The DRBD User's Guide

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by Florian Haas, Philipp Reisner, and Lars Ellenberg

This guide has been released to the DRBD community, and its authors strive to improve it permanently. Feedback from readers is always welcome and encouraged. Please use the DRBD public mailing list [109] for enhancement suggestions and corrections.

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Table of Contents

Please Read This First

This guide is intended to serve users of the Distributed Replicated Block Device (DRBD) as a definitive reference guide and handbook.

It is being made available to the DRBD community by LINBIT [http://www.linbit.com/], the project's sponsor company, free of charge and in the hope that it will be useful. The guide is constantly being updated. We try to add information about new DRBD features simultaneously with the corresponding DRBD releases. An on-line HTML version of this guide is always available at http://www.drbd.org/users-guide/.

Important

This guide assumes, throughout, that you are using DRBD version 8.4.0 or later. If you are using a legacy (pre-8.4) DRBD version instead, please use the version of this guide which has been preserved at http://www.drbd.org/users-guide-legacy/.

Some sections in this guide are marked as **Draft**. They have been added recently, and should not be considered authoritative. Feedback and comments on these sections are particularly welcome and highly encouraged.

Please use the drbd-user mailing list [109] to submit comments.

This guide is organized in seven parts:

- Part I, "Introduction to DRBD" [1] deals with DRBD's basic functionality. It gives a short overview of DRBD's positioning within the Linux I/O stack, and about fundamental DRBD concepts. It also examines DRBD's most important features in detail.
- Part II, "Building, installing and configuring DRBD" [14] talks about building DRBD from source, installing pre-built DRBD packages, and contains an overview of getting DRBD running on a cluster system.
- Part III, "Working with DRBD" [31] is about managing DRBD, configuring and reconfiguring DRBD resources, and common troubleshooting scenarios.
- Part IV, "DRBD-enabled applications" [57] deals with leveraging DRBD to add storage replication and high availability to applications. It not only covers DRBD integration in the Pacemaker cluster manager, but also advanced LVM configurations, integration of DRBD with GFS, and adding high availability to Xen virtualization environments.
- Part V, "Optimizing DRBD performance" [91] contains pointers for getting the best performance out of DRBD configurations.
- Part VI, "Learning more about DRBD" [100] dives into DRBD's internals, and also contains pointers to other resources which readers of this guide may find useful.
- Part VII, "Appendices" [111] contains two appendices. Appendix A, *Recent changes* [112] is an overview of changes in DRBD 8.4, compared to earlier DRBD versions. Appendix B, *DRBD system manual pages* [118] contains online versions of the Linux manual pages distributed with the latest DRBD version, for reference purposes.

Users interested in DRBD training or support services are invited to contact us at sales@linbit.com [mailto:sales@linbit.com].

Part I. Introduction to DRBD

Chapter 1. DRBD Fundamentals

The Distributed Replicated Block Device (DRBD) is a software-based, shared-nothing, replicated storage solution mirroring the content of block devices (hard disks, partitions, logical volumes etc.) between hosts.

DRBD mirrors data

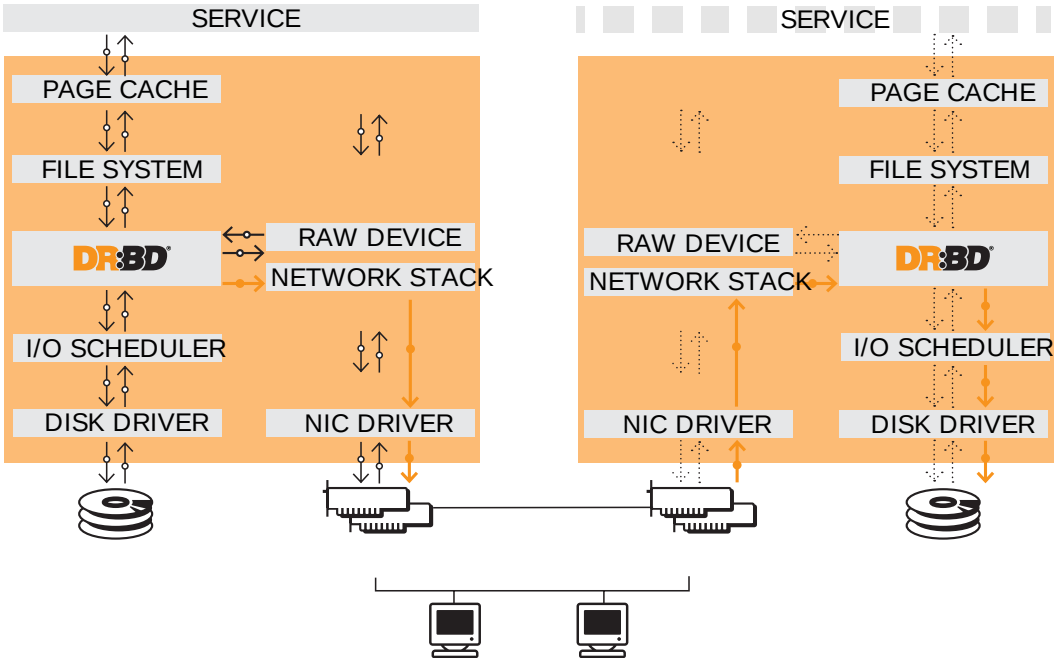
- **in real time**. Replication occurs continuously while applications modify the data on the device.
- **transparently**. Applications need not be aware that the data is stored on multiple hosts.
- **synchronously** or **asynchronously**. With synchronous mirroring, applications are notified of write completions after the writes have been carried out on all hosts. With asynchronous mirroring, applications are notified of write completions when the writes have completed locally, which usually is before they have propagated to the other hosts.

1.1. Kernel module

DRBD's core functionality is implemented by way of a Linux kernel module. Specifically, DRBD constitutes a driver for a virtual block device, so DRBD is situated right near the bottom of a system's I/O stack. Because of this, DRBD is extremely flexible and versatile, which makes it a replication solution suitable for adding high availability to just about any application.

DRBD is, by definition and as mandated by the Linux kernel architecture, agnostic of the layers above it. Thus, it is impossible for DRBD to miraculously add features to upper layers that these do not possess. For example, DRBD cannot auto-detect file system corruption or add active-active clustering capability to file systems like ext3 or XFS.

Figure 1.1. DRBD's position within the Linux I/O stack



1.2. User space administration tools

DRBD comes with a set of administration tools which communicate with the kernel module in order to configure and administer DRBD resources.

drbdadm. The high-level administration tool of the DRBD program suite. Obtains all DRBD configuration parameters from the configuration file `/etc/drbd.conf` and acts as a front-end for `drbdsetup` and `drbdmeta`. `drbdadm` has a *dry-run* mode, invoked with the `-d` option, that shows which `drbdsetup` and `drbdmeta` calls `drbdadm` would issue without actually calling those commands.

drbdsetup. Configures the DRBD module loaded into the kernel. All parameters to `drbdsetup` must be passed on the command line. The separation between `drbdadm` and `drbdsetup` allows for maximum flexibility. Most users will rarely need to use `drbdsetup` directly, if at all.

drbdmeta. Allows to create, dump, restore, and modify DRBD meta data structures. Like `drbdsetup`, most users will only rarely need to use `drbdmeta` directly.

1.3. Resources

In DRBD, *resource* is the collective term that refers to all aspects of a particular replicated data set. These include:

Resource name. This can be any arbitrary, US-ASCII name not containing whitespace by which the resource is referred to.

Volumes. Any resource is a replication group consisting of one of more *volumes* that share a common replication stream. DRBD ensures write fidelity across all volumes in the resource. Volumes are numbered starting with `0`, and there may be up to `65,535` volumes in one resource. A volume contains the replicated data set, and a set of metadata for DRBD internal use.

At the `drbdadm` level, a volume within a resource can be addressed by the resource name and volume number as <resource>/<volume>.

DRBD device. This is a virtual block device managed by DRBD. It has a device major number of `147`, and its minor numbers are numbered from 0 onwards, as is customary. Each DRBD device corresponds to a volume in a resource. The associated block device is usually named `/dev/drbdX`, where X is the device minor number. DRBD also allows for user-defined block device names which must, however, start with `drbd_`.

Note

Very early DRBD versions hijacked NBD's device major number 43. This is long obsolete; 147 is the LANANA-registered [http://www.lanana.org/docs/device-list/] DRBD device major.

Connection. A *connection* is a communication link between two hosts that share a replicated data set. As of the time of this writing, each resource involves only two hosts and exactly one connection between these hosts, so for the most part, the terms `resource` and `connection` can be used interchangeably.

At the `drbdadm` level, a connection is addressed by the resource name.

1.4. Resource roles

In DRBD, every resource [3] has a role, which may be *Primary* or *Secondary*.

Note

The choice of terms here is not arbitrary. These roles were deliberately not named "Active" and "Passive" by DRBD's creators. Primary vs. secondary refers to a concept related to availability of *storage*, whereas active vs. passive refers to the availability

of an *application*. It is usually the case in a high-availability environment that the primary node is also the active one, but this is by no means necessary.

- A DRBD device in the primary role can be used unrestrictedly for read and write operations. It may be used for creating and mounting file systems, raw or direct I/O to the block device, etc.
- A DRBD device in the secondary role receives all updates from the peer node's device, but otherwise disallows access completely. It can not be used by applications, neither for read nor write access. The reason for disallowing even read-only access to the device is the necessity to maintain cache coherency, which would be impossible if a secondary resource were made accessible in any way.

The resource's role can, of course, be changed, either by manual intervention [37] or by way of some automated algorithm by a cluster management application. Changing the resource role from secondary to primary is referred to as *promotion*, whereas the reverse operation is termed *demotion*.

Chapter 2. DRBD Features

This chapter discusses various useful DRBD features, and gives some background information about them. Some of these features will be important to most users, some will only be relevant in very specific deployment scenarios. Chapter 6, *Common administrative tasks* [32] and Chapter 7, *Troubleshooting and error recovery* [53] contain instructions on how to enable and use these features in day-to-day operation.

2.1. Single-primary mode

In single-primary mode, a resource [3] is, at any given time, in the primary role on only one cluster member. Since it is guaranteed that only one cluster node manipulates the data at any moment, this mode can be used with any conventional file system (ext3, ext4, XFS etc.).

Deploying DRBD in single-primary mode is the canonical approach for high availability (fail-over capable) clusters.

2.2. Dual-primary mode

In dual-primary mode, a resource is, at any given time, in the primary role on both cluster nodes. Since concurrent access to the data is thus possible, this mode requires the use of a shared cluster file system that utilizes a distributed lock manager. Examples include GFS [80] and OCFS2 [83].

Deploying DRBD in dual-primary mode is the preferred approach for load-balancing clusters which require concurrent data access from two nodes. This mode is disabled by default, and must be enabled explicitly in DRBD's configuration file.

See Section 6.5, "Enabling dual-primary mode" [37] for information on enabling dual-primary mode for specific resources.

2.3. Replication modes

DRBD supports three distinct replication modes, allowing three degrees of replication synchronicity.

Protocol A. Asynchronous replication protocol. Local write operations on the primary node are considered completed as soon as the local disk write has finished, and the replication packet has been placed in the local TCP send buffer. In the event of forced fail-over, data loss may occur. The data on the standby node is consistent after fail-over, however, the most recent updates performed prior to the crash could be lost. Protocol A is most often used in long distance replication scenarios. When used in combination with DRBD Proxy it makes an effective disaster recovery solution. See Section 2.14, "Long-distance replication with DRBD Proxy" [11] for more information.

Protocol B. Memory synchronous (semi-synchronous) replication protocol. Local write operations on the primary node are considered completed as soon as the local disk write has occurred, and the replication packet has reached the peer node. Normally, no writes are lost in case of forced fail-over. However, in the event of simultaneous power failure on both nodes and concurrent, irreversible destruction of the primary's data store, the most recent writes completed on the primary may be lost.

Protocol C. Synchronous replication protocol. Local write operations on the primary node are considered completed only after both the local and the remote disk write have been confirmed. As a result, loss of a single node is guaranteed not to lead to any data loss. Data loss is, of course, inevitable even with this replication protocol if both nodes (or their storage subsystems) are irreversibly destroyed at the same time.

By far, the most commonly used replication protocol in DRBD setups is protocol C.

The choice of replication protocol influences two factors of your deployment: *protection* and *latency*. *Throughput*, by contrast, is largely independent of the replication protocol selected.

See Section 5.3, "Configuring your resource"[26] for an example resource configuration which demonstrates replication protocol configuration.

2.4. Multiple replication transports

DRBD's replication and synchronization framework socket layer supports multiple low-level transports:

TCP over IPv4. This is the canonical implementation, and DRBD's default. It may be used on any system that has IPv4 enabled.

TCP over IPv6. When configured to use standard TCP sockets for replication and synchronization, DRBD can use also IPv6 as its network protocol. This is equivalent in semantics and performance to IPv4, albeit using a different addressing scheme.

SDP. SDP is an implementation of BSD-style sockets for RDMA capable transports such as InfiniBand. SDP is available as part of the OFED stack for most current distributions. SDP uses and IPv4-style addressing scheme. Employed over an InfiniBand interconnect, SDP provides a high-throughput, low-latency replication network to DRBD.

SuperSockets. SuperSockets replace the TCP/IP portions of the stack with a single, monolithic, highly efficient and RDMA capable socket implementation. DRBD can use this socket type for very low latency replication. SuperSockets must run on specific hardware which is currently available from a single vendor, Dolphin Interconnect Solutions.

2.5. Efficient synchronization

(Re-)synchronization is distinct from device replication. While replication occurs on any write event to a resource in the primary role, synchronization is decoupled from incoming writes. Rather, it affects the device as a whole.

Synchronization is necessary if the replication link has been interrupted for any reason, be it due to failure of the primary node, failure of the secondary node, or interruption of the replication link. Synchronization is efficient in the sense that DRBD does not synchronize modified blocks in the order they were originally written, but in linear order, which has the following consequences:

- Synchronization is fast, since blocks in which several successive write operations occurred are only synchronized once.
- Synchronization is also associated with few disk seeks, as blocks are synchronized according to the natural on-disk block layout.
- During synchronization, the data set on the standby node is partly obsolete and partly already updated. This state of data is called *inconsistent*.

The service continues to run uninterrupted on the active node, while background synchronization is in progress.

Important

A node with inconsistent data generally cannot be put into operation, thus it is desirable to keep the time period during which a node is inconsistent as short as possible. DRBD does, however, ship with an LVM integration facility that automates the creation of LVM snapshots immediately before synchronization. This ensures that a *consistent* copy of the data is always available on the peer, even while

synchronization is running. See Section 10.3, “Using automated LVM snapshots during DRBD synchronization” [74] for details on using this facility.

2.5.1. Variable-rate synchronization

In variable-rate synchronization (the default), DRBD detects the available bandwidth on the synchronization network, compares it to incoming foreground application I/O, and selects an appropriate synchronization rate based on a fully automatic control loop.

See Section 6.7.3, “Variable sync rate configuration” [40] for configuration suggestions with regard to variable-rate synchronization.

2.5.2. Fixed-rate synchronization

In fixed-rate synchronization, the amount of data shipped to the synchronizing peer per second (the *synchronization rate*) has a configurable, static upper limit. Based on this limit, you may estimate the expected sync time based on the following simple formula:

Synchronization time. t_{sync} is the expected sync time. D is the amount of data to be synchronized, which you are unlikely to have any influence over (this is the amount of data that was modified by your application while the replication link was broken). R is the rate of synchronization, which is configurable — bounded by the throughput limitations of the replication network and I/O subsystem.

See Section 6.7, “Configuring the rate of synchronization” [39] for configuration suggestions with regard to fixed-rate synchronization.

2.5.3. Checksum-based synchronization

The efficiency of DRBD’s synchronization algorithm may be further enhanced by using data digests, also known as checksums. When using checksum-based synchronization, then rather than performing a brute-force overwrite of blocks marked out of sync, DRBD *reads* blocks before synchronizing them and computes a hash of the contents currently found on disk. It then compares this hash with one computed from the same sector on the peer, and omits re-writing this block if the hashes match. This can dramatically cut down synchronization times in situation where a filesystem re-writes a sector with identical contents while DRBD is in disconnected mode.

See Section 6.8, “Configuring checksum-based synchronization” [41] for configuration suggestions with regard to synchronization.

2.6. Suspended replication

If properly configured, DRBD can detect if the replication network is congested, and *suspend* replication in this case. In this mode, the primary node "pulls ahead" of the secondary — temporarily going out of sync, but still leaving a consistent copy on the secondary. When more bandwidth becomes available, replication automatically resumes and a background synchronization takes place.

Suspended replication is typically enabled over links with variable bandwidth, such as wide area replication over shared connections between data centers or cloud instances.

See Section 6.9, “Configuring congestion policies and suspended replication” [41] for details on congestion policies and suspended replication.

2.7. On-line device verification

On-line device verification enables users to do a block-by-block data integrity check between nodes in a very efficient manner.

Note that *efficient* refers to efficient use of network bandwidth here, and to the fact that verification does not break redundancy in any way. On-line verification is still a resource-intensive operation, with a noticeable impact on CPU utilization and load average.

It works by one node (the *verification source*) sequentially calculating a cryptographic digest of every block stored on the lower-level storage device of a particular resource. DRBD then transmits that digest to the peer node (the *verification target*), where it is checked against a digest of the local copy of the affected block. If the digests do not match, the block is marked out-of-sync and may later be synchronized. Because DRBD transmits just the digests, not the full blocks, on-line verification uses network bandwidth very efficiently.

The process is termed *on-line* verification because it does not require that the DRBD resource being verified is unused at the time of verification. Thus, though it does carry a slight performance penalty while it is running, on-line verification does not cause service interruption or system down time — neither during the verification run nor during subsequent synchronization.

It is a common use case to have on-line verification managed by the local cron daemon, running it, for example, once a week or once a month. See Section 6.6, “Using on-line device verification” [38] for information on how to enable, invoke, and automate on-line verification.

2.8. Replication traffic integrity checking

DRBD optionally performs end-to-end message integrity checking using cryptographic message digest algorithms such as MD5, SHA-1 or CRC-32C.

These message digest algorithms are not *provided* by DRBD. The Linux kernel crypto API provides these; DRBD merely uses them. Thus, DRBD is capable of utilizing any message digest algorithm available in a particular system’s kernel configuration.

With this feature enabled, DRBD generates a message digest of every data block it replicates to the peer, which the peer then uses to verify the integrity of the replication packet. If the replicated block can not be verified against the digest, the peer requests retransmission. Thus, DRBD replication is protected against several error sources, all of which, if unchecked, would potentially lead to data corruption during the replication process:

- Bitwise errors ("bit flips") occurring on data in transit between main memory and the network interface on the sending node (which goes undetected by TCP checksumming if it is offloaded to the network card, as is common in recent implementations);
- bit flips occuring on data in transit from the network interface to main memory on the receiving node (the same considerations apply for TCP checksum offloading);
- any form of corruption due to a race conditions or bugs in network interface firmware or drivers;
- bit flips or random corruption injected by some reassembling network component between nodes (if not using direct, back-to-back connections).

See Section 6.11, “Configuring replication traffic integrity checking[43] for information on how to enable replication traffic integrity checking.

2.9. Split brain notification and automatic recovery

Split brain is a situation where, due to temporary failure of all network links between cluster nodes, and possibly due to intervention by a cluster management software or human error, both nodes switched to the primary role while disconnected. This is a potentially harmful state, as it

implies that modifications to the data might have been made on either node, without having been replicated to the peer. Thus, it is likely in this situation that two diverging sets of data have been created, which cannot be trivially merged.

DRBD split brain is distinct from cluster split brain, which is the loss of all connectivity between hosts managed by a distributed cluster management application such as Heartbeat. To avoid confusion, this guide uses the following convention:

- *Split brain* refers to DRBD split brain as described in the paragraph above.
- Loss of all cluster connectivity is referred to as a *cluster partition*, an alternative term for cluster split brain.

DRBD allows for automatic operator notification (by email or other means) when it detects split brain. See Section 6.14.1, "Split brain notification"[46] for details on how to configure this feature.

While the recommended course of action in this scenario is to manually resolve [55] the split brain and then eliminate its root cause, it may be desirable, in some cases, to automate the process. DRBD has several resolution algorithms available for doing so:

- **Discarding modifications made on the younger primary.** In this mode, when the network connection is re-established and split brain is discovered, DRBD will discard modifications made, in the meantime, on the node which switched to the primary role *last*.
- **Discarding modifications made on the older primary.** In this mode, DRBD will discard modifications made, in the meantime, on the node which switched to the primary role *first*.
- **Discarding modifications on the primary with fewer changes.** In this mode, DRBD will check which of the two nodes has recorded fewer modifications, and will then discard *all* modifications made on that host.
- **Graceful recovery from split brain if one host has had no intermediate changes.** In this mode, if one of the hosts has made no modifications at all during split brain, DRBD will simply recover gracefully and declare the split brain resolved. Note that this is a fairly unlikely scenario. Even if both hosts only mounted the file system on the DRBD block device (even read-only), the device contents would be modified, ruling out the possibility of automatic recovery.

Whether or not automatic split brain recovery is acceptable depends largely on the individual application. Consider the example of DRBD hosting a database. The discard modifications from host with fewer changes approach may be fine for a web application click-through database. By contrast, it may be totally unacceptable to automatically discard *any* modifications made to a financial database, requiring manual recovery in any split brain event. Consider your application's requirements carefully before enabling automatic split brain recovery.

Refer to Section 6.14.2, "Automatic split brain recovery policies"[47] for details on configuring DRBD's automatic split brain recovery policies.

2.10. Support for disk flushes

When local block devices such as hard drives or RAID logical disks have write caching enabled, writes to these devices are considered completed as soon as they have reached the volatile cache. Controller manufacturers typically refer to this as write-back mode, the opposite being write-through. If a power outage occurs on a controller in write-back mode, the last writes are never committed to the disk, potentially causing data loss.

To counteract this, DRBD makes use of disk flushes. A disk flush is a write operation that completes only when the associated data has been committed to stable (non-volatile) storage — that is to say, it has effectively been written to disk, rather than to the cache. DRBD uses disk flushes for write operations both to its replicated data set and to its meta data. In effect, DRBD circumvents

the write cache in situations it deems necessary, as in activity log [106] updates or enforcement of implicit write-after-write dependencies. This means additional reliability even in the face of power failure.

It is important to understand that DRBD can use disk flushes only when layered on top of backing devices that support them. Most reasonably recent kernels support disk flushes for most SCSI and SATA devices. Linux software RAID (md) supports disk flushes for RAID-1 provided that all component devices support them too. The same is true for device-mapper devices (LVM2, dm-raid, multipath).

Controllers with battery-backed write cache (BBWC) use a battery to back up their volatile storage. On such devices, when power is restored after an outage, the controller flushes all pending writes out to disk from the battery-backed cache, ensuring that all writes committed to the volatile cache are actually transferred to stable storage. When running DRBD on top of such devices, it may be acceptable to disable disk flushes, thereby improving DRBD's write performance. See Section 6.13, "Disabling backing device flushes" [46] for details.

2.11. Disk error handling strategies

If a hard drive fails which is used as a backing block device for DRBD on one of the nodes, DRBD may either pass on the I/O error to the upper layer (usually the file system) or it can mask I/O errors from upper layers.

Passing on I/O errors. If DRBD is configured to pass on I/O errors, any such errors occuring on the lower-level device are transparently passed to upper I/O layers. Thus, it is left to upper layers to deal with such errors (this may result in a file system being remounted read-only, for example). This strategy does not ensure service continuity, and is hence not recommended for most users.

Masking I/O errors. If DRBD is configured to *detach* on lower-level I/O error, DRBD will do so, automatically, upon occurrence of the first lower-level I/O error. The I/O error is masked from upper layers while DRBD transparently fetches the affected block from the peer node, over the network. From then onwards, DRBD is said to operate in diskless mode, and carries out all subsequent I/O operations, read and write, on the peer node. Performance in this mode will be reduced, but the service continues without interruption, and can be moved to the peer node in a deliberate fashion at a convenient time.

See Section 6.10, "Configuring I/O error handling strategies"[42] for information on configuring I/O error handling strategies for DRBD.

2.12. Strategies for dealing with outdated data

DRBD distinguishes between *inconsistent* and *outdated* data. Inconsistent data is data that cannot be expected to be accessible and useful in any manner. The prime example for this is data on a node that is currently the target of an on-going synchronization. Data on such a node is part obsolete, part up to date, and impossible to identify as either. Thus, for example, if the device holds a filesystem (as is commonly the case), that filesystem would be unexpected to mount or even pass an automatic filesystem check.

Outdated data, by contrast, is data on a secondary node that is consistent, but no longer in sync with the primary node. This would occur in any interruption of the replication link, whether temporary or permanent. Data on an outdated, disconnected secondary node is expected to be clean, but it reflects a state of the peer node some time past. In order to avoid services using outdated data, DRBD disallows promoting a resource [3] that is in the outdated state.

DRBD has interfaces that allow an external application to outdate a secondary node as soon as a network interruption occurs. DRBD will then refuse to switch the node to the primary role, preventing applications from using the outdated data. A complete implementation of this functionality exists for the Pacemaker cluster management framework[58] (where it uses

a communication channel separate from the DRBD replication link). However, the interfaces are generic and may be easily used by any other cluster management application.

Whenever an outdated resource has its replication link re-established, its outdated flag is automatically cleared. A background synchronization [6] then follows.

See the section about the DRBD outdate-peer daemon (dopd)[60] for an example DRBD/ Heartbeat/Pacemaker configuration enabling protection against inadvertent use of outdated data.

2.13. Three-way replication

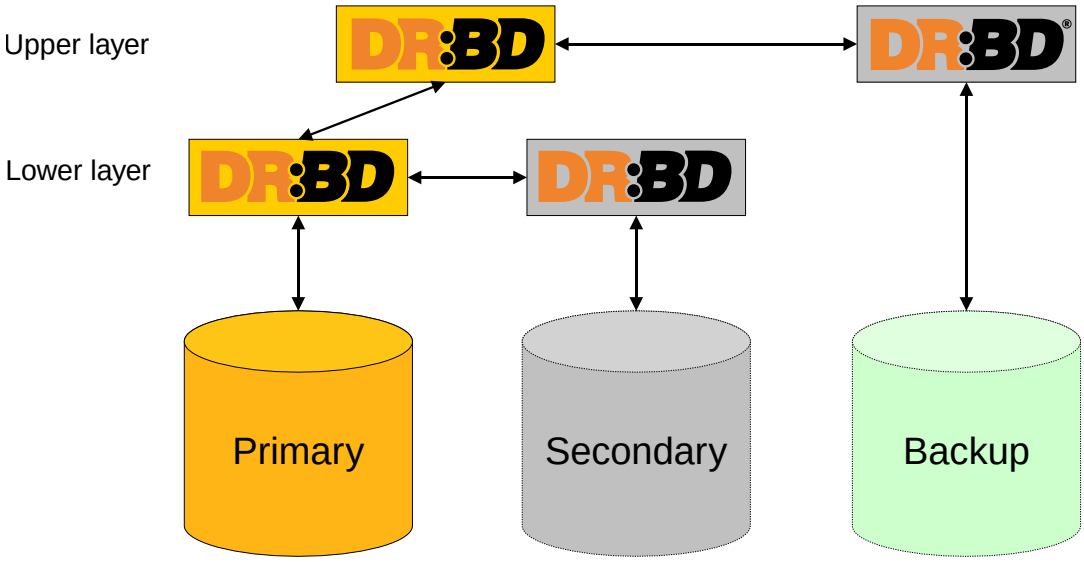
Note

Available in DRBD version 8.3.0 and above

When using three-way replication, DRBD adds a third node to an existing 2-node cluster and replicates data to that node, where it can be used for backup and disaster recovery purposes.

Three-way replication works by adding another, *stacked* DRBD resource on top of the existing resource holding your production data, as seen in this illustration:

Figure 2.1. DRBD resource stacking



The stacked resource is replicated using asynchronous replication (DRBD protocol A), whereas the production data would usually make use of synchronous replication (DRBD protocol C).

Three-way replication can be used permanently, where the third node is continously updated with data from the production cluster. Alternatively, it may also be employed on demand, where the production cluster is normally disconnected from the backup site, and site-to-site synchronization is performed on a regular basis, for example by running a nightly cron job.

2.14. Long-distance replication with DRBD Proxy

Note

DRBD Proxy requires DRBD version 8.2.7 or above.

DRBD's protocol A [5] is asynchronous, but the writing application will block as soon as the socket output buffer is full (see the sndbuf-size option in drbd.conf(5) [119]). In that event, the writing application has to wait until some of the data written runs off through a possibly small bandwith network link.

The average write bandwith is limited by available bandwith of the network link. Write bursts can only be handled gracefully if they fit into the limited socket output buffer.

You can mitigate this by DRBD Proxy's buffering mechanism. DRBD Proxy will suck up all available data from the DRBD on the primary node into its buffers. DRBD Proxy's buffer size is freely configurable, only limited by the address room size and available physical RAM.

Optionally DRBD Proxy can be configured to compress and decompress the data it forwards. Compression and decompression of DRBD's data packets might slightly increase latency. But when the bandwidth of the network link is the limiting factor, the gain in shortening transmit time outweighs the compression and decompression overhead by far.

Compression and decompression were implemented with multi core SMP systems in mind, and can utilize multiple CPU cores.

The fact that most block I/O data compresses very well and therefore the effective bandwidth increases well justifies the use of the DRBD Proxy even with DRBD protocols B and C.

See Section 6.16, "Using DRBD Proxy" [50] for information on configuring DRBD Proxy.

Note

DRBD Proxy is the only part of the DRBD product family that is not published under an open source license. Please contact sales@linbit.com [mailto:sales@linbit.com] or sales_us@linbit.com [mailto:sales_us@linbit.com] for an evaluation license.

2.15. Truck based replication

Truck based replication, also known as disk shipping, is a means of preseeding a remote site with data to be replicated, by physically shipping storage media to the remote site. This is particularly suited for situations where

- the total amount of data to be replicated is fairly large (more than a few hundreds of gigabytes);
- the expected rate of change of the data to be replicated is less than enormous;
- the available network bandwidth between sites is limited.

In such situations, without truck based replication, DRBD would require a very long initial device synchronization (on the order of days or weeks). Truck based replication allows us to ship a data seed to the remote site, and drastically reduce the initial synchronization time. See Section 5.6, "Using truck based replication" [30] for details on this use case.

2.16. Floating peers

Note

This feature is available in DRBD versions 8.3.2 and above.

A somewhat special use case for DRBD is the *floating peers* configuration. In floating peer setups, DRBD peers are not tied to specific named hosts (as in conventional configurations), but instead have the ability to float between several hosts. In such a configuration, DRBD identifies peers by IP address, rather than by host name.

For more information about managing floating peer configurations, see Section 8.5, “Configuring DRBD to replicate between two SAN-backed Pacemaker clusters” [66].

Part II. Building, installing and configuring DRBD

Chapter 3. Installing pre-built DRBD binary packages

3.1. Packages supplied by LINBIT

LINBIT, the DRBD project's sponsor company, provides DRBD binary packages to its commercial support customers. These packages are available at http://www.linbit.com/support/ and are considered "official" DRBD builds.

These builds are available for the following distributions:

- Red Hat Enterprise Linux (RHEL), versions and 5 6
- SUSE Linux Enterprise Server (SLES), versions 10, and 11
- Debian GNU/Linux, versions 5.0 (lenny) and 6.0 (squeeze)
- Ubuntu Server Edition LTS, versions and 8.04 (Hardy Heron) and 10.04 (Lucid Lynx).

LINBIT releases binary builds in parallel with any new DRBD source release.

Package installation on RPM-based systems (SLES, RHEL) is done by simply invoking `rpm -i` (for new installations) or `rpm -U` (for upgrades), along with the corresponding package names.

For Debian-based systems (Debian GNU/Linux, Ubuntu) systems, `drbd8-utils` and `drbd8-module` packages are installed with `dpkg -i, or gdebi` if available.

3.2. Packages supplied by distribution vendors

A number of distributions include DRBD, including pre-built binary packages. Support for these builds, if any, is being provided by the associated distribution vendor. Their release cycle may lag behind DRBD source releases.

3.2.1. SUSE Linux Enterprise Server

SUSE Linux Enterprise Server (SLES), includes DRBD 0.7 in versions 9 and 10. DRBD 8.3 is included in SLES 11 High Availability Extension (HAE) SP1.

On SLES, DRBD is normally installed via the software installation component of YaST2. It comes bundled with the High Availability package selection.

Users who prefer a command line install may simply issue:

```
yast -i drbd
```

or

```
zypper install drbd
```

3.2.2. Debian GNU/Linux

Debian GNU/Linux includes DRBD 8 from the 5.0 release (`lenny`) onwards. In 6.0 (`squeeze`), which is based on a 2.6.32 Linux kernel, Debian ships a backported version of DRBD.

On `squeeze`, since DRBD is already included with the stock kernel, all that is needed to install is the `drbd8-utils` package:

```
apt-get install drbd8-utils
```

On lenny (obsolete), you install DRBD by issuing:

```
apt-get install drbd8-utils drbd8-module
```

3.2.3. CentOS

CentOS has had DRBD 8 since release 5.

DRBD can be installed using yum (note that you will need the extras repository enabled for this to work):

```
yum install drbd kmod-drbd
```

3.2.4. Ubuntu Linux

To install DRBD on Ubuntu, you issue these commands:

```
apt-get update
apt-get install drbd8-utils drbd8-module
```

Chapter 4. Building and installing DRBD from source

4.1. Downloading the DRBD sources

The source tarballs for both current and historic DRBD releases are available for download from http://oss.linbit.com/drbd/. Source tarballs, by convention, are named `drbd-x.y.z.tar.gz`, where x, y and z refer to the major, minor and bugfix release numbers.

DRBD's compressed source archive is less than half a megabyte in size. To download and uncompress into your current working directory, issue the following commands:

```
wget http://oss.linbit.com/drbd/8.4/drbd-8.4.0.tar.gz
tar -xzf drbd-8.4.0.tar.gz
```

Note

The use of `wget` for downloading the source tarball is purely an example. Of course, you may use any downloader you prefer.

It is recommended to uncompress DRBD into a directory normally used for keeping source code, such as `/usr/src` or `/usr/local/src`. The examples in this guide assume `/usr/src`.

4.2. Checking out sources from the public DRBD source repository

DRBD's source code is kept in a public Git [http://git.or.cz] repository, which may be browsed on-line at http://git.drbd.org/. To check out a specific DRBD release from the repository, you must first *clone* your preferred DRBD branch. In this example, you would clone from the DRBD 8.4 branch:

```
git clone git://git.drbd.org/drbd-8.4.git
```

If your firewall does not permit TCP connections to port `9418`, you may also check out via HTTP (please note that using Git via HTTP is much slower than its native protocol, so native Git is usually preferred whenever possible):

```
git clone http://git.drbd.org/drbd-8.4.git
```

Either command will create a Git checkout subdirectory, named `drbd-8.4`. To now move to a source code state equivalent to a specific DRBD release, issue the following commands:

```
cd drbd-8.4
git checkout drbd-8.4.<x>
```

i. where *<x>* refers to the DRBD point release you wish to build.

The checkout directory will now contain the equivalent of an unpacked DRBD source tarball of a that specific version, enabling you to build DRBD from source.

There are actually two minor differences between an unpacked source tarball and a Git checkout of the same release:

- The Git checkout contains a `debian/` subdirectoy, while the source tarball does not. This is due to a request from Debian maintainers, who prefer to add their own Debian build configuration to a pristine upstream tarball.

- The source tarball contains preprocessed man pages, the Git checkout does not. Thus, building DRBD from a Git checkout requires a complete Docbook toolchain for building the man pages, while this is not a requirement for building from a source tarball.

4.3. Building DRBD from source

4.3.1. Checking build prerequisites

Before being able to build DRBD from source, your build host must fulfill the following prerequisites:

- `make`, `gcc`, the glibc development libraries, and the `flex` scanner generator must be installed.

Note

You should make sure that the `gcc` you use to compile the module is the same which was used to build the kernel you are running. If you have multiple `gcc` versions available on your system, DRBD's build system includes a facility to <link linkend="s-build-customcc">select a specific `gcc` version.

- For building directly from a git checkout, GNU Autoconf is also required. This requirement does not apply when building from a tarball.

- If you are running a stock kernel supplied by your distribution, you should install a matching precompiled kernel headers package. These are typically named `kernel-dev`, `kernel-headers`, `linux-headers` or similar. In this case, you can skip Section 4.3.2, "Preparing the kernel source tree"[18] and continue with Section 4.3.3, "Preparing the DRBD build tree" [19].

- If you are not running a distribution stock kernel (i.e. your system runs on a kernel built from source with a custom configuration), your kernel source files must be installed. Your distribution may provide for this via its package installation mechanism; distribution packages for kernel sources are typically named `kernel-source` or similar.

Note

On RPM-based systems, these packages will be named similar to `kernel-source-version.rpm`, which is easily confused with `kernel-version.src.rpm`. The former is the correct package to install for building DRBD.

"Vanilla" kernel tarballs from the kernel.org archive are simply named linux-version-tar.bz2 and should be unpacked in `/usr/src/linux-version`, with the symlink `/usr/src/linux` pointing to that directory.

In this case of building DRBD against kernel sources (not headers), you must continue with Section 4.3.2, "Preparing the kernel source tree" [18].

4.3.2. Preparing the kernel source tree

To prepare your source tree for building DRBD, you must first enter the directory where your unpacked kernel sources are located. Typically this is `/usr/src/linux-version`, or simply a symbolic link named `/usr/src/linux`:

```
cd /usr/src/linux
```

The next step is recommended, though not strictly necessary. Be sure to copy your existing `.config` file to a safe location before performing it. This step essentially reverts your kernel source tree to its original state, removing any leftovers from an earlier build or configure run:

```
make mrproper
```

Now it is time to *clone* your currently running kernel configuration into the kernel source tree. There are a few possible options for doing this:

- Many reasonably recent kernel builds export the currently-running configuration, in compressed form, via the `/proc` filesystem, enabling you to copy from there:

```
zcat /proc/config.gz > .config
```

- SUSE kernel Makefiles include a `cloneconfig` target, so on those systems, you can issue:

```
make cloneconfig
```

- Some installs put a copy of the kernel config into `/boot`, which allows you to do this:

```
cp /boot/config-`uname -r` .config
```

- Finally, you may simply use a backup copy of a `.config` file which you know to have been used for building the currently-running kernel.

4.3.3. Preparing the DRBD build tree

Any DRBD compilation requires that you first configure your DRBD source tree with the included `configure` script.

Note

When building from a git checkout, the `configure` script does not yet exist. You must create it by simply typing `autoconf` at the top of the checkout.

Invoking the configure script with the `--help` option returns a full list of supported options. The table below summarizes the most important ones:

Table 4.1. Options supported by DRBD's `configure` script

Option	Description	Default	Remarks
`--prefix`	Installation directory prefix	`/usr/local`	This is the default to maintain Filesystem Hierarchy Standard compatibility for locally installed, unpackaged software. In packaging, this is typically overridden with /usr+.
`--localstatedir`	Local state directory	`/usr/local/var`	Even with a default `prefix`, most users will want to override this with `/var`.
`--sysconfdir`	System configuration directory	`/usr/local/etc`	Even with a default `prefix`, most users will want to override this with `/etc`.
`--with-km`	Build the DRBD kernel module	no	Enable this option when you are building

Option	Description	Default	Remarks
			a DRBD kernel module.
`--with-utils`	Build the DRBD userland utilities	yes	Disable this option when you are building a DRBD kernel module against a new kernel version, and not upgrading DRBD at the same time.
`--with-heartbeat`	Build DRBD Heartbeat integration	yes	You may disable this option unless you are planning to use DRBD's Heartbeat v1 resource agent or `dopd`.
`--with-pacemaker`	Build DRBD Pacemaker integration	yes	You may disable this option if you are not planning to use the Pacemaker cluster resource manager.
`--with-rgmanager`	Build DRBD Red Hat Cluster Suite integration	no	You should enable this option if you are planning to use DRBD with rgmanager, the Red Hat Cluster Suite cluster resource manager.
`--with-xen`	Build DRBD Xen integration	yes (on x86 architectures)	You may disable this option if you are not planning to use the `block-drbd` helper script for Xen integration.
`--with-bashcompletion`	Build programmable bash completion for `drbdadm`	yes	You may disable this option if you are using a shell other than bash, or if you do not want to utilize programmable completion for the `drbdadm` command.
`--enable-spec`	Create a distribution specific RPM spec file	no	For package builders only: you may use this option if you want to create an RPM spec file adapted to your distribution. See also Section 4.4, "Building a DRBD RPM package" [22].

The configure script will adapt your DRBD build to distribution specific needs. It does so by auto-detecting which distribution it is being invoked on, and setting defaults accordingly. When overriding defaults, do so with caution.

The configure script creates a log file, `config.log`, in the directory where it was invoked. When reporting build issues on the mailing list, it is usually wise to either attach a copy of that file to your email, or point others to a location from where it may be viewed or downloaded.

4.3.4. Building DRBD userspace utilities

Building userspace utilities requires that you configured DRBD with the `--with-utils` option [19], which is enabled by default.

To build DRBD's userspace utilities, invoke the following commands from the top of your DRBD checkout or expanded tarball:

```
$ make
$ sudo make install
```

This will build the management utilities (`drbdadm`, `drbdsetup`, and `drbdmeta`), and install them in the appropriate locations. Based on the other `--with` options selected during the configure stage [19], it will also install scripts to integrate DRBD with other applications.

4.3.5. Compiling DRBD as a kernel module

Building the DRBD kernel module requires that you configured DRBD with the `--with-km` option [19], which is disabled by default.

4.3.5.1. Building DRBD for the currently-running kernel

After changing into your unpacked DRBD sources directory, you should now change into the kernel module subdirectory, simply named `drbd`, and build the module there:

```
cd drbd
make clean all
```

This will build the DRBD kernel module to match your currently-running kernel, whose kernel source is expected to be accessible via the `/lib/modules/uname -r/build` symlink.

4.3.5.2. Building against precompiled kernel headers

If the `/lib/modules/uname -r/build` symlink does not exist, and you are building against a running stock kernel (one that was shipped pre-compiled with your distribution), you may also set the KDIR variable to point to the *matching* kernel headers (as opposed to kernel sources) directory. Note that besides the actual kernel headers — commonly found in `/usr/src/linux-version/include` — the DRBD build process also looks for the kernel Makefile and configuration file (`.config`), which pre-built kernel headers packages commonly include.

To build against precompiled kernel headers, issue, for example:

```
$ cd drbd
$ make clean
$ make KDIR=/lib/modules/2.6.38/build
```

4.3.5.3. Building against a kernel source tree

If you are building DRBD against a kernel *other* than your currently running one, and you do not have precompiled kernel sources for your target kernel available, you need to build DRBD against a complete target kernel source tree. To do so, set the KDIR variable to point to the kernel sources directory:

```
$ cd drbd
$ make clean
```

```
$ make KDIR=/path/to/kernel/source
```

4.3.5.4. Using a non-default C compiler

You also have the option of setting the compiler explicitly via the CC variable. This is known to be necessary on some Fedora versions, for example:

```
cd drbd
make clean
make CC=gcc32
```

4.3.5.5. Checking for successful build completion

If the module build completes successfully, you should see a kernel module file named `drbd.ko` in the `drbd` directory. You may interrogate the newly-built module with /sbin/modinfo drbd.ko if you are so inclined.

4.4. Building a DRBD RPM package

The DRBD build system contains a facility to build RPM packages directly out of the DRBD source tree. For building RPMs, Section 4.3.1, "Checking build prerequisites"[18] applies essentially in the same way as for building and installing with `make`, except that you also need the RPM build tools, of course.

Also, see Section 4.3.2, "Preparing the kernel source tree"[18] if you are not building against a running kernel with precompiled headers available.

The build system offers two approaches for building RPMs. The simpler approach is to simply invoke the `rpm` target in the top-level Makefile:

```
$ ./configure
$ make rpm
$ make km-rpm
```

This approach will auto-generate spec files from pre-defined templates, and then use those spec files to build binary RPM packages.

The `make rpm` approach generates a number of RPM packages:

Table 4.2. DRBD userland RPM packages

Package name	Description	Dependencies	Remarks
`drbd`	DRBD meta-package	All other `drbd-*` packages	Top-level virtual package. When installed, this pulls in all other userland packages as dependencies.
`drbd-utils`	Binary administration utilities		Required for any DRBD enabled host
`drbd-udev`	udev integration facility	`drbd-utils, udev`	Enables udev to manage user-friendly symlinks to DRBD devices
`drbd-xen`	Xen DRBD helper scripts	`drbd-utils, xen`	Enables xend to auto-manage DRBD resources

Package name	Description	Dependencies	Remarks
drbd-heartbeat	DRBD Heartbeat integration scripts	drbd-utils, heartbeat	Enables DRBD management by legacy v1-style Heartbeat clusters
drbd-pacemaker	DRBD Pacemaker integration scripts	drbd-utils, pacemaker	Enables DRBD management by Pacemaker clusters
drbd-rgmanager	DRBD Red Hat Cluster Suite integration scripts	drbd-utils, rgmanager	Enables DRBD management by rgmanager, the Red Hat Cluster Suite resource manager
drbd-bashcompletion	Progammable bash completion	drbd-utils, bash-completion	Enables Programmable bash completion for the drbdadm utility

The other, more flexible approach is to have `configure` generate the spec file, make any changes you deem necessary, and then use the `rpmbuild` command:

```
$ ./configure --enable-spec
$ make tgz
$ cp drbd*.tar.gz `rpm -E _sourcedir`
$ rpmbuild -bb drbd.spec
```

If you are about to build RPMs for both the DRBD userspace utilities and the kernel module, use:

```
$ ./configure --enable-spec --with-km
$ make tgz
$ cp drbd*.tar.gz `rpm -E _sourcedir`
$ rpmbuild -bb drbd.spec
$ rpmbuild -bb drbd-kernel.spec
```

The RPMs will be created wherever your system RPM configuration (or your personal `~/.rpmmacros` configuration) dictates.

After you have created these packages, you can install, upgrade, and uninstall them as you would any other RPM package in your system.

Note that any kernel upgrade will require you to generate a new `drbd-km` package to match the new kernel.

The DRBD userland packages, in contrast, need only be recreated when upgrading to a new DRBD version. If at any time you upgrade to a new kernel *and* new DRBD version, you will need to upgrade both packages.

4.5. Building a DRBD Debian package

The DRBD build system contains a facility to build Debian packages directly out of the DRBD source tree. For building Debian packages, Section 4.3.1, "Checking build prerequisites"[18] applies essentially in the same way as for building and installing with `make`, except that you of course also need the `dpkg-dev` package containing the Debian packaging tools, and `fakeroot` if you want to build DRBD as a non-`root` user (highly recommended).

Also, see Section 4.3.2, "Preparing the kernel source tree"[18] if you are not building against a running kernel with precompiled headers available.

The DRBD source tree includes a `debian` subdirectory containing the required files for Debian packaging. That subdirectory, however, is not included in the DRBD source tarballs — instead, you will need to create a Git checkout [17] of a *tag* associated with a specific DRBD release.

Once you have created your checkout in this fashion, you can issue the following commands to build DRBD Debian packages:

```
dpkg-buildpackage -rfakeroot -b -uc
```

Note

This (example) `drbd-buildpackage` invocation enables a binary-only build (`-b`) by a non-`root` user (`-rfakeroot`), disabling cryptographic signature for the changes file (`-uc`). Of course, you may prefer other build options, see the `dpkg-buildpackage` man page for details.

This build process will create two Debian packages:

- A package containing the DRBD userspace tools, named `drbd8-utils_x.y.z-BUILD_ARCH.deb`;
- A module source package suitable for `module-assistant` named `drbd8-module-source_x.y.z-BUILD_all.deb`.

After you have created these packages, you can install, upgrade, and uninstall them as you would any other Debian package in your system.

Building and installing the actual kernel module from the installed module source package is easily accomplished via Debian's `module-assistant` facility:

```
module-assistant auto-install drbd8
```

You may also use the shorthand form of the above command:

```
m-a a-i drbd8
```

Note that any kernel upgrade will require you to rebuild the kernel module (with `module-assistant`, as just described) to match the new kernel. The `drbd8-utils` and `drbd8-module-source` packages, in contrast, only need to be recreated when upgrading to a new DRBD version. If at any time you upgrade to a new kernel *and* new DRBD version, you will need to upgrade both packages.

Chapter 5. Configuring DRBD

5.1. Preparing your lower-level storage

After you have installed DRBD, you must set aside a roughly identically sized storage area on both cluster nodes. This will become the *lower-level device* for your DRBD resource. You may use any type of block device found on your system for this purpose. Typical examples include:

- A hard drive partition (or a full physical hard drive),
- a software RAID device,
- an LVM Logical Volume or any other block device configured by the Linux device-mapper infrastructure,
- any other block device type found on your system.

You may also use *resource stacking*, meaning you can use one DRBD device as a lower-level device for another. Some specific considerations apply to stacked resources; their configuration is covered in detail in Section 6.15, "Creating a three-node setup" [48].

Note

While it is possible to use loop devices as lower-level devices for DRBD, doing so is not recommended due to deadlock issues.

It is *not* necessary for this storage area to be empty before you create a DRBD resource from it. In fact it is a common use case to create a two-node cluster from a previously non-redundant single-server system using DRBD (some caveats apply — please refer to Section 17.1, "DRBD meta data" [101] if you are planning to do this).

For the purposes of this guide, we assume a very simple setup:

- Both hosts have a free (currently unused) partition named `/dev/sda7`.
- We are using internal meta data [101].

5.2. Preparing your network configuration

It is recommended, though not strictly required, that you run your DRBD replication over a dedicated connection. At the time of this writing, the most reasonable choice for this is a direct, back-to-back, Gigabit Ethernet connection. When DRBD is run over switches, use of redundant components and the `bonding` driver (in `active-backup` mode) is recommended.

It is generally not recommended to run DRBD replication via routers, for reasons of fairly obvious performance drawbacks (adversely affecting both throughput and latency).

In terms of local firewall considerations, it is important to understand that DRBD (by convention) uses TCP ports from 7788 upwards, with every resource listening on a separate port. DRBD uses *two* TCP connections for every resource configured. For proper DRBD functionality, it is required that these connections are allowed by your firewall configuration.

Security considerations other than firewalling may also apply if a Mandatory Access Control (MAC) scheme such as SELinux or AppArmor is enabled. You may have to adjust your local security policy so it does not keep DRBD from functioning properly.

You must, of course, also ensure that the TCP ports for DRBD are not already used by another application.

It is not possible to configure a DRBD resource to support more than one TCP connection. If you want to provide for DRBD connection load-balancing or redundancy, you can easily do so at the Ethernet level (again, using the `bonding` driver).

For the purposes of this guide, we assume a very simple setup:

- Our two DRBD hosts each have a currently unused network interface, `eth1`, with IP addresses `10.1.1.31 and 10.1.1.32` assigned to it, respectively.
- No other services are using TCP ports `7788` through `7799` on either host.
- The local firewall configuration allows both inbound and outbound TCP connections between the hosts over these ports.

5.3. Configuring your resource

All aspects of DRBD are controlled in its configuration file, `/etc/drbd.conf`. Normally, this configuration file is just a skeleton with the following contents:

```
include "/etc/drbd.d/global_common.conf";
include "/etc/drbd.d/*.res";
```

By convention, `/etc/drbd.d/global_common.conf` contains the `global` [28] and `common` [28] sections of the DRBD configuration, whereas the `.res` files contain one `resource` [28] section each.

It is also possible to use `drbd.conf` as a flat configuration file without any `include` statements at all. Such a configuration, however, quickly becomes cluttered and hard to manage, which is why the multiple-file approach is the preferred one.

Regardless of which approach you employ, you should always make sure that `drbd.conf`, and any other files it includes, are *exactly identical* on all participating cluster nodes.

The DRBD source tarball contains an example configuration file in the `scripts` subdirectory. Binary installation packages will either install this example configuration directly in `/etc`, or in a package-specific documentation directory such as `/usr/share/doc/packages/drbd`.

This section describes only those few aspects of the configuration file which are absolutely necessary to understand in order to get DRBD up and running. The configuration file's syntax and contents are documented in great detail in drbd.conf(5) [119].

5.3.1. Example configuration

For the purposes of this guide, we assume a minimal setup in line with the examples given in the previous sections:

Simple DRBD configuration (`/etc/drbd.d/global_common.conf`).

```
global {
  usage-count yes;
}
common {
  net {
    protocol C;
  }
}
```

Simple DRBD resource configuration (`/etc/drbd.d/r0.res`).

```
resource r0 {
  on alice {
    device    /dev/drbd1;
    disk      /dev/sda7;
    address   10.1.1.31:7789;
    meta-disk internal;
  }
  on bob {
    device    /dev/drbd1;
    disk      /dev/sda7;
    address   10.1.1.32:7789;
    meta-disk internal;
  }
}
```

This example configures DRBD in the following fashion:

- You "opt in" to be included in DRBD's usage statistics (see `usage-count` [28]).
- Resources are configured to use fully synchronous replication (Protocol C [5]) unless explicitly specified otherwise.
- Our cluster consists of two nodes, `alice and bob`.
- We have a resource arbitrarily named `r0` which uses `/dev/sda7` as the lower-level device, and is configured with internal meta data [101].
- The resource uses TCP port 7789 for its network connections, and binds to the IP addresses 10.1.1.31 and 10.1.1.32, respectively.

The configuration above implicitly creates one volume in the resource, numbered zero (`0`). For multiple volumes in one resource, modify the syntax as follows:

Multi-volume DRBD resource configuration (`/etc/drbd.d/r0.res`).

```
resource r0 {
  volume 0 {
    device    /dev/drbd1;
    disk      /dev/sda7;
    meta-disk internal;
  }
  volume 1 {
    device    /dev/drbd2;
    disk      /dev/sda8;
    meta-disk internal;
  }
  on alice {
    address   10.1.1.31:7789;
  }
  on bob {
    address   10.1.1.32:7789;
  }
}
```

Note

Volumes may also be added to existing resources on the fly. For an example see Section 10.5, "Adding a new DRBD volume to an existing Volume Group" [76].

5.3.2. The `global` section

This section is allowed only once in the configuration. It is normally in the `/etc/drbd.d/global_common.conf` file. In a single-file configuration, it should go to the very top of the configuration file. Of the few options available in this section, only one is of relevance to most users:

`usage-count`. The DRBD project keeps statistics about the usage of various DRBD versions. This is done by contacting an HTTP server every time a new DRBD version is installed on a system. This can be disabled by setting `usage-count no;`. The default is `usage-count ask;` which will prompt you every time you upgrade DRBD.

DRBD's usage statistics are, of course, publicly available: see http://usage.drbd.org.

5.3.3. The `common` section

This section provides a shorthand method to define configuration settings inherited by every resource. It is normally found in `/etc/drbd.d/global_common.conf`. You may define any option you can also define on a per-resource basis.

Including a `common` section is not strictly required, but strongly recommended if you are using more than one resource. Otherwise, the configuration quickly becomes convoluted by repeatedly-used options.

In the example above, we included `net { protocol C; }` in the `common` section, so every resource configured (including `r0`) inherits this option unless it has another `protocol` option configured explicitly. For other synchronization protocols available, see Section 2.3, "Replication modes" [5].

5.3.4. The `resource` sections

A per-resource configuration file is usually named `/etc/drbd.d/<resource>.res`. Any DRBD resource you define must be named by specifying resource name in the configuration. You may use any arbitrary identifier, however the name must not contain characters other than those found in the US-ASCII character set, and must also not include whitespace.

Every resource configuration must also have two `on <host>` sub-sections (one for every cluster node). All other configuration settings are either inherited from the `common` section (if it exists), or derived from DRBD's default settings.

In addition, options with equal values on both hosts can be specified directly in the `resource` section. Thus, we can further condense our example configuration as follows:

```
resource r0 {
  device    /dev/drbd1;
  disk      /dev/sda7;
  meta-disk internal;
  on alice {
    address   10.1.1.31:7789;
  }
  on bob {
    address   10.1.1.32:7789;
  }
}
```

5.4. Enabling your resource for the first time

After you have completed initial resource configuration as outlined in the previous sections, you can bring up your resource.

Each of the following steps must be completed on both nodes.

Create device metadata. This step must be completed only on initial device creation. It initializes DRBD's metadata:

```
drbdadm create-md resource
v08 Magic number not found
Writing meta data...
initialising activity log
NOT initializing bitmap
New drbd meta data block sucessfully created.
```

Enable the resource. This step associates the resource with its backing device (or devices, in case of a multi-volume resource), sets replication parameters, and connects the resource to its peer:

```
drbdadm up resource
```

Observe `/proc/drbd`. DRBD's virtual status file in the `/proc` filesystem, `/proc/drbd`, should now contain information similar to the following:

```
cat /proc/drbd
version: 8.3.0 (api:88/proto:86-89)
GIT-hash: 9ba8b93e24d842f0dd3fb1f9b90e8348ddb95829 build by buildsystem@linbit,
1: cs:Connected ro:Secondary/Secondary ds:Inconsistent/Inconsistent C r---
ns:0 nr:0 dw:0 dr:0 al:0 bm:0 lo:0 pe:0 ua:0 ap:0 ep:1 wo:b oos:200768
```

Note

The `Inconsistent/Inconsistent` disk state is expected at this point.

By now, DRBD has successfully allocated both disk and network resources and is ready for operation. What it does not know yet is which of your nodes should be used as the source of the initial device synchronization.

5.5. The initial device synchronization

There are two more steps required for DRBD to become fully operational:

Select an initial sync source. If you are dealing with newly-initialized, empty disk, this choice is entirely arbitrary. If one of your nodes already has valuable data that you need to preserve, however, *it is of crucial importance* that you select that node as your synchronization source. If you do initial device synchronization in the wrong direction, you will lose that data. Exercise caution.

Start the initial full synchronization. This step must be performed on only one node, only on initial resource configuration, and only on the node you selected as the synchronization source. To perform this step, issue this command:

```
drbdadm primary --force resource
```

After issuing this command, the initial full synchronization will commence. You will be able to monitor its progress via `/proc/drbd`. It may take some time depending on the size of the device.

By now, your DRBD device is fully operational, even before the initial synchronization has completed (albeit with slightly reduced performance). You may now create a filesystem on the device, use it as a raw block device, mount it, and perform any other operation you would with an accessible block device.

You will now probably want to continue with Chapter 6, *Common administrative tasks*[32], which describes common administrative tasks to perform on your resource.

5.6. Using truck based replication

In order to preseed a remote node with data which is then to be kept synchronized, and to skip the initial device synchronization, follow these steps.

This assumes that your local node has a configured, but disconnected DRBD resource in the Primary role. That is to say, device configuration is completed, identical `drbd.conf` copies exist on both nodes, and you have issued the commands for initial resource promotion [29] on your local node — but the remote node is not connected yet.

- On the local node, issue the following command:

```
drbdadm new-current-uuid --clear-bitmap <resource>
```

- Create a consistent, verbatim copy of the resource's data *and its metadata*. You may do so, for example, by removing a hot-swappable drive from a RAID-1 mirror. You would, of course, replace it with a fresh drive, and rebuild the RAID set, to ensure continued redundancy. But the removed drive is a verbatim copy that can now be shipped off site. If your local block device supports snapshot copies (such as when using DRBD on top of LVM), you may also create a bitwise copy of that snapshot using `dd`.

- On the local node, issue:

```
drbdadm new-current-uuid <resource>
```

Note the absence of the `--clear-bitmap` option in this second invocation.

- Physically transport the copies to the remote peer location.

- Add the copies to the remote node. This may again be a matter of plugging a physical disk, or grafting a bitwise copy of your shipped data onto existing storage on the remote node. Be sure to restore or copy not only your replicated data, but also the associated DRBD metadata. If you fail to do so, the disk shipping process is moot.

- Bring up the resource on the remote node:

```
drbdadm up resource
```

After the two peers connect, they will not initiate a full device synchronization. Instead, the automatic synchronization that now commences only covers those blocks that changed since the invocation of `drbdadm --clear-bitmap new-current-uuid`.

Even if there were *no* changes whatsoever since then, there may still be a brief synchronization period due to areas covered by the Activity Log [106] being rolled back on the new Secondary. This may be mitigated by the use of checksum-based synchronization [7].

You may use this same procedure regardless of whether the resource is a regular DRBD resource, or a stacked resource. For stacked resources, simply add the `-S` or `--stacked` option to `drbdadm`.

Part III. Working with DRBD

Chapter 6. Common administrative tasks

This chapter outlines typical administrative tasks encountered during day-to-day operations. It does not cover troubleshooting tasks, these are covered in detail in Chapter 7, *Troubleshooting and error recovery* [53].

6.1. Checking DRBD status

6.1.1. Retrieving status with `drbd-overview`

The most convenient way to look at DRBD's status is the `drbd-overview` utility.

```
drbd-overview
  0:home                 Connected Primary/Secondary
  UpToDate/UpToDate C r--- /home        xfs  200G 158G 43G  79%
  1:data                 Connected Primary/Secondary
  UpToDate/UpToDate C r--- /mnt/ha1     ext3 9.9G 618M 8.8G 7%
  2:nfs-root             Connected Primary/Secondary
  UpToDate/UpToDate C r--- /mnt/netboot ext3 79G  57G  19G  76%
```

6.1.2. Status information in `/proc/drbd`

`/proc/drbd` is a virtual file displaying real-time status information about all DRBD resources currently configured. You may interrogate this file's contents using this command:

```
cat /proc/drbd
version: 8.3.0 (api:88/proto:86-89)
GIT-hash: 9ba8b93e24d842f0dd3fb1f9b90e8348ddb95829 build by buildsystem@linbit,
 0: cs:Connected ro:Secondary/Secondary ds:UpToDate/UpToDate C r---
    ns:0 nr:8 dw:8 dr:0 al:0 bm:2 lo:0 pe:0 ua:0 ap:0 ep:1 wo:b oos:0
 1: cs:Connected ro:Secondary/Secondary ds:UpToDate/UpToDate C r---
    ns:0 nr:12 dw:12 dr:0 al:0 bm:1 lo:0 pe:0 ua:0 ap:0 ep:1 wo:b oos:0
 2: cs:Connected ro:Secondary/Secondary ds:UpToDate/UpToDate C r---
    ns:0 nr:0 dw:0 dr:0 al:0 bm:0 lo:0 pe:0 ua:0 ap:0 ep:1 wo:b oos:0
```

The first line, prefixed with `version:`, shows the DRBD version used on your system. The second line contains information about this specific build.

The other lines in this example form a block that is repeated for every DRBD device configured, prefixed by the device minor number. In this case, this is `0`, corresponding to the device `/dev/drbd0`.

The resource-specific output from `/proc/drbd` contains various pieces of information about the resource:

`cs` (connection state). Status of the network connection. See Section 6.1.3, "Connection states" [33]for details about the various connection states.

`ro` (roles). Roles of the nodes. The role of the local node is displayed first, followed by the role of the partner node shown after the slash. See Section 6.1.4, "Resource roles"[34]for details about the possible resource roles.

`ds` (disk states). State of the hard disks. Prior to the slash the state of the local node is displayed, after the slash the state of the hard disk of the partner node is shown. See Section 6.1.5, "Disk states" [34]for details about the various disk states.

Replication protocol. Replication protocol used by the resource. Either A, B or C. See Section 2.3, "Replication modes" [5] for details.

I/O Flags. Six state flags reflecting the I/O status of this resource. See Section 6.1.6, "I/O state flags" [35] for a detailed explanation of these flags.

Performance indicators. A number of counters and gauges reflecting the resource's utilization and performance. See Section 6.1.7, "Performance indicators" [35] for details.

6.1.3. Connection states

A resource's connection state can be observed either by monitoring `/proc/drbd`, or by issuing the `drbdadm cstate` command:

```
drbdadm cstate <resource>
Connected
```

A resource may have one of the following connection states:

`StandAlone`. No network configuration available. The resource has not yet been connected, or has been administratively disconnected (using `drbdadm disconnect`), or has dropped its connection due to failed authentication or split brain.

`Disconnecting`. Temporary state during disconnection. The next state is `StandAlone`.

`Unconnected`. Temporary state, prior to a connection attempt. Possible next states: `WFConnection` and `WFReportParams`.

`Timeout`. Temporary state following a timeout in the communication with the peer. Next state: `Unconnected`.

`BrokenPipe`. Temporary state after the connection to the peer was lost. Next state: `Unconnected`.

`NetworkFailure`. Temporary state after the connection to the partner was lost. Next state: `Unconnected`.

`ProtocolError`. Temporary state after the connection to the partner was lost. Next state: `Unconnected`.

`TearDown`. Temporary state. The peer is closing the connection. Next state: `Unconnected`.

`WFConnection`. This node is waiting until the peer node becomes visible on the network.

`WFReportParams`. TCP connection has been established, this node waits for the first network packet from the peer.

`Connected`. A DRBD connection has been established, data mirroring is now active. This is the normal state.

`StartingSyncS`. Full synchronization, initiated by the administrator, is just starting. The next possible states are: `SyncSource` or `PausedSyncS`.

`StartingSyncT`. Full synchronization, initiated by the administrator, is just starting. Next state: `WFSyncUUID`.

`WFBitMapS`. Partial synchronization is just starting. Next possible states: `SyncSource` or `PausedSyncS`.

`WFBitMapT`. Partial synchronization is just starting. Next possible state: `WFSyncUUID`.

`WFSyncUUID`. Synchronization is about to begin. Next possible states: `SyncTarget` or `PausedSyncT`.

SyncSource. Synchronization is currently running, with the local node being the source of synchronization.

SyncTarget. Synchronization is currently running, with the local node being the target of synchronization.

PausedSyncS. The local node is the source of an ongoing synchronization, but synchronization is currently paused. This may be due to a dependency on the completion of another synchronization process, or due to synchronization having been manually interrupted by `drbdadm pause-sync`.

PausedSyncT. The local node is the target of an ongoing synchronization, but synchronization is currently paused. This may be due to a dependency on the completion of another synchronization process, or due to synchronization having been manually interrupted by `drbdadm pause-sync`.

VerifyS. On-line device verification is currently running, with the local node being the source of verification.

VerifyT. On-line device verification is currently running, with the local node being the target of verification.

6.1.4. Resource roles

A resource's role can be observed either by monitoring `/proc/drbd`, or by issuing the `drbdadm role` command:

```
`drbdadm role <resource>`
Primary/Secondary
```

The local resource role is always displayed first, the remote resource role last.

You may see one of the following resource roles:

Primary. The resource is currently in the primary role, and may be read from and written to. This role only occurs on one of the two nodes, unless dual-primary mode [5] is enabled.

Secondary. The resource is currently in the secondary role. It normally receives updates from its peer (unless running in disconnected mode), but may neither be read from nor written to. This role may occur on one or both nodes.

Unknown. The resource's role is currently unknown. The local resource role never has this status. It is only displayed for the peer's resource role, and only in disconnected mode.

6.1.5. Disk states

A resource's disk state can be observed either by monitoring `/proc/drbd`, or by issuing the `drbdadm dstate` command:

```
drbdadm dstate <resource>
UpToDate/UpToDate
```

The local disk state is always displayed first, the remote disk state last.

Both the local and the remote disk state may be one of the following:

Diskless. No local block device has been assigned to the DRBD driver. This may mean that the resource has never attached to its backing device, that it has been manually detached using `drbdadm detach`, or that it automatically detached after a lower-level I/O error.

Attaching. Transient state while reading meta data.

`Failed`. Transient state following an I/O failure report by the local block device. Next state: `Diskless`.

`Negotiating`. Transient state when an `Attach` is carried out on an already-`Connected` DRBD device.

`Inconsistent`. The data is inconsistent. This status occurs immediately upon creation of a new resource, on both nodes (before the initial full sync). Also, this status is found in one node (the synchronization target) during synchronization.

`Outdated`. Resource data is consistent, but outdated [10].

`DUnknown`. This state is used for the peer disk if no network connection is available.

`Consistent`. Consistent data of a node without connection. When the connection is established, it is decided whether the data is `UpToDate` or `Outdated`.

`UpToDate`. Consistent, up-to-date state of the data. This is the normal state.

6.1.6. I/O state flags

The I/O state flag field in `/proc/drbd` contains information about the current state of I/O operations associated with the resource. There are six such flags in total, with the following possible values:

1. I/O suspension. Either `r` for *running* or `s` for *suspended* I/O. Normally `r`.
2. Serial resynchronization. When a resource is awaiting resynchronization, but has deferred this because of a `resync-after` dependency, this flag becomes `a`. Normally `-`.
3. Peer-initiated sync suspension. When resource is awaiting resynchronization, but the peer node has suspended it for any reason, this flag becomes `p`. Normally `-`.
4. Locally initiated sync suspension. When resource is awaiting resynchronization, but a user on the local node has suspended it, this flag becomes `u`. Normally `-`.
5. Locally blocked I/O. Normally `-`. May be one of the following flags:
   - `d`: I/O blocked for a reason internal to DRBD, such as a transient disk state.
   - `b`: Backing device I/O is blocking.
   - `n`: Congestion on the network socket.
   - `a`: Simultaneous combination of blocking device I/O and network congestion.
6. Activity Log update suspension. When updates to the Activity Log are suspended, this flag becomes `s`. Normally `-`.

6.1.7. Performance indicators

The second line of `/proc/drbd` information for each resource contains the following counters and gauges:

`ns` (network send). Volume of net data sent to the partner via the network connection; in Kibyte.

`nr` (network receive). Volume of net data received by the partner via the network connection; in Kibyte.

`dw` (disk write). Net data written on local hard disk; in Kibyte.

dr (disk read). Net data read from local hard disk; in Kibyte.

al (activity log). Number of updates of the activity log area of the meta data.

bm (bit map). Number of updates of the bitmap area of the meta data.

lo (local count). Number of open requests to the local I/O sub-system issued by DRBD.

pe (pending). Number of requests sent to the partner, but that have not yet been answered by the latter.

ua (unacknowledged). Number of requests received by the partner via the network connection, but that have not yet been answered.

ap (application pending). Number of block I/O requests forwarded to DRBD, but not yet answered by DRBD.

ep (epochs). Number of epoch objects. Usually 1. Might increase under I/O load when using either the `barrier` or the `none` write ordering method.

wo (write order). Currently used write ordering method: `b`(barrier), `f`(flush), `d`(drain) or `n`(none).

oos (out of sync). Amount of storage currently out of sync; in Kibibytes.

6.2. Enabling and disabling resources

6.2.1. Enabling resources

Normally, all configured DRBD resources are automatically enabled

- by a cluster resource management application at its discretion, based on your cluster configuration, or
- by the `/etc/init.d/drbd` init script on system startup.

If, however, you need to enable resources manually for any reason, you may do so by issuing the command

```
drbdadm up <resource>
```

As always, you may use the keyword `all` instead of a specific resource name if you want to enable all resources configured in `/etc/drbd.conf` at once.

6.2.2. Disabling resources

You may temporarily disable specific resources by issuing the command

```
drbdadm down <resource>
```

Here, too, you may use the keyword `all` in place of a resource name if you wish to temporarily disable all resources listed in `/etc/drbd.conf` at once.

6.3. Reconfiguring resources

DRBD allows you to reconfigure resources while they are operational. To that end,

- make any necessary changes to the resource configuration in `/etc/drbd.conf`,

- synchronize your `/etc/drbd.conf` file between both nodes,
- issue the `drbdadm adjust <resource>` command on both nodes.

`drbdadm adjust` then hands off to `drbdsetup` to make the necessary adjustments to the configuration. As always, you are able to review the pending `drbdsetup` invocations by running `drbdadm` with the `-d` (dry-run) option.

Note

When making changes to the `common` section in `/etc/drbd.conf`, you can adjust the configuration for all resources in one run, by issuing `drbdadm adjust all`.

6.4. Promoting and demoting resources

Manually switching a resource's role [3] from secondary to primary (promotion) or vice versa (demotion) is done using the following commands:

```
drbdadm primary <resource>
drbdadm secondary <resource>
```

In single-primary mode [5] (DRBD's default), any resource can be in the primary role on only one node at any given time while the connection state [33] is `Connected`. Thus, issuing `drbdadm primary <resource>` on one node while *<resource>* is still in the primary role on the peer will result in an error.

A resource configured to allow dual-primary mode [5] can be switched to the primary role on both nodes.

6.5. Enabling dual-primary mode

Dual-primary mode allows a resource to assume the primary role simultaneously on both nodes. Doing so is possible on either a permanent or a temporary basis.

Note

Dual-primary mode requires that the resource is configured to replicate synchronously (protocol C).

6.5.1. Permanent dual-primary mode

To enable dual-primary mode, set the `allow-two-primaries` option to `yes` in the `net` section of your resource configuration:

```
resource <resource>
  net {
    protocol C;
    allow-two-primaries yes;
  }
  ...
}
```

After that, do not forget to synchronize the configuration between nodes. Run `drbdadm adjust <resource>` on both nodes.

You can now change both nodes to role primary at the same time with `drbdadm primary <resource>`.

6.5.2. Temporary dual-primary mode

To temporarily enable dual-primary mode for a resource normally running in a single-primary configuration, issue the following command:

```
drbdadm net-options --protocol=C --allow-two-primaries <resource>
```

To end temporary dual-primary mode, run the same command as above but with `--allow-two-primaries=no` (and your desired replication protocol, if applicable).

6.5.3. Automating promotion on system startup

When a resource is configured to support dual-primary mode, it may also be desirable to automatically switch the resource into the primary role upon system (or DRBD) startup.

```
resource <resource>
  startup {
    become-primary-on both;
  }
  ...
}
```

The `/etc/init.d/drbd` system init script parses this option on startup and promotes resources accordingly.

Note

The `become-primary-on` approach is not required, nor recommended, in Pacemaker-managed [58] DRBD configurations. In Pacemaker configuration, resource promotion and demotion should always be handled by the cluster manager.

6.6. Using on-line device verification

6.6.1. Enabling on-line verification

On-line device verification [7] is not enabled for resources by default. To enable it, add the following lines to your resource configuration in `/etc/drbd.conf`:

```
resource <resource>
  net {
    verify-alg <algorithm>;
  }
  ...
}
```

<algorithm> may be any message digest algorithm supported by the kernel crypto API in your system's kernel configuration. Normally, you should be able to choose at least from `sha1`, `md5`, and `crc32c`.

If you make this change to an existing resource, as always, synchronize your `drbd.conf` to the peer, and run `drbdadm adjust <resource>` on both nodes.

6.6.2. Invoking on-line verification

After you have enabled on-line verification, you will be able to initiate a verification run using the following command:

```
drbdadm verify <resource>
```

When you do so, DRBD starts an online verification run for *<resource>*, and if it detects any blocks not in sync, will mark those blocks as such and write a message to the kernel log. Any applications using the device at that time can continue to do so unimpeded, and you may also switch resource roles [37] at will.

If out-of-sync blocks were detected during the verification run, you may resynchronize them using the following commands after verification has completed:

```
drbdadm disconnect <resource>
drbdadm connect <resource>
```

6.6.3. Automating on-line verification

Most users will want to automate on-line device verification. This can be easily accomplished. Create a file with the following contents, named `/etc/cron.d/drbd-verify` on *one* of your nodes:

```
42 0 * * 0    root    /sbin/drbdadm verify <resource>
```

This will have `cron` invoke a device verification every Sunday at 42 minutes past midnight.

If you have enabled on-line verification for all your resources (for example, by adding `verify-alg <algorithm>` to the `common` section in `/etc/drbd.conf`), you may also use:

```
42 0 * * 0    root    /sbin/drbdadm verify all
```

6.7. Configuring the rate of synchronization

Normally, one tries to ensure that background synchronization (which makes the data on the synchronization target temporarily inconsistent) completes as quickly as possible. However, it is also necessary to keep background synchronization from hogging all bandwidth otherwise available for foreground replication, which would be detrimental to application performance. Thus, you must configure the sychronization bandwidth to match your hardware — which you may do in a permanent fashion or on-the-fly.

Important

It does not make sense to set a synchronization rate that is higher than the maximum write throughput on your secondary node. You must not expect your secondary node to miraculously be able to write faster than its I/O subsystem allows, just because it happens to be the target of an ongoing device synchronization.

Likewise, and for the same reasons, it does not make sense to set a synchronization rate that is higher than the bandwidth available on the replication network.

6.7.1. Permanent fixed sync rate configuration

The maximum bandwidth a resource uses for background re-synchronization is determined by the `rate` option for a resource. This must be included in the resource configuration's `disk` section in `/etc/drbd.conf`:

```
resource <resource>
  disk {
    sync-rate 40M;
    ...
  }
  ...
```

```
}
```

Note that the rate setting is given in *bytes*, not *bits* per second.

Tip

A good rule of thumb for this value is to use about 30% of the available replication bandwidth. Thus, if you had an I/O subsystem capable of sustaining write throughput of 180MB/s, and a Gigabit Ethernet network capable of sustaining 110 MB/s network throughput (the network being the bottleneck), you would calculate:

Figure 6.1. Syncer rate example, 110MB/s effective available bandwidth

$$110 \pounds\ 0{:}3 = 33\ \mathrm{MB{=}s}$$

Thus, the recommended value for the `rate` option would be `33M`.

By contrast, if you had an I/O subsystem with a maximum throughput of 80MB/s and a Gigabit Ethernet connection (the I/O subsystem being the bottleneck), you would calculate:

Figure 6.2. Syncer rate example, 80MB/s effective available bandwidth

$$80 \pounds\ 0{:}3 = 24\ \mathrm{MB{=}s}$$

In this case, the recommended value for the `rate` option would be `24M`.

6.7.2. Temporary fixed sync rate configuration

It is sometimes desirable to temporarily adjust the sync rate. For example, you might want to speed up background re-synchronization after having performed scheduled maintenance on one of your cluster nodes. Or, you might want to throttle background re-synchronization if it happens to occur at a time when your application is extremely busy with write operations, and you want to make sure that a large portion of the existing bandwidth is available to replication.

For example, in order to make most bandwidth of a Gigabit Ethernet link available to re-synchronization, issue the following command:

```
drbdadm disk-options --resync-rate=110M <resource>
```

You need to issue this command on only one of the nodes.

To revert this temporary setting and re-enable the synchronization rate set in `/etc/drbd.conf`, issue this command:

```
drbdadm adjust <resource>
```

6.7.3. Variable sync rate configuration

Specifically in configurations where multiple DRBD resources share a single replication/synchronization network, fixed-rate synchronization may not be an optimal approach. In this case, you should configure variable-rate synchronization. In this mode, DRBD uses an automated control loop algorithm to determine, and permanently adjust, the synchronization rate. This algorithm ensures that there is always sufficient bandwidth available for foreground replication, greatly mitigating the impact that background synchronization has on foreground I/O.

The optimal configuration for variable-rate synchronization may vary greatly depending on the available network bandwidth, application I/O pattern and link congestion. Ideal configuration settings also depend on whether DRBD Proxy [11] is in use or not. It may be wise to

engage professional consultancy in order to optimally configure this DRBD feature. An *example* configuration (which assumes a deployment in conjunction with DRBD Proxy) is provided below:

```
resource <resource> {
  net {
    c-plan-ahead 200;
    c-max-rate 10M;
    c-fill-target 15M;
  }
}
```

Tip

A good starting value for `c-fill-target` is *BDP×3*, where BDP is your bandwidth delay product on the replication link.

6.8. Configuring checksum-based synchronization

Checksum-based synchronization [7] is not enabled for resources by default. To enable it, add the following lines to your resource configuration in `/etc/drbd.conf`:

```
resource <resource>
  net {
    csums-alg <algorithm>;
  }
  ...
}
```

<algorithm> may be any message digest algorithm supported by the kernel crypto API in your system's kernel configuration. Normally, you should be able to choose at least from `sha1`, `md5`, and `crc32c`.

If you make this change to an existing resource, as always, synchronize your `drbd.conf` to the peer, and run `drbdadm adjust <resource>` on both nodes.

6.9. Configuring congestion policies and suspended replication

In an environment where the replication bandwidth is highly variable (as would be typical in WAN replication setups), the replication link may occasionally become congested. In a default configuration, this would cause I/O on the primary node to block, which is sometimes undesirable.

Instead, you may configure DRBD to *suspend* the ongoing replication in this case, causing the Primary's data set to *pull ahead* of the Secondary. In this mode, DRBD keeps the replication channel open — it never switches to disconnected mode — but does not actually replicate until sufficient bandwith becomes available again.

The following example is for a DRBD Proxy configuration:

```
resource <resource> {
  net {
    on-congestion pull-ahead;
    congestion-fill 2G;
    congestion-extents 2000;
    ...
```

```
  }
  ...
}
```

It is usually wise to set both `congestion-fill` and `congestion-extents` together with the `pull-ahead` option.

A good value for `congestion-fill` is 90%

- of the allocated DRBD proxy buffer memory, when replicating over DRBD Proxy, or
- of the TCP network send buffer, in non-DRBD Proxy setups.

A good value for `congestion-extents` is 90% of your configured `al-extents` for the affected resources.

6.10. Configuring I/O error handling strategies

DRBD's strategy for handling lower-level I/O errors [10] is determined by the `on-io-error` option, included in the resource `disk` configuration in `/etc/drbd.conf`:

```
resource <resource> {
  disk {
    on-io-error <strategy>;
    ...
  }
  ...
}
```

You may, of course, set this in the `common` section too, if you want to define a global I/O error handling policy for all resources.

<strategy> may be one of the following options:

1. `detach` This is the default and recommended option. On the occurrence of a lower-level I/O error, the node drops its backing device, and continues in diskless mode.
2. `pass_on` This causes DRBD to report the I/O error to the upper layers. On the primary node, it is reported to the mounted file system. On the secondary node, it is ignored (because the secondary has no upper layer to report to).
3. `call-local-io-error` Invokes the command defined as the local I/O error handler. This requires that a corresponding `+local-io-error` command invocation is defined in the resource's `handlers` section. It is entirely left to the administrator's discretion to implement I/O error handling using the command (or script) invoked by `local-io-error`.

Note

Early DRBD versions (prior to 8.0) included another option, `panic`, which would forcibly remove the node from the cluster by way of a kernel panic, whenever a local I/O error occurred. While that option is no longer available, the same behavior may be mimicked via the `local-io-error`/+ call-local-io-error+ interface. You should do so only if you fully understand the implications of such behavior.

You may reconfigure a running resource's I/O error handling strategy by following this process:

- Edit the resource configuration in `/etc/drbd.d/<resource>.res`.
- Copy the configuration to the peer node.

- Issue `drbdadm adjust <resource>` on both nodes.

6.11. Configuring replication traffic integrity checking

Replication traffic integrity checking [8] is not enabled for resources by default. To enable it, add the following lines to your resource configuration in `/etc/drbd.conf`:

```
resource <resource>
  net {
    data-integrity-alg <algorithm>;
  }
  ...
}
```

<algorithm> may be any message digest algorithm supported by the kernel crypto API in your system's kernel configuration. Normally, you should be able to choose at least from `sha1`, `md5`, and `crc32c`.

If you make this change to an existing resource, as always, synchronize your `drbd.conf` to the peer, and run `drbdadm adjust <resource>` on both nodes.

6.12. Resizing resources

6.12.1. Growing on-line

If the backing block devices can be grown while in operation (online), it is also possible to increase the size of a DRBD device based on these devices during operation. To do so, two criteria must be fulfilled:

1. The affected resource's backing device must be one managed by a logical volume management subsystem, such as LVM.

2. The resource must currently be in the `Connected` connection state.

Having grown the backing block devices on both nodes, ensure that only one node is in primary state. Then enter on one node:

```
drbdadm resize <resource>
```

This triggers a synchronization of the new section. The synchronization is done from the primary node to the secondary node.

6.12.2. Growing off-line

When the backing block devices on both nodes are grown while DRBD is inactive, and the DRBD resource is using external meta data [102], then the new size is recognized automatically. No administrative intervention is necessary. The DRBD device will have the new size after the next activation of DRBD on both nodes and a successful establishment of a network connection.

If however the DRBD resource is configured to use internal meta data [101], then this meta data must be moved to the end of the grown device before the new size becomes available. To do so, complete the following steps:

Warning

This is an advanced procedure. Use at your own discretion.

- Unconfigure your DRBD resource:

```
drbdadm down <resource>
```

- Save the meta data in a text file prior to shrinking:

```
drbdadm dump-md <resource> > /tmp/metadata
```

You must do this on both nodes, using a separate dump file for every node. *Do not* dump the meta data on one node, and simply copy the dump file to the peer. This will not work.

- Grow the backing block device on both nodes.
- Adjust the size information (`la-size-sect`) in the file `/tmp/metadata` accordingly, on both nodes. Remember that `la-size-sect` must be specified in sectors.
- Re-initialize the metadata area:

```
drbdadm create-md <resource>
```

- Re-import the corrected meta data, on both nodes:

```
drbdmeta_cmd=$(drbdadm -d dump-md test-disk)
${drbdmeta_cmd/dump-md/restore-md} /tmp/metadata
Valid meta-data in place, overwrite? [need to type 'yes' to confirm]
yes
Successfully restored meta data
```

Note

This example uses `bash` parameter substitution. It may or may not work in other shells. Check your `SHELL` environment variable if you are unsure which shell you are currently using.

- Re-enable your DRBD resource:

```
drbdadm up <resource>
```

- On one node, promote the DRBD resource:

```
drbdadm primary <resource>
```

- Finally, grow the file system so it fills the extended size of the DRBD device.

6.12.3. Shrinking on-line

Before shrinking a DRBD device, you *must* shrink the layers above DRBD, i.e. usually the file system. Since DRBD cannot ask the file system how much space it actually uses, you have to be careful in order not to cause data loss.

Note

Whether or not the *filesystem* can be shrunk on-line depends on the filesystem being used. Most filesystems do not support on-line shrinking. XFS does not support shrinking at all.

When using internal meta data, make sure to consider the space required by the meta data. The size communicated to `drbdadm resize` is the net size for the file system. In the case of internal meta data, the gross size required by DRBD is higher (see also Section 17.1.3, “Estimating meta data size” [102]).

To shrink DRBD on-line, issue the following command *after* you have shrunk the file system residing on top of it:

```
drbdadm resize --size=<new-size> <resource>
```

You may use the usual multiplier suffixes for *<new-size>* (K, M, G etc.). After you have shrunk DRBD, you may also shrink the containing block device (if it supports shrinking).

6.12.4. Shrinking off-line

If you were to shrink a backing block device while DRBD is inactive, DRBD would refuse to attach to this block device during the next attach attempt, since it is now too small (in case external meta data is used), or it would be unable to find its meta data (in case internal meta data is used). To work around these issues, use this procedure (if you cannot use on-line shrinking [44]):

Warning

This is an advanced procedure. Use at your own discretion.

- Shrink the file system from one node, while DRBD is still configured.
- Unconfigure your DRBD resource:

```
drbdadm down <resource>
```

- Save the meta data in a text file prior to shrinking:

```
drbdadm dump-md <resource> > +/tmp/metadata+
```

You must do this on both nodes, using a separate dump file for every node. *Do not* dump the meta data on one node, and simply copy the dump file to the peer. This will not work.

- Shrink the backing block device on both nodes.
- Adjust the size information (`la-size-sect`) in the file `/tmp/metadata` accordingly, on both nodes. Remember that `la-size-sect` must be specified in sectors.
- *Only if you are using internal metadata* (which at this time have probably been lost due to the shrinking process), re-initialize the metadata area:

```
drbdadm create-md <resource>
```

- Re-import the corrected meta data, on both nodes:

```
drbdmeta_cmd=$(drbdadm -d dump-md test-disk)
${drbdmeta_cmd/dump-md/restore-md} /tmp/metadata
Valid meta-data in place, overwrite? [need to type 'yes' to confirm]
yes
Successfully restored meta data
```

Note

This example uses `bash` parameter substitution. It may or may not work in other shells. Check your `SHELL` environment variable if you are unsure which shell you are currently using.

- Re-enable your DRBD resource:

```
drbdadm up <resource>
```

6.13. Disabling backing device flushes

Caution

You should only disable device flushes when running DRBD on devices with a battery-backed write cache (BBWC). Most storage controllers allow to automatically disable the write cache when the battery is depleted, switching to write-through mode when the battery dies. It is strongly recommended to enable such a feature.

Disabling DRBD's flushes when running without BBWC, or on BBWC with a depleted battery, is *likely to cause data loss* and should not be attempted.

DRBD allows you to enable and disable backing device flushes [9] separately for the replicated data set and DRBD's own meta data. Both of these options are enabled by default. If you wish to disable either (or both), you would set this in the `disk` section for the DRBD configuration file, `/etc/drbd.conf`.

To disable disk flushes for the replicated data set, include the following line in your configuration:

```
resource <resource>
  disk {
    disk-flushes no;
    ...
  }
  ...
}
```

To disable disk flushes on DRBD's meta data, include the following line:

```
resource <resource>
  disk {
    md-flushes no;
    ...
  }
  ...
}
```

After you have modified your resource configuration (and synchronized your `/etc/drbd.conf` between nodes, of course), you may enable these settings by issuing this command on both nodes:

```
drbdadm adjust <resource>
```

6.14. Configuring split brain behavior

6.14.1. Split brain notification

DRBD invokes the `split-brain` handler, if configured, at any time split brain is *detected*. To configure this handler, add the following item to your resource configuration:

```
resource <resource>
  handlers {
    split-brain <handler>;
    ...
  }
  ...
}
```

<handler> may be any executable present on the system.

The DRBD distribution contains a split brain handler script that installs as `/usr/lib/drbd/notify-split-brain.sh`. It simply sends a notification e-mail message to a specified address. To configure the handler to send a message to `root@localhost` (which is expected to be an email address that forwards the notification to a real system administrator), configure the +split-brain handler+as follows:

```
resource <resource>
  handlers {
    split-brain "/usr/lib/drbd/notify-split-brain.sh root";
    ...
  }
  ...
}
```

After you have made this modification on a running resource (and synchronized the configuration file between nodes), no additional intervention is needed to enable the handler. DRBD will simply invoke the newly-configured handler on the next occurrence of split brain.

6.14.2. Automatic split brain recovery policies

In order to be able to enable and configure DRBD's automatic split brain recovery policies, you must understand that DRBD offers several configuration options for this purpose. DRBD applies its split brain recovery procedures based on the number of nodes in the Primary role at the time the split brain is detected. To that end, DRBD examines the following keywords, all found in the resource's `net` configuration section:

`after-sb-0pri`. Split brain has just been detected, but at this time the resource is not in the Primary role on any host. For this option, DRBD understands the following keywords:

- `disconnect`: Do not recover automatically, simply invoke the `split-brain` handler script (if configured), drop the connection and continue in disconnected mode.
- `discard-younger-primary`: Discard and roll back the modifications made on the host which assumed the Primary role last.
- `discard-least-changes`: Discard and roll back the modifications on the host where fewer changes occurred.
- `discard-zero-changes`: If there is any host on which no changes occurred at all, simply apply all modifications made on the other and continue.

`after-sb-1pri`. Split brain has just been detected, and at this time the resource is in the Primary role on one host. For this option, DRBD understands the following keywords:

- `disconnect`: As with `after-sb-0pri`, simply invoke the `split-brain` handler script (if configured), drop the connection and continue in disconnected mode.
- `consensus`: Apply the same recovery policies as specified in `after-sb-0pri`. If a split brain victim can be selected after applying these policies, automatically resolve. Otherwise, behave exactly as if `disconnect` were specified.
- `call-pri-lost-after-sb`: Apply the recovery policies as specified in `after-sb-0pri`. If a split brain victim can be selected after applying these policies, invoke the `pri-lost-after-sb` handler on the victim node. This handler must be configured in the `handlers` section and is expected to forcibly remove the node from the cluster.
- `discard-secondary`: Whichever host is currently in the Secondary role, make that host the split brain victim.

`after-sb-2pri`. Split brain has just been detected, and at this time the resource is in the Primary role on both hosts. This option accepts the same keywords as `after-sb-1pri` except `discard-secondary` and `consensus`.

Note

DRBD understands additional keywords for these three options, which have been omitted here because they are very rarely used. Refer to drbd.conf(5) [119] for details on split brain recovery keywords not discussed here.

For example, a resource which serves as the block device for a GFS or OCFS2 file system in dual-Primary mode may have its recovery policy defined as follows:

```
resource <resource> {
  handlers {
    split-brain "/usr/lib/drbd/notify-split-brain.sh root"
    ...
  }
  net {
    after-sb-0pri discard-zero-changes;
    after-sb-1pri discard-secondary;
    after-sb-2pri disconnect;
    ...
  }
  ...
}
```

6.15. Creating a three-node setup

A three-node setup involves one DRBD device *stacked* atop another.

6.15.1. Device stacking considerations

The following considerations apply to this type of setup:

- The stacked device is the active one. Assume you have configured one DRBD device `/dev/drbd0`, and the stacked device atop it is `/dev/drbd10`, then `/dev/drbd10` will be the device that you mount and use.
- Device meta data will be stored twice, on the underlying DRBD device *and* the stacked DRBD device. On the stacked device, you must always use internal meta data [101]. This means that the effectively available storage area on a stacked device is slightly smaller, compared to an unstacked device.
- To get the stacked upper level device running, the underlying device must be in the primary role.
- To be able to synchronize the backup node, the stacked device on the active node must be up and in the primary role.

6.15.2. Configuring a stacked resource

In the following example, nodes are named `alice`, `bob`, and `charlie`, with `alice` and `bob` forming a two-node cluster, and `charlie` being the backup node.

```
resource r0 {
  net {
    protocol C;
```

```
  }

  on alice {
    device     /dev/drbd0;
    disk       /dev/sda6;
    address    10.0.0.1:7788;
    meta-disk internal;
  }

  on bob {
    device    /dev/drbd0;
    disk      /dev/sda6;
    address   10.0.0.2:7788;
    meta-disk internal;
  }
}

resource r0-U {
  net {
    protocol A;
  }

  stacked-on-top-of r0 {
    device     /dev/drbd10;
    address    192.168.42.1:7788;
  }

  on charlie {
    device     /dev/drbd10;
    disk       /dev/hda6;
    address    192.168.42.2:7788; # Public IP of the backup node
    meta-disk  internal;
  }
}
```

As with any `drbd.conf` configuration file, this must be distributed across all nodes in the cluster — in this case, three nodes. Notice the following extra keyword not found in an unstacked resource configuration:

`stacked-on-top-of`. This option informs DRBD that the resource which contains it is a stacked resource. It replaces one of the `on` sections normally found in any resource configuration. Do not use `stacked-on-top-of` in an lower-level resource.

Note

It is not a requirement to use Protocol A [5] for stacked resources. You may select any of DRBD's replication protocols depending on your application.

6.15.3. Enabling stacked resources

To enable a stacked resource, you first enable its lower-level resource and promote it:

```
drbdadm up r0
drbdadm primary r0
```

As with unstacked resources, you must create DRBD meta data on the stacked resources. This is done using the following command:

```
drbdadm create-md --stacked r0-U
```

Then, you may enable the stacked resource:

```
drbdadm up --stacked r0-U
drbdadm primary --stacked r0-U
```

After this, you may bring up the resource on the backup node, enabling three-node replication:

```
drbdadm create-md r0-U
drbdadm up r0-U
```

In order to automate stacked resource management, you may integrate stacked resources in your cluster manager configuration. See Section 8.4, "Using stacked DRBD resources in Pacemaker clusters" [61] for information on doing this in a cluster managed by the Pacemaker cluster management framework.

6.16. Using DRBD Proxy

6.16.1. DRBD Proxy deployment considerations

The DRBD Proxy [11] processes can either be located directly on the machines where DRBD is set up, or they can be placed on distinct dedicated servers. A DRBD Proxy instance can serve as a proxy for multiple DRBD devices distributed across multiple nodes.

DRBD Proxy is completely transparent to DRBD. Typically you will expect a high number of data packets in flight, therefore the activity log should be reasonably large. Since this may cause longer re-sync runs after the crash of a primary node, it is recommended to enable DRBD's `csums-alg` setting.

6.16.2. Installation

To obtain DRBD Proxy, please contact your Linbit sales representative. Unless instructed otherwise, please always use the most recent DRBD Proxy release.

To install DRBD Proxy on Debian and Debian-based systems, use the dpkg tool as follows (replace version with your DRBD Proxy version, and architecture with your target architecture):

```
dpkg -i drbd-proxy_1.0.16_i386.deb
```

To install DRBD Proxy on RPM based systems (like SLES or RHEL) use the rpm tool as follows (replace version with your DRBD Proxy version, and architecture with your target architecture):

```
rpm -i drbd-proxy-1.0.16-1.i386.rpm
```

Also install the DRBD administration program drbdadm since it is required to configure DRBD Proxy.

This will install the DRBD proxy binaries as well as an init script which usually goes into `/etc/init.d`. Please always use the init script to start/stop DRBD proxy since it also configures DRBD Proxy using the `drbdadm` tool.

6.16.3. License file

When obtaining a license from Linbit, you will be sent a DRBD Proxy license file which is required to run DRBD Proxy. The file is called `drbd-proxy.license` and must be copied into the `/etc` directory of the target machines.

```
cp drbd-proxy.license /etc
```

6.16.4. Configuration

DRBD Proxy is configured in DRBD's main configuration file. It is configured by an additional options section called `proxy` and additional `proxy on` sections within the host sections.

Below is a DRBD configuration example for proxies running directly on the DRBD nodes:

```
resource r0 {
        net {
          protocol A;
        }
        device     minor 0;
        disk       /dev/sdb1;
        meta-disk  /dev/sdb2;

        proxy {
              compression on;
              memlimit 100M;
        }

        on alice {
                address 127.0.0.1:7789;
                proxy on alice {
                        inside 127.0.0.1:7788;
                        outside 192.168.23.1:7788;
                }
        }

        on bob {
                address 127.0.0.1:7789;
                proxy on bob {
                        inside 127.0.0.1:7788;
                        outside 192.168.23.2:7788;
                }
        }
}
```

The `inside` IP address is used for communication between DRBD and the DRBD Proxy, whereas the `outside` IP address is used for communication between the proxies.

6.16.5. Controlling DRBD Proxy

`drbdadm` offers the `proxy-up` and `proxy-down` subcommands to configure or delete the connection to the local DRBD Proxy process of the named DRBD resource(s). These commands are used by the `start` and `stop` actions which `/etc/init.d/drbdproxy` implements.

The DRBD Proxy has a low level configuration tool, called `drbd-proxy-ctl`. When called without any option it operates in interactive mode. The available commands are displayed by the *help* command.

```
add connection <name> <ip-listen1>:<port> <ip-connect1>:<port>
   <ip-listen2>:<port> <ip-connect2>:<port>
   Creates a communication path between two DRBD instances.

set memlimit <name> <memlimit-in-bytes>
   Sets memlimit for connection <name>

del connection <name>
```

```
   Deletes communication path named name.

show
   Shows currently configured communication paths.

show memusage
   Shows memory usage of each connection.

list [h]subconnections
   Shows currently established individual connections
   together with some stats. With h outputs bytes in human
   readable format.

list [h]connections
   Shows currently configured connections and their states
   With h outputs bytes in human readable format.

list details
   Shows currently established individual connections with
   counters for each DRBD packet type.

quit
   Exits the client program (closes control connection).

shutdown
   Shuts down the drbd-proxy program. Attention: this
   unconditionally terminates any DRBD connections running.
```

6.16.6. Troubleshooting

DRBD proxy logs via syslog using the LOG_DAEMON facility. Usually you will find DRBD Proxy messages in `/var/log/daemon.log`.

For example, if proxy fails to connect it will log something like `Rejecting connection because I can't connect on the other side`. In that case, please check if DRBD is running (not in StandAlone mode) on both nodes and if both proxies are running. Also double-check your configuration.

Chapter 7. Troubleshooting and error recovery

This chapter describes tasks to be performed in the event of hardware or system failures.

7.1. Dealing with hard drive failure

How to deal with hard drive failure depends on the way DRBD is configured to handle disk I/O errors (see Section 2.11, "Disk error handling strategies" [10]), and on the type of meta data configured (see Section 17.1, "DRBD meta data" [101]).

Note

For the most part, the steps described here apply only if you run DRBD directly on top of physical hard drives. They generally do not apply in case you are running DRBD layered on top of

- an MD software RAID set (in this case, use `mdadm` to manage drive replacement),
- device-mapper RAID (use `dmraid`),
- a hardware RAID appliance (follow the vendor's instructions on how to deal with failed drives),
- some non-standard device-mapper virtual block devices (see the device mapper documentation).

7.1.1. Manually detaching DRBD from your hard drive

If DRBD is configured to pass on I/O errors [10] (not recommended), you must first detach the DRBD resource, that is, disassociate it from its backing storage:

```
drbdadm detach <resource>
```

By running the `drbdadm dstate` command, you will now be able to verify that the resource is now in *diskless mode*:

```
drbdadm dstate <resource>
Diskless/UpToDate
```

If the disk failure has occured on your primary node, you may combine this step with a switch-over operation.

7.1.2. Automatic detach on I/O error

If DRBD is configured to automatically detach upon I/O error [10] (the recommended option), DRBD should have automatically detached the resource from its backing storage already, without manual intervention. You may still use the `drbdadm dstate` command to verify that the resource is in fact running in diskless mode.

7.1.3. Replacing a failed disk when using internal meta data

If using internal meta data [101], it is sufficient to bind the DRBD device to the new hard disk. If the new hard disk has to be addressed by another Linux device name than the defective disk, this has to be modified accordingly in the DRBD configuration file.

This process involves creating a new meta data set, then re-attaching the resource:

```
drbdadm create-md <resource>
v08 Magic number not found
Writing meta data...
initialising activity log
NOT initializing bitmap
New drbd meta data block sucessfully created.

drbdadm attach <resource>
```

Full synchronization of the new hard disk starts instantaneously and automatically. You will be able to monitor the synchronization's progress via `/proc/drbd`, as with any background synchronization.

7.1.4. Replacing a failed disk when using external meta data

When using external meta data [102], the procedure is basically the same. However, DRBD is not able to recognize independently that the hard drive was swapped, thus an additional step is required.

```
drbdadm create-md <resource>
v08 Magic number not found
Writing meta data...
initialising activity log
NOT initializing bitmap
New drbd meta data block sucessfully created.

drbdadm attach <resource>
drbdadm invalidate <resource>
```

Here, the `drbdadm invalidate` command triggers synchronization. Again, sync progress may be observed via `/proc/drbd`.

7.2. Dealing with node failure

When DRBD detects that its peer node is down (either by true hardware failure or manual intervention), DRBD changes its connection state from `Connected` to `WFConnection` and waits for the peer node to re-appear. The DRBD resource is then said to operate in *disconnected mode*. In disconnected mode, the resource and its associated block device are fully usable, and may be promoted and demoted as necessary, but no block modifications are being replicated to the peer node. Instead, DRBD stores internal information on which blocks are being modified while disconnected.

7.2.1. Dealing with temporary secondary node failure

If a node that currently has a resource in the secondary role fails temporarily (due to, for example, a memory problem that is subsequently rectified by replacing RAM), no further intervention is necessary — besides the obvious necessity to repair the failed node and bring it back on line. When that happens, the two nodes will simply re-establish connectivity upon system start-up. After this, DRBD replicates all modifications made on the primary node in the meantime, to the secondary node.

Important

At this point, due to the nature of DRBD's re-synchronization algorithm, the resource is briefly inconsistent on the secondary node. During that short time window, the

secondary node can not switch to the Primary role if the peer is unavailable. Thus, the period in which your cluster is not redundant consists of the actual secondary node down time, plus the subsequent re-synchronization.

7.2.2. Dealing with temporary primary node failure

From DRBD's standpoint, failure of the primary node is almost identical to a failure of the secondary node. The surviving node detects the peer node's failure, and switches to disconnected mode. DRBD does *not* promote the surviving node to the primary role; it is the cluster management application's responsibility to do so.

When the failed node is repaired and returns to the cluster, it does so in the secondary role, thus, as outlined in the previous section, no further manual intervention is necessary. Again, DRBD does not change the resource role back, it is up to the cluster manager to do so (if so configured).

DRBD ensures block device consistency in case of a primary node failure by way of a special mechanism. For a detailed discussion, refer to Section 17.3, "The Activity Log" [106].

7.2.3. Dealing with permanent node failure

If a node suffers an unrecoverable problem or permanent destruction, you must follow the following steps:

- Replace the failed hardware with one with similar performance and disk capacity.

Note

Replacing a failed node with one with worse performance characteristics is possible, but not recommended. Replacing a failed node with one with less disk capacity is not supported, and will cause DRBD to refuse to connect to the replaced node.

- Install the base system and applications.
- Install DRBD and copy `/etc/drbd.conf` and all of `/etc/drbd.d/` from the surviving node.
- Follow the steps outlined in Chapter 5, *Configuring DRBD* [25], but stop short of Section 5.5, "The initial device synchronization" [29].

Manually starting a full device synchronization is not necessary at this point, it will commence automatically upon connection to the surviving primary node.

7.3. Manual split brain recovery

DRBD detects split brain at the time connectivity becomes available again and the peer nodes exchange the initial DRBD protocol handshake. If DRBD detects that both nodes are (or were at some point, while disconnected) in the primary role, it immediately tears down the replication connection. The tell-tale sign of this is a message like the following appearing in the system log:

```
Split-Brain detected, dropping connection!
```

After split brain has been detected, one node will always have the resource in a `StandAlone` connection state. The other might either also be in the `StandAlone` state (if both nodes detected the split brain simultaneously), or in `WFConnection` (if the peer tore down the connection before the other node had a chance to detect split brain).

At this point, unless you configured DRBD to automatically recover from split brain, you must manually intervene by selecting one node whose modifications will be discarded (this node is referred to as the *split brain victim*). This intervention is made with the following commands:

```
drbdadm secondary <resource>
drbdadm connect --discard-my-data <resource>
```

On the other node (the *split brain survivor*), if its connection state is also `StandAlone`, you would enter:

```
drbdadm connect <resource>
```

You may omit this step if the node is already in the `WFConnection` state; it will then reconnect automatically.

If the resource affected by the split brain is a stacked resource [48], use `drbdadm --stacked` instead of just `drbdadm`.

Upon connection, your split brain victim immediately changes its connection state to `SyncTarget`, and has its modifications overwritten by the remaining primary node.

Note

The split brain victim is not subjected to a full device synchronization. Instead, it has its local modifications rolled back, and any modifications made on the split brain survivor propagate to the victim.

After re-synchronization has completed, the split brain is considered resolved and the two nodes form a fully consistent, redundant replicated storage system again.

Part IV. DRBD-enabled applications

Chapter 8. Integrating DRBD with Pacemaker clusters

Using DRBD in conjunction with the Pacemaker cluster stack is arguably DRBD's most frequently found use case. Pacemaker is also one of the applications that make DRBD extremely powerful in a wide variety of usage scenarios.

8.1. Pacemaker primer

Pacemaker is a sophisticated, feature-rich, and widely deployed cluster resource manager for the Linux platform. It comes with a rich set of documentation. In order to understand this chapter, reading the following documents is highly recommended:

- Clusters From Scratch [http://www.clusterlabs.org/doc/Cluster_from_Scratch.pdf], a step-by-step guide to configuring high availability clusters;
- CRM CLI (command line interface) tool [http://www.clusterlabs.org/doc/crm_cli.html], a manual for the CRM shell, a simple and intuitive command line interface bundled with Pacemaker;
- Pacemaker Configuration Explained [http://www.clusterlabs.org/doc/en-US/Pacemaker/1.0/html/Pacemaker_Explained/s-intro-pacemaker.html], a reference document explaining the concept and design behind Pacemaker.

8.2. Adding a DRBD-backed service to the cluster configuration

This section explains how to enable a DRBD-backed service in a Pacemaker cluster.

Note

If you are employing the DRBD OCF resource agent, it is recommended that you defer DRBD startup, shutdown, promotion, and demotion *exclusively* to the OCF resource agent. That means that you should disable the DRBD init script:

```
chkconfig drbd off
```

The `ocf:linbit:drbd` OCF resource agent provides Master/Slave capability, allowing Pacemaker to start and monitor the DRBD resource on multiple nodes and promoting and demoting as needed. You must, however, understand that the `drbd` RA disconnects and detaches all DRBD resources it manages on Pacemaker shutdown, and also upon enabling standby mode for a node.

Important

The OCF resource agent which ships with DRBD belongs to the `linbit` provider, and hence installs as `/usr/lib/ocf/resource.d/linbit/drbd`. There is a legacy resource agent that ships as part of the OCF resource agents package, which uses the `heartbeat` provider and installs into `/usr/lib/ocf/resource.d/heartbeat/drbd`. The legacy OCF RA is deprecated and should no longer be used.

In order to enable a DRBD-backed configuration for a MySQL database in a Pacemaker CRM cluster with the `drbd` OCF resource agent, you must create both the necessary resources,

and Pacemaker constraints to ensure your service only starts on a previously promoted DRBD resource. You may do so using the `crm` shell, as outlined in the following example:

Pacemaker configuration for DRBD-backed MySQL service.

```
crm configure
crm(live)configure# primitive drbd_mysql ocf:linbit:drbd \
                    params drbd_resource="mysql" \
                    op monitor interval="15s"
crm(live)configure# ms ms_drbd_mysql drbd_mysql \
                    meta master-max="1" master-node-max="1" \
                         clone-max="2" clone-node-max="1" \
                         notify="true"
crm(live)configure# primitive fs_mysql ocf:heartbeat:Filesystem \
                    params device="/dev/drbd/by-res/mysql" \
                      directory="/var/lib/mysql" fstype="ext3"
crm(live)configure# primitive ip_mysql ocf:heartbeat:IPaddr2 \
                    params ip="10.9.42.1" nic="eth0"
crm(live)configure# primitive mysqld lsb:mysqld
crm(live)configure# group mysql fs_mysql ip_mysql mysqld
crm(live)configure# colocation mysql_on_drbd \
                      inf: mysql ms_drbd_mysql:Master
crm(live)configure# order mysql_after_drbd \
                      inf: ms_drbd_mysql:promote mysql:start
crm(live)configure# commit
crm(live)configure# exit
bye
```

After this, your configuration should be enabled. Pacemaker now selects a node on which it promotes the DRBD resource, and then starts the DRBD-backed resource group on that same node.

8.3. Using resource-level fencing in Pacemaker clusters

This section outlines the steps necessary to prevent Pacemaker from promoting a `drbd` Master/Slave resource when its DRBD replication link has been interrupted. This keeps Pacemaker from starting a service with outdated data and causing an unwanted "time warp" in the process.

In order to enable any resource-level fencing for DRBD, you must add the following lines to your resource configuration:

```
resource <resource> {
  disk {
    fencing resource-only;
    ...
  }
}
```

You will also have to make changes to the `handlers` section depending on the cluster infrastructure being used:

- Heartbeat-based Pacemaker clusters can employ the configuration outlined in Section 8.3.1, “Resource-level fencing with `dopd`” [60].
- Both Corosync- and Heartbeat-based clusters can use the functionality explained in Section 8.3.2, “Resource-level fencing using the Cluster Information Base (CIB)” [61].

Important

It is absolutely vital to configure at least two independent cluster communications channels for this functionality to work correctly. Heartbeat-based Pacemaker clusters should define at least two cluster communication links in their `ha.cf` configuration files. Corosync clusters should list at least two redundant rings in `corosync.conf`.

8.3.1. Resource-level fencing with dopd

In Heartbeat-based Pacemaker clusters, DRBD can use a resources-level fencing facility named the *DRBD outdate-peer daemon*, or `dopd` for short.

8.3.1.1. Heartbeat configuration for dopd

To enable dopd, you must add these lines to your `/etc/ha.d/ha.cf` file:

```
respawn hacluster /usr/lib/heartbeat/dopd
apiauth dopd gid=haclient uid=hacluster
```

You may have to adjust `dopd`'s path according to your preferred distribution. On some distributions and architectures, the correct path is `/usr/lib64/heartbeat/dopd`.

After you have made this change and copied `ha.cf` to the peer node, put Pacemaker in maintenance mode and run `/etc/init.d/heartbeat reload` to have Heartbeat re-read its configuration file. Afterwards, you should be able to verify that you now have a running `dopd` process.

Note

You can check for this process either by running `ps ax | grep dopd` or by issuing `killall -0 dopd`.

8.3.1.2. DRBD Configuration for dopd

Once `dopd` is running, add these items to your DRBD resource configuration:

```
resource <resource> {
    handlers {
        fence-peer "/usr/lib/heartbeat/drbd-peer-outdater -t 5";
        ...
    }
    disk {
        fencing resource-only;
        ...
    }
    ...
}
```

As with `dopd`, your distribution may place the `drbd-peer-outdater` binary in `/usr/lib64/heartbeat` depending on your system architecture.

Finally, copy your `drbd.conf` to the peer node and issue `drbdadm adjust resource` to reconfigure your resource and reflect your changes.

8.3.1.3. Testing dopd functionality

To test whether your `dopd` setup is working correctly, interrupt the replication link of a configured and connected resource while Heartbeat services are running normally. You may do so simply

by physically unplugging the network link, but that is fairly invasive. Instead, you may insert a temporary `iptables` rule to drop incoming DRBD traffic to the TCP port used by your resource.

After this, you will be able to observe the resource connection state [33] change from `Connected` to `WFConnection`. Allow a few seconds to pass, and you should see the disk state [34]become `Outdated/DUnknown`. That is what `dopd` is responsible for.

Any attempt to switch the outdated resource to the primary role will fail after this.

When re-instituting network connectivity (either by plugging the physical link or by removing the temporary `iptables` rule you inserted previously), the connection state will change to `Connected`, and then promptly to `SyncTarget` (assuming changes occurred on the primary node during the network interruption). Then you will be able to observe a brief synchronization period, and finally, the previously outdated resource will be marked as `UpToDate` again.

8.3.2. Resource-level fencing using the Cluster Information Base (CIB)

In order to enable resource-level fencing for Pacemaker, you will have to set two options in `drbd.conf`:

```
resource <resource> {
  disk {
    fencing resource-only;
    ...
  }
  handlers {
    fence-peer "/usr/lib/drbd/crm-fence-peer.sh";
    after-resync-target "/usr/lib/drbd/crm-unfence-peer.sh";
    ...
  }
  ...
}
```

Thus, if the DRBD replication link becomes disconnected, the `crm-fence-peer.sh` script contacts the cluster manager, determines the Pacemaker Master/Slave resource associated with this DRBD resource, and ensures that the Master/Slave resource no longer gets promoted on any node other than the currently active one. Conversely, when the connection is re-established and DRBD completes its synchronization process, then that constraint is removed and the cluster manager is free to promote the resource on any node again.

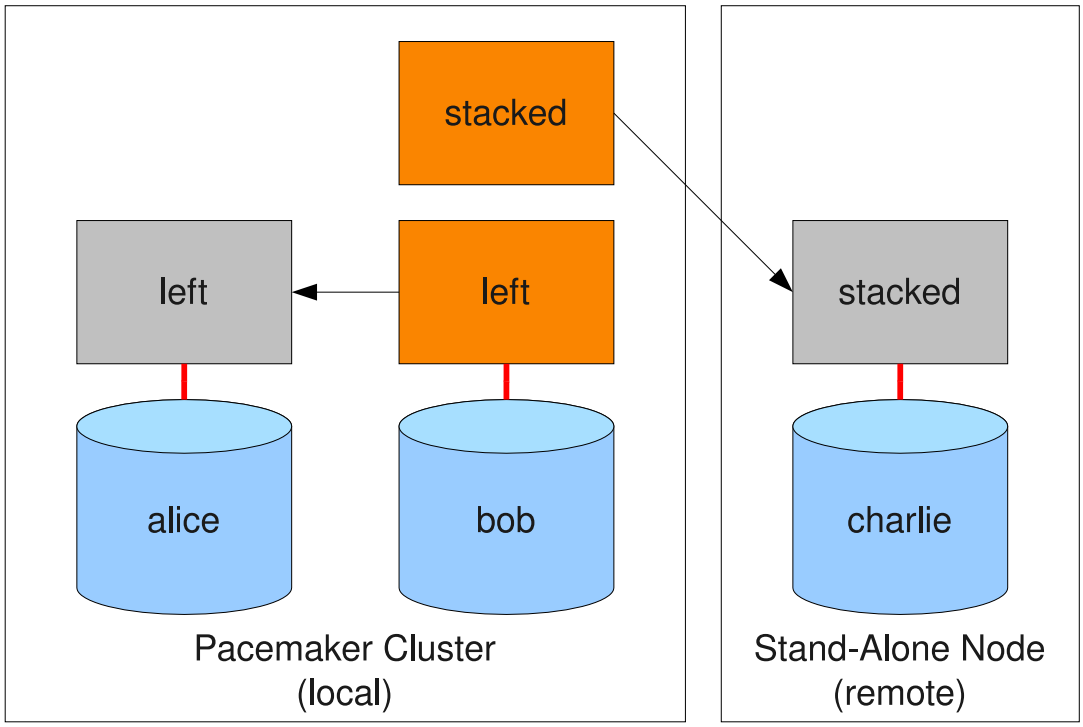
8.4. Using stacked DRBD resources in Pacemaker clusters

Stacked resources allow DRBD to be used for multi-level redundancy in multiple-node clusters, or to establish off-site disaster recovery capability. This section describes how to configure DRBD and Pacemaker in such configurations.

8.4.1. Adding off-site disaster recovery to Pacemaker clusters

In this configuration scenario, we would deal with a two-node high availability cluster in one site, plus a separate node which would presumably be housed off-site. The third node acts as a disaster recovery node and is a standalone server. Consider the following illustration to describe the concept.

Figure 8.1. DRBD resource stacking in Pacemaker clusters



In this example, `alice` and `bob` form a two-node Pacemaker cluster, whereas `charlie` is an off-site node not managed by Pacemaker.

To create such a configuration, you would first configure and initialize DRBD resources as described in Section 6.15, “Creating a three-node setup” [48]. Then, configure Pacemaker with the following CRM configuration:

```
primitive p_drbd_r0 ocf:linbit:drbd \
        params drbd_resource="r0"

primitive p_drbd_r0-U ocf:linbit:drbd \
        params drbd_resource="r0-U"

primitive p_ip_stacked ocf:heartbeat:IPaddr2 \
        params ip="192.168.42.1" nic="eth0"

ms ms_drbd_r0 p_drbd_r0 \
        meta master-max="1" master-node-max="1" \
        clone-max="2" clone-node-max="1" \
        notify="true" globally-unique="false"

ms ms_drbd_r0-U p_drbd_r0-U \
        meta master-max="1" clone-max="1" \
        clone-node-max="1" master-node-max="1" \
        notify="true" globally-unique="false"

colocation c_drbd_r0-U_on_drbd_r0 \
        inf: ms_drbd_r0-U ms_drbd_r0:Master

colocation c_drbd_r0-U_on_ip \
        inf: ms_drbd_r0-U p_ip_stacked

colocation c_ip_on_r0_master \
```

```
        inf: p_ip_stacked ms_drbd_r0:Master

order o_ip_before_r0-U \
        inf: p_ip_stacked ms_drbd_r0-U:start

order o_drbd_r0_before_r0-U \
        inf: ms_drbd_r0:promote ms_drbd_r0-U:start
```

Assuming you created this configuration in a temporary file named `/tmp/crm.txt`, you may import it into the live cluster configuration with the following command:

```
crm configure < /tmp/crm.txt
```

This configuration will ensure that the following actions occur in the correct order on the `alice`/`bob` cluster:

1. Pacemaker starts the DRBD resource `r0` on both cluster nodes, and promotes one node to the Master (DRBD Primary) role.

2. Pacemaker then starts the IP address 192.168.42.1, which the stacked resource is to use for replication to the third node. It does so on the node it has previously promoted to the Master role for `r0` DRBD resource.

3. On the node which now has the Primary role for `r0` and also the replication IP address for `r0-U`, Pacemaker now starts the `r0-U` DRBD resource, which connects and replicates to the off-site node.

4. Pacemaker then promotes the `r0-U` resource to the Primary role too, so it can be used by an application.

Thus, this Pacemaker configuration ensures that there is not only full data redundancy between cluster nodes, but also to the third, off-site node.

Note

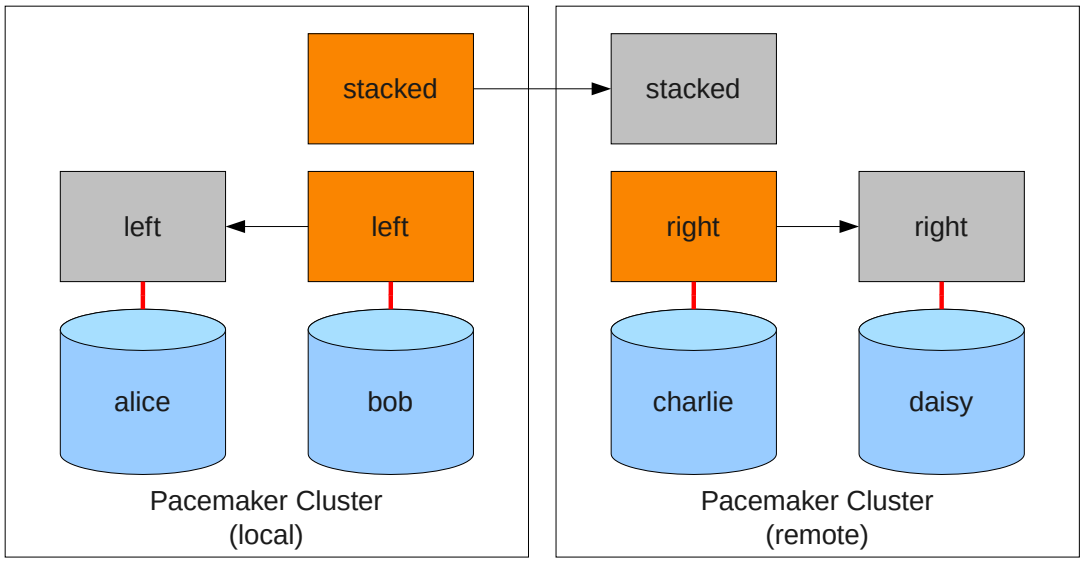
This type of setup is usually deployed together with DRBD Proxy [11].

8.4.2. Using stacked resources to achieve 4-way redundancy in Pacemaker clusters

In this configuration, a total of three DRBD resources (two unstacked, one stacked) are used to achieve 4-way storage redundancy. This means that of a 4-node cluster, up to three nodes can fail while still providing service availability.

Consider the following illustration to explain the concept.

Figure 8.2. DRBD resource stacking in Pacemaker clusters



In this example, `alice`, `bob`, `charlie`, and `daisy` form two two-node Pacemaker clusters. `alice` and `bob` form the cluster named `left` and replicate data using a DRBD resource between them, while `charlie` and `daisy` do the same with a separate DRBD resource, in a cluster named `right`. A third, stacked DRBD resource connects the two clusters.

Note

Due to limitations in the Pacemaker cluster manager as of Pacemaker version 1.0.5, it is not possible to create this setup in a single four-node cluster without disabling CIB validation, which is an advanced process not recommended for general-purpose use. It is anticipated that this is being addressed in future Pacemaker releases.

To create such a configuration, you would first configure and initialize DRBD resources as described in Section 6.15, “Creating a three-node setup” [48] (except that the remote half of the DRBD configuration is also stacked, not just the local cluster). Then, configure Pacemaker with the following CRM configuration, starting with the cluster `left`:

```
primitive p_drbd_left ocf:linbit:drbd \
        params drbd_resource="left"

primitive p_drbd_stacked ocf:linbit:drbd \
        params drbd_resource="stacked"

primitive p_ip_stacked_left ocf:heartbeat:IPaddr2 \
        params ip="10.9.9.100" nic="eth0"

ms ms_drbd_left p_drbd_left \
        meta master-max="1" master-node-max="1" \
        clone-max="2" clone-node-max="1" \
        notify="true"

ms ms_drbd_stacked p_drbd_stacked \
        meta master-max="1" clone-max="1" \
        clone-node-max="1" master-node-max="1" \
        notify="true" target-role="Master"

colocation c_ip_on_left_master \
        inf: p_ip_stacked_left ms_drbd_left:Master
```

```
colocation c_drbd_stacked_on_ip_left \
        inf: ms_drbd_stacked p_ip_stacked_left

order o_ip_before_stacked_left \
        inf: p_ip_stacked_left ms_drbd_stacked_left:start

order o_drbd_left_before_stacked_left \
        inf: ms_drbd_left:promote ms_drbd_stacked_left:start
```

Assuming you created this configuration in a temporary file named `/tmp/crm.txt`, you may import it into the live cluster configuration with the following command:

```
crm configure < /tmp/crm.txt
```

After adding this configuration to the CIB, Pacemaker will execute the following actions:

1. Bring up the DRBD resource `left` replicating between `alice` and `bob` promoting the resource to the Master role on one of these nodes.
2. Bring up the IP address 10.9.9.100 (on either `alice` or `bob`, depending on which of these holds the Master role for the resource `left`).
3. Bring up the DRBD resource `stacked` on the same node that holds the just-configured IP address.
4. Promote the stacked DRBD resource to the Primary role.

Now, proceed on the cluster `right` by creating the following configuration:

```
primitive p_drbd_right ocf:linbit:drbd \
        params drbd_resource="right"

primitive p_drbd_stacked ocf:linbit:drbd \
        params drbd_resource="stacked"

primitive p_ip_stacked_right ocf:heartbeat:IPaddr2 \
        params ip="10.9.10.101" nic="eth0"

ms ms_drbd_right p_drbd_right \
        meta master-max="1" master-node-max="1" \
        clone-max="2" clone-node-max="1" \
        notify="true"

ms ms_drbd_stacked p_drbd_stacked \
        meta master-max="1" clone-max="1" \
        clone-node-max="1" master-node-max="1" \
        notify="true" target-role="Slave"

colocation c_drbd_stacked_on_ip_right \
        inf: ms_drbd_stacked p_ip_stacked_right

colocation c_ip_on_right_master \
        inf: p_ip_stacked_right ms_drbd_right:Master

order o_ip_before_stacked_right \
        inf: p_ip_stacked_right ms_drbd_stacked_right:start

order o_drbd_right_before_stacked_right \
        inf: ms_drbd_right:promote ms_drbd_stacked_right:start
```

After adding this configuration to the CIB, Pacemaker will execute the following actions:

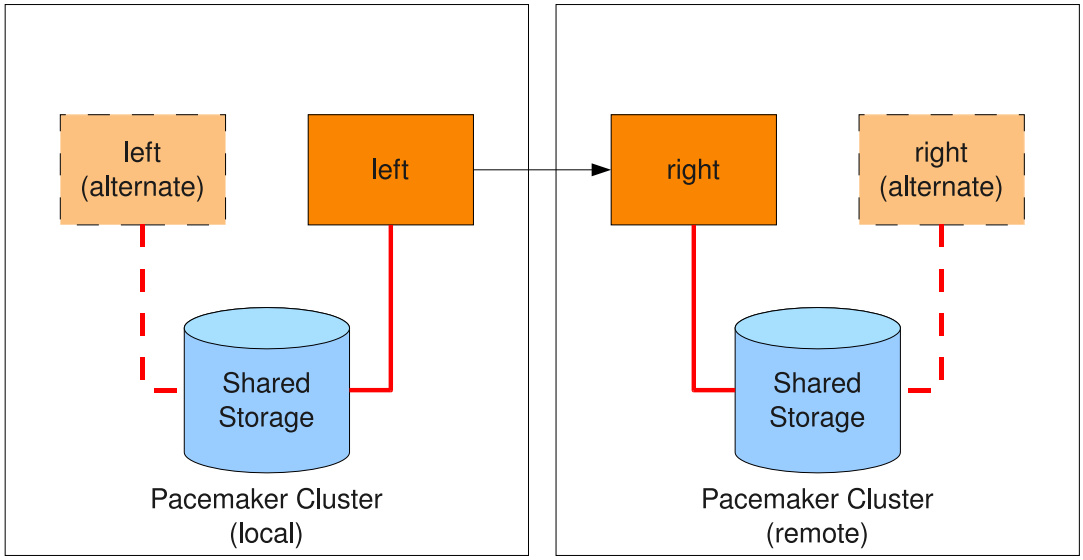
1. Bring up the DRBD resource `right` replicating between `charlie` and `daisy`, promoting the resource to the Master role on one of these nodes.
2. Bring up the IP address 10.9.10.101 (on either `charlie` or `daisy`, depending on which of these holds the Master role for the resource `right`).
3. Bring up the DRBD resource `stacked` on the same node that holds the just-configured IP address.
4. Leave the stacked DRBD resource in the Secondary role (due to `target-role="Slave"`).

8.5. Configuring DRBD to replicate between two SAN-backed Pacemaker clusters

This is a somewhat advanced setup usually employed in split-site configurations. It involves two separate Pacemaker clusters, where each cluster has access to a separate Storage Area Network (SAN). DRBD is then used to replicate data stored on that SAN, across an IP link between sites.

Consider the following illustration to describe the concept.

Figure 8.3. Using DRBD to replicate between SAN-based clusters



Which of the individual nodes in each site currently acts as the DRBD peer is not explicitly defined — the DRBD peers are said to *float* [12]; that is, DRBD binds to virtual IP addresses not tied to a specific physical machine.

Note

This type of setup is usually deployed together with DRBD Proxy [11]and/or truck based replication [12].

Since this type of setup deals with shared storage, configuring and testing STONITH is absolutely vital for it to work properly.

8.5.1. DRBD resource configuration

To enable your DRBD resource to float, configure it in `drbd.conf` in the following fashion:

```
resource <resource> {
  ...
  device /dev/drbd0;
  disk /dev/sda1;
  meta-disk internal;
  floating 10.9.9.100:7788;
  floating 10.9.10.101:7788;
}
```

The `floating` keyword replaces the `on <host>` sections normally found in the resource configuration. In this mode, DRBD identifies peers by IP address and TCP port, rather than by host name. It is important to note that the addresses specified must be virtual cluster IP addresses, rather than physical node IP addresses, for floating to function properly. As shown in the example, in split-site configurations the two floating addresses can be expected to belong to two separate IP networks — it is thus vital for routers and firewalls to properly allow DRBD replication traffic between the nodes.

8.5.2. Pacemaker resource configuration

A DRBD floating peers setup, in terms of Pacemaker configuration, involves the following items (in each of the two Pacemaker clusters involved):

- A virtual cluster IP address.
- A master/slave DRBD resource (using the DRBD OCF resource agent).
- Pacemaker constraints ensuring that resources are started on the correct nodes, and in the correct order.

To configure a resource named `mysql` in a floating peers configuration in a 2-node cluster, using the replication address `10.9.9.100`, configure Pacemaker with the following `crm` commands:

```
crm configure
crm(live)configure# primitive p_ip_float_left ocf:heartbeat:IPaddr2 \
                    params ip=10.9.9.100
crm(live)configure# primitive p_drbd_mysql ocf:linbit:drbd \
                    params drbd_resource=mysql
crm(live)configure# ms ms_drbd_mysql drbd_mysql \
                    meta master-max="1" master-node-max="1" \
                         clone-max="1" clone-node-max="1" \
                         notify="true" target-role="Master"
crm(live)configure# order drbd_after_left \
                      inf: p_ip_float_left ms_drbd_mysql
crm(live)configure# colocation drbd_on_left \
                      inf: ms_drbd_mysql p_ip_float_left
crm(live)configure# commit
bye
```

After adding this configuration to the CIB, Pacemaker will execute the following actions:

1. Bring up the IP address 10.9.9.100 (on either `alice` or `bob`).
2. Bring up the DRBD resource according to the IP address configured.
3. Promote the DRBD resource to the Primary role.

Then, in order to create the matching configuration in the other cluster, configure *that* Pacemaker instance with the following commands:

```
crm configure
```

```
crm(live)configure# primitive p_ip_float_right ocf:heartbeat:IPaddr2 \
                    params ip=10.9.10.101
crm(live)configure# primitive drbd_mysql ocf:linbit:drbd \
                    params drbd_resource=mysql
crm(live)configure# ms ms_drbd_mysql drbd_mysql \
                    meta master-max="1" master-node-max="1" \
                         clone-max="1" clone-node-max="1" \
                         notify="true" target-role="Slave"
crm(live)configure# order drbd_after_right \
                      inf: p_ip_float_right ms_drbd_mysql
crm(live)configure# colocation drbd_on_right
                      inf: ms_drbd_mysql p_ip_float_right
crm(live)configure# commit
bye
```

After adding this configuration to the CIB, Pacemaker will execute the following actions:

1. Bring up the IP address 10.9.10.101 (on either `charlie` or `daisy`).

2. Bring up the DRBD resource according to the IP address configured.

3. Leave the DRBD resource in the Secondary role (due to `target-role="Slave"`).

8.5.3. Site fail-over

In split-site configurations, it may be necessary to transfer services from one site to another. This may be a consequence of a scheduled transition, or of a disastrous event. In case the transition is a normal, anticipated event, the recommended course of action is this:

- Connect to the cluster on the site about to relinquish resources, and change the affected DRBD resource's `target-role` attribute from `Master` to `Slave`. This will shut down any resources depending on the Primary role of the DRBD resource, demote it, and continue to run, ready to receive updates from a new Primary.

- Connect to the cluster on the site about to take over resources, and change the affected DRBD resource's `target-role` attribute from `Slave` to `Master`. This will promote the DRBD resources, start any other Pacemaker resources depending on the Primary role of the DRBD resource, and replicate updates to the remote site.

- To fail back, simply reverse the procedure.

In the event that of a catastrophic outage on the active site, it can be expected that the site is off line and no longer replicated to the backup site. In such an event:

- Connect to the cluster on the still-functioning site resources, and change the affected DRBD resource's `target-role` attribute from `Slave` to `Master`. This will promote the DRBD resources, and start any other Pacemaker resources depending on the Primary role of the DRBD resource.

- When the original site is restored or rebuilt, you may connect the DRBD resources again, and subsequently fail back using the reverse procedure.

Chapter 9. Integrating DRBD with Red Hat Cluster

This chapter describes using DRBD as replicated storage for Red Hat Cluster high availability clusters.

Note

This guide uses the unofficial term *Red Hat Cluster* to refer to a product that has had multiple official product names over its history, including *Red Hat Cluster Suite* and *Red Hat Enterprise Linux High Availability Add-On*.

9.1. Red Hat Cluster background information

9.1.1. Fencing

Red Hat Cluster, originally designed primarily for shared storage clusters, relies on node fencing to prevent concurrent, uncoordinated access to shared resources. The Red Hat Cluster fencing infrastructure relies on the fencing daemon `fenced`, and fencing agents implemented as shell scripts.

Even though DRBD-based clusters utilize no shared storage resources and thus fencing is not strictly required from DRBD's standpoint, Red Hat Cluster Suite still requires fencing even in DRBD-based configurations.

9.1.2. The Resource Group Manager

The resource group manager (`rgmanager`, alternatively `clurgmgr`) is akin to Pacemaker. It serves as the cluster management suite's primary interface with the applications it is configured to manage.

9.1.2.1. Red Hat Cluster resources

A single highly available application, filesystem, IP address and the like is referred to as a *resource* in Red Hat Cluster terminology.

Where resources depend on each other — such as, for example, an NFS export depending on a filesystem being mounted — they form a *resource tree*, a form of nesting resources inside another. Resources in inner levels of nesting may inherit parameters from resources in outer nesting levels. The concept of resource trees is absent in Pacemaker.

9.1.2.2. Red Hat Cluster services

Where resources form a co-dependent collection, that collection is called a *service*. This is different from Pacemaker, where such a collection is referred to as a *resource group*.

9.1.2.3. rgmanager resource agents

The resource agents invoked by `rgmanager` are similar to those used by Pacemaker, in the sense that they utilize the same shell-based API as defined in the Open Cluster Framework (OCF), although Pacemaker utilizes some extensions not defined in the framework. Thus in theory, the resource agents are largely interchangeable between Red Hat Cluster Suite and Pacemaker — in practive however, the two cluster management suites use different resource agents even for similar or identical tasks.

Red Hat Cluster resource agents install into the `/usr/share/cluster` directory. Unlike Pacemaker OCF resource agents which are by convention self-contained, some Red Hat Cluster resource agents are split into a `.sh` file containing the actual shell code, and a `.metadata` file containing XML resource agent metadata.

DRBD includes a Red Hat Cluster resource agent. It installs into the customary directory as `drbd.sh` and `drbd.metadata`.

9.2. Red Hat Cluster configuration

This section outlines the configuration steps necessary to get Red Hat Cluster running. Preparing your cluster configuration is fairly straightforward; all a DRBD-based Red Hat Cluster requires are two participating nodes (referred to as *Cluster Members* in Red Hat's documentation) and a fencing device.

Note

For more information about configuring Red Hat clusters, see Red Hat's documentation on the Red Hat Cluster and GFS. [http://www.redhat.com/docs/manuals/csgfs/]

9.2.1. The `cluster.conf` file

RHEL clusters keep their configuration in a single configuration file, `/etc/cluster/cluster.conf`. You may manage your cluster configuration in the following ways:

Editing the configuration file directly. This is the most straightforward method. It has no prerequisites other than having a text editor available.

Using the `system-config-cluster` GUI. This is a GUI application written in Python using Glade. It requires the availability of an X display (either directly on a server console, or tunneled via SSH).

Using the Conga web-based management infrastructure. The Conga infrastructure consists of a node agent (`ricci`) communicating with the local cluster manager, cluster resource manager, and cluster LVM daemon, and an administration web application (`luci`) which may be used to configure the cluster infrastructure using a simple web browser.

9.3. Using DRBD in Red Hat Cluster fail-over clusters

Note

This section deals exclusively with setting up DRBD for Red Hat Cluster fail over clusters not involving GFS. For GFS (and GFS2) configurations, please see Chapter 11, *Using GFS with DRBD* [80].

This section, like Chapter 8, *Integrating DRBD with Pacemaker clusters* [58], assumes you are about to configure a highly available MySQL database with the following configuration parameters:

- The DRBD resources to be used as your database storage area is named `mysql`, and it manages the device `/dev/drbd0`.
- The DRBD device holds an ext3 filesystem which is to be mounted to `/var/lib/mysql` (the default MySQL data directory).

- The MySQL database is to utilize that filesystem, and listen on a dedicated cluster IP address, 192.168.42.1.

9.3.1. Setting up your cluster configuration

To configure your highly available MySQL database, create or modify your `/etc/cluster/cluster.conf` file to contain the following configuration items.

To do that, open `/etc/cluster/cluster.conf` with your preferred text editing application. Then, include the following items in your resource configuration:

```
<rm>
  <resources />
  <service autostart="1" name="mysql">
    <drbd name="drbd-mysql" resource="mysql">
      <fs device="/dev/drbd/by-res/mysql/0"
          mountpoint="/var/lib/mysql"
          fstype="ext3"
          name="mysql"
          options="noatime"/>
    </drbd>
    <ip address="10.9.9.180" monitor_link="1"/>
    <mysql config_file="/etc/my.cnf"
           listen_address="10.9.9.180"
           name="mysqld"/>
  </service>
</rm>
```

Note

This example assumes a single-volume resource.

Nesting resource references inside one another in `<service/>` is the Red Hat Cluster way of expressing resource dependencies.

Be sure to increment the `config_version` attribute, found on the root `<cluster>` element, after you have completed your configuration. Then, issue the following commands to commit your changes to the running cluster configuration:

```
ccs_tool update /etc/cluster/cluster.conf
cman_tool version -r <version>
```

In the second command, be sure to replace *<version>* with the new cluster configuration version number.

Note

Both the `system-config-cluster` GUI configuration utility and the Conga web based cluster management infrastructure will complain about your cluster configuration after including the `drbd` resource agent in your `cluster.conf` file. This is due to the design of the Python cluster management wrappers provided by these two applications which does not expect third party extensions to the cluster infrastructure.

Thus, when you utilize the `drbd` resource agent in cluster configurations, it is not recommended to utilize `system-config-cluster` nor Conga for cluster configuration purposes. Using either of these tools to only monitor the cluster's status, however, is expected to work fine.

Chapter 10. Using LVM with DRBD

This chapter deals with managing DRBD in conjunction with LVM2. In particular, it covers

- using LVM Logical Volumes as backing devices for DRBD;
- using DRBD devices as Physical Volumes for LVM;
- combining these to concepts to implement a layered LVM approach using DRBD.

If you happen to be unfamiliar with these terms to begin with, Section 10.1, "LVM primer"[72] may serve as your LVM starting point — although you are always encouraged, of course, to familiarize yourself with LVM in some more detail than this section provides.

10.1. LVM primer

LVM2 is an implementation of logical volume management in the context of the Linux device mapper framework. It has practically nothing in common, other than the name and acronym, with the original LVM implementation. The old implementation (now retroactively named "LVM1") is considered obsolete; it is not covered in this section.

When working with LVM, it is important to understand its most basic concepts:

Physical Volume (PV). A PV is an underlying block device exclusively managed by LVM. PVs can either be entire hard disks or individual partitions. It is common practice to create a partition table on the hard disk where one partition is dedicated to the use by the Linux LVM.

Note

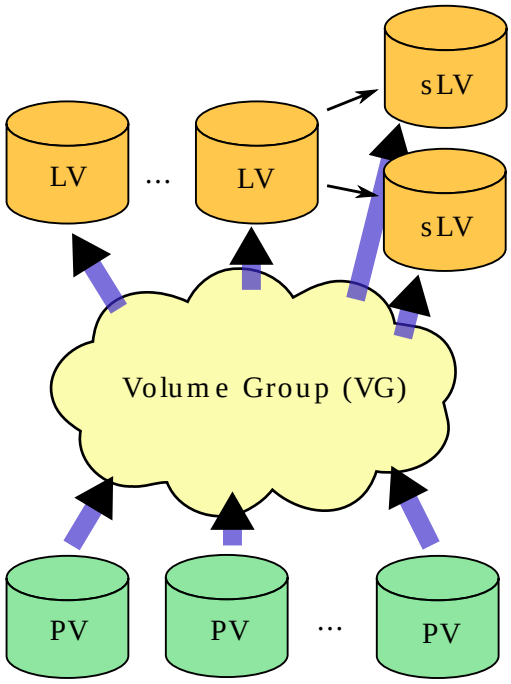
The partition type "Linux LVM" (signature `0x8E`) can be used to identify partitions for exclusive use by LVM. This, however, is not required — LVM recognizes PVs by way of a signature written to the device upon PV initialization.

Volume Group (VG). A VG is the basic administrative unit of the LVM. A VG may include one or more several PVs. Every VG has a unique name. A VG may be extended during runtime by adding additional PVs, or by enlarging an existing PV.

Logical Volume (LV). LVs may be created during runtime within VGs and are available to the other parts of the kernel as regular block devices. As such, they may be used to hold a file system, or for any other purpose block devices may be used for. LVs may be resized while they are online, and they may also be moved from one PV to another (as long as the PVs are part of the same VG).

Snapshot Logical Volume (SLV). Snapshots are temporary point-in-time copies of LVs. Creating snapshots is an operation that completes almost instantly, even if the original LV (the *origin volume*) has a size of several hundred GiByte. Usually, a snapshot requires significantly less space than the original LV.

Figure 10.1. LVM overview



10.2. Using a Logical Volume as a DRBD backing device

Since an existing Logical Volume is simply a block device in Linux terms, you may of course use it as a DRBD backing device. To use LV's in this manner, you simply create them, and then initialize them for DRBD as you normally would.

This example assumes that a Volume Group named `foo` already exists on both nodes of on your LVM-enabled system, and that you wish to create a DRBD resource named `r0` using a Logical Volume in that Volume Group.

First, you create the Logical Volume:

```
lvcreate --name bar --size 10G foo
 Logical volume "bar" created
```

Of course, you must complete this command on both nodes of your DRBD cluster. After this, you should have a block device named `/dev/foo/bar` on either node.

Then, you can simply enter the newly-created volumes in your resource configuration:

```
resource r0 {
  ...
  on alice {
    device /dev/drbd0;
    disk   /dev/foo/bar;
    ...
  }
  on bob {
    device /dev/drbd0;
```

```
    disk   /dev/foo/bar;
    ...
  }
}
```

Now you can continue to bring your resource up [28], just as you would if you were using non-LVM block devices.

10.3. Using automated LVM snapshots during DRBD synchronization

While DRBD is synchronizing, the `SyncTarget`'s state is `Inconsistent` until the synchronization completes. If in this situation the `SyncSource` happens to fail (beyond repair), this puts you in an unfortunate position: the node with good data is dead, and the surviving node has bad data.

When serving DRBD off an LVM Logical Volume, you can mitigate this problem by creating an automated snapshot when synchronization starts, and automatically removing that same snapshot once synchronization has completed successfully.

In order to enable automated snapshotting during resynchronization, add the following lines to your resource configuration:

Automating snapshots before DRBD synchronization.

```
resource r0 {
  handlers {
    before-resync-target "/usr/lib/drbd/snapshot-resync-target-lvm.sh";
    after-resync-target "/usr/lib/drbd/unsnapshot-resync-target-lvm.sh";
  }
}
```

The two scripts parse the $DRBD_RESOURCE$ environment variable which DRBD automatically passes to any `handler` it invokes. The `snapshot-resync-target-lvm.sh` script then create an LVM snapshot for any volume the resource contains immediately before synchronization kicks off. In case the script fails, the synchronization *does not commence*.

Once synchronization completes, the `unsnapshot-resync-target-lvm.sh` script removes the snapshot, which is then no longer needed. In case unsnapshotting fails, the snapshot continues to linger around.

Important

You should review dangling snapshots as soon as possible. A full snapshot causes both the snapshot itself *and its origin volume* to fail.

If at any time your `SyncSource` does fail beyond repair and you decide to revert to your latest snapshot on the peer, you may do so by issuing the `lvconvert -M` command.

10.4. Configuring a DRBD resource as a Physical Volume

In order to prepare a DRBD resource for use as a Physical Volume, it is necessary to create a PV signature on the DRBD device. In order to do so, issue one of the following commands on the node where the resource is currently in the primary role:

```
pvcreate /dev/drbdX
```

or

```
pvcreate /dev/drbd/by-res/<resource>/0
```

Note

This example assumes a single-volume resource.

Now, it is necessary to include this device in the list of devices LVM scans for PV signatures. In order to do this, you must edit the LVM configuration file, normally named `/etc/lvm/lvm.conf`. Find the line in the `devices` section that contains the `filter` keyword and edit it accordingly. If *all* your PVs are to be stored on DRBD devices, the following is an appropriate `filter` option:

```
filter = [ "a|drbd.*|", "r|.*|" ]
```

This filter expression accepts PV signatures found on any DRBD devices, while rejecting (ignoring) all others.

Note

By default, LVM scans all block devices found in `/dev` for PV signatures. This is equivalent to `filter = [ "a|.*|" ]`.

If you want to use stacked resources as LVM PVs, then you will need a more explicit filter configuration. You need to make sure that LVM detects PV signatures on stacked resources, while ignoring them on the corresponding lower-level resources and backing devices. This example assumes that your lower-level DRBD resources use device minors 0 through 9, whereas your stacked resources are using device minors from 10 upwards:

```
filter = [ "a|drbd1[0-9]|", "r|.*|" ]
```

This filter expression accepts PV signatures found only on the DRBD devices `/dev/drbd10` through `/dev/drbd19`, while rejecting (ignoring) all others.

After modifying the `lvm.conf` file, you must run the `vgscan` command so LVM discards its configuration cache and re-scans devices for PV signatures.

You may of course use a different `filter` configuration to match your particular system configuration. What is important to remember, however, is that you need to

- Accept (include) the DRBD devices you wish to use as PVs;
- Reject (exclude) the corresponding lower-level devices, so as to avoid LVM finding duplicate PV signatures.

In addition, you should disable the LVM cache by setting:

```
write_cache_state = 0
```

After disabling the LVM cache, make sure you remove any stale cache entries by deleting `/etc/lvm/cache/.cache`.

You must repeat the above steps on the peer node.

When you have configured your new PV, you may proceed to add it to a Volume Group, or create a new Volume Group from it. The DRBD resource must, of course, be in the primary role while doing so.

```
vgcreate <name> /dev/drbdX
```

Note

While it is possible to mix DRBD and non-DRBD Physical Volumes within the same Volume Group, doing so is not recommended and unlikely to be of any practical value.

When you have created your VG, you may start carving Logical Volumes out of it, using the `lvcreate` command (as with a non-DRBD-backed Volume Group).

10.5. Adding a new DRBD volume to an existing Volume Group

Occasionally, you may want to add new DRBD-backed Physical Volumes to a Volume Group. Whenever you do so, a new volume should be added to an existing resource configuration. This preserves the replication stream and ensures write fidelity across all PVs in the VG.

Important

if your LVM volume group is managed by Pacemaker as explained in Section 10.7, "Highly available LVM with Pacemaker"[78], it is *imperative* to place the cluster in maintenance mode prior to making changes to the DRBD configuration.

Extend your resource configuration to include an additional volume, as in the following example:

```
resource r0 {
  volume 0 {
    device    /dev/drbd1;
    disk      /dev/sda7;
    meta-disk internal;
  }
  volume 1 {
    device    /dev/drbd2;
    disk      /dev/sda8;
    meta-disk internal;
  }
  on alice {
    address   10.1.1.31:7789;
  }
  on bob {
    address   10.1.1.32:7789;
  }
}
```

Make sure your DRBD configuration is identical across nodes, then issue:

```
drbdadm new-minor r0 1
```

This will enable the new volume `1` in the resource `r0`. Once the new volume has been added to the replication stream, you may initialize and add it to the volume group:

```
pvcreate /dev/drbd/by-res/<resource>/1
lvextend <name> /dev/drbd/by-res/<resource>/1
```

This will add the new PV `/dev/drbd/by-res/<resource>/1` to the `<name>` VG, preserving write fidelity across the entire VG.

10.6. Nested LVM configuration with DRBD

It is possible, if slightly advanced, to both use Logical Volumes as backing devices for DRBD *and* at the same time use a DRBD device itself as a Physical Volume. To provide an example, consider the following configuration:

- We have two partitions, named `/dev/sda1`, and `/dev/sdb1`, which we intend to use as Physical Volumes.
- Both of these PVs are to become part of a Volume Group named `local`.
- We want to create a 10-GiB Logical Volume in this VG, to be named `r0`.
- This LV will become the local backing device for our DRBD resource, also named `r0`, which corresponds to the device `/dev/drbd0`.
- This device will be the sole PV for another Volume Group, named `replicated`.
- This VG is to contain two more logical volumes named `foo`(4 GiB) and `bar`(6 GiB).

In order to enable this configuration, follow these steps:

- Set an appropriate `filter` option in your `/etc/lvm/lvm.conf`:

  indexterm:[LVM]indexterm:[filter expression (LVM)]

```
filter = ["a|sd.*|", "a|drbd.*|", "r|.*|"]
```

This filter expression accepts PV signatures found on any SCSI and DRBD devices, while rejecting (ignoring) all others.

After modifying the `lvm.conf` file, you must run the `vgscan` command so LVM discards its configuration cache and re-scans devices for PV signatures.

- Disable the LVM cache by setting:

```
write_cache_state = 0
```

After disabling the LVM cache, make sure you remove any stale cache entries by deleting `/etc/lvm/cache/.cache`.

- Now, you may initialize your two SCSI partitions as PVs:

```
pvcreate /dev/sda1
Physical volume "/dev/sda1" successfully created
pvcreate /dev/sdb1
Physical volume "/dev/sdb1" successfully created
```

- The next step is creating your low-level VG named `local`, consisting of the two PVs you just initialized:

```
vgcreate local /dev/sda1 /dev/sda2
Volume group "local" successfully created
```

- Now you may create your Logical Volume to be used as DRBD's backing device:

```
lvcreate --name r0 --size 10G local
Logical volume "r0" created
```

- Repeat all steps, up to this point, on the peer node.
- Then, edit your `/etc/drbd.conf` to create a new resource named `r0`:

```
resource r0 {
  device /dev/drbd0;
  disk /dev/local/r0;
  meta-disk internal;
  on <host> { address <address>:<port>; }
  on <host> { address <address>:<port>; }
}
```

After you have created your new resource configuration, be sure to copy your `drbd.conf` contents to the peer node.

- After this, initialize your resource as described in Section 5.4, “Enabling your resource for the first time” [28](on both nodes).

- Then, promote your resource (on one node):

```
drbdadm primary r0
```

- Now, on the node where you just promoted your resource, initialize your DRBD device as a new Physical Volume:

```
pvcreate /dev/drbd0
Physical volume "/dev/drbd0" successfully created
```

- Create your VG named `replicated`, using the PV you just initialized, on the same node:

```
vgcreate replicated /dev/drbd0
Volume group "replicated" successfully created
```

- Finally, create your new Logical Volumes within this newly-created VG:

```
lvcreate --name foo --size 4G replicated
Logical volume "foo" created
lvcreate --name bar --size 6G replicated
Logical volume "bar" created
```

The Logical Volumes `foo` and `bar` will now be available as `/dev/replicated/foo` and `/dev/replicated/bar` on the local node.

To make them available on the peer node, first issue the following sequence of commands on the local node:

```
vgchange -a n replicated
0 logical volume(s) in volume group "replicated" now active
drbdadm secondary r0
```

Then, issue these commands on the peer node:

```
drbdadm primary r0
vgchange -a y replicated
2 logical volume(s) in volume group "replicated" now active
```

After this, the block devices `/dev/replicated/foo` and `/dev/replicated/bar` will be available on the peer node.

10.7. Highly available LVM with Pacemaker

The process of transferring volume groups between peers and making the corresponding logical volumes available can be automated. The Pacemaker `LVM` resource agent is designed for exactly that purpose.

In order to put an existing, DRBD-backed volume group under Pacemaker management, run the following commands in the `crm` shell:

Pacemaker configuration for DRBD-backed LVM Volume Group.

```
primitive p_drbd_r0 ocf:linbit:drbd \
  params drbd_resource="r0" \
  op monitor interval="15s"
ms ms_drbd_r0 p_drbd_r0 \
  meta master-max="1" master-node-max="1" \
       clone-max="2" clone-node-max="1" \
       notify="true"
primitive p_lvm_r0 ocf:heartbeat:LVM \
  params volgrpname="r0"
colocation c_lvm_on_drbd inf: p_lvm_r0 ms_drbd_r0:Master
order o_drbd_before_lvm inf: ms_drbd_r0:promote p_lvm_r0:start
commit
```

After you have committed this configuration, Pacemaker will automatically make the `r0` volume group available on whichever node currently has the Primary (Master) role for the DRBD resource.

Chapter 11. Using GFS with DRBD

This chapter outlines the steps necessary to set up a DRBD resource as a block device holding a shared Global File System (GFS). It covers both GFS and GFS2.

In order to use GFS on top of DRBD, you must configure DRBD in dual-primary mode [5].

11.1. GFS primer

The Red Hat Global File System (GFS) is Red Hat's implementation of a concurrent-access shared storage file system. As any such filesystem, GFS allows multiple nodes to access the same storage device, in read/write fashion, simultaneously without risking data corruption. It does so by using a Distributed Lock Manager (DLM) which manages concurrent access from cluster members.

GFS was designed, from the outset, for use with conventional shared storage devices. Regardless, it is perfectly possible to use DRBD, in dual-primary mode, as a replicated storage device for GFS. Applications may benefit from reduced read/write latency due to the fact that DRBD normally reads from and writes to local storage, as opposed to the SAN devices GFS is normally configured to run from. Also, of course, DRBD adds an additional physical copy to every GFS filesystem, thus adding redundancy to the concept.

GFS makes use of a cluster-aware variant of LVM, termed Cluster Logical Volume Manager or CLVM. As such, some parallelism exists between using DRBD as the data storage for GFS, and using DRBD as a Physical Volume for conventional LVM [74].

GFS file systems are usually tightly integrated with Red Hat's own cluster management framework, the Red Hat Cluster [69]. This chapter explains the use of DRBD in conjunction with GFS in the Red Hat Cluster context.

GFS, CLVM, and Red Hat Cluster are available in Red Hat Enterprise Linux (RHEL) and distributions derived from it, such as CentOS. Packages built from the same sources are also available in Debian GNU/Linux. This chapter assumes running GFS on a Red Hat Enterprise Linux system.

11.2. Creating a DRBD resource suitable for GFS

Since GFS is a shared cluster file system expecting concurrent read/write storage access from all cluster nodes, any DRBD resource to be used for storing a GFS filesystem must be configured in dual-primary mode [5]. Also, it is recommended to use some of DRBD's features for automatic recovery from split brain [47]. And, it is necessary for the resource to switch to the primary role immediately after startup. To do all this, include the following lines in the resource configuration:

```
resource <resource> {
  startup {
    become-primary-on both;
    ...
  }
  net {
    allow-two-primaries yes;
    after-sb-0pri discard-zero-changes;
    after-sb-1pri discard-secondary;
    after-sb-2pri disconnect;
    ...
  }
  ...
```

```
}
```

Once you have added these options to your freshly-configured resource [25], you may initialize your resource as you normally would [28]. Since the `allow-two-primaries` option is set to `yes` for this resource, you will be able to promote the resource [37]to the primary role on both nodes.

11.3. Configuring LVM to recognize the DRBD resource

GFS uses CLVM, the cluster-aware version of LVM, to manage block devices to be used by GFS. In order to use CLVM with DRBD, ensure that your LVM configuration

- uses clustered locking. To do this, set the following option in `/etc/lvm/lvm.conf`:

```
locking_type = 3
```

- scans your DRBD devices to recognize DRBD-based Physical Volumes (PVs). This applies as to conventional (non-clustered) LVM; see Section 10.4, “Configuring a DRBD resource as a Physical Volume” [74] for details.

11.4. Configuring your cluster to support GFS

After you have created your new DRBD resource and completed your initial cluster configuration [70], you must enable and start the following system services on both nodes of your GFS cluster:

- `cman`(this also starts `ccsd` and `fenced`),
- `clvmd`.

11.5. Creating a GFS filesystem

In order to create a GFS filesystem on your dual-primary DRBD resource, you must first initialize it as a Logical Volume for LVM [72].

Contrary to conventional, non-cluster-aware LVM configurations, the following steps must be completed on only one node due to the cluster-aware nature of CLVM:

```
pvcreate /dev/drbd/by-res/<resource>/0
Physical volume "/dev/drbd<num>" successfully created
vgcreate <vg-name> /dev/drbd/by-res/<resource>/0
Volume group "<vg-name>" successfully created
lvcreate --size <size> --name <lv-name> <vg-name>
Logical volume "<lv-name>" created
```

Note

This example assumes a single-volume resource.

CLVM will immediately notify the peer node of these changes; issuing `lvs` (or `lvdisplay`) on the peer node will list the newly created logical volume.

Now, you may proceed by creating the actual filesystem:

```
mkfs -t gfs -p lock_dlm -j 2 /dev/<vg-name>/<lv-name>
```

Or, for a GFS2 filesystem:

```
mkfs -t gfs2 -p lock_dlm -j 2 -t <cluster>:<name>
/dev/<vg-name>/<lv-name>
```

The `-j` option in this command refers to the number of journals to keep for GFS. This must be identical to the number of nodes in the GFS cluster; since DRBD does not support more than two nodes, the value to set here is always 2.

The `-t` option, applicable only for GFS2 filesystems, defines the lock table name. This follows the format *<cluster>:<name>*, where *<cluster>* must match your cluster name as defined in `/etc/cluster/cluster.conf`. Thus, only members of that cluster will be permitted to use the filesystem. By contrast, *<name>* is an arbitrary file system name unique in the cluster.

11.6. Using your GFS filesystem

After you have created your filesystem, you may add it to `/etc/fstab`:

```
/dev/<vg-name>/<lv-name> <mountpoint> gfs defaults 0 0
```

For a GFS2 filesystem, simply change the defined filesystem type to:

```
/dev/<vg-name>/<lv-name> <mountpoint> gfs2 defaults 0 0
```

Do not forget to make this change on both cluster nodes.

After this, you may mount your new filesystem by starting the `gfs` service (on both nodes):

```
service gfs start
```

From then onwards, as long as you have DRBD configured to start automatically on system startup, before the RHCS services and the `gfs` service, you will be able to use this GFS file system as you would use one that is configured on traditional shared storage.

Chapter 12. Using OCFS2 with DRBD

This chapter outlines the steps necessary to set up a DRBD resource as a block device holding a shared Oracle Cluster File System, version 2 (OCFS2).

12.1. OCFS2 primer

The Oracle Cluster File System, version 2 (OCFS2) is a concurrent access shared storage file system developed by Oracle Corporation. Unlike its predecessor OCFS, which was specifically designed and only suitable for Oracle database payloads, OCFS2 is a general-purpose filesystem that implements most POSIX semantics. The most common use case for OCFS2 is arguably Oracle Real Application Cluster (RAC), but OCFS2 may also be used for load-balanced NFS clusters, for example.

Although originally designed for use with conventional shared storage devices, OCFS2 is equally well suited to be deployed on dual-Primary DRBD [5]. Applications reading from the filesystem may benefit from reduced read latency due to the fact that DRBD reads from and writes to local storage, as opposed to the SAN devices OCFS2 otherwise normally runs on. In addition, DRBD adds redundancy to OCFS2 by adding an additional copy to every filesystem image, as opposed to just a single filesystem image that is merely shared.

Like other shared cluster file systems such as GFS [80], OCFS2 allows multiple nodes to access the same storage device, in read/write mode, simultaneously without risking data corruption. It does so by using a Distributed Lock Manager (DLM) which manages concurrent access from cluster nodes. The DLM itself uses a virtual file system (`ocfs2_dlmfs`) which is separate from the actual OCFS2 file systems present on the system.

OCFS2 may either use an intrinsic cluster communication layer to manage cluster membership and filesystem mount and unmount operation, or alternatively defer those tasks to the Pacemaker [58]cluster infrastructure.

OCFS2 is available in SUSE Linux Enterprise Server (where it is the primarily supported shared cluster file system), CentOS, Debian GNU/Linux, and Ubuntu Server Edition. Oracle also provides packages for Red Hat Enterprise Linux (RHEL). This chapter assumes running OCFS2 on a SUSE Linux Enterprise Server system.

12.2. Creating a DRBD resource suitable for OCFS2

Since OCFS2 is a shared cluster file system expecting concurrent read/write storage access from all cluster nodes, any DRBD resource to be used for storing a OCFS2 filesystem must be configured in dual-primary mode [5]. Also, it is recommended to use some of DRBD's features for automatic recovery from split brain [47]. And, it is necessary for the resource to switch to the primary role immediately after startup. To do all this, include the following lines in the resource configuration:

```
resource <resource> {
  startup {
    become-primary-on both;
    ...
  }
  net {
    # allow-two-primaries yes;
    after-sb-0pri discard-zero-changes;
    after-sb-1pri discard-secondary;
    after-sb-2pri disconnect;
    ...
```

```
  }
  ...
}
```

It is not recommended to set the `allow-two-primaries` option to `yes` upon initial configuration. You should do so after the initial resource synchronization has completed.

Once you have added these options to your freshly-configured resource [25], you may initialize your resource as you normally would [28]. After you set the `allow-two-primaries` option to `yes` for this resource, you will be able to promote the resource [37]to the primary role on both nodes.

12.3. Creating an OCFS2 filesystem

Now, use OCFS2's `mkfs` implementation to create the file system:

```
mkfs -t ocfs2 -N 2 -L ocfs2_drbd0 /dev/drbd0
mkfs.ocfs2 1.4.0
Filesystem label=ocfs2_drbd0
Block size=1024 (bits=10)
Cluster size=4096 (bits=12)
Volume size=205586432 (50192 clusters) (200768 blocks)
7 cluster groups (tail covers 4112 clusters, rest cover 7680 clusters)
Journal size=4194304
Initial number of node slots: 2
Creating bitmaps: done
Initializing superblock: done
Writing system files: done
Writing superblock: done
Writing backup superblock: 0 block(s)
Formatting Journals: done
Writing lost+found: done
mkfs.ocfs2 successful
```

This will create an OCFS2 file system with two node slots on `/dev/drbd0`, and set the filesystem label to `ocfs2_drbd0`. You may specify other options on `mkfs` invocation; please see the `mkfs.ocfs2` system manual page for details.

12.4. Pacemaker OCFS2 management

12.4.1. Adding a Dual-Primary DRBD resource to Pacemaker

An existing Dual-Primary DRBD resource [83]may be added to Pacemaker resource management with the following `crm` configuration:

```
primitive p_drbd_ocfs2 ocf:linbit:drbd \
  params drbd_resource="ocfs2"
ms ms_drbd_ocfs2 p_drbd_ocfs2 \
  meta master-max=2 clone-max=2 notify=true
```

Important

Note the `master-max=2` meta variable; it enables dual-Master mode for a Pacemaker master/slave set. This requires that `allow-two-primaries` is also set to `yes` in the DRBD configuration. Otherwise, Pacemaker will flag a configuration error during resource validation.

12.4.2. Adding OCFS2 management capability to Pacemaker

In order to manage OCFS2 and the kernel Distributed Lock Manager (DLM), Pacemaker uses a total of three different resource agents:

- `ocf:pacemaker:controld` — Pacemaker's interface to the DLM;
- `ocf:ocfs2:o2cb` — Pacemaker's interface to OCFS2 cluster management;
- `ocf:heartbeat:Filesystem` — the generic filesystem management resource agent which supports cluster file systems when configured as a Pacemaker clone.

You may enable all nodes in a Pacemaker cluster for OCFS2 management by creating a *cloned group* of resources, with the following `crm` configuration:

```
primitive p_controld ocf:pacemaker:controld
primitive p_o2cb ocf:ocfs2:o2cb
group g_ocfs2mgmt p_controld p_o2cb
clone cl_ocfs2mgmt g_ocfs2mgmt meta interleave=true
```

Once this configuration is committed, Pacemaker will start instances of the `controld` and `o2cb` resource types on all nodes in the cluster.

12.4.3. Adding an OCFS2 filesystem to Pacemaker

Pacemaker manages OCFS2 filesystems using the conventional `ocf:heartbeat:Filesystem` resource agent, albeit in clone mode. To put an OCFS2 filesystem under Pacemaker management, use the following `crm` configuration:

```
primitive p_fs_ocfs2 ocf:heartbeat:Filesystem \
  params device="/dev/drbd/by-res/ocfs2/0" directory="/srv/ocfs2" \
         fstype="ocfs2" options="rw,noatime"
clone cl_fs_ocfs2 p_fs_ocfs2
```

Note

This example assumes a single-volume resource.

12.4.4. Adding required Pacemaker constraints to manage OCFS2 filesystems

In order to tie all OCFS2-related resources and clones together, add the following contraints to your Pacemaker configuration:

```
order o_ocfs2 ms_drbd_ocfs2:promote cl_ocfs2mgmt:start cl_fs_ocfs2:start
colocation c_ocfs2 cl_fs_ocfs2 cl_ocfs2mgmt ms_drbd_ocfs2:Master
```

12.5. Legacy OCFS2 management (without Pacemaker)

Important

The information presented in this section applies to legacy systems where OCFS2 DLM support is not available in Pacemaker. It is preserved here for reference purposes only. New installations should always use the Pacemaker [84] approach.

12.5.1. Configuring your cluster to support OCFS2

12.5.1.1. Creating the configuration file

OCFS2 uses a central configuration file, `/etc/ocfs2/cluster.conf`.

When creating your OCFS2 cluster, be sure to add both your hosts to the cluster configuration. The default port (7777) is usually an acceptable choice for cluster interconnect communications. If you choose any other port number, be sure to choose one that does not clash with an existing port used by DRBD (or any other configured TCP/IP).

If you feel less than comfortable editing the `cluster.conf` file directly, you may also use the `ocfs2console` graphical configuration utility which is usually more convenient. Regardless of the approach you selected, your `/etc/ocfs2/cluster.conf` file contents should look roughly like this:

```
node:
    ip_port = 7777
    ip_address = 10.1.1.31
    number = 0
    name = alice
    cluster = ocfs2

node:
    ip_port = 7777
    ip_address = 10.1.1.32
    number = 1
    name = bob
    cluster = ocfs2

cluster:
    node_count = 2
    name = ocfs2
```

When you have configured you cluster configuration, use `scp` to distribute the configuration to both nodes in the cluster.

12.5.1.2. Configuring the O2CB driver

====== SUSE Linux Enterprise systems

On SLES, you may utilize the `configure` option of the `o2cb` init script:

```
/etc/init.d/o2cb configure
Configuring the O2CB driver.

This will configure the on-boot properties of the O2CB driver.
The following questions will determine whether the driver is loaded on
boot.  The current values will be shown in brackets ('[]').  Hitting
<ENTER> without typing an answer will keep that current value.  Ctrl-C
will abort.

Load O2CB driver on boot (y/n) [y]:
Cluster to start on boot (Enter "none" to clear) [ocfs2]:
Specify heartbeat dead threshold (>=7) [31]:
Specify network idle timeout in ms (>=5000) [30000]:
Specify network keepalive delay in ms (>=1000) [2000]:
Specify network reconnect delay in ms (>=2000) [2000]:
```

```
Use user-space driven heartbeat? (y/n) [n]:
Writing O2CB configuration: OK
Loading module "configfs": OK
Mounting configfs filesystem at /sys/kernel/config: OK
Loading module "ocfs2_nodemanager": OK
Loading module "ocfs2_dlm": OK
Loading module "ocfs2_dlmfs": OK
Mounting ocfs2_dlmfs filesystem at /dlm: OK
Starting O2CB cluster ocfs2: OK
```

====== .Debian GNU/Linux systems On Debian, the `configure` option to `/etc/init.d/o2cb` is not available. Instead, reconfigure the `ocfs2-tools` package to enable the driver:

```
dpkg-reconfigure -p medium -f readline ocfs2-tools
Configuring ocfs2-tools
Would you like to start an OCFS2 cluster (O2CB) at boot time? yes
Name of the cluster to start at boot time: ocfs2
The O2CB heartbeat threshold sets up the maximum time in seconds that a node
awaits for an I/O operation. After it, the node "fences" itself, and you will
probably see a crash.

It is calculated as the result of: (threshold - 1) x 2.

Its default value is 31 (60 seconds).

Raise it if you have slow disks and/or crashes with kernel messages like:

o2hb_write_timeout: 164 ERROR: heartbeat write timeout to device XXXX after NNN
milliseconds
O2CB Heartbeat threshold: `31`
                Loading filesystem "configfs": OK
Mounting configfs filesystem at /sys/kernel/config: OK
Loading stack plugin "o2cb": OK
Loading filesystem "ocfs2_dlmfs": OK
Mounting ocfs2_dlmfs filesystem at /dlm: OK
Setting cluster stack "o2cb": OK
Starting O2CB cluster ocfs2: OK
```

12.5.2. Using your OCFS2 filesystem

When you have completed cluster configuration and created your file system, you may mount it as any other file system:

```
mount -t ocfs2 /dev/drbd0 /shared
```

Your kernel log (accessible by issuing the command `dmesg`) should then contain a line similar to this one:

```
ocfs2: Mounting device (147,0) on (node 0, slot 0) with ordered data mode.
```

From that point forward, you should be able to simultaneously mount your OCFS2 filesystem on both your nodes, in read/write mode.

Chapter 13. Using Xen with DRBD

This chapter outlines the use of DRBD as a Virtual Block Device (VBD) for virtualization envirnoments using the Xen hypervisor.

13.1. Xen primer

Xen is a virtualization framework originally developed at the University of Cambridge (UK), and later being maintained by XenSource, Inc. (now a part of Citrix). It is included in reasonably recent releases of most Linux distributions, such as Debian GNU/Linux (since version 4.0), SUSE Linux Enterprise Server (since release 10), Red Hat Enterprise Linux (since release 5), and many others.

Xen uses paravirtualization — a virtualization method involving a high degree of cooperation between the virtualization host and guest virtual machines — with selected guest operating systems for improved performance in comparison to conventional virtualization solutions (which are typically based on hardware emulation). Xen also supports full hardware emulation on CPUs that support the appropriate virtualization extensions, in Xen parlance, this is known as HVM ("hardware-assisted virtual machine").

Note

At the time of writing, CPU extensions supported by Xen for HVM are Intel's Virtualization Technology (VT, formerly codenamed "Vanderpool"), and AMD's Secure Virtual Machine (SVM, formerly known as "Pacifica").

Xen supports *live migration*, which refers to the capability of transferring a running guest operating system from one physical host to another, without interruption.

When a DRBD resource is used as a replicated Virtual Block Device (VBD) for Xen, it serves to make the entire contents of a domU's virtual disk available on two servers, which can then be configured for automatic fail-over. That way, DRBD does not only provide redundancy for Linux servers (as in non-virtualized DRBD deployment scenarios), but also for any other operating system that can be virtualized under Xen — which, in essence, includes any operating system available on 32- or 64-bit Intel compatible architectures.

13.2. Setting DRBD module parameters for use with Xen

For Xen Domain-0 kernels, it is recommended to load the DRBD module with the set to `1`. To do so, create (or open) the file `/etc/modprobe.d/drbd.conf` and enter the following line:

```
options drbd disable_sendpage=1
```

13.3. Creating a DRBD resource suitable to act as a Xen VBD

Configuring a DRBD resource that is to be used as a Virtual Block Device for Xen is fairly straightforward — in essence, the typical configuration matches that of a DRBD resource being used for any other purpose. However, if you want to enable live migration for your guest instance, you need to enable dual-primary mode [5]for this resource:

```
resource <resource> {
  net {
```

```
    allow-two-primaries yes;
    ...
  }
  ...
}
```

Enabling dual-primary mode is necessary because Xen, before initiating live migration, checks for write access on all VBDs a resource is configured to use on both the source and the destination host for the migration.

13.4. Using DRBD VBDs

In order to use a DRBD resource as the virtual block device, you must add a line like the following to your Xen domU configuration:

```
disk = [ 'drbd:<resource>,xvda,w' ]
```

This example configuration makes the DRBD resource named *resource* available to the domU as `/dev/xvda` in read/write mode (`w`).

Of course, you may use multiple DRBD resources with a single domU. In that case, simply add more entries like the one provided in the example to the `disk` option, separated by commas.

Note

There are three sets of circumstances under which you cannot use this approach:

- You are configuring a fully virtualized (HVM) domU.
- You are installing your domU using a graphical installation utility, *and* that graphical installer does not support the `drbd:` syntax.
- You are configuring a domU without the `kernel`, `initrd`, and `extra` options, relying instead on `bootloader` and `bootloader_args` to use a Xen pseudo-bootloader, *and* that pseudo-bootloader does not support the `drbd:` syntax.
  - pygrub+ (prior to Xen 3.3) and `domUloader.py` (shipped with Xen on SUSE Linux Enterprise Server 10) are two examples of pseudo-bootloaders that do not support the `drbd:` virtual block device configuration syntax.
  - `pygrub` from Xen 3.3 forward, and the `domUloader.py` version that ships with SLES 11 *do* support this syntax.

Under these circumstances, you must use the traditional `phy:` device syntax and the DRBD device name that is associated with your resource, not the resource name. That, however, requires that you manage DRBD state transitions outside Xen, which is a less flexible approach than that provided by the `drbd` resource type.

13.5. Starting, stopping, and migrating DRBD-backed domU's

Starting the domU. Once you have configured your DRBD-backed domU, you may start it as you would any other domU:

```
xm create <domU>
Using config file "+/etc/xen/<domU>+".
Started domain <domU>
```

In the process, the DRBD resource you configured as the VBD will be promoted to the primary role, and made accessible to Xen as expected.

Stopping the domU. This is equally straightforward:

```
xm shutdown -w <domU>
Domain <domU> terminated.
```

Again, as you would expect, the DRBD resource is returned to the secondary role after the domU is successfully shut down.

Migrating the domU. This, too, is done using the usual Xen tools:

```
xm migrate --live <domU> <destination-host>
```

In this case, several administrative steps are automatically taken in rapid succession: . The resource is promoted to the primary role on *destination-host*. . Live migration of *domU* is initiated on the local host. . When migration to the destination host has completed, the resource is demoted to the secondary role locally.

The fact that both resources must briefly run in the primary role on both hosts is the reason for having to configure the resource in dual-primary mode in the first place.

13.6. Internals of DRBD/Xen integration

Xen supports two Virtual Block Device types natively:

phy. This device type is used to hand "physical" block devices, available in the host environment, off to a guest domU in an essentially transparent fashion.

`file`. This device type is used to make file-based block device images available to the guest domU. It works by creating a loop block device from the original image file, and then handing that block device off to the domU in much the same fashion as the `phy` device type does.

If a Virtual Block Device configured in the `disk` option of a domU configuration uses any prefix other than `phy:`, `file:`, or no prefix at all (in which case Xen defaults to using the `phy` device type), Xen expects to find a helper script named `block-`*prefix* in the Xen scripts directory, commonly `/etc/xen/scripts`.

The DRBD distribution provides such a script for the `drbd` device type, named `/etc/xen/scripts/block-drbd`. This script handles the necessary DRBD resource state transitions as described earlier in this chapter.

13.7. Integrating Xen with Pacemaker

In order to fully capitalize on the benefits provided by having a DRBD-backed Xen VBD's, it is recommended to have Heartbeat manage the associated domU's as Heartbeat resources.

You may configure a Xen domU as a Pacemaker resource, and automate resource failover. To do so, use the `Xen` OCF resource agent. If you are using the `drbd` Xen device type described in this chapter, you will *not* need to configure any separate `drbd` resource for use by the Xen cluster resource. Instead, the `block-drbd` helper script will do all the necessary resource transitions for you.

Part V. Optimizing DRBD performance

Chapter 14. Measuring block device performance

14.1. Measuring throughput

When measuring the impact of using DRBD on a system's I/O throughput, the *absolute* throughput the system is capable of is of little relevance. What is much more interesting is the *relative* impact DRBD has on I/O performance. Thus it is always necessary to measure I/O throughput both with and without DRBD.

Caution

The tests described in this section are intrusive; they overwrite data and bring DRBD devices out of sync. It is thus vital that you perform them only on scratch volumes which can be discarded after testing has completed.

I/O throughput estimation works by writing significantly large chunks of data to a block device, and measuring the amount of time the system took to complete the write operation. This can be easily done using a fairly ubiquitous utility, `dd`, whose reasonably recent versions include a built-in throughput estimation.

A simple `dd`-based throughput benchmark, assuming you have a scratch resource named `test` which is currently connected and in the secondary role on both nodes, is one like the following:

```
TEST_RESOURCE=test
TEST_DEVICE=$(drbdadm sh-dev $TEST_RESOURCE)
TEST_LL_DEVICE=$(drbdadm sh-ll-dev $TEST_RESOURCE)
drbdadm primary $TEST_RESOURCE
for i in $(seq 5); do
  dd if=/dev/zero of=$TEST_DEVICE bs=512M count=1 oflag=direct
done
drbdadm down $TEST_RESOURCE
for i in $(seq 5); do
  dd if=/dev/zero of=$TEST_LL_DEVICE bs=512M count=1 oflag=direct
done
```

This test simply writes a 512M chunk of data to your DRBD device, and then to its backing device for comparison. Both tests are repeated 5 times each to allow for some statistical averaging. The relevant result is the throughput measurements generated by `dd`.

Note

For freshly enabled DRBD devices, it is normal to see significantly reduced performance on the first `dd` run. This is due to the Activity Log being "cold", and is no cause for concern.

14.2. Measuring latency

Latency measurements have objectives completely different from throughput benchmarks: in I/O latency tests, one writes a very small chunk of data (ideally the smallest chunk of data that the system can deal with), and observes the time it takes to complete that write. The process is usually repeated several times to account for normal statistical fluctuations.

Just as throughput measurements, I/O latency measurements may be performed using the ubiquitous `dd` utility, albeit with different settings and an entirely different focus of observation.

Provided below is a simple `dd`-based latency micro-benchmark, assuming you have a scratch resource named `test` which is currently connected and in the secondary role on both nodes:

```
TEST_RESOURCE=test
TEST_DEVICE=$(drbdadm sh-dev $TEST_RESOURCE)
TEST_LL_DEVICE=$(drbdadm sh-ll-dev $TEST_RESOURCE)
drbdadm primary $TEST_RESOURCE
dd if=/dev/zero of=$TEST_DEVICE bs=512 count=1000 oflag=direct
drbdadm down $TEST_RESOURCE
dd if=/dev/zero of=$TEST_LL_DEVICE bs=512 count=1000 oflag=direct
```

This test writes 1,000 512-byte chunks of data to your DRBD device, and then to its backing device for comparison. 512 bytes is the smallest block size a Linux system (on all architectures except s390) is expected to handle.

It is important to understand that throughput measurements generated by `dd` are completely irrelevant for this test; what is important is the *time* elapsed during the completion of said 1,000 writes. Dividing this time by 1,000 gives the average latency of a single sector write.

Chapter 15. Optimizing DRBD throughput

This chapter deals with optimizing DRBD throughput. It examines some hardware considerations with regard to throughput optimization, and details tuning recommendations for that purpose.

15.1. Hardware considerations

DRBD throughput is affected by both the bandwidth of the underlying I/O subsystem (disks, controllers, and corresponding caches), and the bandwidth of the replication network.

I/O subsystem throughput. I/O subsystem throughput is determined, largely, by the number of disks that can be written to in parallel. A single, reasonably recent, SCSI or SAS disk will typically allow streaming writes of rougly 40MB/s to the single disk. When deployed in a striping configuration, the I/O subsystem will parallelize writes across disks, effectively multiplying a single disk's throughput by the number of stripes in the configuration. Thus the same, 40MB/s disks will allow effective throughput of 120MB/s in a RAID-0 or RAID-1+0 configuration with three stripes, or 200MB/s with five stripes.

Note

Disk *mirroring*(RAID-1) in hardware typically has little, if any effect on throughput. Disk *striping with parity*(RAID-5) does have an effect on throughput, usually an adverse one when compared to striping.

Network throughput. Network throughput is usually determined by the amount of traffic present on the network, and on the throughput of any routing/switching infrastructure present. These concerns are, however, largely irrelevant in DRBD replication links which are normally dedicated, back-to-back network connections. Thus, network throughput may be improved either by switching to a higher-throughput protocol (such as 10 Gigabit Ethernet), or by using link aggregation over several network links, as one may do using the Linux `bonding` network driver.

15.2. Throughput overhead expectations

When estimating the throughput overhead associated with DRBD, it is important to consider the following natural limitations:

- DRBD throughput is limited by that of the raw I/O subsystem.
- DRBD throughput is limited by the available network bandwidth.

The *minimum* between the two establishes the theoretical throughput *maximum* available to DRBD. DRBD then reduces that throughput maximum by its additional throughput overhead, which can be expected to be less than 3 percent.

- Consider the example of two cluster nodes containing I/O subsystems capable of 200 MB/s throughput, with a Gigabit Ethernet link available between them. Gigabit Ethernet can be expected to produce 110 MB/s throughput for TCP connections, thus the network connection would be the bottleneck in this configuration and one would expect about 107 MB/s maximum DRBD throughput.
- By contrast, if the I/O subsystem is capable of only 100 MB/s for sustained writes, then it constitutes the bottleneck, and you would be able to expect only 97 MB/s maximum DRBD throughput.

15.3. Tuning recommendations

DRBD offers a number of configuration options which may have an effect on your system's throughput. This section list some recommendations for tuning for throughput. However, since throughput is largely hardware dependent, the effects of tweaking the options described here may vary greatly from system to system. It is important to understand that these recommendations should not be interpreted as "silver bullets" which would magically remove any and all throughput bottlenecks.

15.3.1. Setting `max-buffers` and `max-epoch-size`

These options affect write performance on the secondary node. `max-buffers` is the maximum number of buffers DRBD allocates for writing data to disk while `max-epoch-size` is the maximum number of write requests permitted between two write barriers. Under most circumstances, these two options should be set in parallel, and to identical values. The default for both is 2048; setting it to around 8000 should be fine for most reasonably high-performance hardware RAID controllers.

```
resource <resource> {
  net {
    max-buffers 8000;
    max-epoch-size 8000;
    ...
  }
  ...
}
```

15.3.2. Tweaking the I/O unplug watermark

The I/O unplug watermark is a tunable which affects how often the I/O subsystem's controller is "kicked" (forced to process pending I/O requests) during normal operation. There is no universally recommended setting for this option; this is greatly hardware dependent.

Some controllers perform best when "kicked" frequently, so for these controllers it makes sense to set this fairly low, perhaps even as low as DRBD's allowable minimum (16). Others perform best when left alone; for these controllers a setting as high as `max-buffers` is advisable.

```
resource <resource> {
  net {
    unplug-watermark 16;
    ...
  }
  ...
}
```

15.3.3. Tuning the TCP send buffer size

The TCP send buffer is a memory buffer for outgoing TCP traffic. By default, it is set to a size of 128 KiB. For use in high-throughput networks (such as dedicated Gigabit Ethernet or load-balanced bonded connections), it may make sense to increase this to a size of 512 KiB, or perhaps even more. Send buffer sizes of more than 2 MiB are generally not recommended (and are also unlikely to produce any throughput improvement).

```
resource <resource> {
  net {
    sndbuf-size 512k;
    ...
```

```
  }
  ...
}
```

DRBD also supports TCP send buffer auto-tuning. After enabling this feature, DRBD will dynamically select an appropriate TCP send buffer size. TCP send buffer auto tuning is enabled by simply setting the buffer size to zero:

```
resource <resource> {
  net {
    sndbuf-size 0;
    ...
  }
  ...
}
```

15.3.4. Tuning the Activity Log size

If the application using DRBD is write intensive in the sense that it frequently issues small writes scattered across the device, it is usually advisable to use a fairly large activity log. Otherwise, frequent metadata updates may be detrimental to write performance.

```
resource <resource> {
  disk {
    al-extents 3389;
    ...
  }
  ...
}
```

15.3.5. Disabling barriers and disk flushes

Warning

The recommendations outlined in this section should be applied *only* to systems with non-volatile (battery backed) controller caches.

Systems equipped with battery backed write cache come with built-in means of protecting data in the face of power failure. In that case, it is permissible to disable some of DRBD's own safeguards created for the same purpose. This may be beneficial in terms of throughput:

```
resource <resource> {
  disk {
    disk-barrier no;
    disk-flushes no;
    ...
  }
  ...
}
```

Chapter 16. Optimizing DRBD latency

This chapter deals with optimizing DRBD latency. It examines some hardware considerations with regard to latency minimization, and details tuning recommendations for that purpose.

16.1. Hardware considerations

DRBD latency is affected by both the latency of the underlying I/O subsystem (disks, controllers, and corresponding caches), and the latency of the replication network.

I/O subsystem latency. I/O subsystem latency is primarily a function of disk rotation speed. Thus, using fast-spinning disks is a valid approach for reducing I/O subsystem latency.

Likewise, the use of a battery-backed write cache (BBWC) reduces write completion times, also reducing write latency. Most reasonable storage subsystems come with some form of battery-backed cache, and allow the administrator to configure which portion of this cache is used for read and write operations. The recommended approach is to disable the disk read cache completely and use all cache memory available for the disk write cache.

Network latency. Network latency is, in essence, the packet round-trip time ( ) between hosts. It is influenced by a number of factors, most of which are irrelevant on the dedicated, back-to-back network connections recommended for use as DRBD replication links. Thus, it is sufficient to accept that a certain amount of latency always exists in Gigabit Ethernet links, which typically is on the order of 100 to 200 microseconds (µs) packet RTT.

Network latency may typically be pushed below this limit only by using lower-latency network protocols, such as running DRBD over Dolphin Express using Dolphin SuperSockets.

16.2. Latency overhead expectations

As for throughput, when estimating the latency overhead associated with DRBD, there are some important natural limitations to consider:

- DRBD latency is bound by that of the raw I/O subsystem.
- DRBD latency is bound by the available network latency.

The *sum* of the two establishes the theoretical latency *minimum* incurred to DRBD. DRBD then adds to that latency a slight additional latency overhead, which can be expected to be less than 1 percent.

- Consider the example of a local disk subsystem with a write latency of 3ms and a network link with one of 0.2ms. Then the expected DRBD latency would be 3.2 ms or a roughly 7-percent latency increase over just writing to a local disk.

Note

Latency may be influenced by a number of other factors, including CPU cache misses, context switches, and others.

16.3. Tuning recommendations

16.3.1. Setting DRBD's CPU mask

DRBD allows for setting an explicit CPU mask for its kernel threads. This is particularly beneficial for applications which would otherwise compete with DRBD for CPU cycles.

The CPU mask is a number in whose binary representation the least significant bit represents the first CPU, the second-least significant bit the second, and so forth. A set bit in the bitmask implies that the corresponding CPU may be used by DRBD, whereas a cleared bit means it must not. Thus, for example, a CPU mask of 1 (`00000001`) means DRBD may use the first CPU only. A mask of 12 (`00001100`) implies DRBD may use the third and fourth CPU.

An example CPU mask configuration for a resource may look like this:

```
resource <resource> {
  options {
    cpu-mask 2;
    ...
  }
  ...
}
```

Important

Of course, in order to minimize CPU competition between DRBD and the application using it, you need to configure your application to use only those CPUs which DRBD does not use.

Some applications may provide for this via an entry in a configuration file, just like DRBD itself. Others include an invocation of the `taskset` command in an application init script.

16.3.2. Modifying the network MTU

When a block-based (as opposed to extent-based) filesystem is layered above DRBD, it may be beneficial to change the replication network's maximum transmission unit (MTU) size to a value higher than the default of 1500 bytes. Colloquially, this is referred to as "enabling Jumbo frames".

Note

Block-based file systems include ext3, ReiserFS (version 3), and GFS. Extent-based file systems, in contrast, include XFS, Lustre and OCFS2. Extent-based file systems are expected to benefit from enabling Jumbo frames only if they hold few and large files.

The MTU may be changed using the following commands:

```
ifconfig <interface> mtu <size>
```

or

```
ip link set <interface> mtu <size>
```

<interface> refers to the network interface used for DRBD replication. A typical value for *<size>* would be 9000 (bytes).

16.3.3. Enabling the `deadline` I/O scheduler

When used in conjunction with high-performance, write back enabled hardware RAID controllers, DRBD latency may benefit greatly from using the simple `deadline` I/O scheduler, rather than the CFQ scheduler. The latter is typically enabled by default in reasonably recent kernel configurations (post-2.6.18 for most distributions).

Modifications to the I/O scheduler configuration may be performed via the `sysfs` virtual file system, mounted at `/sys`. The scheduler configuration is in `/sys/block/<device>`, where <device> is the backing device DRBD uses.

Enabling the `deadline` scheduler works via the following command:

```
`echo deadline > /sys/block/<device>/queue/scheduler`
```

You may then also set the following values, which may provide additional latency benefits:

- Disable front merges:

```
echo 0 > /sys/block/<device>/queue/iosched/front_merges
```

- Reduce read I/O deadline to 150 milliseconds (the default is 500ms):

```
echo 150 > /sys/block/<device>/queue/iosched/read_expire
```

- Reduce write I/O deadline to 1500 milliseconds (the default is 3000ms):

```
 echo 1500 > /sys/block/<device>/queue/iosched/write_expire
```

If these values effect a significant latency improvement, you may want to make them permanent so they are automatically set at system startup. Debian and Ubuntu systems provide this functionality via the `sysfsutils` package and the `/etc/sysfs.conf` configuration file.

You may also make a global I/O scheduler selection by passing the `elevator` option via your kernel command line. To do so, edit your boot loader configuration (normally found in `/boot/grub/menu.lst` if you are using the GRUB bootloader) and add `elevator=deadline` to your list of kernel boot options.

Part VI. Learning more about DRBD

Chapter 17. DRBD Internals

This chapter gives *some* background information about some of DRBD's internal algorithms and structures. It is intended for interested users wishing to gain a certain degree of background knowledge about DRBD. It does not dive into DRBD's inner workings deep enough to be a reference for DRBD developers. For that purpose, please refer to the papers listed in Section 18.6, "Publications" [109], and of course to the comments in the DRBD source code.

17.1. DRBD meta data

DRBD stores various pieces of information about the data it keeps in a dedicated area. This metadata includes:

- the size of the DRBD device,
- the Generation Identifier (GI, described in detail in Section 17.2, "Generation Identifiers" [103]),
- the Activity Log (AL, described in detail in Section 17.3, "The Activity Log" [106]).
- the quick-sync bitmap (described in detail in Section 17.4, "The quick-sync bitmap" [107]),

This metadata may be stored *internally* and *externally*. Which method is used is configurable on a per-resource basis.

17.1.1. Internal meta data

Configuring a resource to use internal meta data means that DRBD stores its meta data on the same physical lower-level device as the actual production data. It does so by setting aside an area at the *end* of the device for the specific purpose of storing metadata.

Advantage. Since the meta data are inextricably linked with the actual data, no special action is required from the administrator in case of a hard disk failure. The meta data are lost together with the actual data and are also restored together.

Disadvantage. In case of the lower-level device being a single physical hard disk (as opposed to a RAID set), internal meta data may negatively affect write throughput. The performance of write requests by the application may trigger an update of the meta data in DRBD. If the meta data are stored on the same magnetic disk of a hard disk, the write operation may result in two additional movements of the write/read head of the hard disk.

Caution

If you are planning to use internal meta data in conjunction with an existing lower-level device that already has data which you wish to preserve, you *must* account for the space required by DRBD's meta data.

Otherwise, upon DRBD resource creation, the newly created metadata would overwrite data at the end of the lower-level device, potentially destroying existing files in the process. To avoid that, you must do one of the following things:

- Enlarge your lower-level device. This is possible with any logical volume management facility (such as LVM) as long as you have free space available in the corresponding volume groupIt may also be supported by hardware storage solutions.
- Shrink your existing file system on your lower-level device. This may or may not be supported by your file system.

- If neither of the two are possible, use external meta data [102] instead.

To estimate the amount by which you must enlarge your lower-level device our shrink your file system, see Section 17.1.3, “Estimating meta data size” [102].

17.1.2. External meta data

External meta data is simply stored on a separate, dedicated block device distinct from that which holds your production data.

Advantage. For some write operations, using external meta data produces a somewhat improved latency behavior.

Disadvantage. Meta data are not inextricably linked with the actual production data. This means that manual intervention is required in the case of a hardware failure destroying just the production data (but not DRBD meta data), to effect a full data sync from the surviving node onto the subsequently replaced disk.

Use of external meta data is also the only viable option if *all* of the following apply:

- You are using DRBD to duplicate an existing device that already contains data you wish to preserve, *and*
- that existing device does not support enlargement, *and*
- the existing file system on the device does not support shrinking.

To estimate the required size of the block device dedicated to hold your device meta data, see Section 17.1.3, “Estimating meta data size” [102].

17.1.3. Estimating meta data size

You may calculate the exact space requirements for DRBD’s meta data using the following formula:

Figure 17.1. Calculating DRBD meta data size (exactly)

$$M_s = \left\lceil \frac{C_s}{2^{18}} \right\rceil \text{£}\ 8 + 72$$

C_s is the data device size in sectors.

Note

You may retrieve the device size by issuing `blockdev --getsz <device>`.

The result, M_s, is also expressed in sectors. To convert to MB, divide by 2048 (for a 512-byte sector size, which is the default on all Linux platforms except s390).

In practice, you may use a reasonably good approximation, given below. Note that in this formula, the unit is megabytes, not sectors:

Figure 17.2. Estimating DRBD meta data size (approximately)

$$M_{MB} < \frac{C_{MB}}{32768} + 1$$

17.2. Generation Identifiers

DRBD uses *generation identifiers* (GIs) to identify "generations"of replicated data.

This is DRBD's internal mechanism used for

- determining whether the two nodes are in fact members of the same cluster (as opposed to two nodes that were connected accidentally),
- determining the direction of background re-synchronization (if necessary),
- determining whether full re-synchronization is necessary or whether partial re-synchronization is sufficient,
- identifying split brain.

17.2.1. Data generations

DRBD marks the start of a new *data generation* at each of the following occurrences:

- The initial device full sync,
- a disconnected resource switching to the primary role,
- a resource in the primary role disconnecting.

Thus, we can summarize that whenever a resource is in the `Connected` connection state, and both nodes' disk state is `UpToDate`, the current data generation on both nodes is the same. The inverse is also true.

Every new data generation is identified by a 8-byte, universally unique identifier (UUID).

17.2.2. The generation identifier tuple

DRBD keeps four pieces of information about current and historical data generations in the local resource meta data:

Current UUID. This is the generation identifier for the current data generation, as seen from the local node's perspective. When a resource is `Connected` and fully synchronized, the current UUID is identical between nodes.

Bitmap UUID. This is the UUID of the generation against which the on-disk sync bitmap is tracking changes. As the on-disk sync bitmap itself, this identifier is only relevant while in disconnected mode. If the resource is `Connected`, this UUID is always empty (zero).

Two Historical UUIDs. These are the identifiers of the two data generations preceding the current one.

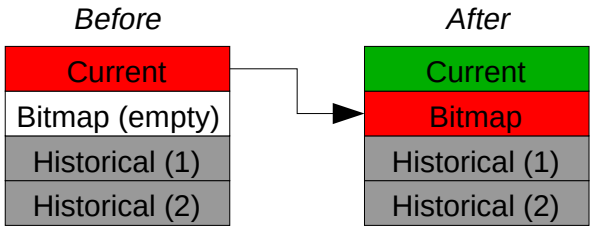
Collectively, these four items are referred to as the *generation identifier tuple*, or GI tuple" for short.

17.2.3. How generation identifiers change

17.2.3.1. Start of a new data generation

When a node loses connection to its peer (either by network failure or manual intervention), DRBD modifies its local generation identifiers in the following manner:

Figure 17.3. GI tuple changes at start of a new data generation

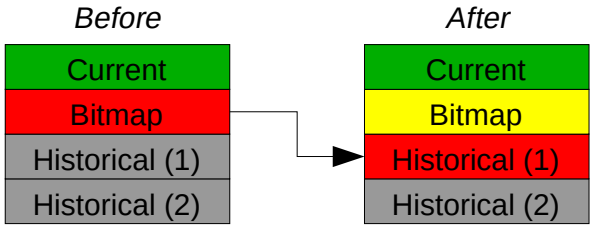


1. A new UUID is created for the new data generation. This becomes the new current UUID for the primary node.
2. The previous UUID now refers to the generation the bitmap is tracking changes against, so it becomes the new bitmap UUID for the primary node.
3. On the secondary node, the GI tuple remains unchanged.

17.2.3.2. Start of re-sychronization

Upon the initiation of re-synchronization, DRBD performs these modifications on the local generation identifiers:

Figure 17.4. GI tuple changes at start of re-synchronization

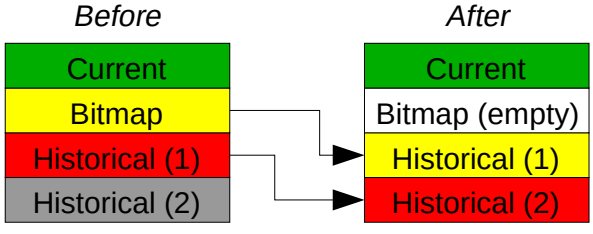


1. The current UUID on the synchronization source remains unchanged.
2. The bitmap UUID on the synchronization source is rotated out to the first historical UUID.
3. A new bitmap UUID is generated on the synchronization source.
4. This UUID becomes the new current UUID on the synchronization target.
5. The bitmap and historical UUID's on the synchronization target remain unchanged.

17.2.3.3. Completion of re-synchronization

When re-synchronization concludes, the following changes are performed:

Figure 17.5. GI tuple changes at completion of re-synchronization



1. The current UUID on the synchronization source remains unchanged.

2. The bitmap UUID on the synchronization source is rotated out to the first historical UUID, with that UUID moving to the second historical entry (any existing second historical entry is discarded).

3. The bitmap UUID on the synchronization source is then emptied (zeroed).

4. The synchronization target adopts the entire GI tuple from the synchronization source.

17.2.4. How DRBD uses generation identifiers

When a connection between nodes is established, the two nodes exchange their currently available generation identifiers, and proceed accordingly. A number of possible outcomes exist:

Current UUIDs empty on both nodes. The local node detects that both its current UUID and the peer's current UUID are empty. This is the normal occurrence for a freshly configured resource that has not had the initial full sync initiated. No synchronization takes place; it has to be started manually.

Current UUIDs empty on one node. The local node detects that the peer's current UUID is empty, and its own is not. This is the normal case for a freshly configured resource on which the initial full sync has just been initiated, the local node having been selected as the initial synchronization source. DRBD now sets all bits in the on-disk sync bitmap (meaning it considers the entire device out-of-sync), and starts synchronizing as a synchronization source. In the opposite case (local current UUID empty, peer's non-empty), DRBD performs the same steps, except that the local node becomes the synchronization target.

Equal current UUIDs. The local node detects that its current UUID and the peer's current UUID are non-empty and equal. This is the normal occurrence for a resource that went into disconnected mode at a time when it was in the secondary role, and was not promoted on either node while disconnected. No synchronization takes place, as none is necessary.

Bitmap UUID matches peer's current UUID. The local node detects that its bitmap UUID matches the peer's current UUID, and that the peer's bitmap UUID is empty. This is the normal and expected occurrence after a secondary node failure, with the local node being in the primary role. It means that the peer never became primary in the meantime and worked on the basis of the same data generation all along. DRBD now initiates a normal, background re-synchronization, with the local node becoming the synchronization source. If, conversely, the local node detects that *its* bitmap UUID is empty, and that the *peer's* bitmap matches the local node's current UUID, then that is the normal and expected occurrence after a failure of the local node. Again, DRBD now initiates a normal, background re-synchronization, with the local node becoming the synchronization target.

Current UUID matches peer's historical UUID. The local node detects that its current UUID matches one of the peer's historical UUID's. This implies that while the two data sets share a common ancestor, and the local node has the up-to-date data, the information kept in the local node's bitmap is outdated and not useable. Thus, a normal synchronization would be insufficient. DRBD now marks the entire device as out-of-sync and initiates a full background re-synchronization, with the local node becoming the synchronization source. In the opposite case (one of the local node's historical UUID matches the peer's current UUID), DRBD performs the same steps, except that the local node becomes the synchronization target.

Bitmap UUIDs match, current UUIDs do not. The local node detects that its current UUID differs from the peer's current UUID, and that the bitmap UUID's match. This is split brain, but one where the data generations have the same parent. This means that DRBD invokes split brain auto-recovery strategies, if configured. Otherwise, DRBD disconnects and waits for manual split brain resolution.

Neither current nor bitmap UUIDs match. The local node detects that its current UUID differs from the peer's current UUID, and that the bitmap UUID's *do not* match. This is split brain with unrelated ancestor generations, thus auto-recovery strategies, even if configured, are moot. DRBD disconnects and waits for manual split brain resolution.

No UUIDs match. Finally, in case DRBD fails to detect even a single matching element in the two nodes' GI tuples, it logs a warning about unrelated data and disconnects. This is DRBD's safeguard against accidental connection of two cluster nodes that have never heard of each other before.

17.3. The Activity Log

17.3.1. Purpose

During a write operation DRBD forwards the write operation to the local backing block device, but also sends the data block over the network. These two actions occur, for all practical purposes, simultaneously. Random timing behavior may cause a situation where the write operation has been completed, but the transmission via the network has not yet taken place.

If, at this moment, the active node fails and fail-over is being initiated, then this data block is out of sync between nodes — it has been written on the failed node prior to the crash, but replication has not yet completed. Thus, when the node eventually recovers, this block must be removed from the data set of during subsequent synchronisation. Otherwise, the crashed node would be "one write ahead" of the surviving node, which would violate the "all or nothing" principle of replicated storage. This is an issue that is not limited to DRBD, in fact, this issue exists in practically all replicated storage configurations. Many other storage solutions (just as DRBD itself, prior to version 0.7) thus require that after a failure of the active, that node must be fully synchronized anew after its recovery.

DRBD's approach, since version 0.7, is a different one. The *activity log* (AL), stored in the meta data area, keeps track of those blocks that have "recently" been written to. Colloquially, these areas are referred to as *hot extents*.

If a temporarily failed node that was in active mode at the time of failure is synchronized, only those hot extents highlighted in the AL need to be synchronized, rather than the full device. This drastically reduces synchronization time after an active node crash.

17.3.2. Active extents

The activity log has a configurable parameter, the number of active extents. Every active extent adds 4MiB to the amount of data being retransmitted after a Primary crash. This parameter must be understood as a compromise between the following opposites:

Many active extents. Keeping a large activity log improves write throughput. Every time a new extent is activated, an old extent is reset to inactive. This transition requires a write operation to the meta data area. If the number of active extents is high, old active extents are swapped out fairly rarely, reducing meta data write operations and thereby improving performance.

Few active extents. Keeping a small activity log reduces synchronization time after active node failure and subsequent recovery.

17.3.3. Selecting a suitable Activity Log size

The definition of the number of extents should be based on the desired synchronisation time at a given synchronization rate. The number of active extents can be calculated as follows:

Figure 17.6. Active extents calculation based on sync rate and target sync time

$$E = \frac{R \cdot t_{sync}}{4}$$

R is the synchronization rate, given in MB/s. t_{sync} is the target synchronization time, in seconds. E is the resulting number of active extents.

To provide an example, suppose our cluster has an I/O subsystem with a throughput rate of 90 MiByte/s that was configured to a synchronization rate of 30 MiByte/s (R=30), and we want to keep our target synchronization time at 4 minutes or 240 seconds (t_{sync}=240):

Figure 17.7. Active extents calculation based on sync rate and target sync time (example)

$$E = \frac{30 \cdot 240}{4} = 1800 \rightarrow 1801$$

The exact result is 1800, but since DRBD's hash function for the implementation of the AL works best if the number of extents is set to a prime number, we select 1801.

17.4. The quick-sync bitmap

The quick-sync bitmap is the internal data structure which DRBD uses, on a per-resource basis, to keep track of blocks being in sync (identical on both nodes) or out-of sync. It is only relevant when a resource is in disconnected mode.

In the quick-sync bitmap, one bit represents a 4-KiB chunk of on-disk data. If the bit is cleared, it means that the corresponding block is still in sync with the peer node. That implies that the block has not been written to since the time of disconnection. Conversely, if the bit is set, it means that the block has been modified and needs to be re-synchronized whenever the connection becomes available again.

As DRBD detects write I/O on a disconnected device, and hence starts setting bits in the quick-sync bitmap, it does so in RAM — thus avoiding expensive synchronous metadata I/O operations. Only when the corresponding blocks turn cold (that is, expire from the Activity Log [106]), DRBD makes the appropriate modifications in an on-disk representation of the quick-sync bitmap. Likewise, if the resource happens to be manually shut down on the remaining node while disconnected, DRBD flushes the *complete* quick-sync bitmap out to persistent storage.

When the peer node recovers or the connection is re-established, DRBD combines the bitmap information from both nodes to determine the *total data set* that it must re-synchronize. Simultaneously, DRBD examines the generation identifiers [105] to determine the *direction* of synchronization.

The node acting as the synchronization source then transmits the agreed-upon blocks to the peer node, clearing sync bits in the bitmap as the synchronization target acknowledges the modifications. If the re-synchronization is now interrupted (by another network outage, for example) and subsequently resumed it will continue where it left off — with any additional blocks modified in the meantime being added to the re-synchronization data set, of course.

Note

Re-synchronization may be also be paused and resumed manually with the `drbdadm pause-sync` and `drbdadm resume-sync` commands. You should, however, not do so light-heartedly — interrupting re-synchronization leaves your secondary node's disk `Inconsistent` longer than necessary.

17.5. The peer fencing interface

DRBD has a defined interface for the mechanism that fences the peer node in case of the replication link being interrupted. The `drbd-peer-outdater` helper, bundled with Heartbeat, is the reference implementation for this interface. However, you may easily implement your own peer fencing helper program.

The fencing helper is invoked only in case

1. a `fence-peer` handler has been defined in the resource's (or common) `handlers` section, *and*

2. the `fencing` option for the resource is set to either `resource-only` or `resource-and-stonith`, *and*

3. the replication link is interrupted long enough for DRBD to detect a network failure.

The program or script specified as the `fence-peer` handler, when it is invoked, has the `DRBD_RESOURCE` and `DRBD_PEER` environment variables available. They contain the name of the affected DRBD resource and the peer's hostname, respectively.

Any peer fencing helper program (or script) must return one of the following exit codes:

Table 17.1. `fence-peer` handler exit codes

Exit code	Implication
3	Peer's disk state was already `Inconsistent`.
4	Peer's disk state was successfully set to `Outdated` (or was `Outdated` to begin with).
5	Connection to the peer node failed, peer could not be reached.
6	Peer refused to be outdated because the affected resource was in the primary role.
7	Peer node was successfully fenced off the cluster. This should never occur unless `fencing` is set to `resource-and-stonith` for the affected resource.

Chapter 18. Getting more information

18.1. Commercial DRBD support

Commercial DRBD support, consultancy, and training services are available from the project's sponsor company, LINBIT [http://www.linbit.com/].

18.2. Public mailing list

The public mailing list for general usage questions regarding DRBD is drbd-user@lists.linbit.com [mailto:drbd-user@lists.linbit.com]. This is a subscribers-only mailing list, you may subscribe at http://lists.linbit.com/drbd-user. A complete list archive is available at http://lists.linbit.com/pipermail/drbd-user.

18.3. Public IRC Channels

Some of the DRBD developers can occasionally be found on the `irc.freenode.net` public IRC server, particularly in the following channels:

- `#drbd`,
- `#linux-ha`,
- `#linux-cluster`.

Getting in touch on IRC is a good way of discussing suggestions for improvements in DRBD, and having developer level discussions.

18.4. Blogs

- Florian Haas, one of the co-authors of this guide, maintains a technical blog [http://blogs.linbit.com/florian].
- Martin Loschwitz a.k.a. `madkiss`, another LINBIT [http://www.linbit.com] employee and co-maintainer of the Debian [http://www.debian.org] DRBD packages, keeps a personal blog [http://blogs.linbit.com/martin] in German.
- Planet HA [http://www.planet-ha.org/] is an aggregated feed centralizing blog posts from a number of high availability developers, technical consultants, and users.

18.5. Official Twitter account

LINBIT [http://www.linbit.com/] maintains an official twitter account, `linbit` [http://twitter.com/linbit].

If you tweet about DRBD, please include the `#drbd` hashtag.

18.6. Publications

DRBD's authors have written and published a number of papers on DRBD in general, or a specific aspect of DRBD. Here is a short selection:

Lars Ellenberg. *DRBD v8.0.x and beyond*. 2007. Available at http://www.drbd.org/fileadmin/drbd/publications/drbd8.linux-conf.eu.2007.pdf

Philipp Reisner. *DRBD v8 – Replicated Storage with Shared Disk Semantics*. 2007. Available at http://www.drbd.org/fileadmin/drbd/publications/drbd8.pdf.

Philipp Reisner. *Rapid resynchronization for replicated storage*. 2006. Available at http://www.drbd.org/fileadmin/drbd/publications/drbd-activity-logging_v6.pdf

18.7. Other useful resources

- Wikipedia keeps an entry on DRBD [http://en.wikipedia.org/wiki/DRBD].
- Both the Linux-HA wiki [http://wiki.linux-ha.org/] and
- ClusterLabs [http://www.clusterlabs.org] have some useful information about utilizing DRBD in High Availability clusters.

Part VII. Appendices

Appendix A. Recent changes

This appendix is for users who upgrade from earlier DRBD versions to DRBD 8.4. It highlights some important changes to DRBD's configuration and behavior.

A.1. Volumes

Volumes are a new concept in DRBD 8.4. Prior to 8.4, every resource had only one block device associated with it, thus there was a one-to-one relationship between DRBD devices and resources. Since 8.4, multiple volumes (each corresponding to one block device) may share a single replication connection, which in turn corresponds to a single resource.

A.1.1. Changes to udev symlinks

The DRBD udev integration scripts manage symlinks pointing to individual block device nodes. These exist in the `/dev/drbd/by-res` and `/dev/drbd/by-disk` directories.

In DRBD 8.3 and earlier, links in `/dev/drbd/by-disk` point to single block devices:

udev managed DRBD symlinks in DRBD 8.3 and earlier.

```
lrwxrwxrwx 1 root root 11 2011-05-19 11:46 /dev/drbd/by-res/home ->
  ../../drbd0
lrwxrwxrwx 1 root root 11 2011-05-19 11:46 /dev/drbd/by-res/data ->
  ../../drbd1
lrwxrwxrwx 1 root root 11 2011-05-19 11:46 /dev/drbd/by-res/nfs-root ->
  ../../drbd2
```

In DRBD 8.4, since a single resource may correspond to multiple volumes, `/dev/drbd/by-res/<resource>` becomes a *directory*, containing symlinks pointing to individual volumes:

udev managed DRBD symlinks in DRBD 8.4.

```
lrwxrwxrwx 1 root root 11 2011-07-04 09:22 /dev/drbd/by-res/home/0 ->
  ../../drbd0
lrwxrwxrwx 1 root root 11 2011-07-04 09:22 /dev/drbd/by-res/data/0 ->
  ../../drbd1
lrwxrwxrwx 1 root root 11 2011-07-04 09:22 /dev/drbd/by-res/nfs-root/0 ->
  ../../drbd2
lrwxrwxrwx 1 root root 11 2011-07-04 09:22 /dev/drbd/by-res/nfs-root/1 ->
   ../../drbd3
```

Configurations where filesystems are referred to by symlink must be updated when moving to DRBD 8.4, usually by simply appending `/0` to the symlink path.

A.2. Changes to the configuration syntax

This section highlights changes to the configuration syntax. It affects the DRBD configuration files in `/etc/drbd.d`, and `/etc/drbd.conf`.

Important

The `drbdadm` parser still accepts pre-8.4 configuration syntax and automatically translates, internally, into the current syntax. Unless you are planning to use new features not present in prior DRBD releases, there is no requirement to modify your configuration to the current syntax. It is, however, recommended that you eventually adopt the new syntax, as the old format will no longer be supported in DRBD 9.

A.2.1. Boolean configuration options

`drbd.conf` supports a variety of boolean configuration options. In pre DRBD 8.4 syntax, these boolean options would be set as follows:

Pre-DRBD 8.4 configuration example with boolean options.

```
resource test {
  disk {
    no-md-flushes;
  }
}
```

This led to configuration issues if you wanted to set a boolean variable in the `common` configuration section, and then override it for individual resources:

Pre-DRBD 8.4 configuration example with boolean options in `common` section.

```
common {
  no-md-flushes;
}
resource test {
  disk {
    # No facility to enable disk flushes previously disabled in
    # "common"
  }
}
```

In DRBD 8.4, all boolean options take a value of `yes` or `no`, making them easily configurable both from `common` and from individual `resource` sections:

DRBD 8.4 configuration example with boolean options in `common` section.

```
common {
  md-flushes no;
}
resource test {
  disk {
    md-flushes yes;
  }
}
```

A.2.2. `syncer` section no longer exists

Prior to DRBD 8.4, the configuration syntax allowed for a `syncer` section which has become obsolete in 8.4. All previously existing `syncer` options have now moved into the `net` or `disk` sections of resources.

Pre-DRBD 8.4 configuration example with `syncer` section.

```
resource test {
  syncer {
    al-extents 3389;
    verify-alg md5;
  }
  ...
}
```

The above example is expressed, in DRBD 8.4 syntax, as follows:

DRBD 8.4 configuration example with `syncer` section replaced.

```
resource test {
  disk {
    al-extents 3389;
  }
  net {
    verify-alg md5;
  }
  ...
}
```

A.2.3. `protocol` option is no longer special

In prior DRBD releases, the `protocol` option was awkwardly (and counter-intuitively) required to be specified on its own, rather than as part of the `net` section. DRBD 8.4 removes this anomaly:

Pre-DRBD 8.4 configuration example with standalone `protocol` option.

```
resource test {
  protocol C;
  ...
  net {
    ...
  }
  ...
}
```

The equivalent DRBD 8.4 configuration syntax is:

DRBD 8.4 configuration example with `protocol` option within `net` section.

```
resource test {
  net {
    protocol C;
    ...
  }
  ...
}
```

A.2.4. New per-resource `options` section

DRBD 8.4 introduces a new `options` section that may be specified either in a `resource` or in the `common` section. The `cpu-mask` option has moved into this section from the `syncer` section in which it was awkwardly configured before. The `on-no-data-accessible` option has also moved to this section, rather than being in `disk` where it had been in pre-8.4 releases.

Pre-DRBD 8.4 configuration example with `cpu-mask` and `on-no-data-accessible`.

```
resource test {
  syncer {
    cpu-mask ff;
  }
  disk {
    on-no-data-accessible suspend-io;
  }
  ...
}
```

The equivalent DRBD 8.4 configuration syntax is:

Pre-DRBD 8.4 configuration example with `options` section.

```
resource test {
  options {
    cpu-mask ff;
    on-no-data-accessible suspend-io;
  }
  ...
}
```

A.3. On-line changes to network communications

A.3.1. Changing the replication protocol

Prior to DRBD 8.4, changes to the replication protocol were impossible while the resource was on-line and active. You would have to change the `protocol` option in your resource configuration file, then issue `drbdadm disconnect` and finally `drbdadm connect` on both nodes.

In DRBD 8.4, the replication protocol can be changed on the fly. You may, for example, temporarily switch a connection to asynchronous replication from its normal, synchronous replication mode.

Changing replication protocol while connection is established.

```
drbdadm net-options --protocol=A <resource>
```

A.3.2. Changing from single-Primary to dual-Primary replication

Prior to DRBD 8.4, it was impossible to switch between single-Primary to dual-Primary or back while the resource was on-line and active. You would have to change the `allow-two-primaries` option in your resource configuration file, then issue `drbdadm disconnect` and finally `drbdadm connect` on both nodes.

In DRBD 8.4, it is possible to switch modes on-line.

Caution

It is *required* for an application using DRBD dual-Primary mode to use a clustered file system or some other distributed locking mechanism. This applies regardless of whether dual-Primary mode is enabled on a temporary or permanent basis.

Refer to Section 6.5.2, "Temporary dual-primary mode" [38] for switching to dual-Primary mode while the resource is on-line.

A.4. Changes to the `drbdadm` command

A.4.1. Changes to pass-through options

Prior to DRBD 8.4, if you wanted `drbdadm` to pass special options through to `drbdsetup`, you had to use the arcane `-- --<option>` syntax, as in the following example:

Pre-DRBD 8.4 `drbdadm` pass-through options.

```
drbdadm -- --discard-my-data connect <resource>
```

Instead, `drbdadm` now accepts those pass-through options as normal options:

DRBD 8.4 `drbdadm` pass-through options.

```
drbdadm connect --discard-my-data <resource>
```

Note

The old syntax is still supported, but its use is strongly discouraged. However, if you choose to use the new, more straightforward syntax, you must specify the option (`--discard-my-data`) *after* the subcommand (`connect`) and *before* the resource identifier.

A.4.2. `--force` option replaces `--overwrite-data-of-peer`

The `--overwrite-data-of-peer` option is no longer present in DRBD 8.4. It has been replaced by the simpler `--force`. Thus, to kick off an initial resource synchronization, you no longer use the following command:

Pre-DRBD 8.4 initial sync `drbdadm` commands.

```
drbdadm -- --overwrite-data-of-peer primary <resource>
```

Use the command below instead:

DRBD 8.4 initial sync `drbdadm` commands.

```
drbdadm primary --force <resource>
```

A.5. Changed default values

In DRBD 8.4, several `drbd.conf` default values have been updated to match improvements in the Linux kernel and available server hardware.

A.5.1. Number of concurrently active Activity Log extents (`al-extents`)

`al-extents`' previous default of 127 has changed to 1237, allowing for better performance by reducing the amount of metadata disk write operations. The associated extended resynchronization time after a primary node crash, which this change introduces, is marginal given the ubiquity of Gigabit Ethernet and higher-bandwidth replication links.

A.5.2. Run-length encoding (`use-rle`)

Run-length encoding (RLE) for bitmap transfers is enabled by default in DRBD 8.4; the default for the `use-rle` option is `yes`. RLE greatly reduces the amount of data transferred during the quick-sync bitmap [107] exchange (which occurs any time two disconnected nodes reconnect).

A.5.3. I/O error handling strategy (`on-io-error`)

DRBD 8.4 defaults to masking I/O errors [10], which replaces the earlier behavior of passing them on [10] to upper layers in the I/O stack. This means that a DRBD volume operating on a

faulty drive automatically switches to the `Diskless` disk state and continues to serve data from its peer node.

A.5.4. Variable-rate synchronization

Variable-rate synchronization [7] is on by default in DRBD 8.4. The default settings are equivalent to the following configuration options:

DRBD 8.4 default options for variable-rate synchronization.

```
resource test {
  net {
    c-plan-ahead 20;
    c-fill-target 50k;
    c-min-rate 250k;
  }
  ...
```

A.5.5. Number of configurable DRBD devices (`minor-count`)

The maximum number of configurable DRBD devices (previously 255) is 1,048,576 (2^{20}) in DRBD 8.4. This is more of a theoretical limit that is unlikely to be reached in production systems.

Appendix B. DRBD system manual pages

Name

drbd.conf — Configuration file for DRBD's devices

Introduction

The file `/etc/drbd.conf` is read by `drbdadm`.

The file format was designed as to allow to have a verbatim copy of the file on both nodes of the cluster. It is highly recommended to do so in order to keep your configuration manageable. The file `/etc/drbd.conf` should be the same on both nodes of the cluster. Changes to `/etc/drbd.conf` do not apply immediately.

By convention the main config contains two include statements. The first one includes the file `/etc/drbd.d/global_common.conf`, the second one all file with a `.res` suffix.

Example B.1. A small example.res file

```
resource r0 {
 net {
  protocol C;
  cram-hmac-alg sha1;
  shared-secret "FooFunFactory";
 }
 disk {
  resync-rate 10M;
 }
 on alice {
  volume 0 {
   device    minor 1;
   disk      /dev/sda7;
   meta-disk internal;
  }
  address   10.1.1.31:7789;
 }
 on bob {
  volume 0 {
   device    minor 1;
   disk      /dev/sda7;
   meta-disk internal;
  }
  address   10.1.1.32:7789;
 }
}
```

In this example, there is a single DRBD resource (called r0) which uses protocol C for the connection between its devices. It contains a single volume which runs on host *`alice`* uses */dev/drbd1* as devices for its application, and */dev/sda7* as low-level storage for the data. The IP addresses are used to specify the networking interfaces to be used. An eventually running resync process should use about 10MByte/second of IO bandwidth. This sync-rate statement is valid for volume 0, but would also be valid for further volumes. In this example it assigns full 10MByte/second to each volume.

There may be multiple resource sections in a single drbd.conf file. For more examples, please have a look at the *DRBD User's Guide* [http://www.drbd.org/users-guide/].

File Format

The file consists of sections and parameters. A section begins with a keyword, sometimes an additional name, and an opening brace ("{"). A section ends with a closing brace ("}"). The braces enclose the parameters.

section [name] { parameter value; [...] }

A parameter starts with the identifier of the parameter followed by whitespace. Every subsequent character is considered as part of the parameter's value. A special case are Boolean parameters which consist only of the identifier. Parameters are terminated by a semicolon (";").

Some parameter values have default units which might be overruled by K, M or G. These units are defined in the usual way (K = 2^10 = 1024, M = 1024 K, G = 1024 M).

Comments may be placed into the configuration file and must begin with a hash sign ("#"). Subsequent characters are ignored until the end of the line.

Sections

`skip`

Comments out chunks of text, even spanning more than one line. Characters between the keyword `skip` and the opening brace ("{") are ignored. Everything enclosed by the braces is skipped. This comes in handy, if you just want to comment out some '`resource [name] {...}`' section: just precede it with '"skip"'.

`global`

Configures some global parameters. Currently only `minor-count`, `dialog-refresh`, `disable-ip-verification` and `usage-count` are allowed here. You may only have one global section, preferably as the first section.

`common`

All resources inherit the options set in this section. The common section might have a `startup`, a `options`, a `handlers`, a `net` and a `disk` section.

`resource` *`name`*

Configures a DRBD resource. Each resource section needs to have two (or more) `on` *`host`* sections and may have a `startup`, a `options`, a `handlers`, a `net` and a `disk` section. It might contain `volumes` sections.

`on` *`host-name`*

Carries the necessary configuration parameters for a DRBD device of the enclosing resource. *`host-name`* is mandatory and must match the Linux host name (uname -n) of one of the nodes. You may list more than one host name here, in case you want to use the same parameters on several hosts (you'd have to move the IP around usually). Or you may list more than two such sections.

```
resource r1 {
 protocol C;
 device minor 1;
 meta-disk internal;

 on alice bob {
  address 10.2.2.100:7801;
  disk /dev/mapper/some-san;
 }
 on charlie {
```

```
  address 10.2.2.101:7801;
  disk /dev/mapper/other-san;
 }
 on daisy {
  address 10.2.2.103:7801;
  disk /dev/mapper/other-san-as-seen-from-daisy;
 }
}
```

See also the `floating` section keyword. Required statements in this section: `address` and `volume`. Note for backward compatibility and convenience it is valid to embed the statements of a single volume directly into the host section.

`volume` *`vnr`*

Defines a volume within a connection. The minor numbers of a replicated volume might be different on different hosts, the volume number (*`vnr`*) is what groups them together. Required parameters in this section: `device`, `disk`, `meta-disk`.

`stacked-on-top-of` *`resource`*

For a stacked DRBD setup (3 or 4 nodes), a `stacked-on-top-of` is used instead of an `on` section. Required parameters in this section: `device` and `address`.

`floating` *`AF addr:port`*

Carries the necessary configuration parameters for a DRBD device of the enclosing resource. This section is very similar to the `on` section. The difference to the `on` section is that the matching of the host sections to machines is done by the IP-address instead of the node name. Required parameters in this section: `device`, `disk`, `meta-disk`, all of which *may* be inherited from the resource section, in which case you may shorten this section down to just the address identifier.

```
resource r2 {
 protocol C;
 device minor 2;
 disk      /dev/sda7;
 meta-disk internal;

 # short form, device, disk and meta-disk inherited
 floating 10.1.1.31:7802;

 # longer form, only device inherited
 floating 10.1.1.32:7802 {
  disk /dev/sdb;
  meta-disk /dev/sdc8;
 }
}
```

`disk`

This section is used to fine tune DRBD's properties in respect to the low level storage. Please refer to drbdsetup(8) for detailed description of the parameters. Optional parameters: `on-io-error`, `size`, `fencing`, `disk-barrier`, `disk-flushes`, `disk-drain`, `md-flushes`, `max-bio-bvecs`, `resync-rate`, `resync-after`, `al-extents`, `c-plan-ahead`,

c-fill-target, c-delay-target, c-max-rate, c-min-rate, disk-timeout.

net — This section is used to fine tune DRBD's properties. Please refer to drbdsetup(8) for a detailed description of this section's parameters. Optional parameters: protocol, sndbuf-size, rcvbuf-size, timeout, connect-int, ping-int, ping-timeout, max-buffers, max-epoch-size, ko-count, allow-two-primaries, cram-hmac-alg, shared-secret, after-sb-0pri, after-sb-1pri, after-sb-2pri, data-integrity-alg, no-tcp-cork, on-congestion, congestion-fill, congestion-extents, verify-alg, use-rle, csums-alg.

startup — This section is used to fine tune DRBD's properties. Please refer to drbdsetup(8) for a detailed description of this section's parameters. Optional parameters: wfc-timeout, degr-wfc-timeout, outdated-wfc-timeout, wait-after-sb, stacked-timeouts and become-primary-on.

options — This section is used to fine tune the behaviour of the resource object. Please refer to drbdsetup(8) for a detailed description of this section's parameters. Optional parameters: cpu-mask, and on-no-data-accessible.

handlers — In this section you can define handlers (executables) that are started by the DRBD system in response to certain events. Optional parameters: pri-on-incon-degr, pri-lost-after-sb, pri-lost, fence-peer (formerly oudate-peer), local-io-error, initial-split-brain, split-brain, before-resync-target, after-resync-target.

The interface is done via environment variables:

- DRBD_RESOURCE is the name of the resource
- DRBD_MINOR is the minor number of the DRBD device, in decimal.
- DRBD_CONF is the path to the primary configuration file; if you split your configuration into multiple files (e.g. in /etc/drbd.conf.d/), this will not be helpful.
- DRBD_PEER_AF , DRBD_PEER_ADDRESS , DRBD_PEERS are the address family (e.g. ipv6), the peer's address and hostnames.

DRBD_PEER is deprecated.

Please note that not all of these might be set for all handlers, and that some values might not be useable for a floating definition.

Parameters

minor-count *count* — *count* may be a number from 1 to FIXME.

Minor-count is a sizing hint for DRBD. It helps to right-size various memory pools. It should be set in the in the same order of magnitude than the actual number of minors you use. Per default the module loads with 11 more resources than you have currently in your config but at least 32.

`dialog-refresh` *time*

time may be 0 or a positive number.

The user dialog redraws the second count every *time* seconds (or does no redraws if *time* is 0). The default value is 1.

`disable-ip-verification`

Use *disable-ip-verification* if, for some obscure reasons, drbdadm can/might not use `ip` or `ifconfig` to do a sanity check for the IP address. You can disable the IP verification with this option.

`usage-count` *val*

Please participate in *DRBD's online usage counter* [http://usage.drbd.org]. The most convenient way to do so is to set this option to `yes`. Valid options are: `yes`, `no` and `ask`.

`protocol` *prot-id*

On the TCP/IP link the specified *protocol* is used. Valid protocol specifiers are A, B, and C.

Protocol A: write IO is reported as completed, if it has reached local disk and local TCP send buffer.

Protocol B: write IO is reported as completed, if it has reached local disk and remote buffer cache.

Protocol C: write IO is reported as completed, if it has reached both local and remote disk.

`device` *name* `minor` *nr*

The name of the block device node of the resource being described. You must use this device with your application (file system) and you must not use the low level block device which is specified with the `disk` parameter.

One can ether omit the *name* or `minor` and the *minor number*. If you omit the *name* a default of /dev/drbd*minor* will be used.

Udev will create additional symlinks in /dev/drbd/by-res and /dev/drbd/by-disk.

`disk` *name*

DRBD uses this block device to actually store and retrieve the data. Never access such a device while DRBD is running on top of it. This also holds true for dumpe2fs(8) and similar commands.

`address` *AF addr:port*

A resource needs one *IP* address per device, which is used to wait for incoming connections from the partner device respectively to reach the partner device. *AF* must be one of `ipv4`, `ipv6`, `ssocks` or `sdp` (for compatibility reasons `sci` is an alias for `ssocks`). It may be omited for IPv4 addresses. The actual IPv6 address that follows the `ipv6` keyword must be placed inside brackets: `ipv6 [fd01:2345:6789:abcd::1]:7800`.

Each DRBD resource needs a TCP *port* which is used to connect to the node's partner device. Two different DRBD resources may not use the same *addr:port* combination on the same node.

`meta-disk internal`, `meta-disk` *device*, `meta-disk` *device* [*index*]

Internal means that the last part of the backing device is used to store the meta-data. The size of the meta-data is computed based on the size of the device.

When a *device* is specified, either with or without an *index*, DRBD stores the meta-data on this device. Without *index*, the size of the meta-data is determined by the size of the data device. This is usually used with LVM, which allows to have many variable sized block devices. The meta-data size is 36kB + Backing-Storage-size / 32k, rounded up to the next 4kb boundary. (Rule of the thumb: 32kByte per 1GByte of storage, rounded up to the next MB.)

When an *index* is specified, each index number refers to a fixed slot of meta-data of 128 MB, which allows a maximum data size of 4 GB. This way, multiple DBRD devices can share the same meta-data device. For example, if /dev/sde6[0] and /dev/sde6[1] are used, /dev/sde6 must be at least 256 MB big. Because of the hard size limit, use of meta-disk indexes is discouraged.

`on-io-error` *handler*

handler is taken, if the lower level device reports io-errors to the upper layers.

handler may be `pass_on`, `call-local-io-error` or `detach`.

`pass_on`: The node downgrades the disk status to inconsistent, marks the erroneous block as inconsistent in the bitmap and retries the IO on the remote node.

`call-local-io-error`: Call the handler script `local-io-error`.

`detach`: The node drops its low level device, and continues in diskless mode.

`fencing` *fencing_policy*

By `fencing` we understand preventive measures to avoid situations where both nodes are primary and disconnected (AKA split brain).

Valid fencing policies are:

`dont-care`

This is the default policy. No fencing actions are taken.

`resource-only`

If a node becomes a disconnected primary, it tries to fence the peer's disk. This is done by calling the `fence-peer` handler. The handler is supposed to reach the other node over alternative communication

paths and call 'drbdadm outdate res' there.

`resource-and-stonith` If a node becomes a disconnected primary, it freezes all its IO operations and calls its fence-peer handler. The fence-peer handler is supposed to reach the peer over alternative communication paths and call 'drbdadm outdate res' there. In case it cannot reach the peer it should stonith the peer. IO is resumed as soon as the situation is resolved. In case your handler fails, you can resume IO with the `resume-io` command.

`disk-barrier`, `disk-flushes`, `disk-drain`

`md-flushes`

Disables the use of disk flushes and barrier BIOs when accessing the meta data device. See the notes on `disk-flushes`.

`max-bio-bvecs`

In some special circumstances the device mapper stack manages to pass BIOs to DRBD that violate the constraints that are set forth by DRBD's merge_bvec() function and which have more than one bvec. A known example is: phys-disk -> DRBD -> LVM -> Xen -> misaligned partition (63) -> DomU FS. Then you might see "bio would need to, but cannot, be split:" in the Dom0's kernel log.

The best workaround is to proper align the partition within the VM (E.g. start it at sector 1024). This costs 480 KiB of storage. Unfortunately the default of most Linux partitioning tools is to start the first partition at an odd number (63). Therefore most distribution's install helpers for virtual linux machines will end up with misaligned partitions. The second best workaround is to limit DRBD's max bvecs per BIO (= `max-bio-bvecs`) to 1, but that might cost performance.

The default value of `max-bio-bvecs` is 0, which means that there is no user imposed limitation.

`disk-timeout`

If the driver of the *`lower_device`* does not finish an IO request within *`disk_timeout`*, DRBD considers the disk as failed. If DRBD is connected to a remote host, it will reissue local pending IO requests to the peer, and ship all new IO requests to the peer only. The disk state advances to diskless, as soon as the backing block device has finished all IO requests.

The default value of is 0, which means that no timeout is enforced. The default unit is 100ms. This option is available since 8.3.12.

`sndbuf-size` *size*
: *size* is the size of the TCP socket send buffer. The default value is 0, i.e. autotune. You can specify smaller or larger values. Larger values are appropriate for reasonable write throughput with protocol A over high latency networks. Values below 32K do not make sense. Since 8.0.13 resp. 8.2.7, setting the *size* value to 0 means that the kernel should autotune this.

`rcvbuf-size` *size*
: *size* is the size of the TCP socket receive buffer. The default value is 0, i.e. autotune. You can specify smaller or larger values. Usually this should be left at its default. Setting the *size* value to 0 means that the kernel should autotune this.

`timeout` *time*
: If the partner node fails to send an expected response packet within *time* tenths of a second, the partner node is considered dead and therefore the TCP/IP connection is abandoned. This must be lower than *connect-int* and *ping-int*. The default value is 60 = 6 seconds, the unit 0.1 seconds.

`connect-int` *time*
: In case it is not possible to connect to the remote DRBD device immediately, DRBD keeps on trying to connect. With this option you can set the time between two retries. The default value is 10 seconds, the unit is 1 second.

`ping-int` *time*
: If the TCP/IP connection linking a DRBD device pair is idle for more than *time* seconds, DRBD will generate a keep-alive packet to check if its partner is still alive. The default is 10 seconds, the unit is 1 second.

`ping-timeout` *time*
: The time the peer has time to answer to a keep-alive packet. In case the peer's reply is not received within this time period, it is considered as dead. The default value is 500ms, the default unit are tenths of a second.

`max-buffers` *number*
: Maximum number of requests to be allocated by DRBD. Unit is PAGE_SIZE, which is 4 KiB on most systems. The minimum is hard coded to 32 (=128 KiB). For high-performance installations it might help if you increase that number. These buffers are used to hold data blocks while they are written to disk.

`ko-count` *number*
: In case the secondary node fails to complete a single write request for *count* times the *timeout*, it is expelled from the cluster. (I.e. the primary node goes into `StandAlone` mode.) The default value is 0, which disables this feature.

`max-epoch-size` *number*
: The highest number of data blocks between two write barriers. If you set this smaller than 10, you might decrease your performance.

`allow-two-primaries`
: With this option set you may assign the primary role to both nodes. You only should use this option if you use a shared storage file system on top of DRBD. At the time of writing the only ones are: OCFS2 and GFS. If you use this option with any other file system, you are going to crash your nodes and to corrupt your data!

`unplug-watermark` *number*

When the number of pending write requests on the standby (secondary) node exceeds the `unplug-watermark`, we trigger the request processing of our backing storage device. Some storage controllers deliver better performance with small values, others deliver best performance when the value is set to the same value as max-buffers. Minimum 16, default 128, maximum 131072.

`cram-hmac-alg` You need to specify the HMAC algorithm to enable peer authentication at all. You are strongly encouraged to use peer authentication. The HMAC algorithm will be used for the challenge response authentication of the peer. You may specify any digest algorithm that is named in `/proc/crypto`.

`shared-secret` The shared secret used in peer authentication. May be up to 64 characters. Note that peer authentication is disabled as long as no `cram-hmac-alg` (see above) is specified.

`after-sb-0pri` *policy*

possible policies are:

`disconnect`	No automatic resynchronization, simply disconnect.
`discard-younger-primary`	Auto sync from the node that was primary before the split-brain situation happened.
`discard-older-primary`	Auto sync from the node that became primary as second during the split-brain situation.
`discard-zero-changes`	In case one node did not write anything since the split brain became evident, sync from the node that wrote something to the node that did not write anything. In case none wrote anything this policy uses a random decision to perform a "resync" of 0 blocks. In case both have written something this policy disconnects the nodes.
`discard-least-changes`	Auto sync from the node that touched more blocks during the split brain situation.

`discard-node-NODENAME` Auto sync to the named node.

`after-sb-1pri` *`policy`*

possible policies are:

`disconnect` No automatic resynchronization, simply disconnect.

`consensus` Discard the version of the secondary if the outcome of the `after-sb-0pri` algorithm would also destroy the current secondary's data. Otherwise disconnect.

`violently-as0p` Always take the decision of the `after-sb-0pri` algorithm, even if that causes an erratic change of the primary's view of the data. This is only useful if you use a one-node FS (i.e. not OCFS2 or GFS) with the `allow-two-primaries` flag, *AND* if you really know what you are doing. This is *DANGEROUS and MAY CRASH YOUR MACHINE* if you have an FS mounted on the primary node.

`discard-secondary` Discard the secondary's version.

`call-pri-lost-after-sb` Always honor the outcome of the `after-sb-0pri` algorithm. In case it decides the current secondary has the right data, it calls the "pri-lost-after-sb" handler on the current primary.

`after-sb-2pri` *`policy`*

possible policies are:

`disconnect` No automatic resynchronization, simply disconnect.

`violently-as0p` Always take the decision of the `after-sb-0pri` algorithm, even if that causes an erratic change

of the primary's view of the data. This is only useful if you use a one-node FS (i.e. not OCFS2 or GFS) with the `allow-two-primaries` flag, *AND* if you really know what you are doing. This is *DANGEROUS and MAY CRASH YOUR MACHINE* if you have an FS mounted on the primary node.

`call-pri-lost-after-sb` Call the "pri-lost-after-sb" helper program on one of the machines. This program is expected to reboot the machine, i.e. make it secondary.

`always-asbp` Normally the automatic after-split-brain policies are only used if current states of the UUIDs do not indicate the presence of a third node.

With this option you request that the automatic after-split-brain policies are used as long as the data sets of the nodes are somehow related. This might cause a full sync, if the UUIDs indicate the presence of a third node. (Or double faults led to strange UUID sets.)

`rr-conflict` *`policy`*

This option helps to solve the cases when the outcome of the resync decision is incompatible with the current role assignment in the cluster.

`disconnect` No automatic resynchronization, simply disconnect.

`violently` Sync to the primary node is allowed, violating the assumption that data on a block device are stable for one of the nodes. *Dangerous, do not use.*

`call-pri-lost` Call the "pri-lost" helper program on one of the machines. This program is expected to reboot the machine, i.e. make it secondary.

`data-integrity-alg` *`alg`*

DRBD can ensure the data integrity of the user's data on the network by comparing hash values. Normally this is ensured by the 16 bit checksums in the headers of TCP/IP packets.

This option can be set to any of the kernel's data digest algorithms. In a typical kernel configuration you should have at least one of `md5`, `sha1`, and `crc32c` available. By default this is not enabled.

See also the notes on data integrity.

`tcp-cork`

DRBD usually uses the TCP socket option TCP_CORK to hint to the network stack when it can expect more data, and when it should flush out what it has in its send queue. It turned out that there is at least one network stack that performs worse when one uses this hinting method. Therefore we introducted this option. By setting `tcp-cork` to `no` you can disable the setting and clearing of the TCP_CORK socket option by DRBD.

`on-congestion` *`congestion_policy`*, `congestion-fill` *`fill_threshold`*, `congestion-extents` *`active_extents_threshold`*

By default DRBD blocks when the available TCP send queue becomes full. That means it will slow down the application that generates the write requests that cause DRBD to send more data down that TCP connection.

When DRBD is deployed with DRBD-proxy it might be more desirable that DRBD goes into AHEAD/BEHIND mode shortly before the send queue becomes full. In AHEAD/BEHIND mode DRBD does no longer replicate data, but still keeps the connection open.

The advantage of the AHEAD/BEHIND mode is that the application is not slowed down, even if DRBD-proxy's buffer is not sufficient to buffer all write requests. The downside is that the peer node falls behind, and that a resync will be necessary to bring it back into sync. During that resync the peer node will have an inconsistent disk.

Available *`congestion_policy`*s are `block` and `pull-ahead`. The default is `block`. *`Fill_threshold`* might be in the range of 0 to 10GiBytes. The default is 0 which disables the check. *`Active_extents_threshold`* has the same limits as `al-extents`.

The AHEAD/BEHIND mode and its settings are available since DRBD 8.3.10.

`wfc-timeout` *`time`*

Wait for connection timeout. The init script drbd(8) blocks the boot process until the DRBD resources are connected. When the cluster manager starts later, it does not see a resource with internal split-brain. In case you want to limit the wait time, do it here. Default is 0, which means unlimited. The unit is seconds.

`degr-wfc-timeout` *`time`*

Wait for connection timeout, if this node was a degraded cluster. In case a degraded cluster (= cluster with only one node left) is rebooted, this timeout value is used instead of wfc-timeout, because the peer is less likely to show up in time, if it had been dead before. Value 0 means unlimited.

`outdated-wfc-timeout` *`time`*

Wait for connection timeout, if the peer was outdated. In case a degraded cluster (= cluster with only one node left) with an outdated peer disk is rebooted, this timeout value is used instead of wfc-timeout, because the peer is not allowed to become primary in the meantime. Value 0 means unlimited.

`wait-after-sb`

By setting this option you can make the init script to continue to wait even if the device pair had a split brain situation and therefore refuses to connect.

`become-primary-on` *node-name*
: Sets on which node the device should be promoted to primary role by the init script. The *node-name* might either be a host name or the keyword `both`. When this option is not set the devices stay in secondary role on both nodes. Usually one delegates the role assignment to a cluster manager (e.g. heartbeat).

`stacked-timeouts`
: Usually `wfc-timeout` and `degr-wfc-timeout` are ignored for stacked devices, instead twice the amount of `connect-int` is used for the connection timeouts. With the `stacked-timeouts` keyword you disable this, and force DRBD to mind the `wfc-timeout` and `degr-wfc-timeout` statements. Only do that if the peer of the stacked resource is usually not available or will usually not become primary. By using this option incorrectly, you run the risk of causing unexpected split brain.

`resync-rate` *rate*
: To ensure a smooth operation of the application on top of DRBD, it is possible to limit the bandwidth which may be used by background synchronizations. The default is 250 KB/sec, the default unit is KB/sec. Optional suffixes K, M, G are allowed.

`use-rle`
: During resync-handshake, the dirty-bitmaps of the nodes are exchanged and merged (using bit-or), so the nodes will have the same understanding of which blocks are dirty. On large devices, the fine grained dirty-bitmap can become large as well, and the bitmap exchange can take quite some time on low-bandwidth links.

  Because the bitmap typically contains compact areas where all bits are unset (clean) or set (dirty), a simple run-length encoding scheme can considerably reduce the network traffic necessary for the bitmap exchange.

  For backward compatibilty reasons, and because on fast links this possibly does not improve transfer time but consumes cpu cycles, this defaults to off.

`resync-after` *res-name*
: By default, resynchronization of all devices would run in parallel. By defining a resync-after dependency, the resynchronization of this resource will start only if the resource *res-name* is already in connected state (i.e., has finished its resynchronization).

`al-extents` *extents*
: DRBD automatically performs hot area detection. With this parameter you control how big the hot area (= active set) can get. Each extent marks 4M of the backing storage (= low-level device). In case a primary node leaves the cluster unexpectedly, the areas covered by the active set must be resynced upon rejoining of the failed node. The data structure is stored in the meta-data area, therefore each change of the active set is a write operation to the meta-data device. A higher number of extents gives longer resync times but less updates to the meta-data. The default number of *extents* is 127. (Minimum: 7, Maximum: 3843)

`verify-alg` *hash-alg*
: During online verification (as initiated by the **verify** sub-command), rather than doing a bit-wise comparison, DRBD

applies a hash function to the contents of every block being verified, and compares that hash with the peer. This option defines the hash algorithm being used for that purpose. It can be set to any of the kernel's data digest algorithms. In a typical kernel configuration you should have at least one of `md5`, `sha1`, and `crc32c` available. By default this is not enabled; you must set this option explicitly in order to be able to use on-line device verification.

See also the notes on data integrity.

`csums-alg` *`hash-alg`*

A resync process sends all marked data blocks from the source to the destination node, as long as no `csums-alg` is given. When one is specified the resync process exchanges hash values of all marked blocks first, and sends only those data blocks that have different hash values.

This setting is useful for DRBD setups with low bandwidth links. During the restart of a crashed primary node, all blocks covered by the activity log are marked for resync. But a large part of those will actually be still in sync, therefore using `csums-alg` will lower the required bandwidth in exchange for CPU cycles.

`c-plan-ahead` *`plan_time`*, `c-fill-target` *`fill_target`*, `c-delay-target` *`delay_target`*, `c-max-rate` *`max_rate`*

The dynamic resync speed controller gets enabled with setting *`plan_time`* to a positive value. It aims to fill the buffers along the data path with either a constant amount of data *`fill_target`*, or aims to have a constant delay time of *`delay_target`* along the path. The controller has an upper bound of *`max_rate`*.

By *`plan_time`* the agility of the controller is configured. Higher values yield for slower/lower responses of the controller to deviation from the target value. It should be at least 5 times RTT. For regular data paths a *`fill_target`* in the area of 4k to 100k is appropriate. For a setup that contains drbd-proxy it is advisable to use *`delay_target`* instead. Only when *`fill_target`* is set to 0 the controller will use *`delay_target`*. 5 times RTT is a reasonable starting value. *`Max_rate`* should be set to the bandwidth available between the DRBD-hosts and the machines hosting DRBD-proxy, or to the available disk-bandwidth.

The default value of *`plan_time`* is 0, the default unit is 0.1 seconds. *`Fill_target`* has 0 and sectors as default unit. *`Delay_target`* has 1 (100ms) and 0.1 as default unit. *`Max_rate`* has 10240 (100MiB/s) and KiB/s as default unit.

The dynamic resync speed controller and its settings are available since DRBD 8.3.9.

`c-min-rate` *`min_rate`*

A node that is primary and sync-source has to schedule application IO requests and resync IO requests. The *`min_rate`* tells DRBD use only up to min_rate for resync IO and to dedicate all other available IO bandwidth to application requests.

Note: The value 0 has a special meaning. It disables the limitation of resync IO completely, which might slow down

application IO considerably. Set it to a value of 1, if you prefer that resync IO never slows down application IO.

Note: Although the name might suggest that it is a lower bound for the dynamic resync speed controller, it is not. If the DRBD-proxy buffer is full, the dynamic resync speed controller is free to lower the resync speed down to 0, completely independent of the `c-min-rate` setting.

`Min_rate` has 4096 (4MiB/s) and KiB/s as default unit.

`on-no-data-accessible` *`ond-policy`*
This setting controls what happens to IO requests on a degraded, disk less node (I.e. no data store is reachable). The available policies are `io-error` and `suspend-io`.

If *`ond-policy`* is set to `suspend-io` you can either resume IO by attaching/connecting the last lost data storage, or by the **drbdadm resume-io *`res`*** command. The latter will result in IO errors of course.

The default is `io-error`. This setting is available since DRBD 8.3.9.

`cpu-mask` *`cpu-mask`*
Sets the cpu-affinity-mask for DRBD's kernel threads of this device. The default value of *`cpu-mask`* is 0, which means that DRBD's kernel threads should be spread over all CPUs of the machine. This value must be given in hexadecimal notation. If it is too big it will be truncated.

`pri-on-incon-degr` *`cmd`*
This handler is called if the node is primary, degraded and if the local copy of the data is inconsistent.

`pri-lost-after-sb` *`cmd`*
The node is currently primary, but lost the after-split-brain auto recovery procedure. As as consequence, it should be abandoned.

`pri-lost` *`cmd`*
The node is currently primary, but DRBD's algorithm thinks that it should become sync target. As a consequence it should give up its primary role.

`fence-peer` *`cmd`*
The handler is part of the `fencing` mechanism. This handler is called in case the node needs to fence the peer's disk. It should use other communication paths than DRBD's network link.

`local-io-error` *`cmd`*
DRBD got an IO error from the local IO subsystem.

`initial-split-brain` *`cmd`*
DRBD has connected and detected a split brain situation. This handler can alert someone in all cases of split brain, not just those that go unresolved.

`split-brain` *`cmd`*
DRBD detected a split brain situation but remains unresolved. Manual recovery is necessary. This handler should alert someone on duty.

`before-resync-target` *`cmd`*
DRBD calls this handler just before a resync begins on the node that becomes resync target. It might be used to take a snapshot of the backing block device.

`after-resync-target` *`cmd`*
DRBD calls this handler just after a resync operation finished on the node whose disk just became consistent after being

inconsistent for the duration of the resync. It might be used to remove a snapshot of the backing device that was created by the `before-resync-target` handler.

Other Keywords

`include` *`file-pattern`* Include all files matching the wildcard pattern *`file-pattern`*. The `include` statement is only allowed on the top level, i.e. it is not allowed inside any section.

Notes on data integrity

There are two independent methods in DRBD to ensure the integrity of the mirrored data. The online-verify mechanism and the `data-integrity-alg` of the `network` section.

Both mechanisms might deliver false positives if the user of DRBD modifies the data which gets written to disk while the transfer goes on. This may happen for swap, or for certain append while global sync, or truncate/rewrite workloads, and not necessarily poses a problem for the integrity of the data. Usually when the initiator of the data transfer does this, it already knows that that data block will not be part of an on disk data structure, or will be resubmitted with correct data soon enough.

The `data-integrity-alg` causes the receiving side to log an error about "Digest integrity check FAILED: Ns +x\n", where N is the sector offset, and x is the size of the request in bytes. It will then disconnect, and reconnect, thus causing a quick resync. If the sending side at the same time detected a modification, it warns about "Digest mismatch, buffer modified by upper layers during write: Ns +x\n", which shows that this was a false positive. The sending side may detect these buffer modifications immediately after the unmodified data has been copied to the tcp buffers, in which case the receiving side won't notice it.

The most recent (2007) example of systematic corruption was an issue with the TCP offloading engine and the driver of a certain type of GBit NIC. The actual corruption happened on the DMA transfer from core memory to the card. Since the TCP checksum gets calculated on the card, this type of corruption stays undetected as long as you do not use either the online `verify` or the `data-integrity-alg`.

We suggest to use the `data-integrity-alg` only during a pre-production phase due to its CPU costs. Further we suggest to do online `verify` runs regularly e.g. once a month during a low load period.

Version

This document was revised for version 8.4.0 of the DRBD distribution.

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Reporting Bugs

Report bugs to <drbd-user@lists.linbit.com>.

Copyright

See Also

drbd(8), drbddisk(8), drbdsetup(8), drbdadm(8), *DRBD User's Guide* [http://www.drbd.org/users-guide/], *DRBD web site* [http://www.drbd.org/]

Name

drbdadm — Administration tool for DRBD

Synopsis

`drbdadm` [-d] [-c{*file*}] [-t{*file*}] [-s{*cmd*}] [-m{*cmd*}] [-S] [-h{*host*}] [--{*backend-options*}] {*command*} [{all} | {*resource[/volume>]*…}]

Description

`Drbdadm` is the high level tool of the DRBD program suite. `Drbdadm` is to `drbdsetup` and `drbdmeta` what `ifup/ifdown` is to `ifconfig`. `Drbdadm` reads its configuration file and performs the specified commands by calling the `drbdsetup` and/or the `drbdmeta` program.

`Drbdadm` can operate on whole resources or on individual volumes in a resource. The sub commands: `attach`, `detach`, `primary`, `secondary`, `invalidate`, `invalidate-remote`, `outdate`, `resize`, `verify`, `pause-sync`, `resume-sync`, `role`, `csytate`, `dstate`, `create-md`, `show-gi`, `get-gi`, `dump-md`, `wipe-md` are work on whole resources and on individual volumes.

Resource level only commands are: `connect`, `disconnect`, `up`, `down`, `wait-connect` and `dump`.

Options

`-d`, `--dry-run`	Just prints the calls of `drbdsetup` to stdout, but does not run the commands.
`-c`, `--config-file` *`file`*	Specifies the configuration file drbdadm will use. If this parameter is not specified, drbdadm will look for `/etc/drbd-84.conf`, `/etc/drbd-83.conf`, `/etc/drbd-08.conf` and `/etc/drbd.conf`.
`-t`, `--config-to-test` *`file`*	Specifies an additional configuration file drbdadm to check. This option is only allowed with the dump and the sh-nop commands.
`-s`, `--drbdsetup` *`file`*	Specifies the full path to the `drbdsetup` program. If this option is omitted, drbdadm will look for `/sbin/drbdsetup` and `./drbdsetup`.
`-m`, `--drbdmeta` *`file`*	Specifies the full path to the `drbdmeta` program. If this option is omitted, drbdadm will look for `/sbin/drbdmeta` and `./drbdmeta`.
`-S`, `--stacked`	Specifies that this command should be performed on a stacked resource.
`-P`, `--peer`	Specifies to which peer node to connect. Only necessary if there are more than two host sections in the resource you are working on.
`--` *`backend-options`*	All options following the doubly hyphen are considered *`backend-options`*. These are passed through to the backend command. I.e. to `drbdsetup`, `drbdmeta` or `drbd-proxy-ctl`.

Commands

attach	Attaches a local backing block device to the DRBD resource's device.
detach	Removes the backing storage device from a DRBD resource's device.
connect	Sets up the network configuration of the resource's device. If the peer device is already configured, the two DRBD devices will connect. If there are more than two host sections in the resource you need to use the `--peer` option to select the peer you want to connect to.
disconnect	Removes the network configuration from the resource. The device will then go into StandAlone state.
syncer	Loads the resynchronization parameters into the device.
up	Is a shortcut for attach and connect.
down	Is a shortcut for disconnect and detach.
primary	Promote the resource's device into primary role. You need to do this before any access to the device, such as creating or mounting a file system.
secondary	Brings the device back into secondary role. This is needed since in a connected DRBD device pair, only one of the two peers may have primary role (except if `allow-two-primaries` is explicitly set in the configuration file).
invalidate	Forces DRBD to consider the data on the *local* backing storage device as out-of-sync. Therefore DRBD will copy each and every block from its peer, to bring the local storage device back in sync.
invalidate-remote	This command is similar to the invalidate command, however, the *peer's* backing storage is invalidated and hence rewritten with the data of the local node.
resize	Causes DRBD to re-examine all sizing constraints, and resize the resource's device accordingly. For example, if you increased the size of your backing storage devices (on both nodes, of course), then DRBD will adopt the new size after you called this command on one of your nodes. Since new storage space must be synchronised this command only works if there is at least one primary node present. The `--assume-peer-has-space` allows you to resize a device which is currently not connected to the peer. Use with care, since if you do not resize the peer's disk as well, further connect attempts of the two will fail.
check-resize	Calls drbdmeta to eventually move internal meta data. If the backing device was resized, while DRBD was not running, meta data has to be moved to the end of the device, so that the next `attach` command can succeed.
create-md	Initializes the meta data storage. This needs to be done before a DRBD resource can be taken online for the first time. In case of issues with that command have a look at drbdmeta(8)
get-gi	Shows a short textual representation of the data generation identifiers.

show-gi — Prints a textual representation of the data generation identifiers including explanatory information.

dump-md — Dumps the whole contents of the meta data storage, including the stored bit-map and activity-log, in a textual representation.

outdate — Sets the outdated flag in the meta data.

adjust — Synchronizes the configuration of the device with your configuration file. You should always examine the output of the dry-run mode before actually executing this command.

wait-connect — Waits until the device is connected to its peer device.

role — Shows the current roles of the devices (local/peer). E.g. Primary/Secondary

state — Deprecated alias for "role", see above.

cstate — Shows the current connection state of the devices.

dump — Just parse the configuration file and dump it to stdout. May be used to check the configuration file for syntactic correctness.

outdate — Used to mark the node's data as outdated. Usually used by the peer's fence-peer handler.

verify — Starts online verify. During online verify, data on both nodes is compared for equality. See `/proc/drbd` for online verify progress. If out-of-sync blocks are found, they are *not* resynchronized automatically. To do that, **disconnect** and **connect** the resource when verification has completed.

See also the notes on data integrity on the drbd.conf manpage.

pause-sync — Temporarily suspend an ongoing resynchronization by setting the local pause flag. Resync only progresses if neither the local nor the remote pause flag is set. It might be desirable to postpone DRBD's resynchronization until after any resynchronization of the backing storage's RAID setup.

resume-sync — Unset the local sync pause flag.

new-current-uuid — Generates a new currend UUID and rotates all other UUID values.

This can be used to shorten the initial resync of a cluster. See the `drbdsetup` manpage for a more details.

dstate — Show the current state of the backing storage devices. (local/peer)

hidden-commands — Shows all commands undocumented on purpose.

Version

This document was revised for version 8.4.0 of the DRBD distribution.

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Reporting Bugs

Report bugs to <drbd-user@lists.linbit.com>.

Copyright

See Also

drbd.conf(5), drbd(8), drbddisk(8), drbdsetup(8), drbdmeta(8) and the *DRBD project web site* [http://www.drbd.org/]

Name

drbdsetup — Setup tool for DRBD

Synopsis

`drbdsetup` new-resource *`resource`* [--cpu-mask {*`val`*}] [--on-no-data-accessible{ io-error | suspend-io }]

`drbdsetup` new-minor *`resource minor volume`*

`drbdsetup` del-resource *`resource`*

`drbdsetup` del-minor *`minor`*

`drbdsetup` attach *`minor lower_dev meta_data_dev meta_data_index`* [--size {*`val`*}] [--max-bio-bvecs {*`val`*}] [--on-io-error{ pass_on | call-local-io-error | detach }] [--fencing{ dont-care | resource-only | resource-and-stonith }] [--disk-barrier] [--disk-flushes] [--disk-drain] [--md-flushes] [--resync-rate {*`val`*}] [--resync-after {*`val`*}] [--al-extents {*`val`*}] [--c-plan-ahead {*`val`*}] [--c-delay-target {*`val`*}] [--c-fill-target {*`val`*}] [--c-max-rate {*`val`*}] [--c-min-rate {*`val`*}] [--disk-timeout {*`val`*}]

`drbdsetup` connect *`resource local_addr remote_addr`* [--tentative] [--discard-my-data] [--protocol{ A | B | C }] [--timeout {*`val`*}] [--max-epoch-size {*`val`*}] [--max-buffers {*`val`*}] [--unplug-watermark {*`val`*}] [--connect-int {*`val`*}] [--ping-int {*`val`*}] [--sndbuf-size {*`val`*}] [--rcvbuf-size {*`val`*}] [--ko-count {*`val`*}] [--allow-two-primaries] [--cram-hmac-alg {*`val`*}] [--shared-secret {*`val`*}] [--after-sb-0pri{ disconnect | discard-younger-primary | discard-older-primary | discard-zero-changes | discard-least-changes | discard-local | discard-remote }] [--after-sb-1pri{ disconnect | consensus | discard-secondary | call-pri-lost-after-sb | violently-as0p }] [--after-sb-2pri{ disconnect | call-pri-lost-after-sb | violently-as0p }] [--always-asbp] [--rr-conflict{ disconnect | call-pri-lost | violently }] [--ping-timeout {*`val`*}] [--data-integrity-alg {*`val`*}] [--tcp-cork] [--on-congestion{ block | pull-ahead | disconnect }] [--congestion-fill {*`val`*}] [--congestion-extents {*`val`*}] [--csums-alg {*`val`*}] [--verify-alg {*`val`*}] [--use-rle]

`drbdsetup` disk-options *`minor`* [--on-io-error{ pass_on | call-local-io-error | detach }] [--fencing{ dont-care | resource-only | resource-and-stonith }] [--disk-barrier] [--disk-flushes] [--disk-drain] [--md-flushes] [--resync-rate {*`val`*}] [--resync-after {*`val`*}] [--al-extents {*`val`*}] [--c-plan-ahead {*`val`*}] [--c-delay-target {*`val`*}] [--c-fill-target {*`val`*}] [--c-max-rate {*`val`*}] [--c-min-rate {*`val`*}] [--disk-timeout {*`val`*}]

`drbdsetup` net-options *`local_addr remote_addr`* [--protocol{ A | B | C }] [--timeout {*`val`*}] [--max-epoch-size {*`val`*}] [--max-buffers {*`val`*}] [--unplug-watermark {*`val`*}] [--connect-int {*`val`*}] [--ping-int {*`val`*}] [--sndbuf-size {*`val`*}] [--rcvbuf-size {*`val`*}] [--ko-count {*`val`*}] [--allow-two-primaries] [--cram-hmac-alg {*`val`*}] [--shared-secret {*`val`*}] [--after-sb-0pri{ disconnect | discard-younger-primary | discard-older-primary | discard-zero-changes | discard-least-changes | discard-local | discard-remote }] [--after-sb-1pri{ disconnect | consensus | discard-secondary | call-pri-lost-after-sb | violently-as0p }] [--after-sb-2pri{ disconnect | call-pri-lost-after-sb | violently-as0p }] [--always-asbp] [--rr-conflict{ disconnect | call-pri-lost | violently }] [--ping-timeout {*`val`*}] [--data-integrity-alg {*`val`*}] [--tcp-cork] [--on-congestion{ block | pull-ahead | disconnect }] [--congestion-fill {*`val`*}] [--congestion-extents {*`val`*}] [--csums-alg {*`val`*}] [--verify-alg {*`val`*}] [--use-rle]

`drbdsetup` resource-options *`resource`* [--cpu-mask {*`val`*}] [--on-no-data-accessible{ io-error | suspend-io }]

`drbdsetup` disconnect *`local_addr remote_addr`* [--force]

`drbdsetup` detach *`minor`* [--force]

`drbdsetup` primary *`minor`* [--force]

`drbdsetup` secondary *`minor`*

`drbdsetup` down *`resource`*

`drbdsetup` verify *`minor`* [--start {*`val`*}]

`drbdsetup` invalidate *`minor`*

`drbdsetup` invalidate-remote *`minor`*

`drbdsetup` wait-connect *`minor`* [--wfc-timeout {*`val`*}] [--degr-wfc-timeout {*`val`*}] [--outdated-wfc-timeout {*`val`*}]

`drbdsetup` wait-sync *`minor`* [--wfc-timeout {*`val`*}] [--degr-wfc-timeout {*`val`*}] [--outdated-wfc-timeout {*`val`*}]

`drbdsetup` role *`minor`*

`drbdsetup` cstate *`minor`*

`drbdsetup` dstate *`minor`*

`drbdsetup` resize *`minor`* [--size {*`val`*}] [--assume-peer-has-space] [--assume-clean]

`drbdsetup` check-resize *`minor`*

`drbdsetup` pause-sync *`minor`*

`drbdsetup` resume-sync *`minor`*

`drbdsetup` outdate *`minor`*

`drbdsetup` show-gi *`minor`*

`drbdsetup` get-gi *`minor`*

`drbdsetup` show { *`resource`* | *`minor`* | *`all`* }

`drbdsetup` suspend-io *`minor`*

`drbdsetup` resume-io *`minor`*

`drbdsetup` events { *`resource`* | *`minor`* | *`all`* }

`drbdsetup` new-current-uuid *`minor`* [--clear-bitmap]

Description

drbdsetup is used to associate DRBD devices with their backing block devices, to set up DRBD device pairs to mirror their backing block devices, and to inspect the configuration of running DRBD devices.

Note

drbdsetup is a low level tool of the DRBD program suite. It is used by the data disk and drbd scripts to communicate with the device driver.

Commands

Each drbdsetup sub-command might require arguments and bring its own set of options. All values have default units which might be overruled by K, M or G. These units are defined in the usual way (e.g. K = 2^10 = 1024).

Common options

All drbdsetup sub-commands accept these two options

`--create-device` In case the specified DRBD device (minor number) does not exist yet, create it implicitly.

new-resource

Resources are the primary objects of any DRBD configuration. A resource must be created with the `new-resource` command before any volumes or minor devices can be created. Connections are referenced by name.

new-minor

A *minor* is used as a synonym for replicated block device. It is represented in the /dev/ directory by a block device. It is the application's interface to the DRBD-replicated block devices. These block devices get addressed by their minor numbers on the drbdsetup commandline.

A pair of replicated block devices may have different minor numbers on the two machines. They are associated by a common *volume-number*. Volume numbers are local to each connection. Minor numbers are global on one node.

del-resource

Destroys a resource object. This is only possible if the resource has no volumes.

del-minor

Minors can only be destroyed if its disk is detached.

attach, disk-options

Attach associates *`device`* with *`lower_device`* to store its data blocks on. The `-d` (or `--disk-size`) should only be used if you wish not to use as much as possible from the backing block devices. If you do not use `-d`, the *`device`* is only ready for use as soon as it was connected to its peer once. (See the `net` command.)

With the disk-options command it is possible to change the options of a minor while it is attached.

`--disk-size` *`size`*
: You can override DRBD's size determination method with this option. If you need to use the device before it was ever connected to its peer, use this option to pass the *`size`* of the DRBD device to the driver. Default unit is sectors (1s = 512 bytes).

  If you use the *`size`* parameter in drbd.conf, we strongly recommend to add an explicit unit postfix. drbdadm and drbdsetup used to have mismatching default units.

`--on-io-error` *`err_handler`*
: If the driver of the *`lower_device`* reports an error to DRBD, DRBD will mark the disk as inconsistent, call a helper

program, or detach the device from its backing storage and perform all further IO by requesting it from the peer. The valid *err_handlers* are: pass_on, call-local-io-error and detach.

--fencing *fencing_policy*

Under fencing we understand preventive measures to avoid situations where both nodes are primary and disconnected (AKA split brain).

Valid fencing policies are:

dont-care
: This is the default policy. No fencing actions are done.

resource-only
: If a node becomes a disconnected primary, it tries to outdate the peer's disk. This is done by calling the fence-peer handler. The handler is supposed to reach the other node over alternative communication paths and call 'drbdadm outdate res' there.

resource-and-stonith
: If a node becomes a disconnected primary, it freezes all its IO operations and calls its fence-peer handler. The fence-peer handler is supposed to reach the peer over alternative communication paths and call 'drbdadm outdate res' there. In case it cannot reach the peer, it should stonith the peer. IO is resumed as soon as the situation is resolved. In case your handler fails, you can resume IO with the resume-io command.

--disk-barrier, --disk-flushes, --disk-drain

DRBD has four implementations to express write-after-write dependencies to its backing storage device. DRBD will use the first method that is supported by the backing storage device and that is not disabled by the user. By default all three options are enabled.

When selecting the method you should not only base your decision on the measurable performance. In case your backing storage device has a volatile write cache (plain disks, RAID of plain disks) you should use one of the first two. In case your backing storage device has battery-backed write cache you may go with option 3 or 4. Option 4 will deliver the best performance such devices.

Unfortunately device mapper (LVM) might not support barriers.

The letter after "wo:" in /proc/drbd indicates with method is currently in use for a device: b, f, d, n. The implementations:

barrier — The first requires that the driver of the backing storage device support barriers (called 'tagged command queuing' in SCSI and 'native command queuing' in SATA speak). The use of this method can be disabled by setting the `disk-barrier` options to `no`.

flush — The second requires that the backing device support disk flushes (called 'force unit access' in the drive vendors speak). The use of this method can be disabled setting `disk-flushes` to `no`.

drain — The third method is simply to let write requests drain before write requests of a new reordering domain are issued. That was the only implementation before 8.0.9. You can disable this method by setting `disk-drain` to `no`.

none — The fourth method is to not express write-after-write dependencies to the backing store at all.

`--md-flushes` — Disables the use of disk flushes and barrier BIOs when accessing the meta data device. See the notes on `--disk-flushes`.

`--max-bio-bvecs` — In some special circumstances the device mapper stack manages to pass BIOs to DRBD that violate the constraints that are set forth by DRBD's merge_bvec() function and which have more than one bvec. A known example is: phys-disk -> DRBD -> LVM -> Xen -> missaligned partition (63) -> DomU FS. Then you might see "bio would need to, but cannot, be split:" in the Dom0's kernel log.

The best workaround is to proper align the partition within the VM (E.g. start it at sector 1024). That costs 480 KiB of storage. Unfortunately the default of most Linux partitioning tools is to start the first partition at an odd number (63). Therefore most distributions install helpers for virtual linux machines will end up with missaligned partitions. The second best workaround is to limit DRBD's max bvecs per BIO (i.e., the `max-bio-bvecs` option) to 1, but that might cost performance.

The default value of `max-bio-bvecs` is 0, which means that there is no user imposed limitation.

`--resync-rate` *rate* — To ensure smooth operation of the application on top of DRBD, it is possible to limit the bandwidth that may be used by background synchronization. The default is 250 KiB/sec, the default unit is KiB/sec.

`--resync-after` *minor* — Start resync on this device only if the device with *minor* is already in connected state. Otherwise this device waits in SyncPause state.

`--al-extents` *extents*

DRBD automatically performs hot area detection. With this parameter you control how big the hot area (=active set) can get. Each extent marks 4M of the backing storage. In case a primary node leaves the cluster unexpectedly, the areas covered by the active set must be resynced upon rejoining of the failed node. The data structure is stored in the meta-data area, therefore each change of the active set is a write operation to the meta-data device. A higher number of extents gives longer resync times but less updates to the meta-data. The default number of *extents* is 127. (Minimum: 7, Maximum: 3843)

`--c-plan-ahead` *plan_time*, `--c-fill-target` *fill_target*, `--c-delay-target` *delay_target*, `--c-max-rate` *max_rate*

The dynamic resync speed controller gets enabled with setting *plan_time* to a positive value. It aims to fill the buffers along the data path with either a constant amount of data *fill_target*, or aims to have a constant delay time of *delay_target* along the path. The controller has an upper bound of *max_rate*.

By *plan_time* the agility of the controller is configured. Higher values yield for slower/lower responses of the controller to deviation from the target value. It should be at least 5 times RTT. For regular data paths a *fill_target* in the area of 4k to 100k is appropriate. For a setup that contains drbd-proxy it is advisable to use *delay_target* instead. Only when *fill_target* is set to 0 the controller will use *delay_target*. 5 times RTT is a reasonable starting value. *Max_rate* should be set to the bandwidth available between the DRBD-hosts and the machines hosting DRBD-proxy, or to the available disk-bandwidth.

The default value of *plan_time* is 0, the default unit is 0.1 seconds. *Fill_target* has 0 and sectors as default unit. *Delay_target* has 1 (100ms) and 0.1 as default unit. *Max_rate* has 10240 (100MiB/s) and KiB/s as default unit.

`--c-min-rate` *min_rate*

We track the disk IO rate caused by the resync, so we can detect non-resync IO on the lower level device. If the lower level device seems to be busy, and the current resync rate is above *min_rate*, we throttle the resync.

The default value of *min_rate* is 4M, the default unit is k. If you want to not throttle at all, set it to zero, if you want to throttle always, set it to one.

`-t`, `--disk-timeout` *disk_timeout*

If the driver of the *lower_device* does not finish an IO request within *disk_timeout*, DRBD considers the disk as failed. If DRBD is connected to a remote host, it will reissue local pending IO requests to the peer, and ship all new IO requests to the peer only. The disk state advances to diskless, as soon as the backing block device has finished all IO requests.

The default value of is 0, which means that no timeout is enforced. The default unit is 100ms. This option is available since 8.3.12.

connect, net-options

Connect sets up the *device* to listen on *af:local_addr:port* for incoming connections and to try to connect to *af:remote_addr:port*. If *port* is omitted, 7788 is used as default. If *af* is omitted ipv4 gets used. Other supported address families are ipv6, ssocks for Dolphin Interconnect Solutions' "super sockets" and sdp for Sockets Direct Protocol (Infiniband).

The net-options command allows you to change options while the connection is established.

`--protocol` *protocol*
: On the TCP/IP link the specified *protocol* is used. Valid protocol specifiers are A, B, and C.

  Protocol A: write IO is reported as completed, if it has reached local disk and local TCP send buffer.

  Protocol B: write IO is reported as completed, if it has reached local disk and remote buffer cache.

  Protocol C: write IO is reported as completed, if it has reached both local and remote disk.

`--connect-int` *time*
: In case it is not possible to connect to the remote DRBD device immediately, DRBD keeps on trying to connect. With this option you can set the time between two retries. The default value is 10. The unit is seconds.

`--ping-int` *time*
: If the TCP/IP connection linking a DRBD device pair is idle for more than *time* seconds, DRBD will generate a keep-alive packet to check if its partner is still alive. The default value is 10. The unit is seconds.

`--timeout` *val*
: If the partner node fails to send an expected response packet within *val* tenths of a second, the partner node is considered dead and therefore the TCP/IP connection is abandoned. The default value is 60 (= 6 seconds).

`--sndbuf-size` *size*
: The socket send buffer is used to store packets sent to the secondary node, which are not yet acknowledged (from a network point of view) by the secondary node. When using protocol A, it might be necessary to increase the size of this data structure in order to increase asynchronicity between primary and secondary nodes. But keep in mind that more asynchronicity is synonymous with more data loss in the case of a primary node failure. Since 8.0.13 resp. 8.2.7 setting the *size* value to 0 means that the kernel should autotune this. The default *size* is 0, i.e. autotune.

`--rcvbuf-size` *size*
: Packets received from the network are stored in the socket receive buffer first. From there they are consumed by DRBD. Before 8.3.2 the receive buffer's size was always set to the size of the socket send buffer. Since 8.3.2 they can be tuned independently. A value of 0 means that the kernel should autotune this. The default *size* is 0, i.e. autotune.

`--ko-count` *count*
: In case the secondary node fails to complete a single write request for *count* times the *timeout*, it is expelled from the cluster, i.e. the primary node goes into StandAlone mode. The default is 0, which disables this feature.

`--max-epoch-size` *val*
: With this option the maximal number of write requests between two barriers is limited. Should be set to the same as `--max-buffers`. Values smaller than 10 can lead to degraded performance. The default value is 2048.

`--max-buffers` *val*
: With this option the maximal number of buffer pages allocated by DRBD's receiver thread is limited. Should be set to the same as `--max-epoch-size`. Small values could lead to degraded performance. The default value is 2048, the minimum 32.

`--unplug-watermark` *val*
: When the number of pending write requests on the standby (secondary) node exceeds the unplug-watermark, we trigger the request processing of our backing storage device. Some storage controllers deliver better performance with small values, others deliver best performance when the value is set to the same value as max-buffers. Minimum 16, default 128, maximum 131072.

`--allow-two-primaries`
: With this option set you may assign primary role to both nodes. You only should use this option if you use a shared storage file system on top of DRBD. At the time of writing the only ones are: OCFS2 and GFS. If you use this option with any other file system, you are going to crash your nodes and to corrupt your data!

`--cram-hmac-alg` *alg*
: You need to specify the HMAC algorithm to enable peer authentication at all. You are strongly encouraged to use peer authentication. The HMAC algorithm will be used for the challenge response authentication of the peer. You may specify any digest algorithm that is named in /proc/crypto.

`--shared-secret` *secret*
: The shared secret used in peer authentication. May be up to 64 characters.

`--after-sb-0pri` *asb-0p-policy*
: possible policies are:

  `disconnect`
  : No automatic resynchronization, simply disconnect.

  `discard-younger-primary`
  : Auto sync from the node that was primary before the split-brain situation occurred.

  `discard-older-primary`
  : Auto sync from the node that became primary as second during the split-brain situation.

  `discard-zero-changes`
  : In case one node did not write anything since the split brain became evident, sync from the node that wrote something to the node that did not write anything. In case none wrote anything this policy uses a random decision to perform a "resync" of 0 blocks. In

		case both have written something this policy disconnects the nodes.
	`discard-least-changes`	Auto sync from the node that touched more blocks during the split brain situation.
	`discard-node-NODENAME`	Auto sync to the named node.
`--after-sb-1pri` *asb-1p-policy*	possible policies are:	
	`disconnect`	No automatic resynchronization, simply disconnect.
	`consensus`	Discard the version of the secondary if the outcome of the `after-sb-0pri` algorithm would also destroy the current secondary's data. Otherwise disconnect.
	`discard-secondary`	Discard the secondary's version.
	`call-pri-lost-after-sb`	Always honor the outcome of the `after-sb-0pri` algorithm. In case it decides the current secondary has the correct data, call the `pri-lost-after-sb` on the current primary.
	`violently-as0p`	Always honor the outcome of the `after-sb-0pri` algorithm. In case it decides the current secondary has the correct data, accept a possible instantaneous change of the primary's data.
`--after-sb-2pri` *asb-2p-policy*	possible policies are:	
	`disconnect`	No automatic resynchronization, simply disconnect.
	`call-pri-lost-after-sb`	Always honor the outcome of the `after-sb-0pri` algorithm. In case it decides the current secondary has

		the right data, call the `pri-lost-after-sb` on the current primary.
	`violently-as0p`	Always honor the outcome of the `after-sb-0pri` algorithm. In case it decides the current secondary has the right data, accept a possible instantaneous change of the primary's data.

`--always-asbp`

Normally the automatic after-split-brain policies are only used if current states of the UUIDs do not indicate the presence of a third node.

With this option you request that the automatic after-split-brain policies are used as long as the data sets of the nodes are somehow related. This might cause a full sync, if the UUIDs indicate the presence of a third node. (Or double faults have led to strange UUID sets.)

`--rr-conflict` *`role-resync-conflict-policy`*

This option sets DRBD's behavior when DRBD deduces from its meta data that a resynchronization is needed, and the SyncTarget node is already primary. The possible settings are: `disconnect`, `call-pri-lost` and `violently`. While `disconnect` speaks for itself, with the `call-pri-lost` setting the `pri-lost` handler is called which is expected to either change the role of the node to secondary, or remove the node from the cluster. The default is `disconnect`.

With the `violently` setting you allow DRBD to force a primary node into SyncTarget state. This means that the data exposed by DRBD changes to the SyncSource's version of the data instantaneously. USE THIS OPTION ONLY IF YOU KNOW WHAT YOU ARE DOING.

`--data-integrity-alg` *`hash_alg`*

DRBD can ensure the data integrity of the user's data on the network by comparing hash values. Normally this is ensured by the 16 bit checksums in the headers of TCP/IP packets. This option can be set to any of the kernel's data digest algorithms. In a typical kernel configuration you should have at least one of `md5`, `sha1`, and `crc32c` available. By default this is not enabled.

See also the notes on data integrity on the drbd.conf manpage.

`--no-tcp-cork`

DRBD usually uses the TCP socket option TCP_CORK to hint to the network stack when it can expect more data, and when it should flush out what it has in its send queue. There is at least one network stack that performs worse when one uses this hinting method. Therefore we introduced this option, which disable the setting and clearing of the TCP_CORK socket option by DRBD.

`--ping-timeout` *`ping_timeout`*

The time the peer has to answer to a keep-alive packet. In case the peer's reply is not received within this time period, it is considered dead. The default unit is tenths of a second, the default value is 5 (for half a second).

`--discard-my-data`

Use this option to manually recover from a split-brain situation. In case you do not have any automatic after-split-brain policies selected, the nodes refuse to connect. By passing this option you make this node a sync target immediately after successful connect.

`--tentative`

Causes DRBD to abort the connection process after the resync handshake, i.e. no resync gets performed. You can find out which resync DRBD would perform by looking at the kernel's log file.

`--on-congestion` *`congestion_policy`*, `--congestion-fill` *`fill_threshold`*, `--congestion-extents` *`active_extents_threshold`*

By default DRBD blocks when the available TCP send queue becomes full. That means it will slow down the application that generates the write requests that cause DRBD to send more data down that TCP connection.

When DRBD is deployed with DRBD-proxy it might be more desirable that DRBD goes into AHEAD/BEHIND mode shortly before the send queue becomes full. In AHEAD/BEHIND mode DRBD does no longer replicate data, but still keeps the connection open.

The advantage of the AHEAD/BEHIND mode is that the application is not slowed down, even if DRBD-proxy's buffer is not sufficient to buffer all write requests. The downside is that the peer node falls behind, and that a resync will be necessary to bring it back into sync. During that resync the peer node will have an inconsistent disk.

Available *`congestion_policy`*s are `block` and `pull-ahead`. The default is `block`. *`Fill_threshold`* might be in the range of 0 to 10GiBytes. The default is 0 which disables the check. *`Active_extents_threshold`* has the same limits as `al-extents`.

The AHEAD/BEHIND mode and its settings are available since DRBD 8.3.10.

`--verify-alg` *`hash-alg`*

During online verification (as initiated by the **verify** sub-command), rather than doing a bit-wise comparison, DRBD applies a hash function to the contents of every block being verified, and compares that hash with the peer. This option defines the hash algorithm being used for that purpose. It can be set to any of the kernel's data digest algorithms. In a typical kernel configuration you should have at least one of `md5`, `sha1`, and `crc32c` available. By default this is not enabled; you must set this option explicitly in order to be able to use on-line device verification.

See also the notes on data integrity on the drbd.conf manpage.

`--csums-alg` *`hash-alg`*

A resync process sends all marked data blocks form the source to the destination node, as long as no `csums-alg` is given. When one is specified the resync process exchanges

hash values of all marked blocks first, and sends only those data blocks over, that have different hash values.

This setting is useful for DRBD setups with low bandwidth links. During the restart of a crashed primary node, all blocks covered by the activity log are marked for resync. But a large part of those will actually be still in sync, therefore using `csums-alg` will lower the required bandwidth in exchange for CPU cycles.

`--use-rle`

During resync-handshake, the dirty-bitmaps of the nodes are exchanged and merged (using bit-or), so the nodes will have the same understanding of which blocks are dirty. On large devices, the fine grained dirty-bitmap can become large as well, and the bitmap exchange can take quite some time on low-bandwidth links.

Because the bitmap typically contains compact areas where all bits are unset (clean) or set (dirty), a simple run-length encoding scheme can considerably reduce the network traffic necessary for the bitmap exchange.

For backward compatibility reasons, and because on fast links this possibly does not improve transfer time but consumes cpu cycles, this defaults to off.

Introduced in 8.3.2.

resource-options

Changes the options of the resource at runtime.

`--cpu-mask` *`cpu-mask`*

Sets the cpu-affinity-mask for DRBD's kernel threads of this device. The default value of *`cpu-mask`* is 0, which means that DRBD's kernel threads should be spread over all CPUs of the machine. This value must be given in hexadecimal notation. If it is too big it will be truncated.

`--on-no-data-accessible` *`ond-policy`*

This setting controls what happens to IO requests on a degraded, disk less node (I.e. no data store is reachable). The available policies are `io-error` and `suspend-io`.

If *`ond-policy`* is set to `suspend-io` you can either resume IO by attaching/connecting the last lost data storage, or by the **drbdadm resume-io *`res`*** command. The latter will result in IO errors of course.

The default is `io-error`. This setting is available since DRBD 8.3.9.

primary

Sets the *`device`* into primary role. This means that applications (e.g. a file system) may open the *`device`* for read and write access. Data written to the *`device`* in primary role are mirrored to the device in secondary role.

Normally it is not possible to set both devices of a connected DRBD device pair to primary role. By using the `--allow-two-primaries` option, you override this behavior and instruct DRBD to allow two primaries.

`--overwrite-data-of-peer` Alias for `--force`.

`--force` Becoming primary fails if the local replica is not up-to-date. I.e. when it is inconsistent, outdated of consistent. By using this option you can force it into primary role anyway. USE THIS OPTION ONLY IF YOU KNOW WHAT YOU ARE DOING.

secondary

Brings the *`device`* into secondary role. This operation fails as long as at least one application (or file system) has opened the device.

It is possible that both devices of a connected DRBD device pair are secondary.

verify

This initiates on-line device verification. During on-line verification, the contents of every block on the local node are compared to those on the peer node. Device verification progress can be monitored via `/proc/drbd`. Any blocks whose content differs from that of the corresponding block on the peer node will be marked out-of-sync in DRBD's on-disk bitmap; they are *not* brought back in sync automatically. To do that, simply disconnect and reconnect the resource.

If on-line verification is already in progress, this command silently does nothing.

This command will fail if the *`device`* is not part of a connected device pair.

See also the notes on data integrity on the drbd.conf manpage.

`--start` *`start-sector`* Since version 8.3.2, on-line verification should resume from the last position after connection loss. It may also be started from an arbitrary position by setting this option.

Default unit is sectors. You may also specify a unit explicitly. The `start-sector` will be rounded down to a multiple of 8 sectors (4kB).

invalidate

This forces the local device of a pair of connected DRBD devices into SyncTarget state, which means that all data blocks of the device are copied over from the peer.

This command will fail if the *`device`* is not part of a connected device pair.

invalidate-remote

This forces the local device of a pair of connected DRBD devices into SyncSource state, which means that all data blocks of the device are copied to the peer.

On a disconnected device, this will set all bits in the out of sync bitmap. As a side affect this suspend updates to the on disk activity log. Updates to the on disk activity log will get resumes automatically when necessary.

wait-connect

Returns as soon as the *`device`* can communicate with its partner device.

`--wfc-timeout` *`wfc_timeout`*, `--degr-wfc-timeout` *`degr_wfc_timeout`*, `--outdated-wfc-timeout` This command will fail if the *`device`* cannot communicate with its partner for *`timeout`* seconds. If the peer was working before this node was rebooted, the *`wfc_timeout`* is used. If the peer was already down before this node was rebooted, the *`degr_wfc_timeout`* is used. If the peer was

outdated_wfc_timeout, --wait-after-sb
: successfully outdated before this node was rebooted the *outdated_wfc_timeout* is used. The default value for all those timeout values is 0 which means to wait forever. The unit is seconds. In case the connection status goes down to StandAlone because the peer appeared but the devices had a split brain situation, the default for the command is to terminate. You can change this behavior with the --wait-after-sb option.

wait-sync

Returns as soon as the *device* leaves any synchronization into connected state. The options are the same as with the *wait-connect* command.

disconnect

Removes the information set by the net command from the *device*. This means that the *device* goes into unconnected state and will no longer listen for incoming connections.

detach

Removes the information set by the disk command from the *device*. This means that the *device* is detached from its backing storage device.

-f, --force
: A regular detach returns after the disk state finally reached diskless. As a consequence detaching from a frozen backing block device never terminates.

  On the other hand A forced detach returns immediately. It allows you to detach DRBD from a frozen backing block device. Please note that the disk will be marked as failed until all pending IO requests where finished by the backing block device.

down

Removes all configuration information from the *device* and forces it back to unconfigured state.

role

Shows the current roles of the *device* and its peer, as *local*/*peer*.

state

Deprecated alias for "role"

cstate

Shows the current connection state of the *device*.

dstate

Shows the current states of the backing storage devices, as *local*/*peer*.

resize

This causes DRBD to reexamine the size of the *device*'s backing storage device. To actually do online growing you need to extend the backing storages on both devices and call the resize command on one of your nodes.

The `--assume-peer-has-space` allows you to resize a device which is currently not connected to the peer. Use with care, since if you do not resize the peer's disk as well, further connect attempts of the two will fail.

When the `--assume-clean` option is given DRBD will skip the resync of the new storage. Only do this if you know that the new storage was initialized to the same content by other means.

check-resize

To enable DRBD to detect offline resizing of backing devices this command may be used to record the current size of backing devices. The size is stored in files in /var/lib/drbd/ named drbd-minor-??.lkbd

This command is called by **drbdadm resize *res*** after **drbdsetup *device* resize** returned.

pause-sync

Temporarily suspend an ongoing resynchronization by setting the local pause flag. Resync only progresses if neither the local nor the remote pause flag is set. It might be desirable to postpone DRBD's resynchronization after eventual resynchronization of the backing storage's RAID setup.

resume-sync

Unset the local sync pause flag.

outdate

Mark the data on the local backing storage as outdated. An outdated device refuses to become primary. This is used in conjunction with `fencing` and by the peer's `fence-peer` handler.

show-gi

Displays the device's data generation identifiers verbosely.

get-gi

Displays the device's data generation identifiers.

show

Shows all available configuration information of the *device*.

suspend-io

This command is of no apparent use and just provided for the sake of completeness.

resume-io

If the fence-peer handler fails to stonith the peer node, and your `fencing` policy is set to resource-and-stonith, you can unfreeze IO operations with this command.

events

Displays every state change of DRBD and all calls to helper programs. This might be used to get notified of DRBD's state changes by piping the output to another program.

`--all-devices` Display the events of all DRBD minors.

`--unfiltered` This is a debugging aid that displays the content of all received netlink messages.

new-current-uuid

Generates a new current UUID and rotates all other UUID values. This has at least two use cases, namely to skip the initial sync, and to reduce network bandwidth when starting in a single node configuration and then later (re-)integrating a remote site.

Available option:

`--clear-bitmap` Clears the sync bitmap in addition to generating a new current UUID.

This can be used to skip the initial sync, if you want to start from scratch. This use-case does only work on "Just Created" meta data. Necessary steps:

1. On *both* nodes, initialize meta data and configure the device.

   drbdadm create-md --force *res*

2. They need to do the initial handshake, so they know their sizes.

   drbdadm up *res*

3. They are now Connected Secondary/Secondary Inconsistent/Inconsistent. Generate a new current-uuid and clear the dirty bitmap.

   drbdadm new-current-uuid --clear-bitmap *res*

4. They are now Connected Secondary/Secondary UpToDate/UpToDate. Make one side primary and create a file system.

   drbdadm primary *res*

   mkfs -t *fs-type* $(drbdadm sh-dev *res*)

One obvious side-effect is that the replica is full of old garbage (unless you made them identical using other means), so any online-verify is expected to find any number of out-of-sync blocks.

You must not use this on pre-existing data! Even though it may appear to work at first glance, once you switch to the other node, your data is toast, as it never got replicated. So *do not leave out the mkfs* (or equivalent).

This can also be used to shorten the initial resync of a cluster where the second node is added after the first node is gone into production, by means of disk shipping. This use-case works on disconnected devices only, the device may be in primary or secondary role.

The necessary steps on the current active server are:

1. **drbdsetup new-current-uuid --clear-bitmap *minor***

2. Take the copy of the current active server. E.g. by pulling a disk out of the RAID1 controller, or by copying with dd. You need to copy the actual data, and the meta data.

3. **drbdsetup new-current-uuid *minor***

Now add the disk to the new secondary node, and join it to the cluster. You will get a resync of that parts that were changed since the first call to **drbdsetup** in step 1.

Examples

For examples, please have a look at the *DRBD User's Guide* [http://www.drbd.org/users-guide/].

Version

This document was revised for version 8.3.2 of the DRBD distribution.

Author

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Reporting Bugs

Report bugs to <drbd-user@lists.linbit.com>.

Copyright

See Also

drbd.conf(5), drbd(8), drbddisk(8), drbdadm(8), *DRBD User's Guide* [http://www.drbd.org/users-guide/], *DRBD web site* [http://www.drbd.org/]

Name

drbdmeta — DRBD's meta data management tool

Synopsis

`drbdmeta` [--force] [--ignore-sanity-checks] { *device* } { v06 *minor* | v07 *meta_dev index* | v08 *meta_dev index* } { *command* } [*cmd args* ...]

Description

Drbdmeta is used to create, display and modify the contents of DRBD's meta data storage. Usually you do not want to use this command directly, but start it via the frontend drbdadm(8).

This command only works if the DRBD resource is currently down, or at least detached from its backing storage. The first parameter is the device node associated to the resource. With the second parameter you can select the version of the meta data. Currently all major DRBD releases (0.6, 0.7 and 8) are supported.

Options

--force
: All questions that get asked by drbdmeta are treated as if the user answered 'yes'.

--ignore-sanity-checks
: Some sanity checks cause drbdmeta to terminate. E.g. if a file system image would get destroyed by creating the meta data. By using that option you can force drbdmeta to ignore these checks.

Commands

create-md
: Create-md initializes the meta data storage. This needs to be done before a DRBD resource can be taken online for the first time. In case there is already a meta data signature of an older format in place, drbdmeta will ask you if it should convert the older format to the selected format.

get-gi
: Get-gi shows a short textual representation of the data generation identifier. In version 0.6 and 0.7 these are generation counters, while in version 8 it is a set of UUIDs.

show-gi
: Show-gi prints a textual representation of the data generation identifiers including explanatory information.

dump-md
: Dumps the whole contents of the meta data storage including the stored bit-map and activity-log in a textual representation.

outdate
: Sets the outdated flag in the meta data. This is used by the peer node when it wants to become primary, but cannot communicate with the DRBD stack on this host.

dstate
: Prints the state of the data on the backing storage. The output is always followed by '/DUnknown' since drbdmeta only looks at the local meta data.

check-resize
: Examines the device size of a backing device, and it's last known device size, recorded in a file /var/lib/drbd/drbd-minor-??.lkbd. In case the size of the backing device changed, and the meta data can be found at the old position, it moves the meta data to the right position at the end of the block device.

Expert's commands

Drbdmeta allows you to modify the meta data as well. This is intentionally omitted for the command's usage output, since you should only use it if you really know what you are doing. By setting the generation identifiers to wrong values, you risk to overwrite your up-to-data data with an older version of your data.

set-gi *gi* — Set-gi allows you to set the generation identifier. *Gi* needs to be a generation counter for the 0.6 and 0.7 format, and a UUID set for 8.x. Specify it in the same way as get-gi shows it.

restore-md *dump_file* — Reads the *dump_file* and writes it to the meta data.

Version

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See Also

drbdadm(8)

Index

Symbols

A

B

C

D

F

G

H

I

J

L

M

N

O

P

Q

R

S

T

U

V

W

X