Best Current Practices
for SUSE® Linux Enterprise High Availability 12

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Introduction
Overview
SUSE® Linux Enterprise High Availability Extension

• Most modern and complete open source solution for implementing high available Linux clusters
• A suite of robust open source technologies that is:
  ‒ Affordable
  ‒ Integrated
  ‒ Virtualization agnostic
• Used with SUSE Linux Enterprise Server, it helps to:
  ‒ Maintain business continuity
  ‒ Protect data integrity
  ‒ Reduce unplanned downtime for your mission-critical Linux workloads
Current status
SUSE® Linux Enterprise High Availability

Fighting Murphy's Law

• Service failover at any distance – from local to geo
• 99.9999% availability with the appropriate tuning
• Rolling updates for less *planned* downtime
• Easy setup, administration, management
• Virtualization agnostic
• Leading open source High Availability
• On par with proprietary products

When will you start?
Benefits
SUSE® Linux Enterprise High Availability

- Quickly and easily install, configure and manage clustered Linux servers
- Ensure continuous access to your mission-critical systems and data
- Transparent to Virtualization – nodes can be virtual or physical
- Meet your Service Level Agreements
- Increase service availability
Overview
SUSE® Linux Enterprise High Availability Extension

- Service availability 24/7
  - Policy driven clustering
- Shared and Scaled data-access
  - Cluster file system
  - Clustered Samba
- Geo Clustering
  - Cluster across unlimited distance
- Virtualization Agnostic
  - Platform independent setup
- Disaster tolerance
  - Data replication via IP
  - Node recovery
- Scale network services
  - IP load-balancing
- User friendly tools
  - Graphical user interface
  - Unified command line interface
- Free Resource Agents
Delivery
SUSE® Linux Enterprise High Availability Extension

- Extension to and with SUSE Linux Enterprise Server
- Releases synchronized with base server product
- Sold as annual support subscriptions
- Inherits the support level of the underlying SUSE Linux Enterprise Server subscription
- Included for free with IBM System z subscriptions
- Charged for 64bit Intel/AMD platform
- Free trial available
Key Use Cases
SUSE® Linux Enterprise High Availability Extension

• High availability for mission-critical services
• Active/active services
  – OCFS2, Databases, Samba File Servers
• Active/passive service fail-over
  – Traditional databases, SAP setups, regular services
• Private Cloud
  – HA, automation and orchestration for managed VMs
• High availability across guests
  – Fine granular monitoring and HA on top of virtualization
• Remote clustering
  – Local, Metro, and Geographical area clusters
Key Use Cases
SUSE® Linux Enterprise High Availability Extension

Simple Stack HA
- Node A: Local Disk, Import/Export, /sapmnt/SID
- Node B: Local Disk, Import/Export, /sapmnt/SID

Enqueue Replication
- Node A: SAP system - database - SAP (A)SCS
- Node B: SAP system - SAP Enq-Repl

DRBD Data Replication
- Node A: DRBD master SAP system
- Node B: DRBD slave SAP system

NFS and SAP in one Cluster
- NFS Mount Point: /export, /sapmnt
- SID: global profile

HA in Virtualized Environments
- Cluster nodes on virtual systems
- Clustered Hyper Visor on physical systems
Version 12 – Key Features
SUSE® Linux Enterprise High Availability Extension

- Major code refresh to latest upstream versions
- Pacemaker
  - Object tagging
  - Significant CIB performance
- Cluster Shell:
  - Health evaluation
  - Improved error reporting and syntax
  - Support corosync configuration
- hawk
  - Improved wizards
  - History explorer
- Geo extension
  - Improved algorithm
  - Per-site attributes in CIB
  - DNS-based IP fail-over
- GFS2 now supported in r/w mode
- New, additional fence-agents
Hawk – Cluster Dashboard & Diagram
Usability - Hawk

Cluster Status

Summary
Cluster Configuration
- STONITH Enabled: true
- No Quorum Policy: ignore
- Symmetric Cluster: true
- Resource Stickiness: 0

Tickets
- Granted: 1
- Revoked: 1

2 nodes configured
- Online: 1
- Standby: 1

9 resources configured
- Started: 4
- Stopped: 5

Details
- xxx: Started: sles11sp3-1
- www: Started: sles11sp3-1
- dummy: Started: sles11sp3-1
- d2: Started: sles11sp3-1

www

Attributes
- target-role: Started

sles11sp3-0
- Fail Count: 0

sles11sp3-1
- Fail Count: 1
- Last Failure: Mon Feb 11 2013 16:03:11 GMT+1100 (EST)

Close
Cluster Architecture
3 Node Cluster Overview

Network Links

Xen VM 1
LAMP Apache IP ext3

Kernel

Xen VM 2

clVM2+OCFS2

DLM

Pacemaker

Corosync + openAIS

Kernel

Client

Storage
Detailed View of Components
Per Node:

- LVS
- DRBD
- MPIO
- Corosync
- YaST2

Linux Kernel

- SCTP
- TCP
- UDP
- Bonding
- Ethernet
- Infiniband

Resource Agents
- LSB init
- systemd units
- DRAC
- iLO
- SBD
- Fencing
- CIB
- Policy Engine
- Pacemaker
- Corosync

Custom agents
- SAP
- MariaDB
- libvirt
- Xen
- Apache
- iSCSI
- IP address
- Filesystems
- DRBD
- clvmd
- dlm_controld

DRBD
- clvmd
- dlm_controld

Local Disks
- SAN FC(oE), iSCSI

cLVM2
- Multipath IO

DLM
- OCFS2
- GFS2

XFS
- OCFS2
- GFS2
- cLVM2
- DLM

Detailed View of Components
Per Node:

- OCFS2
- GFS2
- DLM
Why Is This Talk Necessary?

We heard comments:

• Can't you just make the software stack really easy to understand?

• Why is a multi-node setup more complicated than a single node?

• Gosh, this is awfully complicated! Why is this stuff so powerful? I don't need those other features!

This session addresses most of these questions
Simplify Your Cluster by Using More Features!
Reducing CIB Duplication

- Resource templates
  - Define resources once, inherit often
  - Define a constraint just once, all inherited resources

```ini
rsc_template t_vm ocf:heartbeat:VirtualDomain
  op monitor interval="20s" timeout="60s"
  op migrate_to timeout="300s" interval="0"
  op migrate_from timeout="300s" interval="0"
  meta allow-migrate="false" target-role="Started"
  utilization cpu="2" memory="1024"
  params autoset_utilization_cpu="false"
  migration_transport="ssh"
  hypervisor="qemu:///system"
  autoset_utilization_hv_memory="false" force_stop="true"
```

```ini
primitive vm-01 @t_vm
  params config="/cluster/vmstore/vm-01.xml"
primitive vm-02 @t_vm
  params config="/cluster/vmstore/vm-02.xml"
...
```

colocation colo-fs-vm inf: t_vm baseclone

order order-fs-vm Mandatory: baseclone t_vm
Reducing CIB Duplication, part 2

- Parameters that are shared only need to be specified once
- Reference parameters from other resources

primitive vip IPAddr2 params $my-ip:ip=192.168.0.1
primitive www apache params @my-ip:server_ip
Referring to Many Objects As One

- Assign arbitrary tags to objects
  - Does not imply any ordering or collocation
  - Can be used in constraints or in crmsh commands

```
tag sap1 DB1 SAPEV2
crm resource start sap1
crm resource stop sap1
```
Automate Resource Placement

- Define the capacity that nodes provide &
- Specify how much capacity resources consume
- Set “placement-strategy=balanced”
- Nodes will never over-commit, and make a reasonable attempt at load distribution
- Avoid lengthy & complex rsc_location constraints

```bash
node hex-1 \
  utilization memory="8192" cpu="32"
primitive dummy1 ocf:heartbeat:Dummy \
  utilization cpu="1" memory="512"
```
CLI Management For the Cluster Itself

• Manage the corosync configuration via crmsh!
  – “crm cluster” mode: add/remove nodes, init a new cluster
  – health evaluation of the cluster state

• Improved cluster-bootstrap tools
crm Shell Improvements

• Find out what resource agents are doing, exactly!
  - # crm resource (un)trace sap_DB start

• Test a resource before committing:
  - # crm configure rsctest sap_DB

• Interrogate the cluster history
  - # crm history help
Design and Architecture Considerations
General Considerations

• Consider the support level requirements of your mission-critical systems.

• Your staff is your key asset!
  – Invest in training, processes, knowledge sharing.
  – A good administrator will provide higher availability than a mediocre cluster setup.

• Get expert help for the initial setup, and

• Write concise operation manuals that make sense at 3am on a Saturday ;-) 

• Thoroughly test the cluster regularly.
  – Use a staging system before deploying large changes!
Manage Expectations Properly

- Clustering improves reliability, but does not achieve 100%, ever.
- Fail-over clusters reduce service outage, but do not eliminate it.
- High Availability protects data before the service.
- Clusters are more complex than single nodes.
- Clustering broken applications will not fix them.
- Clusters do not replace backups, RAID, or good hardware.
Complexity Versus Reliability

• **Every** component has a failure probability.
  - Good complexity: Redundant components.
  - Undesirable complexity: chained components.
  - Choke point → single point of failure
  - Also consider: Administrative complexity.

• **Use as few components (features) as feasible.**
  - Our extensive feature list is **not** a mandatory checklist for your deployment ;-)

• **What is your fall-back in case the cluster breaks?**
  - Backups, non-clustered operation
  - Architect your system so that this is feasible!
Cluster Size Considerations

• More nodes:
  – Increased absolute redundancy and capacity.
  – Decreased relative redundancy.
  – One cluster → one failure and security domain.
  – HA is not HPC.

• Does your work-load scale well to more nodes?

• Choose odd node counts
  – 4 and 3 node clusters both lose majority after 2 nodes.

• Question:
  – 5 cheaper servers, or
  – 3 higher quality servers with more capacity each?
Common Setup Issues
General Software Stack

• Please avoid chasing already solved problems!

• Please apply all available software updates:
  - SUSE® Linux Enterprise Server 12
  - SUSE Linux Enterprise High Availability Extension

• Consider migrating to SUSE Linux Enterprise High Availability Extension 12, if you have not already.
From One to Many Nodes

• **Error**: Configuration files not identical across nodes.
  - `/etc/drbd.conf`, `/etc/corosync/corosync.conf`,
    `/etc/ais/openais.conf`, resource-specific configurations ...

• **Symptoms**: Causes weird misbehavior, works one but not on other systems, interoperability issues, and possibly others.

• **Solution**: Make sure they are synchronized.
  - SUSE® Linux Enterprise High Availability Extension 11 SP2 and up provide “csync2” to do this automatically for you.
    - You can add your own files to this list as needed.
Networking

• Switches must support multicast properly.
• Bonding is preferable to using multiple rings:
  – Reduces complexity
  – Exposes redundancy to all cluster services and clients
• Firewall rules are not your friend.
• Keep firmware on switches up-to-date!
• Make NIC names identical on all nodes
• Local hostname resolution versus DNS
• Setup NTP for time synchronization.
Fencing (STONITH)

• Error: Not configuring STONITH at all
  – It defaults to enabled, resource start-up will block and the cluster simply do nothing. This is for your own protection.

• Warning: Disabling STONITH
  – DLM/OCFS2 will block forever waiting for a fence that is never going to happen.

• Error: Using “external/ssh”, “ssh”, “null” in production
  – These plug-ins are for testing. They will not work in production!
  – Use a “real” fencing device or external/sbd

• Error: configuring several power switches in parallel.

• Error: Trying to use external/sbd on DRBD
CIB Configuration Issues

- 2 node clusters cannot have majority with 1 node failed
  - # crm configure property no-quorum-policy=ignore

- Resources are starting up in “random” order or on “wrong” nodes
  - Add required constraints!

- Resources move around when something “unrelated” changes
  - # crm configure property default-resource-stickiness=1000

- # crm_verify -L ; ptest -L -VVVV
  - Will point out some basic issues
Configuring Cluster Resources

• **Symptom:** On start of one or more nodes, the cluster restarts resources!

• **Cause:** resources under cluster control are also started via the “init” sequence.
  - The cluster “probes” all resources on start-up on a node, and when it finds resources active where they should not be – possibly even more than once in the cluster –, the recovery protocol is to stop them all (including all dependencies) and start them cleanly again.

• **Solution:** Remove them from the “init” sequence.
Setting Resource Time-outs

• **Belief**: “Shorter time-outs make the cluster respond faster.”

• **Fact**: Too short time-outs cause resource operations to “fail” erroneously, making the cluster unstable and unpredictable.
  - A somewhat too long time-out will cause a fail-over delay;
  - a slightly too short time-out will cause an unnecessary service outage.

• Consider that a loaded cluster node may be slower than during deployment testing.
  - Check “crm_mon -t1” output for the actual run-times of resources.
OCFS2

• Using ocfs2-tools-o2cb (legacy mode)
  - O2CB only works with Oracle RAC; full features of SUSE® Linux Enterprise High Availability Extension are only available in combination with Pacemaker
  - # zypper rm ocfs2-tools-o2cb
  - Forget about /etc/ocfs2/cluster.conf, /etc/init.d/ocfs2, /etc/init.d/o2cb and /etc/sysconfig/ocfs2

• Nodes crash on shutdown
  - If you have active ocfs2 mounts, you need to umount before shutdown

• Consider: Do you really need OCFS2?
  - Can your application really run concurrently?
Distributed Replicated Block Device

• Myth: has no shared state, thus no STONITH needed.
  – **Fact:** DRBD still needs fencing!

• **Active/Active:**
  – Does not magically make ext3 or applications concurrency-safe, still can only be mounted once
  – With OCFS2, split-brain is still fatal, as data diverges!

• **Active/Passive:**
  – Ensures only one side can modify data, added protection.
  – Does not magically make applications crash-safe.

• **Issue:** Replication traffic during reads.
  – “noatime” mount option.
Storage in General

• Activating non-battery backed caches for performance
  - Causes data corruption.

• iSCSI over unreliable networks.

• Lack of multipath for storage.

• Believing that RAID replaces backups.
  - RAID and replication immediately propagate logical errors!

• Please ensure that device names are identical on all nodes.
Exploring the Effect of Events
What Are Events?

• All state changes to the cluster are events
  - They cause an update of the CIB
  - Configuration changes by the administrator
  - Nodes going up or going down
  - Resource monitoring failures

• Response to events is configured using the CIB policies and computed by the Policy Engine

• This can be simulated using ptest
  - Available comfortably through the “crm” shell
Simulating Node Failure

hex-0:~ #crm

crm(live)# cib new sandbox

INFO: sandbox shadow CIB created

crm(sandbox)# cib cibstatus node hex-0 unclean

crm(sandbox)# simulate
Simulating Node Failure
Simulating Resource Failure

crm(sandbox)# cib cibstatus load live

crm(sandbox)# cib cibstatus op

usage: op <operation> <resource> <exit_code> [<op_status>] [<node>]

crm(sandbox)# cib cibstatus op start dummy1 not_running done hex-0

crm(sandbox)# cib cibstatus op start dummy1 unknown timeout hex-0

crm(sandbox)# configure simulate

ptest[4918]: 2010/02/17_12:44:17 WARN: unpack_rsc_op: Processing failed op dummy1_start_0 on hex-0: unknown error (1)
Simulating Resource Failure
Exploring Configuration Changes

```bash
crm(sandbox)# cib cibstatus load live

crm(sandbox)# configure primitive dummy42 ocf:heartbeat:Dummy

crm(sandbox)# simulate actions nograph

notice: LogActions: Start dummy42 (hex-2)
```
Configuration Changes - Woah!
Log Files and Their Meaning
hb_report Is The Silver Support Bullet

- Compiles
  - Cluster-wide log files,
  - Package state,
  - DLM/OCFS2 state,
  - System information,
  - CIB history,
  - parses core dump reports (install debuginfo packages!)
    - into a single tarball for all support needs.

# hb_report -n “node1 node2 node3” -f 12:00 /tmp/hb_report_example1
Logging

• “The cluster generates too many log messages!”
  – Alas, customers are even more upset when asked to reproduce a problem on their production system ;-)

• System-wide logs: /var/log/messages

• CIB history: /var/lib/pacemaker/pengine/*
  – All cluster events are logged here and can be analyzed with hindsight (python GUI, ptest, and the crm shell).

• Logging can be selectively bumped to “blackbox” logging at runtime for debugging
Where Is the Real Cause?

• The answer is **always** in the logs
• Even though the logs on the DC may print a reference to the error, the real cause may be on another node.
• Most errors are caused by resource agent misconfiguration.
Correlating Messages to Their Cause

- Feb 17 13:06:57 hex-8 pengine: [7717]: WARN: unpack_rsc_op: Processing failed op ocfs2-1:2_monitor_20000 on hex-0: not running (7)
  - This is not the failure, just the Policy Engine reporting on the CIB state! The real messages are on hex-0, grep for the operation key:

- Feb 17 13:06:57 hex-0 Filesystem[24825]: [24861]: INFO: /filer is unmounted (stopped)

- Feb 17 13:06:57 hex-0 crmd: [7334]: info: process_lrm_event: LRM operation ocfs 2-1:2_monitor_20000 (call=37, rc=7, cib-update=55, confirmed=false) not running
  - Look for the error messages from the resource agent before the lrmd/pengine lines!
History Info (loads the report)

```
xen-f:~ # crm history info
INFO: fetching new logs, please wait ...
Source: live
Created on: Thu Sep 12 12:58:41 CEST 2013
By: hb_report -Z -f Thu Sep 12 11:56:18 2013 /var/cache/crm/history/live
Nodes: xen-f xen-g
Groups: web-server nfs
Resources: s-libvirt drbd0-vg fs virtual-ip nfs-server web-ip apache p_drbd_nfs s-sbd
Transitions: 651 652 653
```

```
Source: bug-825765_hb_report-Mon-13-May-2013.tar.bz2
Created on: --:--:--
By: unknown
Nodes: rad4-a rad4-b
Groups: network_grp
Resources: fence phmd snmp_mon service_ip default_gw RP mibreader dbrads pingnet
Transitions: 66 67 68 70 71 72 73 74 75 76 77 78 3 4 335 336 337 338 339
```

```
[0]hex-10:825765 >
```
Basic Transition Usage

```bash
crm(live)# resource start apache
crm(live)# history transition
INFO: fetching new logs, please wait ...
INFO: running ptest with /var/cache/crm/history/live/xen-f/pengine/pengine-pe-input-638.bz2
INFO: starting dotty to show transition graph
warning: unpack_nodes: Blind faith: not fencing unseen nodes
  total 4 actions: 4 Complete
Sep  5 15:18:17 xen-f crmd[12627]: notice: te_rsc_command: Initiating action 2
  8: start apache_start_0 on xen-f (local)
Sep  5 15:18:18 xen-f apache(apache)[29141]: INFO: httpd2: Could not reliably determine the server's fully qualified domain name, using 10.2.13.56 for ServerName
Sep  5 15:18:18 xen-f crmd[12627]: notice: process_lrm_event: LRM operation apache_start_0 (call=309, rc=0, cib-update=370, confirmed=true) ok
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
crm(live)#
```
Resource Events

- Tue Sep 15 20:46:27 CEST 2010

Usage:

```
............
  limit [<from_time>] [<to_time>]
............

Examples:

............
  limit 10:15
  limit 15h22m 16h
  limit "Sun 5 20:46" "Sun 5 22:00"
............

crm(live)history# timeframe 15:17
crm(live)history# resource apache
INFO: 23: fetching new logs, please wait ...
```

```
Sep 5 15:18:17 xen-f crmd[12627]: notice: te_rsc_command: Initiating action 28: start apache_start_0 on xen-f (local)
Sep 5 15:18:18 xen-f apache(apache)[29141]: INFO: httpd2: Could not reliably determine the server's fully qualified domain name, using 10.2.13.56 for ServerName
Sep 5 15:18:18 xen-f crmd[12627]: notice: process_lrm_event: LRM operation apache_start_0 (call=309, rc=0, cib-update=370, confirmed=true) ok
```

crm(live)history#
Node Events

crm(live)history#
crm(live)history#
crm(live)history#
crm(live)history#
crm(live)history#
crm(live)history#
crm(live)history# node xen-g
Sep  5 16:54:26 xen-f corosync[12617]:   [pcmk   ] info: pcmpk_peer_update: lost: xen-g 957153802
Sep  5 16:54:26 xen-f pengine[12626]:   warning: pe_fence_node: Node xen-g will be fenced because the node is no longer part of the cluster
Sep  5 16:54:26 xen-f pengine[12626]:   warning: stage6: Scheduling Node xen-g for STONITH
Sep  5 16:54:26 xen-f crmd[12627]:   notice: te_fence_node: Executing reboot fencing operation (47) on xen-g (timeout=60000)
Sep  5 16:54:37 xen-f stonith-ng[12623]:   notice: log_operation: Operation 'reboot' [10441] (call 3 from crmd.12627) for host 'xen-g' with device 's-sbd' returned: 0 (OK)
Sep  5 16:55:17 xen-g corosync[2766]:   [MAIN   ] Corosync Cluster Engine ('1.4.6') started and ready to provide service.
crm(live)history#
crm(live)history#
crm(live)history#
crm(live)history#
crm(live)history#
crm(live)history#
Debugging Resource Agents
Common Resource Agent Issues

• Operations must succeed if the resource is already in the requested state.

• “monitor” must distinguish between at least “running/OK”, “running/failed”, and “stopped”
  – Probes deserve special attention

• Meta-data must conform to DTD.

• 3rd party resource agents do not belong under /usr/lib/ocf/resource.d/heartbeat – chose your own provider name!

• Use ocf-tester to validate your resource agent.
ocf-tester Example Output

hex-0:~ # ocf-tester -n Example
/usr/lib/ocf/resource.d/bs2010/Dummy

Beginning tests for /usr/lib/ocf/resource.d/bs2010/Dummy...

* Your agent does not support the notify action (optional)
* Your agent does not support the demote action (optional)
* Your agent does not support the promote action (optional)
* Your agent does not support master/slave (optional)
* rc=7: Stopping a stopped resource is required to succeed

Something Hangs and I Don’t Know Where ...

```
hex-0:~ # export OCF_RESKEY_sid=MyDB
hex-0:~ # bash -x
/usr/lib/ocf/ocf/resource.d/heartbeat/oracle
monitor 2>&1 | \
while read L ; do echo "$(date) $L" ; done
```
More about High Availability with SUSE Linux Enterprise

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