and worker under the `master` group. Do **not** add any IP address or hostname under the `node` group.

```
master:
  hosts:
    10.12.xx.x3: {}
node:
  hosts:
```

- ii. Add the address or hostname of the node to the `local_storage_nodes:children` group under `master`. Do not add anything to the `local_storage_nodes:children` group under `node`.

```
local_storage_nodes:
  children:
    master:
      hosts:
        10.12.xx.x3: {}
    node:
      hosts:
```

- iii. Configure the user account and authentication methods to authenticate the the installer in the Ansible control host with the cluster node under the `vars` group.

```
vars:
  ansible_user: root
  ansible_ssh_private_key_file: config/id_rsa
  ansible_password:
```

- iv. (Optional) Specify a name for your Kubernetes cluster in the `kubernetes_cluster_name` group.

```
kubernetes_cluster_name: k8scluster
```

5. Configure the installer using the `conf` command.

```
# ./run -c config-dir conf
```

The `conf` command runs an interactive installation wizard that allows you to choose the components to be installed and configure a basic Paragon Automation setup. The command populates the `config.yml` file with your input configuration. For advanced configuration, you must edit the `config.yml` file manually.

Enter the information as prompted by the wizard. Use the cursor keys to move the cursor, use the space key to select an option, and use `a` or `i` to toggle selecting or clearing all options. Press Enter to move to the next configuration option. You can skip configuration options by entering a period or a dot (`.`). You can re-enter all your choices by exiting the wizard and restarting from the beginning. The installer allows you to exit the wizard after you save the choices that you already made or to restart from the beginning. You cannot go back and redo the choices that you already made in the current workflow without exiting and restarting the wizard altogether.

The configuration options that the `conf` command prompts for are listed in the following table:

Table 13: `conf` Command Options

conf Command Prompts	Description/Options
Select components	<p>You can install the Infrastructure, Pathfinder, Insights, and base platform components. By default, all components are selected.</p> <p>You can choose to install Pathfinder based on your requirement. However, you must install all other components, apart from Foghorn.</p> <p>NOTE: Foghorn is not supported in Release 22.1. You <i>must not</i> select the Foghorn option. Installation fails if you select Foghorn.</p>

Table 13: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Infrastructure Options	<p>The wizard displays these options only if you selected to install the Infrastructure component at the preceding prompt.</p> <ul style="list-style-type: none"> • Install Kubernetes Cluster—Install the required single-node Kubernetes cluster. • Install MetalLB LoadBalancer—Install an internal load balancer for the single-node Kubernetes cluster. By default, this option is already selected. • Install Nginx Ingress Controller—Install Nginx Ingress Controller as a load-balancing proxy for the Pathfinder components. • Install Chrony NTP Client—Install the Chrony NTP client. The node must run NTP or some other time-synchronization protocol at all times. If NTP is already installed and configured, you need not install Chrony. • Allow Master Scheduling—Select to enable master scheduling. Master scheduling determines how the node acting as primary node is used. <i>Master</i> is another term for a node acting as primary. <p>If you select this option, the primary node can also act as worker node, which means that it not only acts as control plane but can run application workloads as well. If you do not select this option, the primary node is used only as the control plane.</p> <p>NOTE: For single-node cluster installations, you <i>must</i> allow master scheduling. If you don't, installation fails.</p>
List of NTP servers	Enter a comma-separated list of NTP servers. The wizard displays this option only if you chose to install Chrony NTP.
Virtual IP address (es) for ingress controller	Enter a virtual IP (VIP) address to be used for Web access of the Kubernetes cluster or the Paragon Automation UI. This address must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for Infrastructure Nginx Ingress Controller	Enter a VIP address for the Nginx Ingress Controller. This address must be an unused IP address that is managed by the MetalLB load balancer pool. This address is used for NetFlow traffic.

Table 13: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Virtual IP address for Insights services	Enter a VIP address for Paragon Insights services. This address must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for SNMP trap receiver (optional)	Enter a VIP address for the SNMP trap receiver proxy only if this functionality is required. If you do not need this option, enter a period (.).
Pathfinder Options	Select to install Netflowd. You can configure a VIP address for netflowd or use a proxy for netflowd (same as the VIP address for the Infrastructure Nginx Ingress Controller). If you choose to not install netflowd, you cannot configure a VIP address for netflowd.
Use netflowd proxy	Enter Y to use a netflowd proxy. This option appears only if you chose to install netflowd. If you chose to use a netflowd proxy, you needn't configure a VIP address for netflowd. The VIP address for the Infrastructure Nginx Ingress Controller is used as the proxy for netflowd.
Virtual IP address for Pathfinder Netflowd	Enter a VIP address to be used for Paragon Pathfinder netflowd. This option appears only if you chose <i>not</i> to use netflowd proxy.
PCE Server Proxy	Select the proxy mode for the PCE server. Select from None and Nginx-Ingress.

Table 13: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Virtual IP address for Pathfinder PCE server	<p>Enter a VIP address to be used for Paragon Pathfinder PCE server access. This address must be an unused IP address that is managed by the load balancer.</p> <p>If you selected Nginx-Ingress, as the PCE Server Proxy, this VIP address is not necessary. The wizard does not prompt you to enter this address and PCEP will use the same address as the VIP address for Infrastructure Nginx Ingress Controller.</p> <p>NOTE: The addresses for ingress controller, Infrastructure Nginx Ingress Controller, Insights services, and PCE server must be unique. You cannot use the same address for all four VIP addresses.</p> <p>All these addresses are listed automatically in the LoadBalancer IP address ranges option.</p>
LoadBalancer IP address ranges	<p>The LoadBalancer IP addresses are prepopulated from your VIP addresses range. You can edit these addresses. The externally accessible services are handled through MetalLB, which needs one or more IP address ranges that are accessible from outside the cluster. VIPs addresses for the different servers are selected from these ranges of addresses.</p> <p>The address ranges can be (but need not be) in the same broadcast domain as the cluster nodes. For ease of management, because the network topologies need access to Insights services and the PCE server clients, we recommend that you select the VIP addresses from the same range.</p> <p>For more information, see "Virtual IP Address Considerations" on page 144.</p> <p>Addresses can be entered as comma-separated values (CSV), as a range, or as a combination of both. For example:</p> <ul style="list-style-type: none"> • 10.x.x.1, 10.x.x.2, 10.x.x.3 • 10.x.x.1-10.x.x.3 • 10.x.x.1, 10.x.x.3-10.x.x.5 • 10.x.x.1-3 is not a valid format.

Table 13: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Hostname of Main web application	<p>Enter a hostname for the ingress controller. You can configure this value as an IP address or as a fully qualified domain name (FQDN). For example, you can enter 10.12.xx.100 or www.paragon.juniper.net (DNS name). Do not include http:// or https://.</p> <p>NOTE: You will use this hostname to access the Paragon Automation Web UI from your browser. For example, https:// <i>hostname</i> or https:// <i>IP-address</i>.</p>
BGP autonomous system number of CRPD peer	<p>Set up the Containerized Routing Protocol Daemon (cRPD) autonomous systems and the nodes with which cRPD creates its BGP sessions.</p> <p>You must configure the autonomous system (AS) number of the network to allow cRPD to peer with one or more BGP Link State (BGP-LS) routers in the network. By default, the AS number is 64500.</p> <p>NOTE: While you can configure the AS number at the time of installation, you can also modify the cRPD configuration later. See "Modify cRPD Configuration" on page 75 .</p>

Table 13: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Comma separated list of CRPD peers	<p>You must configure cRPD to peer with at least one BGP-LS router in the network to import the network topology. For a single autonomous system, configure the address of the BGP-LS router(s) that will peer with cRPD to provide topology information to Paragon Pathfinder. The CRPD instance running as part of a cluster will initiate a BGP-LS connection to the specified peer router(s) and import topology data once the session has been established. If more than one peer is required, these can be added as comma separated values, or as a range or as a combination of both, similar to how LoadBalancer IP addresses are added.</p> <p>NOTE: While you can configure the peer IP addresses at the time of installation, you can also modify the cRPD configuration later, as described in "Modify cRPD Configuration" on page 75.</p> <p>You must configure the BGP peer routers to accept BGP connections initiated from cRPD. The BGP session will be initiated from cRPD using the address of the worker where the bmp pod is running, as the source address. In the single node deployment case, cRPD will be running on the only worker configured. If new workers are added to the cluster later, you must allow connections from the addresses of any of the workers (the current worker, and any additional worker).</p> <p>You can allow the range of IP addresses that the worker address belongs to (for example, 10.xx.43.0/24), or the specific IP address of the worker (for example, 10.xx.43.1/32). You could also configure this using the neighbor command combined with the passive option to prevent the router from attempting to initiate the connection.</p> <p>The following example shows the options to configure a Juniper device to allow BGP-LS connections from cRPD.</p> <p>The following commands configure the router to accept BGP-LS sessions from any host in the 10.xx.43.0/24 network, where the worker is connected. This will accommodate any worker that is added to the cluster later.</p> <pre>[edit groups northstar] root@system# show protocols bgp group northstar type internal; family traffic-engineering { unicast; } export TE; allow 10.xx.43.0/24;</pre>

Table 13: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
	<pre>[edit groups northstar] root@system# show policy-options policy-statement TE from family traffic-engineering; then accept;</pre> <p>The following commands configure the router to accept BGP-LS sessions from 10.xx.43.1 only. Additional allow commands can be added later on, if new workers are added to the cluster.</p> <pre>[edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS allow 10.x.43.1 set protocols bgp group BGP-LS export TE</pre> <p>The following commands also configure the router to accept BGP-LS sessions from 10.xx.43.1 only. The passive option was added to prevent the router from attempting to initiate a BGP-LS session with cRPD. The router will wait for the session to be initiated by this BGP cRPD. Additional neighbor commands can be added later on, if new workers are added to the cluster.</p> <pre>[edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS neighbor 10.xx.43.1 set protocols bgp group BGP-LS passive set protocols bgp group BGP-LS export TE</pre> <p>You will also need to enable OSPF/ISIS and MPLS traffic engineering as shown:</p> <pre>set protocols rsvp interface <i>interface.unit</i> set protocols isis interface <i>interface.unit</i> set protocols isis traffic-engineering igp-topology Or set protocols ospf area <i>area</i> interface <i>interface.unit</i></pre>

Table 13: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
	<pre>set protocols ospf traffic-engineering igp-topology</pre> <pre>set protocols mpls interface <i>interface.unit</i></pre> <pre>set protocols mpls traffic-engineering database import igp-topology</pre> <p>For more information, see https://www.juniper.net/documentation/us/en/software/junos/mpls/topics/topic-map/mpls-traffic-engineering-configuration.html.</p>
Finish and write configuration to file	<p>Click Yes to save the configuration information.</p> <p>This configures a basic setup, and the information is saved in the config.yml file in the config-dir directory.</p>

For example:

```
$ ./run -c config conf
Loaded image: paragonautomation.latest
=====
PO-Runtime installer
=====

Supported command:Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
  info [-mc]        cluster installation info

Starting now: conf

NOTE: depending on options chosen additional IP addresses may be required for:
      multi-master   Kubernetes Master Virtual IP address
      Infrastructure  Virtual IP address(es) for ingress controller
      Infrastructure  Virtual IP address for Infrastructure Nginx Ingress Controller
      Insights        Virtual IP address for Insights services
      Insights        Virtual IP address for SNMP Trap receiver (optional)
      Pathfinder      Virtual IP address for Pathfinder Netflowd
```

Pathfinder Virtual IP address for Pathfinder PCE server

```
? Select components  done (4 selections)
? Infrastructure Options  done (4 selections)
? List of NTP servers  0.pool.ntp.org
? Virtual IP address(es) for ingress controller  10.12.xx.x7
? Virtual IP address for Infrastructure Nginx Ingress Controller  10.12.xx.x8
? Virtual IP address for Insights services  10.12.xx.x9
? Virtual IP address for SNMP Trap receiver (optional)
? Pathfinder Options  [Install Netflowd]
? Use netflowd proxy?  Yes
? PCEServer proxy  Nginx Ingress
? LoadBalancer IP address ranges  10.12.xx.x7-10.12.xx.x9
? Hostname of Main web application  host.example.net
? BGP autonomous system number of CRPD peer  64500
? Comma separated list of CRPD peers  10.12.xx.11
? Finish and write configuration to file  Yes
```

6. (Optional) For more advanced configuration of the cluster, use a text editor to manually edit the **config.yml** file.

The **config.yml** file consists of an essential section at the beginning of the file that corresponds to the configuration options that the installation wizard prompts you to enter. The file also has an extensive list of sections under the essential section that allows you to enter complex configuration values directly in the file.

The following options are available.

- Set the `opendistro_es_admin_password` password to log in to the Kibana application. Open Distro is used to consolidate and index application logs and Kibana is the visualization tool that enables you to search logs using keywords and filters.

By default, the username is preconfigured as `admin` in `#opendistro_es_admin_user: admin` and `install_opendistro_es` option is set to `true` to replace the Elasticsearch version with Open Distro. Use `admin` as username and this password to log in to Kibana.

By default, data is retained on the disks for seven days, before being purged, in a production deployment. You can edit the number of days to a smaller number in `opendistro_es_retain` if your disk size is low.

```
# install_opendistro_es: true
# opendistro_es_admin_user: admin
```

```
# opendistro_es_admin_password: opendistro_password
# opendistro_es_retain: 7d
```

If you do not configure the `opendistro_es_admin_password`, the installer will generate a random password. You can retrieve the password using the command:

```
# kubectl -n kube-system get secret opendistro-es-account -o jsonpath={..password} | base64 -d
```

- Set the `iam_skip_mail_verification` configuration option to true for user management without SMTP by Identity Access Management (IAM). By default, this option is set to false for user management with SMTP. You must configure SMTP in Paragon Automation so that the Paragon Automation users can be notified when their account is created, activated, locked, or when the password is changed for their account.
- Configure the `callback_vip` option with an IP address different from that of the VIP for the ingress controller. You can configure a separate IP address, which is a part of the MetalLB pool of addresses, to enable segregation of management and data traffic from the southbound and northbound interfaces. By default, `callback_vip` is assigned the same or one of the addresses of the ingress controller.

Save and exit the file after you finish editing it.

7. (Optional) If you want to deploy custom SSL certificates signed by a recognized certificate authority (CA), store the private key and certificate in the `config-dir` directory. Save the private key as **ambassador.key.pem** and the certificate as **ambassador.cert.pem**.

By default, ambassador uses a locally generated certificate signed by the Kubernetes cluster-internal CA.

NOTE: If the certificate is about to expire, save the new certificate as **ambassador.cert.pem** in the same directory, and execute the `./run -c config-dir deploy -t ambassador` command.

8. Install the Paragon Automation cluster based on the information that you configured in the **config.yml** and **inventory** files.

```
# ./run -c config-dir deploy
```

The installation time to install the configured cluster depends on the complexity of the cluster. A basic setup installation takes at least 45 minutes to complete.

NTP synchronization is checked at the start of deployment. If clocks are out of sync, deployment will fail. If you are installing Paragon Automation on an existing Kubernetes cluster, the `deploy` command upgrades the currently deployed cluster to the latest Kubernetes version. The command also upgrades the Docker CE version, if required. If Docker EE is already installed on the nodes, the

deploy command will not overwrite it with Docker CE. When upgrading the Kubernetes version or the Docker version, the command performs the upgrade sequentially on one node at a time. Each node is cordoned off and removed from scheduling and upgrades are performed, Kubernetes is restarted on the node, and the node is finally uncordoned and brought back into scheduling.

9. When deployment is completed, log in to single cluster node.

Use a text editor to configure the following recommended information for Paragon Insights in the **limits.conf** and **sysctl.conf** files. These values set the soft and hard memory limits for influx DB memory requirements. If you do not set these limits, you might see errors such as “out of memory” or “too many open files” because of default system limits.

a.

```
# vi /etc/security/limits.conf

# End of file
*          hard    nofile    1048576
*          soft    nofile    1048576
root       hard    nofile    1048576
root       soft    nofile    1048576
influxdb   hard    nofile    1048576
influxdb   soft    nofile    1048576
```

b.

```
# vi /etc/sysctl.conf

fs.file-max = 2097152
vm.max_map_count=262144
fs.inotify.max_user_watches=524288
fs.inotify.max_user_instances=512
```

Now that you've installed and deployed your Paragon Automation cluster, you're ready to log in to the Paragon Automation UI.

Log in to the Paragon Automation UI

After you install Paragon Automation, log in to the Paragon Automation UI.

1. Open a browser, and enter either the hostname of the main Web application or the VIP of the ingress controller that you entered in the URL field of the installation wizard.

For example, <https://vip-of-ingress-controller-or-hostname-of-main-web-application>. The Paragon Automation login page is displayed.

2. For first-time access, enter **admin** as username and **Admin123!** as the password to log in. You must change the password immediately.

The **Set Password** page is displayed. To access the Paragon Automation setup, you must set a new password.

3. Set a new password that meets the password requirements.

The password should be between 6 to 20 characters and must be a combination of uppercase letters, lowercase letters, numbers, and special characters. Confirm the new password, and click **OK**.

The **Dashboard** page is displayed. You have successfully installed and logged in to the Paragon Automation UI.

4. Update the URL to access the Paragon Automation UI in **Administration > Authentication > Portal Settings** to ensure that the activation e-mail sent to users for activating their account contains the correct link to access the GUI. For more information, see *Configure Portal Settings*.

For high-level tasks that you can perform after you log in to the Paragon Automation GUI, see [Paragon Automation Getting Started](#).

5

CHAPTER

Install Paragon Automation on RHEL

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Installation Prerequisites on Red Hat Enterprise Linux

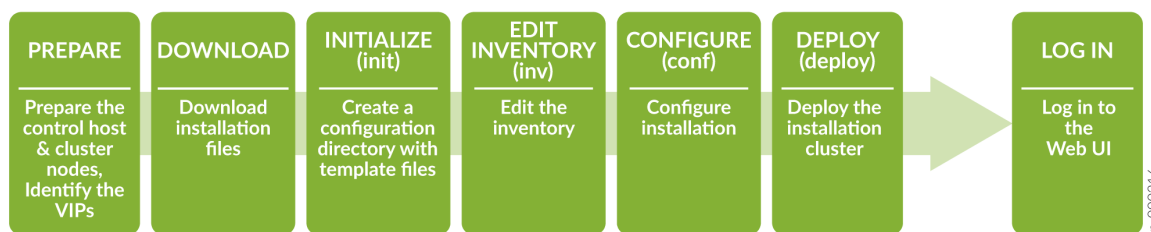
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To successfully install and deploy a Paragon Automation cluster, you must have a control host that installs the distribution software on a single node or on multiple cluster nodes. You can download the distribution software on the control host and then create and configure the installation files to run the installation from the control host. You must have **Internet access** to download the packages on the control host. You must also have Internet access on the cluster nodes to download any additional software such as Docker and OS patches. Alternatively, you can use the air-gap method of installation if your cluster nodes don't have Internet access.

The order of installation tasks is shown at a high level in [Figure 24 on page 137](#).

Figure 24: High-Level Process Flow for Installing Paragon Automation



Before you download and install the distribution software, you must configure the control host and the cluster nodes as described in this topic.

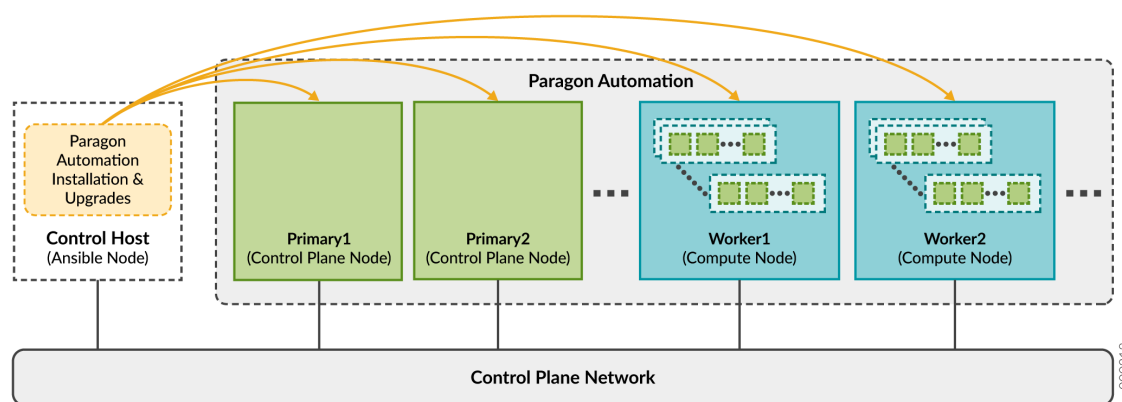
Prepare the Control Host

The control host is a dedicated machine that orchestrates the installation and upgrade of a Paragon Automation cluster. It carries out the Ansible operations that run the software installer and install the software on the cluster nodes as illustrated in [Control Host Functions on page 138](#).

You must download the installer packages on the Ansible control host. As part of the Paragon Automation installation process, the control host installs any additional packages required on the cluster nodes. The packages include optional OS packages, Docker, and Elasticsearch. All microservices, including third-party microservices, are downloaded onto the cluster nodes. The microservices do not access any public registries during installation.

The control host can be on a different broadcast domain from the cluster nodes, but you must ensure that the control host can use SSH to connect to all the nodes.

Figure 25: Control Host Functions



After installation is complete, the control host plays no role in the functioning of the cluster. However, you'll need the control host to update the software or any component, make changes to the cluster, or reinstall the cluster if a node fails. You can also use the control host to archive configuration files. We recommend that you keep the control host available, and not use it for something else, after installation.

Prepare the control host for the installation process as follows:

- 1. Install the base OS**—Install Red Hat Enterprise Linux (RHEL) 8.4. Paragon Automation Release 22.1 is qualified to work with RHEL 8.4.
- 2. Install Docker**—Install and configure Docker on the control host to implement the Linux container environment. Paragon Automation supports Docker CE and Docker EE. The Docker version you choose to install in the control host is independent of the Docker version you plan to use in the cluster nodes.

If you want to install Docker EE, ensure that you have a trial or subscription before installation. For more information about Docker EE, supported systems, and installation instructions, see <https://www.docker.com/blog/docker-enterprise-edition/>.

To download and install Docker CE, perform the following steps:

```
# sudo yum install -y yum-utils
# sudo yum-config-manager \
    --add-repo \
    https://download.docker.com/linux/rhel/docker-ce.repo
# sudo yum install docker-ce docker-ce-cli containerd.io docker-compose-plugin
# sudo systemctl start docker
```

To verify that Docker is installed and running, use the `# docker run hello-world` command.

To verify the Docker version installed, use the `# docker --version` command.

For full instructions and more information, see <https://docs.docker.com/engine/install/rhel/>.

- 3. Configure SSH client authentication**—The installer running on the control host connects to the cluster nodes using SSH. For SSH authentication, you must use a root or non-root user account with superuser (sudo) privileges. We will refer to this account as the install user account in subsequent steps. You must ensure that the install user account is configured on **all** the nodes in the cluster. The installer will use the inventory file to determine which username to use, and whether the authentication will use SSH keys or a password. See, customize the inventory file for [multinode](#) or [single-node](#) implementations.

If you choose the ssh-key authentication (recommended) method, generate the SSH key.

```
# cd ~/.ssh
# ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/root/.ssh/id_rsa):    <= ENTER (use default)
Enter passphrase (empty for no passphrase):                <= ENTER (no passphrase)
Enter same passphrase again:                                <= ENTER (no passphrase)
Your identification has been saved in /root/.ssh/id_rsa.
Your public key has been saved in /root/.ssh/id_rsa.pub.
The key fingerprint is:
SHA256:YS8cWopND9RFnpHGqaI1Q8e5ca2fxP/yMVzZtIDINbg root@Control1
The key's randomart image is:
+---[RSA 2048]-----+
|    ..o *==+    |
|    ..= *o*oo    |
|    .o==*+. . .|
|    =+o0.Eo    ..+|
```

```
|  o.++ So.o  oo|
|  .      .o .. . |
|           .+  |
|           . .o |
|           o.  |
+----[SHA256]-----+
```

If you want to protect the SSH key with a passphrase, you can use ssh-agent key manager. See <https://www.ssh.com/academy/ssh/agent>.

NOTE: You'll need to copy this key to the nodes as part of the cluster nodes preparation tasks, as described in the next section.

4. **(Optional) Install wget**—Install the `wget` utility to download the Paragon Automation distribution software.

```
# yum install wget
```

Alternatively, you can use `rsync` or any other file download software to copy the distribution software.

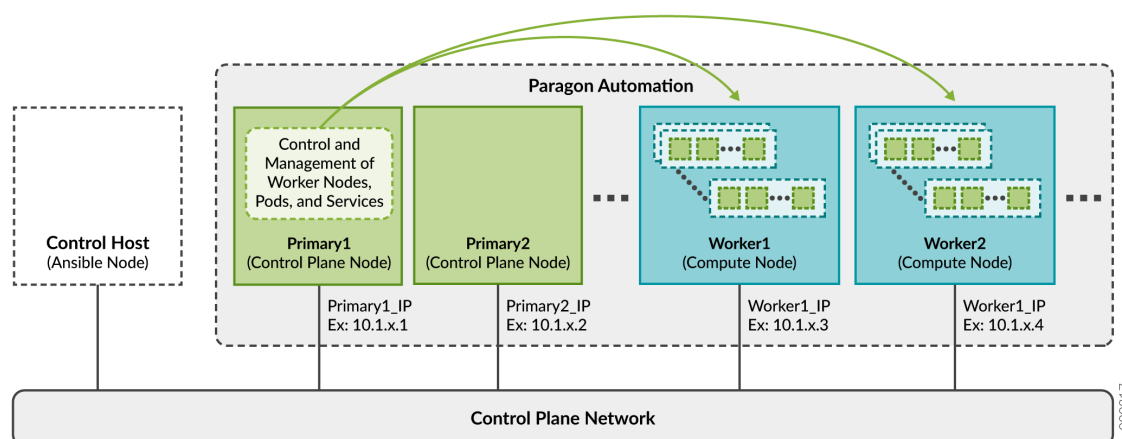
Prepare Cluster Nodes

The primary and worker nodes are collectively called *cluster nodes*. Each cluster node must have at least one unique static IP address, as illustrated in [Figure 26 on page 141](#). When configuring the hostnames, use only lowercase letters, and do not include any special characters other than hyphen (-) or the period (.). If the implementation has a separate IP network to provide communication between the Paragon Automation components, as described in the overview section, the IP addresses in that separate network do not need to be reachable outside the cluster. However, then you must assign a second set of IP addresses to the worker nodes. These IP addresses enable devices outside the cluster to reach the worker nodes and also enable communication between:

- Paragon Automation and the managed devices
- Paragon Automation and the network administrator

We recommend that you place all the nodes in the same broadcast domain. For cluster nodes in different broadcast domains, see ["Configure Load Balancing" on page 151](#) for additional load balancing configuration.

Figure 26: Cluster Node Functions



As described in "[Paragon Automation System Requirements](#)" on page 8, you can install Paragon Automation using a single-node or a multinode deployment. The node installation prerequisites are the same for both multinode and single-node deployments, except for storage requirements.

You need to prepare the cluster nodes for the Paragon Automation installation process as follows:

1. **Configure raw disk storage**—The cluster nodes must have raw storage block devices with unpartitioned disks or unformatted disk partitions attached. You can also partition the nodes such that the root partition and other file systems can use a portion of the disk space available. You must leave the remaining space unformatted, with no file systems, and reserve it for Ceph to use. For more information, see "[Disk Requirements](#)" on page 14.

NOTE: You don't need to install or configure anything to allow Ceph to use the unpartitioned disks or unformatted disk partitions. The Paragon Automation installation process automatically assigns the space for Ceph storage.

For multinode clusters, you must have a minimum of three cluster nodes with storage space attached. For a single-node cluster, the single node must have storage space. Installation fails if unformatted disks are **not** available.

Ceph requires newer Kernel versions. If your Linux kernel is very old, consider upgrading or reinstalling a new one. For a list of minimum Linux kernel versions supported by Ceph for your OS, see <https://docs.ceph.com/en/latest/start/os-recommendations>.

2. **Install the base OS**—Install RHEL 8.4. Paragon Automation Release 22.1 is qualified to work with RHEL 8.4.

3. **Create install-user account**—The install user is the user that the Ansible playbooks use to log in to the primary and worker nodes and perform all the installation tasks. Ensure that you configure either a root password or an account with superuser (`sudo`) privileges. You will add this information to the **inventory** file during the installation process.

Set the root user password.

```
# passwd root
New password:
Retype new password:
passwd: password updated successfully
```

4. **Install SSH authentication**—The installer running on the control host connects to the cluster nodes through SSH using the install-user account.

- a. Log in to the cluster nodes and install the open-ssh server on all nodes.

- b. Edit the `sshd_config` file.

```
# vi /etc/ssh/sshd_config
```

- c. If you are using "root" as the install-user account, then permit root login.

```
PermitRootLogin yes
```

If you chose to use plain text password for authentication, then you must enable password authentication.

```
PasswordAuthentication yes
```

We do not recommend the use of password authentication.

- d. Ensure that the `AllowTcpForwarding` parameter is set to yes.

```
AllowTcpForwarding yes
```

NOTE: Paragon Automation installation fails when the `AllowTcpForwarding` parameter is set to no.

- e. If you changed `/etc/ssh/sshd_config`, restart the SSH daemon.

```
# systemctl restart sshd
```

- f. Log in to the control host:

- i. To allow authentication using the SSH key, copy **id_rsa.pub** to the cluster nodes.

```
# ssh-copy-id -i ~/.ssh/id_rsa.pub cluster-node-IP-or-hostname
```

Repeat this step for *all* the nodes in the cluster (primary and workers). *cluster-node-IP* is the unique address of the node as shown in [Figure 26 on page 141](#). If a hostname is used instead, the Ansible control host should be able to resolve the name to its IP address.

- ii. Use SSH authentication to log in to the cluster node using the install-user account. You must not need a password to log in.

You should be able to use SSH to connect to all nodes in the cluster (primary and workers) from the control host using the install-user account. If you are not able to log in, review the previous steps and make sure that you didn't miss anything.

5. Install Docker—Select one of the following Docker versions to install.

- Docker CE—If you want to use Docker CE, you do *not* need to install it on the cluster nodes. The deploy script installs Docker CE on the nodes during Paragon Automation installation.
- Docker EE—If you want to use Docker EE, you *must* install Docker EE on *all* the cluster nodes. If you install Docker EE on the nodes, the deploy script uses the installed version and does not attempt to install Docker CE in its place. For more information about Docker EE and supported systems, and for instructions to download and install Docker EE, see <https://www.docker.com/blog/docker-enterprise-edition/>.

The Docker version you choose to install in the cluster nodes is not dependent on the Docker version installed in the control host.

6. Disable Firewall—Disable the local firewall.

```
# systemctl stop firewalld
```

```
# systemctl disable firewalld
```

Consider protecting your cluster with an external firewall.

7. Install Python—Install Python 3, if it is not preinstalled with your OS, on the cluster nodes:

```
# yum install python3
```

To verify the Python version installed, use the `# python3 --version` command.

8. Use the `# yum list installed` command and ensure that the following packages are installed:

```
bash-completion, gdisk, iptables, lvm2, python-six, PyYAML, openssl
```

9. Install and Enable NTP—All nodes must run NTP or other time-synchronization at all times. By default, Paragon Automation installs the Chrony NTP client. If you don't want to use Chrony, you

must manually install an alternative service on all nodes and ensure that the `timedatectl` command reports that the clocks are synchronized.

```
# timedatectl
          Local time: Fri 2022-05-20 07:14:49 PDT
        Universal time: Fri 2022-05-20 14:14:49 UTC
              RTC time: Fri 2022-05-20 14:14:48
            Time zone: America/Los_Angeles (PDT, -0700)
System clock synchronized: yes
systemd-timesyncd.service active: no
          RTC in local TZ: no
```

- 10. (Optional) Upgrade your Linux kernel version** Upgrade the kernel version of your RHEL server to the latest LTS version to meet the requirements for Paragon Automation installation.

For Red Hat Enterprise Linux (RHEL) 8.4, ensure that the Linux kernel version is 4.18 and later.

Virtual IP Address Considerations

IN THIS SECTION

- [VIP Address for Multi-Primary Node Deployment | 150](#)
- [Configure Load Balancing | 151](#)

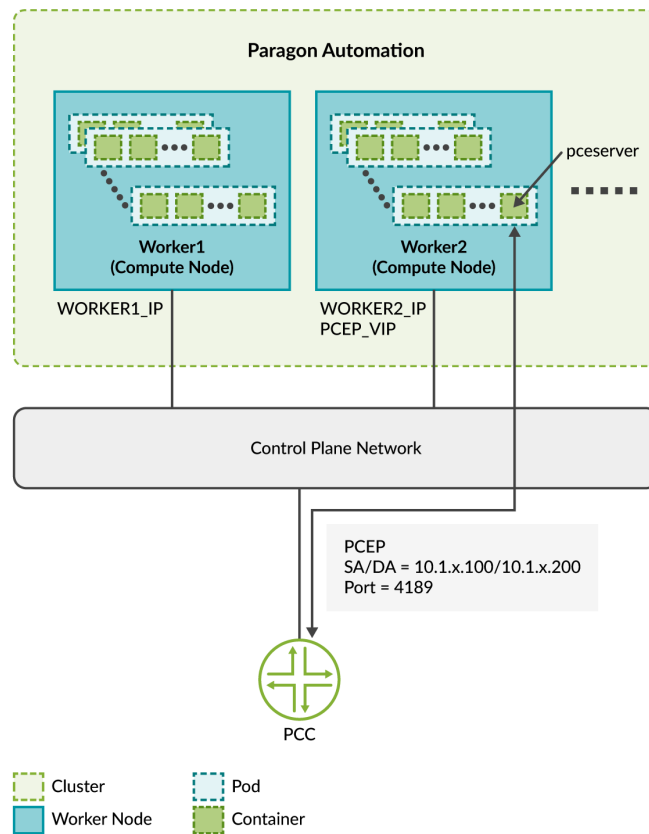
The Kubernetes worker nodes host the pods that handle the workload of the applications.

A pod is the smallest deployable unit of computing created and managed in Kubernetes. A pod contains one or more containers, with shared storage and network resources, and with specific instructions on how to run the applications. Containers are the lowest level of processing, and you execute applications or microservices in containers.

The primary node in the cluster determines which worker node will host a particular pod and containers.

You implement all features of Paragon Automation using a combination of microservices. You need to make some of these microservices accessible from outside the cluster as they provide services to end users (managed devices) and administrators. For example, you must make the `pceserver` service accessible to establish PCEP sessions between provider edge (PE) routers and Paragon Automation.

You need to expose these services outside of the Kubernetes cluster with specific addresses that are reachable from the external devices. Because a service can be running on any of the worker nodes at a given time, you must use virtual IP addresses (VIPs) as the external addresses. You must not use the address of any given worker node as an external address.



In this example:

- Consider that Worker 1 is 10.1.x.3 and Worker 2 is 10.1.x.4.
- SERVICE IP = PCEP VIP is 10.1.x.200
- PCC_IP is 10.1.x.100

Paragon Automation services use one of two methods of exposing services outside the cluster:

- **Load balancer**—Each load balancer is associated with a specific IP address and routes external traffic to a specific service in the cluster. This is the default method for many Kubernetes installations in the cloud. The load balancer method supports multiple protocols and multiple ports per service. Each service has its own load balancer and IP address.

Paragon Automation uses the MetalLB load balancer. MetalLB simulates external load balancer by either managing virtual IP addresses in Layer 2 mode, or interacts with external router(s) in Layer 3 mode. MetalLB provides load-balancing infrastructure to the kubernetes cluster.

Services of type "LoadBalancer" will interact with the Kubernetes load-balancing infrastructure to assign an externally reachable IP address. Some services can share an external IP address.

- **Ingress**—The ingress method acts as a proxy to bring traffic into the cluster, and then uses internal service routing to route the traffic to its destination. Under the hood, this method also uses a load balancer service to expose itself to the world so it can act as that proxy.

Paragon Automation uses the following ingress proxies:

- Ambassador
- Nginx

Devices from outside the cluster need to access the following services and thus these services require a VIP address.

Table 14: Services That Need VIPs

Required VIP Address	Description	Load Balancer/Proxy
Ingress controller	<p>Used for accessing the Paragon Automation GUI over the Web.</p> <p>Paragon Automation provides a common Web server that provides access to the components and applications. Access to the server is managed through the Kubernetes Ingress Controller.</p> <p>Ingress Controller also provides access for device initiated NETCONF connections. To allow for separation of network element initiated traffic and management traffic, Ingress Controller can be configured using multiple addresses.</p>	<p>Ambassador</p> <p>MetalLB</p>
Paragon Insights services	Used for Insights services such as syslog, DHCP relay, and JTI.	MetalLB

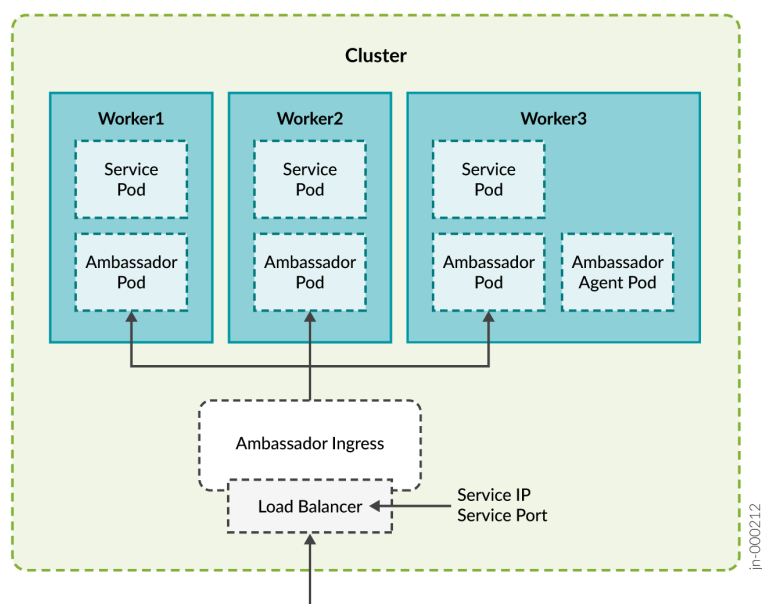
Table 14: Services That Need VIPs *(Continued)*

Required VIP Address	Description	Load Balancer/Proxy
Paragon Pathfinder PCE server	Used to establish PCEP sessions with devices in the network. PCE server can use Nginx as a proxy, in which case it will not use its own VIP address.	MetaLB
SNMP trap receiver proxy (Optional)	User for the SNMP trap receiver proxy only if this functionality is required.	MetaLB
VIP for Infrastructure Nginx Ingress Controller	Used as a proxy for the Paragon Pathfinder netflowd server and, optionally, the Paragon Pathfinder PCE server. The Nginx Ingress Controller needs a VIP within the MetaLB load balancer pool. This means that during the installation process you need to include this address as part of the LoadBalancer IP address ranges that you will be required to include while creating the configuration file.	Nginx MetaLB
Virtual IP address for Pathfinder Netflowd	Used for Paragon Pathfinder netflowd server. Netflowd can use Nginx as proxy, in which case it will not require its own VIP address.	MetaLB

Ports used by Ambassador:

- HTTP 80 (TCP) redirect to HTTPS
- HTTPS 443 (TCP)
- Paragon Planner 7000 (TCP)
- DCS/NETCONF initiated 7804 (TCP)

Figure 27: Ambassador



Ports used by Insights Services, PCE server, and SNMP:

- **Insights Services**

JTI 4000 (UDP)

DHCP (ZTP) 67 (UDP)

SYSLOG 514 (UDP)

SNMP proxy 162 (UDP)

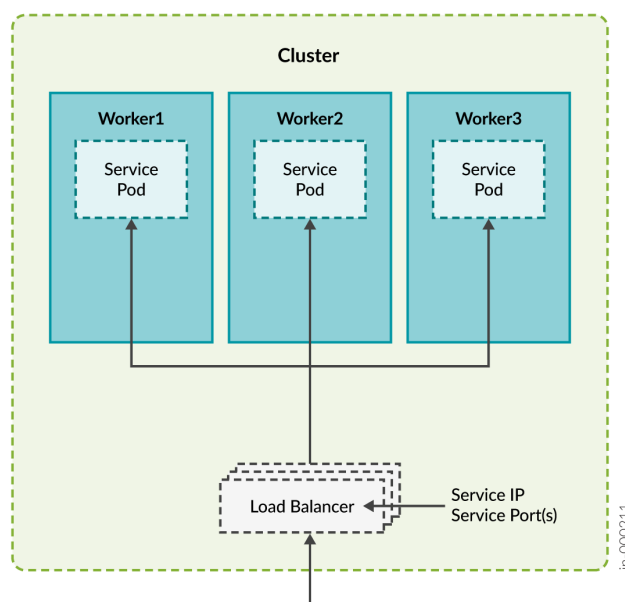
- **PCE Server**

PCEP 4189 (TCP)

- **SNMP**

SNMP Trap Receiver 162 (UDP)

Figure 28: Ports Used by Services



Ports used by Nginx Controller:

- NetFlow 9000 (UDP)
- PCEP 4189 (TCP)

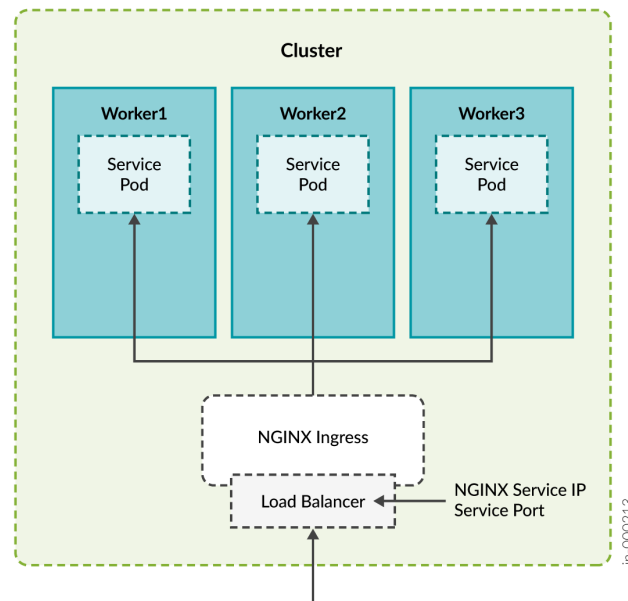
Using Nginx for PCEP

During the installation process, you will be asked whether you want to enable ingress proxy for PCEP. You can select from None or Nginx-Ingress as the proxy for the Path Computation Element (PCE) server.

If you select Nginx-Ingress as the proxy, you do *not* need to configure the VIP for the PCE server described in the table. In this case, the VIP address for Infrastructure Nginx Ingress Controller is used for the PCE server also. If you choose to not use a netflowd proxy, the VIP for the Infrastructure Nginx Ingress Controller is used for netflowd, as well.

NOTE: The benefit of using Nginx is that you can use a single IP address for multiple services.

Figure 29: Nginx Controller



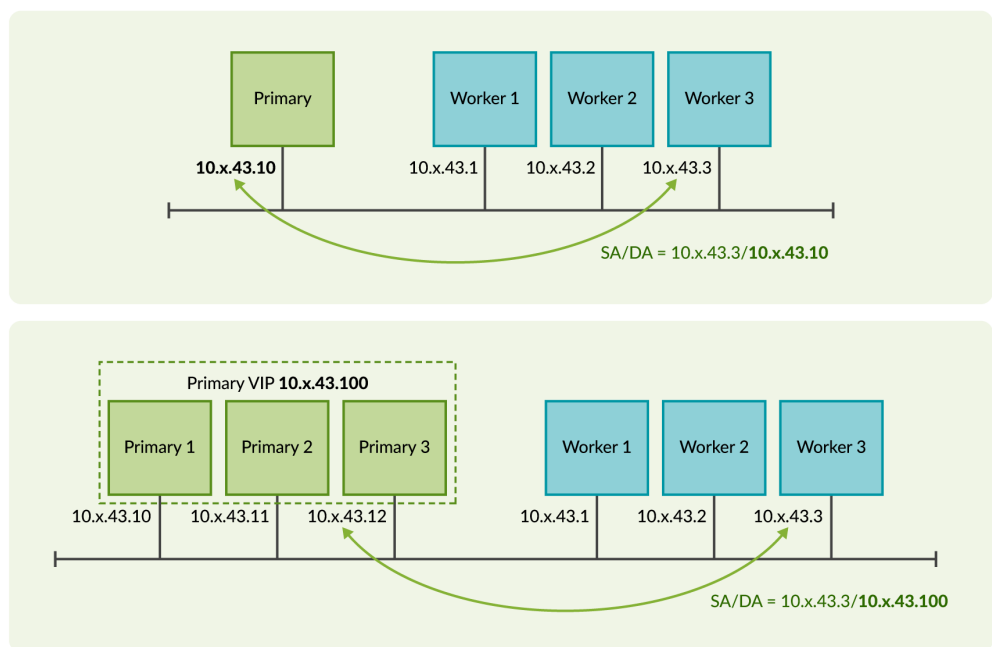
VIP Address for Multi-Primary Node Deployment

If you are deploying a setup with multiple primary nodes, you need an additional VIP address in the same broadcast domain as the cluster nodes. This address will be used for communication between the elected primary node and the worker nodes.

In a multi-primary setup, the worker node communicates with the primary function using the VIP address, instead of the address assigned to any of the nodes acting as primary.

The installation wizard refers to this IP address as the Kubernetes Master Virtual IP address. The VIP address pool of the MetalLB load balancer must *not* contain this VIP address.

In a setup with a single primary node, the worker node communicates with the primary node using the address assigned to that node acting as primary (IP address configured on the interface of the node acting as primary).



NOTE: You must identify all the required VIP addresses before you start the Paragon Automation installation process. You will be asked to enter these addresses as part of the installation process.

Configure Load Balancing

VIPs are managed in Layer 2 by default. When all cluster nodes are in the same broadcast domain, each VIP address is assigned to one cluster node at a time. Layer 2 mode provides fail-over of the VIP and does not provide actual load balancing. For true load balancing between the cluster nodes or if the nodes are in different broadcast domains, you must configure load balancing in Layer 3.

You must configure a BGP router to advertise the VIP address to the network. Make sure that the BGP router uses ECMP to balance TCP/IP sessions between different hosts. Connect the BGP router directly to the cluster nodes.

To configure load balancing on the cluster nodes, edit the **config.yml** file. For example:

```
metallb_config:
  peers:
    - peer-address: 192.x.x.1 ## address of BGP router
      peer-asn: 64501 ## autonomous system number of BGP router
      my-asn: 64500 ## ASN of cluster
```

```
address-pools:
  - name: default
    protocol: bgp
    addresses:
      - 10.x.x.0/24
```

In this example, The BGP router at 192.x.x.1 is responsible for advertising reachability of the VIP addresses with the 10.x.x.0/24 prefix to the rest of the network. The cluster allocates the VIP address of this range and advertises the address for the cluster nodes that can handle the address.

Configure DNS Server (Optional)

You can access the main Web gateway either through the ingress controller's VIP address or through a hostname that is configured in the Domain Name System (DNS) server that resolves to the ingress controller's VIP address. You need to configure the DNS server only if you want to use a hostname to access the Web gateway.

Add the hostname to the DNS as an A, AAAA, or CNAME record. For lab and Proof of Concept (POC) setups, you can add the hostname to the `/etc/hosts` file on the cluster nodes.

RELATED DOCUMENTATION

[Install Multinode Cluster on Red Hat Enterprise Linux | 152](#)

[Install Single-Node Cluster on Red Hat Enterprise Linux | 172](#)

[Air-Gap Install Paragon Automation on RHEL | 190](#)

Install Multinode Cluster on Red Hat Enterprise Linux

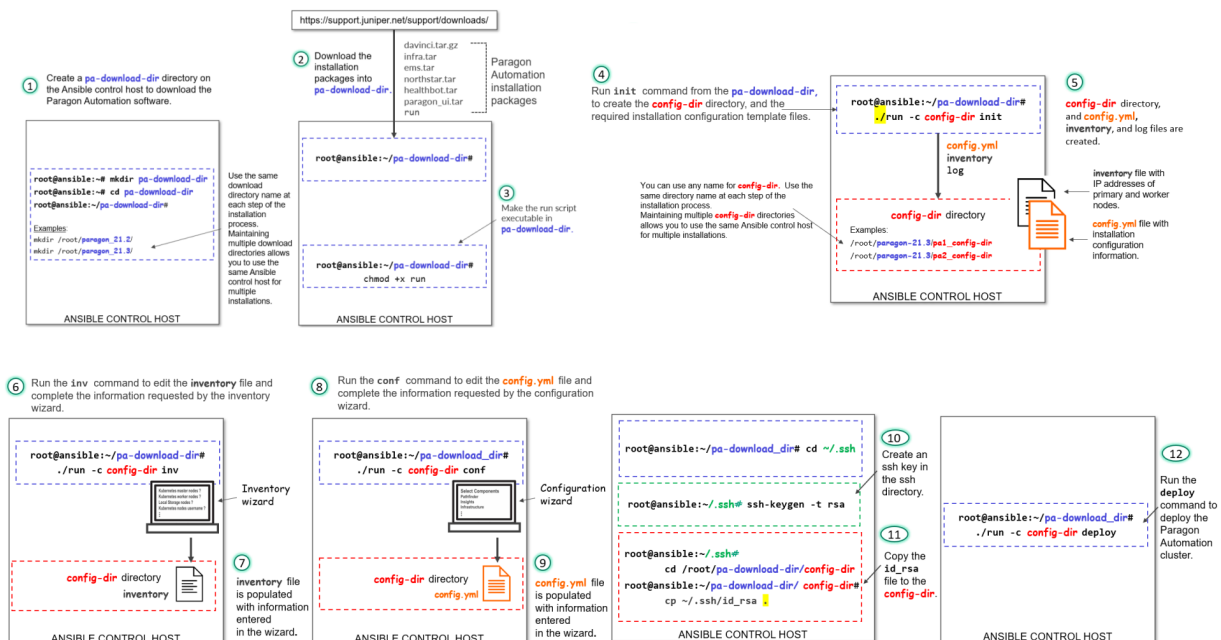
IN THIS SECTION

- [Download the Paragon Automation Software | 153](#)
- [Install Paragon Automation on a Multinode Cluster | 154](#)

● Log in to the Paragon Automation UI | 172

Read the following topics to learn how to install Paragon Automation on a multinode cluster with Red Hat Enterprise Linux (RHEL) host OS. [Figure 30 on page 153](#) shows a summary of installation tasks at a high level. Ensure that you've completed the preconfiguration and preparation steps described in ["Installation Prerequisites on Red Hat Enterprise Linux" on page 137](#) before you begin installation.

Figure 30: Installation Sequence - Infographic



To view a higher-resolution image in your Web browser, right-click the image and open in a new tab. To view the image in PDF, use the zoom option to zoom in.

Download the Paragon Automation Software

Prerequisite

- You need a Juniper account to download the Paragon Automation software.

- Log in to the control host.
- Create a directory in which you'll download the software.

We refer to this directory as *pa-download-dir* in this guide.

3. Select the version number from the **Version** list on the Paragon Automation software download page at <https://support.juniper.net/support/downloads/?p=pa>.

4. Download the **Paragon Automation Setup** installation files to the download folder using the `wget "http://cdn.juniper.net/software/file-download-url"` command.

The Paragon Automation setup installation bundle consists of the following scripts and TAR files to install each of the component modules:

- **davinci.tar.gz**, which is the primary installer file.
- **infra.tar**, which installs the Kubernetes infrastructure components including Docker and Helm.
- **ems.tar**, which installs the base platform component.
- **northstar.tar**, which installs the Paragon Pathfinder and Paragon Planner components.
- **healthbot.tar**, which installs the Paragon Insights component.
- **paragon_ui.tar**, which installs the Paragon Automation UI component.
- **addons.tar**, which installs infrastructure components that are not part of the base Kubernetes installation. The infrastructure components include, IAM, Kafka, ZooKeeper, cert-manager, Ambassador, Postgres, Metrics, Kubernetes Dashboard, Open Distro for Elasticsearch, Fluentd, Reloader, ArangoDB, and Argo.
- **rhel-84-airgap.tar.gz**, which installs Paragon Automation using the air-gap method on nodes *only* where the base OS is Red Hat Enterprise Linux (RHEL).
- **run** script, which executes the installer image.

NOTE: The Paragon Automation setup installation bundle comprises of a **foghorn.tar** file. However, Foghorn is not supported in Release 22.1.

Now that you've downloaded the software, you're ready to install Paragon Automation.

Install Paragon Automation on a Multinode Cluster

To install Paragon Automation on a Kubernetes cluster of multiple primary and worker nodes:

1. Make the run script executable in the *pa-download-dir* directory.

```
# chmod +x run
```

2. Use the run script to create and initialize a configuration directory with the configuration template files.

```
# ./run -c config-dir init
```

config-dir is a user-defined directory on the control host that contains configuration information for a particular installation. The `init` command automatically creates the directory if it does not exist. Alternatively, you can create the directory before you execute the `init` command.

Ensure that you include the dot and slash (./) with the `run` command.

If you are using the same control host to manage multiple installations of Paragon Automation, you can differentiate between installations by using differently named configuration directories.

3. Ensure that the control host can connect to the cluster nodes through SSH using the install-user account.

Copy the private key that you generated in ["Configure SSH client authentication" on page 139](#) to the user-defined *config-dir* directory. The installer allows the Docker container to access the *config-dir* directory. The SSH key must be available in the directory for the control host to connect to the cluster nodes.

```
# cd config-dir
# cp ~/.ssh/id_rsa .
# cd ..
```

Ensure that you include the dot (.) at the end of the copy command (`cp`).

4. Customize the inventory file, available in the *config-dir* directory, with the IP addresses or hostnames of the cluster nodes, as well as the usernames and authentication information that are required to connect to the nodes. The inventory file is in the YAML format and describes the cluster nodes on which Paragon Automation will be installed. You can edit the file using the `inv` command or a Linux text editor such as `vi`.

- a. Customize the inventory file using the `inv` command:

```
# ./run -c config-dir inv
```

The following table lists the configuration options that the `inv` command prompts you to enter.

Table 15: *inv* Command Options

inv Command Prompts	Description
Kubernetes master nodes	Enter IP addresses of the Kubernetes primary nodes.
Kubernetes worker nodes	Enter IP addresses of the Kubernetes worker nodes.
Local storage nodes	<p>Define the nodes that have disk space available for applications. The local storage nodes are prepopulated with the IP addresses of the primary and worker nodes. You can edit these addresses. Enter IP addresses of the nodes on which you want to run applications that require local storage.</p> <p>Services such as Postgres, ZooKeeper, and Kafka use local storage or disk space partitioned inside export/local-volumes. By default, worker nodes have local storage available. If you do not add primary nodes here, you can run only those applications that do not require local storage on the primary nodes.</p> <p>NOTE: Local storage is different from Ceph storage.</p>
Kubernetes nodes' username (for example, root)	Configure the user account and authentication methods to authenticate the installer with the cluster nodes. The user account must be root or, in the case of non-root users, the account must have superuser (sudo) privileges.
SSH private key file (optional)	If you chose ssh-key authentication, for the control host to authenticate with the nodes during the installation process, configure the path to the config-dir directory where the ansible_ssh_private_key_file is located, and the id_rsa file, as config/id_rsa . This is because the path to the config-dir is mounted internally in the installer container at config . Alternatively, you can also use the default <code>{{ inventory_dir }}/id_rsa</code> .

Table 15: *inv* Command Options (Continued)

inv Command Prompts	Description
Kubernetes nodes' password (optional)	<p>If you chose password authentication for the control host to authenticate with the nodes during the installation process, enter the authentication password directly. WARNING: The password is written in plain text.</p> <p>We do <i>not</i> recommend using this option for authentication.</p>
Kubernetes cluster name (optional)	Enter a name for your Kubernetes cluster.
Write inventory file?	Click Yes to save the inventory information.

For example:

```
$ ./run -c config-dir inv
Loaded image: paragonautomation:latest
=====
PO-Runtime installer
=====

Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
  info [-mc]        cluster installation info

Starting now: inv

INVENTORY

This script will prompt for the DNS names or IP addresses of the Kubernetes master and
worker nodes.
Addresses should be provided as comma-delimited lists.

At least three master nodes are recommended. The number of masters should be an odd number.
```

A minimum of four nodes are recommended.

Root access to the Kubernetes nodes is required.

See https://docs.ansible.com/ansible/2.10/user_guide/intro_inventory.html

```
? Kubernetes master nodes 10.12.xx.x3,10.12.xx.x4,10.12.xx.x5
? Kubernetes worker nodes 10.12.xx.x6
? Local storage nodes 10.12.xx.x3,10.12.xx.x4,10.12.xx.x5,10.12.xx.x6
? Kubernetes nodes' username (e.g. root) root
? SSH private key file (optional; e.g. "{{ inventory_dir }}/id_rsa") config/id_rsa
? Kubernetes nodes' password (optional; WARNING - written as plain text)
? Kubernetes cluster name (optional) k8scluster
? Write inventory file? Yes
```

- b.** Alternatively, you can customize the inventory file manually using a text editor.

```
# vi config-dir/inventory
```

Edit the following groups in the **inventory** file.

- i.** Add the IP addresses of the Kubernetes primary and worker nodes of the cluster.

The `master` group identifies the primary nodes, and the `node` group identifies the worker nodes. You cannot have the same IP address in both `master` and `node` groups.

To create a multi-primary node setup, list the addresses or hostnames of all the nodes that will be acting as primary nodes under the `master` group. Add the addresses or hostnames of the nodes that will be acting as worker nodes under the `node` group.

```
master:
  hosts:
    10.12.xx.x3: {}
    10.12.xx.x4: {}
    10.12.xx.x5: {}
node:
  hosts:
    10.12.xx.x6: {}
```

- ii. Define the nodes that have disk space available for applications under the `local_storage_nodes:children` group.

```
local_storage_nodes:
  children:
    master:
      hosts:
        10.12.xx.x3: {}
        10.12.xx.x4: {}
        10.12.xx.x5: {}
    node:
      hosts:
        10.12.xx.x6: {}
```

- iii. Configure the user account and authentication methods to authenticate the installer in the Ansible control host with the cluster nodes under the `vars` group.

```
vars:
  ansible_user: root
  ansible_ssh_private_key_file: config/id_rsa
  ansible_password:
```

- iv. (Optional) Specify a name for your Kubernetes cluster in the `kubernetes_cluster_name` group.

```
kubernetes_cluster_name: k8scluster
```

5. Configure the installer using the `conf` command.

```
# ./run -c config-dir conf
```

The `conf` command runs an interactive installation wizard that enables you to choose the components you want to install and configure a basic Paragon Automation setup. The command populates the `config.yml` file with your input configuration. For advanced configuration, you must edit the `config.yml` file manually.

Enter the information as prompted by the wizard. Use the cursor keys to move the cursor, use the space key to select an option, and use the `a` or `i` key to toggle selecting or clearing all options. Press Enter to move to the next configuration option. You can skip configuration options by entering a period (`.`). You can reenter all your choices by exiting the wizard and restarting from the beginning. The installer allows you to exit the wizard after you save the choices that you already made or to

restart from the beginning. You cannot go back and redo the choices that you already made in the current workflow without exiting and restarting the wizard altogether.

The following table lists the configuration options that the `conf` command prompts you to enter :

Table 16: *conf* Command Options

conf Command Prompts	Description/Options
Select components	<p>You can install the Infrastructure, Pathfinder, Insights, and base platform components. By default, all components are selected.</p> <p>You can choose to install Pathfinder based on your requirement. However, you must install all other components, apart from Foghorn.</p> <p>NOTE: Foghorn is not supported in Release 22.1. You <i>must not</i> select the Foghorn option. Installation fails if you select Foghorn.</p>

Table 16: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Infrastructure Options	<p>These options appear only if you selected to install the Infrastructure component at the previous prompt.</p> <ul style="list-style-type: none"> • Install Kubernetes Cluster—Install the required Kubernetes cluster. If you are installing Paragon Automation on an existing cluster, you can clear this selection. • Install MetalLB LoadBalancer—Install an internal load balancer for the Kubernetes cluster. By default, this option is already selected. If you are installing Paragon Automation on an existing cluster with preconfigured load balancing, you can clear this selection. • Install Nginx Ingress Controller—Install Nginx Ingress Controller is a load-balancing proxy for the Pathfinder components. • Install Chrony NTP Client—Install Chrony NTP. You need NTP to synchronize the clocks of the cluster nodes. If NTP is already installed and configured, you need not install Chrony. All nodes must run NTP or some other time-synchronization protocol at all times. • Allow Master Scheduling—Select to enable master scheduling. Master scheduling determines how the nodes acting as primary nodes are used. <i>Master</i> is another term for a node acting as primary. <p>If you select this option, the primary nodes can also act as worker nodes, which means they not only act as the control plane but can run application workloads as well. If you do not select master scheduling, the primary nodes are used only as the control plane.</p> <p>Master scheduling allows the available resources of the nodes acting as primary to be available for workloads. However, if you select this option, a misbehaving workload might exhaust resources on the primary node and affect the stability of the whole cluster. Without master scheduling, if you have multiple primary nodes with high capacity and disk space, you risk wasting their resources by not utilizing them completely.</p> <p>NOTE: This option is required for Ceph storage redundancy.</p>
List of NTP servers	<p>Enter a comma-separated list of NTP servers. This option is displayed only if you chose to install Chrony NTP.</p>

Table 16: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Kubernetes Master Virtual IP address	<p>Enter a virtual IP (VIP) address for the Kubernetes API Server for a multi-primary node deployment only. Make sure that the VIP address is in the same Layer 2 domain as the primary nodes. This VIP address is not part of the LoadBalancer pool of VIP addresses.</p> <p>You see this option only if you've configured multiple primary nodes in the inventory file (multi-primary installation).</p>
Install LoadBalancer for Master Virtual IP address	<p>(Optional) Select to install keepalived LoadBalancer for the Master VIP address.</p> <p>You see this option only if you've configured multiple primary nodes in the inventory file (multi-primary installation).</p>
Virtual IP address (es) for ingress controller	Enter a VIP address to be used for Web access of the Kubernetes cluster or the Paragon Automation UI. This must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for Infrastructure Nginx Ingress Controller	Enter a VIP address for the Nginx Ingress Controller. This must be an unused IP address that is managed by the MetalLB load balancer pool. This address is used for NetFlow traffic.
Virtual IP address for Insights services	Enter a VIP address for Paragon Insights services. This must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for SNMP trap receiver (optional)	<p>Enter a VIP address for the SNMP trap receiver proxy only if this functionality is required.</p> <p>If you do not need this option, enter a period (.).</p>
Pathfinder Options	<p>Select to install Netflowd. You can configure a VIP address for netflowd or use a proxy for netflowd (same as the VIP address for the Infrastructure Nginx Ingress Controller).</p> <p>If you choose to not install netflowd, you cannot configure a VIP address for netflowd.</p>

Table 16: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Use netflowd proxy	<p>Enter Y to use a netflowd proxy. This option appears only if you chose to install netflowd.</p> <p>If you chose to use a netflowd proxy, you needn't configure a VIP address for netflowd. The VIP address for the Infrastructure Nginx Ingress Controller is used as the proxy for netflowd.</p>
Virtual IP address for Pathfinder Netflowd	<p>Enter a VIP address to be used for Paragon Pathfinder netflowd. This option appears only if you chose <i>not</i> to use netflowd proxy.</p>
PCE Server Proxy	<p>Select the proxy mode for the PCE server. Select from None and Nginx-Ingress.</p>
Virtual IP address for Pathfinder PCE server	<p>Enter a VIP address to be used for Paragon Pathfinder PCE server access. This address must be an unused IP address that is managed by the load balancer.</p> <p>If you selected Nginx-Ingress, as the PCE Server Proxy, this VIP address is not necessary. The wizard does not prompt you to enter this address and PCEP will use the same address as the VIP address for Infrastructure Nginx Ingress Controller.</p> <p>NOTE: The addresses for ingress controller, Infrastructure Nginx Ingress Controller, Insights services, and PCE server must be unique. You cannot use the same address for all four VIP addresses.</p> <p>All these addresses are listed automatically in the LoadBalancer IP address ranges option.</p>

Table 16: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
LoadBalancer IP address ranges	<p>The LoadBalancer IP addresses are prepopulated from your VIP addresses range. You can edit these addresses. The externally accessible services are handled through MetalLB, which needs one or more IP address ranges that are accessible from outside the cluster. VIPs addresses for the different servers are selected from these ranges of addresses.</p> <p>The address ranges can be (but need not be) in the same broadcast domain as the cluster nodes. For ease of management, because the network topologies need access to Insights services and the PCE server clients, we recommend that you select the VIP addresses from the same range.</p> <p>For more information, see "Virtual IP Address Considerations" on page 144.</p> <p>Addresses can be entered as comma-separated values (CSV), as a range, or as a combination of both. For example:</p> <ul style="list-style-type: none"> • 10.x.x.1, 10.x.x.2, 10.x.x.3 • 10.x.x.1-10.x.x.3 • 10.x.x.1, 10.x.x.3-10.x.x.5 • 10.x.x.1-3 is not a valid format.
Hostname of Main web application	<p>Enter a hostname for the ingress controller. You can configure this value as an IP address or as a fully qualified domain name (FQDN). For example, you can enter 10.12.xx.100 or www.paragon.juniper.net (DNS name). Do not include http:// or https://.</p> <p>NOTE: You will use this hostname to access the Paragon Automation Web UI from your browser. For example, https://<i>hostname</i> or https://<i>IP-address</i>.</p>
BGP autonomous system number of CRPD peer	<p>Set up the Containerized Routing Protocol Daemon (cRPD) autonomous systems and the nodes with which cRPD creates its BGP sessions.</p> <p>You must configure the autonomous system (AS) number of the network to allow cRPD to peer with one or more BGP Link State (BGP-LS) routers in the network. By default, the AS number is 64500.</p> <p>NOTE: While you can configure the AS number at the time of installation, you can also modify the cRPD configuration later. See "Modify cRPD Configuration" on page 75.</p>

Table 16: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Comma separated list of CRPD peers	<p>Configure cRPD to peer with at least one BGP-LS router in the network to import the network topology. For a single autonomous system, configure the address of the BGP-LS routers that will peer with cRPD to provide topology information to Paragon Pathfinder. The cRPD instance running as part of a cluster will initiate a BGP-LS connection to the specified peer routers and import topology data after the session is established. If more than one peer is required, you can add the peers as CSVs, as a range, or as a combination of both, similar to how you add LoadBalancer IP addresses.</p> <p>NOTE: While you can configure the peer IP addresses at the time of installation, you can also modify the cRPD configuration later, as described in "Modify cRPD Configuration" on page 75.</p> <p>You must configure the BGP peer routers to accept BGP connections initiated from cRPD. The BGP session will be initiated from cRPD using the address of the worker where the bmp pod is running as the source address.</p> <p>Because cRPD could be running on any of the worker nodes at a given time, you must allow connections from any of these addresses. You can allow the range of IP addresses that the worker addresses belong to (for example, 10.xx.43.0/24), or the specific IP address of each worker (for example, 10.xx.43.1/32, 10.xx.43.2/32, and 10.xx.43.3). You could also configure this using the <code>neighbor</code> command with the <code>passive</code> option to prevent the router from attempting to initiate the connection.</p> <p>If you chose to enter each individual worker address, either with the <code>allow</code> command or the <code>neighbor</code> command, make sure you include all the workers, because any worker could be running cRPD at a given time. Only one BGP session will be initiated. If the node running cRPD fails, the bmp pod that contains the cRPD container will be created in a different node, and the BGP session will be re-initiated.</p> <p>The sequence of commands in the following example shows the options to configure a Juniper device to allow BGP-LS connections from cRPD.</p> <p>The following commands configure the router to accept BGP-LS sessions from any host in the 10.xx.43.0/24 network, where all the worker nodes are connected.</p> <pre>[edit groups northstar] root@system# show protocols bgp group northstar type internal; family traffic-engineering {</pre>

Table 16: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
	<pre> unicast; } export TE; allow 10.xx.43.0/24; [edit groups northstar] root@system# show policy-options policy-statement TE from family traffic-engineering; then accept; The following commands configure the router to accept BGP-LS sessions from 10.xx.43.1, 10.xx.43.2, and 10.xx.43.3 (the addresses of the three workers in the cluster) only. [edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS allow 10.x.43.1 set protocols bgp group BGP-LS allow 10.x.43.2 set protocols bgp group BGP-LS allow 10.x.43.3 set protocols bgp group BGP-LS export TE cRPD initiates the BGP session. Only one session is established at a time and is initiated using the address of the worker node currently running cRPD. If you choose to configure the specific IP addresses instead of using the allow option, configure the addresses of all the workers nodes for redundancy. The following commands also configure the router to accept BGP-LS sessions from 10.xx.43.1, 10.xx.43.2, and 10.xx.43.3 only (the addresses of the three workers in the cluster). The passive option prevents the router from attempting to initiate a BGP-LS session with cRPD. The router will wait for the session to be initiated by any of these three routers. [edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS neighbor 10.xx.43.1 set protocols bgp group BGP-LS neighbor 10.xx.43.2 set protocols bgp group BGP-LS neighbor 10.xx.43.3 </pre>

Table 16: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
	<pre>set protocols bgp group BGP-LS passive set protocols bgp group BGP-LS export TE</pre> <p>You will also need to enable OSPF/IS-IS and MPLS traffic engineering as shown here:</p> <pre>set protocols rsvp interface <i>interface.unit</i></pre> <pre>set protocols isis interface <i>interface.unit</i> set protocols isis traffic-engineering igp-topology</pre> <p>Or</p> <pre>set protocols ospf area <i>area</i> interface <i>interface.unit</i> set protocols ospf traffic-engineering igp-topology</pre> <pre>set protocols mpls interface <i>interface.unit</i> set protocols mpls traffic-engineering database import igp-topology</pre> <p>For more information, see https://www.juniper.net/documentation/us/en/software/junos/mpls/topics/topic-map/mpls-traffic-engineering-configuration.html.</p>
Finish and write configuration to file	<p>Click Yes to save the configuration information.</p> <p>This action configures a basic setup and saves the information in the config.yml file in the <i>config-dir</i> directory.</p>

For example:

```
$ ./run -c config conf
Loaded image: paragonautomation.latest
=====
PO-Runtime installer
=====

Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
```

```
info [-mc]          cluster installation info
```

```
Starting now: conf
```

```
NOTE: depending on options chosen additional IP addresses may be required for:
```

```
multi-master    Kubernetes Master Virtual IP address
Infrastructure   Virtual IP address(es) for ingress controller
Infrastructure   Virtual IP address for Infrastructure Nginx Ingress Controller
Insights        Virtual IP address for Insights services
Insights        Virtual IP address for SNMP Trap receiver (optional)
Pathfinder      Virtual IP address for Pathfinder Netflowd
Pathfinder      Virtual IP address for Pathfinder PCE server
```

```
? Select components  done (4 selections)
? Infrastructure Options  done (4 selections)
? List of NTP servers  0.pool.ntp.org
? Virtual IP address(es) for ingress controller  10.12.xx.x7
? Virtual IP address for Infrastructure Nginx Ingress Controller  10.12.xx.x8
? Virtual IP address for Insights services  10.12.xx.x9
? Virtual IP address for SNMP Trap receiver (optional)
? Pathfinder Options  [Install Netflowd]
? Use netflowd proxy?  Yes
? PCEServer proxy  Nginx Ingress
? LoadBalancer IP address ranges  10.12.xx.x7-10.12.xx.x9
? Hostname of Main web application  host.example.net
? BGP autonomous system number of CRPD peer  64500
? Comma separated list of CRPD peers  10.12.xx.11
? Finish and write configuration to file  Yes
```

6. (Optional) For more advanced configuration of the cluster, use a text editor to manually edit the **config.yml** file.

The **config.yml** file consists of an essential section at the beginning of the file that corresponds to the configuration options that the installation wizard prompts you to enter. The file also has an extensive list of sections under the essential section that allows you to enter complex configuration values directly in the file.

You can configure the following options:

- Set the `opendistro_es_admin_password` password to log in to the Kibana application. You use Open Distro to consolidate and index application logs and the visualization tool Kibana to search logs using keywords and filters.

By default, the username is preconfigured as `admin` in `#opendistro_es_admin_user`: `admin` and the `install_opendistro_es` option is set to `true` to replace the Elasticsearch version with Open Distro. Use `admin` as username and this password to log in to Kibana.

By default, data is retained on the disks for seven days, before being purged, in a production deployment. You can edit the number of days to a smaller number in `opendistro_es_retain` if your disk size is low.

```
# install_opendistro_es: true
# opendistro_es_admin_user: admin
# opendistro_es_admin_password: opendistro_password
# opendistro_es_retain: 7d
```

If you do not configure the `opendistro_es_admin_password` password, the installer generates a random password. You can retrieve the password using the command:

```
# kubectl -n kube-system get secret opendistro-es-account -o jsonpath={..password} | base64 -d
```

- Set the `iam_skip_mail_verification` configuration option to `true` for user management without SMTP by Identity and Access Management (IAM). By default, this option is set to `false` for user management with SMTP. You must configure SMTP in Paragon Automation so that you can notify Paragon Automation users when their account is created, activated, or locked, or when their account password is changed.
- Configure the `callback_vip` option with an IP address different from that of the virtual IP (VIP) address of the ingress controller. You can use an IP address from the MetalLB pool of VIP addresses. You configure this IP address to enable segregation of management and data traffic from the southbound and northbound interfaces. By default, `callback_vip` is assigned the same or one of the addresses of the ingress controller.
- If you want to use an interface other than the default interface for intercluster communication, set the `kubernetes_system_interface` variable. The current setting is `"{{ ansible_default_ipv4.interface }}"`, which is the interface that the default route uses. The `kubernetes_system_interface` variable configures the Kubernetes API server and Calico.

To view the default interface, run this command on a primary node:

```
root@primary-node:~# ip r show default
default via 10.12.xx.254 dev ens3 proto dhcp src 10.12.xx.121 metric 100
```

In this example, `ens3` is default interface for this machine.

If you want to use an interface different from the default one and the same interface can be used on all cluster nodes, configure `kubernetes_system_interface` in the **config.yml** file. For example:

```
kubernetes_system_interface: ens4
```


If you want to use an interface different from the default one but the interface is different on different nodes, you must remove `kubernetes_system_interface` from the **config.yml** file. Instead, configure the interface names in the inventory file. For example:

```

master:
  hosts:
    10.12.xx.x3:
      kubernetes_system_interface: ens7
    10.12.xx.x4:
      kubernetes_system_interface: ens8
    10.12.xx.x5:
      kubernetes_system_interface: ens9
node:
  hosts:
    10.12.xx.x6:
      kubernetes_system_interface: ens7

```

Note that, `calico_ip_autodetect` is set to `"interface={{ kubernetes_system_interface }}"`, and takes the same value as `kubernetes_system_interface` and does not need to be explicitly changed if the default interface is changed.

Save and exit the file after you finish editing it.

7. (Optional) If you want to deploy custom SSL certificates signed by a recognized certificate authority (CA), store the private key and certificate in the **config-dir** directory. Save the private key as **ambassador.key.pem** and the certificate as **ambassador.cert.pem**.

By default, Ambassador uses a locally generated certificate signed by the Kubernetes cluster-internal CA.

NOTE: If the certificate is about to expire, save the new certificate as **ambassador.cert.pem** in the same directory, and execute the `./run -c config-dir deploy -t ambassador` command.

8. Install the Paragon Automation cluster based on the information that you configured in the **config.yml** and **inventory** files.

```
# ./run -c config-dir deploy
```

The installation time to install the configured cluster depends on the complexity of the cluster. A basic setup installation takes at least 45 minutes to complete.

The installer checks NTP synchronization at the beginning of installation. If clocks are out of sync, installation fails.

For **multi-primary node** deployments only, the installer checks the disk input/output operations per second (IOPS) at the beginning of installation. If the IOPS value is below 300, installation fails. To disable disk IOPS check, use the # `./run -c config-dir deploy -e ignore_iops_check=yes` command and rerun the deployment.

If you are installing Paragon Automation on an existing Kubernetes cluster, the `deploy` command upgrades the currently deployed cluster to the latest Kubernetes version. The command also upgrades the Docker CE version, if required. If Docker EE is already installed on the nodes, the `deploy` command does not overwrite it with Docker CE. When upgrading the Kubernetes version or the Docker version, the command performs the upgrade sequentially on one node at a time. The command cordons off each node and removes it from scheduling. It performs upgrades, restarts Kubernetes on the node, and finally uncordons the node and brings it back into scheduling.

9. After deployment is completed, log in to the worker nodes.

Use a text editor to configure the following recommended information for Paragon Insights in the **limits.conf** and **sysctl.conf** files. These values set the soft and hard memory limits for influx DB memory requirements. If you do not set these limits, you might see errors such as “out of memory” or “too many open files” because of the default system limits.

a.

```
# vi /etc/security/limits.conf

# End of file
*          hard    nofile    1048576
*          soft    nofile    1048576
root       hard    nofile    1048576
root       soft    nofile    1048576
influxdb   hard    nofile    1048576
influxdb   soft    nofile    1048576
```

b.

```
# vi /etc/sysctl.conf

fs.file-max = 2097152
vm.max_map_count=262144
fs.inotify.max_user_watches=524288
fs.inotify.max_user_instances=512
```

Repeat this step for all worker nodes.

Now that you've installed and deployed your Paragon Automation cluster, you're ready to log in to the Paragon Automation UI.

Log in to the Paragon Automation UI

To log in to the Paragon Automation UI:

1. Open a browser, and enter either the hostname of the main Web application or the VIP address of the ingress controller that you entered in the URL field of the installation wizard.
For example, <https://vip-of-ingress-controller-or-hostname-of-main-web-application>. The Paragon Automation login page is displayed.
2. For first-time access, enter **admin** as username and **Admin123!** as the password to log in. You must change the password immediately.
The **Set Password** page appears. To access the Paragon Automation setup, you must set a new password.
3. Set a new password that meets the password requirements.
Use between 6 and 20 characters and a combination of uppercase letters, lowercase letters, numbers, and special characters. Confirm the new password, and click **OK**.
The **Dashboard** page appears. You have successfully installed and logged in to the Paragon Automation UI.
4. Update the URL to access the Paragon Automation UI in **Administration > Authentication > Portal Settings** to ensure that the activation e-mail sent to users for activating their account contains the correct link to access the GUI. For more information, see *Configure Portal Settings*.
For high-level tasks that you can perform after you log in to the Paragon Automation UI, see [Paragon Automation Getting Started](#).

Install Single-Node Cluster on Red Hat Enterprise Linux

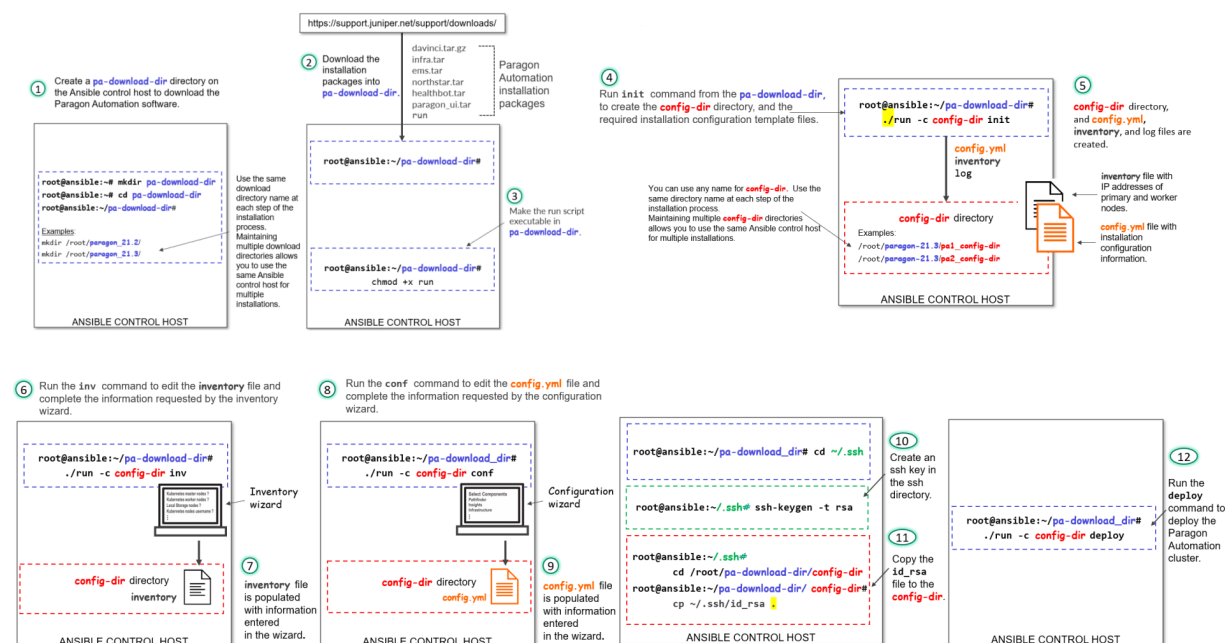
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You can also install Paragon Automation on a single node that acts as both primary node and worker node. Make sure you use a single-node setup *only* as proof of concept (POC) or for lab deployments and not for production deployments.

Read the following topics to learn how to install Paragon Automation on a single node, with Red Hat Enterprise Linux (RHEL) as the base OS. [Figure 31 on page 173](#) shows a summary of installation tasks at a high level. Ensure that you've completed all the preconfiguration and preparation steps described in ["Installation Prerequisites on Red Hat Enterprise Linux" on page 137](#) before you begin installation.

Figure 31: Installation Sequence - Infographic



To view a higher-resolution image in your Web browser, right-click the image and open in a new tab. To view the image in PDF, use the zoom option to zoom in.

Download the Software

Prerequisite

- You need a Juniper account to download the Paragon Automation software.

- Log in to the control host.
- Create a directory in which you'll download the software.

We refer to this directory as *pa-download-dir* in this guide.

3. Select the version number from the **Version** list on the Paragon Automation software download page at <https://support.juniper.net/support/downloads/?p=pa>.
4. Download the **Paragon Automation Setup** installation files to the download folder using the `wget "http://cdn.juniper.net/software/file-download-url"` command.

The Paragon Automation setup installation bundle consists of the following scripts and TAR files to install each of the component modules:

- **davinci.tar.gz**, which is the primary installer file.
- **infra.tar**, which installs the Kubernetes infrastructure components including Docker and Helm.
- **ems.tar**, which installs the base platform component.
- **northstar.tar**, which installs the Paragon Pathfinder and Paragon Planner components.
- **healthbot.tar**, which installs the Paragon Insights component.
- **paragon_ui.tar**, which installs the Paragon Automation UI component.
- **addons.tar**, which installs infrastructure components that are not part of the base Kubernetes installation. The infrastructure components include, IAM, Kafka, ZooKeeper, cert-manager, Ambassador, Postgres, Metrics, Kubernetes Dashboard, Open Distro for Elasticsearch, Fluentd, Reloader, ArangoDB, and Argo.
- **rhel-84-airgap.tar.gz**, which installs Paragon Automation using the air-gap method on nodes *only* where the base OS is Red Hat Enterprise Linux (RHEL).
- **run script**, which executes the installer image.

NOTE: The Paragon Automation setup installation bundle comprises of a **foghorn.tar** file. However, Foghorn is not supported in Release 22.1.

Now that you've downloaded the software, you're ready to install Paragon Automation.

Install Paragon Automation on a Single-Node

1. Make the run script executable in the *pa-download-dir* directory.

```
# chmod +x run
```

2. Use the `run` script to create and initialize a configuration directory with the configuration template files.

```
# ./run -c config-dir init
```

`config-dir` is a user-defined directory on the control host that contains configuration information for a particular installation. The `init` command automatically creates the directory if it does not exist. Alternatively, you can create the directory before you execute the `init` command.

Ensure that you include the dot and slash (./) with the `run` command.

If you are using the same control host to manage multiple installations of Paragon Automation, you can differentiate between installations by using differently named configuration directories.

3. Ensure that the control host can connect to the cluster nodes through SSH using the `install-user` account.

Copy the private key that you generated in ["Configure SSH client authentication" on page 139](#) to the user-defined `config-dir` directory. The installer allows the Docker container to access the `config-dir` directory. The SSH key must be available in the directory for the control host to connect to the cluster nodes.

```
# cd config-dir
# cp ~/.ssh/id_rsa .
# cd ..
```

Ensure that you include the dot (.) at the end of the copy command (`cp`).

4. Customize the inventory file, available in the `config-dir` directory, with the IP address or hostname of the single cluster node, as well as the username and authentication information that are required to connect to the nodes. The inventory file is in the YAML format and describes the cluster nodes on which Paragon Automation will be installed. You can edit the file using the `inv` command or a Linux text editor such as `vi`.

- a. Customize the inventory file using the `inv` command:

```
# ./run -c config-dir inv
```

The following table lists the configuration options that the `inv` command prompts you to enter.

Table 17: *inv* Command Options

inv Command Prompts	Description
Kubernetes master nodes	Enter the IP address of the single Kubernetes cluster node.
Kubernetes worker nodes	Leave this field empty for a single-node cluster.
Local storage nodes	<p>Define the node that has disk space available for applications that require local storage. The local storage node is prepopulated with the IP address of the single cluster node. Services such as Postgres, ZooKeeper, and Kafka, use local storage or disk space partitioned inside export/local-volumes.</p> <p>NOTE: Local storage is different from Ceph storage.</p>
Kubernetes nodes' username (for example, root)	Configure the user account and authentication methods to authenticate the installer with the cluster node. The user account must be root or, in case of non-root users, the account must have superuser (sudo) privileges.
SSH private key file (optional)	<p>If you chose ssh-key authentication, for the control host to authenticate with the nodes during the installation process, configure the path to the <i>config-dir</i> directory where the ansible_ssh_private_key_file is located, and the id_rsa file, as <code>config/id_rsa</code>. This is because the path to the <i>config-dir</i> is mounted internally in the installer container at <code>config</code>. Alternatively, you can also use the default <code>{{ inventory_dir }}/id_rsa</code>.</p>
Kubernetes nodes' password (optional)	<p>If you chose password authentication for the control host to authenticate with the node during the installation process, enter the authentication password directly.</p> <p>WARNING: The password is written in plain text.</p> <p>We do <i>not</i> recommend using this option for authentication.</p>

Table 17: *inv* Command Options (*Continued*)

inv Command Prompts	Description
Kubernetes cluster name (optional)	Enter a name for your Kubernetes cluster.
Write inventory file?	Click Yes to save the inventory information.

For example:

```
$ ./run -c config-dir inv
Loaded image: paragonautomation:latest
=====
PO-Runtime installer
=====

Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
  info [-mc]        cluster installation info

Starting now: inv

INVENTORY

This script will prompt for the DNS names or IP addresses of the Kubernetes master and
worker nodes.
Addresses should be provided as comma-delimited lists.

At least three master nodes are recommended. The number of masters should be an odd number.
A minimum of four nodes are recommended.

Root access to the Kubernetes nodes is required.

See https://docs.ansible.com/ansible/2.10/user\_guide/intro\_inventory.html

? Kubernetes master nodes 10.12.xx.x3
```



```
? Kubernetes worker nodes
? Local storage nodes 10.12.xx.x3
? Kubernetes nodes' username (e.g. root) root
? SSH private key file (optional; e.g. "{{ inventory_dir }}/id_rsa") config/id_rsa
? Kubernetes nodes' password (optional; WARNING - written as plain text)
? Kubernetes cluster name (optional) k8scluster
? Write inventory file? Yes
```

b. Alternatively, you can customize the inventory file manually using a text editor.

```
# vi config-dir/inventory
```

Edit the following groups in the **inventory** file.

i. Add the IP address of the single Kubernetes node in the `master` group only.

The `master` group identifies the primary nodes, and the `node` group identifies the worker nodes. You cannot have the same IP address in both `master` and `node` groups.

To create a single-primary-node setup, include the IP address or hostname of the node that will be acting as both primary and worker under the `master` group. Do *not* add any IP address or hostname under the `node` group.

```
master:
  hosts:
    10.12.xx.x3: {}
node:
  hosts:
```

ii. Add the IP address or hostname of the single Kubernetes node under the `local_storage_nodes:children` group under `master`. Do not add anything to the `local_storage_nodes:children` group under `node`.

```
local_storage_nodes:
  children:
    master:
      hosts:
        10.12.xx.x3: {}
    node:
      hosts:
```

- iii. Configure the user account and authentication methods to authenticate the installer in the Ansible control host with the cluster node under the `vars` group.

```
vars:
  ansible_user: root
  ansible_ssh_private_key_file: config/id_rsa
  ansible_password:
```

- iv. (Optional) Specify a name for your Kubernetes cluster in the `kubernetes_cluster_name` group.

```
kubernetes_cluster_name: k8scluster
```

5. Configure the installer using the `conf` command.

```
# ./run -c config-dir conf
```

The `conf` command runs an interactive installation wizard that enables you to choose the components you want to install and configure a basic Paragon Automation setup. The command populates the **config.yml** file with your input configuration. For advanced configuration, you must edit the **config.yml** file manually.

Enter the information as prompted by the wizard. Use the cursor keys to move the cursor, use the space key to select an option, and use the `a` or `i` key to toggle selecting or clearing all options. Press Enter to move to the next configuration option. You can skip configuration options by entering a period (`.`). You can reenter all your choices by exiting the wizard and restarting from the beginning. The installer allows you to exit the wizard after you save the choices that you already made or to restart from the beginning. You cannot go back and redo the choices that you already made in the current workflow without exiting and restarting the wizard altogether.

The following table lists the configuration options that the `conf` command prompts you to enter :

Table 18: *conf* Command Options

conf Command Prompts	Description/Options
Select components	<p>You can install the Infrastructure, Pathfinder, Insights, and base platform components. By default, all components are selected.</p> <p>You can choose to install Pathfinder based on your requirement. However, you must install all other components, apart from Foghorn.</p> <p>NOTE: Foghorn is not supported in Release 22.1. You <i>must not</i> select the Foghorn option. Installation fails if you select Foghorn.</p> <p>You can choose to install Pathfinder based on your requirement. However, you must install all other components.</p>
Infrastructure Options	<p>The wizard displays these options only if you selected to install the Infrastructure component at the preceding prompt.</p> <ul style="list-style-type: none"> • Install Kubernetes Cluster—Install the required single-node Kubernetes cluster. • Install MetalLB LoadBalancer—Install an internal load balancer for the single-node Kubernetes cluster. By default, this option is already selected. • Install Nginx Ingress Controller—Install Nginx Ingress Controller as a load-balancing proxy for the Pathfinder components. • Install Chrony NTP Client—Install the Chrony NTP client. The node must run NTP or some other time-synchronization protocol at all times. If NTP is already installed and configured, you need not install Chrony. • Allow Master Scheduling—Select to enable master scheduling. Master scheduling determines how the node acting as primary node is used. <i>Master</i> is another term for a node acting as primary. <p>If you select this option, the primary node can also act as worker node, which means that it not only acts as control plane but can run application workloads as well. If you do not select this option, the primary node is used only as the control plane.</p> <p>NOTE: For single-node cluster installations, you <i>must</i> allow master scheduling. If you don't, installation fails.</p>

Table 18: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
List of NTP servers	Enter a comma-separated list of NTP servers. The wizard displays this option only if you chose to install Chrony NTP.
Virtual IP address (es) for ingress controller	Enter a virtual IP (VIP) address to be used for Web access of the Kubernetes cluster or the Paragon Automation UI. This address must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for Infrastructure Nginx Ingress Controller	Enter a VIP address for the Nginx Ingress Controller. This address must be an unused IP address that is managed by the MetalLB load balancer pool. This address is used for NetFlow traffic.
Virtual IP address for Insights services	Enter a VIP address for Paragon Insights services. This address must be an unused IP address that is managed by the MetalLB load balancer pool.
Virtual IP address for SNMP trap receiver (optional)	Enter a VIP address for the SNMP trap receiver proxy only if this functionality is required. If you do not need this option, enter a period (.).
Pathfinder Options	Select to install Netflowd. You can configure a VIP address for netflowd or use a proxy for netflowd (same as the VIP address for the Infrastructure Nginx Ingress Controller). If you choose to not install netflowd, you cannot configure a VIP address for netflowd.
Use netflowd proxy	Enter Y to use a netflowd proxy. This option appears only if you chose to install netflowd. If you chose to use a netflowd proxy, you needn't configure a VIP address for netflowd. The VIP address for the Infrastructure Nginx Ingress Controller is used as the proxy for netflowd.
Virtual IP address for Pathfinder Netflowd	Enter a VIP address to be used for Paragon Pathfinder netflowd. This option appears only if you chose <i>not</i> to use netflowd proxy.
PCE Server Proxy	Select the proxy mode for the PCE server. Select from None and Nginx-Ingress.

Table 18: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Virtual IP address for Pathfinder PCE server	<p>Enter a VIP address to be used for Paragon Pathfinder PCE server access. This address must be an unused IP address that is managed by the load balancer.</p> <p>If you selected Nginx-Ingress, as the PCE Server Proxy, this VIP address is not necessary. The wizard does not prompt you to enter this address and PCEP will use the same address as the VIP address for Infrastructure Nginx Ingress Controller.</p> <p>NOTE: The addresses for ingress controller, Infrastructure Nginx Ingress Controller, Insights services, and PCE server must be unique. You cannot use the same address for all four VIP addresses.</p> <p>All these addresses are listed automatically in the LoadBalancer IP address ranges option.</p>
LoadBalancer IP address ranges	<p>The LoadBalancer IP addresses are prepopulated from your VIP addresses range. You can edit these addresses. The externally accessible services are handled through MetalLB, which needs one or more IP address ranges that are accessible from outside the cluster. VIPs addresses for the different servers are selected from these ranges of addresses.</p> <p>The address ranges can be (but need not be) in the same broadcast domain as the cluster nodes. For ease of management, because the network topologies need access to Insights services and the PCE server clients, we recommend that you select the VIP addresses from the same range.</p> <p>For more information, see "Virtual IP Address Considerations" on page 144.</p> <p>Addresses can be entered as comma-separated values (CSV), as a range, or as a combination of both. For example:</p> <ul style="list-style-type: none"> • 10.x.x.1, 10.x.x.2, 10.x.x.3 • 10.x.x.1-10.x.x.3 • 10.x.x.1, 10.x.x.3-10.x.x.5 • 10.x.x.1-3 is not a valid format.

Table 18: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Hostname of Main web application	<p>Enter a hostname for the ingress controller. You can configure this value as an IP address or as a fully qualified domain name (FQDN). For example, you can enter 10.12.xx.100 or www.paragon.juniper.net (DNS name). Do not include http:// or https://.</p> <p>NOTE: You will use this hostname to access the Paragon Automation Web UI from your browser. For example, https:// <i>hostname</i> or https:// <i>IP-address</i>.</p>
BGP autonomous system number of CRPD peer	<p>Set up the Containerized Routing Protocol Daemon (cRPD) autonomous systems and the nodes with which cRPD creates its BGP sessions.</p> <p>You must configure the autonomous system (AS) number of the network to allow cRPD to peer with one or more BGP Link State (BGP-LS) routers in the network. By default, the AS number is 64500.</p> <p>NOTE: While you can configure the AS number at the time of installation, you can also modify the cRPD configuration later. See "Modify cRPD Configuration" on page 75 .</p>

Table 18: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
Comma separated list of CRPD peers	<p>You must configure cRPD to peer with at least one BGP-LS router in the network to import the network topology. For a single autonomous system, configure the address of the BGP-LS router(s) that will peer with cRPD to provide topology information to Paragon Pathfinder. The CRPD instance running as part of a cluster will initiate a BGP-LS connection to the specified peer router(s) and import topology data once the session has been established. If more than one peer is required, these can be added as comma separated values, or as a range or as a combination of both, similar to how LoadBalancer IP addresses are added.</p> <p>NOTE: While you can configure the peer IP addresses at the time of installation, you can also modify the cRPD configuration later, as described in "Modify cRPD Configuration" on page 75.</p> <p>You must configure the BGP peer routers to accept BGP connections initiated from cRPD. The BGP session will be initiated from cRPD using the address of the worker where the bmp pod is running, as the source address. In the single node deployment case, cRPD will be running on the only worker configured. If new workers are added to the cluster later, you must allow connections from the addresses of any of the workers (the current worker, and any additional worker).</p> <p>You can allow the range of IP addresses that the worker address belongs to (for example, 10.xx.43.0/24), or the specific IP address of the worker (for example, 10.xx.43.1/32). You could also configure this using the neighbor command combined with the passive option to prevent the router from attempting to initiate the connection.</p> <p>The following example shows the options to configure a Juniper device to allow BGP-LS connections from cRPD.</p> <p>The following commands configure the router to accept BGP-LS sessions from any host in the 10.xx.43.0/24 network, where the worker is connected. This will accommodate any worker that is added to the cluster later.</p> <pre>[edit groups northstar] root@system# show protocols bgp group northstar type internal; family traffic-engineering { unicast; } export TE; allow 10.xx.43.0/24;</pre>

Table 18: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
	<pre>[edit groups northstar] root@system# show policy-options policy-statement TE from family traffic-engineering; then accept;</pre> <p>The following commands configure the router to accept BGP-LS sessions from 10.xx.43.1 only. Additional allow commands can be added later on, if new workers are added to the cluster.</p> <pre>[edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS allow 10.x.43.1 set protocols bgp group BGP-LS export TE</pre> <p>The following commands also configure the router to accept BGP-LS sessions from 10.xx.43.1 only. The passive option was added to prevent the router from attempting to initiate a BGP-LS session with cRPD. The router will wait for the session to be initiated by this BGP cRPD. Additional neighbor commands can be added later on, if new workers are added to the cluster.</p> <pre>[edit protocols bgp group BGP-LS] root@vmx101# show display set set protocols bgp group BGP-LS family traffic-engineering unicast set protocols bgp group BGP-LS peer-as 11 set protocols bgp group BGP-LS neighbor 10.xx.43.1 set protocols bgp group BGP-LS passive set protocols bgp group BGP-LS export TE</pre> <p>You will also need to enable OSPF/ISIS and MPLS traffic engineering as shown:</p> <pre>set protocols rsvp interface <i>interface.unit</i> set protocols isis interface <i>interface.unit</i> set protocols isis traffic-engineering igp-topology Or set protocols ospf area <i>area</i> interface <i>interface.unit</i></pre>

Table 18: *conf* Command Options (Continued)

conf Command Prompts	Description/Options
	<p>set protocols ospf traffic-engineering igp-topology</p> <p>set protocols mpls interface <i>interface.unit</i></p> <p>set protocols mpls traffic-engineering database import igp-topology</p> <p>For more information, see https://www.juniper.net/documentation/us/en/software/junos/mpls/topics/topic-map/mpls-traffic-engineering-configuration.html.</p>
Finish and write configuration to file	<p>Click Yes to save the configuration information.</p> <p>This configures a basic setup, and the information is saved in the config.yml file in the config-dir directory.</p>

For example:

```
$ ./run -c config conf
Loaded image: paragonautomation.latest
=====
PO-Runtime installer
=====

Supported command:Supported command:
  deploy [-t tags]  deploy runtime
  destroy [-t tags] destroy runtime
  init              init configuration skeleton
  inv               basic inventory editor
  conf              basic configuration editor
  info [-mc]        cluster installation info

Starting now: conf

NOTE: depending on options chosen additional IP addresses may be required for:
      multi-master   Kubernetes Master Virtual IP address
      Infrastructure  Virtual IP address(es) for ingress controller
      Infrastructure  Virtual IP address for Infrastructure Nginx Ingress Controller
      Insights        Virtual IP address for Insights services
      Insights        Virtual IP address for SNMP Trap receiver (optional)
      Pathfinder      Virtual IP address for Pathfinder Netflowd
```

Pathfinder Virtual IP address for Pathfinder PCE server

```
? Select components  done (4 selections)
? Infrastructure Options  done (4 selections)
? List of NTP servers  0.pool.ntp.org
? Virtual IP address(es) for ingress controller  10.12.xx.x7
? Virtual IP address for Infrastructure Nginx Ingress Controller  10.12.xx.x8
? Virtual IP address for Insights services  10.12.xx.x9
? Virtual IP address for SNMP Trap receiver (optional)
? Pathfinder Options  [Install Netflowd]
? Use netflowd proxy?  Yes
? PCEServer proxy  Nginx Ingress
? LoadBalancer IP address ranges  10.12.xx.x7-10.12.xx.x9
? Hostname of Main web application  host.example.net
? BGP autonomous system number of CRPD peer  64500
? Comma separated list of CRPD peers  10.12.xx.11
? Finish and write configuration to file  Yes
```

6. (Optional) For more advanced configuration of the cluster, use a text editor to manually edit the **config.yml** file.

The **config.yml** file consists of an essential section at the beginning of the file that corresponds to the configuration options that the installation wizard prompts you to enter. The file also has an extensive list of sections under the essential section that allows you to enter complex configuration values directly in the file.

The following options are available.

- Set the `opendistro_es_admin_password` password to log in to the Kibana application. Open Distro is used to consolidate and index application logs and Kibana is the visualization tool that enables you to search logs using keywords and filters.

By default, the username is preconfigured as `admin` in `#opendistro_es_admin_user: admin` and `install_opendistro_es` option is set to `true` to replace the Elasticsearch version with Open Distro. Use `admin` as username and this password to log in to Kibana.

By default, data is retained on the disks for seven days, before being purged, in a production deployment. You can edit the number of days to a smaller number in `opendistro_es_retain` if your disk size is low.

```
# install_opendistro_es: true
# opendistro_es_admin_user: admin
```

```
# opendistro_es_admin_password: opendistro_password
# opendistro_es_retain: 7d
```

If you do not configure the `opendistro_es_admin_password`, the installer will generate a random password. You can retrieve the password using this command:

```
# kubectl -n kube-system get secret opendistro-es-account -o jsonpath={..password} | base64 -d
```

- Set the `iam_skip_mail_verification` configuration option to true for user management without SMTP by Identity Access Management (IAM). By default, this option is set to false for user management with SMTP. You must configure SMTP in Paragon Automation so that the Paragon Automation users can be notified when their account is created, activated, locked, or when the password is changed for their account.
- Configure the `callback_vip` option with an IP address different from that of the VIP for the ingress controller. You can configure a separate IP address, which is a part of the MetalLB pool of addresses, to enable segregation of management and data traffic from the southbound and northbound interfaces. By default, `callback_vip` is assigned the same or one of the addresses of the ingress controller.

Save and exit the file after you finish editing it.

7. (Optional) If you want to deploy custom SSL certificates signed by a recognized certificate authority (CA), store the private key and certificate in the *config-dir* directory. Save the private key as **ambassador.key.pem** and the certificate as **ambassador.cert.pem**.

By default, Ambassador uses a locally generated certificate signed by the Kubernetes cluster-internal CA.

NOTE: If the certificate is about to expire, save the new certificate as **ambassador.cert.pem** in the same directory, and execute the `./run -c config-dir deploy -t ambassador` command.

8. Install the Paragon Automation cluster based on the information that you configured in the **config.yml** and **inventory** files.

```
# ./run -c config-dir deploy
```

The installation time to install the configured cluster depends on the complexity of the cluster. A basic setup installation takes at least 45 minutes to complete.

NTP synchronization is checked at the start of deployment. If clocks are out of sync, deployment fails.

If you are installing Paragon Automation on an existing Kubernetes cluster, the `deploy` command upgrades the currently deployed cluster to the latest Kubernetes version. The command also

upgrades the Docker CE version, if required. If Docker EE is already installed on the node, the `deploy` command does not overwrite it with Docker CE. When upgrading the Kubernetes version or the Docker version, the command performs the upgrade sequentially on one node at a time. The command cordons off each node and removes it from scheduling. It performs upgrades, restarts Kubernetes on the node, and finally uncordons the node and brings it back into scheduling.

9. When deployment is completed, log in to the worker node.

Use a text editor to configure the following recommended information for Paragon Insights in the **limits.conf** and **sysctl.conf** files. These values set the soft and hard memory limits for influx DB memory requirements. If you do not set these limits, you might see errors such as “out of memory” or “too many open files” because of default system limits.

a.

```
# vi /etc/security/limits.conf

# End of file
*          hard    nofile      1048576
*          soft    nofile      1048576
root       hard    nofile      1048576
root       soft    nofile      1048576
influxdb   hard    nofile      1048576
influxdb   soft    nofile      1048576
```

b.

```
# vi /etc/sysctl.conf

fs.file-max = 2097152
vm.max_map_count=262144
fs.inotify.max_user_watches=524288
fs.inotify.max_user_instances=512
```

Now that you've installed and deployed your Paragon Automation cluster, you're ready to log in to the Paragon Automation UI.

Log in to the Paragon Automation UI

After you install Paragon Automation, log in to the Paragon Automation UI.

1. Open a browser, and enter either the hostname of the main Web application or the VIP address of the ingress controller that you entered in the URL field of the installation wizard.

For example, <https://vip-of-ingress-controller-or-hostname-of-main-web-application>. The Paragon Automation login page is displayed.

2. For first-time access, enter **admin** as username and **Admin123!** as the password to log in. You must change the password immediately.

The **Set Password** page appears. To access the Paragon Automation setup, you must set a new password.

3. Set a new password that meets the password requirements.

The password should be between 6 to 20 characters and must be a combination of uppercase letters, lowercase letters, numbers, and special characters. Confirm the new password, and click **OK**.

The **Dashboard** page appears. You have successfully installed and logged in to the Paragon Automation UI.

4. Update the URL to access the Paragon Automation UI in **Administration > Authentication > Portal Settings** to ensure that the activation e-mail sent to users for activating their account contains the correct link to access the GUI. For more information, see *Configure Portal Settings*.

For high-level tasks that you can perform after you log in to the Paragon Automation GUI, see [Paragon Automation Getting Started](#).

Air-Gap Install Paragon Automation on RHEL

IN THIS SECTION

- [Prerequisites | 190](#)
- [Download and Install Paragon Automation | 191](#)

You can install and deploy a paragon Automation cluster using the air-gap method of installation. In the air-gap method you need not have Internet access on the cluster nodes. You need a control host to download the distribution software and then create and configure the installation files to run the installation from the control host. You must be able to use SSH to connect to all the nodes.

Prerequisites

Before you download and install the distribution software, you must preconfigure the control host and the cluster nodes as described in the following sections.

1. Prepare the control host for the installation process as described in "[Prepare the Control Host](#)" on [page 138](#).
2. Prepare the cluster nodes for the installation process as described in "[Prepare Cluster Nodes](#)" on [page 140](#).
3. Ensure you have the required virtual IP addresses as described in "[Virtual IP Address Considerations](#)" on [page 144](#).

Download and Install Paragon Automation

1. Log in to the control host.
2. Download the Paragon Automation Release 22.1 software from the software download page at <https://support.juniper.net/support/downloads/?p=pa> to your *pa-download-dir* download directory. You need a Juniper account to download the Paragon Automation software.

You can use the `wget "http://cdn.juniper.net/software/file-download-url"` command to download the installation files.

NOTE: During the installation process, you *must* download and untar the **rhel-84-airgap.tar.gz** file to use the air-gap method.

3. Follow steps [1](#) through [7](#) of the installation process as described in "[Install Paragon Automation on a Multinode Cluster](#)" on [page 154](#).
For single node installations, follow steps [1](#) through [7](#) in "[Install Paragon Automation on a Single-Node](#)" on [page 174](#).
4. Manually edit the **config.yml** file using a text editor and set the following values.

```
docker_version: 20.10.13-3

containerd_version_redhat: 1.5.10-3
```

5. Log in to the cluster nodes through SSH using the `install-user` account. Perform the following steps on all the cluster nodes.
 - a. Set all the repos in `/etc/yum.repos.d/` to `enabled = 0`, using a text editor.

Repeat this step for all cluster nodes.

- b. Apply the following firewall rules to all nodes:

```
"iptables -A OUTPUT --dst=10.0.0.0/8 -j ACCEPT"
"iptables -A OUTPUT --dst=172.16.0.0/12 -j ACCEPT"
"iptables -A OUTPUT --dst=192.168.0.0/16 -j ACCEPT"
"iptables -A OUTPUT --dst=127.0.0.1 -j ACCEPT"
```

6. Log back in to the control host, and install the Paragon Automation cluster based on the information that you configured in the **config.yml** and **inventory** files.

```
# ./run -c config-dir deploy -e offline_install=true
```

The installation time to install the configured cluster depends on the complexity of the cluster. A basic setup installation takes at least 45 minutes to complete.

NTP synchronization is checked at the start of deployment. If clocks are out of sync, deployment fails.

7. When deployment is completed, log in to the worker nodes.

Use a text editor to configure the soft and hard memory limits for influx DB memory requirements for Paragon Insights in the **limits.conf** and **sysctl.conf** files.

- a. # vi /etc/security/limits.conf

```
# End of file
*          hard    nofile    1048576
*          soft    nofile    1048576
root       hard    nofile    1048576
root       soft    nofile    1048576
influxdb   hard    nofile    1048576
influxdb   soft    nofile    1048576
```

- b. # vi /etc/sysctl.conf

```
fs.file-max = 2097152
vm.max_map_count=262144
fs.inotify.max_user_watches=524288
fs.inotify.max_user_instances=512
```

Repeat this step for all worker nodes.

8. Follow the steps described in ["Log in to the Paragon Automation UI- Multinode installation"](#) on page 172 to access the GUI. For single-node implementations, follow the steps described in ["Log in to the Paragon Automation UI- Single-node installations"](#) on page 189.



Upgrade and Update Paragon Automation

[Upgrade to Paragon Automation Release 22.1 | 194](#)

[Reinstall Paragon Automation | 196](#)

[Edit Cluster Nodes | 198](#)

[Uninstall Paragon Automation | 201](#)

Upgrade to Paragon Automation Release 22.1

You can upgrade to Paragon Automation Release 22.1 from Releases 21.3 and 21.2. If you are using Paragon Automation Release 21.1, you cannot upgrade to any later release and must perform a fresh installation of Release 22.1.

Before you upgrade:

- Verify that the control host and cluster nodes meet the preparation prerequisites described in ["Installation Prerequisites on Ubuntu" on page 20](#) or ["Installation Prerequisites on CentOS" on page 80](#) as required.
- (Optional) Back up the *config-dir* directory on your control host to an alternate directory or to a remote location. The *config-dir* contains the *inventory*, *config.yml*, and *id_rsa* files for your current Release 21.3 setup. If the upgrade fails, you can reinstall your current setup with the same installation configuration files. See ["Back Up the Control Host" on page 227](#).
- (Optional) Back up your current Release 21.3 configuration. If the upgrade fails, you can restore your current deployment from the backed-up configuration. See ["Back Up the Configuration" on page 205](#).

Upgrade from Release 21.3 to Release 22.1

1. Log in to the control host. You can use the same host that you used to install Release 21.3.
2. Download the Release 22.1 files to a download folder on the control host.
Make the run script executable by using the `chmod +x run` command.
3. Initialize the new configuration folder. You can use the same folder name that you did for Release 21.3, as long as you backed up the contents of the folder to another location. For the purpose of this topic, we will use the same folder name, *config-dir*.

```
# ./run -c config-dir init
```
4. Run the `inv` command to input information into the inventory file. Use the same IP addresses of the primary and worker nodes as you did for your current Release 21.3 setup.

```
# ./run -c config-dir inv
```
5. Copy the private key that you generated while installing the SSH server during the cluster node preparation process to the *config-dir* directory, where the inventory file is saved.

```
# cd config-dir
# cp ~/.ssh/id_rsa .
```

6. Configure the installer using the `conf` command.

```
# ./run -c config-dir conf
```

Enter the same configuration values as you did for your current Release 21.3 setup.

NOTE: If you choose to manually edit the `config.yml` file, ensure that the format of the `ingress_vip` is a list of IP addresses. For example:

```
ingress_vip:
  - 10.10.3.4
  - 10.10.6.7
```

7. Install the Release 22.1 Paragon Automation cluster.

```
# ./run -c config-dir deploy
```

8. Log in to the worker nodes.

Use a text editor to configure the following recommended information for Paragon Insights in the `limits.conf` and `sysctl.conf` files.

a.

```
# vi /etc/security/limits.conf

# End of file
*          hard    nofile    1048576
*          soft    nofile    1048576
root       hard    nofile    1048576
root       soft    nofile    1048576
influxdb   hard    nofile    1048576
influxdb   soft    nofile    1048576
```

b.

```
# vi /etc/sysctl.conf

fs.file-max = 2097152
vm.max_map_count=262144
fs.inotify.max_user_watches=524288
fs.inotify.max_user_instances=512
```

Repeat this step for all worker nodes.

9. Open a browser, and enter in the URL field either the hostname of the main Web application or the VIP address of the ingress controller that you configured in of the installation wizard.

For example, <https://vip-of-ingress-controller-or-hostname-of-main-web-application>. The Paragon Automation login page appears.

10. Log in using **admin** as the username and the previously configured password for Release 21.3.

The **Dashboard** page appears. You've successfully upgraded and logged in to the Paragon Automation UI.

11. Update the URL to access the Paragon Automation UI in **Administration > Authentication > Portal Settings** to ensure that the activation e-mail sent to users for activating their account contains the correct link to access the GUI. For more information, see *Configure Portal Settings*.

Upgrade Failure Scenario

If upgrade fails and you are unable to install Release 22.1, you must reinstall Release 21.3 to restore operations. Use one or both of the following options to restore the cluster.

- You can use the backed-up **config-dir** files to reinstall the previously operational cluster.
- You can restore the cluster data if you previously backed up Release 21.3 configuration.

You cannot restore a backed-up Release 22.1 setup on an upgraded Release 22.1 cluster. That is, if you back up a Release 21.3 setup, and then successfully upgrade it to a Release 22.1 setup, you cannot restore the Release 21.3 configuration using the backup.

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| [Backup and Restore](#) | 204

Reinstall Paragon Automation

To reinstall Paragon Automation, run the deploy script again on the control host.

To update an existing instance of Paragon Automation, edit the **inventory** and **config.yml** files, and run the deploy script again on the control host.

```
# ./run -c config-dir deploy
```

If the deploy script fails for a particular component, you can run the destroy command to uninstall the component, and then reinstall it with the deploy script.

```
# ./run -c config-dir destroy -t tags
# ./run -c config-dir deploy -t tags
```

We support the following optional parameters for the deploy script:

- **--list-tags**—View a list of available tags.
- **-t tag1,tag2**—Deploy or redeploy a subset of the installation tasks or components of the cluster selectively. For example, to install or update only the Infrastructure component, use `# ./run -c config-dir deploy -t infra`.
- **--skip-tags tag1,tag2**—Skip over some installation tasks. For example, to deploy the cluster without installing the Paragon Insights component, use `# ./run -c config-dir deploy --skip-tags healthbot`.
- **--ask-vault-pass**—Prompt for the password to decrypt authentication passwords, if Ansible vault was previously configured.

RELATED DOCUMENTATION

[Install MultiNode Cluster on CentOS | 97](#)

[Install Multinode Cluster on Ubuntu | 36](#)

[Troubleshoot Paragon Automation Installation | 212](#)

Edit Cluster Nodes

IN THIS SECTION

- [Edit Primary Nodes in Multi-Primary NodeClusters and Worker Nodes in All Clusters | 198](#)
- [Edit Primary Nodes in Single-Primary Node Clusters | 199](#)

Use the information provided in this topic to edit operational Paragon Automation cluster nodes. You can use the `repair` command to add, remove, or replace cluster nodes, and repair failed nodes. The repair process rebuilds the cluster node and restarts the pods in the node.

Edit Primary Nodes in Multi-Primary NodeClusters and Worker Nodes in All Clusters

In clusters with multiple primary nodes, you can edit both primary and worker nodes. You can add or remove primary and worker nodes. However, when you add or remove primary nodes, you must ensure that the total number of primary nodes is an odd number. You must also have a minimum of three primary nodes for high availability in the control plane. Use the following procedure to edit nodes in multi-primary node clusters.

You can also use the same procedure to edit only worker nodes in single-primary node clusters.

1. Prepare the new node or the replacement node and ensure that it meets all the cluster node prerequisites. See ["Prepare CentOS Cluster Nodes" on page 83](#) or ["Prepare Ubuntu Cluster Nodes" on page 23](#) depending on your base OS.
2. Log in to node you want to add or repair.
3. Disable the `udev` daemon.
 - a. Check whether `udev` is running.


```
# systemctl is-active systemd-udev
```
 - b. If `udev` is active, disable it.

```
# systemctl mask system-udev --now
```
4. Log in to the control host.

5. If you are adding a node, edit the inventory file to add the IP address of the new node.

If you are removing a node, edit the inventory file to delete the IP address of the node you want to remove.

If you are replacing a node, and the IP address of the replacement node is different from the current node, update the inventory file to replace the old node address with the new node address.

If you are repairing a node and the IP address is unchanged, you need not edit the inventory file.

6. Run one of the following commands:

If the node address is unchanged or you are adding or removing a node, use

```
./run -c config-dir repair node-ip-address-or-hostname
```

If the node address has changed, use

```
./run -c config-dir repair old-node-ip-address-or-hostname,new-node-ip-address-or-hostname
```

7. When a node is repaired or replaced, the Ceph distributed filesystems are not automatically updated. If the data disks were destroyed as part of the repair process, then the object storage daemons (OSDs) hosted on those data disks must be recovered.

- a. Connect to the Ceph toolbox and view the status of OSDs. The `ceph-tools` script is installed on a primary node. You can log in to the primary node and use the `kubectl` interface to access `ceph-tools`. To use a node other than the primary node, you must copy the **admin.conf** file (in the `config-dir` on the control host) and set the `kubeconfig` environment variable or use the `export KUBECONFIG=config-dir/admin.conf` command.

```
$ ceph-tools# ceph osd status
```

- b. Verify that all OSDs are listed as `exists,up`. If OSDs are damaged, follow the troubleshooting instructions explained in ["Troubleshoot Ceph and Rook" on page 221](#).

8. Log in to node that you added or repaired after verifying that all OSDs are created.

9. Reenable `udev` on that node.

```
systemctl unmask system-udev
```

Edit Primary Nodes in Single-Primary Node Clusters

In single-primary node clusters, you can edit both primary and worker nodes. However, you cannot remove or add additional primary nodes.

NOTE: You can add additional primary nodes only if your existing cluster is already a multiple-primary cluster.

During node repair, you cannot schedule new pods, and existing pods remain nonoperational, resulting in service degradation.

You need the latest version of the **etcd-snapshot.db** file to restore the primary node in single-primary node clusters.

NOTE: The **etcd-snapshot.db** file is backed up locally in **/export/backup/etcd-snapshot.db** every five minutes. We recommend that you copy this file to a separate remote location at regular intervals or mount **/export/backup/** to an external fileserver.

To replace or repair the primary node, you have the **etcd-snapshot.db** file available.

1. Log in to the node that you want to replace or repair.
2. Disable the udevd daemon.
 - a. Check whether udevd is running.
`# systemctl is-active systemd-udev`
 - b. If udevd is active, disable it. `# systemctl mask system-udev --now`
3. Log in to the control host.
4. Copy the **etcd-snapshot.db** file to the control host or restore the external **/export/backup/** mount.
5. Run one of the following commands to replace or repair the node:

If the node address is unchanged, use

```
./run -c config-dir repair node-ip-address-or-hostname -e etcd_backup=path-to-etcd-snapshot.db
```

If the node address has changed, use

```
./run -c config-dir repair old-node-ip-address-or-hostname,new-node-ip-address-or-hostname -e etcd_backup=path-to-etcd-snapshot.db
```

6. When a node is repaired or replaced, the Ceph distributed filesystems are not automatically updated. If the data disks were destroyed as part of the repair process, then the object storage daemons (OSDs) hosted on those data disks must be recovered.

- a. Connect to the Ceph toolbox and view the status of OSDs. The `ceph-tools` script is installed on a primary node. You can log in to the primary node and use the `kubectl` interface to access `ceph-tools`. To use a node other than the primary node, you must copy the **admin.conf** file (in the **config-dir** on the control host) and set the `kubeconfig` environment variable or use the `export KUBECONFIG=config-dir/admin.conf` command.

```
$ ceph-tools# ceph osd status
```

- b. Verify that all OSDs are listed as `exists,up`. If OSDs are damaged, follow the troubleshooting instructions explained in ["Troubleshoot Ceph and Rook" on page 221](#).

7. Log in to the node that you added or repaired after verifying that all OSDs are created.

8. Reenable `udev` on that node.

```
systemctl unmask system-udev
```

RELATED DOCUMENTATION

[Install MultiNode Cluster on CentOS | 97](#)

[Install Multinode Cluster on Ubuntu | 36](#)

[Troubleshoot Paragon Automation Installation | 212](#)

Uninstall Paragon Automation

To uninstall Paragon Automation:

1. Log in to the control host.
2. Uninstall individual components or component groups.

```
# ./run -c config-dir destroy -t tags
```

To view a list of available tags, use `# ./run -c config-dir deploy --list-tags`.

If you uninstall Paragon Automation completely, you must also ensure that you've removed the `/var/lib/rook` directory from all nodes, and cleared all Ceph block devices. For information about clearing Ceph block devices, see ["Reformat a Disk" on page 221](#).

NOTE: To completely uninstall the whole cluster, we recommend that you reimage all the cluster nodes. Reimaging is a faster and more complete option.

RELATED DOCUMENTATION

No Link Title
Reinstall Paragon Automation 196
Edit Cluster Nodes 198

7

CHAPTER

Backup and Restore

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Backup and Restore

IN THIS SECTION

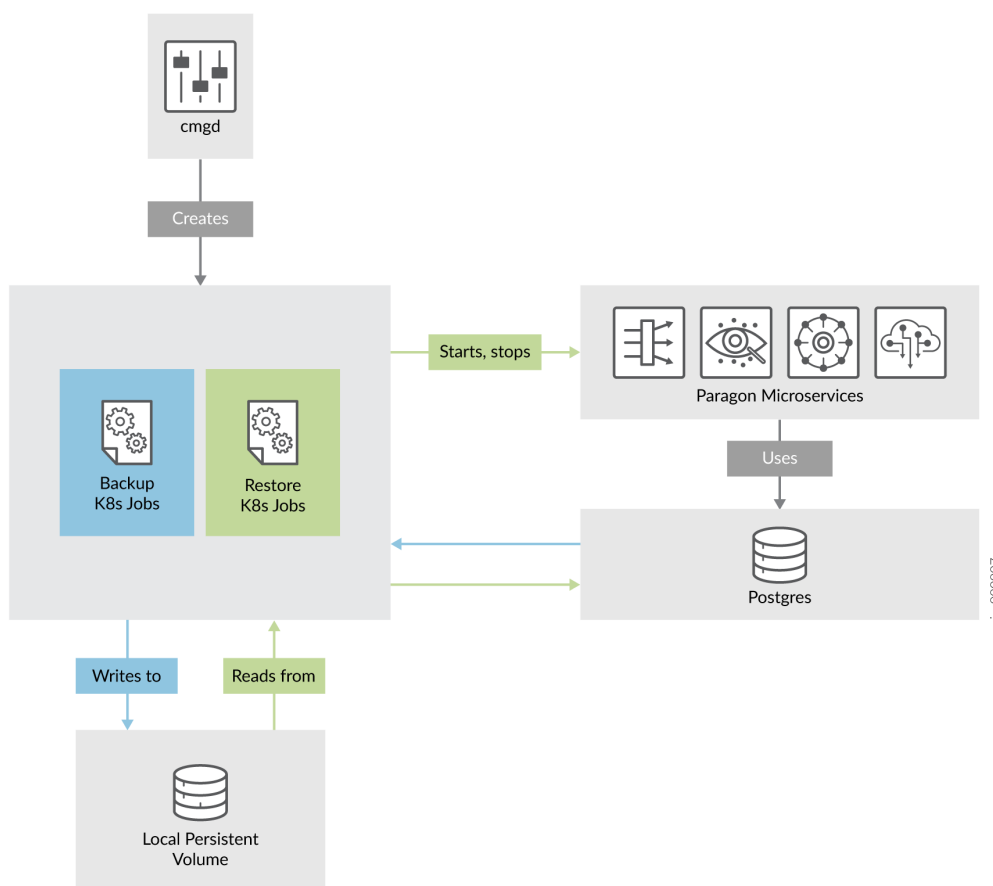
- [Back Up the Configuration | 205](#)
- [Restore the Configuration | 208](#)

This topic describes the backup and restore capabilities available in Paragon Automation. Although Paragon Automation is a GUI-based application, the backup and restore operations are managed from the Paragon Insights cMGD CLI. Postgres is the primary persistent storage database for microservices. Backup files are saved in a local persistent volume on the cluster nodes. The backup procedure can be performed while microservices are running and does not affect the operation of the cluster. However, for restore procedures, microservices are stopped and the cluster is not functional until the databases are restored.

Currently, you cannot schedule a backup or restore procedure. Also, you cannot select applications to be backed up and restored. You can back up and restore only a preconfigured and fixed set of applications for each component.

You use containerized scripts invoked through Kubernetes jobs to implement the backup and restore procedures.

Figure 32: Backup and Restore Process



Back Up the Configuration

Data across most Paragon Automation applications is primarily stored in Postgres. When you back up a configuration, system-determined and predefined data is backed up. When you perform a backup, the operational system and microservices are not affected. You can continue to use Paragon Automation while a backup is running. You'll use the management daemon (MGD) CLI, managed by Paragon Insights (formerly Healthbot), to perform the backup.

To back up the current Paragon Automation configuration:

1. Determine the name of the MGD Kubernetes pod, and connect to the cMGD CLI using this name.

For example:

```
root@primary-node:~# kubectl get -n healthbot pods -l app=mgd
NAME                                READY   STATUS    RESTARTS   AGE
mgd-57b5754b7f-26mlm              1/1     Running   0           10d
root@primary-node:~# kubectl exec -it -n healthbot mgd-57b5754b7f-26mlm -- bash
root@primary-node:~# cli
```

NOTE: The main CLI tool in Kubernetes is kubectl, which is installed on a primary node. You can use a node other than the primary node, but you must ensure that you copy the **admin.conf** file and set the kubeconfig environment variable. Alternatively, you can use the `export KUBECONFIG=config-dir/admin.conf` command.

You can also access the Kubernetes API from any node that has access to the cluster, including the control host.

2. Enter the request system backup path *path-to-backup-folder* command to start a backup job that backs up all databases up until the moment you run the command.

For example:

```
root@mgd-57b5754b7f-26mlm> request system backup path /hello/world
```

The command creates a corresponding Kubernetes db-backup-hello-world job. The Kubernetes job creates a backup of the predefined data. The files are stored in a local persistent volume.

3. After backup is complete, you must explicitly and manually back up the base platform resources using kubectl.
 - a. Back up **jobmanager-identitysrvcreds** and **devicemodel-connector-default-scope-id**.

```
root@primary-node:~# kubectl get secrets -n ems jobmanager-identitysrvcreds devicemodel-connector-default-scope-id -o yaml > ems-scope-bkup.yaml
```

- b. (Optional) If SMTP is configured on the Paragon Automation cluster, then back up the available **iam-smtp-config** secret.

```
root@primary-node:~# kubectl get secrets -n common iam-smtp-config -o yaml > iam-smtp-bkup.yaml
```

If this command fails, then SMTP is not configured in the cluster and you can ignore the error.

Frequently Used kubectl Commands to View Backup Details

To view the status of your backup or the location of your backup files, or to view more information on the backup files, use the following commands.

- Backup jobs exist in the common namespace and use the `common=db-backup` label. To view all backup jobs:

```
root@primary-node:~# kubectl get -n common jobs -l common=db-backup
```

NAME	COMPLETIONS	DURATION	AGE
db-backup-hello-world	1/1	3m11s	2d20h

- To view more details of a specific Kubernetes job:

```
root@primary-node:~# kubectl describe -n common jobs/db-backup-hello-world
```

- To view the logs of a specific Kubernetes job:

```
root@primary-node:~# kubectl logs -n common --tail 50 jobs/db-backup-hello-world
```

- To determine the location of the backup files:

```
root@primary-node:~# kubectl get -n common pvc db-backup-pvc
```

NAME	STATUS	VOLUME	CAPACITY	ACCESS MODES	STORAGECLASS	AGE
db-backup-pvc	Bound	local-pv-cb20f386	145Gi	RWO	local-storage	3d3h

The output points you to the local persistent volume. Use that persistent volume to determine the node on which the backup files are stored.

```
root@primary-node:~# kubectl describe -n common pv local-pv-cb20f386
```

Node Affinity:

Required Terms:

Term 0: kubernetes.io/hostname in [10.49.xxx.x2]

Message:

Source:

Type: LocalVolume (a persistent volume backed by local storage on a node)

Path: /export/local-volumes/pv*

To view all the backup files, log in to the node and navigate to the location of the backup folder.

```
root@primary-node:~# ssh root@10.49.xxx.x2
root@10.49.xxx.x2:~# ls -l /export/local-volumes/pv*
```

To view commonly seen backup and restore failure scenarios, see ["Common Backup and Restore Issues" on page 213](#).

Restore the Configuration

You can restore a Paragon Automation configuration from a previously backed-up configuration folder. A restore operation rewrites the databases with all the backed-up configuration information. You cannot selectively restore databases. When you perform a restore operation, a Kubernetes job is spawned, which stops the affected microservices. The job restores the backed-up configuration and restarts the microservices. Paragon Automation remains nonfunctional until the restoration procedure is complete.

You cannot run multiple restore jobs at the same time because the Kubernetes job stops the microservices during the restoration process. Also, you cannot run both backup and restore processes concurrently.

NOTE: We strongly recommend that you restore a configuration during a maintenance window, otherwise the system can go into an inconsistent state.

To restore the Paragon Automation configuration to a previously backed-up configuration:

1. Determine the name of the MGD Kubernetes pod, and connect to the cMGD CLI using this name.

For example:

```
root@primary-node:~# kubectl get -n healthbot pods -l app=mgd
NAME                                READY   STATUS    RESTARTS   AGE
mgd-57b5754b7f-26mlm               1/1     Running   0           10d
root@primary-node:~# kubectl exec -it -n healthbot mgd-57b5754b7f-26mlm -- bash
root@primary-node:~# cli
```

2. Enter the request `system restore path path-to-backup-folder` command to restore the configuration with the files in the specified backup folder on the persistent volume.

For example:

```
root@mgd-57b5754b7f-26mlm> request system restore path /hello/world
```

A corresponding Kubernetes db-restore-hello-world job is created. The restore process takes longer than a backup process because the Kubernetes job stops restarts the microservices. When the restoration is complete, the Paragon Automation system is not operational immediately. You must wait around ten minutes for the system to stabilize and become fully functional.

NOTE: If you are logged in during the restore process, you must log out and log back in after the restore process is complete.

3. After restore process is complete, you must explicitly restore the base platform resources with the previously manually backed-up base-platform backup files.
 - a. Delete the **jobmanager-identitysrvcreds** and **devicemodel-connector-default-scope-id** base-platform secrets resources.

```
root@primary-node:~# kubectl delete secrets -n ems jobmanager-identitysrvcreds devicemodel-connector-default-scope-id
```

- b. Restore the previously backed-up base-platform resources.

```
root@primary-node:~# kubectl apply -f ems-scope-bkup.yaml
```

- c. Restart the **jobmanager** and **devicemodel-connector** base-platform services.

```
root@primary-node:~# kubectl rollout restart deploy jobmanager devicemodel-connector -n ems
```

- d. (Optional) If SMTP is configured on the Paragon Automation cluster, delete the current SMTP secrets file and restore from the previously backed-up file.

```
root@primary-node:~# kubectl delete secret -n common iam-smtp-config
root@primary-node:~# kubectl apply -f iam-smtp-bkup.yaml
```


- e. (Optional) Delete the manually backed-up files.

```
root@primary-node:~# rm ems-scope-bkup.yaml iam-smtp-bkup.yaml
```

Frequently Used kubectl Commands to View Restore Details

To view more information and the status of your restore process, use the following commands:

- Restore jobs exist in the common namespace and use the `common=db-restore` label. To view all restore jobs:

```
root@primary-node:~# kubectl get -n common jobs -l common=db-restore
```

NAME	COMPLETIONS	DURATION	AGE
db-restore-hello-world	0/1	20s	21s

- To view more details of a specific Kubernetes job:

```
root@primary-node:~# kubectl describe -n common jobs/db-restore-hello-world
```

- To view the logs of a particular Kubernetes job:

```
root@primary-node:~# kubectl logs -n common --tail 50 jobs/db-restore-hello-world
```

To view commonly seen backup and restore failure scenarios, see "[Common Backup and Restore Issues](#)" on page 213.

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8

CHAPTER

Troubleshooting

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Troubleshoot Paragon Automation Installation

SUMMARY

Read the following topics to learn how to troubleshoot typical problems that you might encounter during and after installation.

IN THIS SECTION

- [Resolve Merge Conflicts of the Configuration File | 212](#)
- [Resolve Common Backup and Restore Issues | 213](#)
- [View Installation Log Files | 213](#)
- [View Log Files in Kibana | 214](#)
- [Troubleshooting Using the kubectl Interface | 214](#)
- [Troubleshoot Ceph and Rook | 221](#)
- [Troubleshoot Air-Gap Installation Failure | 224](#)
- [Recover from a RabbitMQ Cluster Failure | 225](#)
- [Disable udevd Daemon During OSD Creation | 226](#)
- [Wrapper Scripts for Common Utility Commands | 227](#)
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Resolve Merge Conflicts of the Configuration File

The `init` script creates the template configuration files. If you update an existing installation using the same `config-dir` directory that was used for the installation, the template files that the `init` script creates are merged with the existing configuration files. Sometimes, this merging action creates a merge conflict that you must resolve. The script prompts you about how to resolve the conflict. When prompted, select one of the following options:

- C—You can retain the existing configuration file and discard the new template file. This is the default option.

- n—You can discard the existing configuration file and reinitialize the template file.
- m—You can merge the files manually. Conflicting sections are marked with lines starting with “<<<<<<<”, “|||||”, “=====”, and “>>>>>>”. You must edit the file and remove the merge markers before you proceed with the update.
- d—You can view the differences between the files before you decide how to resolve the conflict.

Resolve Common Backup and Restore Issues

Suppose you destroy an existing cluster and redeploy a software image on the same cluster nodes. In such a scenario, if you try to restore a configuration from a previously backed-up configuration folder, the restore operation might fail. The restore operation fails because the mount path for the backed-up configuration is now changed. When you destroy an existing cluster, the persistent volume is deleted. When you redeploy the new image, the persistent volume gets re-created in one of the cluster nodes wherever space is available, but not necessarily in the same node as it was present in previously. As a result, the restore operation fails.

To work around these backup and restore issues:

1. Determine the mount path of the new persistent volume.
2. Copy the contents of the previous persistent volume's mount path to the new path.
3. Retry the restore operation.

View Installation Log Files

If the deploy script fails, you must check the installation log files in the *config-dir* directory. By default, the *config-dir* directory stores six zipped log files. The current log file is saved as **log**, and the previous log files are saved as **log.1** through **log.5** files. Every time you run the deploy script, the current log is saved, and the oldest one is discarded.

You typically find error messages at the end of a log file. View the error message, and fix the configuration.

View Log Files in Kibana

You use Open Distro to consolidate and index application logs. The Kibana application is the visualization tool that you can use to search logs using keywords and filters.

To view logs in the Kibana application:

1. Use one of the following methods to access Kibana:
 - Use the virtual IP (VIP) address of the ingress controller: Open a browser and enter *https://vip-of-ingress-controller-or-hostname-of-main-web-application/kibana* in the URL field.
 - Use the Logs page: In the Paragon Automation UI, click **Monitoring > Logs** in the left-nav bar.
2. Enter the `opendistro_es_admin_user` username and the `opendistro_es_admin_password` password that you configured in the **config.yml** file during installation. The default username is **admin**.
 If you do not configure the `opendistro_es_admin_password` password, the installer generates a random password. You can retrieve the password using the following command:


```
# kubectl -n kube-system get secret opendistro-es-account -o jsonpath={..password} | base64 -d
```
3. If you are logging in for the first time, create an index pattern by clicking the **Create index pattern** option.
4. Enter **logstash-*** in the **Index pattern name** field, and then click **Next Step >**.
5. Select **@timestamp** from the **Time field** list, and then click **Create index pattern** to create an index pattern.
6. Click the hamburger icon and select **Discover** from the left-nav bar to browse the log files, and to add or remove filters as required.

Troubleshooting Using the kubectl Interface

IN THIS SECTION

- [View Node Status | 217](#)
- [View Pod Status | 218](#)
- [View Detailed Information About a Pod | 218](#)
- [View the Logs for a Container in a Pod | 218](#)
- [Run a Command on a Container in a Pod | 219](#)
- [View Services | 220](#)

kubectl (Kube Control) is a command-line utility that interacts with the Kubernetes API, and the most common command line tool to control Kubernetes clusters.

You can issue kubectl commands on the primary node right after installation. To issue kubectl commands on the worker nodes, you need to copy the **admin.conf** file and set the `kubeconfig` environment variable or use the **export KUBECONFIG=config-dir /admin.conf** command. The **admin.conf** file is copied to the **config-dir** directory on the control host as part of the installation process.

You use the kubectl command-line tool to communicate with the Kubernetes API and obtain information about API resources such as nodes, pods, and services, show log files, as well as create, delete, or modify those resources.

The syntax of kubectl commands is as follows:

```
kubectl [command] [TYPE] [NAME] [flags]
```

[command] is simply the action that you want to execute.

You can use the following command to view a list of kubectl commands:

```
root@primary-node:/# kubectl [enter]
```

You can ask for help, to get details and list all the flags and options associated with a particular command. For example:

```
root@primary-node:/# kubectl get -h
```

To verify and troubleshoot the operations in Paragon Automation, you'll use the following commands:

[command]	Description
get	Display one or many resources. The output shows a table of the most important information about the specified resources.
describe	Show details of a specific resource or a group of resources.
explain	Documentation of resources.

(Continued)

[command]	Description
logs	Print the logs for a container in a pod.
rollout restart	Manage the rollout of a resource.
edit	Edit a resource.

[TYPE] represents the type of resource that you want to view. Resource types are case-insensitive, and you can use singular, plural, or abbreviated forms.

For example, pod, node, service, or deployment. For a complete list of resources, and allowed abbreviations (example, pod = po), issue this command:

```
kubectl api-resources
```

To learn more about a resource, issue this command:

```
kubectl explain [TYPE]
```

For example:

```
root@primary-node:/# kubectl explain pod
KIND:      Pod
VERSION:   v1

DESCRIPTION:
  Pod is a collection of containers that can run on a host. This resource is
  created by clients and scheduled onto hosts.
---more---
```

[NAME] is the name of a specific resource—for example, the name of a service or pod. Names are case-sensitive.

```
root@primary-node:/# kubectl get pod pod_name
```

[flags] provide additional options for a command. For example, -o lists more attributes for a resource. Use help (-h) to get information about the available flags.

Note that most Kubernetes resources (such as pods and services) are in some namespaces, while others are not (such as nodes).

Namespaces provide a mechanism for isolating groups of resources within a single cluster. Names of resources need to be unique within a namespace, but not across namespaces.

When you use a command on a resource that is in a namespace, you must include the namespace as part of the command. Namespaces are case-sensitive. Without the proper namespace, the specific resource you are interested in might not be displayed.

```
root@primary-node:/# kubectl get services mgd
Error from server (NotFound): services "mgd" not found

root@primary-node:/# kubectl get services mgd -n healthbot
```

NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
mgd	ClusterIP	10.102.xx.12	<none>	22/TCP,6500/TCP,8082/TCP	18h

You can get a list of all namespaces by issuing the `kubectl get namespace` command.

If you want to display resources for all namespaces, or you are not sure what namespaces the specific resource you are interested in belongs to, you can enter `--all-namespaces` or `-A`.

For more information about Kubernetes, see:

- <https://kubernetes.io/docs/reference/kubectl/overview/>
- <https://kubernetes.io/docs/reference/generated/kubectl/kubectl-commands>

Use the following topics to troubleshoot and view installation details using the `kubectl` interface.

View Node Status

Use the `kubectl get nodes` command, abbreviated as the `kubectl get no` command, to view the status of the cluster nodes. The status of the nodes must be `Ready`, and the roles must be either `control-plane` or `none`. For example:

```
root@primary-node:~# kubectl get no
```

NAME	STATUS	ROLES	AGE	VERSION
10.49.xx.x1	Ready	control-plane,master	5d5h	v1.20.4
10.49.xx.x6	Ready	<none>	5d5h	v1.20.4
10.49.xx.x7	Ready	<none>	5d5h	v1.20.4
10.49.xx.x8	Ready	<none>	5d5h	v1.20.4

If a node is not `Ready`, verify whether the `kubelet` process is running. You can also use the system log of the node to investigate the issue.

To verify `kubelet`: `root@primary-node:/# kubelet`

View Pod Status

Use the `kubectl get po -n namespace` or `kubectl get po -A` command to view the status of a pod. You can specify an individual namespace (such as `healthbot`, `northstar`, and `common`) or you can use the `-A` parameter to view the status of all namespaces. For example:

```
root@primary-node:~# kubectl get po -n northstar
```

NAME	READY	STATUS	RESTARTS	AGE
bmp-854f8d4b58-4hwx4	3/3	Running	1	30h
dcscheduler-55d69d9645-m9ncf	1/1	Running	1	7h13m

The status of healthy pods must be `Running` or `Completed`, and the number of ready containers should match the total. If the status of a pod is not `Running` or if the number of containers does not match, use the `kubectl describe po` or `kubectl log (POD | TYPE/NAME) [-c CONTAINER]` command to troubleshoot the issue further.

View Detailed Information About a Pod

Use the `kubectl describe po -n namespace pod-name` command to view detailed information about a specific pod. For example:

```
root@primary-node:~# kubectl describe po -n northstar bmp-854f8d4b58-4hwx4
```

```
Name:          bmp-854f8d4b58-4hwx4
Namespace:     northstar
Priority:       0
Node:          10.49.xx.x1/10.49.xx.x1
Start Time:    Mon, 10 May 2021 07:11:17 -0700
Labels:        app=bmp
               northstar=bmp
               pod-template-hash=854f8d4b58
...

```

View the Logs for a Container in a Pod

Use the `kubectl logs -n namespace pod-name [-c container-name]` command to view the logs for a particular pod. If a pod has multiple containers, you must specify the container for which you want to view the logs. For example:

```
root@primary-node:~# kubectl logs -n common atom-db-0 | tail -3
```

```
2021-05-31 17:39:21.708 36 LOG {ticks: 0, maint: 0, retry: 0}
```


View Services

Use the `kubectl get svc -n namespace` or `kubectl get svc -A` command to view the cluster services. You can specify an individual namespace (such as `healthbot`, `northstar`, and `common`), or you can use the `-A` parameter to view the services for all namespaces. For example:

```
root@primary-node:~# kubectl get svc -A --sort-by spec.type
```

NAMESPACE	NAME	TYPE	EXTERNAL-IP	PORT(S)
...				
healthbot	tsdb-shim	LoadBalancer	10.54.xxx.x3	
				8086:32081/TCP
healthbot	ingest-snmp-proxy-udp	LoadBalancer	10.54.xxx.x3	162:32685/UDP
healthbot	hb-proxy-syslog-udp	LoadBalancer	10.54.xxx.x3	514:31535/UDP
ems	ztpservicedhcp	LoadBalancer	10.54.xxx.x3	67:30336/UDP
ambassador	ambassador	LoadBalancer	10.54.xxx.x2	80:32214/TCP, 443:31315/TCP, 7804:32529/TCP, 7000:30571/TCP
northstar	ns-pceserver	LoadBalancer	10.54.xxx.x4	4189:32629/TCP
...				

In this example, the services are sorted by type, and only services of type `LoadBalancer` are displayed. You can view the services that are provided by the cluster and the external IP addresses that are selected by the load balancer to access those services.

You can access these services from outside the cluster. The external IP address is exposed and accessible from devices outside the cluster.

Frequently Used `kubectl` Commands

- List the replication controllers:

```
# kubectl get -n namespace deploy
```

```
# kubectl get -n namespace statefulset
```

- Restart a component:

```
kubectl rollout restart -n namespace deploy deployment-name
```

- Edit a Kubernetes resource: You can edit a deployment or any Kubernetes API object, and these changes are saved to the cluster. However, if you reinstall the cluster, these changes are not preserved.

```
# kubectl edit -ti -n namespace deploy deployment-name
```

Troubleshoot Ceph and Rook

Ceph requires relatively newer Kernel versions. If your Linux kernel is very old, consider upgrading or reinstalling a new one.

Use this section to troubleshoot issues with Ceph and Rook.

Insufficient Disk Space

A common reason for installation failure is that the object storage daemons (OSDs) are not created. An OSD configures the storage on a cluster node. OSDs might not be created because of non-availability of disk resources, in the form of either insufficient resources or incorrectly partitioned disk space. Ensure that the nodes have sufficient unpartitioned disk space available.

Reformat a Disk

Examine the logs of the "rook-ceph-osd-prepare-hostname-*" jobs. The logs are descriptive. If you need to reformat the disk or partition, and restart Rook, perform the following steps:

1. Use one of the following methods to reformat an existing disk or partition.
 - If you have a block storage device that should have been used for Ceph, but wasn't used because it was in an unusable state, you can reformat the disk completely.

```
$ sgdisk -zap /dev/disk
$ dd if=/dev/zero of=/dev/disk bs=1M count=100
```

- If you have a disk partition that should have been used for Ceph, you can clear the data on the partition completely.

```
$ wipefs -a -f /dev/partition
$ dd if=/dev/zero of=/dev/partition bs=1M count=100
```

NOTE: These commands completely reformat the disk or partitions that you are using and you will lose all data on them.

2. Restart Rook to save the changes and reattempt the OSD creation process.

```
$ kubectl rollout restart deploy -n rook-ceph rook-ceph-operator
```

View Pod Status

To check the status of Rook and Ceph pods installed in the `rook-ceph` namespace, use the `# kubectl get po -n rook-ceph` command. The following pods must be in the running state.

- `rook-ceph-mon-*`—Typically, three monitor pods are created.
- `rook-ceph-mgr-*`—One manager pod
- `rook-ceph-osd-*`—Three or more OSD pods
- `rook-ceph-mds-cephfs-*`—Metadata servers
- `rook-ceph-rgw-object-store-*`—ObjectStore gateway
- `rook-ceph-tools*`—For additional debugging options.

To connect to the toolbox, use the command:

```
$ kubectl exec -ti -n rook-ceph $(kubectl get po -n rook-ceph -l app=rook-ceph-tools \ -o
jsonpath={..metadata.name}) -- bash
```

Some of the common commands you can use in the toolbox are:

```
# ceph status # ceph osd status, # ceph osd df, # ceph osd utilization, # ceph osd pool stats, # ceph osd
tree, and # ceph pg stat
```

Troubleshoot Ceph OSD failure

Check the status of pods installed in the rook-ceph namespace.

```
# kubectl get po -n rook-ceph
```

If a rook-ceph-osd-*number* pod is in the Error or CrashLoopBackoff state, then you must repair the disk.

1. Stop the rook-ceph-operator.

```
# kubectl scale deploy -n rook-ceph rook-ceph-operator --replicas=0
```

2. Remove the failing OSD processes.

```
# kubectl delete deploy -n rook-ceph rook-ceph-osd-number
```

3. Connect to the toolbox.

```
$ kubectl exec -ti -n rook-ceph $(kubectl get po -n rook-ceph -l app=rook-ceph-tools -o jsonpath={..metadata.name}) -- bash
```

4. Identify the failing OSD.

```
# ceph osd status
```

5. Mark out the failed OSD.

```
[root@rook-ceph-tools-/#]# ceph osd out 5
marked out osd.5.
[root@rook-ceph-tools-/#]# ceph osd status
```

ID	HOST	USED	AVAIL	WR OPS	WR DATA	RD OPS	RD DATA	STATE
0	10.xx.xx.210	4856M	75.2G	0	0	0	0	exists,up
1	10.xx.xx.215	2986M	77.0G	0	0	1	89	exists,up
2	10.xx.xx.98	3243M	76.8G	0	0	1	15	exists,up
3	10.xx.xx.195	4945M	75.1G	0	0	0	0	exists,up
4	10.xx.xx.170	5053M	75.0G	0	0	0	0	exists,up
5	10.xx.xx.197	0	0	0	0	0	0	exists

6. Remove the failed OSD.

```
# ceph osd purge number --yes-i-really-mean-it
```

7. Connect to the node that hosted the failed OSD and do one of the following:

- Replace the hard disk in case of a hardware failure.

- Reformat the disk completely.

```
$ sgdisk -zap /dev/disk
$ dd if=/dev/zero of=/dev/disk bs=1M count=100
```

- Reformat the partition completely.

```
$ wipefs -a -f /dev/partition
$ dd if=/dev/zero of=/dev/partition bs=1M count=100
```

8. Restart rook-ceph-operator.

```
# kubectl scale deploy -n rook-ceph rook-ceph-operator --replicas=1
```

9. Monitor the OSD pods.

```
# kubectl get po -n rook-ceph
```

If the OSD does not recover, use the same procedure to remove the OSD, and then remove the disk or delete the partition before restarting rook-ceph-operator.

For more information about Rook and Ceph, see <https://github.com/rook/rook/blob/master/Documentation/ceph-common-issues.md>.

Troubleshoot Air-Gap Installation Failure

The air-gap installation as well as the kube-apiserver fails with the following error because you do not have an existing `/etc/resolv.conf` file.

```
TASK [kubernetes/master : Activate etcd backup cronjob]
*****
fatal: [192.xx.xx.2]: FAILED! => changed=true
  cmd:
    - kubectl
    - apply
    - -f
    - /etc/kubernetes/etcd-backup.yaml
  delta: '0:00:00.197012'
  end: '2022-09-13 13:46:31.220256'
  msg: non-zero return code
```

```

rc: 1
start: '2022-09-13 13:46:31.023244'
stderr: The connection to the server 192.xx.xx.2:6443 was refused - did you specify the right
host or port?
stderr_lines: <omitted>
stdout: ''
stdout_lines: <omitted>

```

To create a new file, you must run the `#touch /etc/resolv.conf` command as the root user, and then redeploy the Paragon Automation cluster.

Recover from a RabbitMQ Cluster Failure

If your Paragon Automation cluster fails (for example, from a power outage), the RabbitMQ message bus may not restart properly.

To check for this condition, run the `kubectl get po -n northstar -l app=rabbitmq` command. This command should show three pods with their status as Running. For example:

```

$ kubectl get po -n northstar -l app=rabbitmq
NAME READY STATUS RESTARTS AGE
rabbitmq-0 1/1 Running 0 10m
rabbitmq-1 1/1 Running 0 10m
rabbitmq-2 1/1 Running 0 9m37s

```

However, if the status of one or more pods is Error, use the following recovery procedure:

1. Delete RabbitMQ.

```
kubectl delete po -n northstar -l app=rabbitmq
```

2. Check the status of the pods.

```
kubectl get po -n northstar -l app=rabbitmq.
```

Repeat `kubectl delete po -n northstar -l app=rabbitmq` until the status of all pods is Running.

3. Restart the Paragon Pathfinder applications.

```
kubectl rollout restart deploy -n northstar
```


Disable udevd Daemon During OSD Creation

You use the `udev` daemon for managing new hardware such as disks, network cards, and CDs. During the creation of OSDs, the `udev` daemon detects the OSDs and can lock them before they are fully initialized. The Paragon Automation installer disables `systemd-udev` during installation and enables it after Rook has initialized the OSDs.

When adding or replacing nodes and repairing failed nodes, you must manually disable the `udev` daemon so that OSD creation does not fail. You can reenable the daemon after the OSDs are created.

Use these commands to manually disable and enable `udev`.

1. Log in to the node that you want to add or repair.
2. Disable the `udev` daemon.
 - a. Check whether `udev` is running.


```
# systemctl is-active systemd-udev
```
 - b. If `udev` is active, disable it. `# systemctl mask system-udev --now`
3. When you repair or replace a node, the Ceph distributed filesystems are not automatically updated. If the data disks are destroyed as part of the repair process, then you must recover the object storage daemons (OSDs) hosted on those data disks.
 - a. Connect to the Ceph toolbox and view the status of OSDs. The `ceph-tools` script is installed on a primary node. You can log in to the primary node and use the `kubectl` interface to access `ceph-tools`. To use a node other than the primary node, you must copy the **admin.conf** file (in the **config-dir** directory on the control host) and set the `kubeconfig` environment variable or use the `export KUBECONFIG=config-dir/admin.conf` command.


```
$ ceph-tools# ceph osd status
```
 - b. Verify that all OSDs are listed as `exists,up`. If OSDs are damaged, follow the troubleshooting instructions explained in ["Troubleshoot Ceph and Rook" on page 221](#).
4. Log in to node that you added or repaired after verifying that all OSDs are created.
5. Reenable `udev` on the node.

```
systemctl unmask system-udev
```

Alternatively, you can set `disable_udev: true` in the **config.yml** and run the `./run -c config-dir deploy` command. We do not recommend that you redeploy the cluster only to disable the `udev` daemon.

Wrapper Scripts for Common Utility Commands

You can use the following wrapper scripts installed in `/usr/local/bin` to connect to and run commands on pods running in the system.

Command	Description
<code>paragon-db [arguments]</code>	Connect to the database server and start the Postgres SQL shell using the superuser account. Optional arguments are passed to the Postgres SQL command.
<code>pf-cmgd [arguments]</code>	Start the CLI in the Paragon Pathfinder CMGD pod. Optional arguments are executed by the CLI.
<code>pf-crpd [arguments]</code>	Start the CLI in the Paragon Pathfinder CRPD pod. Optional arguments are executed by the CLI.
<code>pf-redis [arguments]</code>	Start the (authenticated) redis-cli in the Paragon Pathfinder Redis pod. Optional arguments are executed by the Redis pod.
<code>pf-debugutils [arguments]</code>	Start the shell in the Paragon Pathfinder debugutils pod. Optional arguments are executed by the shell. Pathfinder debugutils utilities are installed if <code>install_northstar_debugutils: true</code> is configured in the <code>config.yml</code> file.
<code>ceph-tools [arguments]</code>	Start the shell to the Ceph toolbox. Optional arguments are executed by the shell.

Back Up the Control Host

If your control host fails, you must back up the ***config-dir*** directory to a remote location to be able to rebuild your cluster. The ***config-dir*** contains the **inventory**, **config.yml**, and **id_rsa** files.

Alternatively, you can also rebuild the **inventory** and **config.yml** files by downloading information from the cluster using the following commands:

```
# kubectl get cm -n common metadata -o jsonpath={..inventory} > inventory
```

```
# kubectl get cm -n common metadata -o jsonpath={..config.yml} > config.yml
```

You cannot recover SSH keys; you must replace failed keys with new keys.

User Service Accounts for Debugging

Paragon Pathfinder, telemetry manager, and base platform applications internally use Paragon Insights for telemetry collection. To debug configuration issues associated with these applications, three user service accounts are created, by default, during Paragon Automation installation. The scope of these service accounts is limited to debugging the corresponding application only. The service accounts details are listed in the following table.

Table 19: Service Account Details

Application Name and Scope	Account Username	Account Default Password
Paragon Pathfinder (northstar)	hb-northstar-admin	Admin123!
Telemetry manager (tm)	hb-tm-admin	
Base platform (ems-dmon)	hb-ems-dmon	

You must use these accounts solely for debugging purposes. Do not use these accounts for day-to-day operations or for modifying any configuration. We recommend that you change the login credentials for security reasons.

RELATED DOCUMENTATION

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[Install Multinode Cluster on Ubuntu | 36](#)

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9

CHAPTER

Migrate Data

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Migrate Data from NorthStar to Paragon Automation

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You can migrate DeviceProfile, Cassandra DB, and Analytics (ES DB) data from an existing NorthStar Release 6.x setup to a Paragon Automation Release 21.3 setup.

Use the steps described in this topic to migrate data from NorthStar to Paragon Automation.

Prerequisites

- Ensure that both the NorthStar and Paragon Automation setups are up and running.
- Cassandra must be accessible from Paragon Automation. Set the `rpc_address` parameter in the `/opt/northstar/data/apache-cassandra/conf/cassandra.yaml` path to an address to which the Paragon Automation setup can connect. After setting the address, restart Cassandra for the configuration changes to take effect:

```
root@ns1: # supervisorctl restart infra:cassandra
```

- Ensure that both NorthStar and Paragon Automation have sufficient disk space to migrate the Cassandra DB. The Cassandra migration exports all data to CSV files and sufficient space must be available for the migration operation. To ensure that sufficient space is available:

1. Log in to NorthStar and check the current disk usage by Cassandra. For a multisite setup, issue the following command on all nodes in the setup and add them to calculate total disk usage:

```
[root@ns1-site1 ~]# du -sh /opt/northstar/data/apache-cassandra/
404M    /opt/northstar/data/apache-cassandra/    <--- Disk space used by Cassandra
```

2. Ensure that the available disk space on both NorthStar and Paragon exceeds the total Cassandra disk usage by at least a factor of 2. For Paragon Automation, this amount of space must be available on every node that has scheduling enabled on the device used for the **/var/local** directory. For NorthStar, only the node from which data is exported must have the available disk space.

For example, on a Paragon Automation node that has a large root partition '/' without an optional partition for '/var/local':

```
root@pa-master:~# df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            11G   0    11G   0% /dev
tmpfs           2.2G  32M   2.1G   2% /run
/dev/sda3       150G  33G   110G  24% /
tmpfs           11G   0    11G   0% /dev/shm
...
```

<--- Available space for /var/local

See ["Disk Requirements" on page 14](#) for more information on partition options.

On NorthStar:

```
[root@ns1-site1 ~]# df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/sda1       108G  9.6G   99G   9% /
devtmpfs        7.6G   0    7.6G   0% /dev
tmpfs           7.6G  12K   7.6G   1% /dev/shm
tmpfs           7.6G  25M   7.6G   1% /run
```

<--- Available space

Follow this procedure to migrate data from NorthStar to Paragon Automation.

Create the nsmigration Task Pod

1. Log in to the Paragon Automation primary node.
2. Create the nsmigration task pod.

```
root@pa-primary: # kubectl apply -f /etc/kubernetes/po/nsmigration/kube-cfg.yml
job.batch/nsmigration created
```

3. Log in to the nsmigration task pod.

```
root@pa-primary:~# kubectl exec -it $(kubectl get po -n northstar -l app=nsmigration -o
jsonpath={..metadata.name}) -c nsmigration -n northstar -- bash
root@nsmigration-fcvl6:/# cd /opt/northstar/util/db/nsmigration
```

Export Cassandra DB Data to CSV Files

For the migration procedure, you must export the contents of the Cassandra database in NorthStar to CSV files and copy those files to Paragon Automation.

1. Copy the **opt/northstar/thirdparty/dsbulk-1.8.0.tar.gz** file and **/opt/northstar/util/db/export_csv/cass_dsbulk_export_csv.py** from the nsmigration container in Paragon Automation to the target NorthStar installation:

Copy the files locally to the current node:

```
root@pa-master:~# mkdir migration_files && cd migration_files
root@pa-master:~/migration_files# kubectl cp northstar/$(kubectl get po -n northstar -l
app=nsmigration -o jsonpath={..metadata.name}):/opt/northstar/thirdparty/
dsbulk-1.8.0.tar.gz ./dsbulk-1.8.0.tar.gz
root@pa-master:~/migration_files# kubectl cp northstar/$(kubectl get po -n northstar -l
app=nsmigration -o jsonpath={..metadata.name}):/opt/northstar/util/db/export_csv/
cass_dsbulk_export_csv.py ./cass_dsbulk_export_csv.py
```

Copy the files to the target NorthStar installation.

```
root@pa-master:~# scp -r migration_files root@${northstar_host}:/root/
```

2. Log in to the NorthStar instance, and install the migration utils by extracting the **dsbulk-1.8.0.tar.gz** file,

```
[root@ns1-site1 migration_files]# tar -xf dsbulk-1.8.0.tar.gz
```

3. Export the contents of the Cassandra database to CSV files by running the **cass_dsbulk_export_csv.py** script. The **--skip-historical-data** option can be passed to this script to skip the export of historical event date. For more information, see [Table 20 on page 233](#).

Source the NorthStar environment file.

```
[root@ns1-site1 migration_files]# source /opt/northstar/northstar.env
```

Run the export script.

```
[root@ns1-site1 migration_files]# python3 cass_dsbulk_export_csv.py --dsbulk=$PWD/
dsbulk-1.8.0/bin/dsbulk
```

Table 20: Historical Event Data Tables

keyspace	table
taskscheduler	taskstatus
pcs	topology, lsp_topo, lsp_link, ntad, messages, pcs_lsp_event, link_event, node_event
pcs_provision	provision

Running the script exports the contents of the Cassandra database (according to **db_schema.json**) to the **export_csv** folder in the current working directory. The script pipes the progress output from the dsbulk invocations to stdout. Each table has its own sub-directory with one or more CSV files. The procedure may take a long time for larger databases.

```
[root@ns1-site1 migration_files]# python3 cass_dsbulk_export_csv.py --dsbulk=$PWD/
dsbulk-1.8.0/bin/dsbulk
2021-11-22 23:12:36,908: INFO: ns_dsbulk_export: Exporting NorthStarML0:Default (page size
500)
2021-11-22 23:12:39,232: INFO: ns_dsbulk_export: Operation directory: /root/dsbulk/logs/
UNLOAD_20211122-231239-029958
```



```

2021-11-22 23:12:43,580: INFO: ns_dsbulk_export: total | failed | rows/s | p50ms | p99ms |
p999ms
2021-11-22 23:12:43,580: INFO: ns_dsbulk_export:      1 |      0 |      2 | 8.18 | 8.19 |
8.19
2021-11-22 23:12:43,581: INFO: ns_dsbulk_export: Operation UNLOAD_20211122-231239-029958
completed successfully in less than one second.
...
2021-11-22 23:14:22,886: INFO: ns_dsbulk_export: Exporting pcs:links (page size 500)
2021-11-22 23:14:24,891: INFO: ns_dsbulk_export: Operation directory: /root/dsbulk/logs/
UNLOAD_20211122-231424-683902
2021-11-22 23:14:28,863: INFO: ns_dsbulk_export: total | failed | rows/s | p50ms | p99ms |
p999ms
2021-11-22 23:14:28,863: INFO: ns_dsbulk_export:     16 |      0 |     29 | 6.08 | 6.09 |
6.09
2021-11-22 23:14:28,863: INFO: ns_dsbulk_export: Operation UNLOAD_20211122-231424-683902
completed successfully in less than one second
...
[root@ns1-site1 migration_files]# ls -l export_csv/
total 0
drwxr-xr-x. 2 root root  6 Nov 22 23:20 anycastgroup-anycastgroupIndex
drwxr-xr-x. 2 root root  6 Nov 22 23:20 cmgd-configuration
drwxr-xr-x. 2 root root  6 Nov 22 23:19 device_config-configlets
drwxr-xr-x. 2 root root  6 Nov 22 23:19 device_config-configlets_workorder
...
[root@ns1-site1 migration_files]# ls -l export_csv/pcs-links
total 16
-rw-r--r--. 1 root root 14685 Nov 22 23:14 pcs-links-000001.csv

```

NOTE: The exported CSV files also serve as a backup of the Cassandra DB data. We recommend archiving the files in case data needs to be restored in the future.

4. Copy the **export_csv** folder to the Paragon Automation node where the `nsmigration` pod is running.

```

root@pa-master:~# kubectl get po -n northstar -l app=nsmigration -o jsonpath={..spec.nodeName}
10.52.44.210
node

```

<--- In this example, this is the *worker3*

Copy the exported files to the correct directory on *worker3* node.

```
root@pa-worker3:~# cd /var/local/ns_db_migration/ && scp -r root@[northstar_ip]:/root/
migration_files/export_csv .
```

Migrate DeviceProfile and Cassandra DB

1. Run the `ns_data_migration.py -a -sp -dp` script from the `nsmigration` task pod. The complete command syntax is `./ns_data_migration.py -a ns-app-server-ip -su root -sp ns-app-user-ssh-password -dh cassandra-db-host -du cassandra -dp cassandra-password -dcsv /opt/northstar/ns_db_migration/export_csv -pu postgres-user -pp postgres-password -ph postgres-host -po postgres-port -pah vip-of-ingress-controller-or-hostname-of-main-web-application -pau paragon-web-ui-login -pap paragon-web-ui-password -dr 1`.

For example:

```
root@nsmigration-7xbbz:/opt/northstar/util/db/nsmigration# ./ns_data_migration.py -a
10.xx.xx.200 -su root -sp password -dh 10.xx.xx.200 -dp password -dcsv /opt/northstar/
ns_db_migration/export_csv -pu northstar -pp BB91qaDCfjpGWPbjEZBV -ph atom-db.common -po 5432
-pah 10.xx.xx.11 -pau admin -pap password1 -dr 1
Logs stored at /opt/northstar/util/db/nsmigration/logs/nsdatamigration.log
Cassandra connection established...connection attempt: 1
Testing cassandra connectivity
Connected to cluster Test Cluster
Testing EMS connectivity
scope_id: d3ae39f7-35c6-49dd-a1bd-c509a38bd4ea, auth_token length: 1160
scoped token length: 1303
jwt_token length: 40974
All connection ok starting migration
Starting device profile migration...
Found 2 devices in Northstar device profile

...
2022-04-26 20:57:01,976:INFO:Loading health_monitor-health_history-000001.csv (~ 5 rows)
2022-04-26 20:57:01,996:INFO:Loaded 5/~5 rows
2022-04-26 20:57:01,996:INFO:Copying csv data for table health_monitor:thresholds
2022-04-26 20:57:01,997:INFO:Using batch size 500
2022-04-26 20:57:02,001:INFO:Loading health_monitor-thresholds-000001.csv (~ 1 rows)
2022-04-26 20:57:02,003:INFO:Loaded 1/~1 rows
2022-04-26 20:57:02,004:INFO:Copying csv data for table planner:networkdata
```

```

2022-04-26 20:57:02,005:INFO:Using batch size 20
2022-04-26 20:57:02,008:INFO:Loading planner-networkdata-000001.csv (~ 1 rows)
2022-04-26 20:57:02,071:INFO:Loaded 1/~1 rows
...
The NS data migration completed

```

You must specify the following parameters while running the `ns_data_migration.py` script.

- `-a APP, --app APP`—IP address or hostname of the application server
- `-su SSHUSER, --sshuser SSHUSER`—SSH username (default is root)
- `-sp SSHPASS, --sshpass SSHPASS`—SSH password
- `-so SSHPORT, --sshport SSHPORT`—SSH port (default is 22)
- `-du DBUSER, --dbuser DBUSER`—Cassandra DB username (default is cassandra)
- `-dp DBPASS, --dbpass DBPASS`—Cassandra DB password
- `-do DBPORT, --dbport DBPORT`—Cassandra DB port (default is 9042)
- `-dh DBHOST, --dbhost DBHOST`—Comma-separated host IP addresses of Cassandra DB
- `-pu PGUSER, --pguser PGUSER`—Postgres DB username (default is northstar)
- `-dcsv DBCSV, --dbCsvPath DBCSV`—The path with CSV data exported from Cassandra
- `-pp PGPASS, --pgpass PGPASS`—Postgres DB password
- `-ph PGHOST, --pghost PGHOST`—Postgres DB host (default is atom-db.common)
- `-po PGPORT, --pgport PGPORT`—Postgres DB port (default is 5432)
- `-pah PARAGONHOST, --paragonHost PARAGONHOST`—Virtual IP (VIP) address of Paragon Automation Web UI
- `-pau PARAGONUSER, --paragonUser PARAGONUSER`—Paragon Automation Web UI username
- `-pap PARAGONPASSWORD, --paragonPassword PARAGONPASSWORD`—Paragon Automation Web UI user password
- `-dr DISCOVERYRETRIES, --discoveryRetries DISCOVERYRETRIES`—Device discovery retries (default is 2).

You use the `dr DISCOVERYRETRIES` option for DeviceProfile migration when Paragon Automation fails to discover devices at the first attempt. There are multiple reasons for discovery failure, such as devices not being reachable or device credentials being incorrect. Despite discovery failure for devices with incorrect information, Paragon Automation discovers devices with correct information. Partial failure for a subset of devices while discovering multiple devices at a time is possible. To determine the exact reason of failure, see the **Monitoring > Jobs** page in the Paragon Automation Web UI.

If the `dr` option is set to more than 1, on getting a discovery failure, the `ns_data_migration.py` script retries the discovery for all the devices. This attempt does not impact the devices that are already discovered. However, the chances of successfully discovering devices in subsequent attempts for any failed device discovery is minimal. We recommend that you set the maximum value for the `dr` option to 2, which is the default value. If there are too many devices in the network, then use a value of 1 to avoid unnecessary retries.

NOTE: When migrating Cassandra DB data from NorthStar to Paragon Automation, large tables with millions of rows might cause the migration to proceed very slowly and take a long time. Often these large tables contain historical event data that you can discard during migration. To skip migrating this data, you can manually set the `--dbSkipHistoricalData` flag while calling the `'ns_data_migration.py'` script. This means that the data in the historical event tables listed in [Table 20 on page 233](#) is not available in Paragon Automation. This data is permanently lost if not backed up once the NorthStar instance is removed.

2. Verify the DeviceProfile data.

Log in to Paragon Automation Web UI and navigate to **Configuration > Device**. Verify that all the devices are discovered and present. Also, verify that the configuration information is the same as that in the NorthStar device profile.

To view the device discovery result, go to the **Monitoring > Jobs** page in the Paragon Automation Web UI.

3. Verify Cassandra DB data.

The log output of the `ns_data_migration.py` script indicates whether there were any problems migrating data from Cassandra. You can also run a script to verify the data in Paragon Automation against the exported CSV files. Note, this may take a long time for larger databases. From the `nsmigration` container, run:

```
root@nsmigration-h7b9m:~# python3 /opt/northstar/util/db/dbinit.py --schema=/opt/northstar/
util/db/db_schema.json --host=$PG_HOST --port=$PG_PORT --user=$PG_USER --password=$PG_PASS --
dbtype=postgres --check-schema-version --from-cassandra-csv=/opt/northstar/ns_db_migration/
export_csv --verify-data --log-level=DEBUG 2>&1 | tee debug_migration.log
...
2022-04-26 21:11:12,466:INFO:Loading health_monitor-health_history-000001.csv (~ 5 rows)
2022-04-26 21:11:12,484:INFO:Loaded 5/~5 rows
2022-04-26 21:11:12,484:INFO:Verify stats health_monitor:health_history: Verified 5/5
2022-04-26 21:11:12,484:INFO:Copying csv data for table health_monitor:thresholds
2022-04-26 21:11:12,484:INFO:Using batch size 500
2022-04-26 21:11:12,489:INFO:Loading health_monitor-thresholds-000001.csv (~ 1 rows)
2022-04-26 21:11:12,491:INFO:Loaded 1/~1 rows
2022-04-26 21:11:12,491:INFO:Verify stats health_monitor:thresholds: Verified 1/1
```

```

2022-04-26 21:11:12,491:INFO:Copying csv data for table planner:networkdata
2022-04-26 21:11:12,491:INFO:Using batch size 20
2022-04-26 21:11:12,496:INFO:Loading planner-networkdata-000001.csv (~ 1 rows)
2022-04-26 21:11:12,532:INFO:Loaded 1/~1 rows
2022-04-26 21:11:12,533:INFO:Verify stats planner:networkdata: Verified 1/1

```

The script outputs (rows verified)/(rows checked) in each table (see lines beginning with "Verify") to stdout and debug_migration.log. Note that some rows may have been updated after the data was imported but before it was verified, so 'rows verified' may not always equal 'rows checked'. The exported CSV files can be removed once the migration is complete by simply removing the `/var/local/ns_db_migration/export_csv` directory on the relevant node.

(Optional) Migrate Analytics Data

If you have installed Analytics, perform the following steps to migrate analytics data from NorthStar ES DB to Paragon Automation Influx DB:

1. Log in to the nsmigration task pod, and run the `import_es_data.py -a` script.

```

root@nsmigration-p7tcd:/# cd /opt/northstar/util/db/nsmigration
root@nsmigration-p7tcd:/opt/northstar/util/db/nsmigration# ./import_es_data.py -a 10.xx.xx.95
Logs stored at /opt/northstar/util/db/nsmigration/logs/es_data_migration.log
Certs are missing, fetching them from Northstar app server
Please enter SSH password:
Testing Elasticsearch connectivity
Elasticsearch DB connection ok
Testing Influx DB connectivity
Influx DB connection ok
Starting data extraction for type= interface

<OUTPUT SNIPPED>

  "migration_rate_sec": 1471.1758360302051,
  "timetaken_min": 0.7725,
  "total_points": 68189
}
ETLWorker-2 completed, total points=68189 in 0.7725 minutes with
migration_rate=1471.1758360302051

```

You must specify the following `import_es_data.py` script options:

2. Verify Influx DB data using the following commands.

- To query all tunnel traffic data for the last 30 days in Influx DB, run the `/opt/pcs/bin/getTrafficFiles.py` script inside the `dcscheduler` pod:

[illegible]

```

vmx102:Silver-102-101 A2Z 0 1071913 1072869 1073082 1073378 1073436 1073378 1073620
1073378 1073388 1073484 1073896 1074086 1073974 1073795 1073378 1073590 1073790 1074498
1074595 1074498 1074092 1076565 1076565 1076919 1075502 1075857 1075325 1075148 -1 -1
vmx102:Silver-102-103 A2Z 0 2118101 2120705 2121258 2120438 2120773 2119652 2121258
2120296 2120190 2120962 2121364 2121867 2121817 2122209 2120167 2120323 2121665 2122733
2122685 2122321 2121511 2121855 2119546 2119700 2109572 2102489 2101604 2121258 2109749
2110280
vmx102:Silver-102-104 A2Z 0 3442749 3449550 3450757 3448983 3448603 3446081 3453525
3451513 3448142 3449008 3450874 3452721 3451650 3450733 3447297 3447147 3449132 3451747
3450887 3450727 3448429 3452310 3448132 3447328 3200657 3200480 3197646 3445363 3215530
3215884
vmx103:Silver-103-101 A2Z 0 2149705 2151625 2158319 2170251 2170980 2171171 2169252
2167757 2168518 2172730 2168582 2166350 2161904 2161460 2167162 2158050 2160413 2166131
2167033 2166226 2165632 2171717 2178973 2178102 2158015 2158015 2157661 2157306 -1 -1
vmx103:Silver-103-102 A2Z 0 2122922 2125508 2131074 2141411 2142899 2141840 2139937
2138338 2139743 2144156 2139602 2138745 2134561 2132725 2137973 2129397 2132755 2138203
2138653 2136713 2135444 2144637 2150006 2147677 2108332 2107801 2107270 2124800 2112228
2113113
vmx103:Silver-103-104 A2Z 0 3426540 3437589 3447876 3461550 3464308 3461249 3460710
3453848 3458821 3463446 3456119 3456969 3450036 3446943 3451602 3439059 3445325 3455444
3455491 3454308 3449833 3468558 3472376 3470223 3185429 3187731 3183304 3430135 3198001
3202781
vmx104:Silver-104-102 A2Z 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
vmx104:Silver-104-103 A2Z 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
vmx105:rsvp-105-106 A2Z 0 114 114 121 116 122 125 125 114 214 224 215 223 213 223 222 226
222 217 213 214 216 219 218 219 202 202 202 211 204 202

```

- To query all egress interface traffic data for the last 30 days in Influx DB, run the `/opt/pcs/bin/getTrafficFiles.py` script inside the `dcscheduler` pod:

```

root@pa-primary:~# kubectl exec -it $(kubectl get po -n northstar -l app=dcscheduler -o
jsonpath={..metadata.name}) -c dcscheduler -n northstar -- /opt/pcs/bin/
getTrafficFiles.py -t interface_out -i 1d -b 30
#Starting Time : 08/17/21 12:00:00 AM
#Interval : 24 hour
# UNIT = 1

# Aggregation:
#   - Series: time series
#   - Statistic: 95th percentile
#   - Interval: 1 day
# Report Date= 2021-09-16 (Thu) 08:49

```

```

vmx101 ge-0/0/8.0 A2Z 0 2620 2620 2621 2621 2621 2621 2622 2622 2623 2624 2626 2627 2627
2627 2627 2627 2627 2627 2627 2628 2631 2631 2632 2632 0 0 0 2632 -1 -1
vmx101 ge-0/0/5 A2Z 0 843 846 848 860 843 858 863 866 1001 1012 1012 1018 1011 1048 1018
1048 1027 1013 1025 1017 1010 1046 1046 1048 1053 1055 1073 1045 -1 -1
...
...
...
vmx107 ge-0/0/8.0 A2Z 0 2620 2621 2622 2622 2623 2624 2626 2626 2630 2631 2632 2632 2632
2632 2632 2632 2633 2633 2635 2635 2635 2635 2636 2636 0 0 0 2636 0 0
vmx107 ge-0/1/9.0 A2Z 0 6888955 6907022 6907653 6902645 6899706 6892876 6905804 6902894
6899395 6897851 6897322 6896863 6900351 6898745 6890080 6889337 6896781 6902034 6899116
6898749 6898630 6903136 6889662 6890800 6401393 6410976 6400867 6885900 6431500 6436156
vmx107 ge-0/0/5 A2Z 0 4290428 4296767 4297691 4295393 4292480 4290593 4293842 4293149
4295279 4294504 4294045 4294905 4294996 4294921 4292093 4292703 4295408 4297494 4296424
4295983 4295972 4296808 4294929 4299425 4285605 4286205 4285146 4288390 2126258 2127510
vmx107 ge-0/0/6 A2Z 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 122 122 122 122 122 122
122 122 122
vmx107 ge-0/0/7 A2Z 0 878 874 915 898 886 879 897 889 1028 1021 1022 1023 1055 1079 1077
1097 1094 1092 1044 1007 1028 1062 1065 1057 1094 1075 1071 1102 1082 1054
vmx107 ge-0/0/8 A2Z 0 2921 2925 2925 2924 2925 2926 2928 2928 2930 2934 2934 2936 2934
2935 2935 2934 2935 2936 2939 2938 2938 19892 20581 20965 20582 21076 20376 21578 23252
21312
vmx107 ge-0/1/8 A2Z 0 2127443 2130145 2130846 2128792 2128138 2127177 2128628 2128331
2128820 2128716 2128916 2129022 2129380 2128995 2127648 2127240 2128885 2130132 2130474
2130345 2129410 2129376 2125952 2125957 2117061 2114139 2119148 2126518 2122808 2121792
vmx107 ge-0/1/9 A2Z 0 6889737 6907821 6908350 6903585 6900486 6893779 6906516 6903747
6900412 6898908 6898427 6897892 6901325 6899809 6891078 6890377 6897822 6903099 6900152
6899763 6899726 6904248 6890745 6891782 6402507 6412083 6401924 6884168 6432556 6437280

```

(Optional) Migrate NorthStar Planner Data

If you want to use saved NorthStar Planner models on the NorthStar application server file system in Paragon Automation, copy the models using the following steps:

1. Log in to the NorthStar server.

2. Use `scp` and copy the directory (`/opt/northstar/data/specs`) where your Planner models are saved to the Paragon Automation primary node (`/root/ns_specs`). For example:

```
[root@ns1-site1 specs]# ls -l /opt/northstar/data/specs
total 8
drwx----- 2 root root 4096 Sep 16 08:18 network1
drwx----- 2 root root 4096 Sep 16 08:18 sample_fish

[root@ns1-site1 data]#
[root@ns1-site1 ~]# scp -r /opt/northstar/data/specs root@10.xx.xx.153:/root/ns_specs
The authenticity of host '10.xx.xx.153 (10.xx.xx.153)' can't be established.
ECDSA key fingerprint is SHA256:haylHqFfEuIEm8xThKbHJhG2uuTpT2xBpC2GZdzfZss.
ECDSA key fingerprint is MD5:15:71:76:c7:d2:2b:0d:fe:ff:0d:5f:62:7f:52:80:fe.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '10.xx.xx.153' (ECDSA) to the list of known hosts.
bblink.x
          100% 3893    2.2MB/s   00:00
bgplink.x
          100%  140    9.6KB/s   00:00
bgpnode.x
          100%  120   56.5KB/s   00:00
bgpobj.x
          100% 4888    1.8MB/s   00:00
cosalias.x
          100%  385   180.4KB/s   00:00
custrate.x
          100% 1062   184.0KB/s   00:00
demand.x
          100% 104KB    2.1MB/s   00:00
dparam.x
          100%  11KB    2.5MB/s   00:00
...
```

3. Log in to the Paragon Automation primary node.
4. Copy the `/root/ns_specs` folder to the NorthStar Planner pod at `/opt/northstar/data/specs` using the `kubect1` command. For example:

```
root@pa-primary:~# ls -l /root/ns_specs
total 8
drwx----- 4 root root 4096 Sep 16 01:41 network1
```

```
drwx----- 4 root root 4096 Sep 16 01:41 sample_fish
```

```
root@pa-primary:~# kubectl cp /root/ns_specs northstar/$(kubectl get po -n northstar -l
app=ns-web-planner -o jsonpath={..metadata.name}):/opt/northstar/data/specs -c ns-web-planner
```

5. Verify that the NorthStar Planner models are copied inside the NorthStar Planner pod at **/opt/northstar/data/specs/ns_specs**.

```
root@pa-primary:~/ns_specs# kubectl exec -it $(kubectl get po -n northstar -l app=ns-web-
planner -o jsonpath={..metadata.name}) -c ns-web-planner -n northstar -- ls -l /opt/northstar/
data/specs/ns_specs
total 8
drwx----- 2 root root 4096 Sep 16 08:18 network1
drwx----- 2 root root 4096 Sep 16 08:18 sample_fish
```

RELATED DOCUMENTATION

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