# Install Crosswork Cluster on VMware vCenter

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## Installation Overview

Crosswork Network Controller Crosswork Cluster can be installed using the following methods:

Crosswork Cluster can be installed using the following methods:

- **Installation using Installer**: The cluster installer tool is a day-0 installation tool used to deploy the Crosswork cluster with user specified parameters supplied via a template file. The tool is run from a Docker container which can be hosted on any Docker capable platform including a regular PC/laptop. The Docker container contains a set of template files which can be edited to provide the deployment specific data.
- **Manual Installation (via the VMware UI)**: This option is available for deployments that cannot use the installer tool.

The installer tool method is the preferred option as it is faster and easier to use.

**Note** Secure ZTP and Secure Syslog require the Crosswork cluster to be deployed with FQDN.

## Installation Parameters

This section explains the important parameters that must be specified while installing the Crosswork cluster. Kindly ensure that you have relevant information to provide for each of the parameters mentioned in the table and that your environment meets all the requirements specified under Installation Prerequisites for VMware vCenter.

**Note** Some of the below parameters may be named differently depending upon the installation method (automated or manual) and IP stack (IPv4 or IPv6) you choose.

**Attention** Please use the latest template file that comes with the Crosswork installer tool.

***Table 1: General parameters***

| Parameter Name | Description |
|---|---|
| `ClusterName` | Name of the cluster file |
| `ClusterIPStack` | The IP stack protocol: IPv4 or IPv6 |
| `ManagementIPAddress` | The Management IP address of the VM (IPv4 or IPv6). |
| `ManagementIPNetmask` | The Management IP subnet in dotted decimal format (IPv4 or IPv6). |
| `ManagementIPGateway` | The Gateway IP on the Management Network (IPv4 or IPv6). The address must be reachable, otherwise the installation will fail. |
| `ManagementVIP` | The Management Virtual IP for the cluster. |
| `ManagementVIPName` | Name of the Management Virtual IP for the cluster. This is an optional parameters used to reach Crosswork cluster Management VIP via DNS name. If this parameter is used, the corresponding DNS record must exist in the DNS server and must match the ManagementVIP and ManagementVIPName. |
| `DataIPAddress` | The Data IP address of the VM (IPv4 or IPv6). |
| `DataIPNetmask` | The Data IP subnet in dotted decimal format (IPv4 or IPv6). |
| `DataIPGateway` | The Gateway IP on the Data Network (IPv4 or IPv6). The address must be reachable, otherwise the installation will fail. |
| `DataVIP` | The Data Virtual IP for the cluster. |
| `DataVIPName` | Name of the Data Virtual IP for the cluster. This is an optional parameters used to reach Crosswork cluster Data VIP via DNS name. If this parameter is used, the corresponding DNS record must exist in the DNS server and must match the DataVIP and DataVIPName. |
| `DNS` | The IP address of the DNS server (IPv4 or IPv6). The address must be reachable, otherwise the installation will fail. |
| `NTP` | NTP server address or name. The address must be reachable, otherwise the installation will fail. |
| `DomainName` | The domain name used for the cluster. |

| Parameter Name | Description |
|---|---|
| `CWusername` | Username to log into Cisco Crosswork.<br>This is an optional parameter. |
| `CWPassword` | Password to log into Cisco Crosswork.<br>Use a strong VM Password (8 characters long, including upper & lower case letters, numbers, and one special character). Avoid using passwords similar to dictionary words (for example, "Pa55w0rd!") or relatable words (for example, C!sco123 or Cwork321!). While they satisfy the criteria, such passwords are weak and will result in the failure of VM setup. |
| `VMSize` | VM size for the cluster. Value is `large`. |
| `VMName` | Name of the VM<br>You will require at least 3 unique names (one for each VM). See |
| `NodeType` | Indicates the type of VM. Choose either "Hybrid" or "Worker".<br>**Note**<br>The Crosswork cluster for 5.0 release requires at least three VMs operating in a hybrid configuration. |
| `IsSeed` | Choose "True" if this is the first VM being built in a new cluster.<br>Choose "False" for all other VMs, or when rebuilding a failed VM.<br>This paramater is optional for installing using the cluster installer tool. |
| `InitNodeCount` | Total number of nodes in the cluster including Hybrid and Worker nodes. The default value is 3. Set this to match the number of VMs (nodes) you are going to deploy. For more information on VM count, see Table 1.<br>This paramater is optional for installing using the cluster installer tool. |
| `InitMasterCount` | Total number of Hybrid nodes in the cluster. The default value is 3.<br>This paramater is optional for installing using the cluster installer tool. |
| `BackupMinPercent` | Minimum percentage of the data disk space to be used for the size of the backup partition. The default value is 50 (valid range is from 1 to 80).<br>Please use the default value unless recommended otherwise.<br>**Note**<br>The final backup partition size will be calculated dynamically. This parameter defines the minimum. |
| `ManagerDataFsSize` | Refers to the data disk size for Hybrid nodes (in Giga Bytes). This is an optional parameter and the default value is 450 (valid range is from 450 to 8000), if not explicitly specified.<br>Please use the default value unless recommended otherwise. |

| Parameter Name | Description |
|---|---|
| `WorkerDataFsSize` | Refers to the data disk size for Worker nodes (in Gigabytes). This is an optional parameter and the default value is 450 (valid range is from 450 to 8000), if not explicitly specified.<br>Please use the default value unless recommended otherwise. |
| `ThinProvisioned` | Set to "false" for production deployments. |
| `EnableHardReservations` | Determines the enforcement of VM CPU and Memory profile reservations (see Installation Prerequisites for VMware vCenter for more information). This is an optional parameter and the default value is `true`, if not explicitly specified.<br>If set as `true`, the VM's resources are provided exclusively. In this state, the installation will fail if there are insufficient CPU cores, memory or CPU cycles.<br>If set as `false` (only set for lab installations), the VM's resources are provided on best efforts. In this state, the installation will fail if there are insufficient CPU cores. |
| `RamDiskSize` | Size of the Ram disk.<br>This parameter is only used for lab installations (value must be at least 2). When a non-zero value is provided for `RamDiskSize`, the `HSDatastore` value is not used. |
| `OP_Status` | This optional parameter is used (uncommented) to import inventory post manual deployment of Crosswork cluster.<br>The parameter refers to the state for this VM. To indicate a running status, the value must be 2 (`#OP_Status = 2`). |
| `SchemaVersion` | The configuration Manifest schema version.<br>Schema version should map to the version packaged with sample template in installer tool. |
| `LogFsSize` | Log partition size (in Giga Bytes). Minimum value is 10 GB and Maximum value is 1000 GB. You are recommended to use the default value. |
| `Timezone` | Enter the timezone. Input is a standard IANA time zone (for example, "America/Chicago").<br>If left blank, the default value (UTC) is selected.<br>This is an optional parameter.<br>**Note**<br>The timestamp in Kafka log messages represents the NSO server time. If you change the `Timezone` parameter in Crosswork without updating the NSO server time, there will be a mismatch between the Crosswork server time and the NSO event time. |

| Parameter Name | Description |
|---|---|
| `EnableSkipAutoInstallFeature` | Any pods marked as skip auto install will not be brought up until a dependent application/pod explicitly asks for it.<br>If left blank, the default value ("False") is selected. |
| `EnforcePodReservations` | Enforces minimum resource reservations for the pod.<br>If left blank, the default value ("True") is selected. |
| `K8sServiceNetwork` | The network address for the kubernetes service network. The CIDR range is fixed to '/16'.<br>This is an optional parameter. |
| `K8sPodNetwork` | The network address for the kubernetes pod network. The CIDR range is fixed to '/16'.<br>This is an optional parameter. |

***Table 2: VMware template parameters***

| Parameter Name | Description |
|---|---|
| `vCentreAddress` | The vCenter IP or host name. |
| `vCentreUser` | The username needed to log into vCenter. |
| `vCentrePassword` | The password needed to log into vCenter. |
| `DCname` | The name of the Data Center resource to use.<br>Example: `DCname = "WW-DCN-Solutions"` |
| `MgmtNetworkName` | The name of the vCenter network to attach to the VM's Management interface. |
| `DataNetworkName` | The name of the vCenter network to attach to the VM's Data interface. |
| `Host` | The ESXi host, or ONLY the vcenter cluster/resource group name where the VM is to be deployed.<br>The primary option is to use the host IP or name (all the hosts should be under the Datacentre). If the hosts are under a cluster in the Datacentre, only provide the cluster name (all hosts within the cluster will be picked up).<br>The subsequent option is to use a resource group. In this case, a full path should be provided.<br>Example: `Host = "Main infrastructure/Resources/00_trial"` |
| `Datastore` | The datastore name available to be used by this host or resource group.<br>The primary option is to use host IP or name. The subsequent option is to use a resource group.<br>Example: `Datastore = "SDRS-DCNSOL-prodexsi/bru-netapp-01_FC_Prodesx_ds_15"` |

| Parameter Name | Description |
|---|---|
| `HSDatastore` | The high speed datastore available for this host or resource group.<br>When not using a highspeed data store, set to same value as Datastore. |
| `DCfolder` | The resource folder name on vCenter. To be used if you do not have root access as a VMware user, or when you need to create VMs in separate folders for maintenance purposes. You must provide the complete path as value for the DCfolder.<br>Example: `DCfolder = "/WW-DCN-Solutions/vm/00_trial"`<br>Please contact your VMware administrator for any queries regarding the complete folder path.<br>Leave as empty if not used. |
| `Cw_VM_Image` | The name of Crosswork cluster VM image in vCenter. |
| `HostedCwVMs` | The IDs of the VMs to be hosted by the ESXi host or resource. |

After you have decided the installation parameters values for Crosswork Network Controller, choose the method you prefer and begin your deployment:

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- Manual Installation of Cisco Crosswork using vCenter vSphere UI, on page 16

# Install Cisco Crosswork on VMware vCenter using Cluster Installer Tool

This section explains the procedure to install Cisco Crosswork on VMware vCenter using the cluster installer tool.

**Note** The time taken to create the cluster can vary based on the size of your deployment profile and the performance characteristics of your hardware.

### Before you begin

Few pointers to know when using the cluster installer tool:

- Make sure that your environment meets all the vCenter requirements specified in Installation Prerequisites for VMware vCenter.
- The edited template in the `/data` directory will contain sensitive information (VM passwords and the vCenter password). The operator needs to manage access to this content. Store them in a secure environment or edit them to remove the passwords.

- The `install.log`, `install_tf.log`, and `.tfstate` files will be created during the install and stored in the `/data` directory. If you encounter any trouble with the installation, provide these files to the Cisco Customer Experience team when opening a case.
- The install script is safe to run multiple times. Upon error, input parameters can be corrected and re-run. You must remove the `install.log`, `install_tf.log`, and `tfstate` files before each re-run. Please note that running the tool multiple times may result in the deletion and re-creation of VMs.
- In case you are using the same installer tool for multiple Crosswork cluster installations, it is important to run the tool from different local directories, allowing for the deployment state files to be independent. The simplest way for doing so is to create a local directory for each deployment on the host machine and map each one to the container accordingly.
- Docker version 19 or higher is required while using the cluster installer option. For more information on Docker, see https://docs.docker.com/get-docker/
- In order to change install parameters or to correct parameters following installation errors, it is important to distinguish whether the installation has managed to deploy the VMs or not. Deployed VMs are evidenced by the output of the installer similar to:

```
vsphere_virtual_machine.crosswork-IPv4-vm["1"]: Creation complete after 2m50s
[id=4214a520-c53f-f29c-80b3-25916e6c297f]
```

- In case of deployed VMs, changes to the Crosswork VM settings or the Data Center host for a deployed VM are NOT supported. To change a setting using the installer when the deployed VMs are present, the clean operation needs to be run and the cluster redeployed. For more information, see Delete the VM using the Cluster Installer.
- A VM redeployment will delete the VM's data, hence caution is advised. We recommend you perform VM parameter changes from the Crosswork UI, or alternatively one VM at a time. Installation parameter changes that occur prior to any VM deployment, e.g. an incorrect vCenter parameter, can be performed by applying the change and simply re-running the install operation.

**Known limitations:**

These following scenarios are the caveats for installing the Crosswork cluster using the cluster installer tool.

- The vCenter host VMs defined must use the same network names (vSwitch) across all hosts in the data center.
- The vCenter storage folders or datastores organized under a virtual folder structure, are not supported currently. Please ensure that the datastores referenced are not grouped under a folder.
- Any VMs that are not created by the day 0 installer (for example, manually brought up VMs), cannot be changed either by the day 0 installer or via the Crosswork UI later. Similarly, VMs created via the Crosswork UI cannot be modified using the day 0 installer. When making modifications after the initial deployment of the cluster, ensure that you capture the inventory information. For more information, see the *Manage Clusters* chapter in the *Crosswork Network Controller 5.0 Administration Guide*.
- Crosswork does not support dual stack configurations, and all addresses for the environment must be either IPv4 or IPv6. However, vCenter UI provides a service where a user accessing via IPv4 can upload images to the IPv6 ESXi host. Cluster installer cannot use this service. Follow either of the following workarounds for IPv6 ESXi hosts:

  1. Upload the OVA template image manually, via the GUI and convert it to template.
  2. Run the cluster installer from an IPv6 enabled machine. To do this, configure the Docker daemon to map an IPv6 address into the docked container.

**Note** The installer tool will deploy the software and power on the virtual machines. If you wish to power on the virtual machines yourself, use the manual installation.

### Procedure

**Step 1** In your vCenter datacenter, go to **Host** > **Configure** > **Networking** > **Virtual Switches** and select the virtual switch. In the virtual switch, select **Edit** > **Security**, and configure the following DVS port group properties:

- Set **Promiscuous mode** as *Reject*
- Set **MAC address changes** as *Reject*

Confirm the settings and repeat the process for each virtual switch used in the cluster.

**Step 2** In your Docker capable machine, create a directory where you will store everything you will use during this installation.

**Note**
If you are using a Mac, please ensure that the directory name is in lower case.

**Step 3** Download the installer bundle (.tar.gz file) and the OVA file from cisco.com to the directory you created previously. For the purpose of these instructions, we will use the file names as **cw-na-platform-5.0.0-signed-installer.tar.gz** and **cw-na-platform-5.0.0-81-release-230502.ova** respectively.

**Attention**
The file names mentioned in this topic are sample names and may differ from the actual file names in cisco.com.

**Step 4** Use the following command to unzip the installer bundle:

```
tar -xvf cw-na-platform-5.0.0-signed-installer.tar.gz
```

The contents of the installer bundle is unzipped to a new directory (e.g. `cw-na-platform-5.0.0-signed-installer`). This new directory will contain the installer image (**cw-na-platform-installer-5.0.0-81-release-230502.tar.gz**) and files necessary to validate the image.

**Step 5** Change the directory to the directory created by opening the file and then review the contents of the README file in order to understand everything that is in the package and how it will be validated in the following steps.

**Step 6** Use the following command to verify the signature of the installer image:

**Note**
Use `python --version` to find out the version of python on your machine.

If you are using python 2.x, use the following command to validate the file:

```
python cisco_x509_verify_release.py -e <.cer file> -i <.tar.gz file> -s <.tar.gz.signature file>
-v dgst -sha512
```

If you are using python 3.x, use the following command to validate the file:

```
python cisco_x509_verify_release.py3 -e <.cer file> -i <.tar.gz file> -s <.tar.gz.signature file>
-v dgst -sha512
```

**Note**

If you do not have python installed, go to python.org and download the version of python that is appropriate for your work station.

**Step 7** Use the following command to load the installer image file into your Docker environment.

```
docker load -i <.tar.gz file>
```

For example:

```
docker load -i cw-na-platform-installer-5.0.0-81-release-230502.tar.gz
```

**Step 8** Run Docker image list or Docker images command to get the "image ID" (which is needed in the next step).

For example:

```
docker images
```

The result will be similar to the following: (section we will need is underlined for clarity)

```
My Machine% docker images
REPOSITORY                          TAG                                                 IMAGE ID
         CREATED        SIZE
dockerhub.cisco.com/cw-installer  cw-na-platform-installer-5.0.0-81-release-230502   a4570324fad30
  7 days ago     276MB
```

**Note**
Pay attention to the "CREATED" time stamp in the table presented when you run `docker images`, as you might have other images present from the installation of prior releases. If you wish to remove these, the `docker image rm {image id}` command can be used.

**Step 9** Launch the Docker container using the following command:

```
docker run --rm -it -v `pwd`:/data {image id of the installer container}
```

To run the image loaded in our example, the command would be:

```
docker run --rm -it -v `pwd`:/data a4570324fad30
```

**Note**

- You do not have to enter that full value. In this case, "docker run --rm -it -v `pwd`:/data a45" was adequate. Docker requires enough of the image ID to uniquely identify the image you want to use for the installation.
- In the above command, we are using the backtick (`). Do not use the single quote or apostrophe (') as the meaning to the shell is very different. By using the backtick (recommended), the template file and OVA will be stored in the directory where you are on your local disk when you run the commands, instead of inside the container.
- When deploying a IPv6 cluster, the installer needs to run on an IPv6 enabled container/VM. This requires additionally configuring the Docker daemon before running the installer, using the following method:
  - **Linux hosts (ONLY)**: Run the Docker container in host networking mode by adding the "–network host" flag to the Docker run command line.

    ```
    docker run --network host <remainder of docker run options>
    ```

- Centos/RHEL hosts, by default, enforce a strict SELinux policy which does not allow the installer container to read from or write to the mounted data volume. On such hosts, run the Docker volume command with the Z option as shown below:

  ```
  docker run --rm -it -v `pwd`:/data:Z <remainder of docker options>
  ```

**Note**

The Docker command provided will use the current directory to read the template and the ova files, and to write the log files used during the install. If you encounter either of the following errors you should move the files to a directory where the path is in lowercase (all lowercase, no spaces or other special characters).

Error 1:

```
% docker run --rm -it -v `pwd`:/data a45
docker: invalid reference format: repository name must be lowercase.
See 'docker run --help'
```

Error 2:

```
docker: Error response from daemon: Mounts denied: approving /Users/Desktop: file does not exist
ERRO[0000] error waiting for container: context canceled
```

**Step 10** Navigate to the directory with the VMware template.

`cd /opt/installer/deployments/5.0.0/vcentre`

**Step 11** Copy the template file found under `/opt/installer/deployments/5.0.0/vcentre/deployment_template_tfvars` to the `/data` folder using a different name.

For example: `cp deployment_template_tfvars /data/deployment.tfvars`

For the rest of this procedure, we will use `deployment.tfvars` in all the examples.

**Step 12** Edit the template file located in the `/data` directory in a text editor, to match your planned deployment. Refer to the Installation Parameters, on page 1 table for details on the required and optional fields and their proper settings. The Sample manifest template for VMware vCenter, on page 11 includes an example that you can reference for proper formatting. The example is more compact due to the removal of descriptive comments:

**Step 13** From the `/opt/installer` directory, run the installer.

```
./cw-installer.sh install -p -m /data/<template file name> -o /data/<.ova file>
```

For example:

```
./cw-installer.sh install -p -m /data/deployment.tfvars -o
/data/cw-na-platform-5.0.0-81-release-230502.ova
```

**Step 14** Read, and then enter "yes" if you accept the End User License Agreement (EULA). Otherwise, exit the installer and contact your Cisco representative.

**Step 15** Enter "yes" when prompted to confirm the operation.

**Note**
It is not uncommon to see some warnings like the following during the install:

```
Warning: Line 119: No space left for device '8' on parent controller '3'.
Warning: Line 114: Unable to parse 'enableMPTSupport' for attribute 'key' on element 'Config'.
```

If the install process proceeds to a successful conclusion (see sample output below), these warnings can be ignored.

**Sample output:**

```
cw_cluster_vms = <sensitive>
INFO: Copying day 0 state inventory to CW
INFO: Waiting for deployment status server to startup on 10.90.147.66. Elapsed time 0s, retrying
in 30s
Crosswork deployment status available at
http://{VIP}:30602/d/NK1bwVxGk/crosswork-deployment-readiness?orgId=1&refresh=10s&theme=dark
Once deployment is complete login to Crosswork via: https://{VIP}:30603/#/logincontroller
INFO: Cw Installer operation complete.
```

**Note**
If the installation fails due to a timeout, you should try rerunning the installation (step 13) without the `-p` option. This will deploy the VMs serially rather than in parallel.

If the installer fails for any other reason (for example, mistyped IP address), correct the error and rerun the install script.

If the installation fails (with or without the -p), open a case with Cisco and provide the .log files that were created in the /data directory (and the local directory where you launched the installer docker container), to Cisco for review. The two most common reasons for the install to fail are: (a) password that is not adequately complex, and (b) errors in the template file.

### What to do next

- See Monitor the Installation, on page 26 to know how you can check the status of the installation.
- See Troubleshoot the Cluster, on page 13 for common troubleshooting scenarios.

**Return to the installation workflow:** Install Cisco Crosswork Network Controller on VMware vCenter

# Sample manifest template for VMware vCenter

The following example deploys a Crosswork cluster containing 3 Hybrid nodes (IDs 0,1, 2) and 2 worker nodes (IDs 3, 4).

**Note** In case you are using resource pools, please note that individual ESXi host targeting is not allowed and vCenter is responsible for assigning the VM to a host in the resource pool. If vCenter is not configured with resource pools, then the exact ESXi host path must be passed.

```
*******
vCenter Example
********

ClusterIPStack = "IPv4"
ManagementVIP = "172.25.87.94"
ManagementIPNetmask = "255.255.255.192"
ManagementIPGateway = "172.25.87.65"
DataVIP = "192.168.123.94"
DataIPNetmask = "255.255.255.0"
DataIPGateway = "0.0.0.0"
DNS = "171.70.168.183"
DomainName = "cisco.com"
CWPassword = "****"
VMSize = "Large"
NTP = "ntp.cisco.com"
CloneTimeOut = 90
ManagerDataFsSize = 450
ThinProvisioned = true
BackupMinPercent = 50
EnableHardReservations = false
ManagerDataFsSize     = 450
WorkerDataFsSize      = 450

CwVMs = {
```

```
  "0" = {
    VMName = "vm0",
    ManagementIPAddress = "172.25.87.82",
DataIPAddress = "0.0.0.0",
    DataIPAddress = "192.168.123.82",
    NodeType = "Hybrid"
  },
  "1" = {
    VMName = "vm1",
    ManagementIPAddress = "172.25.87.83",
DataIPAddress = "0.0.0.0",
    DataIPAddress = "192.168.123.83",
    NodeType = "Hybrid"
  },
  "2" = {
    VMName = "vm2",
    ManagementIPAddress = "172.25.87.84",
DataIPAddress = "0.0.0.0",
    DataIPAddress = "192.168.123.84",
    NodeType = "Hybrid"
  },
  "3" = {

    VMName = "vmworker0",
    ManagementIPAddress = "172.25.87.85",
DataIPAddress = "0.0.0.0",
    DataIPAddress = "192.168.123.84",
    NodeType = "Worker"
  },
  "4" = {

    VMName = "vmworker1",
    ManagementIPAddress = "172.25.87.86",
DataIPAddress = "0.0.0.0",
    DataIPAddress = "192.168.123.86",
    NodeType = "Worker"
  },

}


/********* vCentre Resource Data with Cw VM assignment *********/

VCenterDC = {
  VCenterAddress = "172.25.87.90",
  VCenterUser = administrator@vsphere.local,
  VCenterPassword = "******",
  DCname = "dc-cr",
  MgmtNetworkName = "VM Network",
  DataNetworkName = "DPortGroup10",
  VMs = [
    {
      HostedCwVMs = [
        "0",
        "1",
        "2",
       "3", "4"
  ],
      Host = "172.25.87.93",
      Datastore = "datastore3"
     HSDatastore = "datastore3",
    },]
}
```

# Set seed node explicitly

The cluster installer tool, by default, selects the first VM (VM 0) as the seed node. You can set the seed node explicitly by adding the following section to the manifest template (.tfvars file) indicating the unique key of the seed node.

**Note** You are recommended not to modify the default seed node value unless advised to do so by the Cisco Customer Experience team.

```
cluster_settings = {
#Default Minimum number of nodes in inventory
    min_inventory     = 3
#Default Max number of nodes in inventory
    max_inventory     = 9
#Default Min number of manager nodes
    min_mngr_nodes    = 2
#Default Max number of manager nodes
    max_mngr_nodes    = 3
#Default seed node key name
    default_seed_node = "0"
}
```

# Troubleshoot the Cluster

By default, the installer displays progress data on the command line. The install log is fundamental in identifying the problems, and it is written into the `/data` directory.

| Scenario | Possible Resolution |
|---|---|
| Missing or invalid parameters | The installer provides a clue as regards to the issue; however, in case of errors in the manfiest file HCL syntax, these can be misguiding. If you see "Type errors", check the formatting of the configuration manifest.<br>The manifest file can also be passed as a simple JSON file. Use the following converter to validate/convert: https://www.hcl2json.com/ |
| Certificate Error | The ESXi hosts that will run the Crosswork application and Crosswork Data Gateway VM must have NTP configured, or the initial handshake may fail with "certificate not valid" errors. |
| Image upload takes a long time or upload is interrupted. | The image upload duration depends on the link and datastore performance and can be expected to take around 10 minutes or more. If an upload is interrupted, the user needs to manually remove the partially uploaded image file from vCenter via the vSphere UI. |
| vCenter authorization | The vCenter user needs to have authorization to perform the actions as described in Installation Prerequisites for VMware vCenter. |

| Scenario | Possible Resolution |
|---|---|
| Floating VIP address is not reachable | The VRRP protocol requires unique router_id advertisments to be present on the network segment. By default, Crosswork uses the ID 169 on the management and ID 170 on the data network segments. A symptom of conflict, if it arises, is that the VIP address is not reachable. Remove the conflicting VRRP router machines or use a different network. |
| Crosswork VM is not allowing to log in | The password specified is not strong enough. Change the configuration manfiest and redeploy. |
| Error conditions such as:<br>*Error: Error locking state: Error acquiring the state lock: resource temporarily unavailable*<br>*Error: error fetching virtual machine: vm not found*<br>*Error: Invalid index* | These errors are common when re-running the installer after an initial run is interrupted (Control C, or TCP timeout, etc). Remediation steps are:<br>**1.** Run the clean operation (`./cw-installer.sh clean -m <your manifest here>`) OR remove the VM files manually from the vCenter.<br>**2.** Remove the state file (`rm /data/crosswork-cluster.tfstate`) and retry. |
| Deployment fails with: *Failed to validate Crosswork cluster initialization.* | The clusters' seed VM is either unreachable or one or more of the cluster VMs have failed to get properly configured.<br>**1.** Check whether the VM is reachable, and collect logs from `/var/log/firstBoot.log` and `/var/log/vm_setup.log`<br>**2.** Check the status of the other cluster nodes. |
| The VMs are deployed but the Crosswork cluster is not being formed. | A successful deployment allows the operator logging in to the VIP or any cluster IP address to run the following command to get the status of the cluster:<br>`sudo kubectl get nodes`<br>A healthy output for a 3-node cluster is:<br>`NAME STATUS ROLES AGE VERSION`<br>`172-25-87-2-hybrid.cisco.com Ready master 41d v1.16.4`<br>`172-25-87-3-hybrid.cisco.com Ready master 41d v1.16.4`<br>`172-25-87-4-hybrid.cisco.com Ready master 41d v1.16.4`<br>In case of a different output, collect the following logs: `/var/log/firstBoot.log` and `/var/log/vm_setup.log`<br>In addition, for any cluster nodes not displaying the Ready state, collect:<br>`sudo kubectl describe node <name of node>` |

| Scenario | Possible Resolution |
|---|---|
| The following error is displayed while uploading the image:<br>*govc: The provided network mapping between OVF networks and the system network is not supported by any host.* | The Dswitch on the vCenter is misconfigured. Please check whether it is operational and mapped to the ESXi hosts. |
| The VMs take a long time to deploy | The disk load on the vCenter plays a major role in cloning VM. To ease loaded systems, it is possible to run the VM install operations in a serialized manner. On higher performance systems, run the deployment in parallel by passing the [-p] flag. |
| VMs deploy but install fails with *Error: timeout waiting for an available IP address* | Most likely cause would be an issue in the VM parameters provided or network reachability. Enter the VM host through the vCenter console. and review and collect the following logs: `/var/log/firstBoot.log` and `/var/log/vm_setup.log` |
| On cluster node failure, the VIP is not transferred to the remaining nodes | Ensure that switch or the vCenter Dswitch connected the VMs allows IP address movement (Allow Forged Transmits in vCenter). For more information, see VMware Settings. |
| When deploying on a vCenter, the following error is displayed towards the end of the VM bringup:<br>Error processing disk changes post-clone: *disk.0: ServerFaultCode: NoPermission: RESOURCE (vm-14501:2000), ACTION (queryAssociatedProfile): RESOURCE (vm-14501), ACTION (PolicyIDByVirtualDisk)* | Enable Profile-driven storage. Query permissions for the vCenter user at the root level (i.e. for all resources) of the vCenter. |
| Installer reports plan to add more resources than the current numbr of VMs | Other than the Crosswork cluster VMs, the installer tracks a couple of other meta-resources. Thus, when doing an installation of, say a 3-VM cluster, the installer may report a "plan" to add more resources than the number of VMs. |
| On running or cleaning, installer reports *Error: cannot locate virtual machine with UUID "xxxxxxx": virtual machine with UUID "xxxxxxxx" not found* | To resolve, remove the `/data/crosswork-cluster.tfstate` file.<br>The installer uses the `tfstate` file stored as `/data/crosswork-cluster.tfstate` to maintain the state of the VMs it has operated upon. If a VM is removed outside of the installer, that is through the vCenter UI, this state is out of synchronization. |

| Scenario | Possible Resolution |
|---|---|
| The following error is displayed if the Crosswork password is not complex enough:<br>`Error: Invalid value for variable on cluster_vars.tf line 113:`<br>`├─────────────────`<br>`This was checked by the validation rule at cluster_vars.tf:115,3-13.`<br>`Error: expected length of name to be in the range (1 - 80), got`<br>`with data.vsphere_virtual_machine.template_from_ovf,`<br>`on main.tf line 32, in data "vsphere_virtual_machine" "template_from_ovf":`<br>`32: name = var.Cw_VM_Image`<br>`Mon Aug 21 18:52:47 UTC 2023: ERROR: Installation failed. Check installer and the VMs' log by accessing via console and viewing /var/log/firstBoot.log` | To resolve, ensure to create a strong password.<br>The password must be at least 8-characters long and should include upper & lower case letters, numbers, and special characters. Avoid using passwords similar to dictionary words (for example, "Pa55w0rd!") or relatable words (for example, C!sco123 or Cwork321!). While they satisfy the criteria, such passwords are weak and will result in the failure of VM setup. |

# Manual Installation of Cisco Crosswork using vCenter vSphere UI

This section explains the procedure to manually install Cisco Crosswork on VMware using the vCenter vSphere UI. The procedure needs to be repeated for each node in the cluster.

The manual installation workflow is broken into two parts:

1. Build the OVF template, on page 17
2. Deploy the template, on page 23

In the first part, you create a template. In the second part, you deploy the template as many times as needed to build the cluster of 3 Hybrid nodes (typically) along with any Worker nodes that your environment requires.

**Note** If the template already exists and you need to rebuild or deploy a Worker node, you can directly go to deploying the template (the second part of this procedure).

**Important** In case of manual installation of Crosswork Cluster, you must import a cluster inventory file (.tfvars file) to the Crosswork UI. The inventory file (a sample can be downloaded from the Crosswork UI) will contain information about the VMs in your cluster along with the data center parameters. You must set the parameter `OP_Status = 2` to enable manual import of the inventory.

Cisco Crosswork cannot deploy or remove VM nodes in your cluster until you complete this operation. For more information, see the *Import Cluster Inventory* topic in the *Cisco Crosswork Network Controller 5.0 Administration Guide*.

**Before you begin:**

- Make sure that your environment meets all the vCenter requirements specified under Crosswork Cluster VM Requirements and Installation Prerequisites for VMware vCenter.

# Build the OVF template

### Procedure

**Step 1** Download the latest available Cisco Crosswork image file (*.ova) to your system.

**Step 2** With VMware ESXi running, log into the VMware vSphere Web Client. On the left navigation pane, choose the ESXi host on which you want to deploy the VM.

**Step 3** In the vSphere UI, go to **Host** > **Configure** > **Networking** > **Virtual Switches** and select the virtual switch. In the virtual switch, select **Edit** > **Security**, and configure the following DVS port group properties:

- Set **Promiscuous mode** as *Reject*
- Set **MAC address changes** as *Reject*

Confirm the settings and repeat the process for each virtual switch used in the cluster.

**Step 4** Review and confirm that your network settings meet the requirements.

**Step 5** Choose **Actions** > **Deploy OVF Template**.

**Caution**
The default VMware vCenter deployment timeout is 15 minutes. The total time needed to deploy the OVA image file may take much longer than 15 minutes, depending on your network speed and other factors. If vCenter times out during deployment, the resulting VM will be unbootable. To prevent this, we recommend that you document the choices (such as IP address, gateway, DNS server, etc.) so that you can enter the information quickly and avoid any issues with the VMware configuration.

**Step 6** The VMware **Deploy OVF Template** window appears, with the first step, **1 - Select an OVF template**, highlighted. Click **Choose Files** to navigate to the location where you downloaded the OVA image file and select it. Once selected, the file name is displayed in the window.

**Step 7** Click **Next**. The **Deploy OVF Template** window is refreshed, with **2 - Select a name and folder** now highlighted. Enter a name and select the respective Datacenter for the Cisco Crosswork VM you are creating.

We recommend that you include the Cisco Crosswork version and build number in the name, for example: Cisco Crosswork 5.0 Build 152.

**Step 8** Click **Next**. The **Deploy OVF Template** window is refreshed, with **3 - Select a compute resource** highlighted. Select the host for your Cisco Crosswork VM.

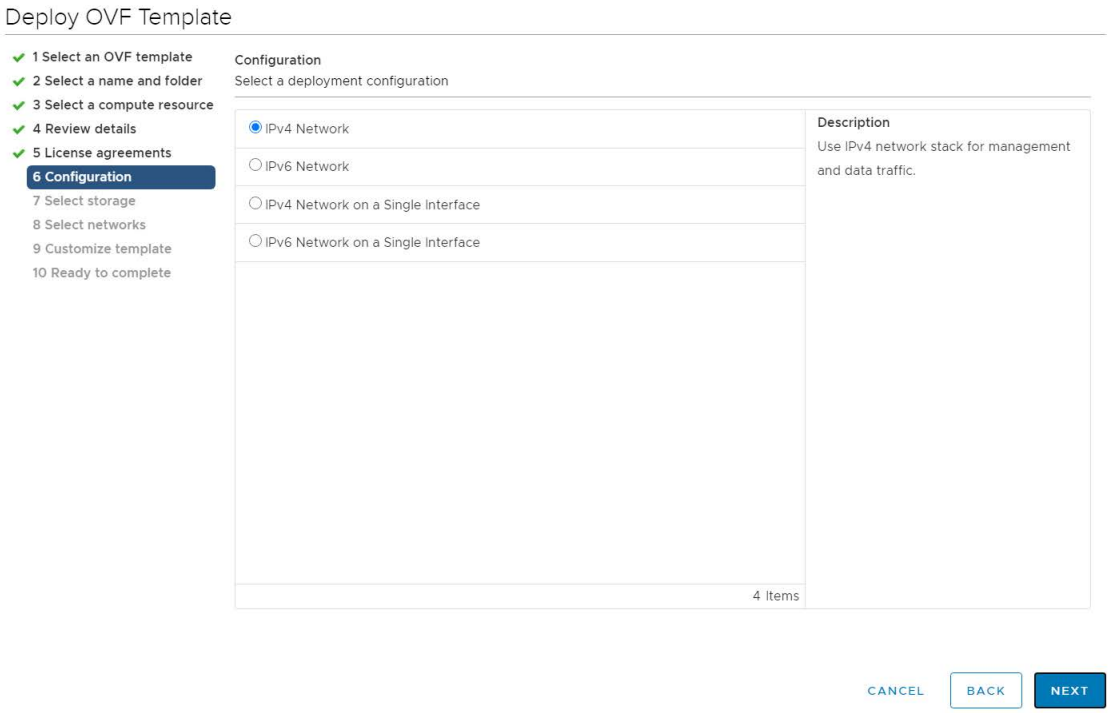
**Step 9** Click **Next**. The VMware vCenter Server validates the OVA. Network speed will determine how long validation takes. After the validation is complete, the **Deploy OVF Template** window is refreshed, with **4 - Review details** highlighted.

**Step 10** Review the OVF template that you are deploying. Note that this information is gathered from the OVF, and cannot be modified.

**Step 11** Click **Next**. The **Deploy OVF Template** window is refreshed, with **5 - License agreements** highlighted. Review the End User License Agreement and if you agree, click the **I accept all license agreements** checkbox. Otherwise, contact your Cisco Experience team for assitance.

**Step 12** Click **Next** The **Deploy OVF Template** window is refreshed, with **6 - Configuration** highlighted. Choose the desired deployment configuration.

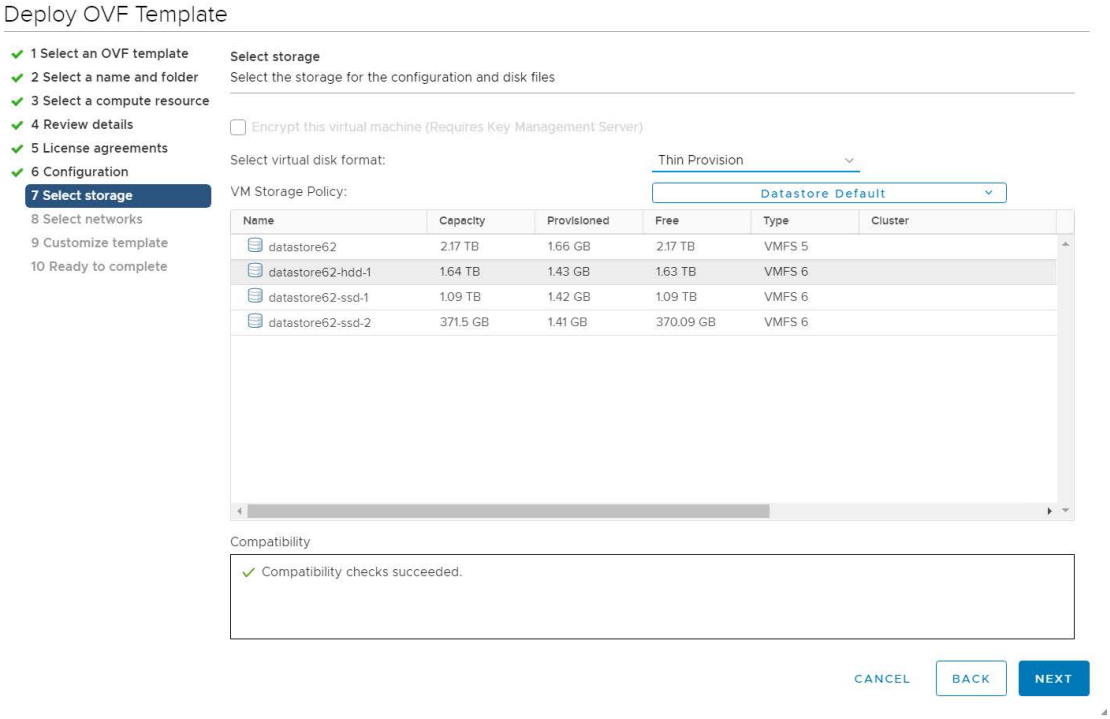
***Figure 1: Select a deployment configuration***




**Note**
If Cisco Crosswork is deployed using a single interface, then Cisco Crosswork Data Gateway must be deployed using a single interface as well (only recommended for lab deployments).

**Step 13** Click **Next**. The **Deploy OVF Template** window is refreshed, with **7 - Select Storage** highlighted. Choose the relevant option from the **Select virtual disk format** drop-down list. From the table, choose the datastore you want to use, and review its properties to ensure there is enough available storage.

*Figure 2: Select Storage*




**Note**
For production deployment, choose the **Thick Provision Eager Zeroed** option because this will preallocate disk space and provide the best performance. For lab purposes, we recommend the **Thin Provision** option because it saves disk space.

**Step 14** Click **Next**. The **Deploy OVF Template** window is refreshed, with **8 - Select networks** highlighted. From the **Data Network** and **Management Network** drop-down lists, choose an appropriate destination network.

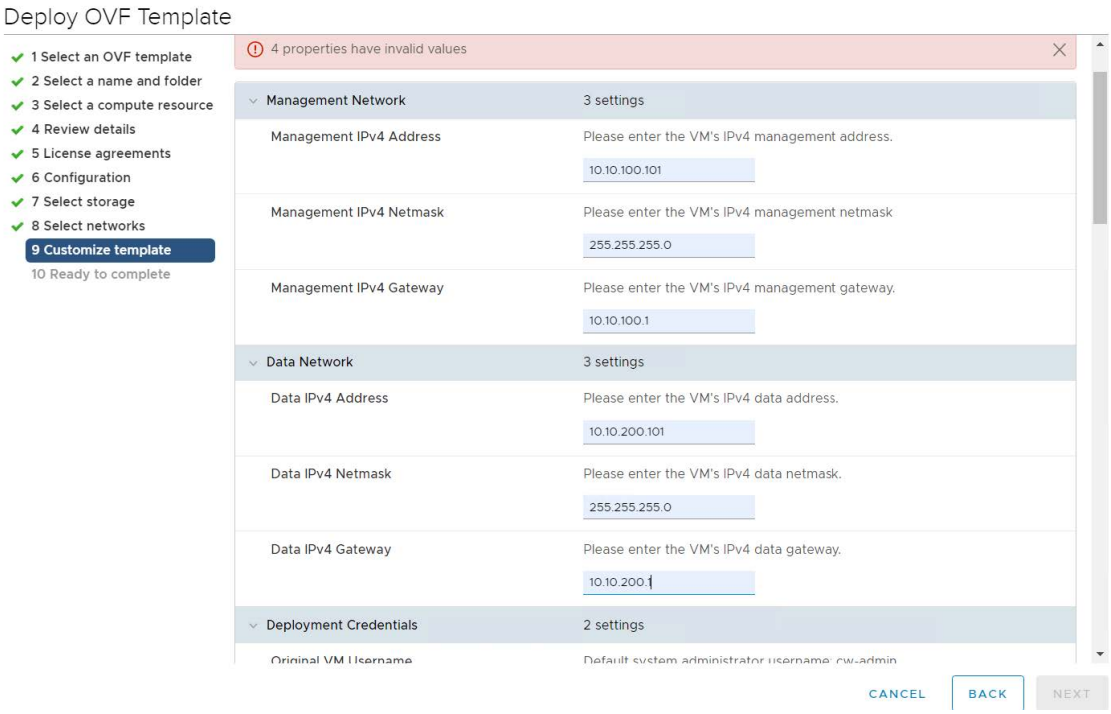
**Important**
Admin Network and NBI Network are not applicable for Crosswork Network Controller deployments.

**Step 15** Click **Next**. The **Deploy OVF Template** window is refreshed, with **9 - Customize template** highlighted.

a) Expand the **Management Network** settings. Provide information for the IPv4 or IPv6 deployment (as per your selection).

b) Expand the **Data Network** settings. Provide information for the IPv4 or IPv6 deployment (as per your selection).

*Figure 3: Customize template settings*



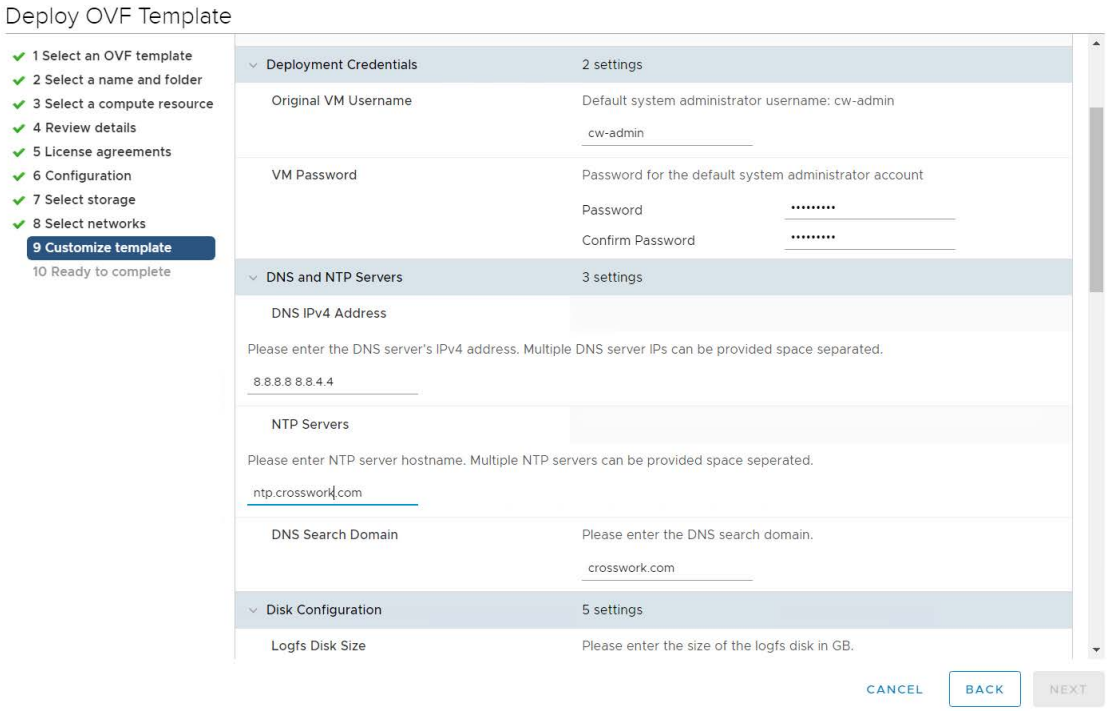

**Note**
**Data Network** settings are not displayed if you have selected the **IPv4 on a Single Interface** or **IPv6 on a Single Interface** configuration.

c) Expand the **Deployment Credentials** settings. Enter relevant values for the VM Username and Password.

**Note**
Use a strong VM Password (8 characters long, including upper & lower case letters, numbers, and one special character). Avoid using passwords similar to dictionary words (for example, "Pa55w0rd!") or relatable words (for example, C!sco123 or Cwork321!). While they satisfy the criteria, such passwords are weak and will result in the failure of VM setup.

d) Expand the **DNS and NTP Servers** settings. According to your deployment configuration (IPv4 or IPv6), the fields that are displayed are different. Provide information in the following three fields:

- **DNS IP Address**: The IP addresses of the DNS servers you want the Cisco Crosswork server to use. Separate multiple IP addresses with spaces.
- **DNS Search Domain**: The name of the DNS search domain.
- **NTP Servers**: The IP addresses or host names of the NTP servers you want to use. Separate multiple IPs or host names with spaces.




**Note**
The DNS and NTP servers must be reachable using the network interfaces you have mapped on the host. Otherwise, the configuration of the VM will fail.

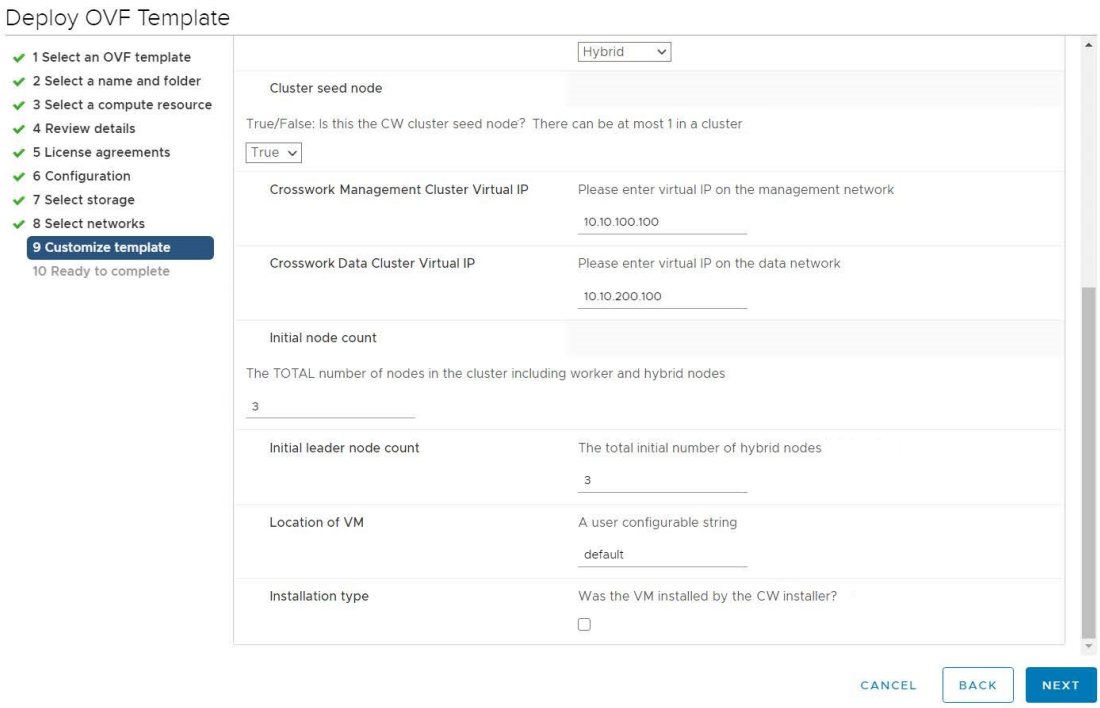
e) The default **Disk Configuration** settings should work for most environments. Change the settings only if you are instructed to by the Cisco Customer Experience team.

f) Expand **Crosswork Configuration** and enter your legal disclaimer text (users will see this text if they log into the CLI).

g) Expand **Crosswork Cluster Configuration**. Provide relevant values for the following fields:

- **VM Type**:
  - Choose **Hybrid** if this is one of the 3 Hybrid nodes.
  - Choose **Worker** if this is a Worker node.
- **Cluster Seed node**:
  - Choose **True** if this is the first VM being built in a new cluster.
  - Choose **False** for all other VMs, or when rebuilding a failed VM.
- **Crosswork Management Cluster Virtual IP**: Enter the Management Virtual IP address and Management Virtual IP DNS name.
- **Crosswork Data Cluster Virtual IP**: Enter the Data Virtual IP address. and the Data Virtual IP DNS name.
- **Initial node count**: Default value is 3.
- **Initial leader node count**: Default value is 3.

- **Location of VM**: Enter the location of VM.
- **Installation type**:
  - *For new cluster installation*: Do not select the checkbox.
  - *Replacing a failed VM*: Select the checkbox if this VM is being installed to replace a failed VM.




**Step 16** Click **Next**. The **Deploy OVF Template** window is refreshed, with **10 - Ready to Complete** highlighted.

**Step 17** Review your settings and then click **Finish** if you are ready to begin deployment. Wait for the deployment to finish before continuing. To check the deployment status:

a) Open a VMware vCenter client.

b) In the **Recent Tasks** tab of the host VM, view the status of the **Deploy OVF template** and **Import OVF package** jobs.

**Step 18** To finalize the template creation, select the host and right-click on the newly installed VM and select **Template** > **Convert to Template**. A prompt confirming the action is displayed. Click **Yes** to confirm. The template is created under the **VMs and Templates** tab in the vSphere Client UI.

*This is the end of the first part of the manual installation workflow. In the second part, use the newly created template to build the cluster VMs.*

# Deploy the template

### Procedure

**Step 1** To build the VM, right-click on the newly created template and select **New VM from This Template**.

**Step 2** The VMware **Deploy From Template** window appears, with the first step, **1 - Select a name and folder**, highlighted. Enter a name and select the respective Datacenter for the VM.

**Step 3** Click **Next**. The **Deploy From Template** window is refreshed, with **2 - Select a compute resource** highlighted. Select the host for your Cisco Crosswork VM.

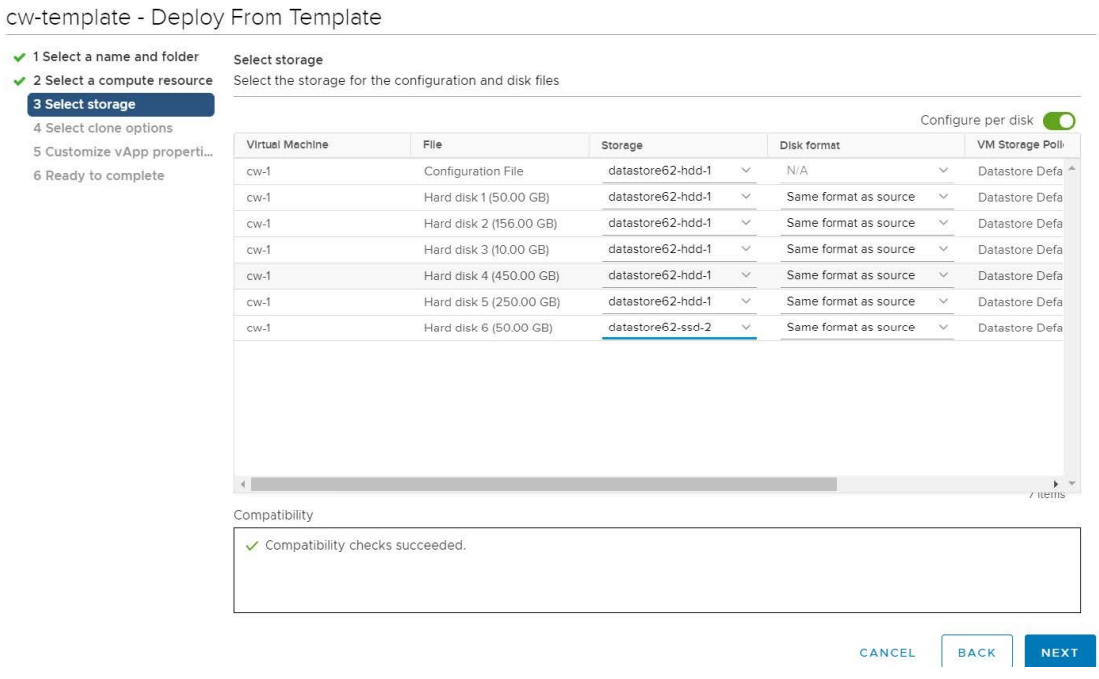
**Step 4** Click **Next**. The **Deploy From Template** window is refreshed, with **3 - Select Storage** highlighted. Choose **Same format as source** option as the virtual disk format (recommended).

The recommended configuration for the nodes uses a combination of high-speed (typically SSD based) and normal (typical disks) storage. If you are following the recommended configuration follow the steps for two data stores. Otherwise, follow the steps for using a single data store.

***If you are using two data stores (regular and high speed)***:

- Enable **Configure per disk** option.
- Select same data store (regular) as the **Storage** setting for disks 1 through 5. This data store must have 916 GB of space.
- Select the host's high speed (ssd) data store as the **Storage** setting for disk 6. The high speed data store must have at least 50 GB of space.

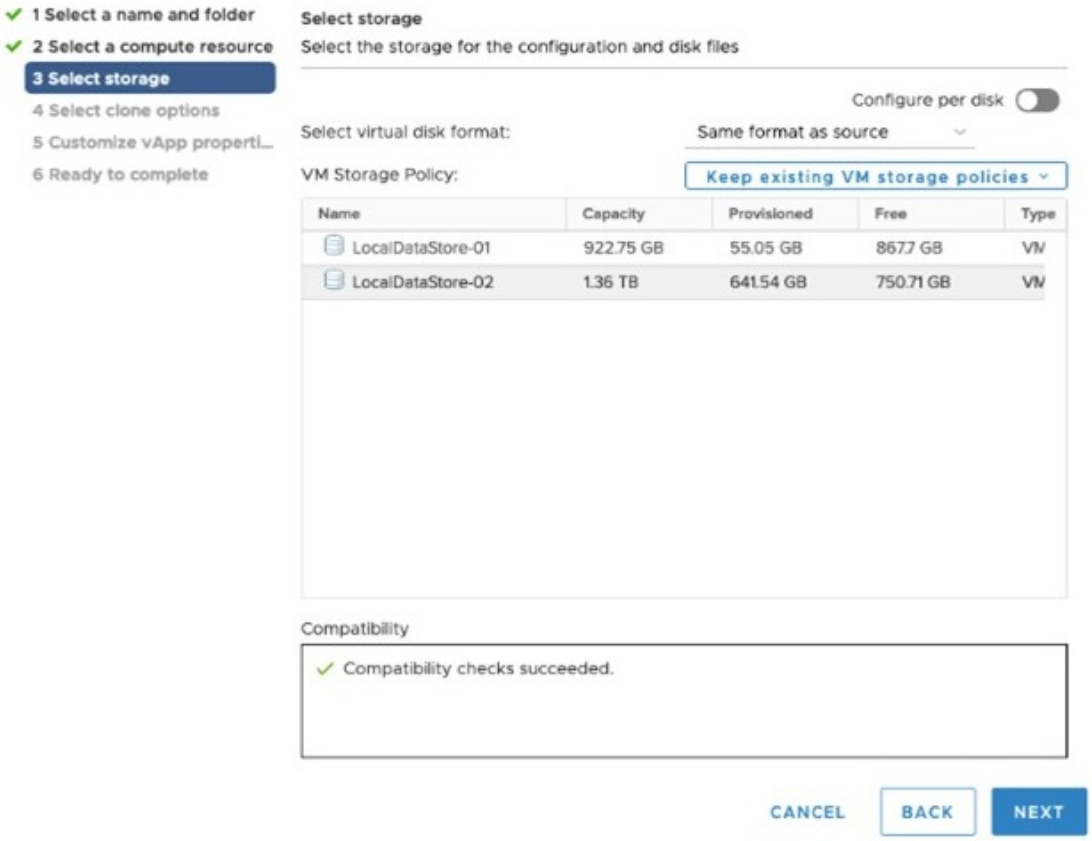
***Figure 4: Select Storage - Configure per disk***




- Click **Next**.

***If you are using a single data store***: Select the data store you wish to use, and click **Next**.

***Figure 5: Select Storage - single data store***




**Step 5** The **Deploy From Template** window is refreshed, with **4 - Select clone options** highlighted. You can choose further clone options here.

(Optional) Perform the following steps to configure the disk, memory and Extensive Firmware Interface (EFI) boot settings:

**Note**
For non-lab environments, you need to reconfigure the hardware to use the proper amount of memory and CPU resources.

- Choose **Customize this virtual machine's hardware** and click **Next**. The **Edit Settings** dialog box is displayed.
- Under **Virtual Hardware** tab, enter the relevant values (see Crosswork Cluster VM Requirements) for **CPU** and **Memory**.
- Under **VM Options** tab, expand **Boot Options**, select **EFI** as the Firmware, and check the **Secure Boot** checkbox.

**Step 6** Click **Next**. The **Deploy From Template** window is refreshed, with **5 - Customize vApp properties** highlighted. The vApp properties from the template is already populated in this window. You need to check the following fields:

- **Cluster Seed node**:
  - Choose **True** if this is the first VM being built in a new cluster.

- Choose **False** for all other VMs, or when rebuilding a failed VM.

- **Management Network settings**: Enter correct IP values for each VM in the cluster.
- **Data Network settings**: Enter correct IP values for each VM in the cluster.
- **Crosswork Management Cluster Virtual IP**: The Virtual IP will remain same for each cluster node.
- **Crosswork Data Cluster Virtual IP**: The Virtual IP will remain same for each cluster node.
- **Deployment Credentials**: Enter same deployment credentials for each VM in the cluster.

**Note**
(Optional) Use the **Reservation** field under the **Virtual Hardware** tab to set reservation for the VM's CPU allocation (in MHz) and memory profile (in MB).

**Note**
If this VM is being deployed to replace a failed VM, the IP and other settings must match the machine being replaced.

**Step 7** Click **Next**. The **Deploy From Template** window is refreshed, with **6 - Ready to complete** highlighted. Review your settings and then click **Finish** if you are ready to begin deployment.

**Step 8** Repeat from **Step 1** to **Step 7** to deploy the remaining VMs in the cluster.

**Step 9** You can now power on Cisco Crosswork VMs to complete the deployment process. The VM selected as the cluster seed node must be powered on first, followed by the remaining VMs (after a delay of few minutes). To power on, expand the host's entry, click the Cisco Crosswork VM, and then choose **Actions** > **Power** > **Power On**.

**Step 10** The time taken to create the cluster can vary based on the size of your deployment profile and the performance characteristics of your hardware. See Monitor the Installation, on page 26 to know how you can check the status of the installation.

**Note**
If you are running this procedure to replace a failed VM, then you can check the status from the Cisco Crosswork GUI (go to **Administration** > **Crosswork Manager** and click on the cluster tile to check the *Crosswork Cluster* status.

**Note**
If you are using this process to build a new Worker node, no additional work is required after the node is powered on. The node will register with the existing Kubernetes cluster.

For more information on how the resources are allocated to the Worker node, see the *Rebalance Cluster Resources* topic in the *Cisco Crosswork Network Controller 5.0 Administration Guide*.

### What to do next

After you login to Crosswork UI, please import a cluster inventory file (.tfvars file) to the Crosswork UI. The inventory file (a sample can be downloaded from the Crosswork UI) will contain information about the VMs in your cluster along with the data center parameters. You must set the parameter `OP_Status = 2` to enable manual import of the inventory. Cisco Crosswork cannot deploy or remove VM nodes in your cluster until you complete this operation. For more information, see the *Import Cluster Inventory* topic in the *Cisco Crosswork Network Controller 5.0 Administration Guide*.

**Return to the installation workflow:** Install Cisco Crosswork Network Controller on VMware vCenter

# Monitor the Installation

This section explains how to monitor and verify if the installation has completed successfully. As the installer builds and configures the cluster it will report progress. The installer will prompt you to accept the license agreement and then ask if you want to continue the install. After you confirm, the installation will progress and any possible errors will be logged in either `installer.log` or `installer_tf.log`. If the VMs get built and are able to boot, the errors in applying the operator specified configuration will be logged on the VM in the /var/log/firstboot.log.

**Note** During installation, Cisco Crosswork will create a special administrative ID (**virtual machine (VM) administrator**, *cw-admin*, with the password that you provided in the manifest template. In case the installer is unable to apply the password, it creates the administrative ID with the default password *cw-admin*). The first time you log in using this administrative ID, you will be prompted to change the password.

The administrative username is reserved and cannot be changed. Data center administrators use this ID to log into and troubleshoot the Crosswork application VM.

The following is a list of critical steps in the process that you can watch for to be certain that things are progressing as expected:

1. The installer uploads the crosswork image file (.ova file) to the vCenter data center.

**Note** On running, the installer will upload the .ova file into the vCenter if it is not already present, and convert it into a VM template. After the installation is completed successfully, you can delete the template file from the vCenter UI (located under *VMs and Templates*) if the image is no longer needed.

2. The installer creates the VMs, and displays a success message (e.g. "Creation Complete") after each VM is created.

**Note** For VMware deployments, this activity can also be monitored from the vSphere UI.

3. After each VM is created, it is powered on (either automatically when the installer completes, or after you power on the VMs during the manual installation). The parameters specified in the template are applied to the VM, and it is rebooted. The VMs are then registed by Kubernetes to form the cluster.
4. Once the cluster is created and becomes accessible, a success message (e.g. "Crosswork Installer operation complete") will be displayed and the installer script will exit and return you to a prompt on the screen.

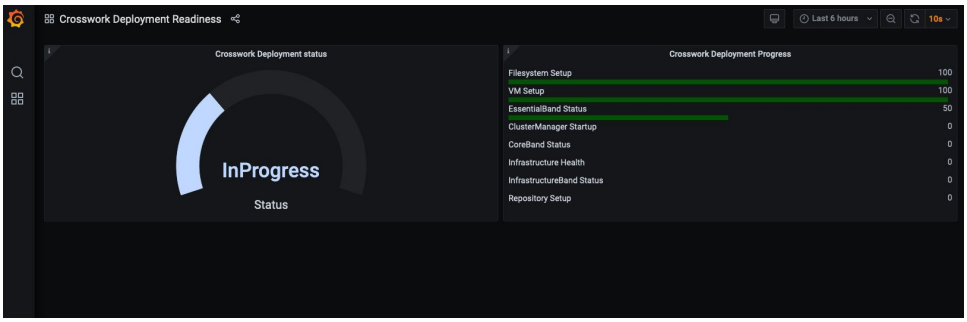
You can monitor startup progress using the following methods:

- **Using browser accessible dashboard:**
  1. While the cluster is being created, monitor the setup process from a browser accessible dashboard.
  2. The URL for this grafana dashboard (in the format `http://{VIP}:30602/d/NK1bwVxGk/crosswork-deployment-readiness?orgId=1&refresh=10s&theme=dark`)

is displayed once the installer completes. This URL is temporary and will be available only for a limited time (around 30 minutes).

3. At the end of the deployment, the grafana dashboard will report a "Ready" status. If the URL is inaccessible, use the SSH console described in this section to monitor the installation process.

***Figure 6: Crosswork Deployment Readiness***




- **Using the console:**

1. Check the progress from the console of one of the hybrid VMs or by using SSH to the Virtual IP address.
2. In the latter case, login using the *cw-admin* user name and the password you assigned to that account in the install template.
3. Switch to super user using `sudo su -` command.
4. Run `kubectl get nodes` (to see if the nodes are ready) and `kubectl get pods` (to see the list of active running pods) commands.
5. Repeat the `kubectl get pods` command until you see `robot-ui` in the list of active pods.
6. At this point, you can try to access the Cisco Crosswork UI.

After the Cisco Crosswork UI becomes accessible, you can also monitor the status from the UI. For more information, see Log into the Cisco Crosswork UI, on page 28.

### Failure Scenario

In the event of a failue scenario (listed below), contact the Cisco Customer Experience team and provide the `installer.log`, `installer_tf.log`, and `firstBoot.log` files (there will be one per VM) for review:

- Installation is incomplete
- Installation is completed, but the VMs are not functional
- Installation is completed, but you are directed to check `/var/log/firstBoot.log` or `/opt/robot/bin/firstBoot.log` file.

### What to do next:

Return to the installation workflow: Install Cisco Crosswork Network Controller on VMware vCenter

# Log into the Cisco Crosswork UI

Once the cluster activation and startup have been completed, you can check if all the nodes are up and running in the cluster from the Cisco Crosswork UI. Perform the following steps to log into the Cisco Crosswork UI and check the cluster health:

**Note** If the Cisco Crosswork UI is not accessible, during installation, please access the host's console from the VMware or AWS UI to confirm if there was any problem in setting up the VM. When logging in, if you are directed to review the `firstboot.log` file, please check the file to determine the problem. If you are able to identify the error, rectify it and rerun the installer. If you require assistance, please contact the Cisco Customer Experience team.

### Procedure

**Step 1** Launch one of the supported browsers (see Supported Web Browsers).

**Step 2** In the browser's address bar, enter:

`https://<Crosswork Management Network Virtual IP (IPv4)>:30603/`

or

`https://[<Crosswork Management Network Virtual IP (IPv6)>]:30603/`

**Note**
Please note that the IPv6 address in the URL must be enclosed with brackets.

**Note**
You can also log into the Crosswork UI using the Crosswork FQDN name.

The **Log In** window opens.

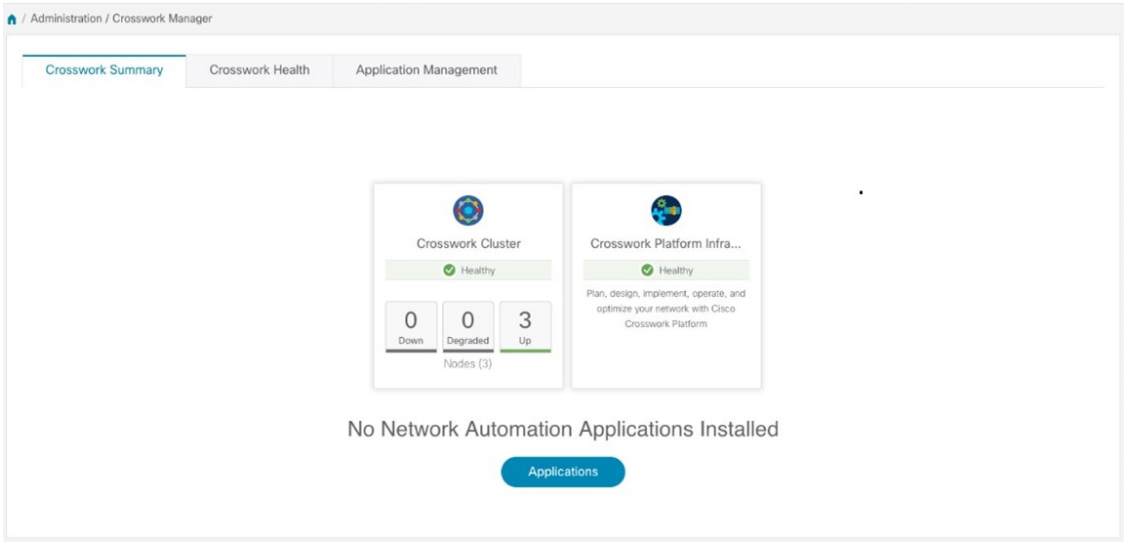
**Note**
When you access the Cisco Crosswork for the first time, some browsers display a warning that the site is untrusted. When this happens, follow the prompts to add a security exception and download the self-signed certificate from the Cisco Crosswork server. After you add a security exception, the browser accepts the server as a trusted site in all future login attempts. If you want to use a CA signed certificate, see the *Manage Certificates* topic in the *Cisco Crosswork Network Controller 5.0 Administration Guide*.

**Step 3** Log into the Cisco Crosswork as follows:

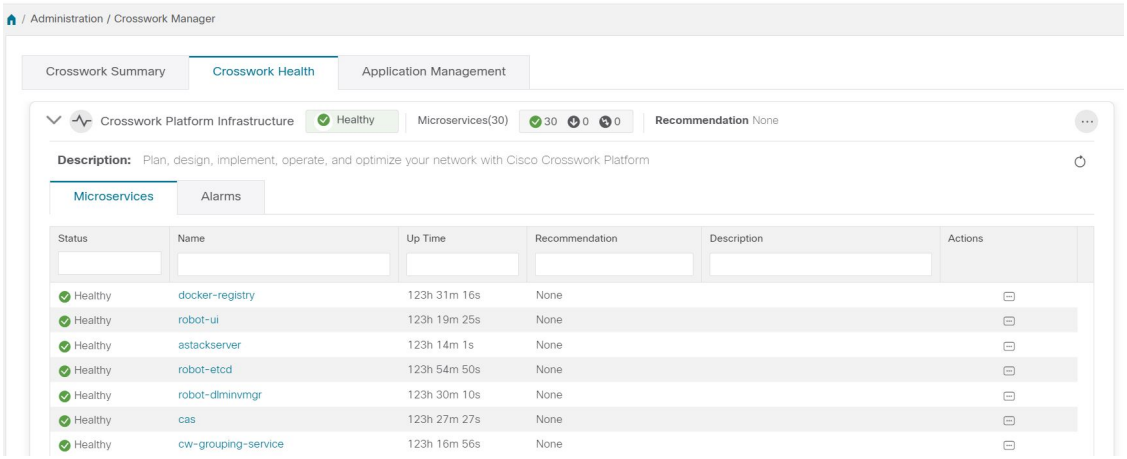
a) Enter the Cisco Crosswork administrator username **admin** and the default password **admin**.
b) Click **Log In**.
c) When prompted to change the administrator's default password, enter the new password in the fields provided and then click **OK**.

**Note**
Use a strong VM Password (minimum 8 characters long, including upper & lower case letters, numbers, and one special character). Avoid using passwords similar to dictionary words (for example, "Pa55w0rd!") or relatable words (for example, C!sco123 or Cwork321!).

The **Crosswork Manager** window is displayed.




**Step 4** (Optional) Click on the **Crosswork Health** tab, and click the **Crosswork Platform Infrastructure** tab to view the health status of the microservices running on Cisco Crosswork.




### What to do next

Return to the installation workflow: Install Cisco Crosswork Network Controller on VMware vCenter