



# Healing Virtual Network Functions

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## Healing Overview

As part of life cycle management, ESC heals the VNFs when there is a failure. The healing parameters are configured in the KPI section of the datamodel. ESC uses KPI to monitor the VM and the events are triggered based on the KPI conditions. The actions to be taken for every event that is triggered are configured in the rules section during the deployment.

## Healing a VM

Each VM group is configured to enable the healing. Healing is performed at two stages: Before the service is alive and after the service is alive with a recovery policy defined in the data model.

The VMs are deployed and are being monitored. After ESC receives a VM Alive event, if it receives a VM Down event, the healing workflow attempts to recover the VM with the recovery policy.

If ESC does not receive a VM Alive after deployment, ESC recovers the VM with the recovery policy when timeout happens. All the recovery procedures depend on the recovery policy configuration. For example, if the user configured either one of the recovery policy such as Reboot Only, Redeploy Only, or Reboot and Redeploy then ESC will follow the same configured policy.

ESC provides YANG based data model with comprehensive details of all the parameters and description that is needed to define the healing. ESC uses two sections in the data model xml file which define the events and rules:

- `<kpi>` section defines the type of monitoring, events, polling interval and other parameters.
- `<rule>` section defines the actions when the KPI monitoring events are triggered.

For more information on KPI, rules, and data model, see [KPIs, Rules and Metrics](#).

The configuration involves the following steps:

1. Define kpi
2. Define rules

The following example shows how to configure the KPI in the data model:

```
<kpi>
<event_name>VM_ALIVE</event_name>
<metric_value>1</metric_value>
<metric_cond>GT</metric_cond>
<metric_type>UINT32</metric_type>
<metric_collector>
<type>ICMPPing</type>
<nicid>0</nicid>
<poll_frequency>3</poll_frequency>
<polling_unit>seconds</polling_unit>
<continuous_alarm>>false</continuous_alarm>
</metric_collector>
</kpi>
```

The following example shows how to configure the rules for every event:

```
<rules>
<admin_rules>
<rule>
<event_name>VM_ALIVE</event_name>
<action>ALWAYS_log</action>
<action>FALSE_recover_autohealing</action>
<action>TRUE_servicebooted.sh</action>
</rule>
</admin_rules>
</rules>
```

In the above examples, we define a KPI to monitor the ICMP Ping on the nicid 0. It defines the attributes metric condition and polling. Based on the KPI, the VM\_ALIVE event is triggered with appropriate values. The action in the corresponding rule defines what the next steps are:

- FALSE—Triggers recovery of the VM.
- TRUE—Triggers the defined action.

If recovery is triggered on the VM with reboot then redeploy option configured in the recovery policy, ESC reboots the VM as the first step to recover the VM. If it fails, the VM is un-deployed and a new VM with same day-0 configuration is deployed. ESC tries to reuse the same network configuration like MAC and IP Address as the previous VM.

Typically, if the VM is unreachable, ESC starts VM recovery on all unreachable VMs. During a network outage, ESC suspends VM recovery for the duration of the network outage, thus delaying the VM recovery. ESC detects the unreachable VM, and evaluates the reachability of the gateway first to detect the presence of a network failure.

If ESC cannot ping the gateway, no action is taken to recover the VM. VM recovery resumes when the gateway becomes reachable.

In case of a double fault condition, that is, when the network gateway and the VM failure occur at the same time, ESC automatically performs VM monitoring after the gateway is reachable again.

For information on healing a VNF using ETSI API, see the *Cisco Elastic Services Controller NFV MANO Guide*.

## Recovery Policy

The VMs are deployed and are being monitored. After ESC receives a VM Alive event, if it receives a VM Down event, the healing workflow attempts to recover the VM with the recovery policy.

If ESC does not receive a VM Alive after deployment, ESC recovers VM with the recovery policy when timeout happens. All the recovery procedures depend on the recovery policy configuration.

ESC has the following VM recovery policies that you can specify when you deploy a VNF:

- **Auto Recovery**
- **Manual Recovery**

ESC supports recovery using the policy-driven framework, see [Recovery Policy \(Using the Policy Framework\)](#) for details.

There are three types of actions for a VM recovery:

- **REBOOT\_THEN\_REDEPLOY (default)**—When a VM down event is received or timer expires, the healing workflow first attempts to reboot the VM, if it fails to reboot, then it attempts to redeploy the VM on the same host.
- **REBOOT\_ONLY**—When a VM down event is received or timer expires, the healing workflow only attempts to reboot the VM.
- **REDEPLOY\_ONLY**—When a VM down event is received or timer expires, the healing workflow only attempts to redeploy the VM.




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**Note** If the policy involves REBOOT\_THEN\_REDEPLOY and REDEPLOY\_ONLY for redeploying the VMs, and if the placement policy is not enforced, then the VIM decides which host to redeploy the VM on.

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**Note** ESC supports both manual and auto recovery for vCloud Director. All three types of recovery actions are applicable for vCloud Director. The REBOOT\_THEN\_REDEPLOY is the default recovery action. For vCD deployment, see [Deploying Virtual Network Functions on VMware vCloud Director \(vCD\)](#).

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### Auto Recovery

In Auto recovery, the recovery type parameter is set to Auto. ESC automatically recovers the VM with the specified <action-on-recovery> value in the recovery policy. The recovery type is auto by default if the user does not choose a recovery type.

```
<recovery_policy>
  <recovery_type>AUTO</recovery_type>
  <action_on_recovery>REBOOT_THEN_REDEPLOY</action_on_recovery>
  <max_retries>3</max_retries>
</recovery_policy>
```

### Manual Recovery

#### Manual Recovery of a VM

In manual recovery, ESC sends the VM\_MANUAL\_RECOVERY\_NEEDED notification to northbound (NB) and waits for the instruction from NB for recovery. ESC performs recovery when it receives recovery instruction from NB. Further, the recovery action is based on the action-on-recovery parameter in the recovery policy. For manual recovery of a complete deployment, see [Manual Recovery of a Deployment, on page 5](#)

The manual recovery policy datamodel is as follows:

```
<vm_group>
.....
<recovery_policy>
<recovery_type>MANUAL</recovery_type>
<action_on_recovery>REBOOT_THEN_REDEPLOY</action_on_recovery>
<max_retries>3</max_retries>
</recovery_policy>
</vm_group>
```

For more information about recovery policy parameters in the datamodel, see [Elastic Services Controller Deployment Attributes](#). For more information about configuring the recovery policy in the ESC Portal (VMware only), see the [Deploying VNFs on VMware vCenter using ESC Portal](#).

The VM\_MANUAL\_RECOVERY\_NEEDED notification is as follows:

```
===== SEND NOTIFICATION STARTS =====
WARN Type: VM_MANUAL_RECOVERY_NEEDED
WARN Status: SUCCESS
WARN Status Code: 200
WARN Status Msg: Recovery event for VM
[manual-recover_error-gl_0_7d96ad0b-4f27-4a5a-bdf7-ec830e93d07e] triggered.
WARN Tenant: manual-recovery-tenant
WARN Service ID: NULL
WARN Deployment ID: 08491863-846a-4294-b305-c0002b9e8daf
WARN Deployment name: dep-error
WARN VM group name: error-gl
WARN VM Source:
WARN VM ID: ffea079d-0ea2-4d47-ba31-26a08e6dff22
WARN Host ID: 3a5351dc4bb7df0ee25e238a8ebbd6c6fcdf225aebcb9dff6ba10249
WARN Host Name: my-server-27
WARN [DEBUG-ONLY] VM IP: 192.168.0.3;
WARN ===== SEND NOTIFICATION ENDS =====
```

### APIs for Manual Recovery of a VM

You can perform manual recovery using the ConfD and Rest APIs. The manual recovery request can be configured to override the predefined recovery action to any desired action.

- **Netconf API** recovery-vm-action DO generated vm name [xmlfile]

To perform recovery using the API, login to esc\_nc\_cli and run the following command:

```
$ esc_nc_cli recovery-vm-action DO [xmlfile]
```

The recovery is performed and the recovery notification is sent to NB.



**Note** Recovery (recovery-vm-action DO <VM-NAME>) can be performed after the VM is alive and the service is active. If the deployment is incomplete, it must be completed before performing recovery.

If a failover happens during a configurable manual recovery, the manual recovery resumes with predefined recover action.

The migration of any deployment must always use default recovery policy. You must not provide recovery action for VM/VNF manual recovery in an LCS based recovery. You must not use enable monitor and configurable manual recovery options together.

• **REST API**

http://ip:8080/ESCAPI/#!/Recovery\_VM\_Operations/handleOperation

POST /v0/{internal\_tenant\_id}/deployments/recovery-vm/{vm\_name}

Recovery VM operation payload:

```
{
  "operation": "recovery_do",
  "properties": {
    "property": [
      {
        "name": "action",
        "value": "REDEPLOY_ONLY"
      }
    ]
  }
}
```

**Supported VM States and Service Combinations for Manual Recovery of a VM**

The API, recovery-vm-action, applies to both auto and manual recovery types, but only under certain VM states and services. The following table shows the details. In general, during deployment, service update, undeployment and recovery, the manual recovery action is rejected by ESC.

VM State	Service State	recovery-vm-action
ALIVE	ACTIVE	supported
ALIVE	ERROR	supported
ERROR	ERROR	supported

**Manual Recovery of a Deployment**

**Recovery Without Monitoring Parameters**

ESC supports manual recovery of VMs at the service level, that is, recovery of a complete deployment. After the successful deployment of a service, the service may move into an error state because of failed VMs. ESC can manually recover these failed VMs, or the complete deployment through a deployment recovery request. For manual recovery of a single VM, see [Manual Recovery, on page 3](#).

### APIs for Manual Recovery of a Deployment

You can perform manual recovery using the NETCONF and REST APIs.

The manual recovery request can be configured to override the predefined recovery action to any desired action.



**Note** There is no service active notification after the deployment recovery. You must run a query, for example, `esc_nc_cli get esc_datamodel` to see if the service state of the deployment is active or not.

If a failover happens during a configurable manual recovery, the manual recovery resumes with predefined recover action.

The migration of any deployment must always use default recovery policy. You must not provide recovery action for VM/VNF manual recovery in an LCS based recovery. You must not use enable monitor and configurable manual recovery options together.

- **NETCONF API** `svc-action RECOVER tenant-name deployment-name [xmlfile]`

To perform recovery using the API, login to `esc_nc_cli`.

- **REST API**

```
POST /v0/{internal_tenant_id}/deployments/service/{internal_deployment_id}
Content-Type: application/xml
Accept: application/json
Callback: http://172.16.0.1:9010/
Callback-ESC-Events: http://172.16.0.1:9010/
<service_operation xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <operation>recover</operation>
</service_operation>
```

where,

**internal\_tenant\_id**—is the system admin tenant ID or the tenant name.

**internal\_deployment\_id**—is the deployment name.

### Supported VM States and Service Combinations for Manual Recovery of a Deployment

The API, `svc-action RECOVER`, applies to both auto and manual recovery types, but only under certain VM states and services. The following table shows the details. In general, during deployment, service update, undeployment and recovery, the manual recovery action is rejected by ESC.



**Note** ESC accepts VM level recovery request when the service is in active or error state.

Notifications are not sent to NB if all VMs are in the ALIVE state after a service recovery request.

VM State	Service State	svc-action RECOVER
ERROR	ERROR	supported
ERROR	ACTIVE	supported

### Recovery Enabled with Monitoring Parameters

During manual recovery, you can recover a VM depending on its monitoring parameters. If the VM is in error state, set the monitoring parameters to bring back the VM in error state to live state. If the VM is recovered, then ESC sends a RECOVERY\_CANCELLED notification. If the VM does not come back live, then the recovery process is triggered. See Manual Recovery for more details.

#### NETCONF API

```
svc-action SET_MONITOR_AND_RECOVER <tenant-name> <dep-name>
```

Recovery notification:

```
===== SEND NOTIFICATION STARTS =====  
WARN Type: VM_RECOVERY_INIT  
WARN Status: SUCCESS  
WARN Status Code: 200  
WARN Status Msg: Recovery with enabling monitor first event for VM Generated ID  
[dep-resource_g1_0_74132737-d0a4-4ef0-bd9e-86465c1017bf] triggered.
```



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**Note** Recovery enabled with monitoring parameters is for manual recovery at service level only.

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## Recovery and Redeployment Policies

ESC uses a policy driven framework to perform actions based on the lifecycle stages in a deployment. A deployment consists of several stages through its lifecycle. Each lifecycle stage (LCS) is associated with a condition. The condition in turn is associated with a predefined action or custom scripts. These conditions and actions are specified within the policies tag in the data model. For more information on Policy driven Framework, see [Policy-Driven Data model](#).

The recovery and redeployment workflows in ESC are policy driven. When VNFs are deployed, the recovery and redeployment policies are specified in the deployment data model. These policies are based on the lifecycle stages of VM or VNF and have actions associated with it.

When a deployment data model is created, you can specify the following policies:

- **Recovery Policy**—The recovery policy is for the VM lifecycle, that is for the recovery of a single VM. Based on the predefined actions, the VM is rebooted, or redeployed. You can perform recovery without using the policy framework. See [Recovery Policy, on page 3](#).
- **Redeployment Policy**—The redeployment policy is for the entire deployment lifecycle, that is for all the VM groups within a deployment. Based on a set of predefined actions, the host is disabled, and VMs are recovered in the deployment.

If the VM recovery fails after the maximum attempts, ESC disables the host and triggers redeployment for all VMs within the deployment. All VMs are undeployed from the old host and redeployed to a new host.

ESC supports redeploying the failed VMs first. During a redeployment, the failed VMs are recovered first, and the VMs that have not failed are queued up for redeployment.

## Recovery Policy (Using the Policy Framework)

Later than Cisco ESC Release 2.2, ESC supports recovery of VMs using the policy-driven framework data model. The recovery is based on the lifecycle stages of VM deployment and predefined actions.

For auto and manual recovery, see [Recovery Policy, on page 3](#).

The table below describes the predefined actions performed at different lifecycle stages.

Predefined Action Name	Scope	Description
SET_RECOVERY::REBOOT_ONLY	Deployment	Sets the recovery action for all VM groups (in a deployment), or for a VM (in a VM group) to REBOOT_ONLY.
SET_RECOVERY::REBOOT_THEN_REDEPLOY	Deployment	Sets the recovery action for all VM groups (in a deployment), or for a VM (in a VM group) to REBOOT_THEN_REDEPLOY.
SET_RECOVERY::REDEPLOY_ONLY	Deployment	Sets the recovery action for all VM groups (in a deployment), or for a VM (in a VM group) to REDEPLOY_ONLY.

### Supported Conditions and Predefined Action Combinations

The following table describes the supported LCS conditions and its actions for recovery and redeployment policies using the policy framework. For more details on the policy driven framework, see [Recovery and Redeployment Policies, on page 7](#).



Condition	Predefined action	Description
<p>LCS::PRE_DEPLOY —Occurs just before deploying VMs in a deployment.</p> <hr/> <p>LCS:: POST_DEPLOY_ALIVE —Occurs immediately after the deployment is active.</p>	<ul style="list-style-type: none"> <li>• SET_RECOVERY::REBOOT_ONLY —Sets the recovery action for all VM groups (in a deployment), or for a VM (in a VM group) to REBOOT_ONLY.</li> <li>• SET_RECOVERY::REBOOT_THEN_REDEPLOY —Sets the recovery action for all VM groups (in a deployment), or for a VM (in a VM group) to REBOOT_THEN_REDEPLOY.</li> <li>• SET_RECOVERY::REDEPLOY_ONLY —Sets the recovery action for all VM groups (in a deployment), or for a VM (in a VM group) to REDEPLOY_ONLY.</li> <li>• SET_RECOVERY_REDEPLOY::SERIALIZED —Queues up the recoveries in the deployment. That is, new recovery does not start until the current ongoing recovery completes.</li> </ul>	<p>Choose any one of the predefined action for recovery.</p> <p>Choose SET_RECOVERY_REDEPLOY::SERIALIZED, if DROP_RECOVERIES action is used. This means the VMs need to be kept on the original host once the redeployment fails. If not chosen, then DROP_RECOVERIES action cannot be used.</p>
<p>LCS::DEPLOY_ERR —Occurs immediately after the deployment fails.</p>	<p>DISABLE_HOST —Disables the host(s) the deployment or the VM is using.</p>	<p>-</p>
<p>LCS::POST_DEPLOY::VM_RECOVERY_ERR —Occurs immediately after the recovery of one VM fails.</p>	<p>DISABLE_HOST —Disables the host(s) the deployment or the VM is using.</p> <p>REDEPLOY_ALL::DISABLE_HOST —Disables the host the VM is using then trigger redeploy for all VMs (within a deployment), or all VMs on that host.</p>	<p>Choose DISABLE_HOST if needed.</p> <p>REDEPLOY_ALL::DISABLE_HOST Choose if redeploy is needed after disabling the host.</p> <p>DISABLE_HOST and REDEPLOY_ALL::DISABLE_HOST cannot be together as they overlap.</p>

Condition	Predefined action	Description
LCS::POST_ DEPLOY::VM_RECOVERY_ REDEPLOY_ERR —Occurs immediately after the redeploy of one VM fails.	<ul style="list-style-type: none"> <li>• DISABLE_HOST —Disables the host(s) the deployment or the VM is using.</li> <li>• DROP_RECOVERIES —Drops all pending recoveries in the deployment.</li> </ul>	DISABLE_HOST Choose if DISABLE_HOST is needed. Choose DROP_RECOVERIES if VMs need to be kept on the original host once the redeploy fails. When choosing DROP_RECOVERIES, ensure SET_RECOVERY_REDEPLOY::SERIALIZED action is complete.

## Redeployment Policy

Redeployment policies are a part of the policy driven framework. Using this framework, you can specify predefined actions for specific lifecycle conditions. For more information on ESC policy driven framework, see [Policy-Driven Data model](#).

Redeployment policies are invoked when a VM recovery fails after the maximum number of attempts. ESC disables the host and triggers redeployment for all VMs within the deployment. All VMs are undeployed from the old host and redeployed to a new host. Based on the combination of lifecycle stages (LCS) and predefined actions, the VMs are redeployed. The redeployment policy is for the entire deployment.

You can use the following lifecycle condition and action combination in the policy datamodel.



**Note** ESC uses default recovery action, **REBOOT\_THEN\_REDEPLOY** if nothing is chosen.

A sample redeployment policy data model is as follows:

```
<tenants>
  <tenant>
    <name>xyz-redeploy-ten-0502</name>
    <deployments>
      <deployment>
        <name>dep</name>
        <policies>
          <policy>
            <name>1</name>
            <conditions>
              <condition>
                <name>LCS::PRE_DEPLOY</name>
              </condition>
            </conditions>
            <actions>
              <action>
                <name>SET_RECOVERY::REBOOT_THEN_REDEPLOY</name>
                <type>pre-defined</type>
              </action>
            </actions>
          </policy>
        </policies>
      </deployment>
    </deployments>
  </tenant>
</tenants>
```

```

        <action>
          <name>SET_RECOVERY_REDEPLOY::SERIALIZED</name>
          <type>pre-defined</type>
        </action>
      </actions>
    </policy>
  </policy>
  <policy>
    <name>2</name>
    <conditions>
      <condition>
        <name>LCS::POST_DEPLOY_ALIVE</name>
      </condition>
    </conditions>
    <actions>
      <action>
        <name>SET_RECOVERY::REBOOT_ONLY</name>
        <type>pre-defined</type>
      </action>
    </actions>
  </policy>
  <policy>
    <name>3</name>
    <conditions>
      <condition>
        <name>LCS::DEPLOY_ERR</name>
      </condition>
    </conditions>
    <actions>
      <action>
        <name>DISABLE_HOST</name>
        <type>pre-defined</type>
      </action>
    </actions>
  </policy>
  <policy>
    <name>4</name>
    <conditions>
      <condition>
        <name>LCS::POST_DEPLOY::VM_RECOVERY_ERR</name>
      </condition>
    </conditions>
    <actions>
      <action>
        <name>REDEPLOY_ALL::DISABLE_HOST</name>
        <type>pre-defined</type>
      </action>
    </actions>
  </policy>
  <policy>
    <name>5</name>
    <conditions>
      <condition>
        <name>LCS::POST_DEPLOY::VM_RECOVERY_REDEPLOY_ERR</name>
      </condition>
    </conditions>
    <actions>
      <action>
        <name>DISABLE_HOST</name>
        <type>pre-defined</type>
      </action>
      <action>
        <name>DROP_RECOVERIES</name>
        <type>pre-defined</type>
      </action>
    </actions>
  </policy>

```

```

        </action>
      </actions>
    </policy>
  </policies>
  <vm_group>
    <name>Group1</name>
    <image>xyz-redeploy-img-0502</image>
    <flavor>xyz-redeploy-flv-0502</flavor>
    <recovery_policy>
      <max_retries>1</max_retries>
    </recovery_policy>
    .....
  </deployment>
</deployments>
</tenant>
</tenants>

```

**Supported Lifecycle Stages (LCS)**

Condition Name	Scope	Description
LCS::PRE_DEPLOY	Deployment	Occurs just before deploying VMs of the deployment.
LCS::POST_DEPLOY_ALIVE	Deployment	Occurs immediately after the deployment is active.
LCS::DEPLOY_ERR	Deployment	Occurs immediately after the deployment fails.
LCS::POST_DEPLOY:: VM_RECOVERY_ERR	Deployment	Occurs immediately after the recovery of one VM fails.  (This is specified at deployment level and applies to all VM groups)
LCS::POST_DEPLOY:: VM_RECOVERY_REDEPLOY_ERR	Deployment	Occurs immediately after the redeployment of one VM fails.  (This is specified at deployment level and applies to all VM groups)

**Supported Predefined actions**

Predefined Action Name	Scope	Description
DISABLE_HOST	Deployment	Disables the host(s) the deployment or the VM is using.
REDEPLOY_ALL::DISABLE_HOST	Deployment	Disables the host the VM is using then trigger redeploy for all VMs (within a deployment), or all VMs on that host.
DROP_RECOVERIES	Deployment	Drops all pending recoveries in the deployment.
SET_RECOVERY_REDEPLOY::SERIALIZED	Deployment	Queues up the recoveries in the deployment. That is, new recovery does not start until the current ongoing recovery completes.

## Limiting the Number of Redeployments

Cisco Elastic Services Controller (ESC) limits the number of redeployments using the following parameters:

- **max\_redep**: limits the maximum number of redeployments. By default, the max\_redep value is -1, which indicates that there is no limit on the maximum number of redeployments. You can change this value using the bootvm.py arguments or REST API.
- **redep\_count**: consists of the current number of redeployments. The redep\_count automatically increases by 1 after a redeployment, irrespective of the success or failure of the redeployment.



**Note** The redeployment limit is for,

- redeployments triggered by REDEPLOY\_ALL::DISABLE\_HOST policy.
- deployments with single VIM configuration only.

Cisco Elastic Services Controller (ESC) performs redeployment,

- if the maximum number of redeployments is set to the default value of -1, that is max\_redep = -1.
- if the current number of redeployments is less than the maximum number of redeployments (redep\_count < max\_redep), then ESC performs redeployment, and increases the redeployment count by 1 after the redeployment is complete.

ESC does not perform any redeployment if the redeployment count is more than or equal to the maximum number of redeployments, (redep\_count >= max\_redep).

You can use the bootvm.py parameters and REST APIs to configure the values.

### Using the bootvm.py parameters

Specify the max\_redep value in the esc\_params.conf file that contains the following line: default.max\_redep = 3

Run the command, `bootvm.py ... --esc_params_file <path_to_file>/esc_params.conf ...`

### Using the REST APIs

You can retrieve, and reset the redep\_count parameter using the following APIs:

- To retrieve the current value of redep\_count:

```
GET http://<ESC IP>:8080/ESCManager/v0/systemstate/redep_count
```

- To reset redep\_count:

```
POST http://<ESC IP>:8080/ESCManager/v0/systemstate/redep_count/reset
```

You can also use the REST API to retrieve and change the max\_redep value.

- To retrieve the current value of max\_redep:

```
GET http://<ESC IP>:8080/ESCManager/v0/config/default/max_redep
```

- To change the max\_redep value:

```
PUT http://<ESC IP>:8080/ESCManager/v0/config/default/max_redep/<value>
```

where <value> can be,

- 1, which is the default value with no limit
- 0, which does not allow any redeployment
- more than zero (> 0), which specifies the maximum number of redeployments allowed.

You can also use the `escadm` tool to configure these values. For more information on the `escadm` tool, see the [Elastics Services Controller Install and Upgrade Guide](#).

For more details on the redeployment policy, see [Redeployment Policy, on page 10](#).

The VMs that are not redeployed because of the redeployment limit are moved to error state. ESC manually recovers these VMs in error state by enabling the monitoring operation on each VM.

To enable monitoring operation on a single VM in error state:

```
POST http://<ESC_IP>:8080/ESCManager/v0/<internal-tenant-id>/deployments/vm/<vm-name> {
  "operation" : "enable_monitoring" }
```

You can also enable monitoring using the `esc_nc_cli` command:

```
esc_nc_cli vm-action ENABLE_MONITOR <generated vm name>
```

As part of the manual recovery process, the enable monitoring operation moves the VMs from error state to alive state. If manual recovery fails for these VMs, then auto recovery is triggered.

To enable the monitoring operation on VMs (in error state) in a deployment:

```
POST http://<ESC_IP>:8080/ESCManager/v0/<internal-tenant-id>/deployments/service/<internal-deployment-id> {
  "operation" : "enable_monitoring" }
```

You can also enable monitoring using the `esc_nc_cli` command:

```
esc_nc_cli svc-action ENABLE_MONITOR <tenant> <dep name>
```

As part of the manual recovery process, the enable monitoring operation moves all the VMs in a deployment from error state to alive state. If manual recovery fails, then auto recovery is triggered on all the VMs in the deployment.

For more information, see [Monitoring Operations](#) and [Recovery Policy](#).

## Enabling and Disabling the Host

You can enable or disable the host on OpenStack using NETCONF and REST APIs. The host can also be disabled during a VNF recovery or redeployment scenario.



**Note** Enabling and disabling the host on VMware vCenter is not supported.

You cannot enable or disable a host on a non-default VIM using NETCONF and REST APIs in an ESC with multiple OpenStack VIMs.

### Using NETCONF

```
/opt/cisco/esc/esc-confd/esc-cli/esc_nc_cli host-action < ENABLE | DISABLE > <host-name>
```

The payload is as follows:

```
<hostAction xmlns="http://www.cisco.com/esc/esc">
  <actionType>ENABLE/DISABLE</actionType>
  <hostName>my-server</hostName>
</hostAction>
```

where,

- actionType is ENABLE or DISABLE
- hostName is the host name or UUID of the target host

### Using REST

```
POST /v0/hosts/{hostName}/disable
POST /v0/hosts/{hostName}/enable
GET /v0/hosts/{hostName}/status
```

### Enabling the Host

By enabling the host, you bring a disabled host back to OpenStack and deploy new VM instances on it.

Sample NETCONF notification is as follows:

```
<notification xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
  <eventTime>2016-03-30T15:04:05.95+00:00</eventTime>
  <escEvent xmlns="http://www.cisco.com/esc/esc">
    <status>SUCCESS</status>
    <status_code>200</status_code>
    <status_message>Host action successful</status_message>
    <vm_source>
      <hostname>my-server</hostname>
    </vm_source>
    <vm_target>
    </vm_target>
  </escEvent>
  <event>
    <type>HOST_ENABLE</type>
  </event>
</notification>
```

Sample REST notification is as follows:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
  <host_action_event xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
    <event_type>HOST_ENABLE</event_type>
    <host_name>my-server</host_name>
    <message>Host action successful</message>
  </host_action_event>
```

### Disabling a Host

During VNF redeployment, you disable the host, and trigger a host-based redeployment for all the VMs within that deployment. This ensures that the redeployed VMs are on a different host. You can also disable a host when it is not working properly. Once a host is disabled, it is removed from OpenStack, so that no new instances are deployed on it.

Sample NETCONF notification is as follows:

```
<notification xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
  <eventTime>2016-03-30T15:03:48.121+00:00</eventTime>
  <escEvent xmlns="http://www.cisco.com/esc/esc">
    <status>SUCCESS</status>
    <status_code>200</status_code>
    <status_message>Host action successful</status_message>
```

```

    <vm_source>
      <hostname>my-server</hostname>
    </vm_source>
    <vm_target>
  </vm_target>
  <event>
    <type>HOST_DISABLE</type>
  </event>
</escEvent>
</notification>

```

Sample REST notification is as follows:

```

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<host_action_event xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <event_type>HOST_DISABLE</event_type>
  <host_name>my-server</host_name>
  <message>Host action successful</message>
</host_action_event>

```

## Notifications and Events

The following notifications are generated by the ESC during healing:

- VM\_RECOVERY\_INIT
- VM\_RECOVERY\_DEPLOYED
- VM\_RECOVERY\_UNDEPLOYED
- VM\_RECOVERY\_COMPLETE
- VM\_RECOVERY\_CANCELLED
- VM\_RECOVERY\_REBOOT

These notifications are generated based on the workflow. Each notification will have details about the deployment for which the notification is triggered. All recovery starts with VM\_RECOVERY\_INIT and ends with VM\_RECOVERY\_COMPLETE.

During vm recovery, if the vm is back to normal within the recovery wait time, the VM\_RECOVERY\_CANCELLED notification is sent as there is no recovery action to be performed. If the recovery wait time expires, then the recovery workflow reboots the vm and sends the VM\_RECOVERY\_REBOOT notification.

The following table lists the different scenarios and the notifications that are generated for every event:



Scenario	Notifications
<p>ESC-NORTHBOUND Recovery Call Flow After VM Alive - Reboot</p>	<p>When Northbound places a deploy request to ESC, ESC deploys VMs and set KPI to monitor on all VM Alive received. The following NETCONF notification is triggered:</p> <pre data-bbox="755 430 1084 478">&lt;type&gt;SERVICE_ALIVE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>After ESC receives VM down event, the following NETCONF notification is triggered:</p> <pre data-bbox="755 604 1123 653">&lt;type&gt;VM_RECOVERY_INIT&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC performs hard reboot on the VM, and the VM alive event is received within the boot time.</p> <pre data-bbox="755 779 1175 827">&lt;type&gt;VM_RECOVERY_COMPLETE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC receives an error while attempting to recover through Reboot. The following NETCONF notification is triggered:</p> <pre data-bbox="755 919 1175 982">&lt;type&gt;VM_RECOVERY_COMPLETE&lt;/type&gt; &lt;status&gt;FAILURE&lt;/status&gt;</pre>

Scenario	Notifications
<p>ESC-NORTHBOUND Recovery Call Flow After VM Alive - Undeploy/Redeploy</p>	<p>When Northbound places a deploy request to ESC, ESC deploys VMs and set KPI to monitor on all VM Alive received. The following NETCONF notification is triggered:</p> <pre data-bbox="716 428 1049 478">&lt;type&gt;SERVICE_ALIVE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>After ESC receives VM down event, the following NETCONF notification is triggered:</p> <pre data-bbox="716 600 1086 651">&lt;type&gt;VM_RECOVERY_INIT&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC fails to recover the VM by <i>Reboot</i> and proceeds with recovery by <i>Undeploy</i> and then <i>Redeploy</i>.</p> <p>It unsets monitoring and un-deploys the VM.</p> <p>The following NETCONF notification is triggered:</p> <pre data-bbox="716 869 1162 919">&lt;type&gt;VM_RECOVERY_UNDEPLOYED&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC deploys VM and sets KPI to monitor VM Alive event and triggers the following NETCONF notifications:</p> <pre data-bbox="716 1041 1138 1092">&lt;type&gt;VM_RECOVERY_DEPLOYED&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC receives a VM Alive event and triggers the following NETCONF notifications:</p> <pre data-bbox="716 1213 1138 1264">&lt;type&gt;VM_RECOVERY_COMPLETE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre>

Scenario	Notifications
<p>ESC-NORTHBOUND Recovery Call Flow Multiple Recovery Attempts</p>	<p>When Northbound places a deploy request to ESC, ESC deploys VMs and set KPI to monitor on all VM Alive received. The following NETCONF notification is triggered:</p> <pre data-bbox="756 428 1084 478">&lt;type&gt;SERVICE_ALIVE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>After ESC receives VM down event, the following NETCONF notification is triggered:</p> <pre data-bbox="756 600 1122 651">&lt;type&gt;VM_RECOVERY_INIT&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC fails to recover the VM by <i>Undeploy</i> and then <i>ReDeploy</i> until it receives a VM Alive event. It keeps attempting the recovery for a specified boot time until the maximum attempts of recovery is reached.</p> <p>It un-sets monitoring and un-deploys the VM.</p> <p>The following NETCONF notification is triggered:</p> <pre data-bbox="756 898 1198 949">&lt;type&gt;VM_RECOVERY_UNDEPLOYED&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC deploys VM and sets KPI to monitor VM Alive event.</p> <p>The following NETCONF notifications is triggered:</p> <pre data-bbox="756 1087 1174 1138">&lt;type&gt;VM_RECOVERY_DEPLOYED&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC receives a VM Alive event and triggers the following NETCONF notifications:</p> <pre data-bbox="756 1260 1174 1310">&lt;type&gt;VM_RECOVERY_COMPLETE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre>

Scenario	Notifications
<p>ESC-NORTHBOUND Recovery Call Flow Before VM Alive - Undeploy/Redeploy</p>	<p>When Northbound places a deploy request to ESC, ESC deploys VMs and sets KPI to monitor on all VM Alive received.</p> <p>ESC does not receive a VM Alive event after the deployment. Recovery is performed by <i>Undeploying</i> and <i>Redeploying</i> the VM.</p> <p>The following NETCONF notification is triggered:</p> <pre data-bbox="716 527 1084 575">&lt;type&gt;VM_RECOVERY_INIT&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC un-sets the monitoring and un-deploys the VM.</p> <p>The following NETCONF notification is triggered:</p> <pre data-bbox="716 716 1162 764">&lt;type&gt;VM_RECOVERY_UNDEPLOYED&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC deploys VM and sets KPI to monitor VM Alive event and triggers the following NETCONF notifications:</p> <pre data-bbox="716 884 1135 932">&lt;type&gt;VM_RECOVERY_DEPLOYED&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC receives a VM Alive event and triggers the following NETCONF notifications:</p> <pre data-bbox="716 1052 1135 1100">&lt;type&gt;VM_RECOVERY_COMPLETE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre>

Scenario	Notifications
<p>Error Path For ESC-NORTHBOUND Recovery Call Flow After VM Alive - Undeploy/ReDeploy</p>	<p>When Northbound places a deploy request to ESC, ESC deploys VMs and set KPI to monitor on all VM Alives received. The following NETCONF notification is triggered:</p> <pre data-bbox="756 428 1084 478">&lt;type&gt;SERVICE_ALIVE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>After ESC receives VM down event, the following NETCONF notification is triggered:</p> <pre data-bbox="756 600 1122 651">&lt;type&gt;VM_RECOVERY_INIT&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC fails to recover the VM by <i>Reboot</i> and proceeds with recovery by <i>Undeploy</i> and then <i>Redeploy</i>.</p> <p>It un-sets monitoring and un-deploys the VM.</p> <p>The following NETCONF notification is triggered:</p> <pre data-bbox="756 869 1198 919">&lt;type&gt;VM_RECOVERY_UNDEPLOYED&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>If ESC receives an error or if the maximum attempts for recovery is reached.</p> <p>The following NETCONF notifications is triggered:</p> <pre data-bbox="756 1087 1174 1138">&lt;type&gt;VM_RECOVERY_COMPLETE&lt;/type&gt; &lt;status&gt;FAILURE&lt;/status&gt;</pre>

Scenario	Notifications
<p>Error Path For ESC-NORTHBOUND Recovery Call Flow Before VM Alive - Undeploy/Redeploy</p>	<p>When Northbound places a deploy request to ESC, ESC deploys VMs and set KPI to monitor on all VM Alives received. The following NETCONF notification is triggered:</p> <pre data-bbox="716 430 1047 478">&lt;type&gt;SERVICE_ALIVE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>After ESC receives VM down event, the following NETCONF notification is triggered:</p> <pre data-bbox="716 600 1084 648">&lt;type&gt;VM_RECOVERY_INIT&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC un-sets monitoring and un-deploys the VM. Recovery is performed by <i>Undeploy</i> and then <i>Redeploy</i>.</p> <p>The following NETCONF notification is triggered:</p> <pre data-bbox="716 821 1161 869">&lt;type&gt;VM_RECOVERY_UNDEPLOYED&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>If ESC receives an error or if the maximum attempts for recovery is reached.</p> <p>The following NETCONF notifications is triggered:</p> <pre data-bbox="716 1041 1133 1089">&lt;type&gt;VM_RECOVERY_COMPLETE&lt;/type&gt; &lt;status&gt;FAILURE&lt;/status&gt;</pre> <pre data-bbox="716 1136 1047 1184">&lt;type&gt;SERVICE_ALIVE&lt;/type&gt; &lt;status&gt;FAILURE&lt;/status&gt;</pre>
<p>ESC-NORTHBOUND Recovery Call Flow After VM Alive -VM_RECOVERY_CANCELLED</p>	<p>When Northbound places a deploy request to ESC, ESC deploys VMs and sets KPI to monitor all VM Alive notifications received. The following NETCONF notification is triggered:</p> <pre data-bbox="716 1318 1047 1367">&lt;type&gt;SERVICE_ALIVE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>After ESC receives VM down event, the following NETCONF notification is triggered:</p> <pre data-bbox="716 1465 1084 1514">&lt;type&gt;VM_RECOVERY_INIT&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>During the recovery wait time, if VM is back to normal, then the VM_RECOVERY_CANCELLED notification is sent. Recovery action is not performed.</p> <pre data-bbox="716 1644 1149 1692">&lt;type&gt;VM_RECOVERY_CANCELLED&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre>

Scenario	Notifications
<p>ESC-NORTHBOUND Recovery Call Flow After VM Alive - Reboot</p>	<p>When Northbound places a deploy request to ESC, ESC deploys VMs and sets KPI to monitor all VM Alive notifications received. The following NETCONF notification is triggered:</p> <pre data-bbox="756 405 1084 451">&lt;type&gt;SERVICE_ALIVE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>After ESC receives VM down event, the following NETCONF notification is triggered:</p> <pre data-bbox="756 552 1122 598">&lt;type&gt;VM_RECOVERY_INIT&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>ESC performs hard reboot on the VM and sends reboot notification.</p> <pre data-bbox="756 663 1149 709">&lt;type&gt;VM_RECOVERY_REBOOT&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>And the VM alive event is received within the boot time.</p> <pre data-bbox="756 777 1174 823">&lt;type&gt;VM_RECOVERY_COMPLETE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre>
<p>Error Path For ESC-NORTHBOUND Recovery Call Flow After VM Alive - Reboot</p>	<p>When Northbound places a deploy request to ESC, ESC deploys VMs and sets KPI to monitor on all VM Alive notifications received. The following NETCONF notification is triggered:</p> <pre data-bbox="756 966 1084 1012">&lt;type&gt;SERVICE_ALIVE&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>After ESC receives VM down event, the following NETCONF notification is triggered:</p> <pre data-bbox="756 1113 1122 1159">&lt;type&gt;VM_RECOVERY_INIT&lt;/type&gt; &lt;status&gt;SUCCESS&lt;/status&gt;</pre> <p>Then ESC sends reboot notification.</p> <pre data-bbox="756 1224 1149 1270">&lt;type&gt;VM_RECOVERY_REBOOT&lt;/type&gt; &lt;status&gt;FAILURE&lt;/status&gt;</pre> <p>ESC receives an error while attempting to recover through <i>Reboot</i>.</p> <p>The following NETCONF notification is triggered:</p> <pre data-bbox="756 1388 1174 1434">&lt;type&gt;VM_RECOVERY_COMPLETE&lt;/type&gt; &lt;status&gt;FAILURE&lt;/status&gt;</pre>

