HA clustering made simple with OpenVZ

server virtualization

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Profoss Virtualisation event 2008
Brussels, 23rd January 2008

Short Bio

- Werner Fischer
  - 2000-2004: Computer- and Media Security (Upper Austria University of Applied Sciences, Hagenberg Campus)
  - 2004-2005: IBM Mainz, Linz, San Jose/CA, Raleigh/NC
  - redbooks covering HA Clustering and Storage
  - since 9/2005: Thomas-Krenn.AG, R&D (HA-Clustering, Virtualisation)

Thomas-Krenn.AG®
Speed is (y)our success
TK SERVER

- relationship to OpenVZ project
  - using OpenVZ for over two years
  - focussing on OpenVZ clustering, written HOWTO http://wiki.openvz.org/HA_cluster_with_DRBD_and_Heartbeat

Agenda

1. **Cluster Technolgies Overview**
2. HA clustering best practices
3. Concept of HA cluster with OpenVZ
4. OpenVZ details
5. Live Switchover enhancement
6. Outlook: LBVM (load balancing of virtual machines)
7. Conclusion

1) Cluster Technolgies Overview

- term *clustering*
  - High Availability (HA) cluster
  - Load Balancing cluster
  - High Performance Computing (HPC) cluster
  - Grid computing

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2) HA clustering best practices

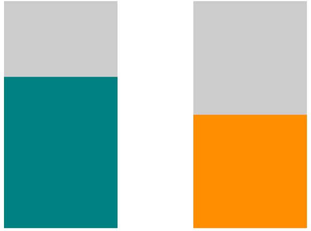
- High Availability (HA) cluster
  - goal: increase availability of services
  - elimination of all SPOFs (single points of failure)
  - failover / switchover
  - 2-node-clusters widely-used

Uptime [%]	Downtime per year	Downtime per week
98 %	7,3 days	3 h 22 min
99 %	3,65 days	1 h 41 min
99,8 %	17 h 30 min	20 min 10 sec
99,9 %	8 h 45 min	10 min 5 sec
99,99 %	52,5 min	1 min
99,999 %	5,25 min	6 sec
99,9999 %	31,5 sec	0,5 sec

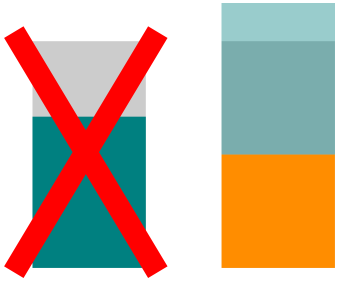
2) HA clustering best practices

active/passive vs. active/active with 2-node-clusters

- when would active/active bring advantages
  - mainly when each of the two servers exceed an utilisation of 50%



- what would be the consquense in case of an outage?
  - the remaining node does not have enough free ressources, services cannot be provided reliable



2) HA clustering best practices

- cluster tests:
  - manual switchover tests (2)
  - power outage tests (7)
  - serial connection tests (4)
  - crossover network connection tests (4)
  - public network connection tests (9)
  - shutdown tests (2)
  - reboot tests (2)
  - hard drive outage tests (2)

2) HA clustering best practices

- Shared Storage (SAN) vs. Replicated Storgae
  - Shared Storage
    - Shared SCSI, Fibre Channel SAN, iSCSI SAN
    - storage system can be SPOF
    - Shared Resource Protection (Node/Resource Level Fencing (STONITH, SCSI Locking), Quorum)
  - Replicated Storage
    - eg. DRBD (Distributed Replicated Block Device)
    - no dedicated storage system (no SPOF)
    - cost-effective
    - Shared Resource Protection less critical

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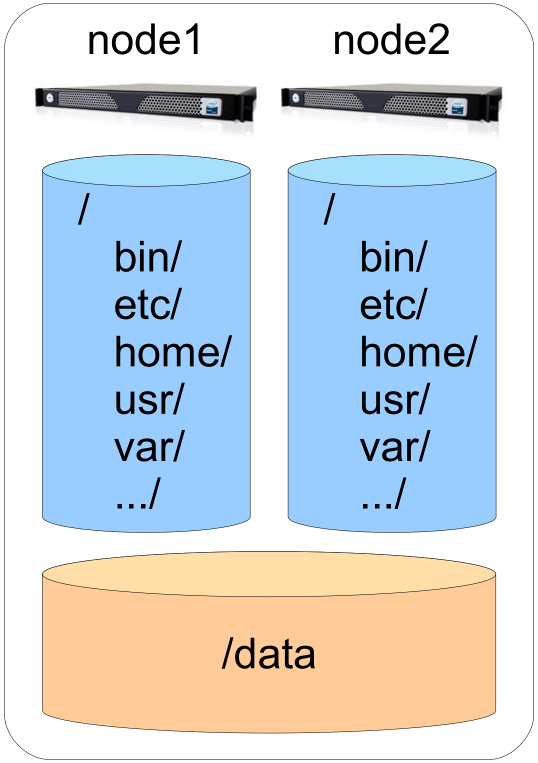
3) Concept of HA cluster with OpenVZ

- challenges of traditional HA cluster systems



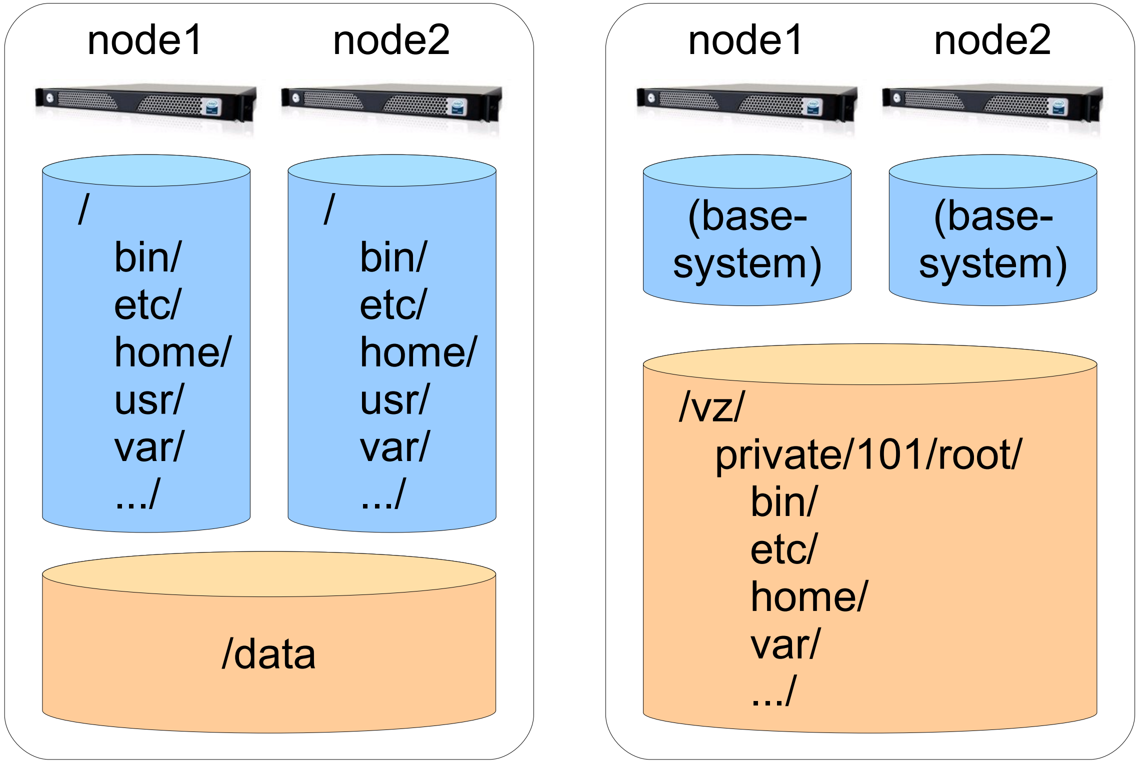
traditional HA Cluster

🟦 local data
🟧 shared data

  - most applications need to be customised
    - config files (/etc) must be synchronised manually (or be replaced by symbolic links to /data/...)
    - keeping system config files like /etc/passwd in sync is complex
    - time-consuming and error-prone -> causes additional costs

3) Concept of HA cluster with OpenVZ

- clustering of entire virtual machines



node1 node2

/
bin/
etc/
home/
usr/
var/
.../

/
bin/
etc/
home/
usr/
var/
.../

/data

node1 node2

(base-system)

(base-system)

/vz/
private/101/root/
bin/
etc/
home/
var/
.../

traditional HA Cluster

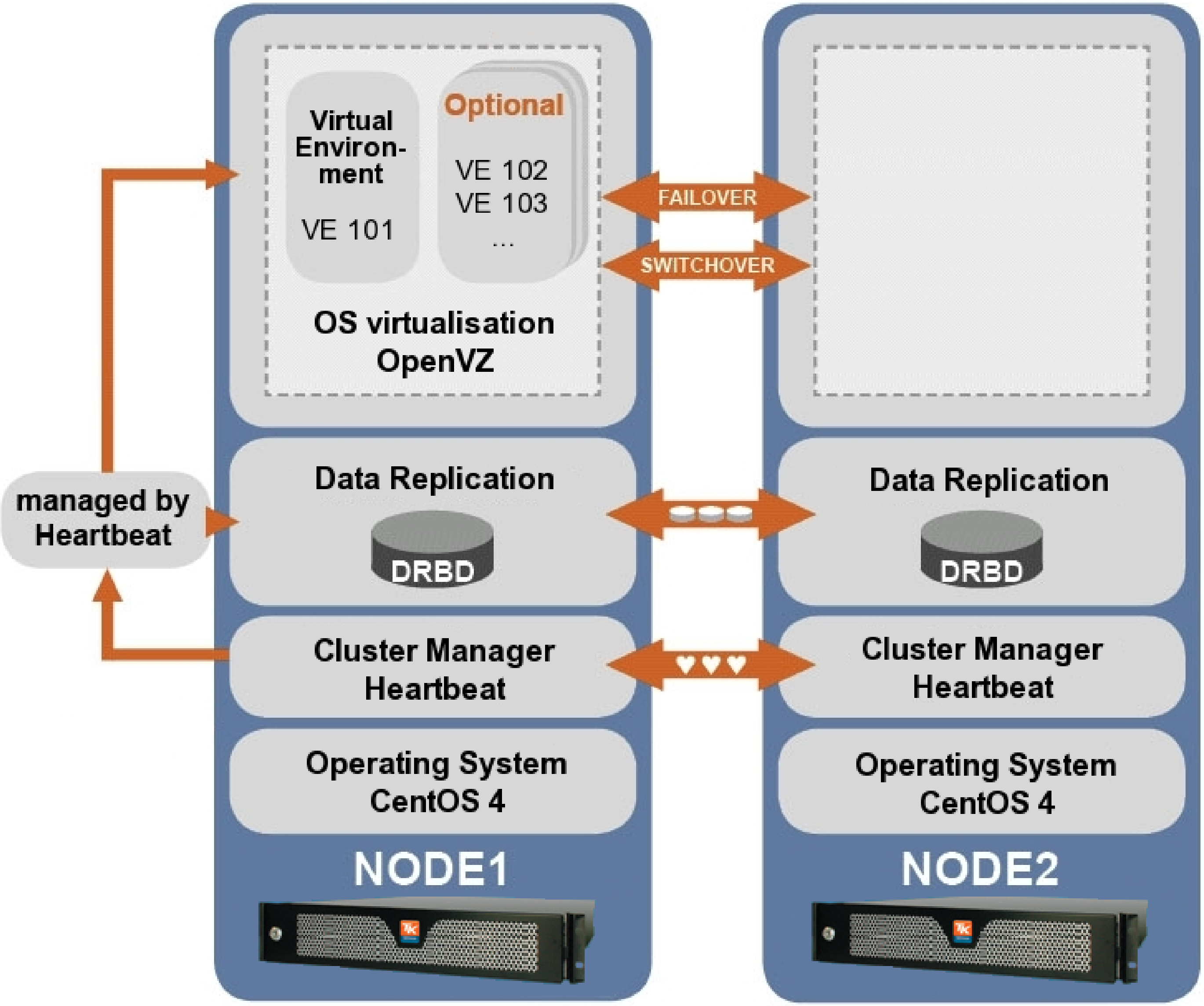
virtualised HA Cluster

🟦 local data

🟧 shared data

  - whole file system of a virtual machine is mirrored
  - applications are only installed once (within the virtual machine), not twice (on each node)

3) Concept of HA cluster with OpenVZ



managed by Heartbeat

Virtual Environment

VE 101

Optional

VE 102

VE 103

...

OS virtualisation OpenVZ

FAILOVER

SWITCHOVER

Data Replication

DRBD

Cluster Manager Heartbeat

Operating System CentOS 4

NODE1

NODE2

OpenVZ server virtualization

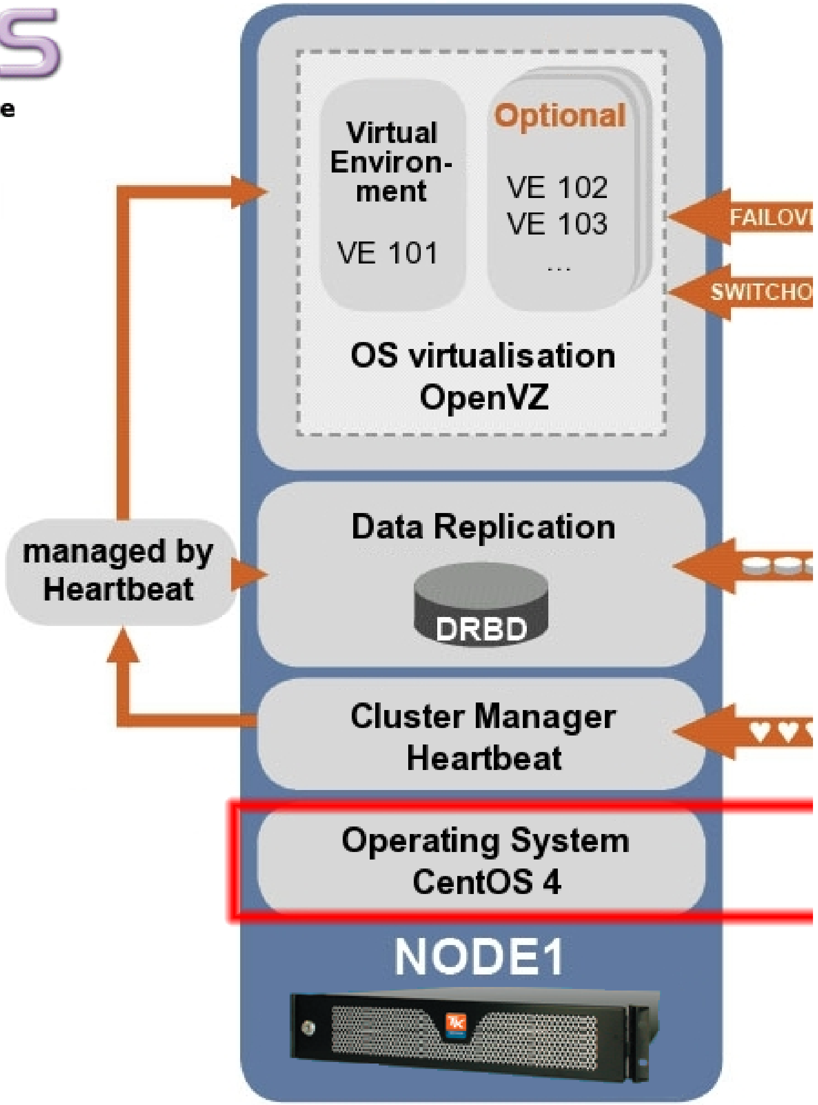
DRBD

HighAvailability

CentOS The Community ENTerprise Operating System

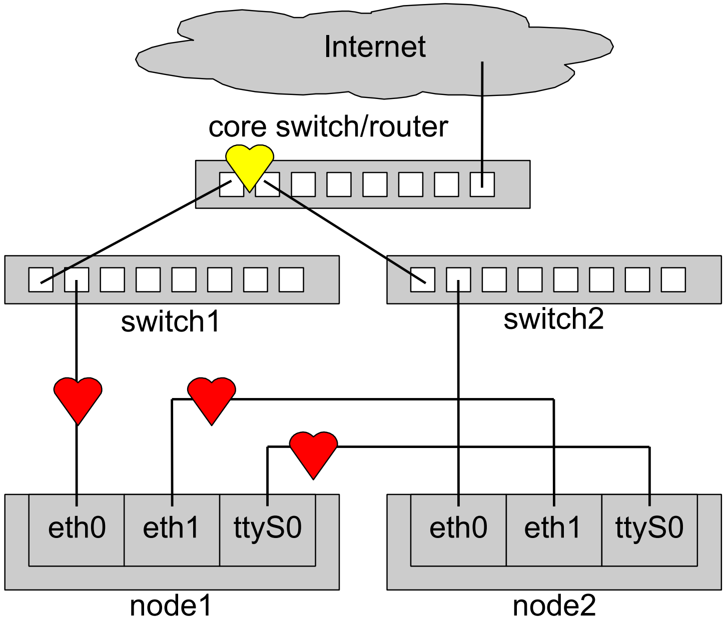
3) Concept of HA cluster with OpenVZ

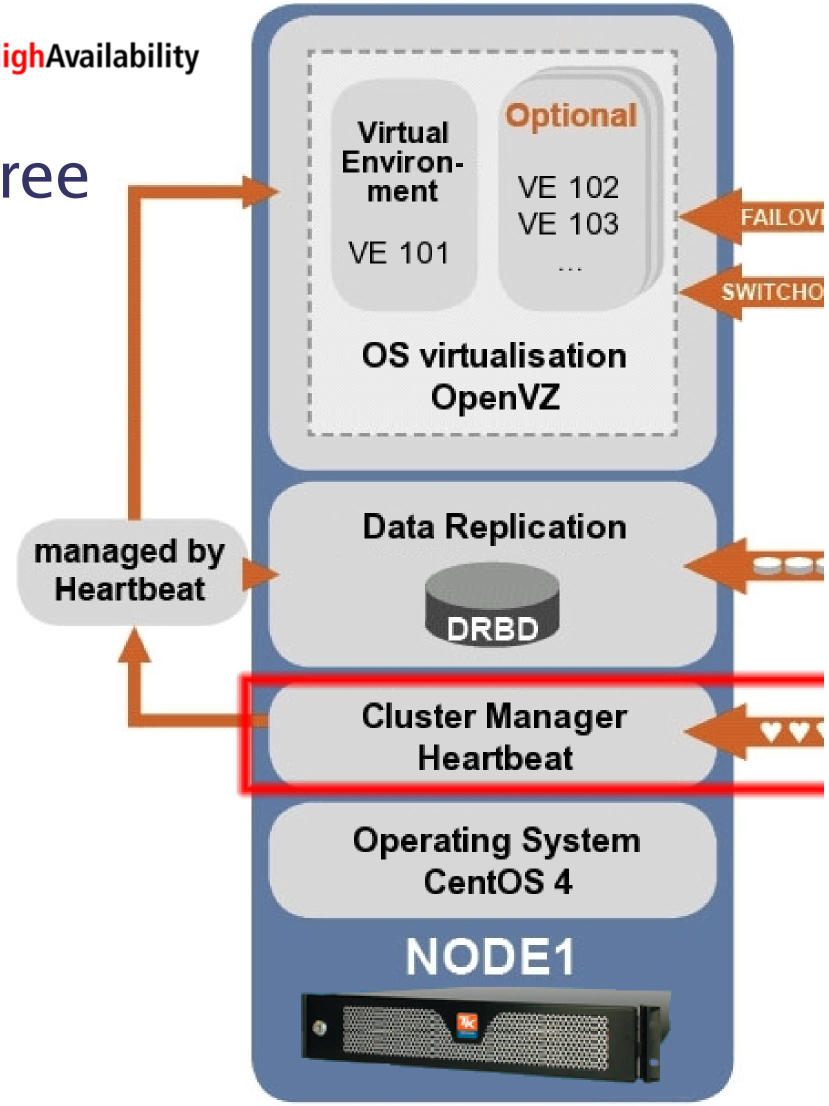
- Operating System CentOS The Community ENTerprise Operating System
  - Community ENTerprise Operating System
  - based on Red Hat Enterprise Linux
  - strives to be 100% binary compatible with the upstream product
  - www.centos.org



3) Concept of HA cluster with OpenVZ

- Cluster Manager Heartbeat
  - cluster nodes communicate via three paths (eth0, eth1, ttyS0) ♥
  - connectivity from outside is monitored via pingnode ♥





Virtual Environ-ment

VE 101

Optional

VE 102
VE 103
...

OS virtualisation OpenVZ

Data Replication

DRBD

Cluster Manager Heartbeat

Operating System CentOS 4

NODE1

managed by Heartbeat

FAILOV

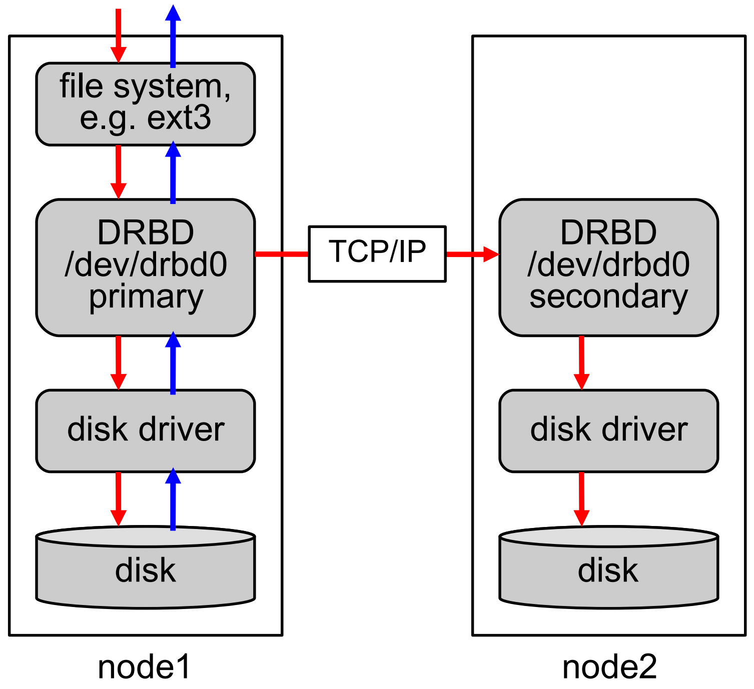
SWITCHO

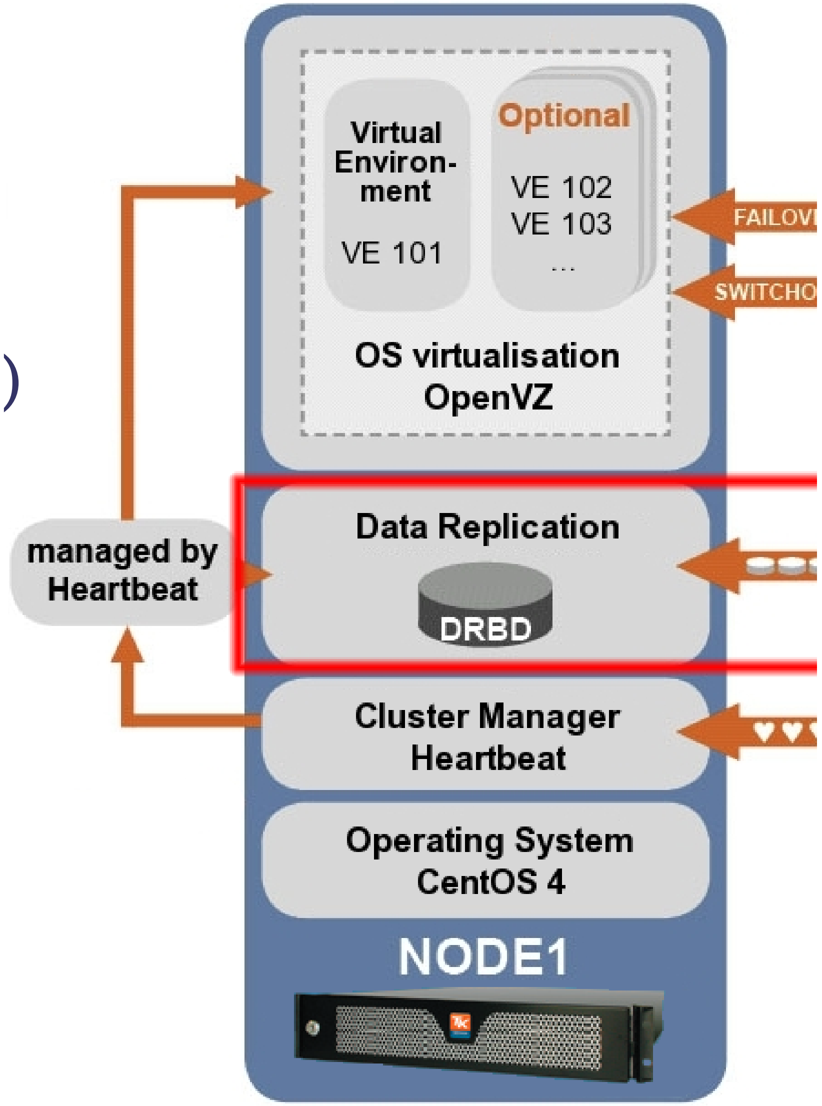
3) Concept of HA cluster with OpenVZ

- Data replication DRBD
  „RAID1 over network“

  ↓ write operation (on both nodes)

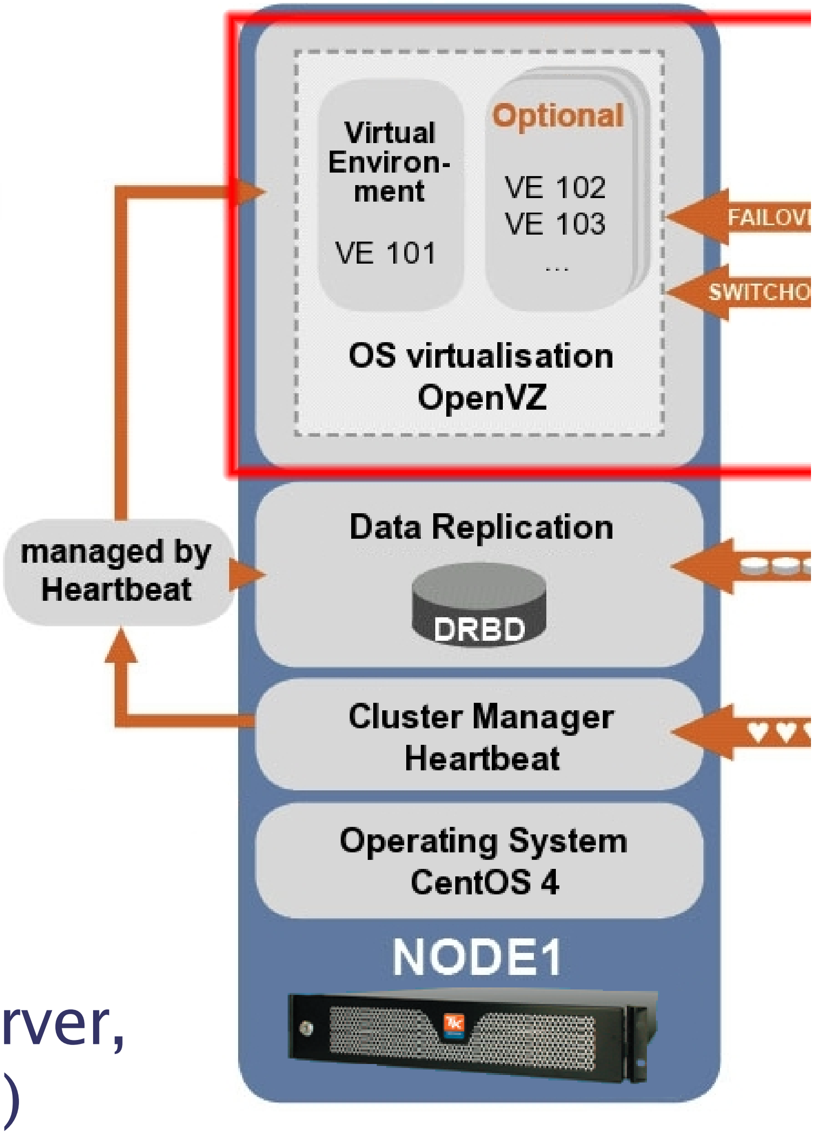
  ↑ read operation (on primary node)





3) Concept of HA cluster with OpenVZ

- OS virtualisation
  - containers-type virtualisation on Linux
  - creates multiple secure, isolated containers (VEs, VPSs)
  - single-kernel technology
  - enables better server utilisation
  - allows resource configuration
  - http://openvz.org
  - (other OS virtualisation tech.: VServer, FreeBSD Jails, Solaris Containers)



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4) OpenVZ details

OpenVZ components:

- Kernel
  - Virtualization and Isolation
  - Resource Management
  - Checkpointing
- Tools
  - vzctl: Virtual Environment (VE) control utility
  - vzpkg: VE software package management
- Templates
  - precreated VE images for fast VE creation

4) OpenVZ details

OpenVZ
server virtualization

Each virtual environment has its own:

- Files
  System libraries, applications, virtualized /proc and /sys, virtualized locks etc.
- Process tree
  Featuring virtualized PIDs, so that the init PID is 1
- Network
  Virtual network device, its own IP addresses, set of netfilter and routing rules
- Devices
  Plus if needed, any VE can be granted access to real devices like network interfaces, serial ports, disk partitions, etc.
- IPC objects
  shared memory, semaphores, messages

4) OpenVZ details

OpenVZ Resource Management:

- **User Beancounters** is a set of per-VE resource counters, limits, and guarantees
  (kernel memory, network buffers, phys pages, etc.)
- **Fair CPU scheduler**
  (with shares and hard limits)
- **Two-level disk quota**
  (first-level: per-VE quota; second-level: ordinary user/group quota inside a VE)
- **I/O scheduler**
  (two-level, based on CFQ)

4) OpenVZ details

OpenVZ Kernel Checkpointing/Migration:

- Complete VE state can be saved in a file
  - running processes
  - opened files
  - network connections, buffers, backlogs, etc.
  - memory segments
- VE state can be restored later
- VE can be restored on a different server

4) OpenVZ details

OpenVZ Tools:

```
# vzctl create 101 --ostemplate fedora-core-5
# vzctl set 101 --ipadd 192.168.4.45 --save
# vzctl start 101
# vzctl exec 101 ps ax
  PID TTY      STAT   TIME COMMAND
    1 ?        Ss     0:00 init
11830 ?        Ss     0:00 syslogd -m 0
11897 ?        Ss     0:00 /usr/sbin/sshd
11943 ?        Ss     0:00 xinetd -stayalive -pidfile ...
12218 ?        Ss     0:00 sendmail: accepting connections
12265 ?        Ss     0:00 sendmail: Queue runner@01:00:00
13362 ?        Ss     0:00 /usr/sbin/httpd
13363 ?        S      0:00  \_ /usr/sbin/httpd
..............................................
13373 ?        S      0:00  \_ /usr/sbin/httpd
6416 ?         Rs     0:00 ps axf
# vzctl enter 101
bash# logout
# vzctl stop 101
# vzctl destroy 101
```

4) OpenVZ details

OpenVZ Tools:

```
# vzpkgls
fedora-core-5-i386-default
centos-4-x86_64-minimal

# vzpkgcache
(creates templates from metadata/updates existing
templates)

# vzyum 101 install gcc
(installs gcc and its deps to VE 101)
```

4) OpenVZ details

OpenVZ
server virtualization

Performance Evaluation of Virtualization Technologies for Server Consolidation
(April 2007, HP Laboratories Palo Alto):

> „For all the cases tested, the virtualization overhead observed in OpenVZ is limited, and can be neglected in many scenarios.“

(http://www.hpl.hp.com/techreports/2007/HPL-2007-59.pdf)

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5) live switchover enhancement

- uses OpenVZ's checkpointing feature
- allows rolling kernel-upgrades without shutting down virtual environments

- the following scripts are necessary:
  - cluster_freeze.sh
  - cluster_unfreeze.sh
  - live_switchover.sh
  - an adjusted init script for openvz

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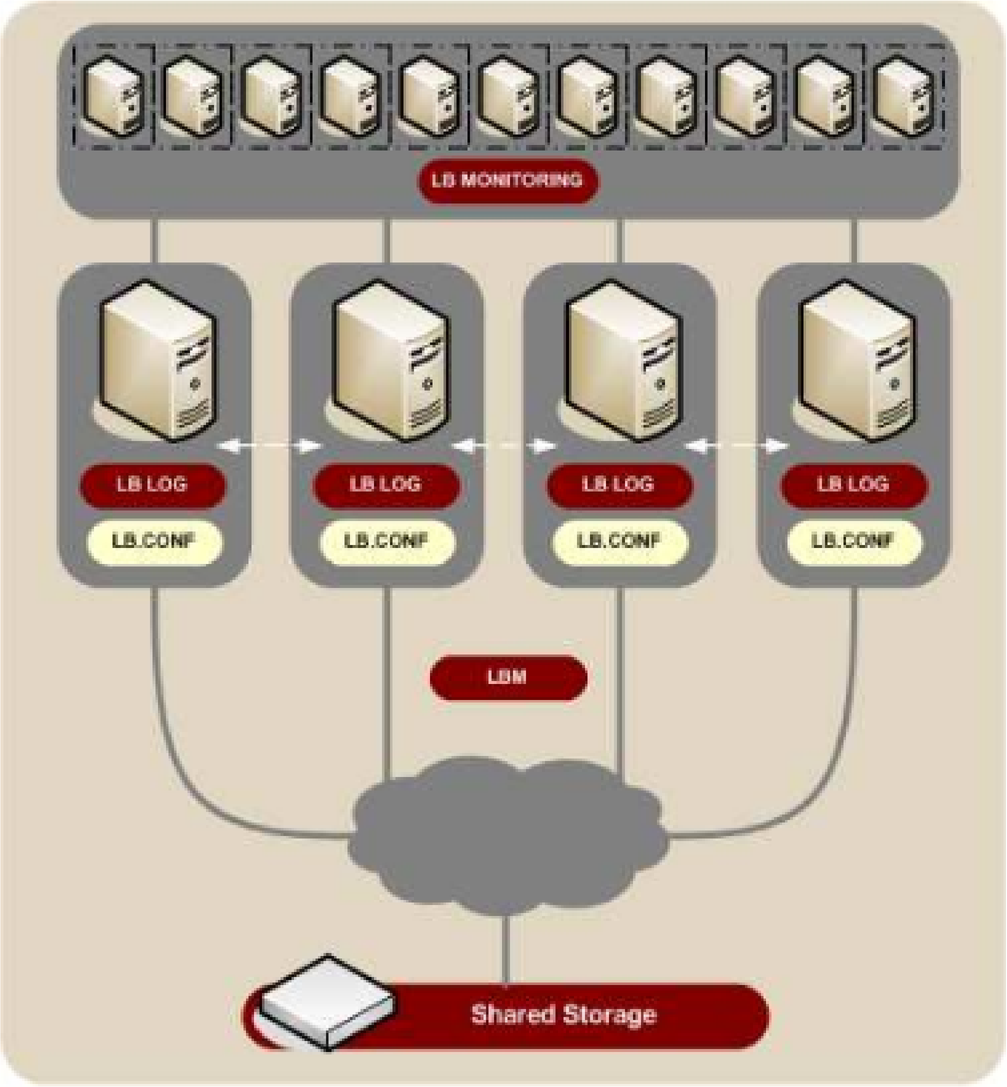
6) outlook: LBVM

- LBVM (load balancing of virtual machines)
  - allows sharing virtual machines among physical servers in a predefined cluster
  - LB MONITOR: load balancer itself
    (uses different algorithms to decide which virtual machines should be moved or reported)
  - LBM script: management interface to the load balancer
    (is used to view all balanced virtual machines, review log files and reports, manually migrate)
  - LB LOG: small cronjob which runs regularly on each server to monitor predefined resources
    (the resource logs are stored on a shared storage and are evaluated by the load balancer)

6) outlook: LBVM



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7) Conclusion

What is it?	Linux High Availability Cluster with OS-level virtualisation
What does it do?	• mirrors whole virtual environments on two cluster nodes • restarts virtual environments in case of an outage on the second (remaining) node
Who can use it?	Linux administators
What are typical usage szenarios?	Misson-Critical database server, mail server, web server, ...

Resources

- http://openvz.org/
- http://wiki.openvz.org/HA_cluster_with_DRBD_and_Heartbeat
- http://www.centos.org/
- http://www.linux-ha.org/
- http://www.drbd.org/
- http://www.hpl.hp.com/techreports/2007/HPL-2007-59.pdf
- http://lbvm.sourceforge.net/

Thanks for your attention!