SUSE

Manually Moving High Availability Cluster Resources

Although the cluster automatically moves resources when necessary, you might want to move resources manually, either to a specific node or just away from the current node. For example, you might move resources to other nodes to distribute the workload more evenly across the cluster, or to help isolate and troubleshoot a hardware or software issue.

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1 What are cluster resources?

In a High Availability cluster, the applications and services that need to be highly available are called *resources*. Cluster resources can include Web sites, e-mail servers, databases, file systems, virtual machines or any other applications or services that need to be available to users at all times. You can start, stop, monitor and move resources as needed. You can also specify whether resources should run together on the same node, or start and stop in sequential order. If a node fails, the resources running on it *fail over* (move) to another node instead of being lost.

In SUSE Linux Enterprise High Availability, the *cluster resource manager* (CRM) is *Pacemaker*, which manages and coordinates all cluster services. Pacemaker uses *resource agents* (RAs) to start, stop and monitor resources. A resource agent abstracts the resource and presents its status to the cluster. This means that Pacemaker only interacts with the resource agent, not with the actual application or service. SUSE Linux Enterprise High Availability supports many different resource agents that are designed to manage specific types of resources.

1.1 Primitive resources

Primitive resources represent the applications or services that need to be highly available. Configuring a primitive specifies the resource agent and any other information required for the cluster to manage a resource. To see the supported resource agent classes, run **`crm ra classes`**. To see the resource agents available within a class, run **`crm ra list`** *`CLASS`*.

Primitive resources can have the following settings:

Properties

Resource properties are the basic details required by the cluster: a unique name for the resource, and the resource agent that manages the application or service.

Parameters

Parameters are specific to each resource agent and determine the details and behavior of an application or service. To show all the parameters available for a resource agent, run **`crm ra info`** *`RESOURCE_AGENT`*.

Operations

Operations are actions that the cluster can perform on a resource, such as `start`, `stop` and `monitor`. To show the supported operations for a resource agent, run **`crm ra info`** *`RESOURCE_AGENT`* and scroll to the bottom of the output.

Meta attributes

Meta attributes change how the cluster treats a resource. To show all the meta attributes available for primitives, run **`crm_resource --list-options primitive`**.

Utilization attributes

If the cluster nodes have utilization attributes configured, you can add these attributes to cluster resources to help with load balancing. For more information, see https://clusterlabs.org/projects/pacemaker/doc/3.0/Pacemaker_Explained/html/utilization.html.

1.2 Resource groups

Cluster resources might depend on other resources, such as a Web server that requires an IP address and a file system. You can combine these resources into a *resource group*. Groups contain multiple primitives that need to be located together, started sequentially and stopped in the reverse order.

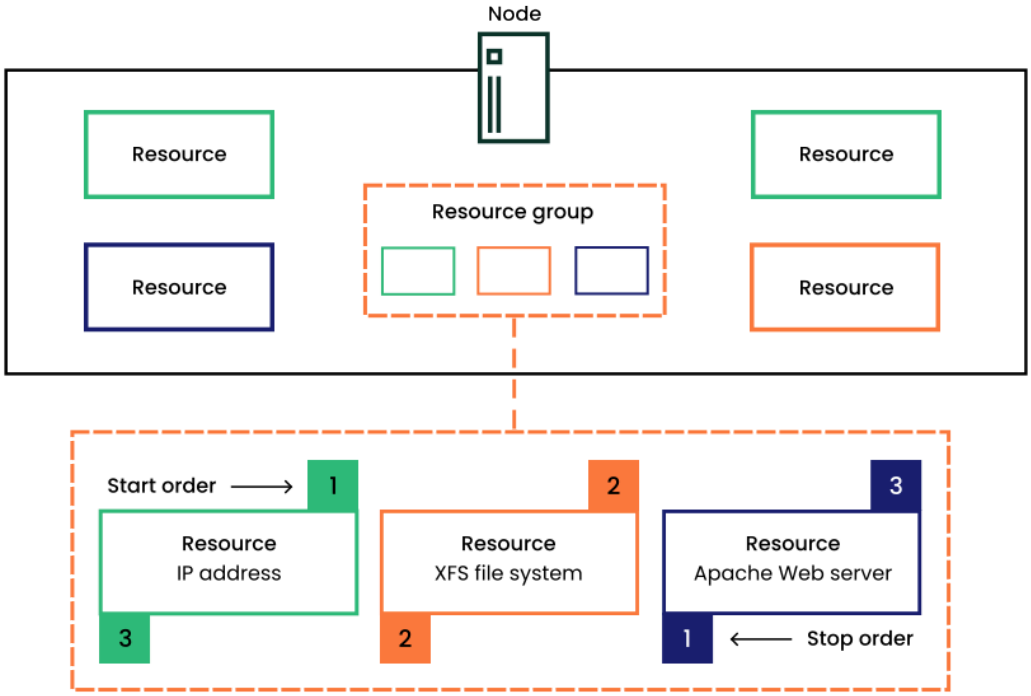


FIGURE 1: RESOURCE GROUP

Groups have the following properties:

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Groups can only contain primitive resources, not clones or other groups.

Starting and stopping

Resources start in the order they appear and stop in the reverse order.

Location

Resources in the group must all run on the same node.

Dependency

If one of the resources can't run anywhere, then the resources that appear after it in the group can't run anywhere either.

Meta attributes

The meta attributes `target-role`, `priority`, `maintenance` and `is-managed` can be added directly to the group. All other attributes are inherited from the group's resources.

Resource stickiness

Stickiness in groups is additive. Every *active* resource in the group contributes its stickiness value to the group's total.

1.3 Resource clones

Resource clones can run simultaneously on multiple nodes. This is required for cluster file systems like GFS2, for example. You can clone a primitive or a group if the resource agent supports it. Clones can also have additional clone-specific meta attributes to change their behavior.

Clones can be one of the following types:

Anonymous clones

Anonymous clones are the simplest type. All instances of the clone behave identically. Therefore, only one instance of an anonymous clone can be active on each node.

Globally unique clones

Globally unique clones are distinct entities. An instance of the clone running on one node is not necessarily equivalent to another instance on another node.

Promotable clones

Promotable clones allow the instances to be in one of two operating modes: promoted or unpromoted (also known as primary and secondary, or active and passive). Promotable clones can be either anonymous or globally unique.

To make a clone promotable, the resource agent must support the *promote* and *demote* operations. The cluster determines which instance of the clone to promote using one of the following methods (or a combination of both):

- If a resource agent supports promotable clones, it might automatically set promotion scores based on its own preference for which instance to promote.
- You can manually set promotion rules or preferences by creating location or colocation constraints.

For more information, see https://clusterlabs.org/projects/pacemaker/doc/3.0/Pacemaker_Explained/html/collective.html#determining-which-instance-is-promoted

1.4 For more information

- Primitive resources: https://clusterlabs.org/projects/pacemaker/doc/3.0/Pacemaker_Explained/html/resources.html
- Groups and clones: https://clusterlabs.org/projects/pacemaker/doc/3.0/Pacemaker_Explained/html/collective.html

- Resource operations: https://clusterlabs.org/projects/pacemaker/doc/3.0/Pacemaker_Explained/html/operations.html
- Utilization attributes: https://clusterlabs.org/projects/pacemaker/doc/3.0/Pacemaker_Explained/html/utilization.html

2 What are relocation constraints?

Cluster resources automatically *fail over* (move) to another node during hardware or software failures. However, you can also choose to manually move a resource, either to a specific node or just away from the current node. A *relocation constraint* is a location constraint used specifically for moving a resource. The cluster creates the relocation constraint automatically when you move a resource with `crmsh` or Hawk.

The type of relocation constraint depends on where you move the resource:

- If you move the resource *to a specific node*, the cluster creates a relocation constraint with an `INFINITY` score for the destination node.
- If you move the resource *away from the current node*, the cluster creates a relocation constraint with a `-INFINITY` score for the current node.

To allow the resource to move back to the original node, you must remove the relocation constraint. When you remove the constraint, the resource might move back to the original node automatically or it might stay on the destination node, depending on the resource's stickiness.



Note: Moving a resource vs live migration

Usually when the cluster moves a resource, it stops the resource on the current node and starts it on the destination node. This is not the same thing as live migration, where the cluster moves a resource from one node to another without stopping it. Live migration is only supported for certain resources and must be enabled for each individual resource.

3 Adding relocation constraints to resources

A *relocation constraint* is a location constraint used specifically for moving a resource. The cluster creates the relocation constraint automatically when you move a resource with `crmsh` or Hawk.

PREREQUISITES

- The resource doesn't have any other constraints that would prevent it from moving.

CRM Shell

You can perform this procedure on any node in the cluster.

1. Log in either as the `root` user or as a user with **`sudo`** privileges.
2. Check which node the resource is currently running on:

```
> sudo crm status
```

3. Move the resource to another node:

```
> sudo crm resource move RESOURCE NODE
```

Alternatively, you can move the resource away from the current node without specifying a specific node to move to:

```
> sudo crm resource move RESOURCE force
```

4. Check the status again to make sure the resource is now running on the other node:

```
> sudo crm status
```

Hawk

You can use Hawk on any machine with a Web browser and network access to the nodes.

1. In a Web browser, go to `https://HAWKSERVER:7630/` and log in.
2. From the left navigation bar, select *Monitoring* › *Status*.
3. Find the resource you want to move. In the *Operations* column, click the down arrow button and select *Migrate*.
4. From the drop-down list, either keep the default *Away from current node* or select a specific node to move the resource to.

5. Click *OK* to continue.
   The node in the *Location* column changes, and a link icon appears in the *Status* column. Hover the cursor over the link icon to see the name of the relocation constraint.

FOR MORE INFORMATION

- `crm resource help move`

4 Removing relocation constraints from resources

A *relocation constraint* is a location constraint used specifically for moving a resource. The cluster creates the relocation constraint automatically when you move a resource with `crmsh` or Hawk. To allow the resource to move back to the previous node, you must remove the relocation constraint. When you remove the constraint, the resource might move back to the original node automatically or it might stay on the current node, depending on the resource's stickiness.

CRM Shell

You can perform this procedure on any node in the cluster.

1. Log in either as the `root` user or as a user with `sudo` privileges.
2. Show the existing location constraints:

   ```
   > sudo crm configure show type:location
   ```

   Relocation constraints are named either `cli-prefer-`*`RESOURCE`* or `cli-ban-`*`RESOURCE`*`-on-`*`NODE`*.
3. Remove any relocation constraints from a specific resource:

   ```
   > sudo crm resource clear RESOURCE
   ```

4. Check the status to see which node the resource is now running on:

   ```
   > sudo crm status
   ```

Hawk

You can use Hawk on any machine with a Web browser and network access to the nodes.

1. In a Web browser, go to `https://HAWKSERVER:7630/` and log in.
2. From the left navigation bar, select *Monitoring* › *Status*.
3. Find the resource you want to remove the relocation constraint from. In the *Operations* column, click the down arrow button and select *Clear*.
4. Click *OK* to continue.
   The link icon disappears from the *Status* column.
5. Check the *Location* column to see which node the resource is now running on.

FOR MORE INFORMATION

- **`crm resource help clear`**

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HA glossary

ACL (access control list)

Access control lists can be used to limit or fine-tune a user's access to the CIB. An ACL consists of an ordered set of access rules. Each rule allows or denies read or write access to a part of the CIB. Rules can be combined into specific roles, and users can be assigned to a role that matches their tasks.

active/active, active/passive

How resources run on the nodes. Active/passive means that resources only run on the active node, but can move to the passive node if the active node fails. Active/active means that all nodes are active at once, and resources can run on (and move to) any node in the cluster.

arbitrator

An *arbitrator* is a machine running outside the cluster to provide an additional instance for cluster calculations. For example, *QNetd* provides a vote to help *QDevice* participate in *quorum* decisions.

CIB (cluster information base)

An XML representation of the whole cluster configuration and status (cluster options, nodes, resources, constraints, etc.). The CIB manager (`pacemaker-based`) keeps the CIB synchronized across the cluster nodes and handles requests to modify it.

clone

In the context of a cluster *resource*, a clone is a resource that can be active on multiple nodes. Any resource can be cloned if its resource agent supports it.

cluster

A *high-availability* cluster is a group of servers (physical or virtual) designed primarily to secure the highest possible availability of data, applications and services. Not to be confused with a *high-performance* cluster, which shares the application load to achieve faster results.

Cluster LVM (Cluster logical volume manager)

The term *Cluster LVM* indicates that LVM is being used in a cluster environment. This requires configuration adjustments to protect the LVM metadata on shared storage.

cluster offline upgrade

If a new product version includes major changes that are backward incompatible, the cluster requires a cluster offline upgrade. You must stop the cluster services on all nodes and upgrade the whole cluster before bringing the nodes back online.

For minor version upgrades, see *cluster rolling upgrade*.

cluster partition

A cluster partition occurs when communication fails between one or more nodes and the rest of the cluster. The nodes are split into partitions but are still active. They can only communicate with nodes in the same partition and are unaware of the separated nodes. This is known as a *split brain* scenario.

cluster rolling upgrade

In a cluster rolling upgrade, one cluster node at a time is upgraded while the rest of the cluster is still running. Stop the cluster services on a node, upgrade it, then bring it back online to join the cluster. Continue one by one until all cluster nodes are upgraded.

For major version upgrades, see *cluster offline upgrade*.

cluster services

The services that run the cluster. Typically this refers to Pacemaker and Corosync, but might also include SBD and QDevice if those services are used.

cluster stack

The ensemble of software technologies and components that make up a cluster.

colocation constraint

A type of *resource constraint* that specifies which resources can or cannot run together on a node.

concurrency violation

A resource that should be running on only one node in the cluster is running on several nodes.

Corosync

Corosync provides reliable messaging, membership and quorum information about the cluster. This is handled by the Corosync Cluster Engine, a group communication system.

CRM (cluster resource manager)

The management entity responsible for coordinating all non-local interactions in a High Availability cluster. SUSE Linux Enterprise High Availability uses *Pacemaker* as the CRM. It interacts with several components: local executors on its own node and on the other nodes, non-local CRMs, administrative commands, the fencing functionality, and the membership layer.

`crmsh` (CRM Shell)

The command-line utility `crmsh` manages the cluster, nodes and resources.

Csync2

A synchronization tool for replicating configuration files across all nodes in the cluster.

DC (designated coordinator)

The `pacemaker-controld` daemon is the cluster controller, which coordinates all actions. This daemon has an instance on each cluster node, but only one instance is elected to act as the DC. The DC is elected when the cluster services start, or if the current DC fails or leaves the cluster. The DC decides whether a cluster-wide change must be performed, such as fencing a node or moving resources.

disaster

An unexpected interruption of critical infrastructure caused by nature, humans, hardware failure, or software bugs.

disaster recovery

The process by which a function is restored to the normal, steady state after a disaster.

Disaster Recovery Plan

A strategy to recover from a disaster with the minimum impact on IT infrastructure.

DLM (Distributed Lock Manager)

DLM coordinates accesses to shared resources in a cluster, for example, managing file locking in clustered file systems to increase performance and availability.

DRBD

DRBD® is a block device designed for building High Availability clusters. It replicates data on a primary device to secondary devices in a way that ensures all copies of the data remain identical.

existing cluster

The term *existing cluster* is used to refer to any cluster that consists of at least one node. An existing cluster has a basic *Corosync* configuration that defines the communication channels, but does not necessarily have resource configuration yet.

failover

Occurs when a resource or node fails on one machine and the affected resources move to another node.

failover domain

A named subset of cluster nodes that are eligible to run a resource if a node fails.

fencing

Prevents access to a shared resource by isolated or failing cluster members. There are two classes of fencing: *resource-level* fencing and *node-level* fencing. Resource-level fencing ensures exclusive access to a resource. Node-level fencing prevents a failed node from accessing shared resources and prevents resources from running on a node with an uncertain status. This is usually done by resetting or powering off the node. In a *Pacemaker* cluster, node fencing is managed by the fencing subsystem `pacemaker-fenced`.

GFS2

Global File System 2 (GFS2) is a shared disk file system for Linux computer clusters. GFS2 allows all nodes to have direct concurrent access to the same shared block storage. GFS2 has no disconnected operating mode, and no client or server roles. All nodes in a GFS2 cluster function as peers. GFS2 supports up to 32 cluster nodes. Using GFS2 in a cluster requires hardware to allow access to the shared storage, and a lock manager to control access to the storage.

group

Resource groups contain multiple resources that need to be located together, started sequentially and stopped in the reverse order.

Hawk (High Availability Web Konsole)

A user-friendly Web-based interface for monitoring and administering a High Availability cluster from Linux or non-Linux machines. Hawk can be accessed from any machine that can connect to the cluster nodes, using a graphical Web browser.

heuristics

QDevice supports using a set of commands (*heuristics*) that run locally on start-up of cluster services, cluster membership change, successful connection to the *QNetd* server, or optionally at regular times. The result is used in calculations to determine which partition should have *quorum*.

knet (kronosnet)

A network abstraction layer supporting redundancy, security, fault tolerance, and fast fail-over of network links. In SUSE Linux Enterprise High Availability 16, *knet* is the default transport protocol for the *Corosync* communication channels.

local cluster

A single cluster in one location (for example, all nodes are located in one data center). Network latency is minimal. Storage is typically accessed synchronously by all nodes.

local executor

The local executor is located between *Pacemaker* and the resources on each node. Through the `pacemaker-execd` daemon, Pacemaker can start, stop and monitor resources.

location

In the context of a whole cluster, *location* can refer to the physical location of nodes (for example, all nodes might be located in the same data center). In the context of a *location constraint*, *location* refers to the nodes on which a resource can or cannot run.

location constraint

A type of *resource constraint* that defines the nodes on which a resource can or cannot run.

meta attribute

Parameters that tell the *CRM (cluster resource manager)* how to treat a specific *resource*. For example, you might define a resource's priority or target role.

metro cluster

A single cluster that can stretch over multiple buildings or data centers, with all sites connected by Fibre Channel. Network latency is usually low. Storage is frequently replicated using mirroring or synchronous replication.

network device bonding

Network device bonding combines two or more network interfaces into a single bonded device to increase bandwidth and/or provide redundancy. When using *Corosync*, the bonded device is not managed by the cluster software. Therefore, the bonded device must be configured on every cluster node that might need to access it.

node

Any server (physical or virtual) that is a member of a cluster.

order constraint

A type of *resource constraint* that defines the sequence of actions.

Pacemaker

Pacemaker is the *CRM (cluster resource manager)* in SUSE Linux Enterprise High Availability, or the "brain" that reacts to events occurring in the cluster. Events might be nodes that join or leave the cluster, failure of resources, or scheduled activities such as maintenance, for example. The `pacemakerd` daemon launches and monitors all other related daemons.

parameters (instance attributes)

Parameters determine which instance of a service the *resource* controls.

primitive

A primitive resource is the most basic type of cluster resource.

promotable clone

Promotable clones are a special type of *clone* resource that can be promoted. Active instances of these resources are divided into two states: promoted and unpromoted (also known as "active and passive" or "primary and secondary").

QDevice

QDevice and *QNetd* participate in *quorum* decisions. The `corosync-qdevice` daemon runs on each cluster node and communicates with QNetd to provide a configurable number of votes, allowing a cluster to sustain more node failures than the standard quorum rules allow.

QNetd

QNetd is an *arbitrator* that runs outside the cluster. The `corosync-qnetd` daemon provides a vote to the `corosync-qdevice` daemon on each node to help it participate in quorum decisions.

quorum

A *cluster partition* is defined to have quorum (be *quorate*) if it has the majority of nodes (or "votes"). Quorum distinguishes exactly one partition. This is part of the algorithm to prevent several disconnected partitions or nodes ("split brain") from proceeding and causing data and service corruption. Quorum is a prerequisite for fencing, which then ensures that quorum is unique.

RA (resource agent)

A script acting as a proxy to manage a *resource* (for example, to start, stop or monitor a resource). SUSE Linux Enterprise High Availability supports different kinds of resource agents.

ReaR (Relax and Recover)

An administrator tool set for creating *disaster recovery* images.

resource

Any type of service or application that is known to *Pacemaker*, for example, an IP address, a file system, or a database. The term *resource* is also used for *DRBD*, where it names a set of block devices that use a common connection for replication.

resource constraint

Resource constraints specify which cluster nodes a resource can run on, what order the resources should start in, and which other resources a specific resource is dependent on.

See also *colocation constraint*, *location constraint* and *order constraint*.

resource set

As an alternative format for defining location, colocation or order constraints, you can use *resource sets*, where primitives are grouped together in one set. When creating a constraint, you can specify multiple resources for the constraint to apply to.

resource template

To help create many resources with similar configurations, you can define a resource template. After being defined, it can be referenced in primitives or in certain types of constraints. If a template is referenced in a primitive, the primitive inherits all operations, instance attributes (parameters), meta attributes and utilization attributes defined in the template.

SBD (STONITH Block Device)

SBD provides a node *fencing* mechanism through the exchange of messages via shared block storage. Alternatively, it can be used in diskless mode. In either case, it needs a hardware or software *watchdog* on each node to ensure that misbehaving nodes are really stopped.

scheduler

The scheduler is implemented as `pacemaker-schedulerd`. When a cluster transition is needed, `pacemaker-schedulerd` calculates the expected next state of the cluster and determines what actions need to be scheduled to achieve the next state.

split brain

A scenario in which the cluster nodes are divided into two or more groups that do not know about each other (either through a software or hardware failure). Also known as a *partitioned cluster* scenario.

The term *split brain* is also used in *DRBD* but means that the nodes contain different data.

SPOF (single point of failure)

Any component of a cluster that, if it fails, triggers the failure of the entire cluster.

stickiness

Resource stickiness is a *meta attribute* that determines how much a resource prefers to stay on its current node.

switchover

The planned moving of resources to other nodes in a cluster. See also *failover*.

utilization

Tells the CRM what capacity a certain *resource* requires from a node.

watchdog

SBD (STONITH Block Device) needs a watchdog on each node to ensure that misbehaving nodes are really stopped. SBD "feeds" the watchdog by regularly writing a service pulse to it. If SBD stops feeding the watchdog, the hardware enforces a system restart. This protects against failures of the SBD process itself, such as becoming stuck on an I/O error.