How To Build A High Available Environment With Linux On System z

Don Vosburg

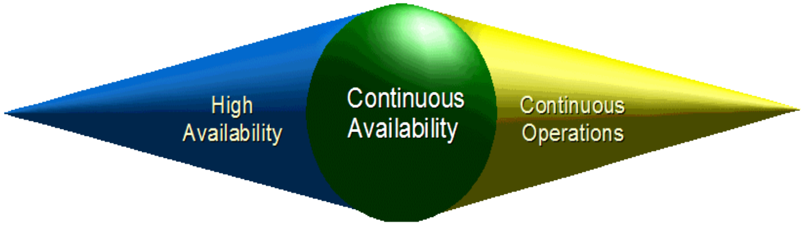
Systems Engineer

dvosburg@suse.com

SUSE

We adapt. You succeed.

Definitions

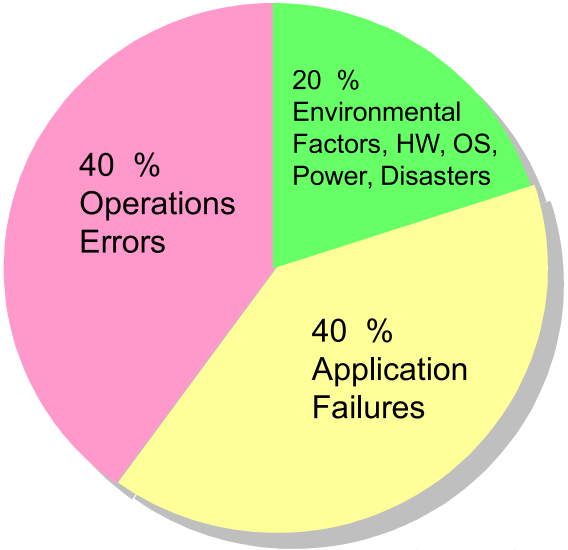


- High Availability (HA)
  - Provide service during defined periods, at agreed levels, and masks *unplanned* outages from end-users. It employs Fault Tolerance; Automated Failure Detection, Recovery, Testing, Problem and Change Management
- Continuous Operations (CO)
  - Continuously operate and mask *planned* outages from end-users. It employs Non-disruptive hardware and software changes, non-disruptive configuration, software coexistence.
- Continuous Availability (CA)
  - Deliver non-disruptive service to users 7day/week, 24hs a day
  - There are no planned or unplanned outages
- The goal is to strive to provide Continuous Availability.

Business Continuity Issues

What are the reasons for system outages?

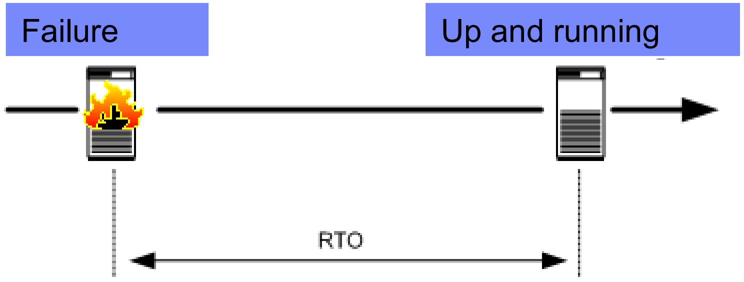
- Planned outages
  - Maintenance
  - Tests
- Unplanned outages
  - Operator errors
    - Lack of application skills
    - Lack of OS skills in heterogeneous environment
  - Application failures
    - SW exceptions
    - Environment / Configuration problems
  - Environmental failures
    - OS failures
    - HW failures
    - …
    - Disasters



Source: Gartner Group

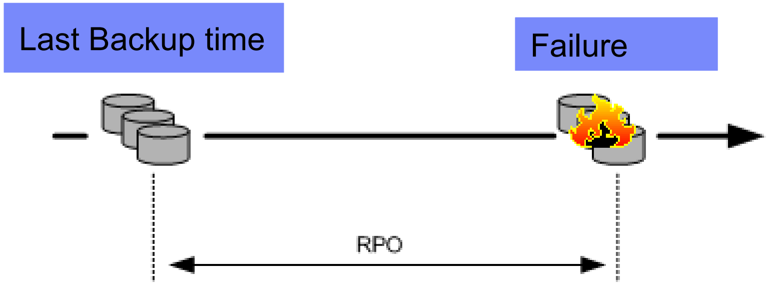
Identify RTO, RPO, NRO

Business Resiliency Plan



Failure

Up and running



Last Backup time

Failure

Recovery Time Objective (RTO)

What time difference can be between Failure and a total productional run level ?

Recovery Point Objective (RPO)

What is the toleration for data loss?
RPO = “0” means, NULL data loss acceptable
RPO = “5” means, data loss in last 5 min acceptable

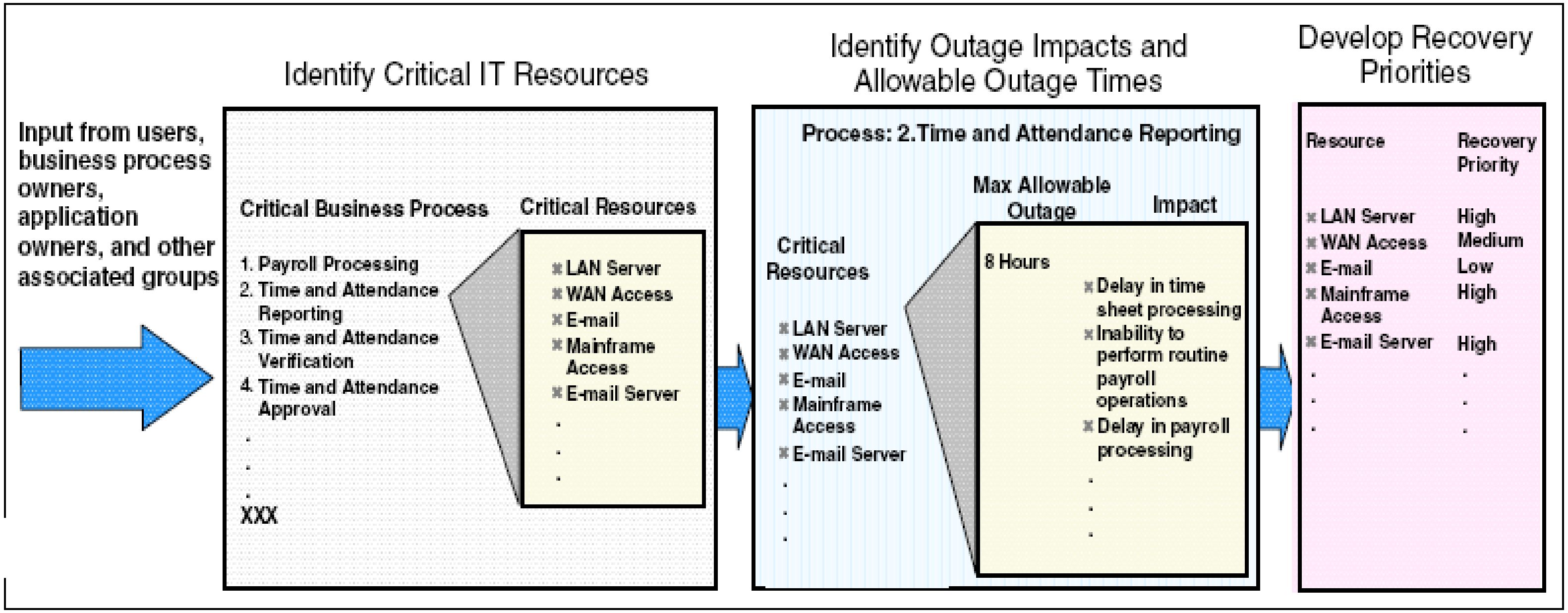
TREND: RPO = 0

Network Recovery Objective (NRO)

Time requirements for network availability.

Business Impact Analysis (BIA)

- IT Resource relation and priorities for DR
  - Consider all environments
  - Prioritize based on business importance



Input from users, business process owners, application owners, and other associated groups

Identify Critical IT Resources

Critical Business Process

1. Payroll Processing
2. Time and Attendance Reporting
3. Time and Attendance Verification
4. Time and Attendance Approval

.
.
.

XXX

Critical Resources

- LAN Server
- WAN Access
- E-mail
- Mainframe Access
- E-mail Server

.
.
.

Identify Outage Impacts and Allowable Outage Times

Process: 2.Time and Attendance Reporting

Critical Resources

- LAN Server
- WAN Access
- E-mail
- Mainframe Access
- E-mail Server

.
.
.

Max Allowable Outage	Impact
8 Hours	Delay in time sheet processing Inability to perform routine payroll operations Delay in payroll processing . . .

Develop Recovery Priorities

Resource	Recovery Priority
LAN Server	High
WAN Access	Medium
E-mail	Low
Mainframe Access	High
E-mail Server	High
.	.
.	.
.	.

Figure 3-2 Example of the Business Impact Analysis process

High Availability And Disaster Recovery

Differences

- High Availability (HA)
  - Failover is typically realized via duplication and clustering
  - Failover times measured in seconds and minutes
  - Reliable inter-node communication

- Disaster Recovery (DR)
  - Failover is typically realized with 2 or more sites in case of disasters
  - Failover times often measured in minutes and hours
  - Unreliable inter-node communication assumed

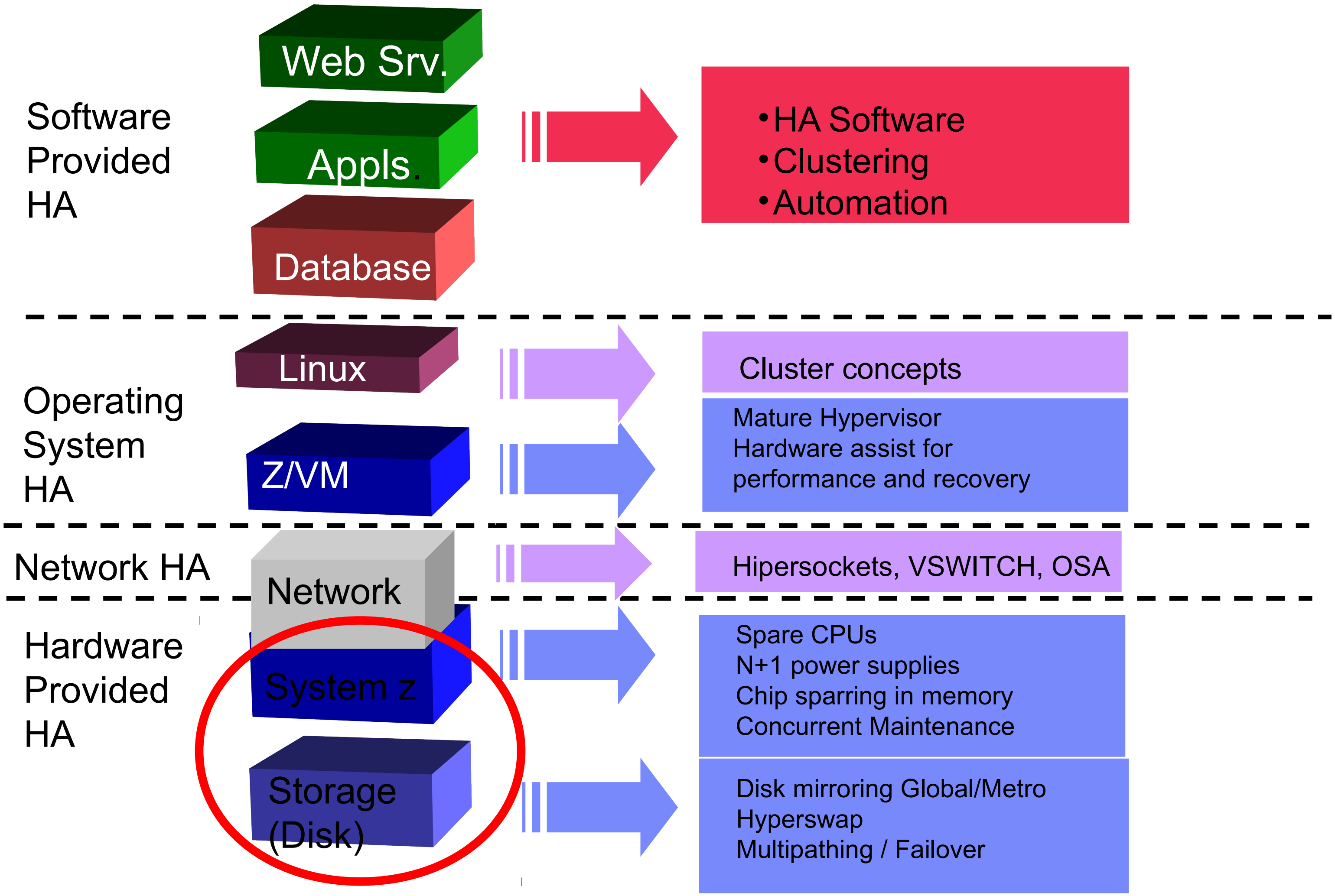
Fundamentals Of High Availability

- Redundancy, Redundancy
  - Duplicate to eliminate single points of failure
- Handle Relations Of Redundant Objects Consistently
  - Status, dependencies, constraints, etc
- Early detection
  - To keep offline time as short as possible
  - Reduce risk of wrong interpretation and unnecessary failover
  - Keep offline time as short as possible (mean-time-to-repair MTTR)

Fundamentals Of High Availability (2)

- Automate Detection and Failover
  - Let the system do the work in order to minimize outage windows
    - Multipath I/0
    - VIPA –Virtual IP Addresses
    - Monitoring and heart-beating
    - Clustered middleware
    - Clustered operating systems
- Protect Data Consistency
  - Provide ability for data and file systems to return to a point of consistency after a crash
    - Journaling databases, journaling file systems
    - Mirroring, routine database backups

Components Of High Availability



Software Provided HA

- HA Software
- Clustering
- Automation

Operating System HA

Cluster concepts

Mature Hypervisor
Hardware assist for performance and recovery

Network HA

Hipersockets, VSWITCH, OSA

Hardware Provided HA

Spare CPUs
N+1 power supplies
Chip sparring in memory
Concurrent Maintenance

Disk mirroring Global/Metro
Hyperswap
Multipathing / Failover

Clustering Concepts

- Computer Cluster
  - A computer cluster consists of a set of loosely connected computers that work together so that in many respects they can be viewed as a single system. (Wikipedia definition: Computer Cluster)

- High Availability Cluster
  - A computer cluster where each cluster operates as workload node. When one node fails another node takes over the entire workload: IP address, data access, services, etc.
  - The key of High Availability is avoiding single points of failure
  - High Availability adds costs because of added complexity due to redundant resources in the environment

High Availability Considerations

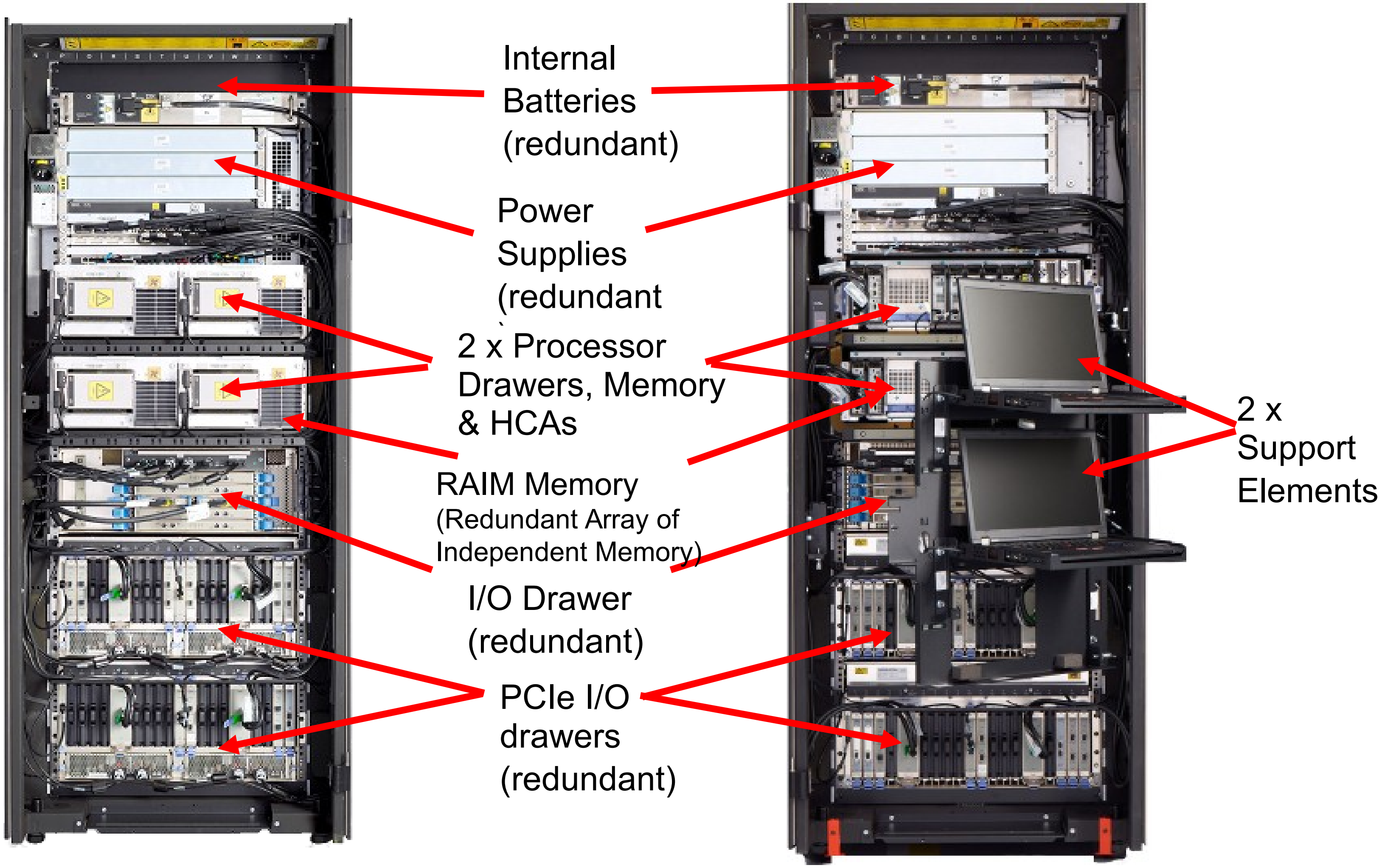
Linux, z/VM, System z

Single Point of Failure	Probability of Failure	Cost to fix
System z hardware	Very Low	High
LPAR	Very Low	Low
z/VM	Low	Low
Linux	Low	Very Low
Disk Subsystem microcode	Low	Medium
Application	High	Very Low

- Besides hardware and software failures, what else can cause production down time?
  - System z hardware upgrades requiring Restart
  - LPAR configuration changes requiring reboot of the LPAR
  - z/VM maintenance (if not SSI clustered)
  - Linux kernel maintenance that requires reboot
  - Application maintenance

IBM System z

Redundancy Build Into The System



Internal Batteries (redundant)

Power Supplies (redundant

2 x Processor Drawers, Memory & HCAs

RAIM Memory
(Redundant Array of Independent Memory)

I/O Drawer (redundant)

PCIe I/O drawers (redundant)

2 x Support Elements

Rear View

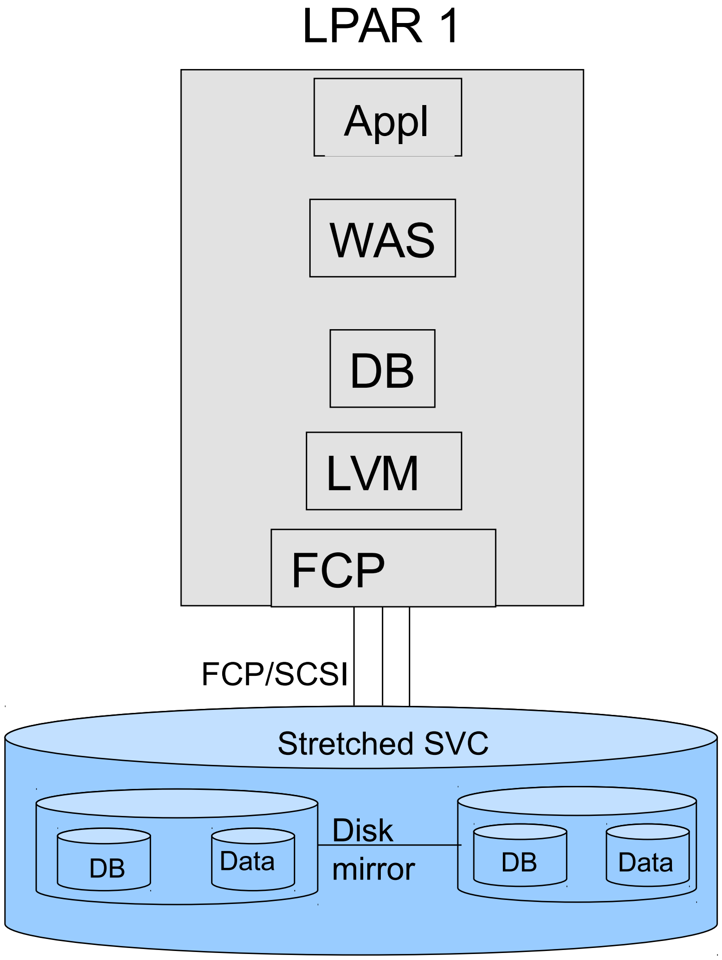
Front View

System z Unique Selling Points

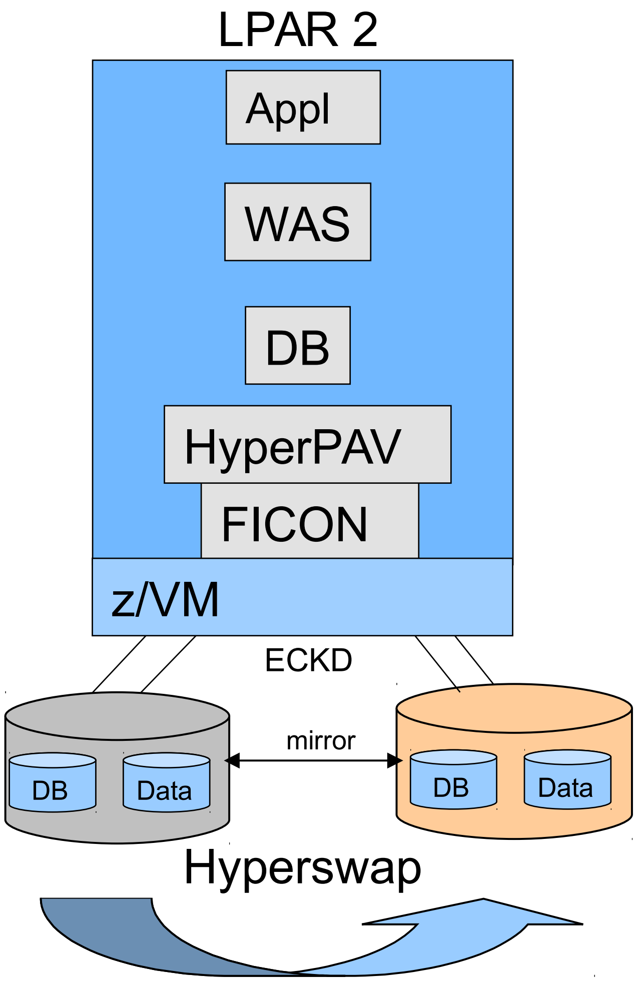
”Changing Tires At 100mph”

Replacing a z10 book during production

Storage High Availability Options



- Multiple Storage Subsystems
- FICON attached Disks
  - ECKD disks
  - multi channel connections
- FCP/SCSI attached disks
  - SCSI disks - LUN attached
  - Multi pathing / LVM
  - Streched SVC for HA
- Disk Replication
  - Metro / Global Mirror (PPRC)
  - Virtual disk mirror (SVC)
  - LVM mirror
  - Oracle ASM mirror
- z/VM Hyperswap
  - Online disk swap



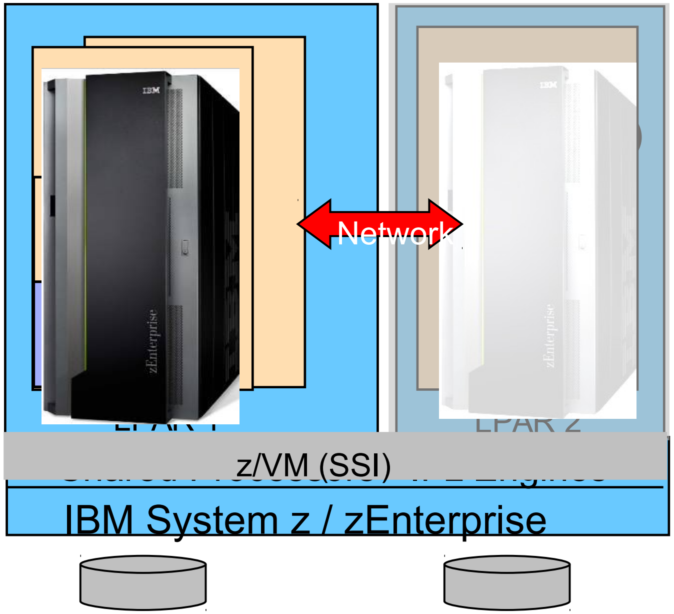
High Availability Scenarios

Active / Passive with System z

- **Active / Passive Deployment**
  - Workload normally contained at site 1, standby server capability at site 2
  - Primary and secondary disk configurations active at both sites
  - During fail over, **Capacity Upgrade on Demand (CUoD)** adds resources to operational site, and standby servers are started. Helps save hardware and software costs, but requires higher recovery time.

- Hot / Cold scenario
  - Workload is not split
  - Each site is configured to handle all operations
  - Cold environment needs longer to get active
  - Often used in DR

- Hot / Warm scenario
  - Workload is not split
  - Each site is configured to handle all operations
  - Warm environment is idling

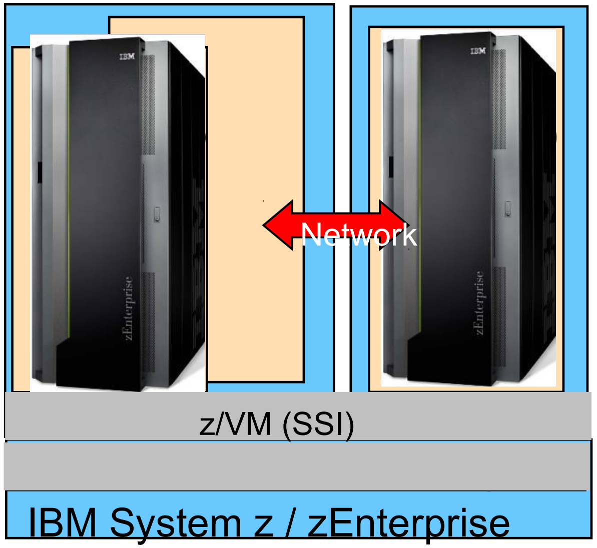


High Availability Scenarios (2)

Active / Active with System z

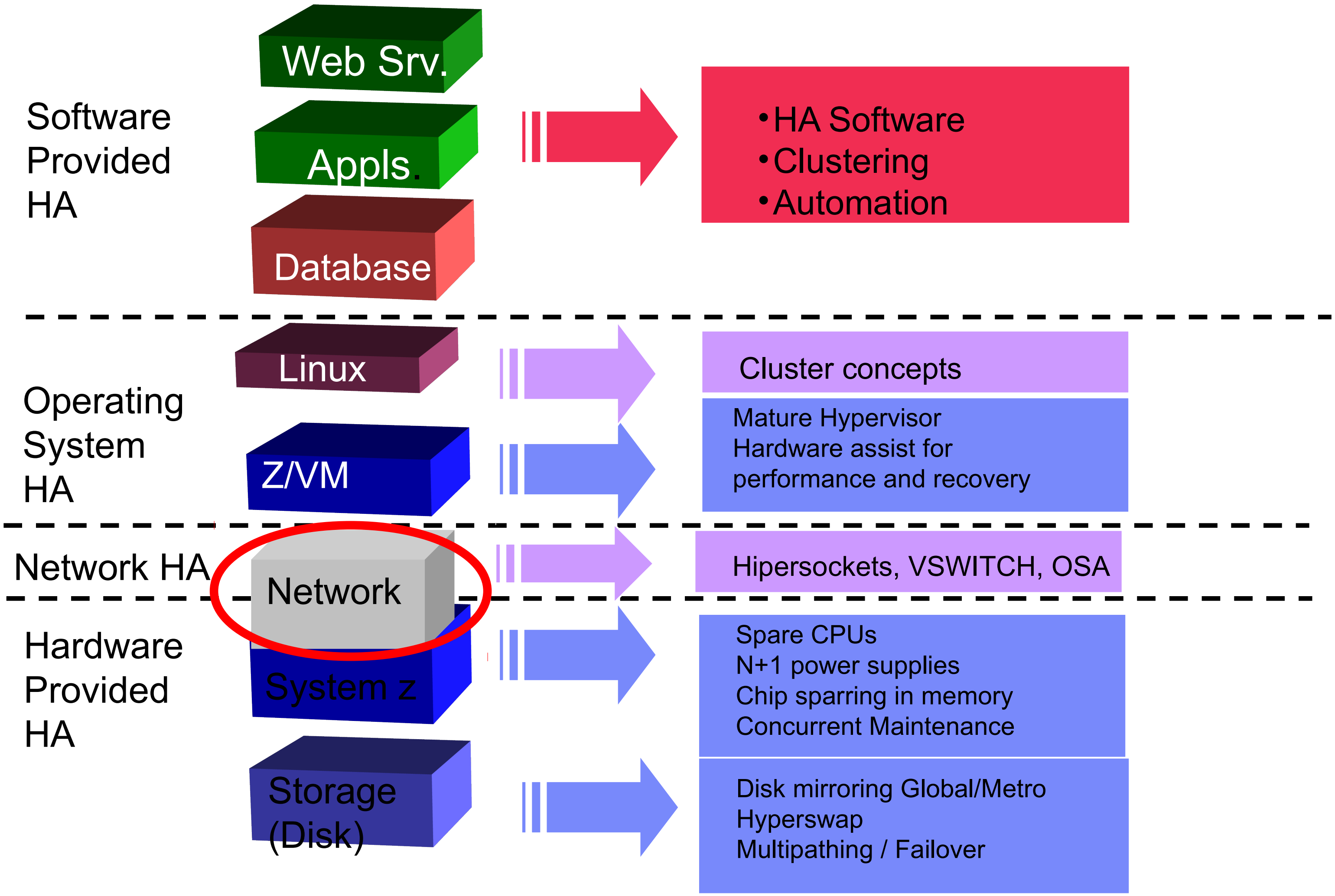
Active / Active Deployment

- Workload is normally split between 2 or more sites
- Each site is configured to be able to instantly cover the workload if needed
- During normal operation, excess capacity at each site is consumed by lower priority, work like development or test activitries
- In a failover situation, low priority work is stopped to free up resources for the production site’s incoming work



- Capacity Upgrade on Demand (Active / Active)
  - Workload is normally split between sites
  - Each site is configured with capacity to handle normal operations
  - Special setup with Capacity Upgrade on Demand (CUoD)
  - In a failover situation, additional CPUs are enabled at the operational site

Components Of High Availability



Software Provided HA

- HA Software
- Clustering
- Automation

Operating System HA

Cluster concepts

Mature Hypervisor
Hardware assist for
performance and recovery

Network HA

Hipersockets, VSWITCH, OSA

Hardware Provided HA

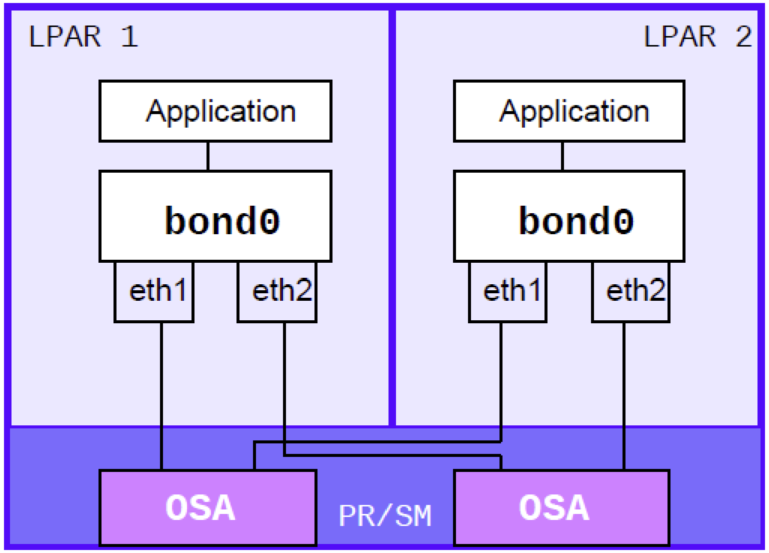
Spare CPUs
N+1 power supplies
Chip sparring in memory
Concurrent Maintenance

Disk mirroring Global/Metro
Hyperswap
Multipathing / Failover

Network Interface
HA and Automated Failover

OSA-card HA

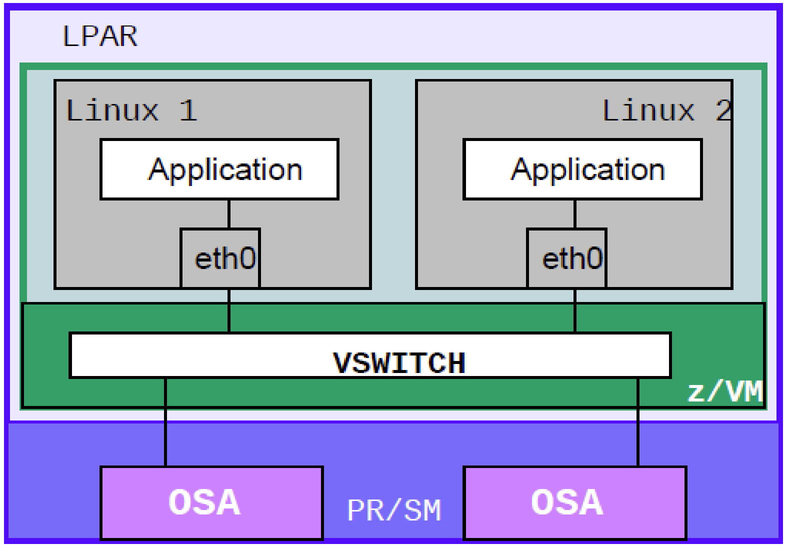
Channel Bonding for enhanced bandwidth



- Linux *bonding* driver enslaves multiple OSA connections to create a single logical network interface card (NIC)
- Detects loss of NIC connectivity and automatically fails over to surviving NIC
- Active/backup & aggregation modes
- Separately configured for each Linux

Network HA with z/VM VSWITCH

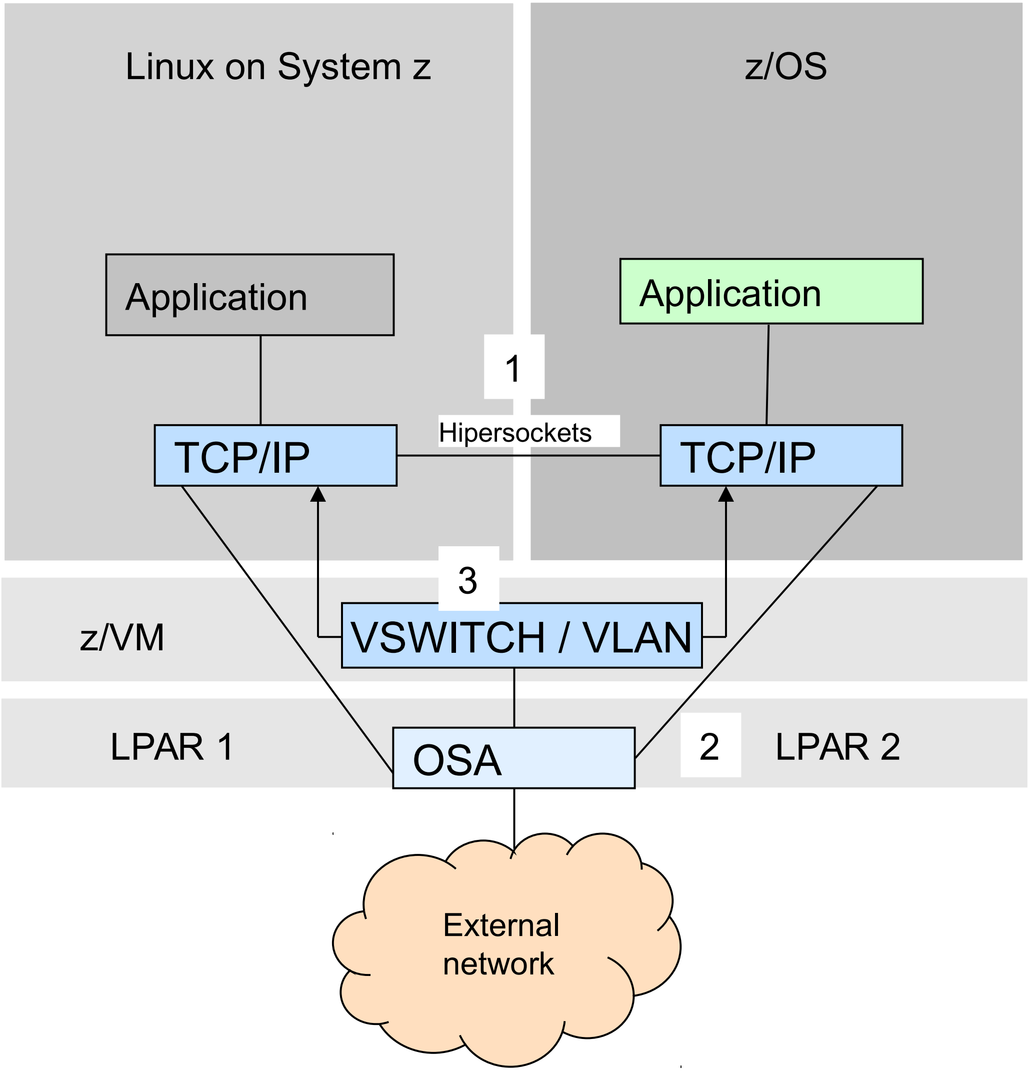
Port aggregation for enhanced bandwidth



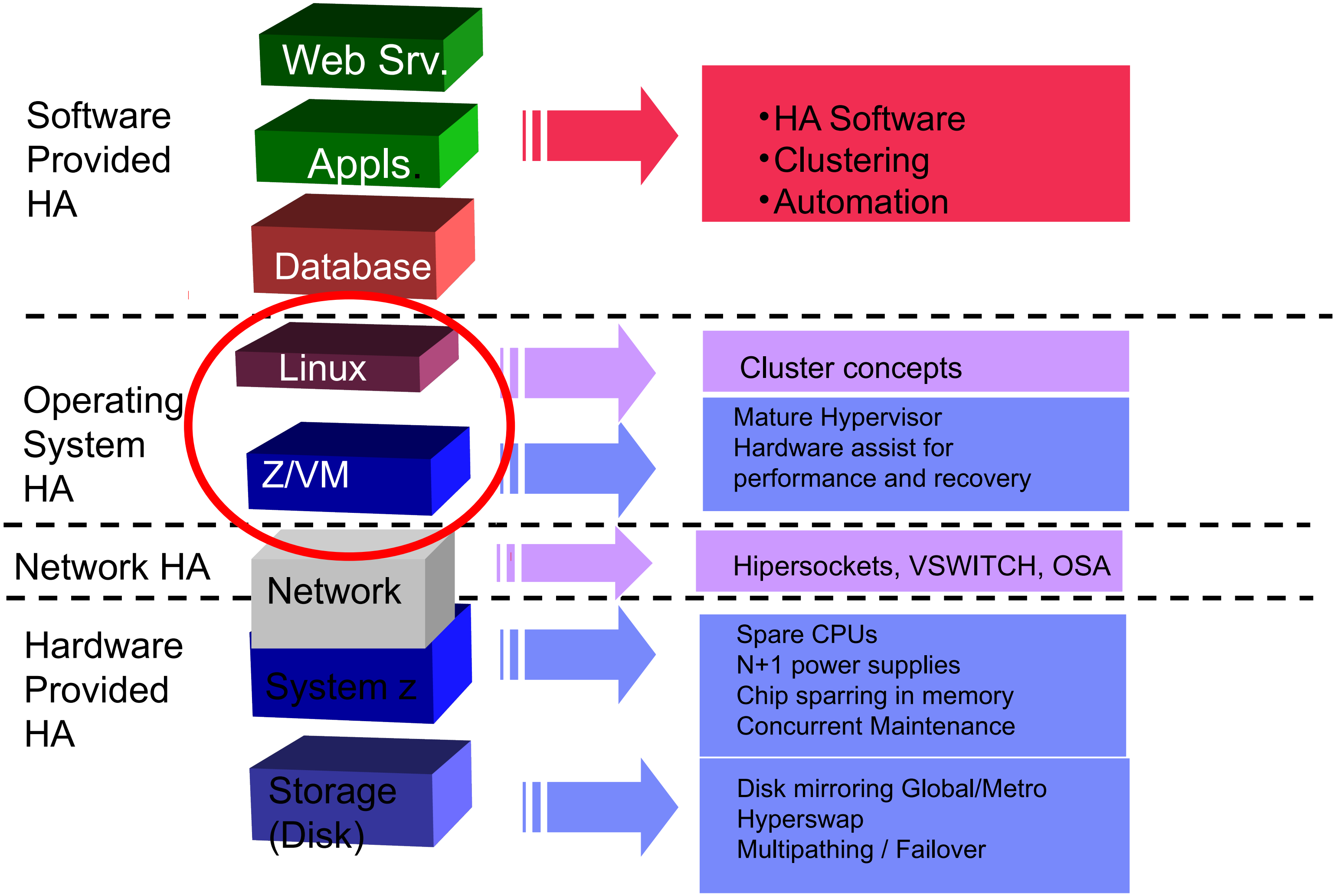
- z/VM *VSWITCH* enslaves multiple OSA connections. Creates virtual NICs for each Linux guest
- Detects loss of physical NIC connectivity and automatically fails over to surviving NIC
- Active/backup & aggregation modes
- Centralized configuration benefits all guests

Network Alternatives

Linux, z/VM, LPAR, System z



Components Of High Availability



Software Provided HA

Web Srv.

Appls.

Database

- HA Software
- Clustering
- Automation

Operating System HA

Linux

Z/VM

Cluster concepts

Mature Hypervisor
Hardware assist for
performance and recovery

Network HA

Network

Hipersockets, VSWITCH, OSA

Hardware Provided HA

System z

Storage (Disk)

Spare CPUs
N+1 power supplies
Chip sparring in memory
Concurrent Maintenance

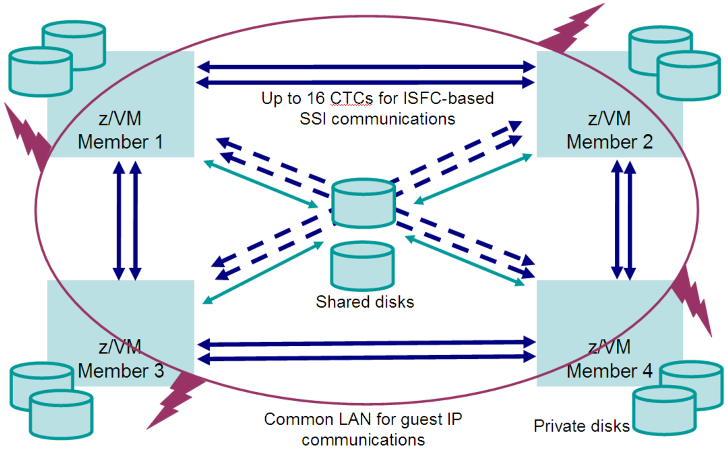
Disk mirroring Global/Metro
Hyperswap
Multipathing / Failover

z/VM V6.3 - Increase Availability for Linux guests

Single System Image, Clustered Hypervisor, Live Guest Relocation

Single System Image (SSI)

- Connect up to four z/VM systems as members of a cluster
- Provides a set of shared resources for member systems and their hosted virtual machines
  - Directory, minidisks, spool files, virtual switch MAC addresses
- Cluster members can be run on the same or different z10, z196, zEC12 or BC servers
- Simplifies systems management of a multi-z/VM environment
  - Single user directory
  - Cluster management from any member
    - Apply maintenance to all members in the cluster from one location
    - Issue commands from one member to operate on another
  - Built-in cross-member capabilities
  - Resource coordination and protection of network and disks


z/VM Member 1
z/VM Member 2
z/VM Member 3
z/VM Member 4
Up to 16 CTCs for ISFC-based SSI communications
Shared disks
Common LAN for guest IP communications
Private disks

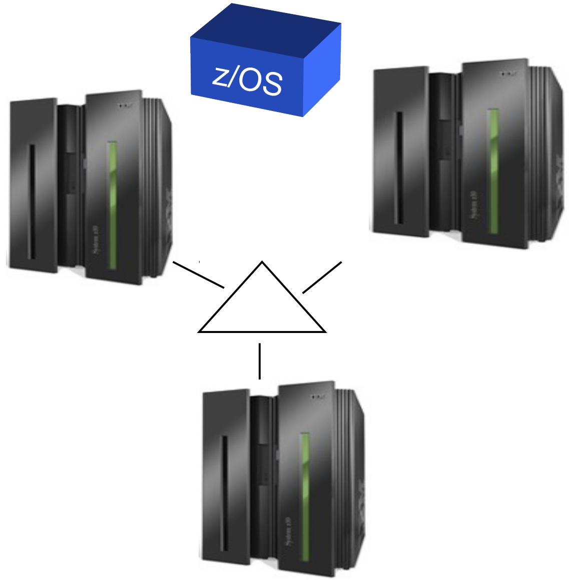
Live Guest Relocation (LGR)

- Dynamically move Linux guests from one z/VM member to another
- Reduce planned outages; enhance workload management
  - Non-disruptively move work to available system resources **and** non-disruptively move system resources to work
  - When combined with Capacity Upgrade on Demand, Capacity Backup on Demand, and Dynamic Memory Upgrade, you will get the best of both worlds

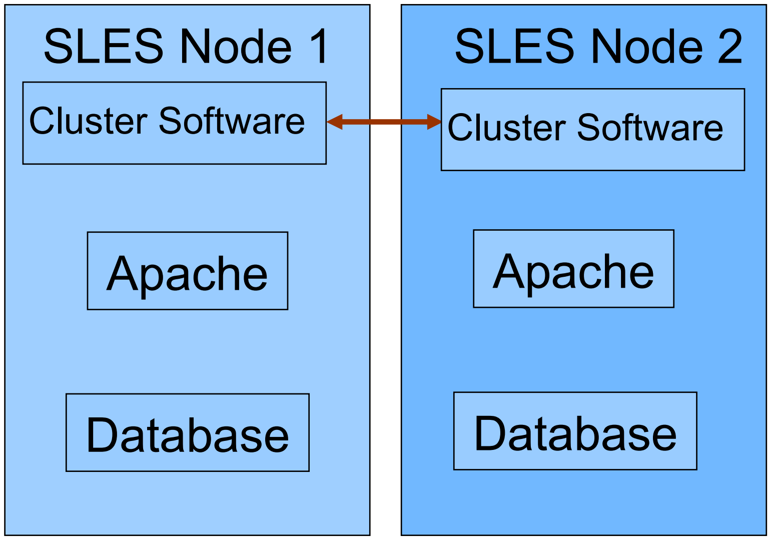
High Availability for Operating Systems

z/OS and Linux

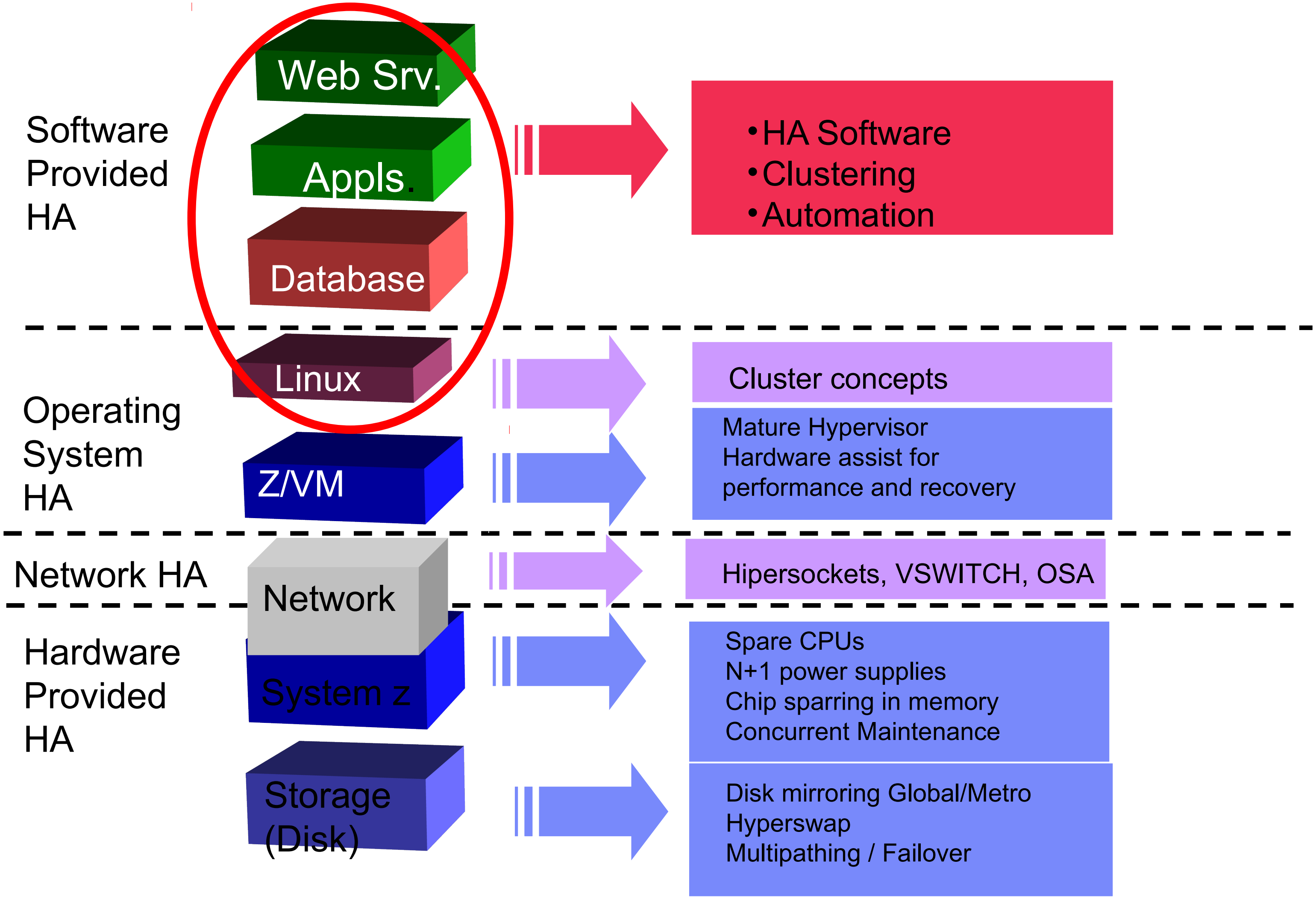
- z/OS Parallel Sysplex HA incl. memory sharing



- SUSE Linux Enterprise High Availability for System z using cluster software



Components Of High Availability



Software Provided HA

- HA Software
- Clustering
- Automation

Operating System HA

Cluster concepts

Mature Hypervisor
Hardware assist for
performance and recovery

Network HA

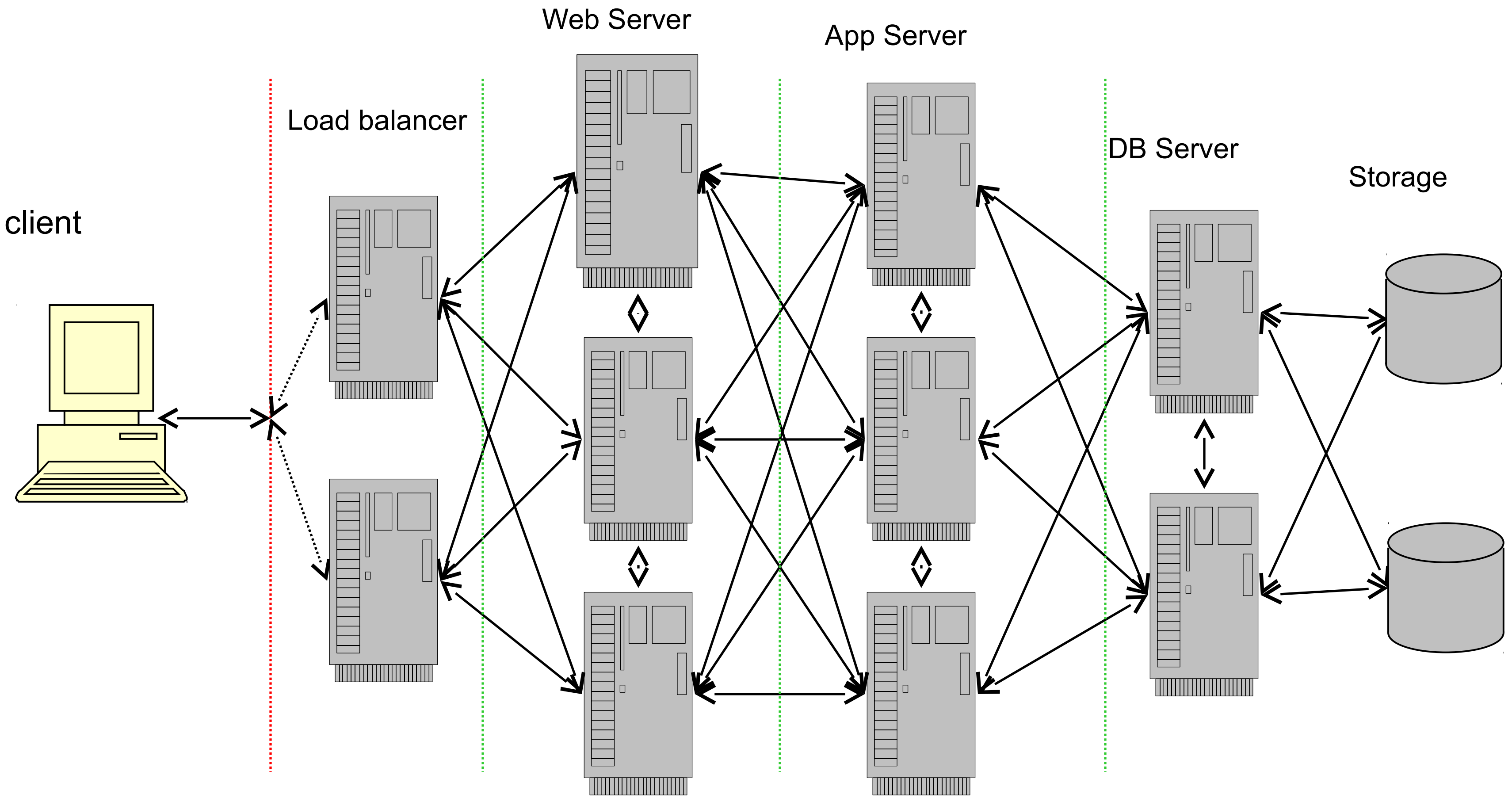
Hipersockets, VSWITCH, OSA

Hardware Provided HA

Spare CPUs
N+1 power supplies
Chip sparring in memory
Concurrent Maintenance

Disk mirroring Global/Metro
Hyperswap
Multipathing / Failover

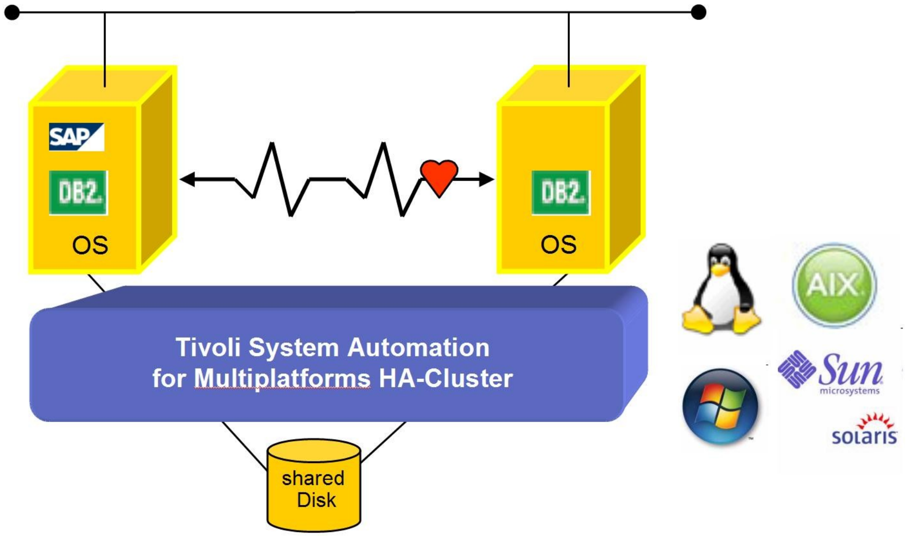
Independent Tiered Execution Streams



High Availability Clustering Cases

Heterogeneous Environment

- SUSE Linux Enterprise High Availability Extension
  - **For SUSE Enterprise Server Linux environments**
- Tivoli System Automation for Multiplatforms
  - **For z/OS**
  - **For multiplatforms**
  - **For distributed heterogeneous environments**



SUSE Linux Enterprise High Availability Extension

SUSE® Linux Enterprise High Availability Extension

Service availability 24/7

- Policy driven clustering
  - Messaging and membership layer
  - Pacemaker cluster resource manager

Sharing and Scaling data-access by multiple nodes

- Cluster file system
  - OCFS2
  - Clustered Logical Volume Manager

Disaster tolerance

- Data replication via IP
  - Distributed Replicated Block Device
- Node recovery

Scale network services

- IP load-balancing

User friendly tools

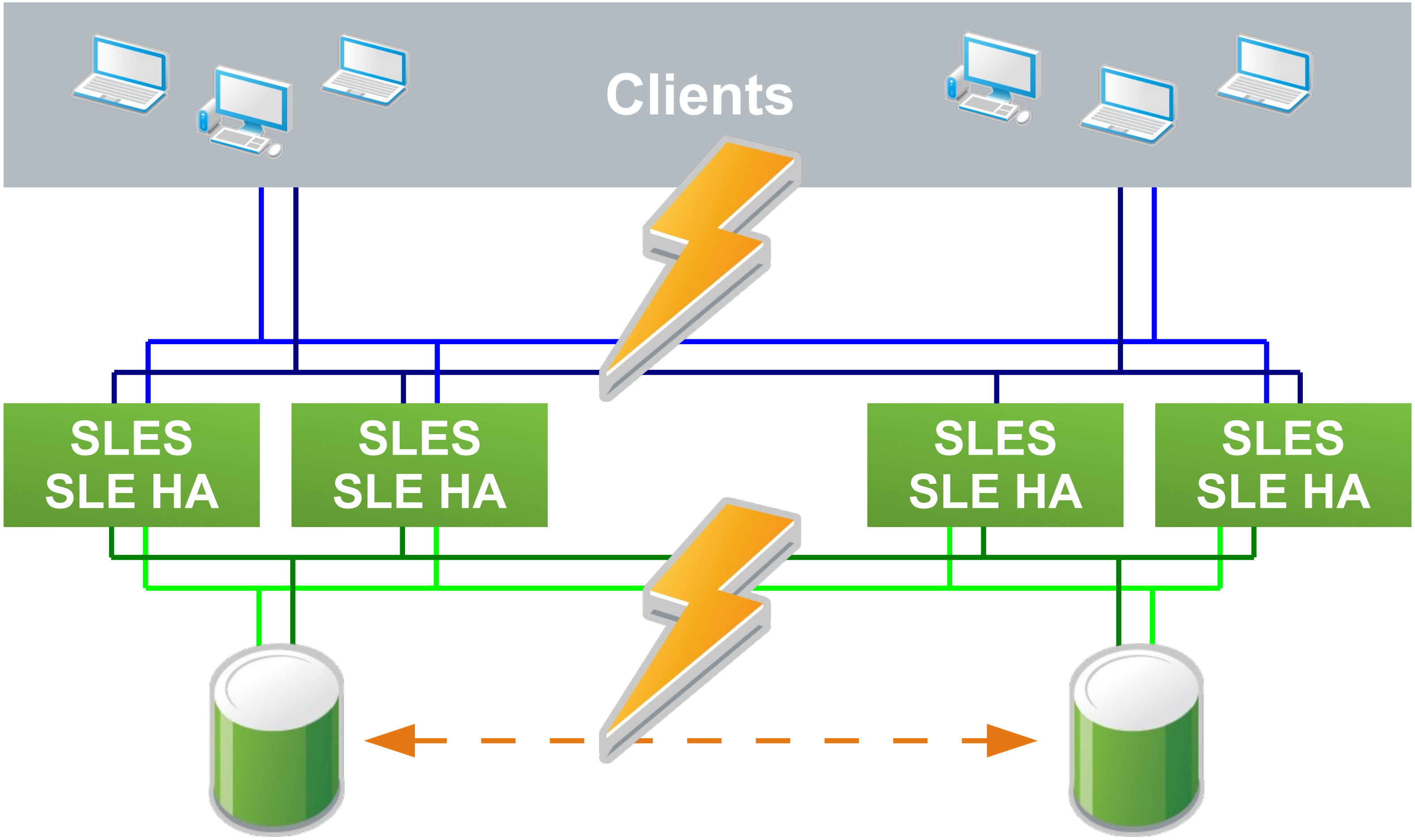
- Graphical user interface
- Unified command line interface

Key Use Cases

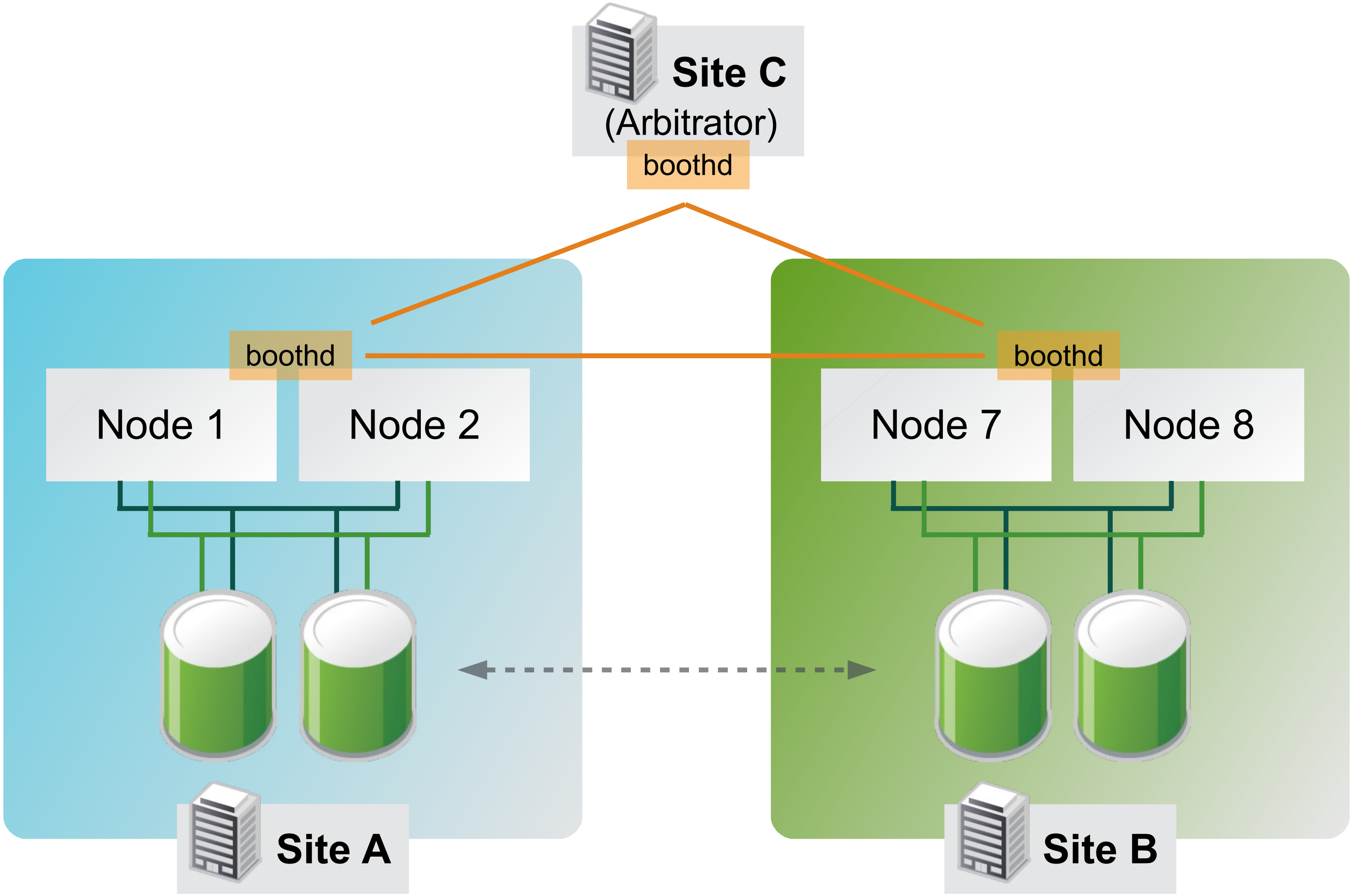
SUSE® Linux Enterprise High Availability Extension

- Achieve high availability of 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
  - Build full HA on top of virtualization
- Remote clustering
  - Local, Metro, and Geographical area clusters

Local & Stretched Cluster



Geo Cluster – Setup



Reasons for

SUSE® Linux Enterprise High Availability

- Long history track record
- Most up-to-date Open Source High Availability stack
- Deep OS integration
- Ready for Virtualization
- Integrated Data Replication
- Superior Cluster File System
- Geo cluster support

SUSE Linux Enterprise HA

HA Components

Linux HA stack, incl. pacemaker, corosync, hawk, and YaST module:

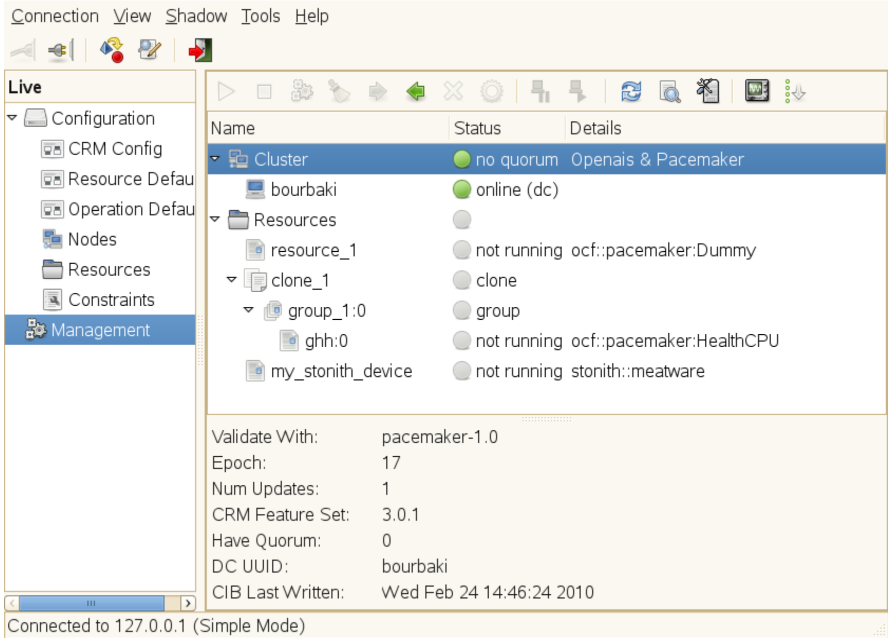
- resource-agents – monitor availability of resources
- stonith – fencing support (VMs and LPARs)
- corosync and OpenAIS – cluster infrastructure
- pacemaker – cluster resource manager
- hawk – Web console for cluster monitoring and dependencies editing
- crm – command line to interact with the CIB: editing, prepare multiple changes & commit once, syntax validation, etc.
- crm GUI - graphical interface for cluster resource and dependencies editing
- YaST module – easy basic installation
- sleha-init, sleha-join scripts to quickly create clusters

Management Tools

- SUSE Linux Enterprise High Availability Extension includes a powerful new unified command-line interface for experienced IT managers to quickly and easily install, configure and manage their clustered Linux servers.
- HAWK – HA Web Console– visual management and view of the cluster without the need for X
- Graphical user interface that provides operators with a simple, user-friendly tool for monitoring and administering their clustered environment.
- New YaST2 modules for the configuration:
  - of DRBD,
  - openAIS
  - multipath

Supported Platforms

- SUSE Linux Enterprise Server 11
- for x86, x86_64,
- System z*
- Itanium*
- Power*



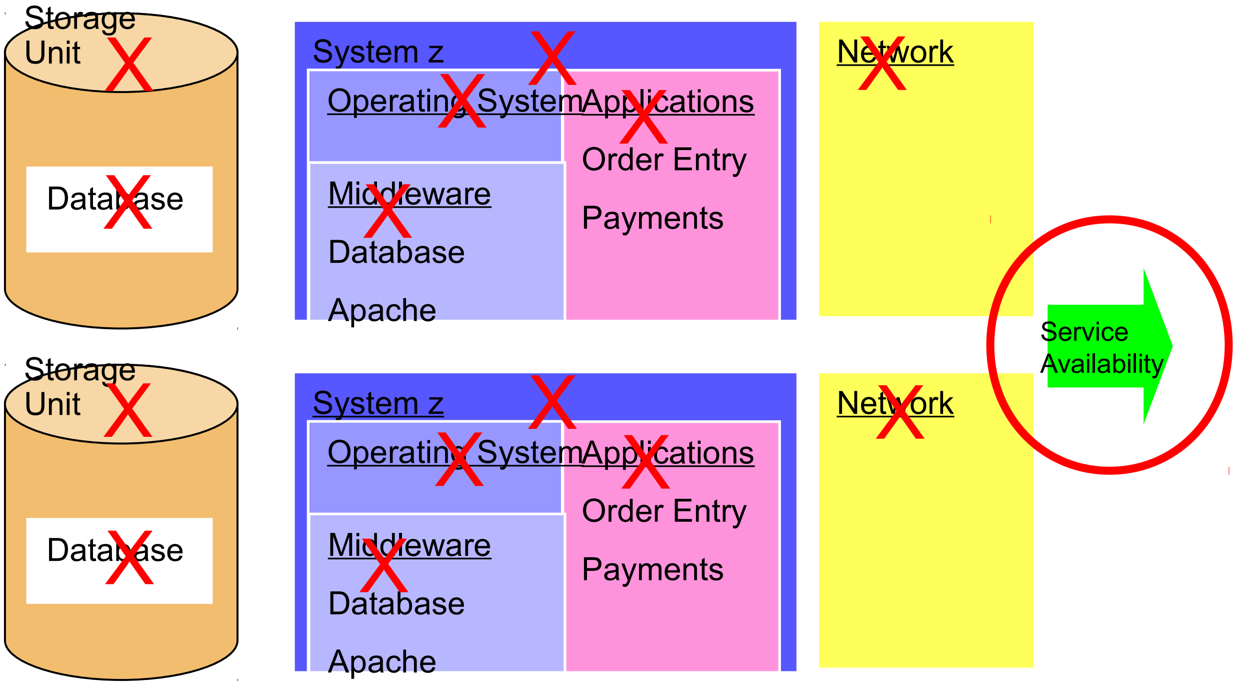
Name	Status	Details
Cluster	no quorum	Openais & Pacemaker
bourbaki	online (dc)	
Resources		
resource_1	not running	ocf::pacemaker:Dummy
clone_1	clone	
group_1:0	group	
ghh:0	not running	ocf::pacemaker:HealthCPU
my_stonith_device	not running	stonith::meatware

Validate With:	pacemaker-1.0
Epoch:	17
Num Updates:	1
CRM Feature Set:	3.0.1
Have Quorum:	0
DC UUID:	bourbaki
CIB Last Written:	Wed Feb 24 14:46:24 2010

Connected to 127.0.0.1 (Simple Mode)

Ideal High Availability Architecture

Allows service to continue no matter what fails ...



- An HA architecture protects the service from product failures by eliminating Single Points of Failure (SPoFs) at all layers (not just internal within the box).
  - Facilities, HW & SW components, Middleware or subsystems, Applications, Data, etc.
- This ideal approach is typically referred to as an active/active solution and may eliminate any service disruption for a single failure scenario.

It's ***SHOWTIME!***

Thank you.

SUSE®
We adapt. You succeed.

We adapt. You succeed.

Corporate Headquarters
Maxfeldstrasse 5
90409 Nuremberg
Germany

+49 911 740 53 0 (Worldwide)
www.suse.com

Join us on:
www.opensuse.org

Appendix

Abstract

Linux running on IBM System z inherits the characteristics of a reliable and highly scalable server.

If you want to build an High Available environment, on the technical side, you need to consider all levels in the IT environment from your disk infrastructure, virtualization layer to the applications and databases.

Come and see what you need to consider and how you can build it, with out of the box tools from SUSE and IBM to take advantage of the qualities of System z.

Experience increased up-time, serviceability and resilience for your mission critical business services.

SUSE Linux Enterprise High Availability

for Linux on System z

- HA for Linux on z using clustering
  - is implemented in the SLES Distro for Linux on System z
  - License is part of SLES for Linux on System z
  - HA implementation bases on Linux-HA
  - Graphical tools included for cluster management and monitoring resources
- SUSE Linux Enterprise High Availability Extension delivers all the essential monitoring, messaging and cluster resource management functionality
- HA Add-on: Geo Clustering for SUSE Linux Enterprise High Availability Extension lets you deploy Linux clusters between data centers spread anywhere in the world.
- In the SLE HA, Pacemaker is included, a scalable cluster resource manager with a flexible policy engine that supports n-node clusters
- OpenAIS, as one of the leading standards-based communication protocol for server and storage clustering is used for communication
  - Using OpenAIS and Pacemaker, you can continuously monitor the health of your resources, manage dependencies, and automatically stop and start services based on highly configurable rules and policies

Additional documentation

- SUSE Linux Enterprise High Availability 11 SP3 Guide
  http://www.suse.com/documentation/sle_ha/pdfdoc/book_sleha/book_sleha.pdf

- Linux-HA project Open source
  http://www.linux-ha.org/wiki/Main_Page

- IBM Redbook
  Achieving High Availability on Linux for System z with Linux-HA Release 2
  SG24-7711 : http://www.redbooks.ibm.com/abstracts/sg247711.html?Open

- Tivoli System Automation for Multiplatforms
  http://www-01.ibm.com/software/tivoli/products/sys-auto-multi/

General Disclaimer

This document is not to be construed as a promise by any participating company to develop, deliver, or market a product. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. SUSE makes no representations or warranties with respect to the contents of this document, and specifically disclaims any express or implied warranties of merchantability or fitness for any particular purpose. The development, release, and timing of features or functionality described for SUSE products remains at the sole discretion of SUSE. Further, SUSE reserves the right to revise this document and to make changes to its content, at any time, without obligation to notify any person or entity of such revisions or changes. All SUSE marks referenced in this presentation are trademarks or registered trademarks of Novell, Inc. in the United States and other countries. All third-party trademarks are the property of their respective owners.

SUSE®