NVIDIA Base Command Manager 11

Edge Manual

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Preface

Welcome to the *Edge Manual* for NVIDIA Base Command Manager 11.

0.1 About This Manual

This manual is aimed at helping cluster administrators install, understand, configure, and manage the edge computing capabilities of NVIDIA Base Command Manager. The administrator is expected to be reasonably familiar with the *Administrator Manual*.

0.2 About The Manuals In General

Regularly updated versions of the NVIDIA Base Command Manager 11 manuals are available on updated clusters by default at `/cm/shared/docs/cm`. The latest updates are always online at `https://docs.nvidia.com/base-command-manager`.

- The *Installation Manual* describes installation procedures for the basic cluster.
- The *Administrator Manual* describes the general management of the cluster.
- The *User Manual* describes the user environment and how to submit jobs for the end user.
- The *Cloudbursting Manual* describes how to deploy the cloud capabilities of the cluster.
- The *Developer Manual* has useful information for developers who would like to program with BCM.
- The *Containerization Manual* describes how to manage containers with BCM.
- The *NVIDIA Mission Control Manual* describes NVIDIA Mission Control capabilities and integration with BCM.

If the manuals are downloaded and kept in one local directory, then in most pdf viewers, clicking on a cross-reference in one manual that refers to a section in another manual opens and displays that section in the second manual. Navigating back and forth between documents is usually possible with keystrokes or mouse clicks.

For example: `<Alt>-<Backarrow>` in Acrobat Reader, or clicking on the bottom leftmost navigation button of xpdf, both navigate back to the previous document.

The manuals constantly evolve to keep up with the development of the BCM environment and the addition of new hardware and/or applications. The manuals also regularly incorporate feedback from administrators and users, who can submit comments, suggestions or corrections via the website

`https://enterprise-support.nvidia.com/s/create-case`

Section 14.2 of the *Administrator Manual* has more details on submitting an issue.

0.3 Getting Administrator-Level Support

Support for BCM subscriptions from version 10 onwards is available via the NVIDIA Enterprise Support page at:

`https://www.nvidia.com/en-us/support/enterprise/`

Section 14.2 of the *Administrator Manual* has more details on working with support.

0.4 Getting Professional Services

The BCM support team normally differentiates between

- regular support (customer has a question or problem that requires an answer or resolution), and
- professional services (customer asks for the team to do something or asks the team to provide some service).

Professional services can be provided via the NVIDIA Enterprise Services page at:
`https://www.nvidia.com/en-us/support/enterprise/services/`

1

Introduction

1.1 Cloud Computing Vs Edge Computing

Cloud computing is traditionally about the concept of end users using resources that are located in a cloud elsewhere. The cloud is the central coordinator, and end users use the resources that are in the cloud rather than using their local resources.

As computing power has become cheaper over time, and resource use has grown, it has in many cases become more financially attractive to shift the emphasis of resource coordination, from the center of the cloud (core of the cloud), over to the local resources which are at the *edge*. These local devices are then called *edge nodes*.

A strong case for edge computing is when the following resource requirements are easier to provide locally via local devices, than via central processing in the cloud:

- low latency
- high bandwidth consumption
- high CPU cycle consumption

For example, a self-driving car requires a low latency, high bandwidth, and high CPU cycle consumption in order to ensure a speedy and safe response to traffic requirements. Attempting to run a self-driving car via central processing in the cloud would be impractically slow or prohibitively dangerous.

Generally, edge computing is regarded as a way to have a geographically spread-out cluster make more local use of its computing resources. A geographically spread-out cluster typically already has plenty of CPU cycles, bandwidth, and low latency at its regular nodes. So, for such a geographically spread-out cluster, making more local use of its computing resources tends to mean granting extra autonomy to the edge computing devices, and making them more independent of the head node.

To achieve this greater autonomy, NVIDIA Base Command Manager uses an *edge director*. This is somewhat similar to the cloud director, but is required to be geographically close to the edge nodes, and is also optimized for edge requirements.

1.2 High Speed Monitoring And Local Processing

The importance of being local and autonomous is often due to the environment that the regular nodes are in. The environment is typically under high speed monitoring by many sensors linked to the regular nodes. The data values obtained by the sensors are processed very quickly by the nodes. Such high speed processing of the monitoring data values can typically only reasonably be achieved by the nodes managing the processing locally as much as possible, rather than having the nodes managed by a head node a large distance away.

2

BCM Edge

2.1 BCM Edge

The edge feature of NVIDIA Base Command Manager allows a single cluster to span many geographical locations ("one cluster, multiple locations"). Typical use cases are:

- HPC: organizations that have compute resources located in different cities or countries
- IoT: companies that have "edge" locations with the required compute resources at each location

BCM can be used to deploy and manage resources at edge locations from the central head node.

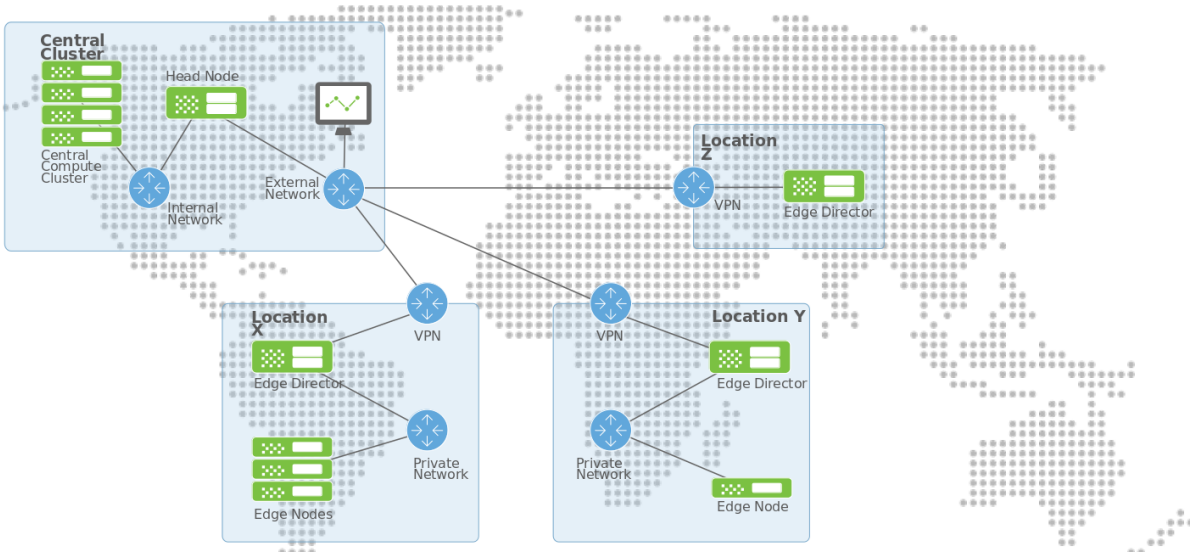

Figure 2.1: BCM Edge: The Big Picture

BCM Edge sites comprise an edge director and edge nodes.

- The edge director must be reachable from the central head node. The edge director forwards requests from the edge nodes to the central head node when required.
- The edge nodes are similar to regular nodes, and are provisioned by them PXE booting off the edge director. Unlike with regular nodes, no direct connection is required between the central head node and the edge nodes.

Items to check before creating edge sites:

- The BCM license must allow edge site creation
- The to-be-provisioned edge director must have an IP address that can be reached from the central head node
- Conversely, the central head node must have an IP address that can be reached by the edge director

Creating and deploying edge sites involve the following steps:

- Create the edge site using `cm-edge-setup`
- Create an edge ISO for provisioning the edge director
- Provision the edge director using the edge ISO
- Provision the edge nodes off the edge director

The following sections explain each of the preceding steps in further detail:

2.1.1 Defining The Edge Site

Edge sites are defined in BCM using the TUI-based `cm-edge-setup`. This section goes through a `cm-edge-setup` session on the central head node that creates an edge site definition.

Running `cm-edge-setup` In Interactive Mode

Running `cm-edge-setup` without any options brings up the main edge setup screen (figure 2.2):

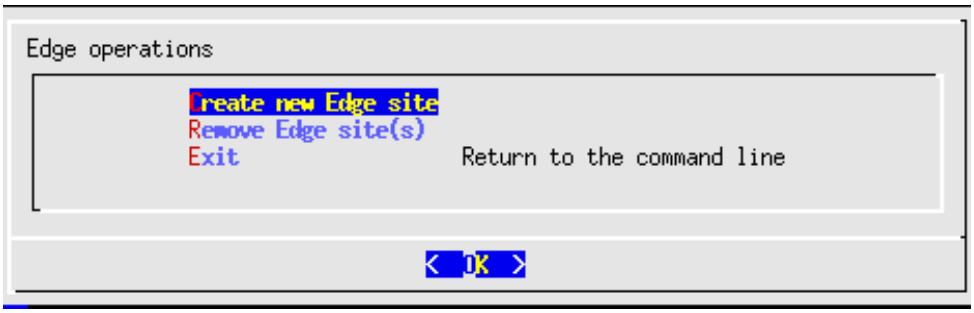

Figure 2.2: Edge setup main screen

A new edge site can be created by entering a series of parameters (figure 2.3):

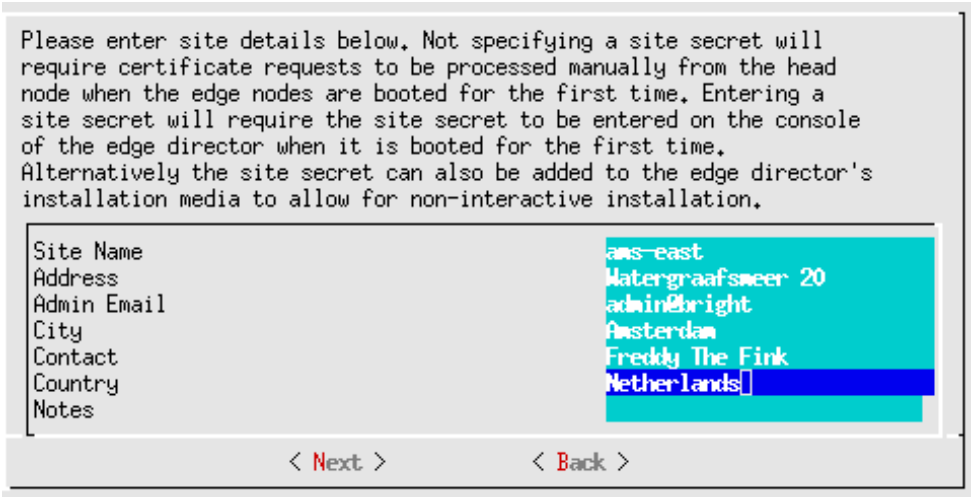

Figure 2.3: Entry of edge site parameters

A secret for the site should be entered (figure 2.4):

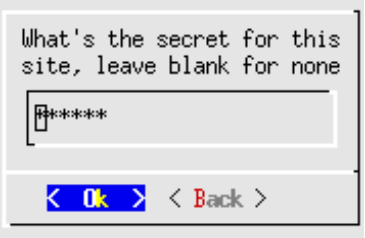

Figure 2.4: Entry of site secret

The site secret entry is reconfirmed by the administrator in a subsequent entry screen.

The next screen after that asks how the external network for the edge director should be set (figure 2.5):

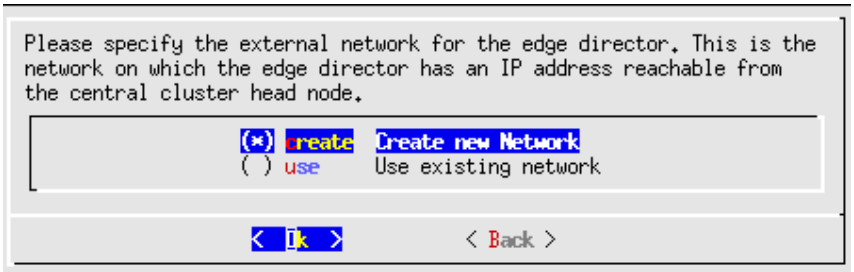

Figure 2.5: Selection of edge external network

- If networks defined as type `EdgeExternal` are found, then these networks are presented for selection (figure 2.6).
- If no networks of type `EdgeExternal` are found, then the only option is to create a new network (figure 2.7).

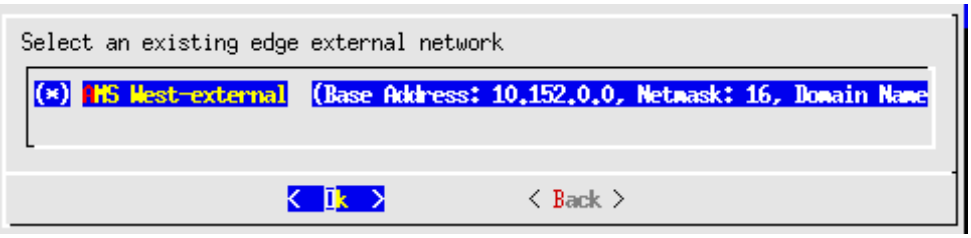

Figure 2.6: Selection of an existing edge external network

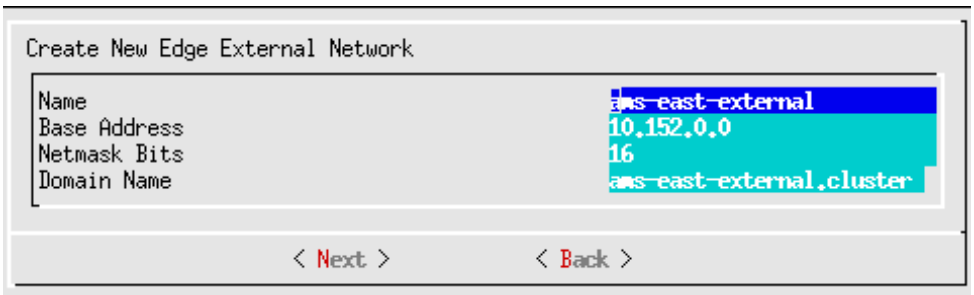

Figure 2.7: Creation of a new edge external network

Similarly to the external network configuration for the edge director, a screen comes up next that asks how the internal network for the edge director (figure 2.8) should be set:

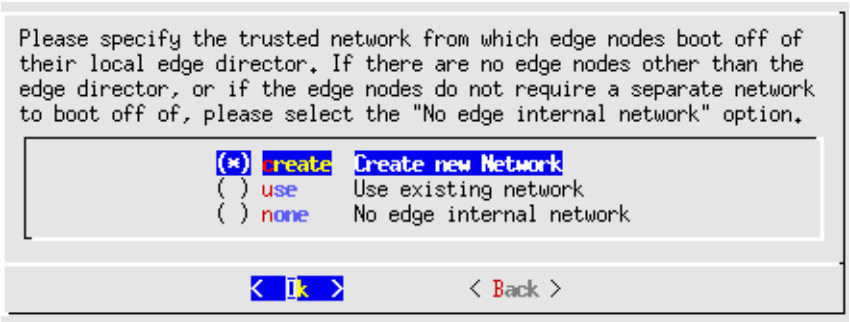

Figure 2.8: Selection of an existing edge internal network

Similarly to the external network configuration, the configuration for trusted internal network for the edge director presents the following similar options:

- If networks defined as type `EdgeInternal` are found, then these networks are presented for selection.
- If no networks of type `EdgeInternal` are found, then the only option is to create a new network (figure 2.9).

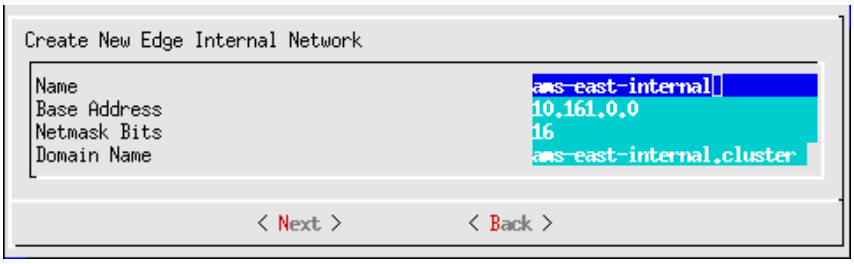

Figure 2.9: Creation of a new edge internal network

The next screen (figure 2.10) allows edge director parameters to be entered:

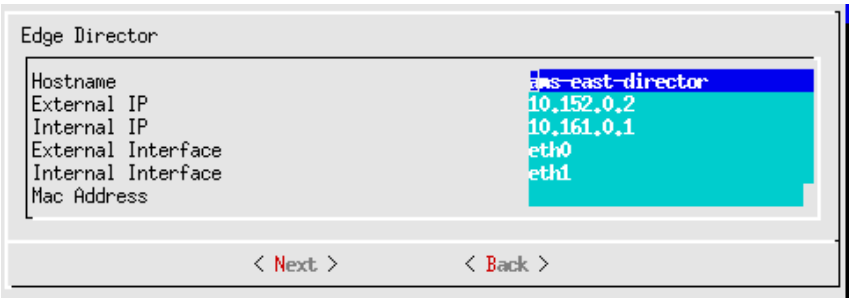

Figure 2.10: Entry of edge director parameters

In the next screen (figure 2.11) Edge director High Availability (HA) can be enabled:

Figure 2.11: Choice of edge director HA

The cluster administrator may want

- `/cm/shared` to be shared from a common network storage to the edge directors
- `/cm/shared` to not be shared, but synchronized between edge directors

Synchronization is can be set for an edge directors in the `edgedirector` role, by setting `Sync/cm/shared` to `yes`, as described on page 75 of the *Cloudbursting Manual*.

A screen later on (figure 2.12) allows secondary edge director parameters to be set:

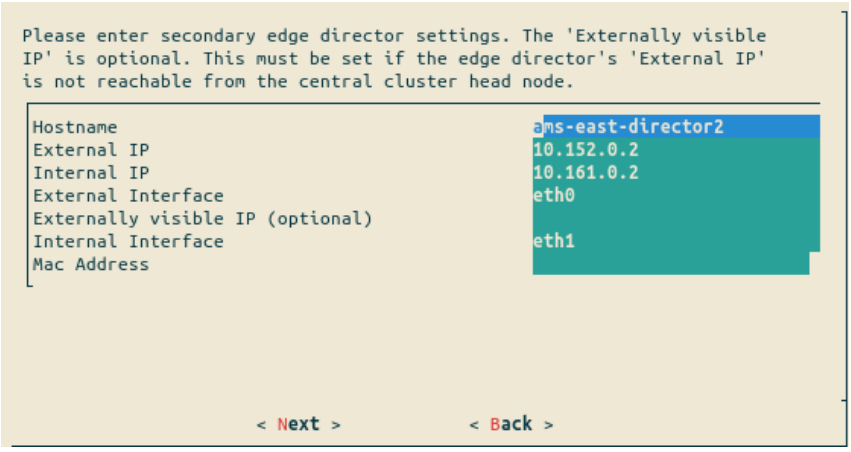

Figure 2.12: Entry of secondary edge director parameters

Shared IP settings for edge directors can be entered in the next screen (figure 2.13):

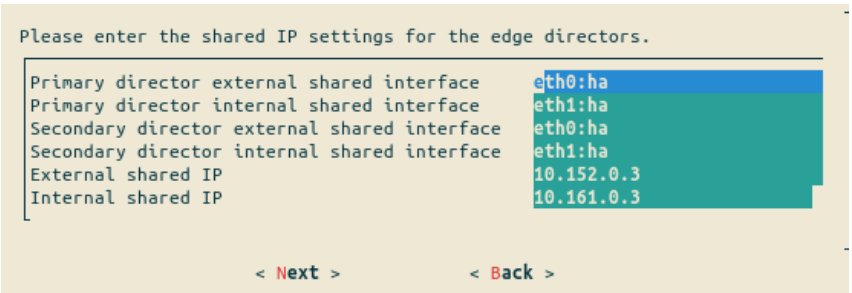

Figure 2.13: Entry of shared IP settings for edge directors

The edge nodes can now be configured. Individual nodes (figure 2.14), or a range of nodes (figure 2.15), can be configured:

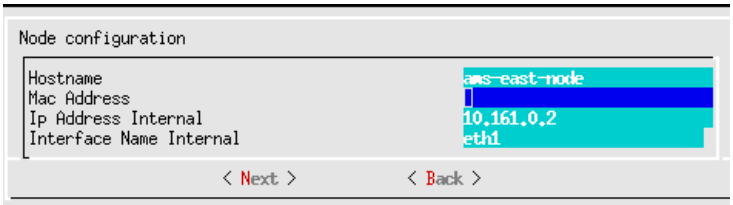

Figure 2.14: Definition of single edge node

Figure 2.15: Define multiple edge nodes

Running `cm-edge-setup` In Batch Mode

In the preceding section `cm-edge-setup` was used interactively to define edge sites. It can also be used non-interactively for the same purpose. This is done by saving a site configuration file at the end of the interactive setup. This is a YAML file, and it can be used to re-create the edge sites, or it can be used as a template to create new sites.

Example

```
[root@headnode ~]# cat /root/cm/edge/ams-west.yaml
######################################################################
##  This config file should be used with cm-edge-setup tool
##  Example:
##      cm-edge-setup -c <filename>
##
##  Generated by:
##      cm-edge-setup
##      cluster-tools-8.2-112301_cm8.2_b7ed6dbd8a
##      cmdline: /cm/local/apps/cm-setup/bin/cm-edge-setup
##  Generate on host:
##      smcluster
##  Date of generation:
##      Thu Dec  6 11:05:29 2018
##  MD5 checksum of everything after the closing comment:
##      5ca8aef31f8a047677c220824474e747
##      to compare:  grep -v '^##' <this_file> | md5sum
######################################################################
edge_sites:
- address: Kings
  admin_email: admin@bright
  city: Amsterdam
  contact: admin
  country: Amsterdam
  edge_director:
    category: edge-director
    hostname: ams-west-director
    interface_name_external: eth0
```

```
    interface_name_internal: eth1
    ip_address_external: 10.2.125.125
    ip_address_internal: 10.161.255.254
    mac_address: ''
    secondary:
      externally_visible_ip: ''
      hostname: edge-director2
      interface_name_external: eth0
      interface_name_internal: eth1
      ip_address_external: 10.2.125.126
      ip_address_internal: 10.161.255.253
      mac_address: ''
    shared_ip:
      ip_address_external: 10.2.125.127
      ip_address_internal: 10.161.255.252
      primary_interface_name_external: eth0:ha
      primary_interface_name_internal: eth1:ha
      secondary_interface_name_external: eth0:ha
      secondary_interface_name_internal: eth1:ha
    software_image: default-image
  edge_nodes:
  - category: edge-director
    hostname: ams-west-node001
    interface_name_internal: eth1
    ip_address_internal: 10.161.0.1
    mac_address: ''
  external_network:
    base_address: 10.2.0.0
    domainname: brightcomputing.com
    name: externalnet
    netmask_bits: 16
  internal_network:
    base_address: 10.161.0.0
    domainname: ams-west-internal.cluster
    name: ams-west-internal
    netmask_bits: 16
  notes: ''
  secret: xxxxxx
  site_name: ams-west
meta:
  command_line: /cm/local/apps/cm-setup/bin/cm-edge-setup
  date: Thu Dec  6 11:05:29 2018
  generated_with: Edge
  hostname: smcluster
  package_name: cluster-tools-8.2-112301_cm8.2_b7ed6dbd8a
  package_version: '112301'
```

2.1.2 Adding Nodes To Pre-existing Edge Sites With `cmsh`

Edge nodes can also be added to an existing edge site. This is typically required when no edge nodes were added during `cm-edge-setup`, or if the site is being expanded by adding more nodes. The addition can be done in the usual way, which is to first add the required node object with `cmsh` (section 2.5.3 of the *Administrator Manual*). The nodes are then added to the relevant edge site(s).

Adding nodes to an edge site can be done as follows:

Example

```
[root@smcluster ~]# cmsh
[smcluster]% edgesite
[smcluster->edgesite]% use ams-west
[smcluster->edgesite->ams-west]% append nodes edge-node005 edge-node006
[smcluster->edgesite->ams-west]% commit
[smcluster->edgesite->ams-west]% list
Name (key)   Director            Nodes
------------ ------------------- ------------------------------------------------------------
ams-west     ams-west-director   ams-west-node001,ams-west-director,edge-node005,edge-node006
dell-edge    dell-edge-director  dell-edge-director
```

2.1.3 Viewing Edge Sites Using `cmsh`

Edge sites can be viewed from the `edgesite` mode of `cmsh`

Example

```
[root@smcluster ~]# cmsh
[smcluster]% edgesite
[smcluster->edgesite]% list
Name (key)                Director                 Nodes
------------------------- ------------------------ ----------------------------------------
ams-west                  ams-west-director        ams-west-node001,ams-west-director
dell-edge                 dell-edge-director       dell-edge-director
[smcluster->edgesite]%

[smcluster->edgesite]% show ams-west
Parameter                        Value
-------------------------------- ------------------------------------------------
Address                          Kings
Administrator e-mail             admin@bright
City                             Amsterdam
Contact                          admin
Country                          Amsterdam
Director                         ams-west-director
Name                             ams-west
Nodes                            ams-west-node001,ams-west-director
Notes
Revision
Secret                           *********
```

2.1.4 Viewing Edge Sites Using Base View

Edge sites can also be viewed via the navigation path `Datacenter Infrastructure` > `Edge Sites` (figure 2.16). Properties of an edge site can be managed via editing a particular edge site.

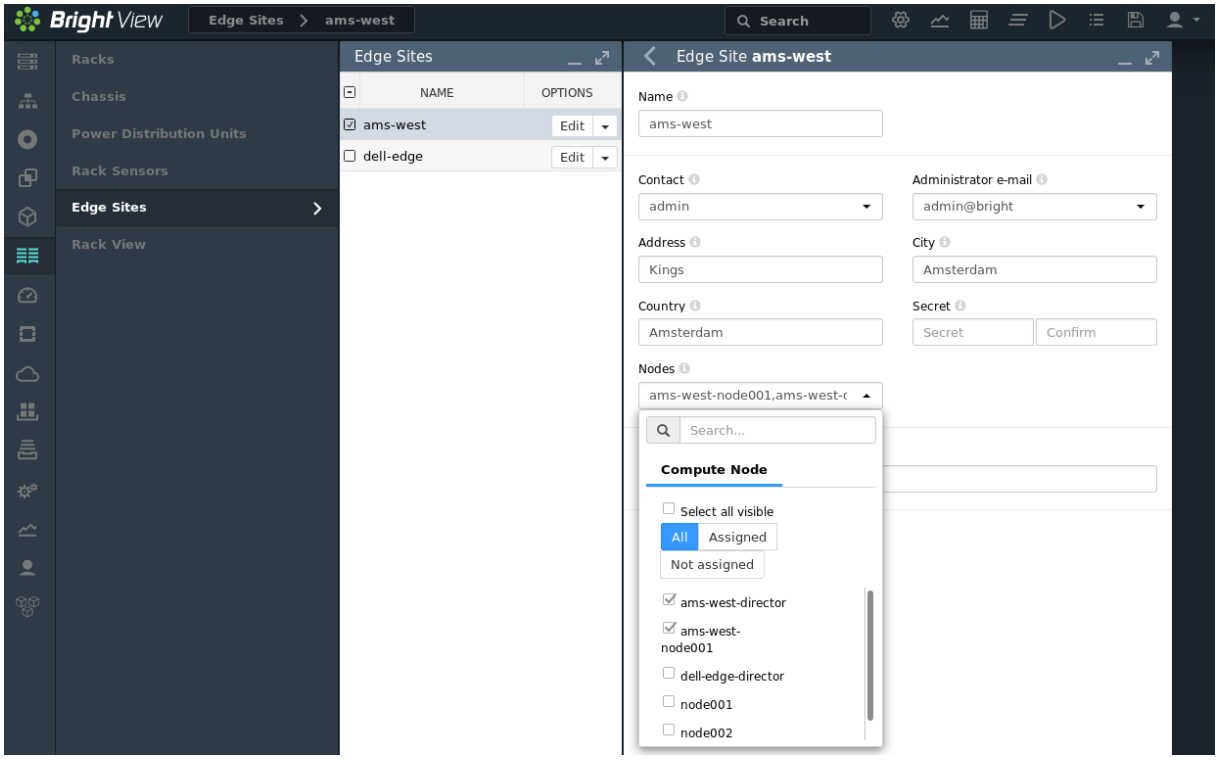

Figure 2.16: Edge sites in Base View

2.1.5 Create Edge ISO

The next step in the deployment is to create the edge ISO on the head node. Typically, the edge ISO is configured so that the edge director boots from it the first time, and carries out a FULL install using the ISO for its source of files that will be installed on the edge director. The edge director is also configured to allow a boot from the hard drive.

If booting from the ISO after the first time, and if the partitions on the edge director have not changed, then a SYNC install is carried out against the central head node. If booting after the first time, and if there is no ISO, then the edge director simply boots from its local hard drive, and no files are synced with the central head node

There are two ways to create the edge ISO:

1. The edge ISO can be created with a site-specific auto-generated wrapper script. This is the recommended approach. When an edge site is created, CMDaemon on the head node creates a wrapper script at `/var/spool/cmd/edge/create-<site-name>-iso.sh`. The wrapper script then provides all the site-specific information that needs to be provided for the edge node-installer. The behavior of the wrapper script depends on whether the setup was done with edge director HA enabled.

   - The wrapper script that is generated when edge director HA configuration is enabled, can be used as follows:
     - The following command produces an ISO that can be used for booting the primary edge director:

       ```
       /var/spool/cmd/edge/create-dell-edge-iso.sh --primary
       ```

     - The following command produces an ISO that can be used for booting the secondary edge director:

```
/var/spool/cmd/edge/create-dell-edge-iso.sh --secondary
```

– The following command produces two ISOs, one for the primary and one for the secondary:

```
/var/spool/cmd/edge/create-dell-edge-iso.sh --both
```

– The following command produces an ISO that can be used to boot both the primary and secondary edge directors, but the correct option for the edge director IP must be manually chosen in the node-installer screen:

```
/var/spool/cmd/edge/create-dell-edge-iso.sh
```

- The wrapper script that is generated in the case when no edge director HA configuration is selected, takes no additional arguments. It produces an ISO that is used to boot the single edge director, and is invoked as:

```
/var/spool/cmd/edge/create-dell-edge-iso.sh
```

2. Alternatively, the edge site ISO can be created manually by setting the options to `create-edge-iso`:

Example

```
[root@headnode ~]# create-edge-iso --help
usage: create-edge-iso [-h] [-v] [-d] [-c] [-f EDGEINTERFACE]
                       [-e EDGEDIRECTORIP] [-m HEADNODEIP] [-g DEFAULTGATEWAY]
                       [-k KERNELIMAGE] [-i IMAGENAME] [-s] [-p PATHTOISOFILE]
                       [-n]

Create edge iso

optional arguments:
  -h, --help            show this help message and exit
  -v, --verbose         Turn on verbose logging
  -d, --debug           Turn on debug mode, iso work directory will not be cleaned up
  -c, --includecmshared
                        Include /cm/shared on iso
  -f EDGEINTERFACE, --edgeinterface EDGEINTERFACE
                        Name of interface on edge node
  -e EDGEDIRECTORIP, --edgedirectorip EDGEDIRECTORIP
                        IP[/Netmask bits] of edge director
                        If Netmask bits is not specified, defaults to /16
  -m HEADNODEIP, --headnodeip HEADNODEIP
                        IP[:port] of head node
                        If port is not specified, defaults to :8081
  -g DEFAULTGATEWAY, --defaultgateway DEFAULTGATEWAY
                        Gateway for edge director to reach central head node
  -k KERNELIMAGE, --kernelimage KERNELIMAGE
                        Name of image whose kernel will be used for booting iso
  -i IMAGENAME, --imagename IMAGENAME
                        Name of software image to include on iso
  -s, --sitesecret      Prompt user to enter Edge site secret
  -p PATHTOISOFILE, --pathtoisofile PATHTOISOFILE
                        Path to iso file name
  -n, --donotstoresecret
                        Inform node-installer not to store the secret on the edge director
```

2.1.6 Edge ISO Node Installer

The edge ISO is used to provision the edge director. The node installer displays the following screens when booting from the edge ISO:

Figure 2.17: Edge node-installer ISO boot menu

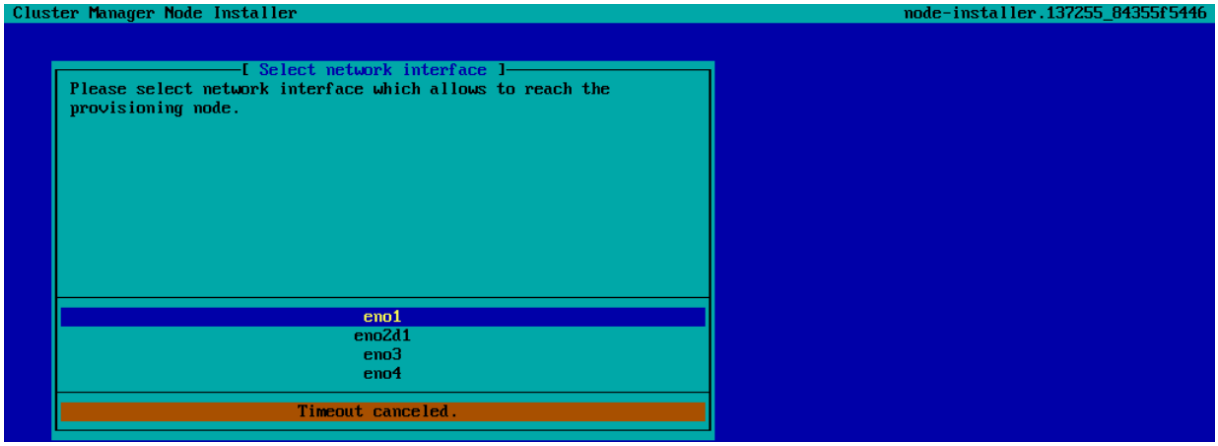

Figure 2.18: Edge node-installer select interface

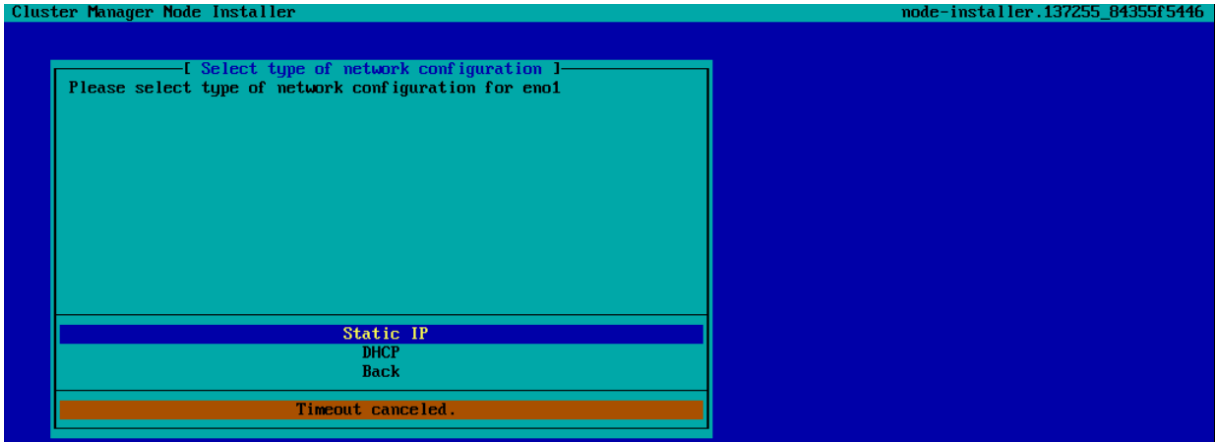

Figure 2.19: Edge director IP Static/DHCP selection

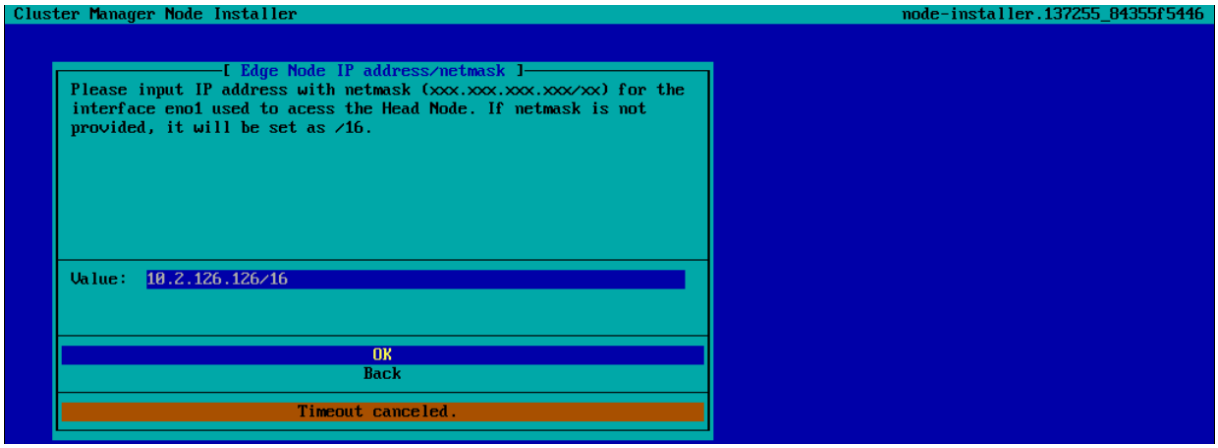

Figure 2.20: Edge director IP address and netmask

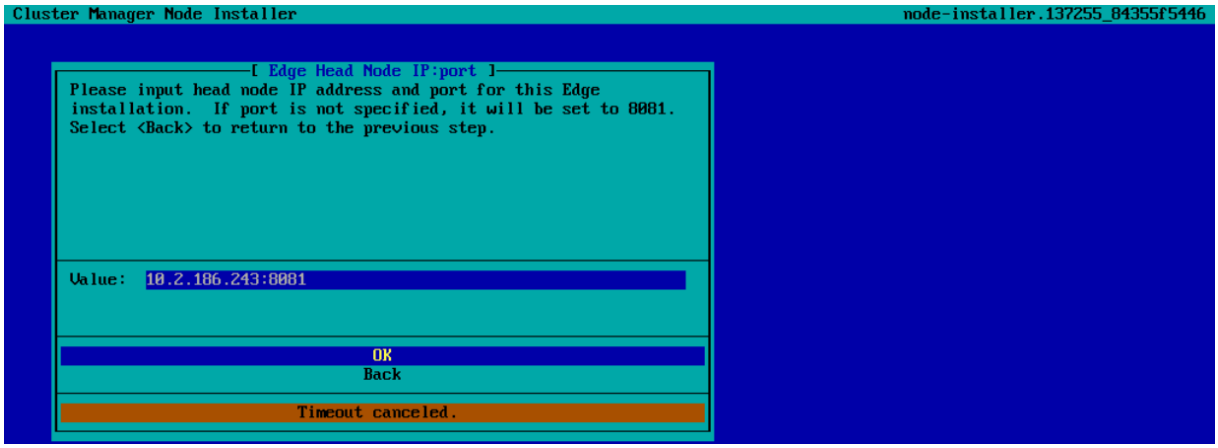

Figure 2.21: Central head node IP address and port

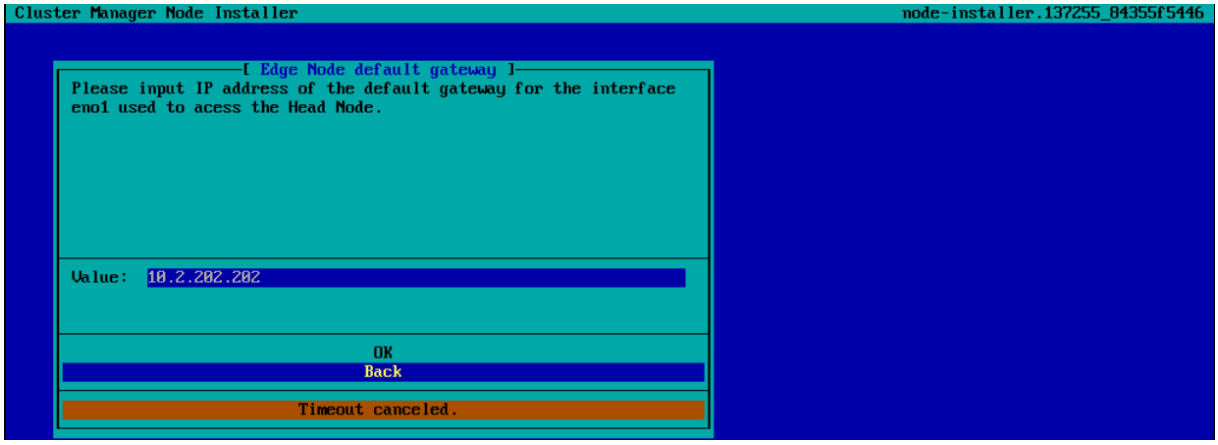

Figure 2.22: Gateway IP address to central head node

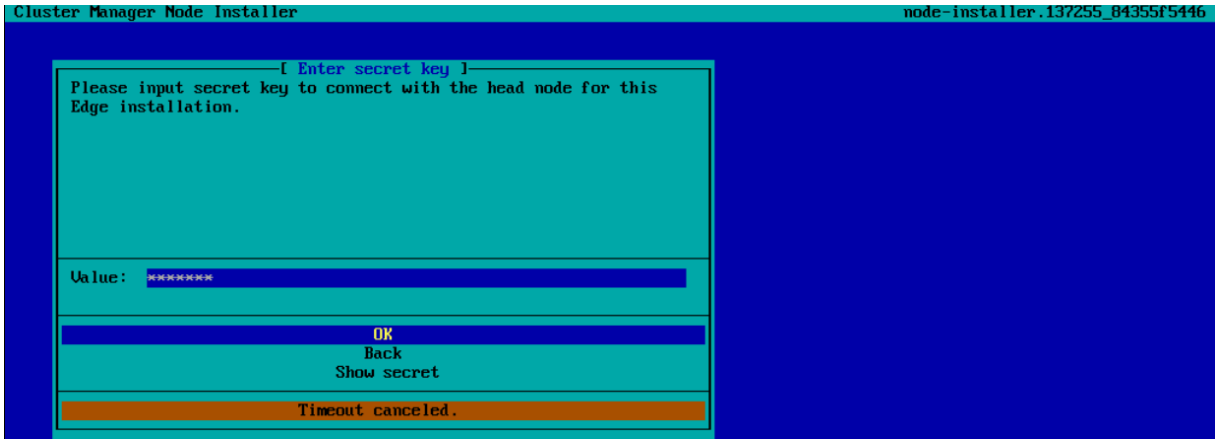

Figure 2.23: Edge site secret

2.1.7 Edge Directors

Edge directors can be provisioned from the head node, but are normally provisioned using the software image on the edge ISO/USB. This means:

- The ISO/USB should have a software image included in it
- The ISO/USB should have `/cm/shared` included in it

If the edge director is booting from the ISO/USB, it means that:

- There is a minimal overhead when only updates, rather than an entire filesystem, are synced from the head node to the edge director
- A `FULL` install of the edge director only takes place during the first installation of that director, or if the director disk partitions have changed.
- If the edge director has already been installed previously, and its disk partitions are unchanged, then a `SYNC` install is carried out, so that local files on the edge director can get updated against the head node

If there is no ISO/USB available to the edge director, then the director simply boots off its local drive, and no SYNC install is followed. An explicit `imageupdate` can however be carried out afterwards when needed, if connectivity is there, to update the software image.

Once the edge director is in the `UP` state, it is responsible for the following local operations:

- Ramdisk creation for the edge nodes
- Power control for itself and the edge nodes
- Device state (`UP`, `DOWN`) check via ICMP ping to the edge nodes
- Monitoring for the edge nodes

2.1.8 Edge Nodes

Edge nodes are expected to PXE boot off the edge internal network. The edge director provisions edge nodes in the same way that the head node provisions regular nodes.

3

Installing Slurm To An Edge Site

On some edge sites there may be a need to run a workload manager.

The Slurm workload manager can be run on an edge site if the cluster is prepared and software installed as in sections 3.1 and 3.2.

3.1 Preparation

1. The edge director must be `UP` according to `cmsh` or Base View.
2. The Slurm installation needs an existing installation of MySQL on the edge director node. The installation of MySQL on edge nodes is not supported.

3.2 Installation

- The BCM script `cm-wlm-setup` (section 7.3 of the *Administrator Manual*) is then run on the head node.
  - At the `Select installation type` screen, the edge name should be selected, and the edge director should then be specified as the only server role node.
  - The storage server type for accounting, which is set in the Slurm accounting role, must be set to use the director with the MySQL installation .
- By default there are no user home directories on the edge director or edge nodes. These must therefore be mounted or created, otherwise jobs cannot run on the edge nodes. This is true for all WLMs running on edge nodes.