JUNIPER NETWORKS | Engineering Simplicity

# Address Pool Manager User Guide

Published
2025-11-04

RELEASE

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# Introduction to Address Pool Manager

**SUMMARY**

Use this guide to configure and manage Address Pool Manager.

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## Introduction to Address Pool Manager

**IN THIS SECTION**



Juniper Address Pool Manager (APM) is a cloud-native, container-based application running on a Kubernetes cluster that manages IPv4 address pools in a network. It automatically provisions prefixes from a centralized address pool to broadband network gateways (BNGs) before the BNGs deplete their address pools. The BNGs add the supplied prefixes from APM as new pools to a linked address pool. A linked address pool and the pool's associated attributes (utilization, threshold, and so on) is called a *pool domain*.

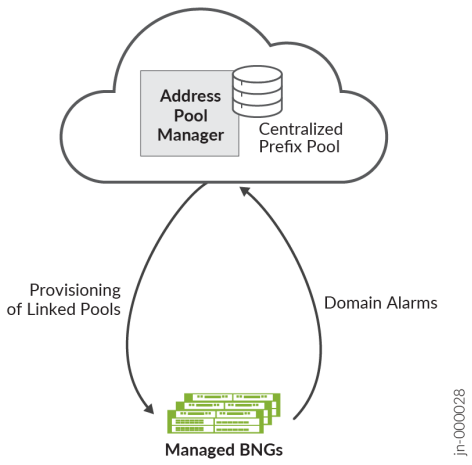
BNG constantly monitors the domain’s free addresses against the domain's thresholds as follows:

- BNG sends an alarm to APM requesting additional addresses when the number of free addresses in the domain reaches or drops below the domain's apportion-threshold.
- APM allocates the requested number of pool prefixes matching the requested prefix length and returns the addresses in the alarm response.
- When the number of free addresses in the domain reaches or exceeds the domain's reclaim-threshold, the BNG selects a pool prefix to remove. It also raises an alarm to APM requesting reclamation.
- APM responds to the reclamation alarm by instructing the BNG to place an active-drain on the pool. Once the pool has completely drained (no allocated addresses), the BNG raises a pool-drained alarm.
- APM informs the BNG that the prefix is returned to the domain's source partition and that the BNG can safely remove the pool prefix from the domain.
- The reclaimed prefix is now available for another BNG to request.

**NOTE**: The term BNG in this document also applies to the BNG CUPS Controller.

Figure 1 on page 2 shows a high-level view of APM operations to monitor BNGs and provision them with the addresses they need, when they need them.

**Figure 1: Basic APM Operations**




APM provides an address management solution that helps network operators efficiently allocate IPv4 addresses. Typical address allocation schemes are complex and not as efficient as network operators need. Providers typically preprovision addresses on network devices to handle the worst-case load in an

attempt to prevent devices from running out of addresses. This means that the devices are over-provisioned for most of their operating time.

APM does not pre-provision addresses, because the addresses might never be needed and could be used elsewhere. Instead of preprovisioning, APM allocates prefixes only when the BNG needs them. Specific network considerations that can affect the timely and efficient allocation of addresses include:

- Number of network devices that consume addresses
- Presence of VPNs
- System redundancy schemes
- Geographic distribution of network elements

APM reclaims prefixes to continually adjust the distribution of prefixes and to maximize address space utilization. Prefix reclamation occurs on APM, whereas address reclamation occurs on the BNG. Prefix reclamation happens when the BNG has a surplus of IP addresses. The BNG sends a reclaim alarm to APM with a suggested pool prefix to reclaim. APM initiates a drain request on the pool to ensure that the pool is free of any address allocations before APM reclaims the pool prefix. APM can then reallocate the prefixes to other pools among its managed BNGs when those BNGs near address exhaustion and need more addresses.

## Benefits of Address Pool Manager

- Efficiency—Improves the efficiency of address utilization. APM centralizes and automates address allocation for multiple BNGs in the network. APM uses just-in-time prefix allocation, so that it provisions prefixes only when a BNG needs additional IP addresses.

  APM provisions only as many prefixes as the BNG needs. After you partition the APM global pool into groups of prefixes, APM further subdivides the prefixes to match the BNG's request. This subdivision enables APM to optimize the size of the prefixes that it allocates.

- Simplicity—Avoids the overhead and complexity of manual monitoring and provisioning individual BNGs.
- Deployability—Installs and operates on any hardware that meets the requirements.
- Reclaimability—Reclaims the unused prefixes from pools that are using few IP addresses to a central pool and redistributes those prefixes to other pools that need them.

## Addressing Terminology

You should have a good understanding of IP addressing, classless inter-domain routing (CIDR), variable-length subnet masks (VLSMs), and how to subdivide IP prefixes into subnetworks (subnets). When you devise your addressing strategy (outside the scope of this documentation) or use manual address

reclamation, you might find it helpful to see an IP subnet calculator. You can find many such calculators online.

We use the following terminology in this documentation:

- Prefix—A 32-bit IPv4 network address and prefix length expressed using CIDR notation; for example, 198.51.100.0/24. A prefix defines the network portion of an IP address. A prefix represents a subnetwork.
- Prefix length—The number of bits that determines the length of the prefix and the size of the network portion of an IP address. A /24 prefix length means that the network portion of the address is 24 bits long. The remaining bits (out of 32) represent the host portion of a network address. For a prefix with a /24 prefix length, the host portion is 8 bits: 32 – 24 = 8.
- Network size—This term is sometimes used to mean several different things depending on the context, which can lead to ambiguity. We describe the prefix length and how it corresponds to the number of host addresses in subnetworks as follows:
  - A longer prefix, determined by a longer prefix length, corresponds to more subnetworks with fewer host addresses to allocate per subnetwork.
  - A shorter prefix, determined by a shorter prefix length, corresponds to fewer subnetworks with more host addresses to allocate per subnetwork.
- Free addresses are IP addresses that are available and have not been assigned to subscribers.

## How APM Works

APM maintains a centralized collection of IP prefixes for a group of BNGs in the network. The APM CLI refers to the managed BNGs as entities. This document generally uses the term *BNG*, but in some cases this document uses the term *entity*.

APM coordinates the creation of pool domains with the BNG. Each pool domain corresponds to a linked address pool for a given routing instance combination on the BNG. Also, on a BNG CUPS Controller, a pool domain corresponds to a linked address pool for a given subscriber group and routing instance combination. As pool domains are created dynamically, both the BNG and APM maintain profiles or templates containing attributes necessary to instantiate a pool domain. The APM profile contains attributes such as apportion, reclamation thresholds, and auto-reclamation behavior. The BNG. profile contains attributes such as prefix size and discard route installation behavior.

APMi version 1 (compatible with Junos OS Release 22.1R1 and later). You can check the APMi version by running the "show apm entity" on page 64 command.

### Thresholds and Alarms

The BNG creates the pool domain and monitors the number of free addresses in the pool domain. When the number of free addresses crosses a threshold value, the BNG sends an alarm message to APM. The BNG monitors the number of free addresses against the following thresholds:

- Apportion threshold—When the number of free addresses reaches or falls below this value, the BNG runs the risk of running out of addresses. The BNG sends an apportion alarm to APM requesting more addresses. APM selects an available prefix to apportion and allocates the prefix to the BNG, BNG adds one or more prefix as a new pool in the pool domain. Failure to allocate a prefix (for example; an empty partition) results in a negative response. The retry time is set to a timestamp that is 15 minutes from the time of receiving the request. If the BNG still needs prefixes for the domain, it retries at the provided timestamp value.

- Reclaim threshold—When the number of free addresses reaches or rises above this value, the BNG has a surplus of addresses. The BNG sends a reclaim alarm to APM with a suggested pool to drain. Depending on the configuration, APM may initiate a drain on the pool. A drained pool has no IP addresses within the pool being used by a subscriber.

  During the drain, the BNG router stops assigning addresses from the pool and waits for subscribers to log off to free up those addresses.

  After draining the pool, the BNG sends the pool drained alarm to APM. APM sends a message to the BNG router to delete the pool from the pool domain.

  **NOTE**: APM initiates the reclamation process on the pool when:

  - Automatic reclamation is enabled for the pool domain.
  - Reclamation is allowed at the current time period.

  If APM cannot process the reclamation alarm because the auto-reclamation was outside the window, APM responds with a `ALARM_NACK/NOOP` and a retry time that is set to the second that the auto-reclamation window begins.

You configure the apportion threshold and reclaim threshold values in the pool domain profile. The thresholds determine whether there are enough free addresses for the BNG and when APM should allocate or reclaim prefixes. Consider the following fictional timeline in Figure 2 on page 6. BNG assigns addresses to subscribers when they log in and reclaims the addresses when they log out. The timeline shows the number of free addresses as tracked by the BNG over a period of time. Table 1 on page 6 describes the actions taken by the BNG and APM for different scenarios as the number of free addresses crosses different thresholds.

**Figure 2: Free Addresses on a BNG**

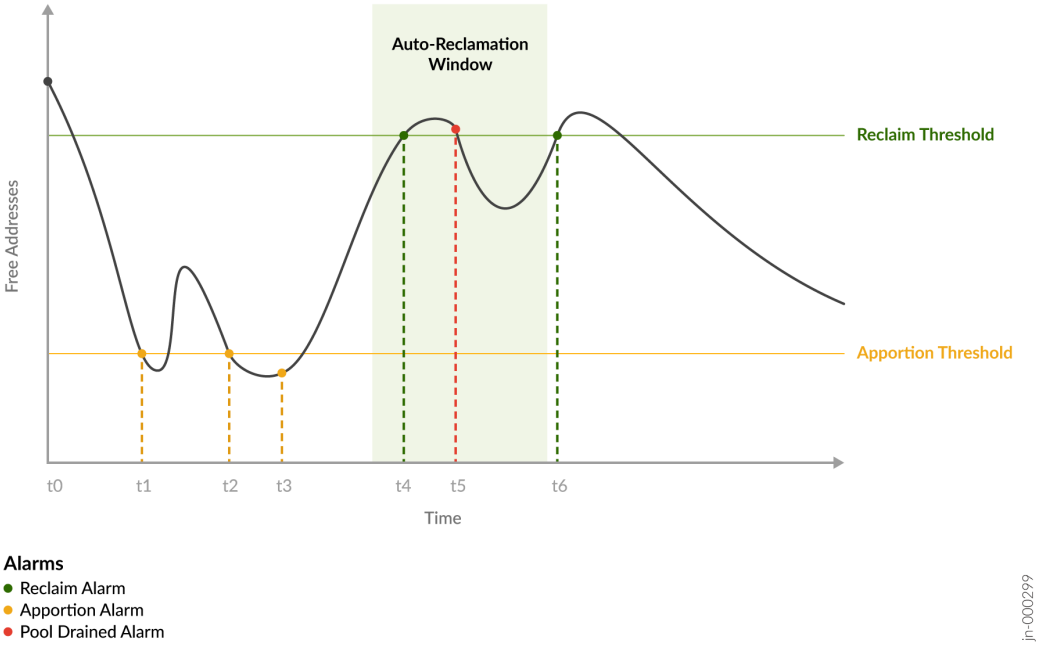



**Table 1: Action Taken by APM for Different Alarms**

| Time | Alarm Sent by BNG | Description |
|---|---|---|
| t0 | — | Start of the timeline with a populated pool domain. |
| t1 | Apportion alarm | As subscribers log in, the number of free addresses on the BNG falls below the apportion threshold. The BNG sends an apportion alarm. APM receives the apportion alarm and allocates prefixes to the pool domain. The BNG allocates addresses from the pool domain's pool prefixes. |

**Table 1: Action Taken by APM for Different Alarms *(Continued)***

| Time | Alarm Sent by BNG | Description |
|---|---|---|
| t2 | Apportion alarm | APM receives the apportion alarm, but the partition has no available prefixes. The alarm is NACKed and a retry timestamp is set to 15 minutes later. The BNG retries the apportion alarm at this timestamp unless it no longer needs the addresses. |
| t3 | Apportion alarm | At the retry timestamp, BNG resends the apportion alarm since the number of free addresses is still below the apportion threshold. |
| t4 | Reclaim alarm | Subscribers continue to log out until the number of free addresses rises above the reclaim threshold. The BNG sends the reclaim alarm with the suggested pool to be reclaimed. APM places a drain on the suggested pool and the BNG starts the drain process on the pool. |
| t5 | Pool-drained alarm | When the address pool has zero subscribers, there are no allocated addresses in the pool. BNG sends the pool-drained alarm to APM. APM responds to the pool-drained alarm with a delete request. The BNG removes the pool from the pool domain's list of pools. APM moves the corresponding prefix back to the partition for reallocation.<br>The number of free addresses drops upon removal of the pool. |

**Table 1: Action Taken by APM for Different Alarms *(Continued)***

| Time | Alarm Sent by BNG | Description |
|---|---|---|
| t6 | Reclaim alarm | APM receives the reclaim alarm, but does not take any action because the alarm occurred outside of the reclamation window. APM returns an alarm NACK with a retry timestamp set to the time of the beginning of the reclamation window. The BNG retries the reclamation alarm at this time if there's still a surplus of free addresses. |

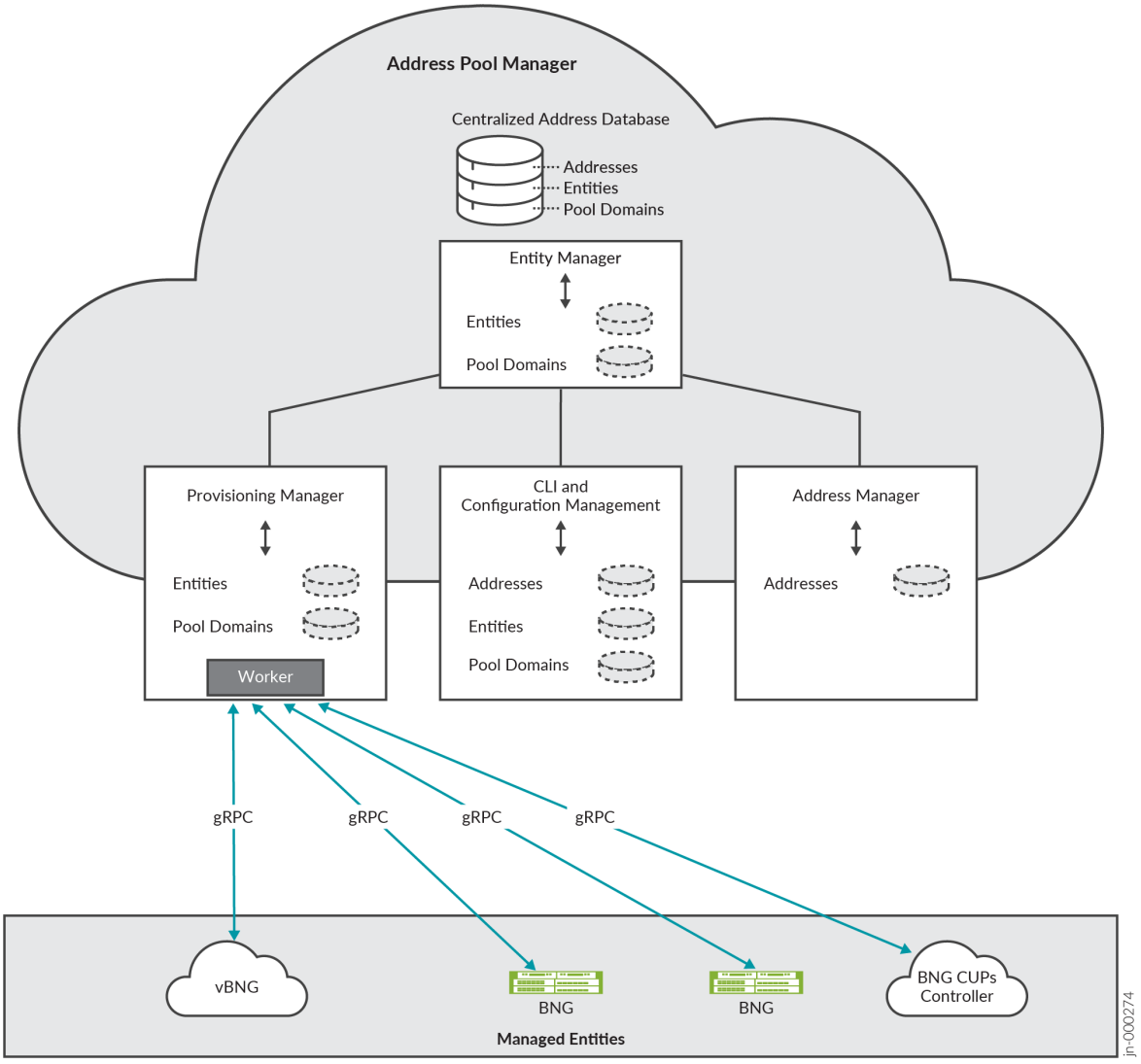
## General Operation of APM

The following steps explain the general operation of APM:

1. The BNG and APM communicate using the APMi, Juniper-defined gRPC-based protocol. Google RPC (gRPC) is common framework for building extensible and interoperable communication protocols. Upon initial connection, the BNG initiates pool domain synchronization. The pool domain synchronization process synchronizes the set of pool domains that are active. APM aligns the list of active pool domains with the BNG's list of pool domains. After pool domain synchronization, the BNG runs pool synchronization (discovery) for each pool domain. APM aligns the list of pools for each domain with the BNG's list. If APM has retained any additional pools (not in BNG's list of pools for the domain), the pool prefixes are released to the partition. If APM is missing pools, APM attempts to allocate pools.
2. APM monitors alarm messages sent by the BNG.
3. APM evaluates and acts on the alarm. For example, if a BNG is running out of addresses, the BNG sends an apportion alarm to APM. APM allocates the requested number of prefixes from the domain's source partition and returns them in the alarm response. The BNG adds these pool prefixes to the pool domain.

Figure 1 on page 2 shows a more detailed view of the relationships among the various functional components of a single APM instance. Each manager block shows the database tables it uses.

**Figure 3: Functional Components of APM**




**NOTE**: You can run multiple instances of APM simultaneously on multiple different clusters in the network. These instances of APM are independent and unaware of each other. The instances do not share state or configuration.

Each APM instance includes the following microservices as functional components of the application:

- Entity manager —Orchestrates the activities of pool management for the BNGs under management. These activities include processing alarms, and allocating and reclaiming pool prefixes.

- Address manager—Organizes the central pool of addresses into partitions and manages the allocations of the root prefixes configured in each partition. It subdivides the root prefixes into smaller prefixes and allocates the prefixes according to the configured criteria for the BNG.

- Provisioning manager—Interfaces with the BNG to provision pool domains and their associated address pools. The provisioning manager ensures that the domains and the associated allocated pool prefixes remain synchronized between APM and the BNG.

  The APM provisioning manager communicates with the managed BNGs using the APMi. The provisioning manager sends gRPC messages to directly provision and deprovision prefixes on the BNGs in response to domain alarms initiated by the BNG.

- The MGMT microservice provides a text-based configuration schema and CLI so that you can configure the global prefix pool, the managed BNGs, and their associated pool domain attributes. You can use the CLI to display statistics and state for various functional components. The output provides information about system load, efficiency, utilization, and errors or abnormal conditions.

- Broadband Edge (BBE) Event Collection and Visualization (cloud-based centralized utility)—provides a way to capture APM logs that span the life-cycle of APM microservices. The utility collects and stores logs across instances of APM microservices.

- Database instance (DB)—Provides shared access to database tables that each functional component of APM uses. The database includes tables for address, BNG, and pool domain information. The database provides persistent storage for configuration information and operational states.

  APM employs a database with state information about the entities, pool domains, pools, prefixes, allocations, configuration, and so on. Two database instances, a primary and a standby, deploy in a hot-standby mode. The database instances are monitored by a database sentinel service that detects a failure in the primary database. Upon failure of the primary database, the secondary assumes the role of the primary while a new standby database is restored.

**NOTE**: Redundancy requires a minimum of three worker nodes in addition to the primary node. The worker nodes must all be on separate physical servers. However, the nodes can be either physical or virtual machines.

# Functional Components of APM

IN THIS SECTION



## CLI and Configuration Management

The user interface (MGMT) is a containerized version of the Junos OS management process. With this interface, you can use the same CLI structure as Junos OS for configuration and monitoring. The MGMT also provides an interface that enables you to remotely manage APM.

APM performs the following tasks:

- Loads the initial APM configuration from the MGMT service into the database before other APM components can proceed to their runtime state.
- Translates commands and configurations into actions and parameters that the APM microservices understand.
- Records the initial configuration and subsequent changes in the database for persistence. It notifies APM components about any changes.

## Entity Manager

The entity manager coordinates the operations of other functional components, that affect the entity state.

For each BNG under management, the entity manager tracks the following information:

- The BNG address, which is the transport address of the BNG that hosts managed pools.
- A list of the pool domains being managed.

A pool domain represents a linked address pool on the BNG. For each pool domain, the entity manager tracks the following information:

- Pool domain name—A user-defined string that identifies the managed pool for the BNG. Each pool domain name must be unique for that BNG. That means the pool domain name effectively acts as a key; it is sometimes referred to as the pool domain key. A user-defined string constructed by the entity. For BNG, the string consists of the domain-profile name linked with the routing instance name. For the BNG CUPS Controller, the string consists of the domain-profile name linked with the subscriber-group name and routing-instance name.

- APM uses the format *pool-domain-name-sequence-number* to name the pools that it creates. The *sequence-number* is at least 4 digits; if the value is less than 1,000 the sequence number is padded with leading 0's. So 0001, 0999, 1000, 213339 are valid sequence numbers. For example, if the name of a pool domain is test-pd, then APM names the first pool test-pd. It names subsequent pools test-pd-0000, test-pd-0001, and so on.

- Prefixes—An ordered list of the prefixes that make up the pool domain.

The entity manager collects a number of volatile statistics for various operations (last discovery, last allocation, last reclamation, and so on) on the pool domain. The statistics include the alarm counts, the number of pools, their associated prefixes, and the timestamps. You can display these statistics with APM `show` commands, such as `show apm entity`.

The entity manager requests a new prefix for a pool domain from the address manager when the provisioning manager relays the apportion alarm from the BNG to the entity manager.

The prefix request includes the following information:

- Address family—Currently supports IPv4

- Allocation key—The IP address and pool domain of the managed BNG

- Requested prefix length—The size of the prefix that you want to allocate from a partition to a pool domain.

The entity manager subsequently attempts to provision the allocated prefix(es) to the BNG's address pool.

The entity manager begins a process to discover and to reconcile the BNG pool domains (Sync) under management when the provisioning manager notifies the entity manager that a BNG is reachable. The provisioning manager sends a reachability report to the entity manager whenever the reachability state changes. The entity manager requests discovery of all pool domains managed for that BNG.

The discovery process uses the provisioning interface to find the pool domains and the associated pool information as known by the BNG. At the end of the discovery process, APM and the BNG have the same pool domains and allocated pool prefixes.

If the discovered information does not match the existing information, then APM updates its databases with the partition information for pool domains (to match the BNG). If APM discovers a conflict during the update, it flags the conflict as a warning in the log.

## Address Manager

The address manager uses a VLSM algorithm to subdivide the root prefixes in the address pool partitions into smaller sub-prefixes up to the `max-prefix-len` value that you configured for each root prefix. During apportionment, the address manager matches a request for an appropriately sized prefix to a partition and a root prefix. APM allocates a free sub-prefix from the root prefix to satisfy the apportioning event.

The address manager logs a warning message if the percentage of free addresses within a partition drops below the `free-prefix-utilization` threshold. The crossing of that threshold indicates that the partition is in danger of running out of addresses because it has allocated so many addresses.

When you configure APM, you assign root prefixes to a partition. The address manager apportions prefixes from only a single partition for any domain. Each partition represents an allocation context. The address manager uses the bias that you configure for the domain to select the partition from which it subdivides prefixes for allocation to the domain.

When you add a root prefix to a partition, make sure it fits within the specified minimum and maximum prefix length limits for that partition:

- The *`min-prefix-len`* value is the shortest valid root prefix.
- The *`max-prefix-len`* value is the longest valid root prefix.

Thus, `min-prefix-len` <= root prefix length <= `max-prefix-len`.

For example, if `min-prefix-len` is 20 and `max-prefix-len` is 24, you can add a root prefix with prefix lengths of /20, /21, /22, /23, or /24.

The smaller the prefix length, the more individual host addresses available in the subnet. The larger the prefix length, the fewer individual host addresses available in the subnet. For example:

- A prefix length of /20 provides 4,094 usable host addresses.
- A prefix length of /24 provides 254 usable host addresses.

**NOTE**: If you configure a root prefix that is outside the specified limits, APM does not add it to the partition.

### Prefix Subdivision

The goals of prefix subdivision enable APM to share a root prefix among several domains and to allow domains to grow in smaller increments. The address manager uses a VLSM algorithm to subdivide root prefixes in a partition during configuration. Each subdivision is a subnetwork (subnet).

You can control how deeply the address manager subdivides a root prefix by specifying the maximum allowed prefix length. The value of `max-prefix-length` is the longest prefix allowed for a subnet. Consequently, this configuration determines the minimum number of host addresses that an allocated prefix must provide.

### Prefix Allocation

The address manager can allocate any particular prefix to only one domain. Prefix allocation depends on the domain's bias information and the requested prefix size.

The address manager makes a best-effort attempt to match the requested prefix size (`preferred-prefix-len`) when it allocates a prefix. The partition might not have any prefixes left that match the requested length. For example, when the address manager allocates a superior prefix to a pool, it also allocates all of its subordinate prefixes to the pool.

### VLSM

VLSM creates a hierarchy of subnets from a root prefix. It subdivides the root prefix by adding bits to the prefix length. Each bit added to the prefix length creates another subordinate level of subnets with the following property:

- Each level has twice as many subnets as the next higher level.
- Each level has only half as many host addresses per subnet as the next higher level.

Each root prefix and its associated subnet hierarchies constitute a prefix tree. A partition, therefore, consists of a collection of prefix trees. The address manager can allocate only a prefix that fits somewhere within one of these prefix trees.

Prefixes might be in one of the following states:

- Available—The prefix is available for allocation to a domain.
- Allocated—The prefix is already allocated to a domain and an entity.

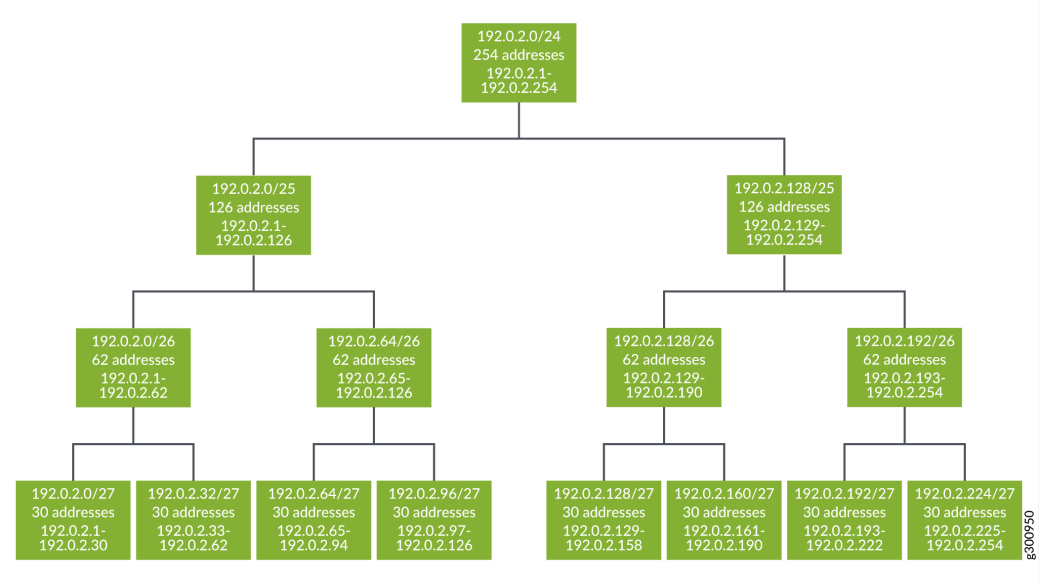
### VLSM Example

Figure 4 on page 15 shows a hierarchy for the root prefix 192.0.2.0/24 in the partition test-1. You can see that the number of subnets doubles for each bit added to the prefix length, from one subnet for /24 to eight subnets for /27. The number of usable addresses per subnet is halved for each additional prefix length bit, from 254 addresses for /24 to 30 addresses for /27.

**NOTE**: Each prefix block in the diagram shows *usable* addresses:Usable addresses = Total number of addresses – 2

The two excluded addresses correspond to the lowest address (the network address) and the highest address (the multicast address).

**Figure 4: VLSM Subnet Hierarchy Example**




Consider the following scenario with this root prefix tree:

1. The address manager receives an allocation request with a preferred prefix length of 25.
2. The address manager looks for a /25 prefix that includes the address. 192.0.2.0/25 matches and is selected if it is available.

What happens if 192.0.2.0/25 is not available? This means that 192.0.2.0/24 is also unavailable. The address manager looks for another /25 prefix.

The address manager selects 192.0.2.128/25 if it is available. If that prefix is not available, then the address manager tries to allocate a /25 prefix from a different root prefix.

## Provisioning Manager

The provisioning manager consists of worker processes that manage the following provisioning operations:

- Discovery—Synchronizes the pool domains and the associated pool information between APM and a BNG. At the end of the discovery process, APM and the BNG agree on the list of pool domains and allocated pool prefixes.

  APM behavior—APM reconciles its pool domains with the BNG's list such that the APM list matches the BNG's list. The pool prefixes for domains that are deleted during reconciliation have their associated pool prefixes returned to their original partition.

  The provisioning manager performs discovery whenever APM establishes a connection with the managed BNG, including a reestablished connection after a connection failure. While the connection is down, an administrator could change the configuration on the BNG. APM adjusts accordingly if it detects a change during the subsequent discovery.

- Provisioning—Provisions and deprovisions prefixes on a managed BNG. While the address manager manages the allocation of prefixes, the provisioning manager communicates with the BNG to provision the address pool.

When the connection is restored, the provisioning manager notifies the entity manager that the BNG is reachable. The entity manager requests the provisioning manager to start the synchronization process.

## How Prefix Reclamation Works

**IN THIS SECTION**



Address reclamation on the BNG recovers the underutilized provisioned prefixes from the device address pools and returns the prefixes to APM's centralized pool. APM can then reallocate these prefixes as needed to other pools that are nearing address exhaustion. This means that the distribution of prefixes continually adjusts to maximize address space utilization and efficiency.

Reclamation is the process of reclaiming pool prefixes from a BNG's pool domain when the BNG has a surplus of free addresses. You set the reclaim threshold value in the pool domain profile configuration. You then reference the pool domain profile in the entity configuration on APM.

The BNG monitors the free-address count for each of its pool domains. When the free-address count reaches the reclaim threshold, the BNG is considered to have a surplus of addresses. The BNG sends a reclaim alarm to APM with information identifying a suggested pool to be reclaimed. The reclaim alarm drives the automatic reclamation process. Alternatively, you can initiate a manual reclamation process.

Reclamation consists of draining a pool and then recovering the prefixes from the pool, as explained here:

- When APM initiates a drain, it sends a message to the device to begin actively draining the pool. This means that no new subscribers are allocated from this pool. For connection-based access model subscribers (for example PPP), an active drain triggers an immediate logout and re-connect. For lease-based subscribers, an active drain causes the lease-renewal to be rejected. For both models, the net result is the subscriber re-connects but is allocated an address from another pool in the domain.
- The pool is completely drained when there are no subscribers using an address in the pool. All addresses in that pool are free. The BNG sends a pool-drained alarm message to APM.

APM can perform address reclamation by either of the following methods:

- Automatic—You can configure reclamation to be an entirely automatic process that occurs when APM receives a reclaim or pool-drained alarm. You can specify the process to begin immediately, or to take place only during a specific time window, or to wait a period of time before acting on the alarm.
- Manual—You use `show` commands to display the alarms for individual pools on the BNG. You then issue `request apm` commands to drain addresses from a pool, deprovision the drained pool, and recover its addresses.

## Automatic Reclamation of Prefixes

You can enable APM to automatically handle the task of reclamation. You can configure automatic reclamation in the `pool-domain-profile` assigned to the entity as configured in the `entity-match` statement.

When you enable automatic reclamation, these actions take place:

- APM responds to domain reclamation alarms sent by the entity. The reclamation alarm contains a suggested pool name to reclaim.
- APM responds to the reclamation alarm by instructing the entity to place an active-drain on the pool. When the pool has completely drained (no outstanding address allocations from the pool), the entity raises a domain pool-drained alarm.
- APM responds to the pool-drained alarm by instructing the entity to delete the pool; APM returns the pool prefix to the partition from which it was allocated.

- Once the prefix has been returned to the partition, it is available to other entities raising domain apportion alarms.

Auto-reclamation allows you to limit the number of unused addresses maintained on the entity. Because the auto-reclamation process involves a potentially service impacting active-drain, you can configure APM to only initiate auto-reclamation during a configured maintenance window.

## Releasing Allocated Prefixes for an Entity

In the event that a network entity should fail and is unable to reconnect with APM to allow any allocated pool prefixes to be reclaimed to their source partitions, you can use the `request apm release entity` *`system-id`* command. This command deallocates all pool prefixes and pool domains associated with a network entity. You cannot use the `request apm release entity` *`system-id`* command if the entity's APMi state is `reachable`.

Use these steps for releasing prefixes from an unreachable entity.

1. Use the `show apm entity` *`system id`* command to display the entity's reachability status and the pool prefixes held by its pool domains. the output shows that the entity is reachable and has allocated 3 pool prefixes.

```
root@jnpr-apm-mgmt> show apm entity id yarmouth pool-domain iroh-default
Entity Statistics:
  Entity ID:  yarmouth
  APMi Ver :  1
  Name     :  yarmouth
  Status   :  reachable
  Pool Domain Statistics:
    Pool Domain     :  iroh-default
    Source Partition:  westford
    Free Addresses  :  253
    Pools           :  3
    Thresholds:
        Apportion  :  200
        Reclamation:  457
    Events:
        Last Discovery  :  2023-09-22T12:55:08Z
        Last Allocation :  2023-09-22T12:55:15Z
        Last Reclamation:  -
        Allocations     :  3
        Reclamations    :  0
    Alarms:
        Apportion   :  3
```

```
        Reclamation :  0
        Pool-drained:  0
        Abatement   :  0
    Pool                          Prefix             Total Addrs    Used Addrs
    iroh-default                  192.168.0.0/24     255            255
    iroh-default-0000             192.168.1.0/24     255            255
    iroh-default-0001             192.168.2.0/24     255            2
```

2. The `request apm release entity` *`system id`* command is unsuccessful when the entity is reachable.

```
root@jnpr-apm-mgmt> request apm release entity yarmouth
Response error: Entity yarmouth is still connected..release request is ignored
```

3. Enter the `show apm entity` to see if the entity is unreachable.

```
root@jnpr-apm-mgmt> sshow apm entity
Entity ID                     APMi Ver  Name                         Status    Pool Domains
yarmouth                      1         yarmouth                     unreachable 1
```

4. As the entity in Step 3 is unreachable, you can enter the `request apm release entity` *`system-id`* command to begin reclamation. APM deprovisions the pool and returns the addresses to the source partition for reallocation. All the pool prefixes that were reported in Step 1 are released.

```
root@jnpr-apm-mgmt> request apm release entity yarmouth
Released Prefix    Destination Partition
192.168.0.0/24     westford
192.168.1.0/24     westford
192.168.2.0/24     westford
```

## Manual Reclamation of Addresses

Manual reclamation gives you fine-grained control. Manual reclamation requires you to closely monitor the pool domains and address pools on your managed BNGs.

1. Use the `show apm alarms` command to display all pending alarms received from the BNG. The output displays the names of pools with the `reclaim` alarm status.

```
root@jnpr-apm-mgmt> show apm alarms
Entity        Pool Domain    Alarm                Info                  Age
10.4.4.108    vks009-default reclaim              vks009-default-0005   2:33:15
10.2.1.1      alpha-drop     reclaim              alpha-drop-0000       3 days, 15:20:01
10.3.23.10    feeder-default apportion            -                     0:0:10
152.13.5.5    azimuth-ri2    pool-drained         azimuth-ri2-0007      0:0:21
```

   The `reclaim` alarm means that the pool domain has a surplus of addresses. The `Info` field contains the name of a pool that the BNG recommends for reclamation. A reclaim alarm does not mean that the pool has an active drain set. If a drain is not in place on the pool, the pool could still allocate addresses.

2. Issue the `request apm drain` command to begin draining the pool.

```
root@jnpr-apm-mgmt> request apm drain entity 10.2.1.1 pool-domain alpha-drop
pool alpha-drop-0000
```

   **NOTE**: You can remove a drain that you have initiated by issuing the `request apm activate` command.

3. Use the `show apm alarms` command to see that the pool has been drained. The alarm status displays the `pool-drained` status.

4. Issue the `request apm reclaim` command to begin reclamation. APM deprovisions the pool and returns the addresses to the source partition for reallocation.

```
root@jnpr-apm-mgmt> request apm reclaim entity 10.2.1.1 pool-domain pool alpha-drop-0000
```

When you choose manual reclamation, be careful in choosing the pool to reclaim. Here are some of the considerations for choosing a pool to reclaim.

- When you drain a pool, you must accommodate the subscribers using those addresses in other pools in the pool domain. There must be enough free addresses in the other pools (in the domain) to absorb these subscribers. Therefore, the number of free addresses in the pool domain must be greater than the number of used addresses in the pool that you drain:

  (pool domain free addresses) –(drain pool free addresses) > (drain pool used addresses)

- When you drain a pool, you must not leave the pool domain in immediate danger of running out of free addresses. If the free address count in the domain falls below the apportion threshold, it triggers an apportion alarm that results in APM provisioning more addresses for the pool. In other words, try not to initiate a drain on a pool unless the following inequality holds true:

  (pool domain free addresses) – (drain pool total addresses) > (apportion threshold)

### Timestamps

You use the `show apm entity` command to monitor APM's reclamation operations. The command output shows timestamps for the last discovery, last allocation, and last reclamation events when you display statistics for a router or a specific pool domain. The timestamps are in ISO-8601 format with a 24-hour clock:

*YYYY-MM-DD*T*hh:mm:ss*Z

- T is the delimiter between the date and the time.
- Z indicates that the time is in the UTC time zone. If the router time uses a different time zone, the format shows the offset from UTC to identify the time zone.
- Time zones west of UTC have a negative offset, designated by –*hh:mm*.
- Time zones east of UTC have a positive offset designated by +*hh:mm*.

For example, the following timestamps all show the same time, assuming standard time:

- 2020–03–20T15:10:25Z (London)
- 2020–03–20T10:10:25-05:00 (New York)
- 2020–03–20T16:10:25+01:00 (Paris)
- 2020–03–20T23:10:25+08:00 (Beijing)

## APM and Kubernetes

**IN THIS SECTION**

APM operates in a Kubernetes cluster environment. APM is a containerized application, where Kubernetes is the orchestrator for the containers. It groups containers into logical units (pods) that simplify management. The APM command and CLI simplify the interactions with Kubernetes.

With Kubernetes, you can automatically restart APM microservices. Because Kubernetes deploys the microservices as replica sets, it can ensure that the pod with the microservice restarts if the pod fails. At initial deployment and upon restart, the service pod checks that the configuration has completed loading. The service pod also verifies that it can connect to the database and the message broker. Upon successful confirmation, the APM service starts.

Kubernetes provides redundancy for the APM functionality, because it distributes and manages the application containers across a cluster that consists of multiple node machines. Each node may take on one or more roles in the cluster.

- Control plane (etcd) nodes—Control plane nodes are responsible for scheduling application workloads (pods) across the available nodes. The control plane nodes support a worker role, archiving state related to workloads, monitoring node availability, and the workload state. The control plane nodes ensure continuous operation of the application on the cluster.
- Worker node—A worker node is a scheduling target for application workloads.

If you choose to use virtual machines to construct the cluster nodes, the virtual machines must be on different physical nodes. Using different physical nodes ensures maximum availability of the cluster nodes. If a worker node fails, the Kubernetes control plane detects the failure. It attempts to reschedule the workloads that were running on the failed node to other worker nodes in the cluster.

h

**NOTE**: The database service used by APM requires at least three physical worker nodes to provide high availability for the application.

Replication provides database redundancy. The primary database instance duplicates to one replica database instance. Each instance is a separate pod. An odd number of database sentinel instances monitor the primary and replica database instance. When a sentinel detects a failure of the primary instance, a majority of the sentinels must agree. Then a majority of the sentinels must elect the replica instance to promote to the primary role. If the previous primary instance recovers, it assumes the role of a replica instance.

## APM-Provisioned Kubernetes Objects

APM creates the following Kubernetes objects during start or rollout. APM uses these objects throughout its life cycle. The objects are removed on `apm stop`.

- Namespace—Virtual cluster of node machines that are running APM. All APM objects are isolated in the jnpr-apm.
- External-Services—Objects are created at setup time to obtain the external IP address assigned by the cluster's load balancer (ingress controller). External services outside the cluster use these external IP addresses to initiate communication with APM. If the cluster does not support a network load balancer, the cluster uses the primary node as the external IP address.
- ConfigMap—Stores the configuration file for the database server (**redis.conf**) and an initial configuration file (**juniper.conf**) for MGMT.
- PersistentVolumeClaims—For containers that have dynamic data storage requirements. This object includes MGMT and the database deployments.
- Secrets—Stores keys and certificates that you need to secure the APMi.

## Automatic Archival of the APM Configuration

APM uses an initial configuration file when it is first started and rolled out. The configuration file can be either the factory default configuration file or it can be a configuration file provided by you during setup. This initial configuration file is stored in the jump host's cluster repository. After a change is committed to the configuration, the initial configuration file used during start and roll out can be updated when you perform an APM `save-config` utility script command.

Using the automatic archival feature, APM can be set up to automatically archive a copy of a committed configuration to an external file server. Every time the configuration is changed and committed, APM transfers a copy of the committed configuration file to the external file server.

You configure automatic archival of your configuration file through the `setup` command. This is the same `setup` command that you use when you initially set up APM.

If you did not initially configure automatic archival during your set up and want to automatically save configuration changes to an external configuration file, perform the following:

1. Run the `setup` command (for details, see *Address Pool Manager Installation Guide*). During the setup process, configure the following:
   - **Config Archival copy rollback configs**—Enter **True** to archive the rollback configuration files.
   - **Config Archival retain source filename**—Enter **True** to copy the configuration file using the filename stored in the mgmt microservice's filesystem (for example, **juniper.conf.gz**). If you enter **False**, the archived configuration file name is prepended with the prefix **apm_<date-stamp>_<time-stamp>_**.

- **Config Archival secret** —Enter the name of the Kubernetes Secret in the APM namespace that contains the SSH private key data.

  If you do not supply a secret, you will be prompted for an SSH key file:

  - **Config Archival ssh-key**—Enter the name of the SSH private key file.

- **Config Archival scp URL**—Enter the Secure Copy Protocol (SCP) URL of the server where the configuration file will be archived. The URL must be in the format `scp://`*`user-login@server-fqdn`*`:`*`server-port`*`/`*`absolute-file-path`*.

  **NOTE**: The server port number (*`server-port`*) is optional.

2. If APM is already running, run the `rollout` command to update the mgmt microservice.

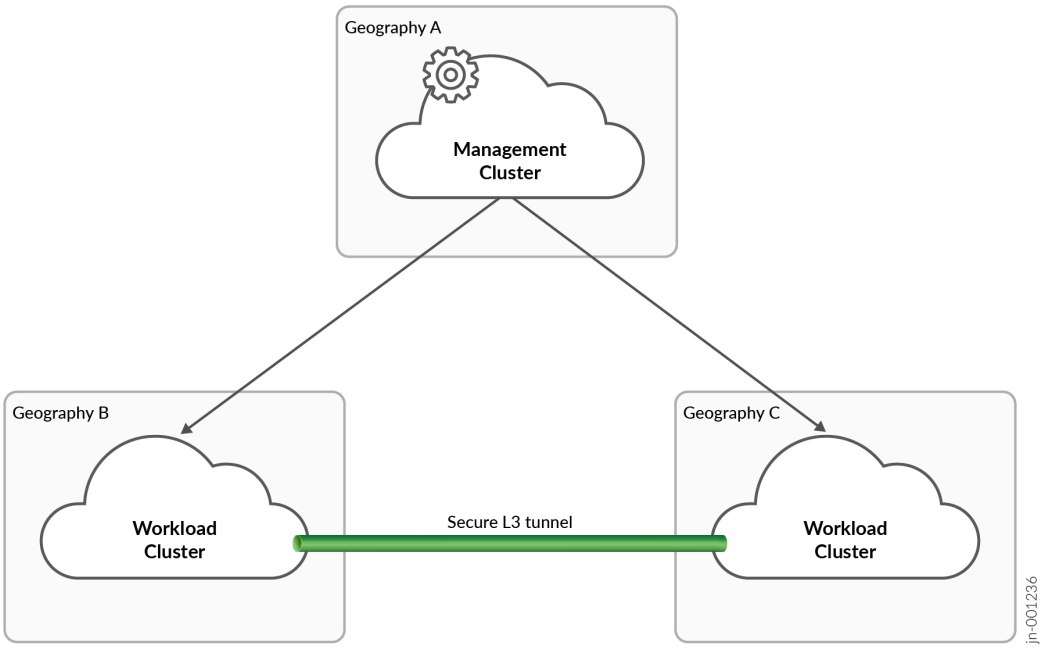
## Use APM with Multiple Geographical Redundancy

APM can be set up to operate in a multiple geographic, multiple cluster environment. A multiple geographic, mutiple cluster setup improves the availability of APM. In this type of setup, if the data center experiencs a total failure, APM can retain its state and resume operations.

Kubernetes increases the scalability, operational efficiency, and reliability for the solution. The modularity of a Kubernetes cloud enables cluster architectures to have unparalleled redundancy. Even the most redundant cluster architectures are susceptible to events such as natural disasters or cyberattacks which might target a specific location or geography. A multiple geographic, multiple cluster setup mitigates these susceptibilities.

Figure 5 on page 25 shows an example of a multiple geographic, multiple cluster setup.

**Figure 5: Multiple Geographies with Multiple Clusters Setup**




In a multiple geographic, multiple cluster setup, the management cluster maintains a separate context for running multiple cluster scheduling and monitoring functions and is connected to both workload clusters. The multiple cluster context is driven by a policy engine that informs the scheduler how to distribute the application across the workload clusters. Applications that use the multiple cluster setup for multiple geographical redundancy, have policy rules that distribute application microservices involved in state replication to both workload clusters. Other application microservices are distributed to one workload cluster that is chosen as the primary workload cluster.

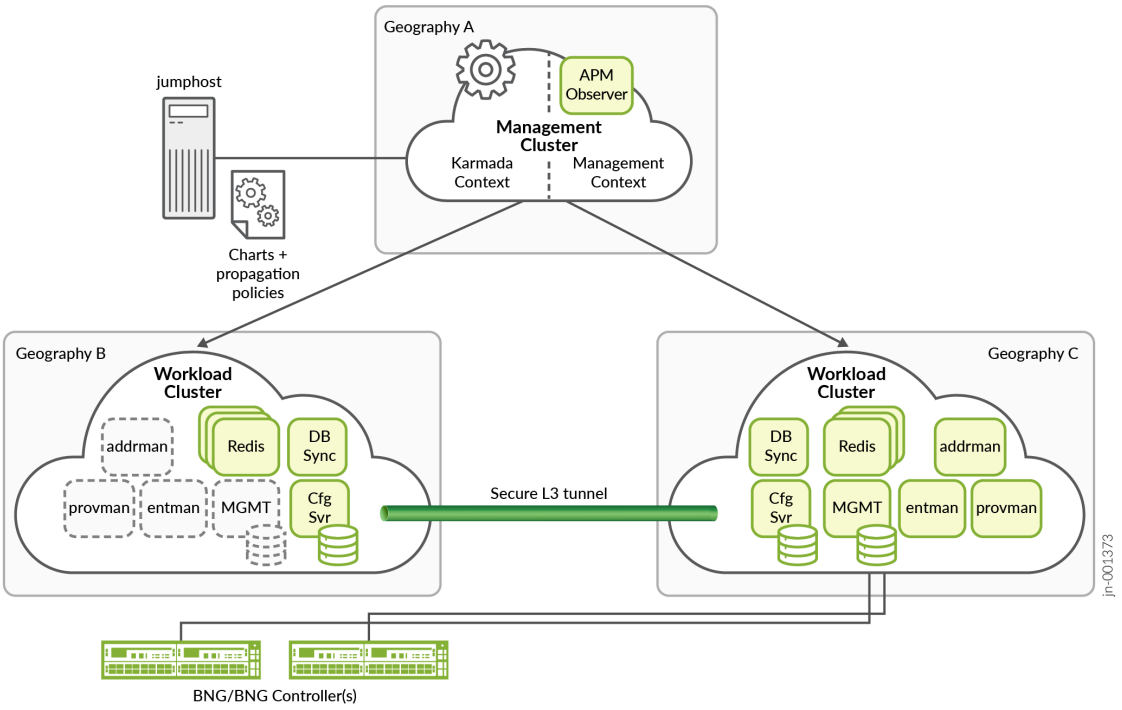
The workload clusters accept work from the management cluster through the Kubernetes REST API. The workload clusters are standard Kubernetes cluster. A secure L3 tunnel is maintained between the workload clusters. The tunnel facilitates the exchange of application state and general communication between the two workload clusters. As a standard Kubernetes cluster, a workload cluster monitors pods and deployments and performs scheduling tasks for the worker nodes in the cluster, maintaining the deployed application components. The workload cluster does not require the presence of the management cluster to maintain its application workloads. When applications are deployed, it is the workload cluster's responsibility to maintain the application deployment.

If the management cluster detects that a workload cluster has failed or that an application's microservice cannot be satisfactorily scheduled on a workload cluster, the management cluster will drive a switchover event. The switchover action is controlled by the policies that are defined for the application. In a switchover event, any application's microservices that exist only on the failed workload cluster are redeployed to the other workload cluster.

APM can be deployed in a multiple geographic, multiple cluster environment. The APM's Helm charts include propagation policy rules that instruct the management cluster's multiple cluster context to deploy an instance of the dbSync microservice on both workload clusters. The two dbSync instances communicate over the secure tunnel to mirror the partition state stored in the database between the two geographies. The database microservice and dbSync microservice are deployed to both workload clusters. The dbSync microservice makes sure that the database is synchronized between the two geographies. The bulk of APM's workloads and microservices run on one workload cluster and switchover to the other workload cluster when necessary.

Figure 6 on page 26 shows APM in a multiple geographic, multiple cluster setup.

**Figure 6: APM in a Multiple Geographic and Multiple Cluster Setup**




If the workload cluster fails, the management cluster reschedules APM on the other workload cluster. When APM initializes on the second workload cluster, it recovers its configuration from a replicated configuration cache maintained by the configserver microservice. APM also recovers its partition state from the local database instance just as it would on any microservice restart. Since the local database received replication state information from the previous workload cluster, all partition states are recovered. Other states, such as pool domain and pool state, are recovered directly from the entities as they reconnect and cycle through their normal synchronization procedure.

APM also deploys a microservice on the management cluster that is called the observer. The observer runs in the regular context of the management cluster and watches APM scheduling events in the multiple cluster context (associated with the management cluster). In switchover situations where APM might exist temporarily in both workload clusters, the observer allows APM to resolve any ambiguity over which APM should be running.

For example, in the event that the management cluster can no longer reach or monitor a workload cluster, the management cluster declares that the workload cluster has failed. The management cluster initiates a switchover of workloads from the failed workload cluster to the other workload cluster.

A scenario where the failed workload cluster is operational, but not reachable from the management cluster creates an ambiguous deployment. Multiple instances of application workloads exist on both workload clusters. Since the management cluster is the final arbiter on where workloads run in a multiple cluster deployment, a mechanism is needed to force the duplicate workloads on the workload cluster that has perceived to have failed to enter an inactive or dormant state in deference to their switched over counterparts.

As previously mentioned, the observer microservice runs on the management cluster. The observer watches for scheduling events for application workloads. Each time an application workload is scheduled on a workload cluster, the observer assigns a unique generation number to that workload. When the same workload is switched over to the other workload cluster, the generation number is incremented. As the applications workloads initialize, they request their generation number from the observer. The generation number passes between the workload clusters. Application workloads on the failed workload cluster take note that the same workloads have a higher generation number on the other workload cluster and transition the workload cluster into a dormant state (all connections are dropped, no state is generated or consumed).

The generation number helps correct the ambiguous deployment caused by the management cluster's inability to view the true state of the failed workload cluster. When reachability is restored to the failed workload cluster, the management cluster removes the dormant application workloads.

## APM Backup Partitions

As a centralized prefix resource, APM can source pool prefixes for multiple regions or data centers of BNGs. In the event that one region experiences a failure, subscriber traffic is redirected to its designated backup region. Both the designated backup region’s BNGs or BNG User Planes and the assigned APM partitions will see an increase in subscriber loads. Assuming that partitions are sized correctly for their region’s subscriber load, the sudden influx of backup subscribers would likely deplete the region’s partition, resulting in login failures. You can configure a backup partition to alleviate this problem.

A backup partition can be associated with one or more origin partitions. An origin partition is the source partition from the entity's perspective. All apportionment and reclamation requests from the entity are made relative to the origin partition. The origin partition is configured on the BNG under the `system`

`services subscriber-management location` command. In Juniper BNG CUPS, the origin is configured under the `dynamic-address-pools` stanza for the BNG User Plane in the BNG CUPS Controller's configuration. APM treats an origin partition with a configured backup partition as an extended origin partition. An origin partition can have only one backup partition.

Prefix apportionments are attempted in the origin partition first. If the origin partition is depleted and a backup partition is configured, the apportionment is attempted in the backup partition. Apportionment in the backup partitions follow the same behavior as in the origin partitions.

For reclamations APM must determine to which partition a reclaimed prefix belongs by inspecting the root prefixes. Because APM must identify the correct root prefix for reclamation, there cannot be any overlapping root prefixes across the origin and its backup partition. Overlap prevention is strictly enforced through commit check.

Once prefixes have been apportioned from the backup partition and the origin partition is no longer depleted, manually reclaim the pools apportioned with prefixes from the backup partition. Subscribers displaced from the backup pools during drain will relogin and be assigned an address from a pool with a prefix from the origin partition.

# How to Configure APM

**SUMMARY**

This section describes configuration tasks for Address Pool Manager (APM).

**IN THIS SECTION**

## APM Configuration Overview

You use the APM CLI when you configure APM to manage address pools in the network. The APM CLI is a simplified, limited, containerized version of Junos OS. To use the APM CLI, you should have basic knowledge of the Junos OS CLI. Day One: Exploring the Junos CLI provides a good overview of Junos OS CLI basics. The CLI User Guide provides more detailed information.

Before you begin configuring APM for a network, make sure that you know the following:

- The system identifiers that APM will manage.
- The names of the centralized address pool partitions.
- The apportion and reclaim threshold that you would like to use on the BNGs.
- Your detailed strategy for partitioning APM's centralized pool of addresses, including:
  - The size of the prefixes to partition from the address space; for example, whether the prefixes are /15, /22, /24, and so on.
  - The set of addresses for APM to allocate for each BNG.

Here are the primary operations you'll perform to configure APM:

- Configure pool-domain-profiles that you use in the entity-match configuration to drive pool-domain creation and management. Each pool domain profile describes apportion and reclaim thresholds and auto-reclamation behavior. See "Configure Pool Domain Profiles" on page 34
- Configure partitions to contain root prefixes for supplying pool-domains with pool prefixes. See "Configure Prefix Partitions" on page 32
- Configure entity-match stanzas which match against known system Ids (BNGs) to enable communications with a BNG.

## Access Configuration Mode from the APM Utility

Here's how to access the set of CLI commands for configuring APM:

1. Access the CLI from the utility command prompt.

```
$ apm cli
root@jnpr-apm-mgmt#>
```

2. Enter configuration mode from the basic CLI prompt.

```
root@jnpr-apm-mgmt#> configure
root@jnpr-apm-mgmt##
```

3. Enter CLI statements to configure the APM-managed BNGs, pool domains, pools, and system attributes.
4. Save and activate the configuration. This command succeeds only when there are no configuration syntax errors.

```
root@jnpr-apm-mgmt# commit
commit complete
```

5. (Optional) Exit configuration mode and return to the top-level CLI prompt.

```
root@jnpr-apm-mgmt# exit
root@jnpr-apm-mgmt>
```

Now you're ready to start configuring APM.

## Access CLI Operational Commands

To monitor APM, view APM configuration and statistics, or run certain operations manually:

1. Use the APM utility command `apm cli` to access the top-level CLI prompt.

```
$ apm cli

root@jnpr-apm-mgmt>
```

2. Enter specific commands.

- Use `show` commands to display statistics and the relationships between partitions, BNGs, pool domains, and pools.
- Use `request` commands to manually initiate certain APM operations.

## Configure an External Syslog Server

APM can export logs generated from the mgmt, addrman, entman, and provman microservices to a syslog collector (server). To export logs to a syslog collector, a syslog host must be configured.

If APM detects that the Broadband Edge (BBE) Event Collection and Visualization application is deployed on the same cluster as APM, the generated factory default configuration includes the BBE Event Collection and Visualization IP Address and ingress port as part of the syslog configuration.

If you supply your own initial configuration file, a syslog configuration must be added to enable export of APM logs.

Add the following configuration:

```
[edit]
system {
    syslog {
        host <syslogServerIpAddress> {
            any any;
            port <syslogServerIngestPort>;
            structured-data;
        }
    }
}
```

## Configure TACACS+ Authentication

APM supports TACACS+ for central authentication of users on network devices. To use TACACS+ authentication on the device, you (the network administrator) must configure information about one or more TACACS+ servers on the network.

For information about configuring TACACS+ authentication, see TACACS+ Authentication.

## Configure Prefix Partitions

Partitions are a way to organize your root prefixes (those prefixes from which prefixes are used to supply entities with pools). Consider using multiple partitions for:

- Wholesaling applications— Wholesale subscribers who need to have addresses assigned from pools with prefixes that are different from the native subscribers.
- Peering applications—Entities that need prefixes that align with the route aggregation policy for the network peering point they are associated with.

**NOTE**: You can configure partitions (from which pool prefixes are drawn) from entities and BNG CUPS (individual user planes). Unless you have a reason for multiple partitions, a single partition results in a more efficient use of prefixes.

Configure the global pool of IPv4 addresses into partitions from which APM allocates addresses to individual BNG pools.

1. Create a partition. In practice, you create and configure as many partitions as you need to implement your address allocation strategy.

```
[edit apm inet-pool]
root@jnpr-apm-mgmt# set partition partition-name
```

2. (Optional) Configure a lower limit and an upper limit on the valid prefix length for the root prefixes in the partition.

```
[edit apm inet-pool partition partition-name]
root@jnpr-apm-mgmt# set min-prefix-len length
root@jnpr-apm-mgmt# set max-prefix-len length
```

   The prefix length for root prefixes that you add to the partition must be within the range defined by these limits.

3. (Optional) Configure the minimum threshold percentage for free (unallocated) prefixes in the partition. When the percentage drops below this value, the Address Manager generates a warning-level log message to warn APM that the partition is running low on available addresses. The notification is informative and triggers no other actions.

```
[edit apm inet-pool partition partition-name]
root@jnpr-apm-mgmt# set free-prefix-utilization percentage
```

4. (Optional) Configure a role for the partition. The role can be either **origin** or **backup**. If a role is not configured, origin is assumed by default.

```
[edit apm inet-pool partition partition-name]
root@jnpr-apm-mgmt# set role origin
```

5. (Optional) Configure a backup partition to use in the event of a region failure.

   The `backup-partition` statement can be configured only if the following requirements are met:

   - The role of the partition is `origin`.
   - The backup partition exists in the configuration.
   - The backup partition's and the origin partition's `min-prefix-len` and `max-prefix-len` match.
   - The backup partition's prefixes do not overlap with the origin's prefixes.
   - The backup partition's role is set to backup.

```
[edit apm inet-pool partition partition-name]
root@jnpr-apm-mgmt# set backup-partition partition-name
```

6. Configure a root prefix for the partition. APM subdivides the root prefix into subnetworks to provision addresses for a BNG's pool domains. You typically configure more than one root prefix per partition.

```
[edit apm inet-pool partition partition-name]
root@jnpr-apm-mgmt# set prefix ip-address/prefix-length
```

   a. (Optional) Specify the smallest subnetwork that APM can subdivide from this root prefix.

```
[edit apm inet-pool partition partition-name prefix ip-address/prefix-length]
root@jnpr-apm-mgmt# set max-prefix-length max-length
```

   The *max-length* value represents the number of bits in the prefix length for the root prefix.

   - A higher number specifies a longer prefix, which corresponds to a smaller subnetwork with fewer hosts.
   - A lower number specifies a shorter prefix, which corresponds to a larger subnetwork with more hosts.

b. (Optional) Specify route tag metrics in a list. You use route tags to construct discard routes for the apportioned prefix on the BNG. Each time APM allocates a prefix from the root prefix in a partition, it assigns a route tag from the list of configured route tags in a round-robin fashion.

```
[edit apm inet-pool partition partition-name prefix ip-address/prefix-length]
root@jnpr-apm-mgmt# set route-tag tag-value
```

7. (Optional) Configure a timer, in seconds, for APM to suspend the prefix before returning the prefix to the partition. After APM returns the prefix to the partition, it can re-allocate the prefix on an as-needed basis. The prefix-recycle-hold is a value between 30 and 3600 seconds.

```
[edit apm inet-pool partition partition-name prefix ip-address]
root@jnpr-apm-mgmt# set prefix-recycle-hold time
```

## Configure Pool Domain Profiles

Configure a template with attributes that you can use to create dynamic pool domains.

1. Create or modify a pool domain profile.

```
[edit apm ]
root@jnpr-apm-mgmt# set pool-domain-profile pool-domain-profile-name
```

2. Configure the pool monitoring attributes (apportion threshold and reclaim threshold) on the BNG.
   - The apportion threshold is the minimum number of free addresses in the domain pool that triggers the BNG router to send an apportion alarm to APM.
   - The reclaim threshold value indicates the number of free addresses. APM compares the configured reclaim threshold value with a computed threshold value and uses the larger value. You compute the threshold value using this equation: computed reclaim threshold = apportion threshold + (prefix count * 2^(32 – preferred prefix length)) + 1
   - The hold-down timer suspends any potential reclaim event for a pool domain for the specified duration after an apportion event. You can set the `reclamation-hold-down` between 1 to 3600

seconds (default is 60 seconds), the `reclamation-hold-down` value should be greater than the computed threshold value.

```
[edit apm pool-domain-profile pool-domain-profile-name monitoring]
root@jnpr-apm-mgmt# set monitoring apportion-threshold apportion-threshold-count
root@jnpr-apm-mgmt# set monitoring reclaim-threshold reclaim-threshold-count
root@jnpr-apm-mgmt# set monitoring reclamation-hold-down <0 |1..3600>
```

3. (optional) Configure reclamation rules that the BNG router follows for the pool.
   - Specify whether automatic reclamation is always active or whether to use a window period for reclamation.
   - The `window-duration` option specifies how long the reclamation window stays open.
   - The `window-start` option specifies the daily start time scheduled for the reclamation. The window for reclamation is open for the length of the window duration.

```
[edit apm pool-domain-profile pool-domain-profile-name monitoring]
root@jnpr-apm-mgmt# set autoreclamation active always | window window-duration minutes window-start time
root@jnpr-apm-mgmt#
```

## Configure Attributes for Managing BNGs

Configure attributes that identify a managed BNG and define the pool domains on the BNG.

The entity-match list maps valid entities to a pool domain profile. The `entity-match` command directs incoming APM entities to a pool domain profile. APM reconciles it's pool domains with the BNG's list such that the APM list matches the BNGs list. If an APM entity (identified by its system-id) is not present in the entity-match list, it's not allowed to connect and the connection is aborted.

```
[edit apm entity-match system-id]
root@jnpr-apm-mgmt# set pool-domain-profife domain-profile-name
```

## Configure a Secure Incoming Connection for APM

With APM, you can secure an incoming connection by defining secrets and you can use the entity-match command to map valid entities to a pool-domain-profile.

1. Specify the number of entity clients that are allowed to connect to the APM server.

```
[edit apm]
root@jnpr-apm-mgmt# set system max-clients
```

2. Specify the APM security parameters for incoming APM connections. For dynamically managed BNGs, use the `entity-clients` command to define any secrets used to secure the incoming connection.

**NOTE**: The `filenames` provided in this configuration must match the security key and certificate files you provided during the setup.

- ```
  [edit apm]
  root@jnpr-apm-mgmt# set entity-client
  ```

- Specify root public key certificate file.

```
[edit apm entity-client]
root@jnpr-apm-mgmt# set secrets root-certificate filename
```

- Specify the private key file for APM.

```
[edit apm entity-clients]
root@jnpr-apm-mgmt# set secrets private-key filename
```

- Specify the certificate file for APM.

```
[edit apm entity-clients]
root@jnpr-apm-mgmt# set secrets certificate filename
```
```

# Monitor APM Operations

IN THIS SECTION



## Purpose

Use the APM `show` commands to display status and address utilization information about all BNGs that are under management. You can add qualifiers to the commands to display information more specifically by partition and pool domain.

From configuration mode, exit to the top-level CLI prompt, and then enter the required `show` commands.

```
[edit apm]
root@jnpr-apm-mgmt# exit
root@jnpr-apm-mgmt> show command-options
```

## Action

- Display the overall prefix utilization; that is, how many prefixes APM has available, reserved, or allocated, for all partitions.

```
root@jnpr-apm-mgmt> show apm inet-pool utilization

Partition           Prefixes    Reserved    Allocated
new-england         7           0           4
wholesalers         3           0           2
vpn                 15          0           7
```

- Display the prefix utilization for a single partition.

```
root@jnpr-apm-mgmt> show apm inet-pool utilization partition new-england
```

```
Partition Statistics
    Partition Name:  new-england
    Prefixes:        7
    Reserved:        0
    Allocated:       4
    Prefix           Prefixes    Reserved    Allocated
    203.0.113.0/24   7           0           4
```

- Display the prefix utilization for a single partition and prefix.

```
root@jnpr-apm-mgmt> show apm inet-pool utilization partition new-england prefix 203.0.113.0/24
Partition Statistics:
    Partition Name:  new-england
    Prefixes:        7
    Reserved:        0
    Allocated:       4
    Prefix Statistics:
        Prefix:             203.0.113.0/24
        Total sub-prefixes: 7
        Total reserved:     0
        Total allocated:    4
        Prefix Length    Free        Allocated
        24               0           1
        25               1           1
        26               2           2
```

- Display information about all associated BNGs.

```
root@jnpr-apm-mgmt> show apm entity

root@jnpr-apm-mgmt> show apm entity
Entity ID                     APMi Ver  Name         Status    Pool Domains
test-002                      1                     reachable 1
10.9.164.40                    0         yarmouth    reachable 1
```

- Display detailed information about a specific BNG.

```
root@jnpr-apm-mgmt> show apm entity id test-002

Entity Statistics
```

```
  ID      :  test-002
  APMi Ver:  1
  Name    :  test-002
  Status  :  reachable
  Pool Domain               Last Discovery         Pools       Last Allocation
Allocations   Last Reclamation      Reclamations
  iroh-default              2022-03-29T22:11:55Z   1           2022-03-29T22:11:55Z
1             -                     0
          -                  0
```

- Display detailed information about a BNG's pool domain.

```
root@jnpr-apm-mgmt> show apm entity id test-002 pool-domain iroh-default
Entity Statistics:
  Entity ID:  test-002
  APMi Ver :  1
  Name     :  test-002
  Status   :  reachable
  Pool Domain Statistics:
    Pool Domain     :  iroh-default
    Source Partition:  westford
    Free Addresses  :  245
    Pool Head       :  iroh-default
    Pools           :  1
    Thresholds:
      Apportion  :  200
      Reclamation:  457
    Events:
      Last Discovery  :  2022-03-28T13:05:27Z
      Last Allocation :  2022-03-28T13:05:27Z
      Last Reclamation:  -
      Allocations     :  1
      Reclamations    :  0
    Alarms:
      Apportion   :  1
      Reclamation :  0
      Pool-drained:  0
      Abatement   :  0
    Pool                          Prefix              Total Addrs    Used Addrs
    iroh-default                  192.168.41.0/24     255            10
```

- Display the number of allocations made by each partition.

```
root@jnpr-apm-mgmt> show apm inet-pool allocation

Partition           Allocations
new-england         4
wholesalers         2
vpn                 7
```

- Display information about how addresses are allocated for a specific partition across all BNGs.

```
root@jnpr-apm-mgmt> show apm inet-pool allocation partition wholesalers

Filter fields:     partition=wholesalers, entity=
Source Partition      Prefix               Entity Address    Pool Domain
wholesalers           198.51.100.100/25    192.0.2.108        cust-a970
wholesalers           198.51.100.200/25    192.0.2.108        cust-a970
wholesalers           198.51.100.1/25      192.0.2.233        L3-001a
```

- Display information about how addresses are allocated for all partitions on a specific BNG.

```
root@jnpr-apm-mgmt> show apm inet-pool allocation entity 192.0.2.108

Filter fields:     partition=, entity=192.0.2.108
Source Partition      Prefix               Entity Address    Pool Domain
new-england           203.0.113.10/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.20/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.30/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.40/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.50/24      192.0.2.108        mx480-a3-red
new-england           203.0.113.60/24      192.0.2.108        mx480-a3-red
wholesalers           198.51.100.100/25    192.0.2.108        cust-a970
wholesalers           198.51.100.200/25    192.0.2.108        cust-a970
vpn                   192.0.2.0/25         192.0.2.108        local56
```

- Display information about how addresses are allocated for one partition on a specific BNG.

```
root@jnpr-apm-mgmt> show apm inet-pool allocation entity 192.0.2.108 partition new-england
```

```
Filtered Partition Allocations
Filter fields:     partition=new-england, entity=192.0.2.108
Source Partition      Prefix               Entity Address    Pool Domain
new-england           203.0.113.10/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.20/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.30/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.40/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.50/24      192.0.2.108        mx480-a3-red
new-england           203.0.113.60/24      192.0.2.108        mx480-a3-red
```

# Configure the BNG Router

**IN THIS SECTION**



Read this topic to learn how to configure the border network gateway (BNG) router to use Juniper Address Pool Manager (APM) as the IP address pool manager. You use APM to manage a central pool of IPv4 addresses across multiple pool domains on different BNG routers. APM requires BNG routers to be running a supported Junos OS Release.

**NOTE**: For configuring Juniper BNG CUPS for APM, see the Juniper BNG CUPS User Guide on Juniper.net.

APM and the BNG router communicate and send each other information over a gRPC channel. Upon initial connection or reconnection, APM initiates a process to synchronize pool domain information and to reconcile pool domains on the BNG against its own database. The BNG router monitors pool utilization and notifies APM over the gRPC channel when the number of free addresses in the pool domain crosses one of the following defined thresholds:

- Apportion threshold
- Reclaim threshold

For more information about thresholds, see "How APM Works" on page 4.

The general steps for configuring the BNG router is as follows:

1. Configure secrets on the BNG. You must have already created the necessary keys and certificates. See "Configure a Secure Incoming Connection for APM " on page 36
   - Root certificate authority (CA) certificate
   - BNG certificate
   - BNG private keypair
2. Set the source partition name by using the `set system services subscriber-management location` *`partitionName`* `statement`.
3. Create a routing instance and specify a domain profile that has information about allocating prefix addresses from the APM-managed partitions. See "Configure a Routing Instance and the Pool Domain Attributes for APM" on page 42.

## Configure a Routing Instance and the Pool Domain Attributes for APM

Follow these steps to enable the BNG router to use APM and to configure the pool domain attributes that APM uses in creating a partition. You can create the domain profile in the default routing instance or for a specified routing instance.

1. Enable the BNG to use APM.

```
[edit access]
user@host# set address-pool-manager{
    inet 192.168.0.0;
    port 20557;
    system-id test2;
```

2. (Optional) Secure the APM connection by configuring the secrets stanza. Copy the root CA's certificate, BNG Certificate, and BNG private key to the BNG's file system. Edit the `access address-pool-manager` statement and provide the full path to the key and certificate files.

```
[edit access]
address-pool-manager {
    secrets {
        certificate /var/home/regress/myBng.crt;
```

```
        key /var/home-regress/myBng.key;
        ca-cert /var/home/regress/rootCA.crt;
```

3. Configure a profile name under the `[edit access address-assignment]` hierarchy. The profile name should match the framed pool name that is returned by the authentication server.

```
[edit access address-assignment]
user@host# set domain-profile profile-name family inet
```

4. Configure pool domain information for APM to use in allocating prefixes. The pool domain information includes the following:

   a. Prefix size that APM should use to provision the pool domain.

   b. The IP addresses that APM excludes from being allocated in the pool domain.

   c. (Optional) Support for install discard routes. When you enable `install-discard-routes`, the BNG router routes traffic to the subscriber with the assigned IP address and discards all other traffic in that subnetwork. To keep the static routes from timing out due to inactivity or disconnection, you must also set the purge timeout to `never`.

   d. (Optional) A qualifier for the partition. The source partition qualifier name is appended to the location name. If a qualifier name is not specified, then the BNG router appends `default` to the location name.

```
[edit access address-assignment domain-profile profile-name family inet ]
user@host# set preferred-prefix-length 25
user@host# set excluded-address last-octet 255
user@host# set excluded-address last-octet 0
user@host# set install-discard-routes
user@host# set source-partition-qualifier name
```

## Results

After following the steps above, use the `show` command to verify the results of your configuration.

```
user@host> show access address-assignment

 domain-profile profile test1 {
```

```
        family {
            inet {
                preferred-prefix-length 24;
                excluded-address last-octet [ 255 0 ];
                install-discard-routes;
                source-partition-qualifier spq-name;
            }
        }
    }
```

# APM CLI Configuration Statements

SUMMARY

IN THIS SECTION



## auto-reclamation (APM)

IN THIS SECTION

## Syntax

```
auto-reclamation {
    active (always | window);
    window-duration minutes;
    window-start time-offset;
    }
```

## Hierarchy Level

```
[edit apm pool-domain-profile domain-profile-name]
```

## Description

Configure APM to automatically drain pools and recover their prefixes for use in other pools.

**NOTE**: You enable `auto-reclamation` by configuring the `auto-reclamation` stanza. When configuring the `auto-reclamation` stanza, you must configure it with at least one active option (**always** or **window**).

**NOTE**: APM cancels all pending drain and recovery transactions when you remove `auto-reclamation` from the configuration.

## Options

**active (always | window)**

Specify when automatic reclamation is active.

- `always`—APM always evaluates pools that are critical or idle to determine whether to initiate reclamation.
- `window`—APM evaluates pools for reclamation only during the time window that you define with the `window-start` and `window-duration` options. If either of these options is set to 0, APM acts as if you configured the `always` option.

> **NOTE**: A pool is reclaimed after the window expires if both of the following occur:
>
> - The pool begins draining but doesn't complete it during the time window. This means that the pool still has some addresses and is therefore not idle.
> - The pool continues to drain and becomes idle after the window expires.

> **NOTE**: If the pool is idle, the pool is reclaimed outside of the window.

- **Default:** `always`

**window-duration *minutes***

Specify (in minutes) how long the window is open from the `window-start` time for APM to evaluate pools and initiate reclamation.

- **Default:** 60 minutes
- **Range:** 15 through 720 minutes

**window-start *time-offset***

Specify the window start time using the cluster's local time including its UTC offset. For example, if the cluster nodes are set to use a UTC offset of -5 hours and you want the auto-reclamation window to start at 4:00 AM, set the window start time to **04:00-0500**.

### Release Information

Statement introduced in APM Release 3.0.0.

## entity-match (APM)

IN THIS SECTION

### Syntax

```
entity-match system id  {
    pool-domain-profile domain-profile-name
}
```

### Hierarchy Level

```
[edit apm]
```

### Description

Configure the entity-match list to map valid BNGs to a pool-domain-profile.

The `entity-match` statement identifies. An entity-match statement directs incoming APM entities to a pool-domain profile. APM reconciles its pool domains with the BNG's list so that the two lists match. If any domains are deleted during reconciliation, they have their associated pool prefixes returned to their original partition. If a domain is empty at the end of reconciliation, both APM and the BNG remove the pool domain from their list. If an APM entity (identified by its system-id) is not present in the entity-match list, it's not allowed to connect and the connection is aborted.

### Options

**entity-match** *system-id* — Specify the system-id of the entity. The system-id is a unique string of up to 45 characters assigned to the managed BNG. It's used to identify the entity to APM upon successful connection.

**pool-domain-profile** *domain-profile-name* — The pool domain profile to use for this system.

## inet-pool (APM)

**IN THIS SECTION**

## Syntax

```
inet-pool {
    partition partition-name {
        free-prefix-utilization percentage;
        max-prefix-len max-prefix-length;
        min-prefix-len min-prefix-length;
        role [origin | backup];
        backup-partition partition-name;
        prefix ip-address {
            max-prefix-length max-prefix-length;
            prefix-recycle-hold seconds;
            route-tag tag;
        }
    }
}
```

## Hierarchy Level

```
[edit apm]
```

## Description

Configure how APM partitions its global pool of IPv4 addresses and how it allocates addresses to individual BNG pool domains. The address pool defined by the `inet-pool` statement consists of multiple partitions that you create to define allocation contexts. You configure multiple root prefixes for each partition. You can specify the minimum and maximum size of root prefixes that are valid for the partition. You specify the smallest subnetwork that APM can subdivide from a particular root prefix. APM subdivides the root prefixes and allocates the resulting subnetworks to individual pool domains as needed to supplement the domain's available addresses.

## Options

**partition** *partition-name*
Set the name of the partition.

**free-prefix-utilization** *percentage*
Set the minimum threshold percentage for unallocated prefixes in the partition. When the percentage drops below this value, a warning message is generated to indicate that the partition is running low on available addresses. The notification is only informative and triggers no other actions.

- **Default:** 10
- **Range:** 0 through 100

**max-prefix-length** *max-prefix-length*
Define the size of the root prefix that is valid in this partition. This configuration sets the upper limit on valid prefix lengths for the root prefixes in this partition. This upper limit defines the root prefix with the fewest host addresses to apportion. As the prefix length increases, APM can subdivide fewer subordinate prefixes from the root prefix.

- **Default:** 24
- **Range:** 1 through 31

The `max-prefix-len` value is the maximum number of bits used in defining a subnetwork. It must be greater than or equal to the `min-prefix-len` value. Otherwise, APM does not add the prefix to the partition.

**min-prefix-len** *min-prefix-length*
Define the largest-sized subnetwork that is valid in this partition. This configuration sets the lower limit on valid prefix lengths for the root prefixes in this partition. This lower limit defines the root prefix with the most host addresses to apportion. As the prefix length decreases, APM can subdivide more subordinate prefixes from the root prefix.

- **Default:** 8
- **Range:** 1 through 31

The `min-prefix-len` value must be less than or equal to the `max-prefix-len` value. Otherwise, APM does not add the prefix to the partition.

**role**
The role of the partition. If a role is not configured, origin is assumed by default. The role can be one of the following:

- **origin**—The source partition from which APM allocates addresses to a pool domain.
- **backup**—The backup partition from which APM allocates addresses to a pool domain when an associated origin partition is depleted.

**backup-partition** *partition-name*

Name of the backup partition from which APM allocates addresses to a pool domain. The `backup-partition` statement can be configured only if the following requirements are met:

- The role of the partition is `origin`.
- The backup partition exists in the configuration.
- The backup partition's and the origin partition's `min-prefix-len` and `max-prefix-len` match.
- The backup partition's prefixes do not overlap with the origin's prefixes.
- The backup partition's role is set to backup.

**prefix** *ip-address*

Specify the root prefix for the partition. APM subdivides subnetworks from this root to provision addresses for a BNG's pool domains. The root prefix length must be within the range defined by the values of the partition-level `min-prefix-len` and `max-prefix-len` options. You typically configure more than one root prefix per partition.

- `max-prefix-length` *max-prefix-length*—Define the granularity of the root prefix and the smallest prefix that APM can subdivide from the specified root prefix. As the prefix length increases, the size of the subnetwork decreases.
  - **Default:** 24
  - **Range:** 1 through 31
- `prefix-recycle-hold` *seconds*—Specify the duration, in seconds, that APM will hold on to the reclaimed prefix before it can be made available for allocation.
- `route-tag` *tag*—Specify a list of numbers to be used as route tags that the router associates with the route when it creates a static discard route for the prefix. APM cycles through the route-tag list in a round-robin fashion each time a sub-prefix is allocated from the root prefix.
- **Range:** 5 through 300

## Release Information

Statement introduced in APM Release 3.0.0.

# pool-domain-profile (APM)

IN THIS SECTION



## Syntax

```
pool-domain-profile domain-profile-name {
    auto-reclamation {
        active (always | window);
    }
    monitoring {
        apportion-threshold apportion-threshold-count;
        reclaim-threshold reclaim-threshold-count;
        reclamation-hold-down <0|30..3600>;
    }
}
```

## Hierarchy Level

```
[edit apm]
```

## Description

Configure the pool domain profiles that are used to create pool domains on BNGs during apportionment. The profile specifies the number of prefixes that will be apportioned, thresholds that the BNGs will monitor, and whether automatic reclamation is active.

## Options

**pool-domain-profile** *domain-profile-name*

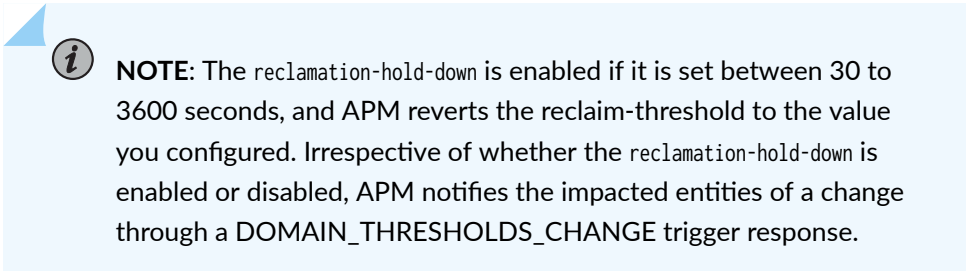
Pool domain profile name.

**monitoring**

Set the attributes for monitoring how a pool domain and the pools within a pool domain are using addresses. Thresholds for free (available) and used (allocated) addresses establish the points at which APM generates an alarm.

- `apportion-threshold` *apportion-threshold-count*—Set the minimum number of available addresses in the pool domain that triggers a provisioning event.
- `reclaim-threshold` *reclaim-threshold-count*—Set the reclaim threshold for pool domains created from this profile. If reclamation-hold-down is disabled (set to 0), APM compares the set reclaim threshold value to a computed threshold value and uses the larger value. The computed threshold value is derived from the equation computed threshold = apportion-threshold + (prefix-count * 2^(32 – preferred-prefix-len)) + 1.
- `reclamation-hold-down`—Set the duration in seconds for the entity to suspend any potential event for a pool domain after an apportion event. Configuring a non-zero reclamation-hold-down value allows you to set lower `reclaim-threshold` values which may be useful when the pool-domain is idle (results in fewer allocated pool prefixes left on the entity). As an apportion event containing reclaim multiple prefixes might temporarily push the number of free addresses above the reclamation threshold, suppressing reclamation events for a specified time allows the subscriber-login rate to catch up with the apportioned prefix set. If the apportion event adds addresses to a pool domain such that the pool domain's free-address count is above the reclaim-threshold, you want to supress generating a reclaim event until the number of free addresses falls below the reclaim threshold.
  - **Default:** 0

    The `hold-down timer` is disabled if it has a value of 0.
  - **Range:** 1 to 3600

  **NOTE**: The `reclamation-hold-down` is enabled if it is set between 30 to 3600 seconds, and APM reverts the reclaim-threshold to the value you configured. Irrespective of whether the `reclamation-hold-down` is enabled or disabled, APM notifies the impacted entities of a change through a DOMAIN_THRESHOLDS_CHANGE trigger response.

Some statements are explained separately. Click the linked statement in the Syntax section for details.

### Release Information

Statement introduced in APM Release 3.0.0.

`reclamation-hold-down` option introduced in 3.1.0

## system (APM)

**IN THIS SECTION**



### Syntax

```
system {

    transaction-time-out seconds;
    max-clients <0..500>
}
```

### Hierarchy Level

```
[edit apm]
```

### Description

Configure the attributes that determine how APM behaves for alarms and transactions and define the number of APMi entities allowed to connect to APM.

### Options

`transaction-time-out` *seconds*

(Optional) Specify (in seconds) how long APM waits for a transaction to complete before it declares that the transaction has stalled (timed out). A transaction consists of a list of tasks. For example, an apportion transaction consists of a task to get an address, a task to provision the entity, and a task to update the runtime state. If any task in a transaction fails, the previously executed tasks in the list are rolled back. For example, if the provisioning task fails, then the task to get the address is rolled back, and the address is returned to the partition.

- **Default:** 240
- **Range:** 60 through 900

`max-clients <0..500>`

Specify the number of APMi entities allowed to connect to the APM server.

- **Default:** 0
- **Range:** 0 through 500

### Release Information

Statement introduced in APM Release 3.0.0.

`max-clients` option introduced in APM Release 3.1.0.

# APM CLI Operational Commands

**IN THIS SECTION**

This topic provides an overview of show commands, including syntax, option descriptions, and sample output. Use these commands in APM.

## request apm activate

IN THIS SECTION



### Syntax

```
request apm activate entity ip-address pool-domain name pool pool-name
```

### Description

Trigger APM to activate the specified pool by deleting the active drain on the pool. You can issue this command when the pool is in either of the following reclamation states:

- `drain`—The command removes the active drain before the BNG has configured the drain on the pool.
- `drain-set`—The command removes the active drain when the pool is being drained.

Use the `show apm reclaim-events` command on APM to check the pool's reclamation state.

**NOTE**: This command works only when the pool is in the `draining` or `drain-set` state as a result of manual reclamation. APM blocks the command when the reclamation state is the result of automatic reclamation.

## Options

| | |
|---|---|
| **entity** *ip-address* | Specify the IP address of the managed BNG that received the instruction. |
| **pool-domain** *name* | Specify the name of the pool domain that contains the targeted pool. |
| **pool** *pool-name* | Specify the name of the pool where the drain will be removed. |

## Required Privilege Level

root

## Sample Output

### request apm activate entity (Specific Pool)

```
user@host> request apm activate entity 10.4.4.108 pool-domain vs009afd pool jnpr-ipb-vs009afd-004

Pool jnpr-ipb-vs009afd-004 in pool domain vs009afd at entity 10.4.4.108 has activated.
```

## Release Information

Statement introduced in APM Release 3.0.0.

# request apm drain

IN THIS SECTION



## Syntax

```
request apm drain entity ip-address pool-domain name pool pool-name
```

## Description

Trigger APM to instruct the specified BNG to drain the specified pool in the pool domain. When the drain is in place on the pool, it cannot allocate any addresses. You can request a drain when the pool has the reclaim status. If there is no drain placed on the pool, the BNG can still allocate addresses.

Use the `show apm alarms` command to display the alarm status. Use the `show apm reclaim-events` command to check the reclamation state; A `drain` and `drain-set`output indicate that a drain has been requested or placed on the pool.

## Options

**entity** *ip-address* Specify the IP address of the managed BNG that receives the instruction.

**pool-domain** *name* Specify the name of the pool domain that contains the targeted pool.

**pool** *pool-name* Specify the name of the pool to drain.

### Required Privilege Level

root

### Sample Output

#### request apm drain

```
user@host> request apm drain entity 10.4.4.108 pool-domain vs009afd pool jnpr-ipb-vs009afd-004

Pool jnpr-ipb-vs009afd-004 in pool domain vs009afd at entity 10.4.4.108 has been set to drain.
```

### Release Information

Statement introduced in APM Release 3.0.0.

## request apm reclaim

IN THIS SECTION



### Syntax

```
request apm reclaim entity ip-address pool-domain name pool pool-name
```

## Description

Trigger APM to instruct the specified BNG to deprovision the specified pool in the pool domain. When the pool is deprovisioned, APM returns the addresses that had been assigned to the pool to the source partition for reallocation. The pool must be idle, meaning that it has no addresses in use. The command fails if any addresses are still in use.

**NOTE**: This command works only when the pool is in the `drain-set` reclamation state as a result of manual reclamation. APM blocks the command when the pool state is the result of automatic reclamation.

## Options

| | |
|---|---|
| **entity** *ip-address* | Specify the IP address of the managed BNG that receives the instruction. |
| **pool-domain** *name* | Specify the name of the pool domain that contains the targeted pool. |
| **pool** *pool-name* | Specify the name of the drained pool from which addresses are recovered. |

## Required Privilege Level

root

## Sample Output

### request apm reclaim (Specific Pool)

```
user@host> request apm reclaim entity 10.4.4.108 pool-domain vs009afd pool jnpr-ipb-vs009afd-004
Pool jnpr-ipb-vs009afd-004 in pool-domain vs009afd at entity 10.4.4.108 has been reclaimed.
```

## Release Information

Statement introduced in APM Release 3.0.0.

# request apm release entity

IN THIS SECTION



## Syntax

```
request apm release entity system-id
```

## Description

Trigger APM to clean up any pool domains established by the entity, and release an entity's domains and their associated pool prefixes back to each domain's source partition. If the access network isn't using an entity's APM-allocated prefixes, APM forces the cleanup of any domains and deallocates the associated pool prefixes in each domain's source partition. This command works only if the entity is unreachable or disconnected. A list of prefixes that were released and the associated target partition displays upon success.

**NOTE**: Releasing the prefixes makes them available to other entities whose address pools are managed by APM and use the same partition. If you're not careful to ensure that the entity's prefixes are no longer in use, reallocation to another entity could cause duplicate addresses, routing loops, and so on.

## Options

| | |
|---|---|
| `entity` *system-id* | Specify the system-id of the entity. The system-id is a unique string of up to 45 characters assigned to the managed BNG. It identifies the entity to APM upon successful connection. |

### Required Privilege Level

root

### Sample Output

#### request apm drain

```
user@host> request apm release entity test-002

Released Prefix Destination Partition
192.168.0.0/24  westford
192.168.1.0/24  westford
192.168.2.0/24  westford
192.168.3.0/24  westford
192.168.4.0/24  westford
```

### Release Information

Statement introduced in APM Release 3.1.0.

## show apm alarms

IN THIS SECTION

## Syntax

```
show apm alarms
<entity ip-address>
<pool-domain name>
```

## Description

Display all pending pool domain alarms. You can display alarms across all managed routers, or you can limit the display to a specific BNG router or pool domain.

## Options

**entity** *ip-address* (Optional) Display the alarms for the specified router.

**pool-domain** *name* (Optional) Display the alarms in the specified pool domain.

## Required Privilege Level

root

## Output Fields

Table 2 on page 62 lists the output fields for the `show apm alarms` command. Output fields are listed in alphabetical order.

**Table 2: show apm alarms Output Fields**

| Field Name | Field Description |
|---|---|
| `Entity` | IP address of the managed BNG. |
| `Pool Domain` | Name of the pool domain with the critical pool. |

**Table 2: show apm alarms Output Fields *(Continued)***

| Field Name | Field Description |
|---|---|
| Alarm | Name of the alarm.<br>• reclaim—When the number of free addresses for the pool domain on the BNG rises above the reclaim threshold, the BNG sends a reclaim alarm message with the name of the pool to APM. APM can then initiated an active drain for the pool domain.<br>• apportion—When the number of free addresses falls below the apportion threshold, the BNG sends an apportion alarm. APM responds by apportioning prefixes to be added to a pool domain.<br>• pool-drained—When a pool is completely drained, the BNG sends a pool-drained alarm letting APM know that the prefix allocated for the pool can be recovered. |
| Info | Name of the apportioned pool. |
| Age | How long an alarm has been outstanding. |

## Sample Output

### show apm alarms

```
user@host> show apm alarms
Entity        Pool Domain    Alarm                Info                  Age
10.4.4.108    vks009-default reclaim              vks009-default-0005   2:33:15
10.2.1.1      alpha-drop     reclaim              alpha-Drop-0000       3 days, 15:20:01
10.3.23.10    feeder-default apportion            -                     0:0:10
152.13.5.5    azimuth-ri2    pool-drained         azimuth-ri2-0007      0:0:21
```

## Release Information

Statement introduced in APM Release 3.0.0.

# show apm entity

IN THIS SECTION



## Syntax

```
show apm entity
<id system-id>
<address ip-address>
<pool-domain name>
```

## Description

Monitor APMs associations with managed BNGs. You can specify a particular router or pool domain to view additional details.

## Options

| | |
|---|---|
| **id** *system-id* | Specify the `system-id` of the entity. The system-id is a unique string of up to 45 characters assigned to the managed BNG. It identifies the entity to APM upon successful connection. |
| **address** *ip-address* | Specify the IP address of the managed BNG to display information for only that BNG. |
| **pool-domain** *name* | Specify the name of a pool domain to display information for only that domain. |

## Required Privilege Level

root

## Output Fields

Table 3 on page 65 lists the output fields for the `show apm entity` command, in alphabetical order.

**Table 3: show apm entity Output Fields**

| Field Name | Field Description |
|---|---|
| `Allocations` | Number of allocations that APM has made to the pool domain. |
| `Entity Id` | Unique system id assigned to the entity. |
| `APMi Version` | APM version that the managed BNG uses to communicate. |
| `Entity Address` | IP address of the managed BNG. |
| `Entity Statistics` | Details about the managed router.<br>• `IP Address`—IP address of the managed BNG.<br>• `Name`—Name of the managed BNG.<br>• `Status`—Status of the connection to the BNG: `up` or `down`. |
| `Pool` | Name of a pool in the domain. An asterisk (*) next to the name indicates that an active drain has been configured for the pool. |

**Table 3: show apm entity Output Fields *(Continued)***

| Field Name | Field Description |
|---|---|
| Pool Domain Statistics | Details about the pool domain:<br>• Free addresses—Number of addresses in the pool domain that are available for allocation.<br>• Last Allocation—Timestamp when the last address allocation operation completed.<br>• Last Discovery—Timestamp when the last discovery operation completed.<br>• Last Reclamation—Timestamp when the last pool reclamation occurred.<br>• Pool Domain—Name of pool domain on the managed router.<br>• Pool head—Name of the domain's pool head.<br>• Pools—Number of pools in the pool domain.<br>• Reclamations—Number of pools in the domain that have been deprovisioned and their addresses recovered to the source partition for future use.<br>• Allocations—Number of prefixes (pools) that have been added to this pool domain.<br>• Source Partition— The partition from which prefixes have been allocated for this pool domain.<br>• Apportion Alarms—Number of apportion alarms sent for this pool domain.<br>• Reclamation Alarms—Number of reclamation alarms sent for this pool domain.<br>• Pool-drained Alarms—Number of pool-drained alarms sent for this pool domain. |
| Pool Domains | Number of pool domains on the managed BNG. |
| Prefix | Subnetwork allocated to an address pool. APM creates this prefix by subdividing the source partition's root prefix. |
| Status | Displays whether the entity is reachable or unreachable. |
| Used | Number of used addresses in the pool. The pool is idle when the value is zero. |

## Sample Output

### show apm entity (All BNGs)

```
user@host> show apm entity

root@jnpr-apm-mgmt> show apm entity
Entity ID                      APMi Ver  Name         Status    Pool Domains
test-002                       1                     reachable 1
10.9.164.40                     0         yarmouth    reachable 1
```

### show apm entity (Specific BNG)

```
user@host> show apm entity id test-002

Entity Statistics
  ID      :  test-002
  APMi Ver:  1
  Name    :  test-002
  Status  :  reachable
  Pool Domain                Last Discovery         Pools       Last Allocation
Allocations   Last Reclamation      Reclamations
  iroh-default               2022-03-29T22:11:55Z   1           2022-03-29T22:11:55Z
1             -                      0
          -                   0
```

### show apm entity (Pool Domain)

```
user@host> show apm entity id test-002 pool-domain iroh-default
Entity Statistics:
  Entity ID:  test-002
  APMi Ver :  1
  Name     :  test-002
  Status   :  reachable
  Pool Domain Statistics:
    Pool Domain     :  iroh-default
    Source Partition:  westford
    Free Addresses  :  245
```

```
Pool Head       :  iroh-default
Pools           :  1
Thresholds:
  Apportion  :  200
  Reclamation:  457
Events:
  Last Discovery  :  2022-03-28T13:05:27Z
  Last Allocation :  2022-03-28T13:05:27Z
  Last Reclamation:  -
  Allocations     :  1
  Reclamations    :  0
Alarms:
  Apportion   :  1
  Reclamation :  0
  Pool-drained:  0
  Abatement   :  0
Pool                          Prefix              Total Addrs    Used Addrs
iroh-default                  192.168.41.0/24     255            10
```

### Release Information

Statement introduced in APM Release 3.0.0.

<id *system-id*> option introduced in 3.1.0

## show apm generation

**IN THIS SECTION**

## Syntax

```
show apm generation
```

## Description

Displays the generation number for APM on each workload cluster. A generation number of 0 indicates that there is no generation number. An initial generation number is assigned to APM and each time APM undergoes a workload cluster switchover the generation number increases. The generation number is used to resolve deployment ambiguities (see "Use APM with Multiple Geographical Redundancy" on page 24).

## Required Privilege Level

root

## Output Fields

Table 3 on page 65 lists the output fields for the `show apm generation` command, in alphabetical order.

**Table 4: show apm generation Output Fields**

| Field Name | Field Description |
|---|---|
| `Cluster Name` | Name of the cluster. |
| `Generation Number` | An number that indicates the current switchover generation. Generation numbers start at 1. A value of 0 indicates that a generation number has not been assigned. |

## Sample Output

### show apm generation

```
user@host> show apm generation
Cluster Name                Generation Number
swwf-fedora-wl1             1
swwf-fedora-wl2             0
```

### Release Information

Statement introduced in APM Release 3.4.0.

## show apm inet-pool allocation

IN THIS SECTION



### Syntax

```
show apm inet-pool allocation
<entity ip-address>
<partition name>
```

### Description

Display information about how prefixes are allocated across all partitions, for a specific partition, for a specific entity, or for a specific partition on a specific entity.

### Options

**entity** *ip-address* Specify the IP address of the managed BNG to display information for only that BNG.

**partition** *name* Specify the name of a partition to display information for only that partition. The partition might be used for multiple BNGs.

## Required Privilege Level

root

## Output Fields

Table 5 on page 71 lists the output fields for the `show apm inet-pool allocation` command. Output fields are listed in alphabetical order.

**Table 5: show apm inet-pool allocation Fields**

| Field Name | Field Description |
|---|---|
| `Allocations` | Number of allocations that APM has made from a partition. |
| `Entity Address` | IP address of the managed BNG. |
| `Backup` | Name of the backup partition from which APM allocates addresses to a pool domain. |
| `Backup-allocations` | The number of prefixes allocated from the backup partition. |
| `Filter fields` | Filters applied to the output before it is displayed. The filters correspond to the qualifiers you specify when you issue the command, such as a partition name or entity IP address. |
| `Partition` | Name of a partition from which APM allocates addresses to a pool domain. |
| `Pool Domain` | Name of a pool domain provisioned from the partition. |
| `Prefix` | Subnetwork allocated to an address pool. This prefix is split off from a partition's root prefix by APM. A given pool can have multiple allocated prefixes. |
| `Source Partition` | Name of a partition from which APM allocates addresses to a pool domain. |

## Sample Output

### show apm inet-pool allocation (All Partitions)

```
user@host> show apm inet-pool allocation
Partition    Backup          Allocations     Backup-allocations
westford     middlesex       3               0
billerica    middlesex       16              10
middlesex    -               10              -
```

### show apm inet-pool allocation (Specific Partition)

```
user@host> show apm inet-pool allocation partition billerica
Source Partition      Prefix               Entity Address    Pool Domain
billerica             192.48.0.0/24        yarmouth          iroh-default
billerica             192.48.1.0/24        yarmouth          iroh-default
billerica             192.48.2.0/24        yarmouth          iroh-default
billerica             192.48.3.0/24        yarmouth          iroh-default
billerica             192.48.4.0/24        yarmouth          iroh-default
billerica             192.48.5.0/24        yarmouth          iroh-default
billerica             192.48.6.0/24        yarmouth          iroh-default
billerica             192.48.7.0/24        yarmouth          iroh-default
billerica             192.48.8.0/24        yarmouth          iroh-default
billerica             192.48.9.0/24        yarmouth          iroh-default
billerica             192.48.10.0/24       yarmouth          iroh-default
billerica             192.48.11.0/24       yarmouth          iroh-default
billerica             192.48.12.0/24       yarmouth          iroh-default
billerica             192.48.13.0/24       yarmouth          iroh-default
billerica             192.48.14.0/24       yarmouth          iroh-default
billerica             192.48.15.0/24       yarmouth          iroh-default
billerica/middlesex   192.168.0.0/24       yarmouth          iroh-default
billerica/middlesex   192.168.1.0/24       yarmouth          iroh-default
billerica/middlesex   192.168.2.0/24       yarmouth          iroh-default
billerica/middlesex   192.168.3.0/24       yarmouth          iroh-default
billerica/middlesex   192.168.4.0/24       yarmouth          iroh-default
billerica/middlesex   192.168.5.0/24       yarmouth          iroh-default
billerica/middlesex   192.168.6.0/24       yarmouth          iroh-default
billerica/middlesex   192.168.7.0/24       yarmouth          iroh-default
```

```
billerica/middlesex   192.168.8.0/24        yarmouth          iroh-default
```

### show apm inet-pool allocation (Specific BNG)

```
user@host> show apm inet-pool allocation entity 192.0.2.108

Filter fields:     partition=, entity=192.0.2.108
Source Partition      Prefix               Entity Address    Pool Domain
new-england           203.0.113.10/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.20/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.30/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.40/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.50/24      192.0.2.108        mx480-a3-red
new-england           203.0.113.60/24      192.0.2.108        mx480-a3-red
wholesalers           198.51.100.100/20    192.0.2.108        cust-a970
wholesalers           198.51.100.200/20    192.0.2.108        cust-a970
vpn                   192.0.2.0/25         192.0.2.108        local56
```

### show apm inet-pool allocation (Specific Partition and BNG)

```
user@host> show apm inet-pool allocation entity 192.0.2.108 partition new-england

Filtered Partition Allocations
Filter fields:     partition=new-england, entity=192.0.2.108
Source Partition      Prefix               Entity Address    Pool Domain
new-england           203.0.113.10/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.20/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.30/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.40/24      192.0.2.108        mx480-a3-default
new-england           203.0.113.50/24      192.0.2.108        mx480-a3-red
new-england           203.0.113.60/24      192.0.2.108        mx480-a3-red
```

## Release Information

Statement introduced in APM Release 3.0.0.

# show apm inet-pool utilization

IN THIS SECTION



## Syntax

```
show apm inet-pool utilization
<partition name>
<prefix address/prefix length>
```

## Description

Display information about how prefixes are being used. You can display utilization for all partitions, for a specific partition, or for a specific prefix and partition.

## Options

| | |
|---|---|
| **partition** *name* | Specify the name of a partition to display address utilization for only that partition. |
| **prefix** *address/prefix-length* | Specify a root (source) prefix and partition name to display address utilization for only that combination. |

## Required Privilege Level

root

## Output Fields

Table 6 on page 75 lists the output fields for the `show apm inet-pool utilization` command. Output fields are listed in alphabetical order.

**Table 6: show apm inet-pool utilization Fields**

| Field Name | Field Description |
|---|---|
| `Allocated` | Number of prefixes that are currently allocated from a partition or from a partition's root prefix. It is possible for a prefix to be both reserved and allocated. |
| `Backup-partition` | Name of the backup partition for which APM allocates addresses to a pool domain. |
| `Partition Name` | Name of a partition from which APM allocates addresses to a pool domain. |
| `Prefix` | Route (source) prefix of a partition. Listed statistics are shown for all prefixes in a partition or for only that specific prefix in a specific partition. |
| `Prefixes` | Total number of prefixes available for allocation from a partition or from a partition's root prefix. |
| `Reserved` | Number of prefixes that are held in reserve from a partition or from a specific root prefix in a partition. |
| `Role` | The role of the partion. The role can be one of the following:<br>• origin<br>• backup |

**Table 6: show apm inet-pool utilization Fields *(Continued)***

| Field Name | Field Description |
|---|---|
| State | The threshold state of the partition. The threshold is set by the free-prefix-utilization statement at the [edit apm inet-pool partition *partition-name*] hierarchy level. A partition can have one of the following threshold states:<br>• empty<br>• above-threshold<br>• below-threshold |
| Prefix Statistics | The following statistics are displayed for a specified partition and root prefix combination:<br>• Prefix—Route (source) prefix of a partition for which statistics are displayed.<br>• Total sub-prefixes—Total number of subnetworks possible for the partition's root prefix.<br>• Total reserved—Total number of prefixes that are currently reserved for all subnetworks of the root prefix.<br>• Total allocated—Total number of prefixes that are currently allocated for all subnetworks of the root prefix.<br>• Prefix length—Length of a prefix subdivided from the partition's root prefix.<br>• Free—Number of prefixes that are currently unallocated or free for subnetworks of the root prefix, indicated by the prefix length.<br>• Allocated—Number of prefixes that are currently allocated for subnetworks of the root prefix, indicated by the prefix length. |

## Sample Output

### show apm inet-pool utilization (All Partitions)

```
user@host> show apm inet-pool utilization
```

```
user@host> show apm inet-pool utilization
Partition  Role      State           Prefixes    Reserved    Allocated
```

```
westford   origin    above-threshold  1023        0           19
billerica  origin    below-threshold  1023        0           1023
middlesex  backup    above-threshold  1023        0           10
```

### show apm inet-pool utilization (Specific Partition)

```
user@host> show apm inet-pool utilization partition westford
Partition Statistics
    Partition Name:   westford
    Role:             origin
    Backup-partition: middlesex
    State:            below-threshold
    Prefixes:         1023
    Reserved:         0
    Allocated:        1023
    Prefix           Prefixes    Reserved    Allocated
    192.168.0.0/16   1023        0           19
```

### show apm inet-pool utilization partion *pation-name* prefix

```
user@host> show apm inet-pool utilization partition westford prefix 192.168.0.0/16
Partition Statistics
    Partition Name:        westford
    Role:                  origin
    Backup-partition:      middlesex
    State:                 above-threshold
    Prefixes:              1023
    Reserved:              0
    Allocated:             26
    Allocated-from-backup: 0
    Prefix Statistics:
        Prefix:             192.168.0.0/16
        Total sub-prefixes: 1023
        Total reserved:     0
        Total allocated:    26
        Prefix Length    Free        Allocated
        16               0           1
        17               1           1
        18               3           1
        19               7           1
```

```
20              15          1
21              31          1
22              62          2
23              125         3
24              251         5
25              502         10
```

### Release Information

Statement introduced in APM Release 3.0.0.

## show apm reclaim-events

**IN THIS SECTION**



### Syntax

```
show apm reclaim-events
<entity ip-address>
<pool-domain name>
```

## Description

Display information about active pool reclamation events for all BNGs, for a specific BNG, or for a specific BNG and pool domain.

## Options

**entity** *ip-address* Specify the IP address of the managed BNG to display information for pools in only that BNG.

**pool-domain** *name* Specify the name of a pool domain to display information for pools in only that domain.

## Required Privilege Level

root

## Output Fields

Table 7 on page 79 lists the output fields for the `show apm reclaim-events` command. Output fields are listed in alphabetical order.

**Table 7: show apm reclaim-events Fields**

| Field Name | Field Description |
|---|---|
| `Entity` | IP address of a managed BNG. |
| `Pool Domain` | Name of a pool domain. |
| `Pool` | Name of a pool in the pool domain. |

**Table 7: show apm reclaim-events Fields *(Continued)***

| Field Name | Field Description |
|---|---|
| State | Current reclamation state of the pool:<br>• draining—APM has sent instructions to the BNG to configure an active drain on the pool. The pool is not yet draining. This is a transient state. When the draining operation completes, the state transitions to drain-set.<br>• drain-set—The BNG has configured a drain on this pool in response to instructions from APM. The pool cannot allocate any addresses. This means that the pool is idle.<br>• pending—The pool is in the process of being deprovisioned (removed from the BNG) by APM. This is a transient state. If this operation fails, the state transitions back to drain-set.<br>Deprovisioning and address recovery follow this sequence:<br>1. BNG notifies the provisioning manager when the last address in use in the pool is freed.<br>2. APM sends deprovisioning instructions to the router.<br>3. When the router finishes deprovisioning the pool, the pool entry disappears from show command output.<br>4. APM puts the drained addresses back in the associated partition for future allocation. |

## Sample Output

### show apm reclaim-events (Specific Entity)

```
user@host> show apm reclaim-events entity 10.4.4.108

Entity        Pool Domain    Pool                     State
10.4.4.108    vks009afd      jnpr-ipb-vs009afd-0003   draining
10.4.4.108    uk001bnf       jnpr-ipb-uk001bnf-0001   pending
```

## Release Information

Statement introduced in APM Release 3.0.0.

# Junos OS CLI Configuration Statements


**SUMMARY**

This topic provides an overview of Junos OS configuration commands used on the BNG router. For an overview of Junos OS configuration commands see the Junos OS Documentation.


**IN THIS SECTION**



## address-pool-manager

**IN THIS SECTION**



### Syntax

```
address-pool-manager {
     system-id unique-identifier;
     inet ip-address;
     port port-number;
     secondary-address {
        inet ip-address;
        port port-number;
     }
     secrets {
```

```
          certificate certificate-file;
          key         private-key-file;
          ca-cert     cacertificate-file;
      }
  }
```

## Hierarchy Level

```
[edit access]
```

## Description

Enable Address Pool Manager (APM) services on the router. APM provisions prefixes from a centralized address pool to a BNG before the BNG's address pools are depleted.

## Options

**system-id *unique-identifier*** A unique network string identifier.

- **Range:** Up to 45 characters

**inet *ip-address*** APM's IPv4 address.

**port *port-number*** The port that APM listens on for incoming connections.

**secondary-address** (Optional) A second transport address that APM uses when it is set up for a multiple geographic multiple cluster environment. If the primary connection is lost, the BNG or BNG CUPS Controller cycles to the next transport address and attempts to connect to APM.

- inet *ip-address*—The secondary IPv4 address.
- port *port-number*—The secondary port that APM listens on for incoming connections.

**secrets** If the gRPC Network Management Interface (gMI) connection is secured, configure any Transport Layer Security (TLS) keys, as follows:

- certificate *certificate-file*
- key *private-key-file*
- ca-cert *ca-certificate-file*

### Required Privilege Level

access

### Release Information

Statement introduced in Junos OS Release 21.3R1.

## domain-profile

**IN THIS SECTION**



### Syntax

```
domain-profile name {
 family {
  inet {
   excluded-address last-octet octet;
   install-discard-routes;
   preferred-prefix-length preferred-prefix-length;
```

```
    source-partition-qualifier source-partition-qualifier;
   }
  }
 }
```

## Hierarchy Level

```
[edit access address-assignment],
[edit logical-systems name access address-assignment],
[edit logical-systems name routing-instances name access address-assignment],
[edit logical-systems name tenants name routing-instances name access address-assignment],
[edit routing-instances name access address-assignment],
[edit tenants name routing-instances name access address-assignment]
```

## Description

Define the domain profile. The domain profile matches the framed pool attribute that is assigned to subscribers during their login sessions.

## Options

| | |
|---|---|
| *name* | Name of the pool domain profile. |
| **family inet** | Specify that Internet Protocol version 4 will be used for the address assignment pool. |
| **excluded-address last-octet** *octet* | Exclude an IP address from being allocated in the pool.<br>Range: 0 through 255. |
| **install-discard-routes** | Enable discard routes. |
| **preferred-prefix-length** *preferred-prefix-length*; | Specify the preferred prefix length to be used in the pool.<br>• **Range:** 8 through 30 |
| **source-partition-qualifier** | Specify a name to be appended to the location name to identify the part of the partition that will be allocated. |

The remaining statements are explained separately. See CLI Explorer.

### Required Privilege Level

access

### Release Information

Statement introduced in Junos OS Release 21.3R1.

**SEE ALSO**

Address-Assignment Pools for Subscriber Management

## location

**IN THIS SECTION**



### Syntax

```
location location;
```

### Hierarchy Level

```
[edit system services subscriber-management]
```

### Description

Location option represents the partition name to use for dynamic pool allocation on an aggregated BNG.

### Options

*location* The location defines the geographical position or area that the system (BNG) belongs to. The default location, if location is not specified, is `default`. The location is also used as the base partition name for dynamic pool allocation.

### Required Privilege Level

system—To view this statement in the configuration.

system-control—To add this statement to the configuration.

### Release Information

Statement introduced in Junos OS Release 22.1R1.

# Junos OS Operational Commands

**SUMMARY**

This topic provides an overview of `show` commands used on the BNG router. This includes syntax, option descriptions, and sample output. For an overview of `show` commands used on the BNG

**IN THIS SECTION**

CUPS router, see the *Juniper BNG CUPS User Guide* on Juniper.net.



# request network-access aaa address-assignment domain-profile

IN THIS SECTION



## Syntax

```
request network-access aaa address-assignment domain-profile profile-name <profileName> ri-name
<riName> <disable-logins | enable-logins>
```

## Description

Use to disable subscriber logins against the domain profile effectively allowing the domain-profile to drain. Once all domains created from the profile have been cleaned up, the domain-profile may be safely deleted from configuration. A domain-profile cannot be deleted from configuration while there are existing domains (and associated pools) created from it.

### Options

| | |
|---|---|
| *profile-name* | Domain profile name. |
| *ri-name* | Routing instance name. |
| **disable-logins** | Disable subsequent logins. |
| **enable-logins** | Enable subsequent logins. |

### Required Privilege Level

view

### Sample Output

#### request network-access aaa address-assignment domain-profile

```
user@host> request network-access aaa address-assignment domain-profile profile-name techPark ri-name default disable-logins
```

## show network-access address-assignment address-pool-manager status

IN THIS SECTION

## Syntax

```
show network-access address-assignment address-pool-manager status
```

## Description

Display the status information for APM when it is connected to the BNG router.

## Required Privilege Level

view and system

## Output Fields

Table 8 on page 89 lists the output fields for the `show network-access address-assignment address-pool-manager status` command. Output fields are listed in the approximate order in which they appear.

**Table 8: show network-access address-assignment address-pool-manager status Output Fields**

| Field Name | Field Description |
|---|---|
| `State` | Connection status of APM; `connected` or `disconnected`. |
| `SystemID` | APM's external IP address. |
| `Security` | Security is either clear-text or `TLS` |
| `Apportionment` | Apportionment is either `Remote` (pool prefixes are sourced from APM) or `Local` (pool prefixes are sourced from Local Reserve). |

## Sample Output

### show network-access address-assignment address-pool-manager status

```
user@host> show network-access address-assignment address-pool-manager status
APM:
    State: connected
```

```
    SystemId: 192.168.0.0
    Security: TLS
Apportionment: Remote
```

## show network-access address-assignment domain

IN THIS SECTION



### Syntax

```
show network-access address-assignment domain
<name name>
<routing-instance routing-instance-name>
```

### Description

Display the status information of each pool domain (linked address pool) managed by APM, including a the number of alarms sent to APM by a pool domain

### Options

| | |
|---|---|
| **none** | Display a summary of all domains for the default routing instance. |
| **name** *name* | (Optional) Display the status information for the domains created from the specified profile name. |

**routing-instance** *routing-instance-name* (Optional) Display the status information for the specified routing instance. If no routing instance is specified, the output displays the default pool domain.

## Required Privilege Level

view and system

## Output Fields

Table 9 on page 91 lists the output fields for the `show network-access address-assignment domain` command. Output fields are listed in the approximate order in which they appear.

**Table 9: show network-access address-assignment domain Output Fields**

| Field Name | Field Description |
|---|---|
| Domain Name | Domain pool name. |
| `Head` | Name of the domain's pool head. |
| `Pool Count` | The number of pools linked to the pool domain. |
| `Addresses` | Total number of IP addresses in the pool. |
| `Free` | Number of free IP addresses. |
| `Apport` | Number of apportion alarms. Apportion alarms are sent when the number of free addresses falls below the apportion threshold. |
| `Reclaim` | Number of reclaim alarms. Reclaim alarms are sent when the number of free addresses rises above the reclaim threshold. |
| Abate | Number of abatement events. Abatement events are sent when the number of free addresses crosses the abatement threshold (midpoint between apportions and reclamation threshold). |

**Table 9: show network-access address-assignment domain Output Fields *(Continued)***

| Field Name | Field Description |
|---|---|
| Drain | Number of pool-drain alarms. Pool-drained alarms are sent after a pool completes its drain. |

### Sample Output

#### show network-access address-assignment domain

```
user@host> show network-access address-assignment domain
Domain Name                 Head                        Pool Count  Addresses  Free
Apport  Reclaim  Abate   Drain
iroh-default                iroh-default                3           765        253
3       0        0       0
```

## show network-access address-assignment domain-state

IN THIS SECTION

## Syntax

```
show network-access address-assignment domain-state
<routing-instance routing-instance-name>
```

## Description

Display the outstanding alarms for each pool domain.

## Options

| | |
|---|---|
| **none** | Display the alarm information for the default routing instance. |
| **routing-instance** *routing-instance-name* | (Optional) Display the alarm information for the specified routing instance. |

## Required Privilege Level

view and system

## Output Fields

Table 10 on page 93 lists the output fields for the `show network-access address-assignment status` command. Output fields are listed in the approximate order in which they appear.

**Table 10: show network-access address-assignment domain-state Output Fields**

| Field Name | Field Description |
|---|---|
| `Domain Name` | Domain pool name. |
| `Alarm` | Current status of the pool domain, including whether an alarm has been raised. |
| `Age` | How long the pool domain has been in this state. |

## Sample Output

### show network-access address-assignment domain-state

```
user@host> show network-access address-assignment domain-state
Domain Name         Alarm       Age
vis235-default      Apportion   00:00:20
arx40a-foo          Reclaim     13:10:18
Portland-default    -           -
```