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Planning a Proof of Concept for deploying Oracle Database on Linux on System z

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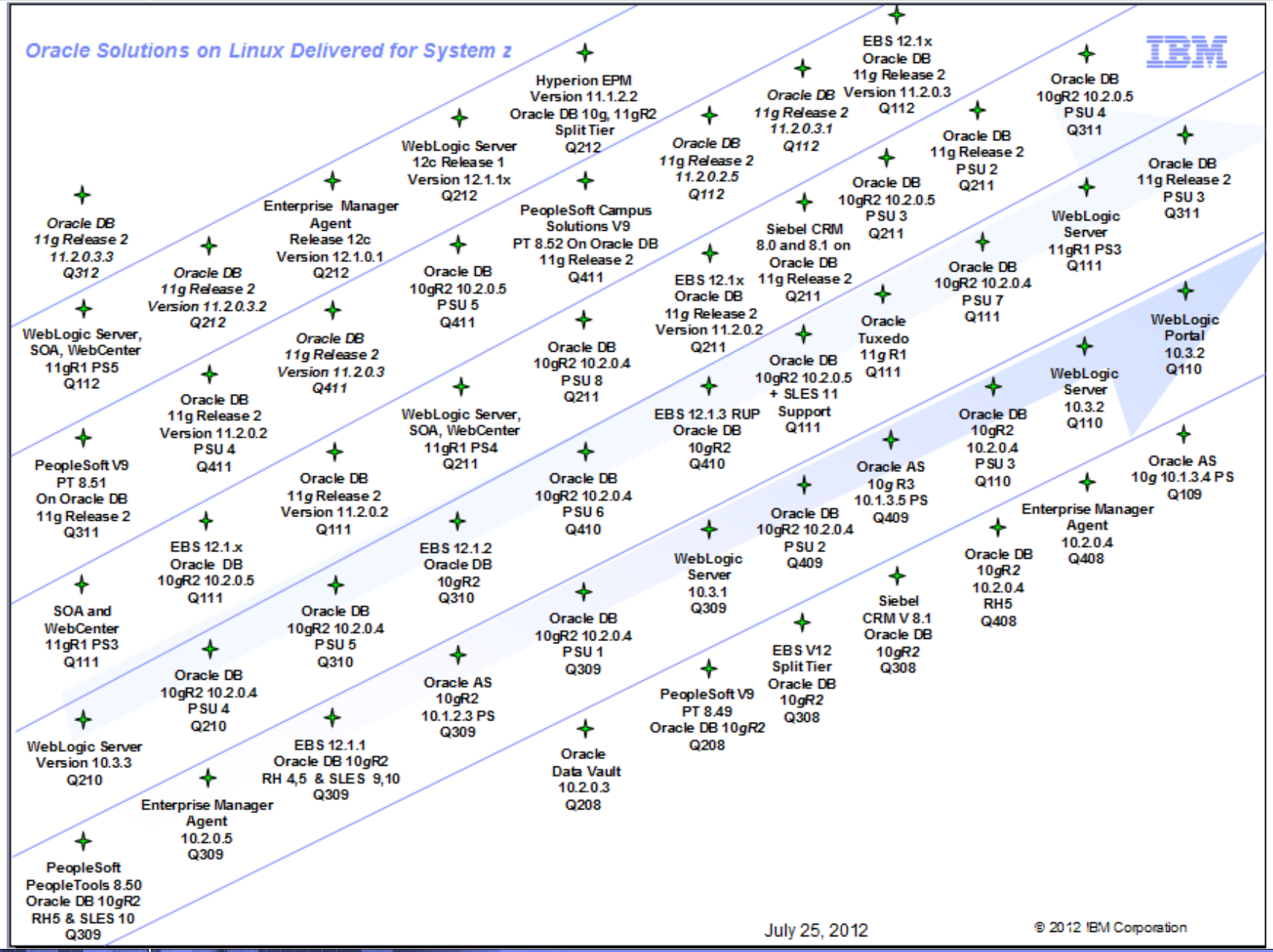
IBM

3:00 PM on Thursday, August 9, 2012
11641

SHARE in Anaheim 2012

Agenda

- Oracle Solutions on Linux on z
- Terminology
- Oracle DB on Linux on z (Loz) through the eyes of availability
- Getting started - Sizing
- Proof of Concept
  - z/VM, Linux, Oracle DB, disk
  - Load the database and test
  - Performance evaluation
- Production Readiness
- Summary of PoC



Is Oracle Database current on Linux on z - Yes

- Current Patch Set Update – July 2012
  - 11.2.0.3.3 (patch 13923374) – available
  - 11.2.0.2.7 – available
  - 10.2.0.5.8 (now in extended support) - available

Critical Patch Update Advisories are available at the following location:

Oracle Technology Network:
http://www.oracle.com/technetwork/topics/security/alerts-086861.html

The Critical Patch Update Advisory - July 2012 is available at the following location:

Oracle Technology Network:
http://www.oracle.com/technetwork/topics/security/cpujul2012-392727.html

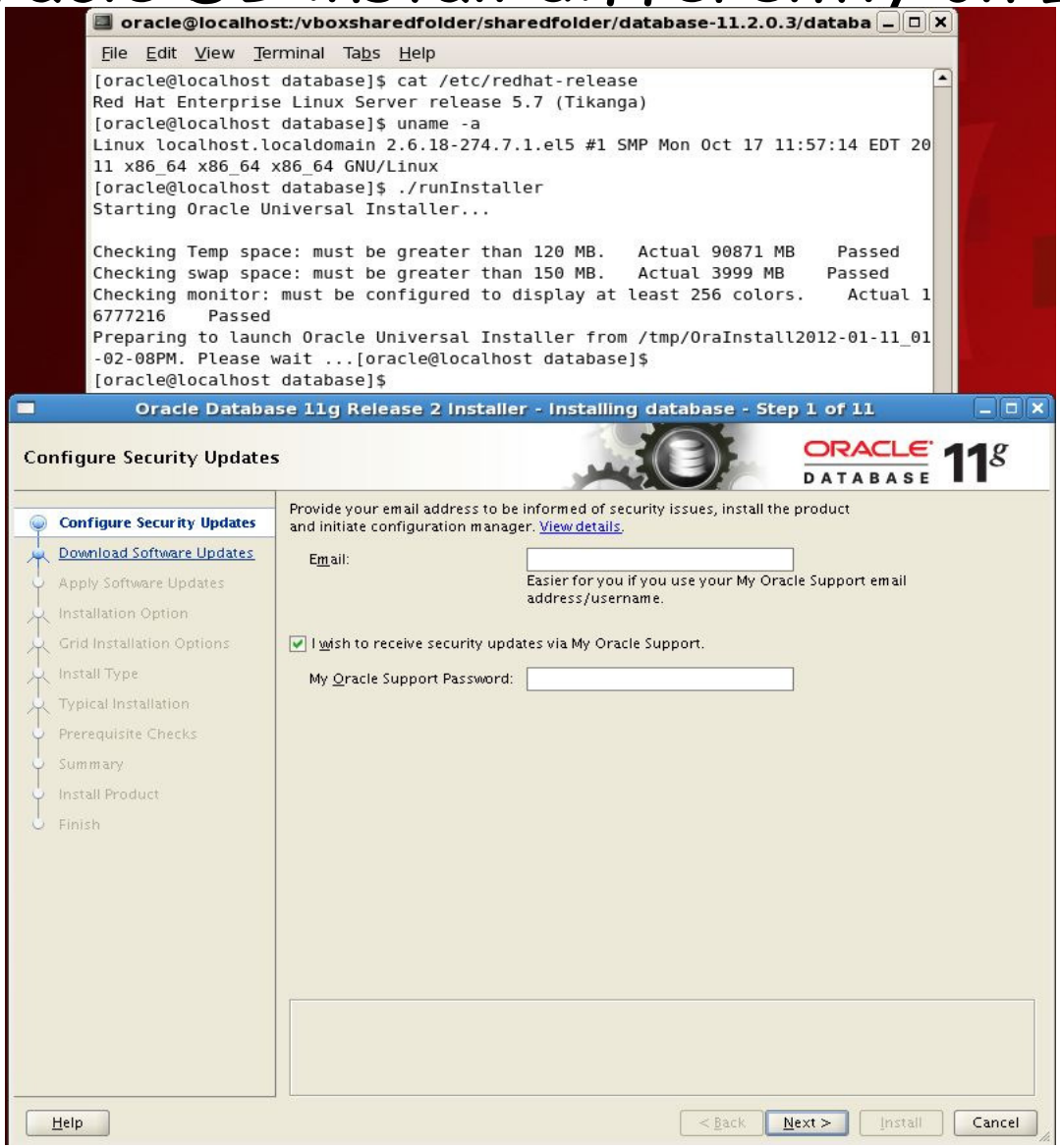
Don't call it zLinux – It is really Linux on z

- zLinux is an IBM term for running Linux on z
- zLinux is NOT a special distribution of Linux created by IBM.
- Linux can run natively on System z or under z/VM (i.e. virtualization)
- Linux on z (Loz) is a better term and is less confusing in the Oracle space
- SLES and Red Hat have Oracle certified distributions for Loz
  - SLES 10 and 11
  - Red Hat 5.x

Does Oracle DB install differently on z - NO

Linux x86-64
RedHat 5.7
Oracle DB
11.2.0.3

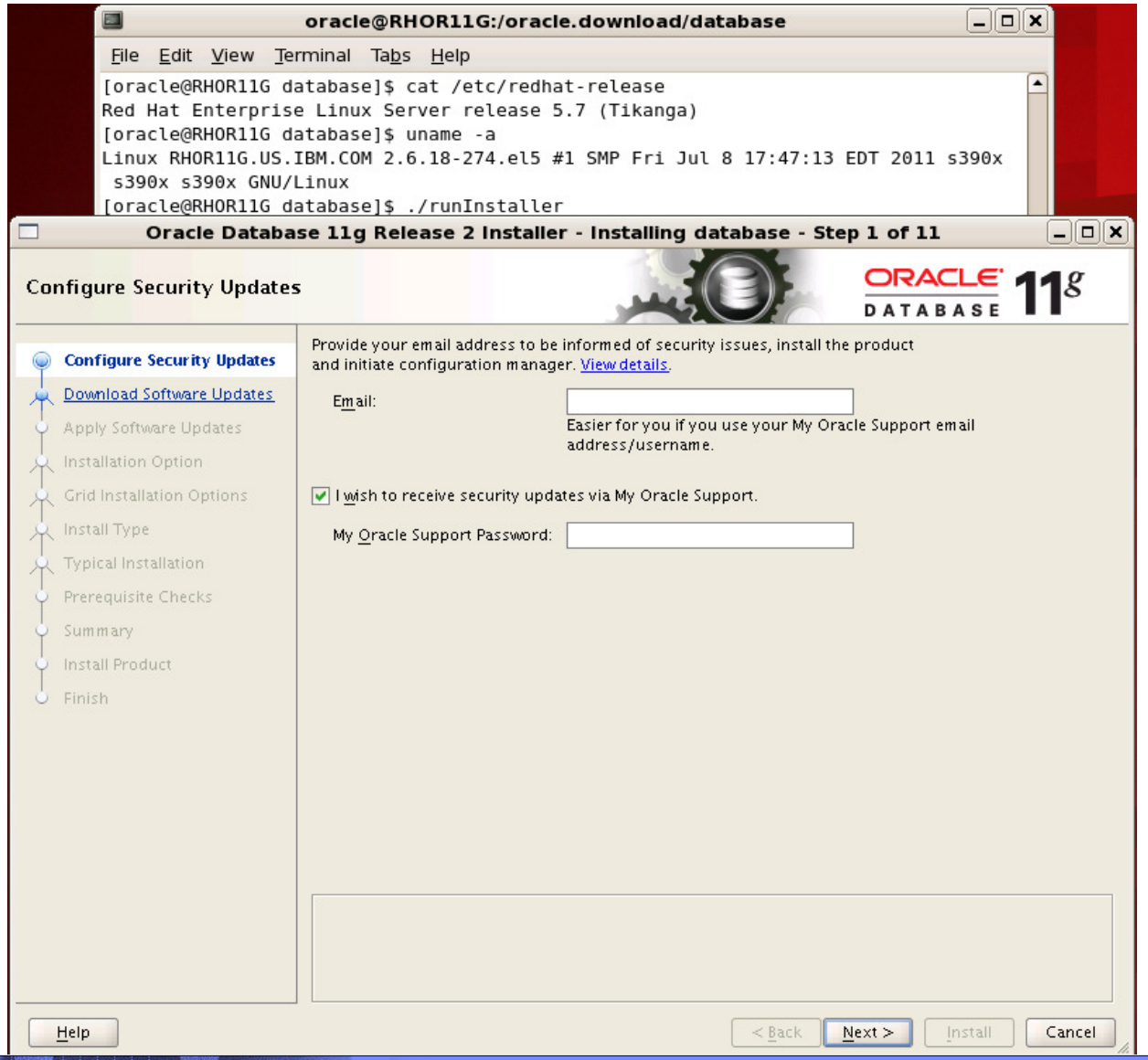
ascii based



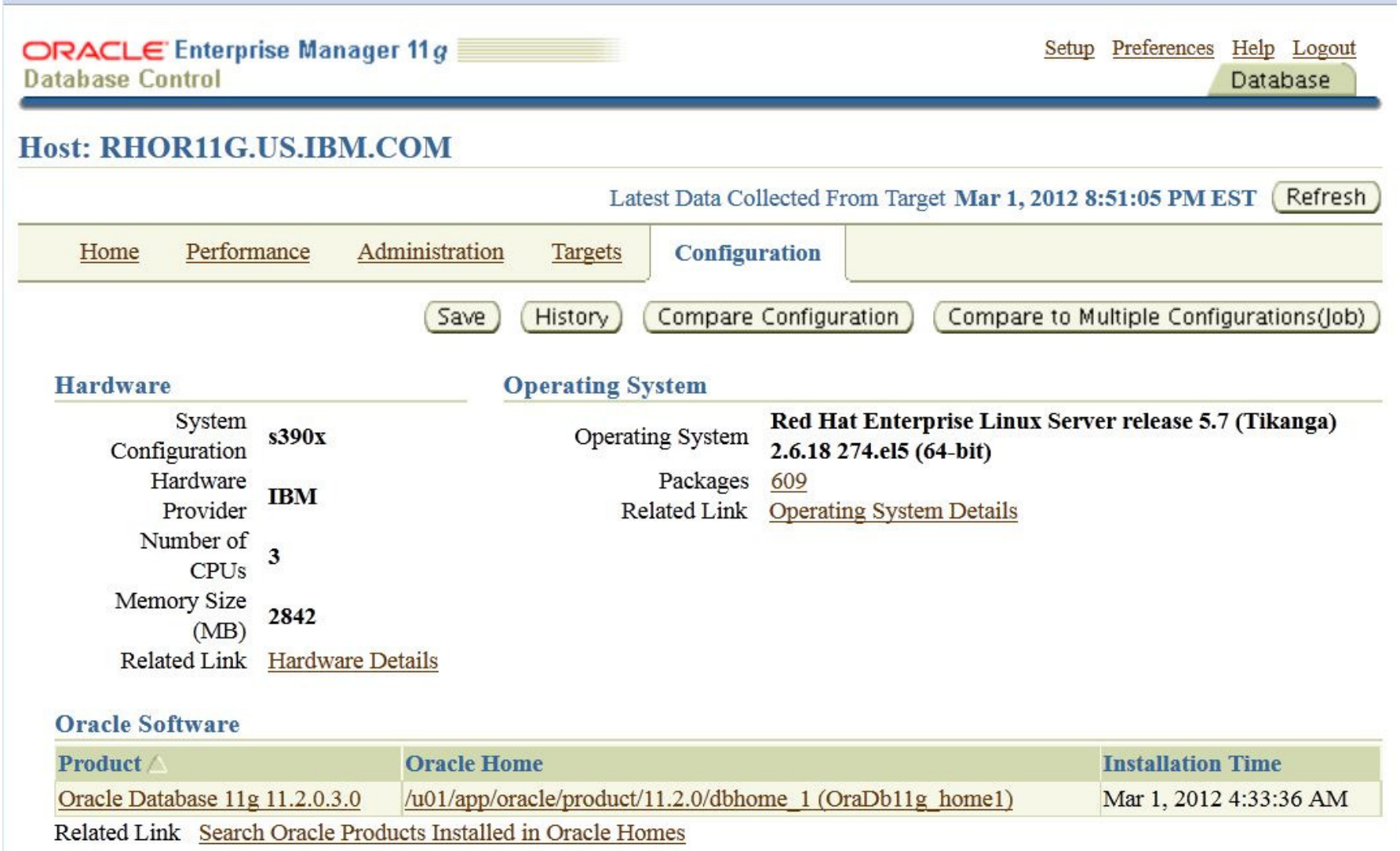
Does Oracle DB install differently on z - NO

Linux on z
Red Hat 5.7
Oracle DB
11.2.0.3

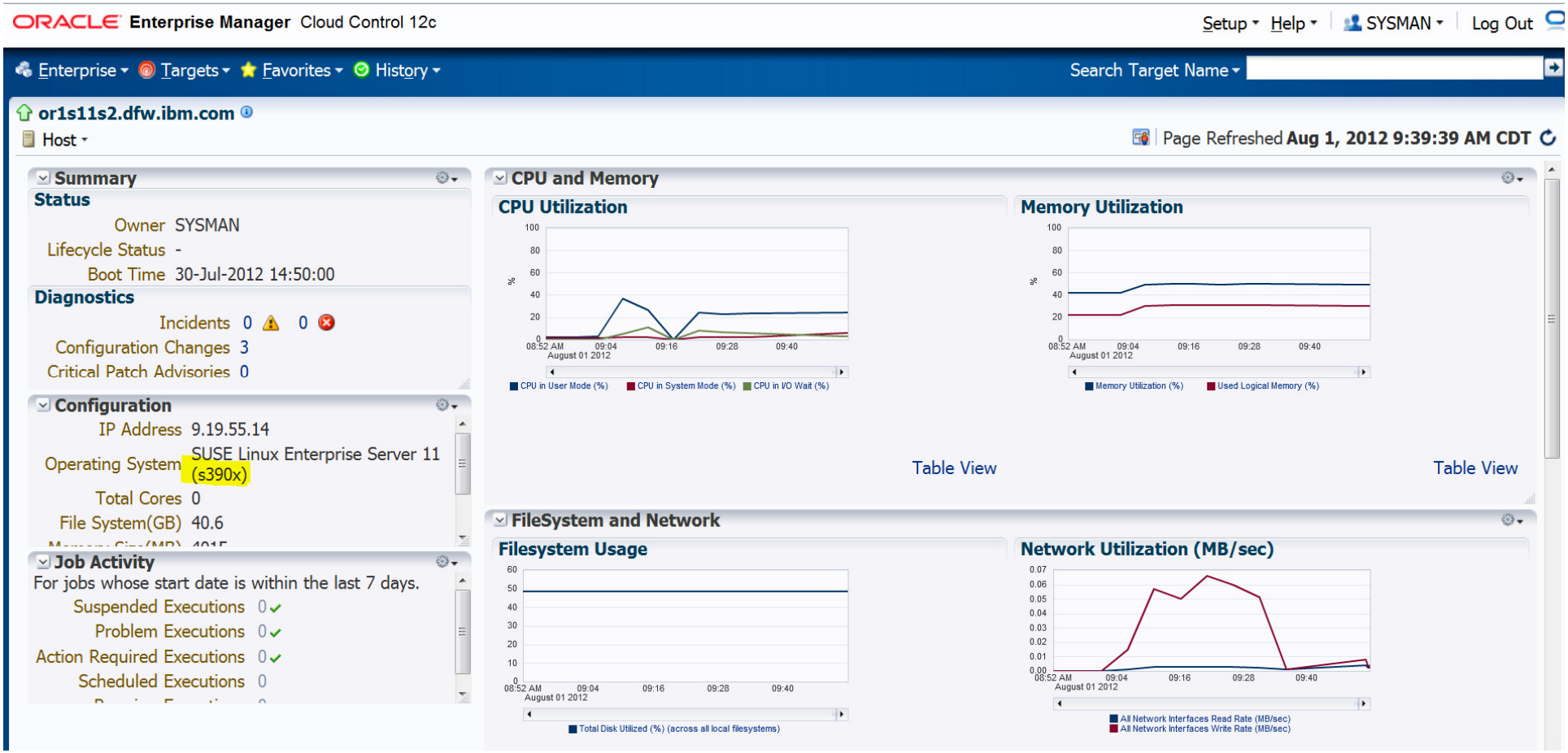
ascii based



Oracle EM looks the same on z as well



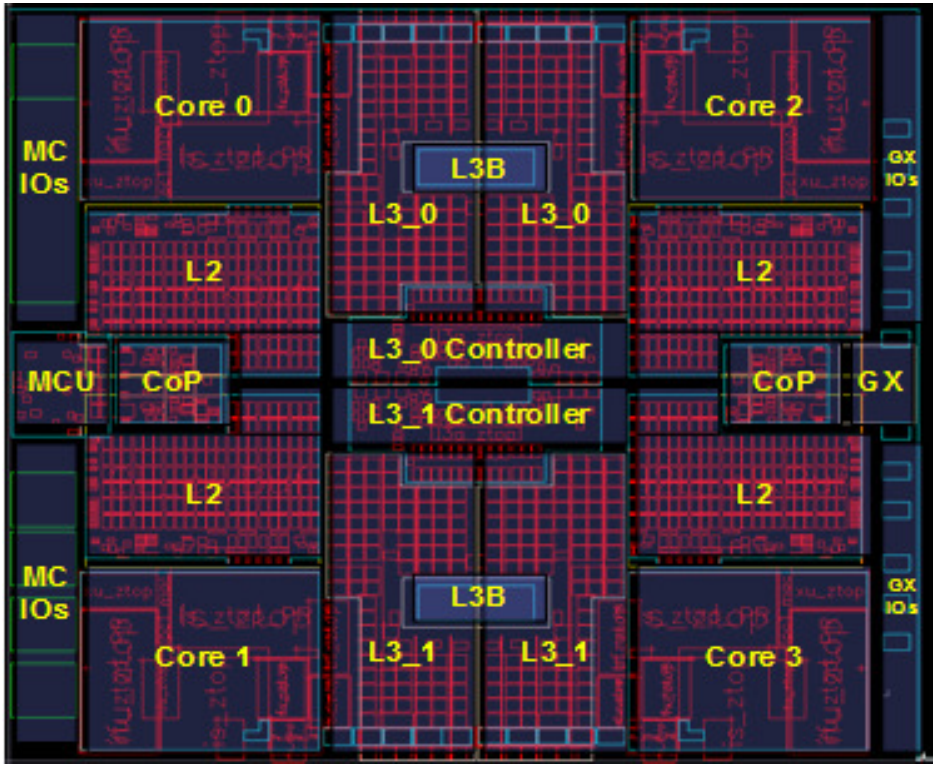
Oracle EM Grid Control View of a database running on z



What is an IFL (Integrated Facility for Linux)?

- An IFL is a specialty engine (i.e., core) on a System z
  - Runs at 5.2 GHz on a z196
- Oracle uses the term core for purposes of core based pricing
- From an Oracle licensing perspective an IFL = one core
- Yes, the System z10, z196 and z114 have quad core processors BUT an IFL represents one core for Oracle licensing purposes. Yes, you can purchase z capacity on a core by core basis and these cores are called IFLs

z196 Quad Core PU Chip Detail



12S0 45nm SOI Technology

13 layers of metal

3.5 km wire

1.4 Billion Transistors

Chip Area – 512.3mm^2

23.5mm x 21.8mm

8093 Power C4's

1134 signal C4's

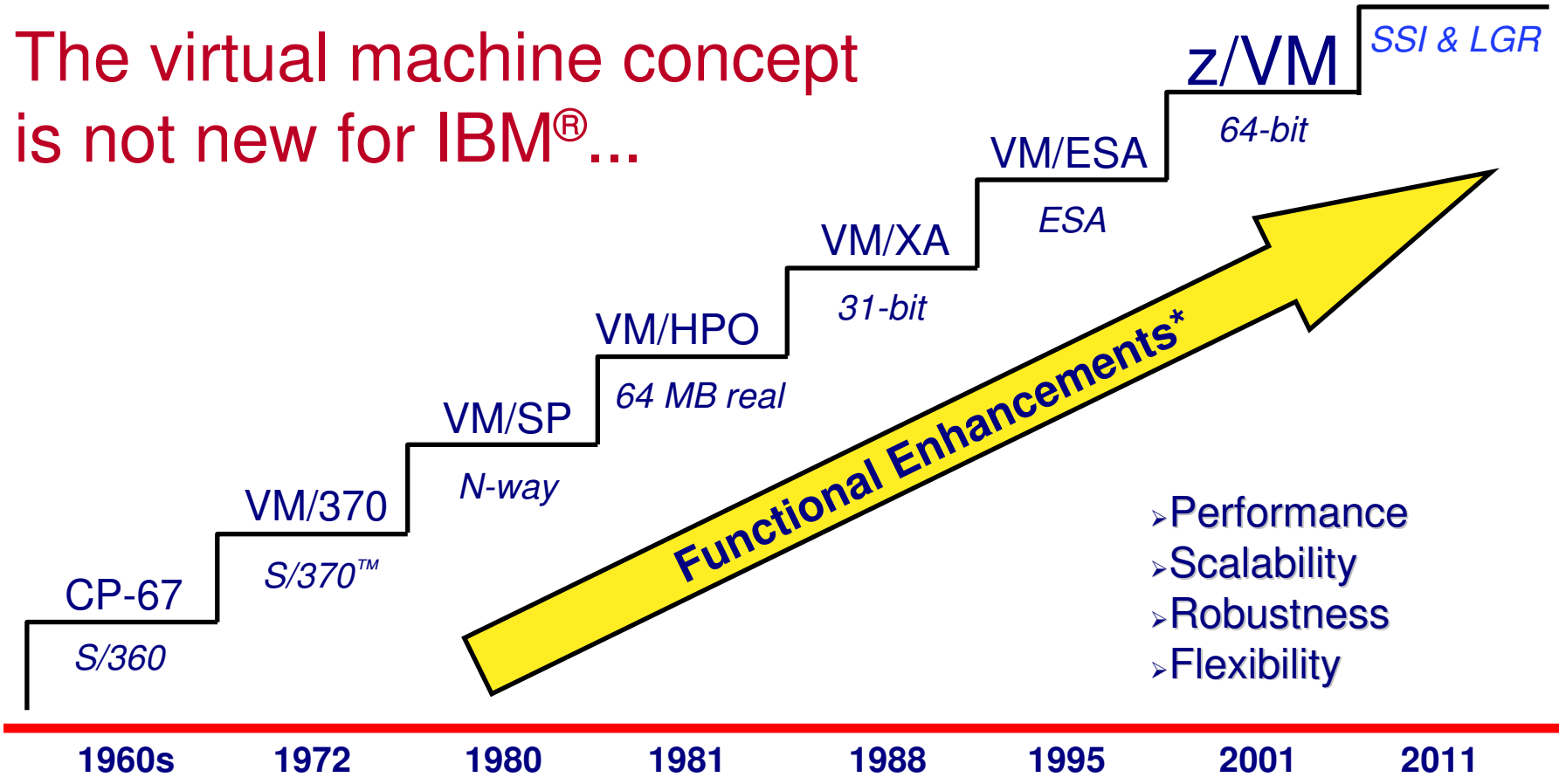
- **Up to Four active cores per chip**
  - 5.2 GHz
  - L1 cache/ core
    - 64 KB I-cache
    - 128 KB D-cache
  - 1.5 MB private L2 cache/ core
- **Two Co-processors (COP)**
  - **Crypto & compression accelerators**
  - Includes 16KB cache
  - Shared by two cores
- **24MB eDRAM L3 Cache**
  - Shared by all four cores
- **Interface to SC chip / L4 cache**
  - 41.6 GB/sec to each of 2 SCs
- **I/O Bus Controller (GX)**
  - Interface to Host Channel Adapter (HCA)
- **Memory Controller (MC)**
  - Interface to controller on memory DIMMs
  - Supports RAIM design

Is Oracle DB Standard Edition supported on z?

- Only on z10 BC and z114
  - Qualifies based upon number of sockets
- Must use **Enterprise Edition** for other models of System z
  - z196
  - z10 EC
  - z9 and z9 BC
  - z990 and z890
  - z900 and z800

IBM Virtualization Technology Evolution

The virtual machine concept is not new for IBM®...



* Investments made in hardware, architecture, microcode, software

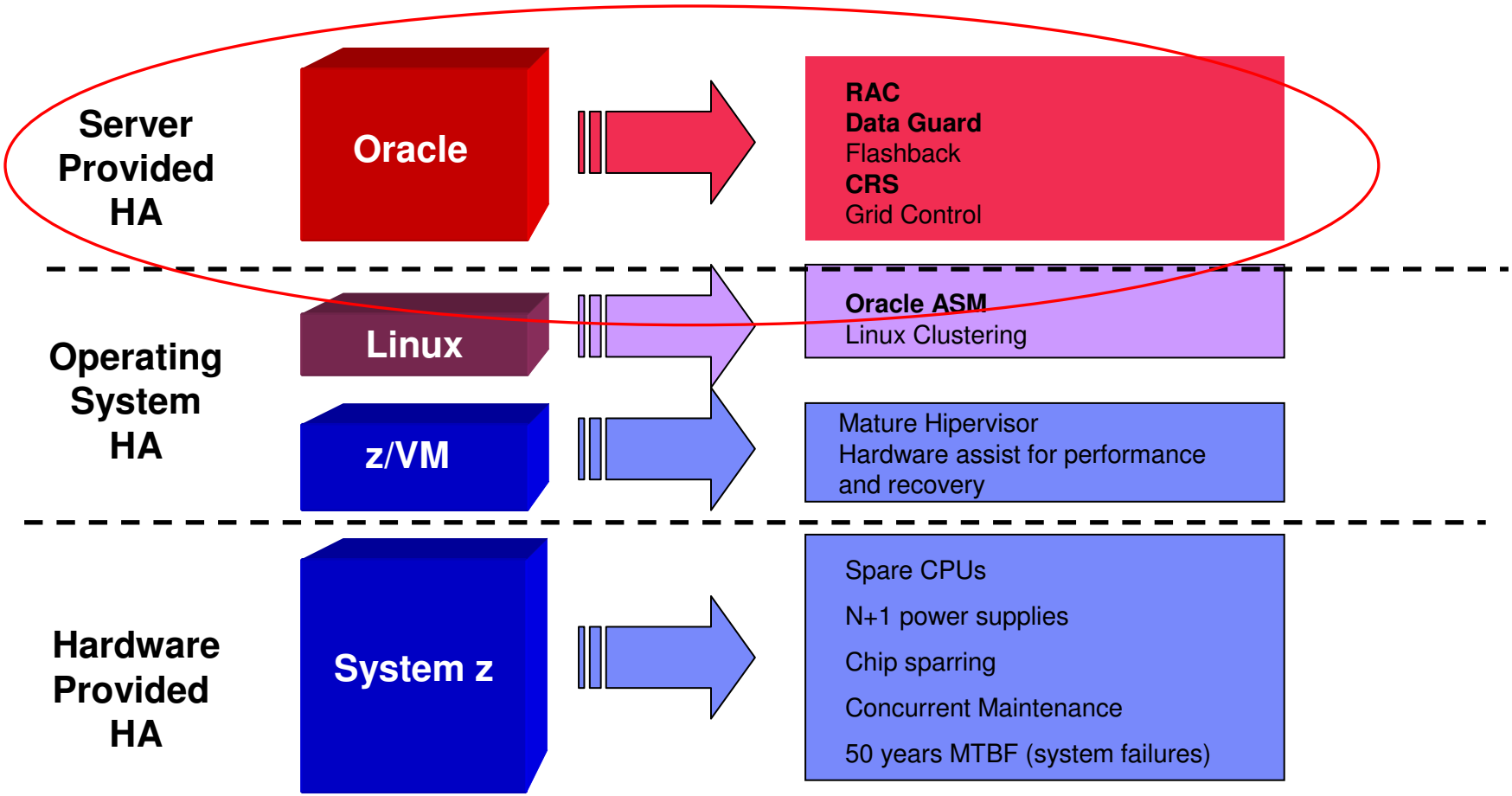
What levels of

Availability

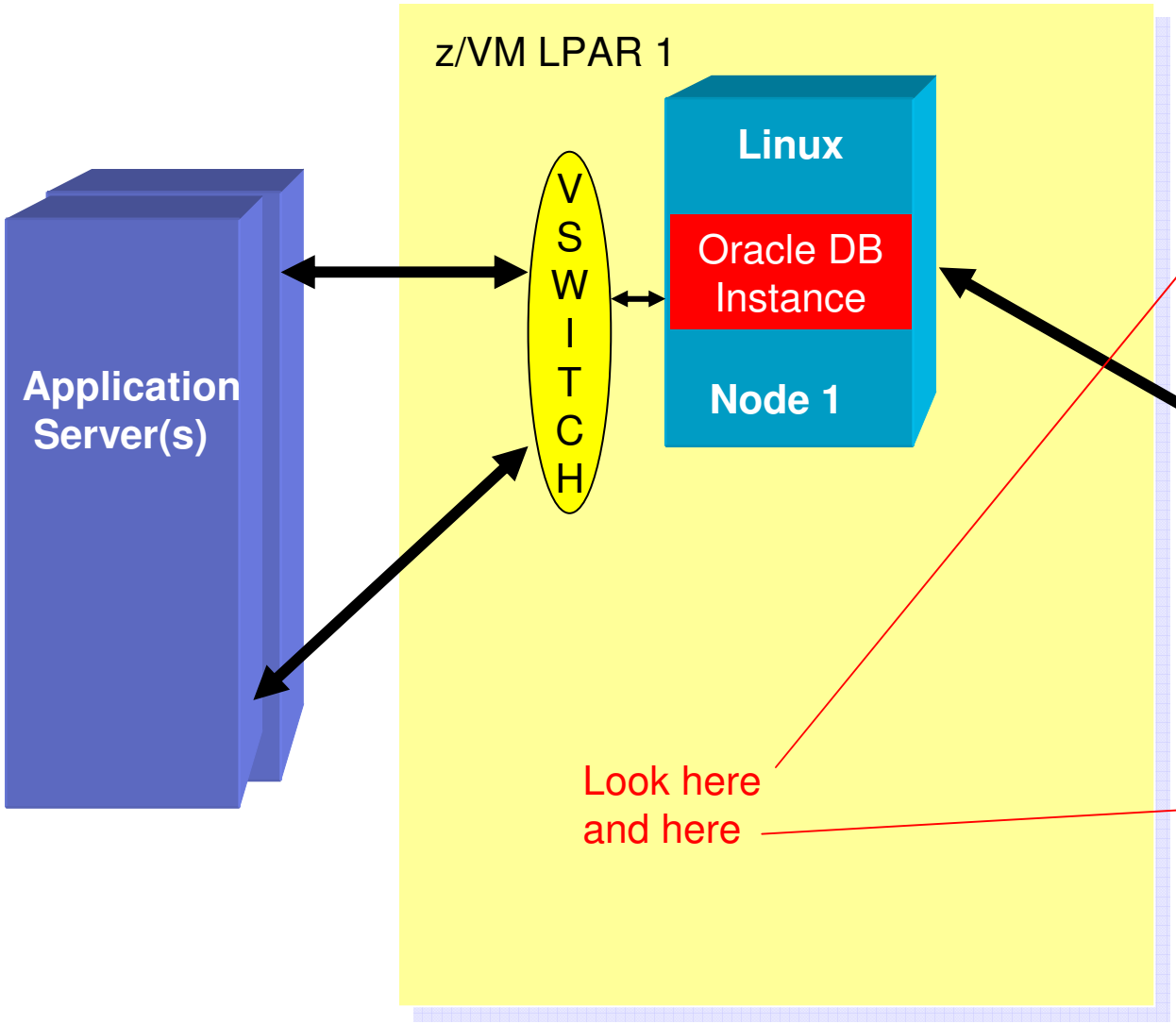
are being tested in the PoC?

aka – Begin with the end in mind

Building Blocks of HA for Oracle DB on Linux for System z



Oracle Database without Oracle MAA



Guards against:

- **Hardware failure – System z**

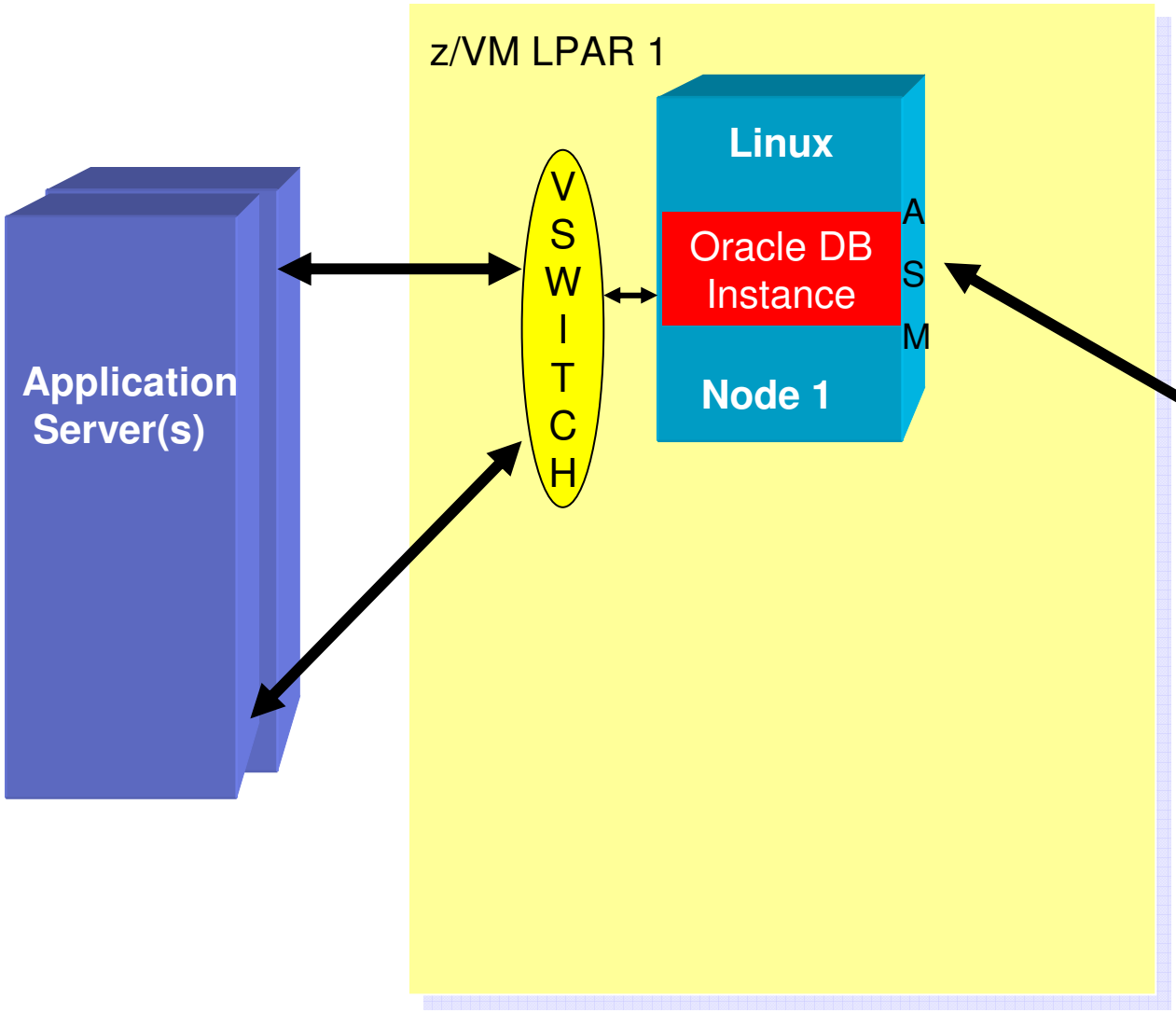
Oracle Database

Comments:

- **Sufficient for many databases**
- **Can have access to all IFLs and memory in the LPAR**

MAA – Maximum Availability Architecture

Oracle Database - building Oracle MAA



Guards against:

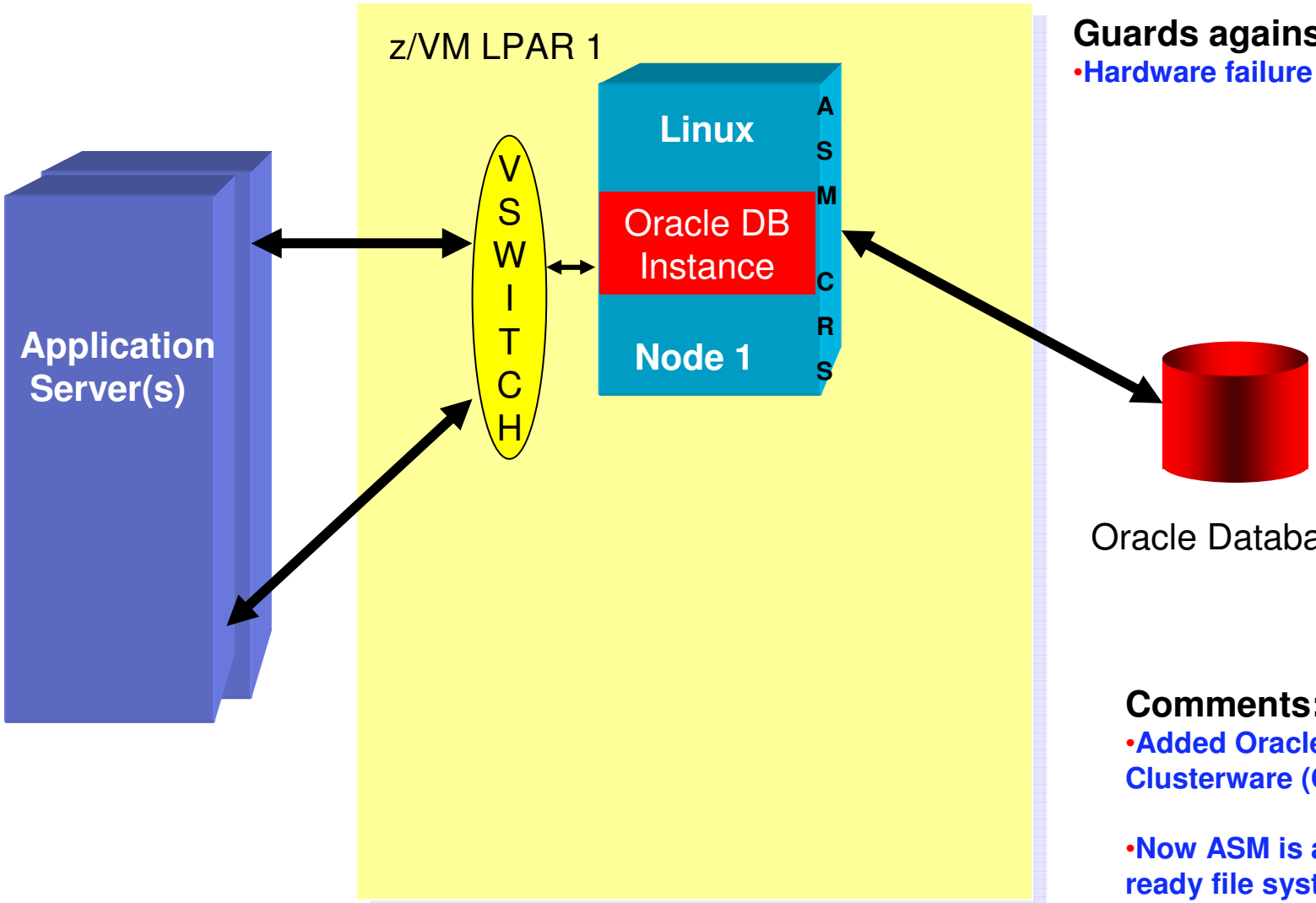
- **Hardware failure – System z**

Oracle Database EE 11gR2 or 10gR2

Comments:

- **Added Oracle's Automated Storage Manager (ASM) which is similar to a LVM but with more capabilities**
- **ASM is a separate Oracle DB but is not shown**

Oracle Database - building Oracle MAA



Guards against:

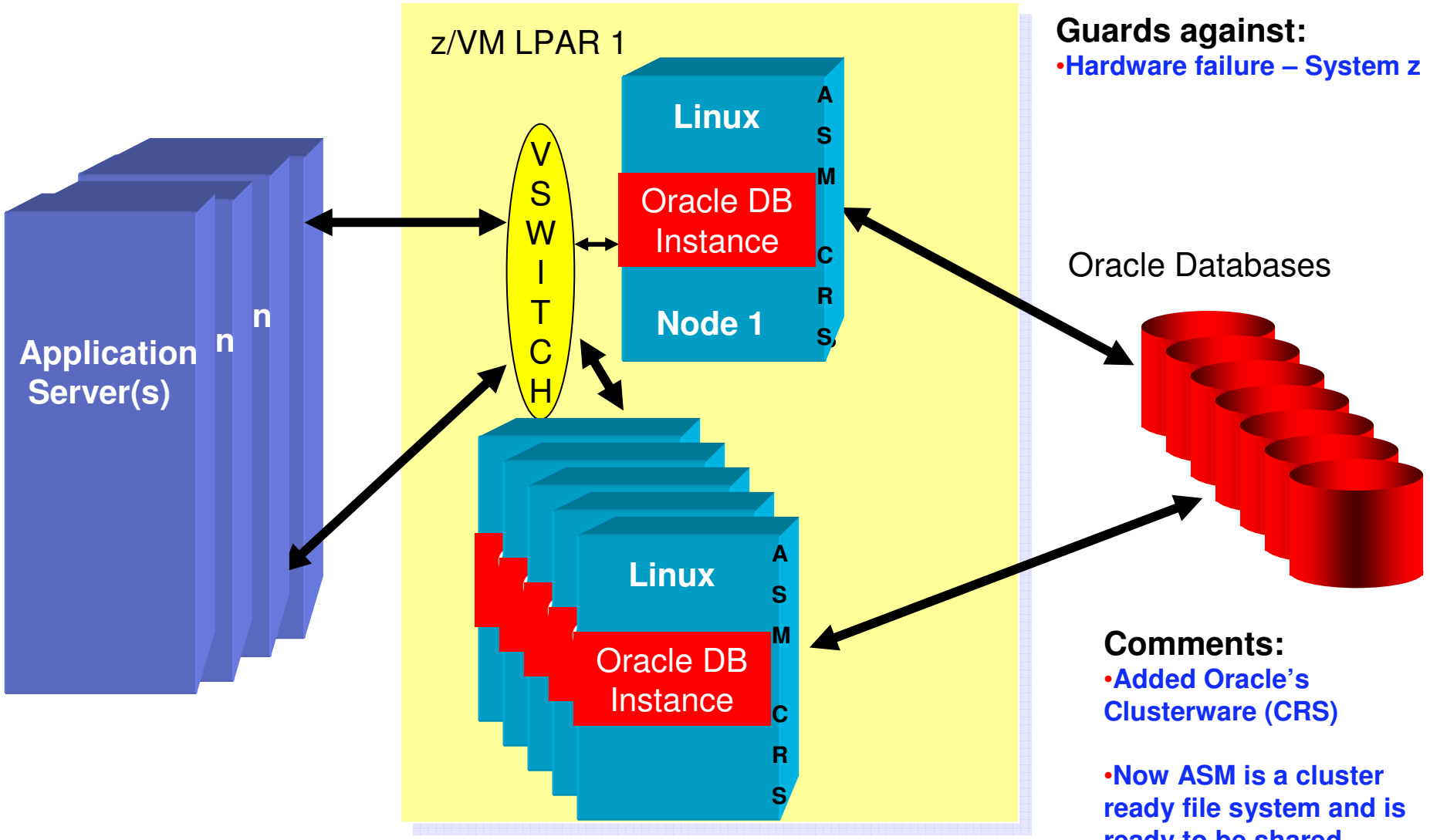
- **Hardware failure – System z**

Comments:

- **Added Oracle's Clusterware (CRS)**
- **Now ASM is a cluster ready file system and is ready to be shared.**

ASM instance not shown

Oracle Database - building Oracle MAA – no RAC



Guards against:

- **Hardware failure – System z**

Comments:

- **Added Oracle's Clusterware (CRS)**
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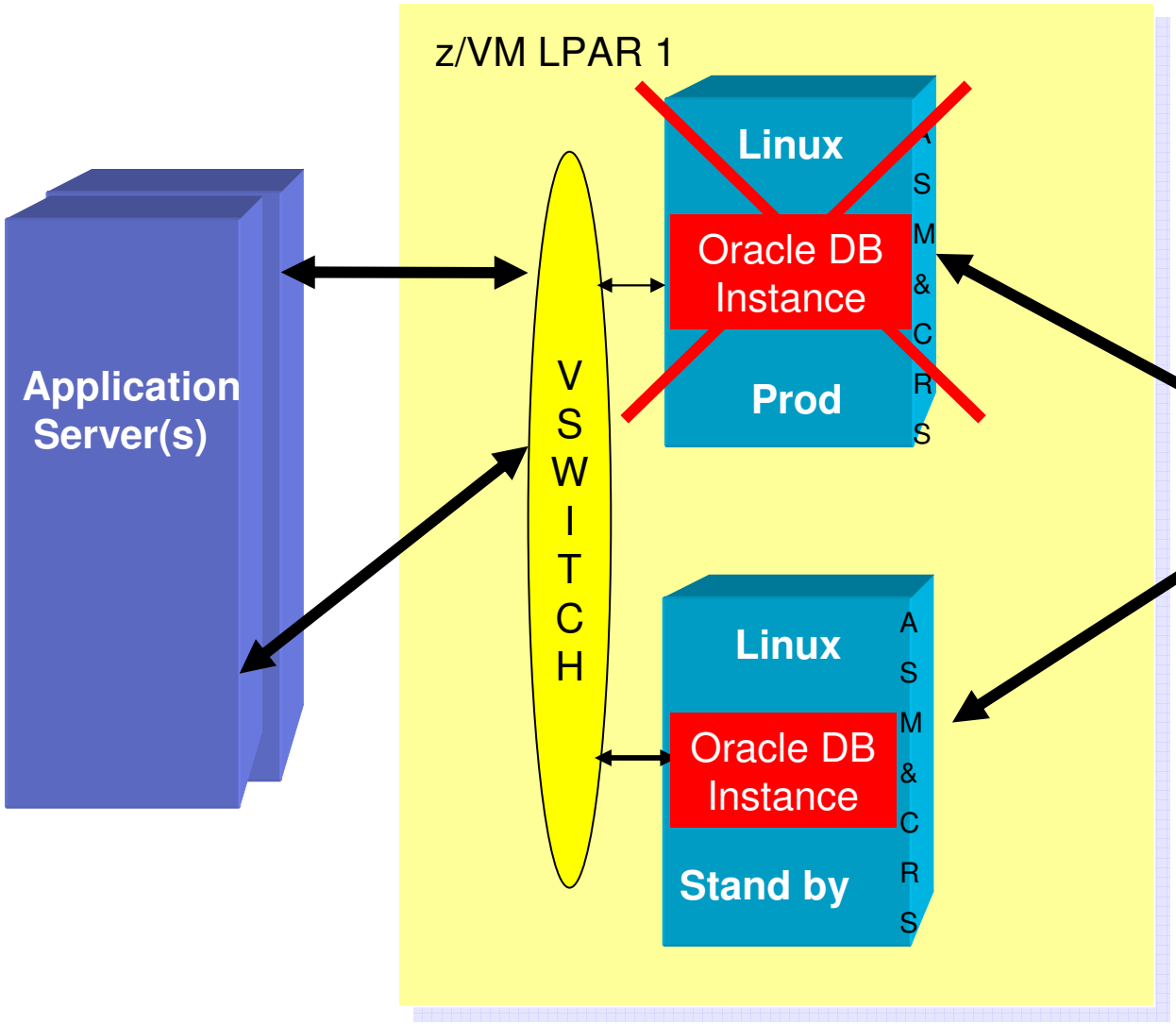
Oracle Database - building Oracle MAA - RAC One Node



Guards against:

- **Hardware failure – System z**
- **Linux OS or Oracle DB failure**
- **Allows for maintenance to Linux and possibly Oracle in the Production guest**

Comments:

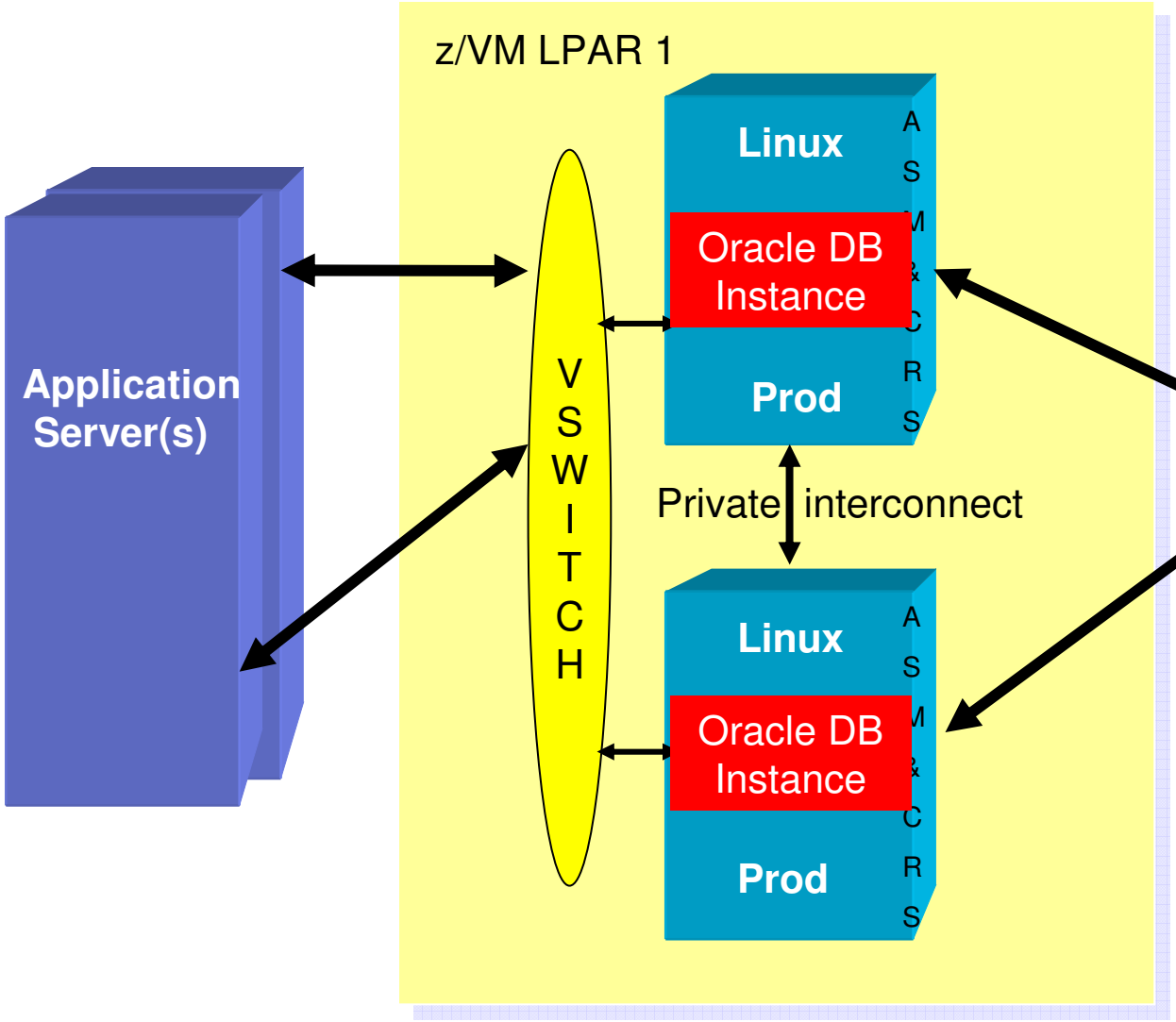
- **Added a hot standby Linux to same Oracle DB.**
- **Through the use of CRS, with its heartbeat, and ASM shared disk storage does a failover to the stand by Linux guest.**

Oracle Database 11gR2 only

Oracle RAC One Node Comments

- Can also be accomplished across LPARs using HiperSockets connections.
- Can be accomplished across different System z platforms using appropriate network connectivity.
- Only allowed between Oracle databases using the same binaries (i.e. Linux on z in this case)
  - Oracle Clusterware and Oracle RAC do not support heterogeneous platforms in the same cluster. For example, you cannot have one node in the cluster running Oracle Linux and another node in the same cluster running Solaris UNIX. All nodes must run the same operating system; that is, they must be binary compatible. Oracle RAC does not support machines having different chip architectures in the same cluster. However, you can have machines of different speeds and sizes in the same cluster.
- An outage that can affect users can be of a short duration (short duration?)

Oracle Database building Oracle MAA - RAC



Guards against:

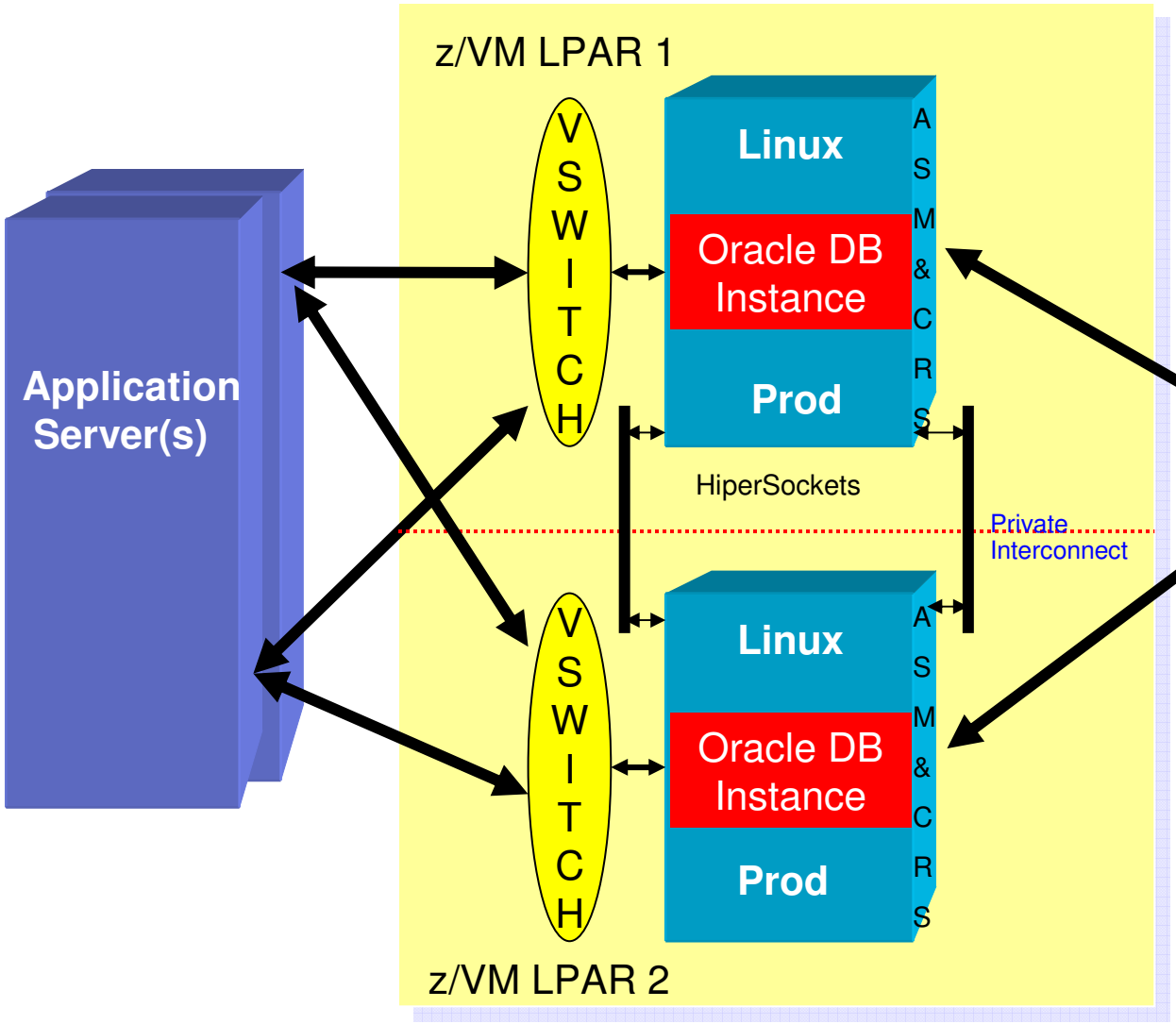
- **Hardware failure – System z**
- **Linux OS or Oracle DB failure**
- **Allows for maintenance to Linux and possibly Oracle in the Production guest**

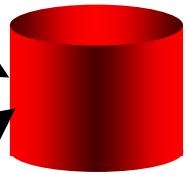
Comments:

- **Unlike hot stand by there will be little impact to the end users of Linux node or instance failure.**
- **Load balancing is occurring between the RAC nodes.**

Interconnect - The private network communication link that is used to synchronize the memory cache of the nodes in the cluster.

Oracle Database - building Oracle MAA - RAC





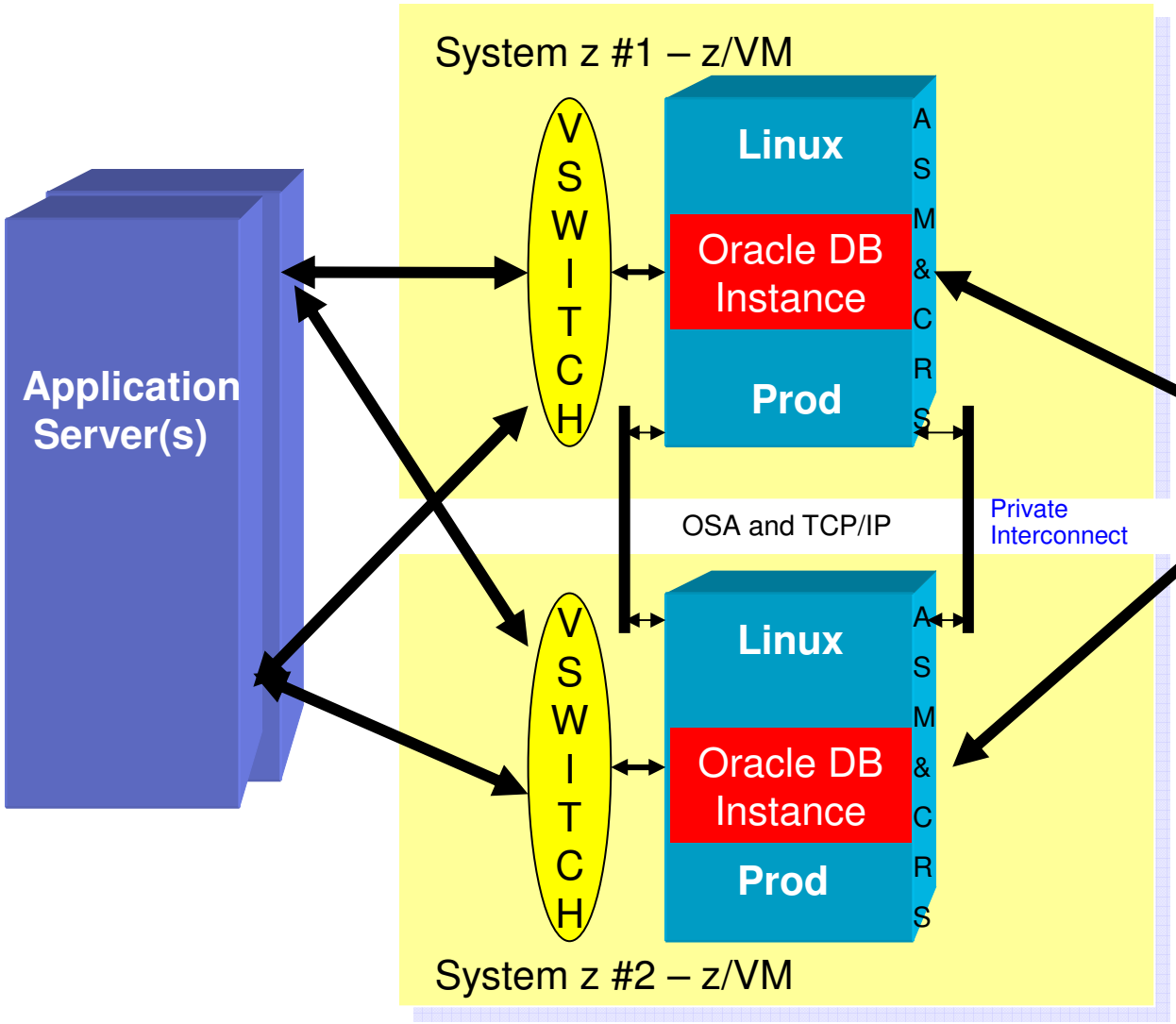
Oracle Database

Guards against:

- **Hardware failure – System z**
- **Linux OS or Oracle DB failure**
- **Allows for maintenance to either z/VM, Linux and possibly Oracle DB in either Prod guest**

Comments:

Oracle Database - building Oracle MAA - RAC



Guards against:

- **Hardware failure – System z**
- **Linux OS or Oracle DB failure**
- **Allows for maintenance to either z/VM, Linux and possibly Oracle DB in either Prod guest**

Comments:

- **Physically separate System z machines**

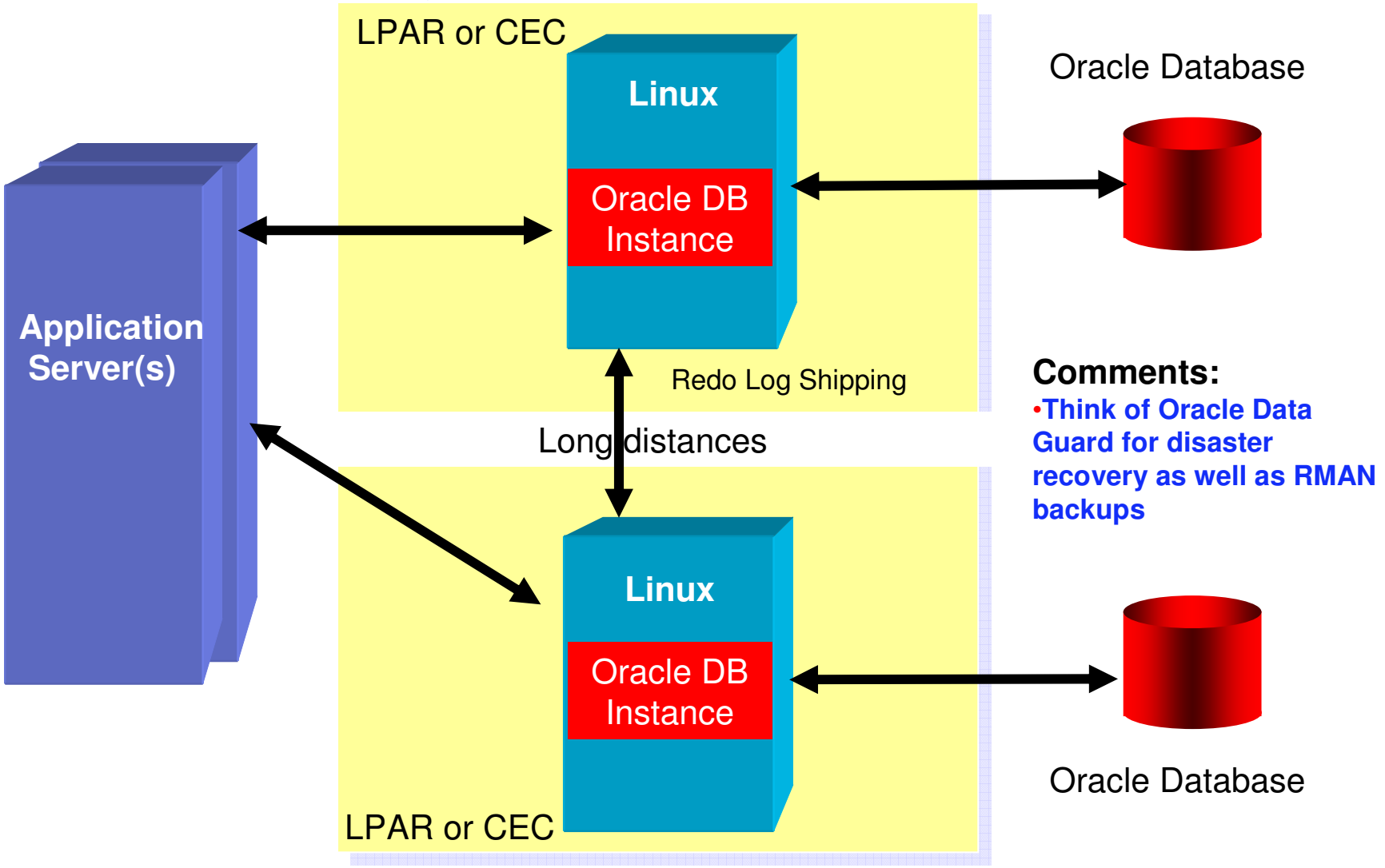
Deploying RAC for High Availability

- RAC – Real Application Clusters
  - Active/Passive configuration
    - One node processes work
    - The other node waits for the first node to fail
  - Active/Active configuration
    - All nodes process work
    - If any node fails the cluster is re-mastered.
  - Besides availability, RAC can be used for workload distribution
    - All work does not have to go through all nodes
  - Deploy
    - In the same LPAR for test/dev applications
    - Across LPARs for LPAR maintenance or software failures (most common implementation)
    - Across CECs when taking entire systems down is a “common” occurrence

Oracle Standby and Replication Solutions for Disaster Recovery

- Standby – replication to standby database
  - Oracle Data Guard
    - Uses redo log shipping for log apply or SQL Apply
    - Less data transmitted than replication
    - Sync or async
    - Various configurations of logical and physical standby databases
  - Both production and standby databases must be installed from same CD/DVD
    - Support for heterogeneous systems not supported yet
    - Both systems must match for endian, chip set and headers
  - Data Guard generally deployed between CECs

Disaster Recovery Database - Data Guard



Comments:

- **Think of Oracle Data Guard for disaster recovery as well as RMAN backups**

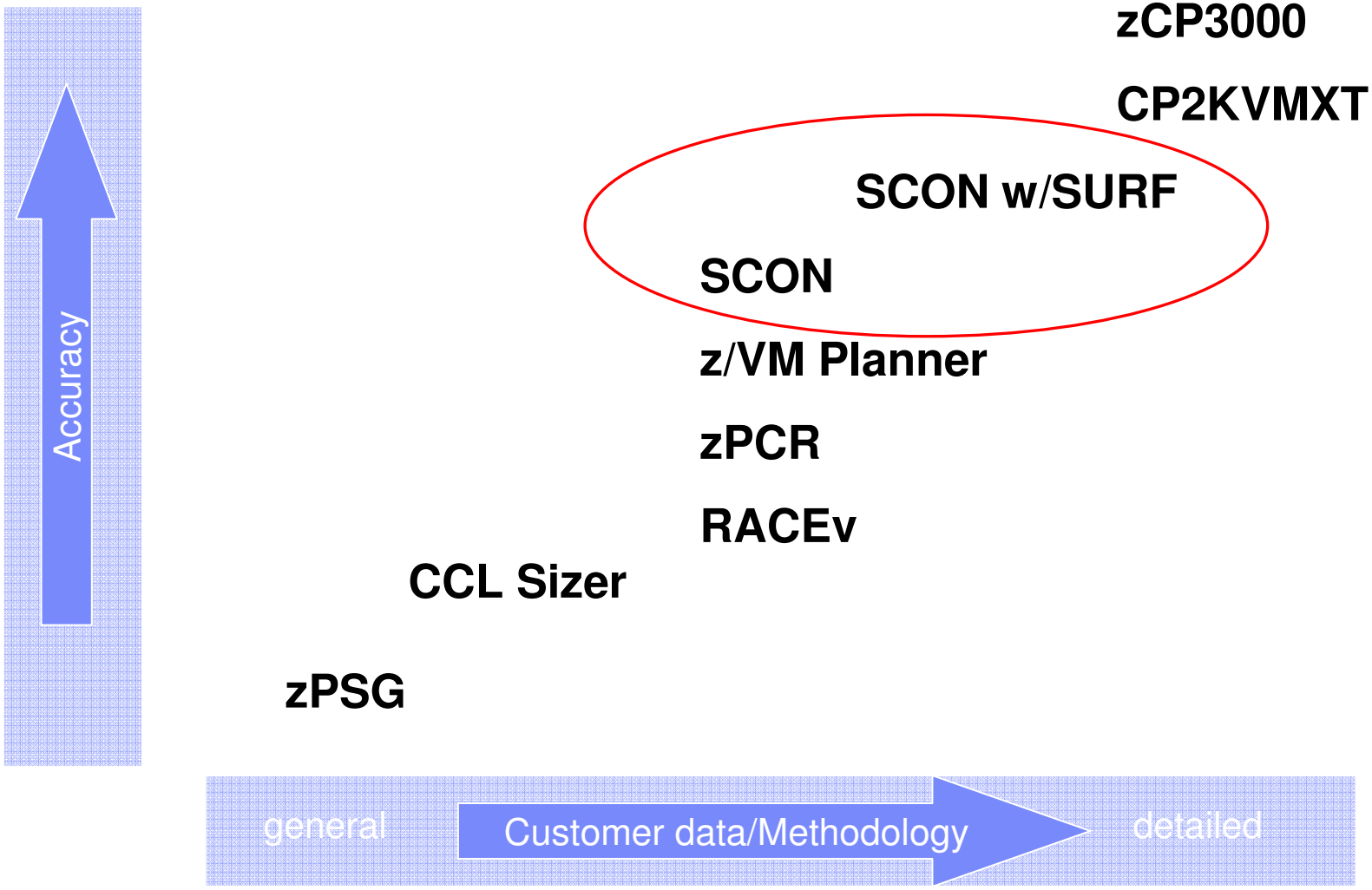
High Availability for Oracle database on Linux for System z

- System z - highly available platform
  - Attention to detail over decades of engineering
    - Fault Tolerant (HA) design
    - Elimination of single points of failure
  - Driving to 100 years MTBF
- Oracle Maximum Availability Architecture
  - Best Practices based on Oracle database technology
    - Constantly evolves with new releases
- Synergistic
  - Continue on your path with Oracle Grid using System z
  - Develop a Grid strategy for Oracle on Linux for System z
  - Take advantages of the HA/DR features of IBM and Oracle technologies

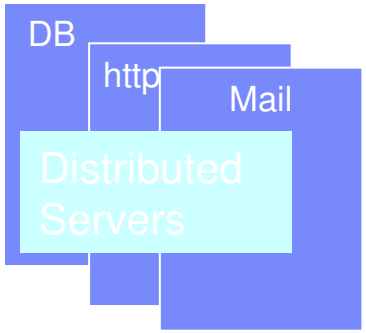
Sizing – the most important step

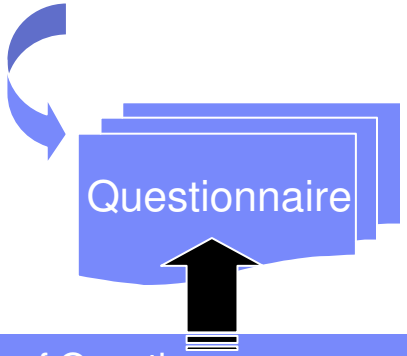
For PoC or full production

System z Sizing Tools

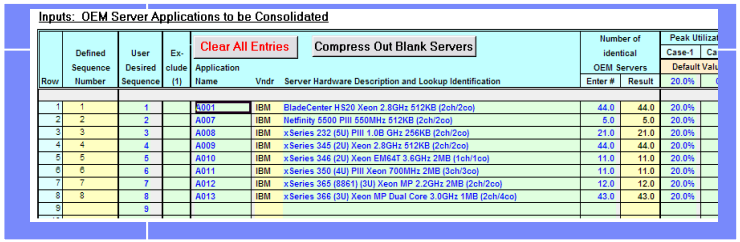


System z Linux Server Consolidation
Sizing Process - SCON





Type of Questions:
- Servers make & model
- Speed (MHz)
- Peak Average Utilization (%)
- Workload type (i.e. DB,Mail,http)



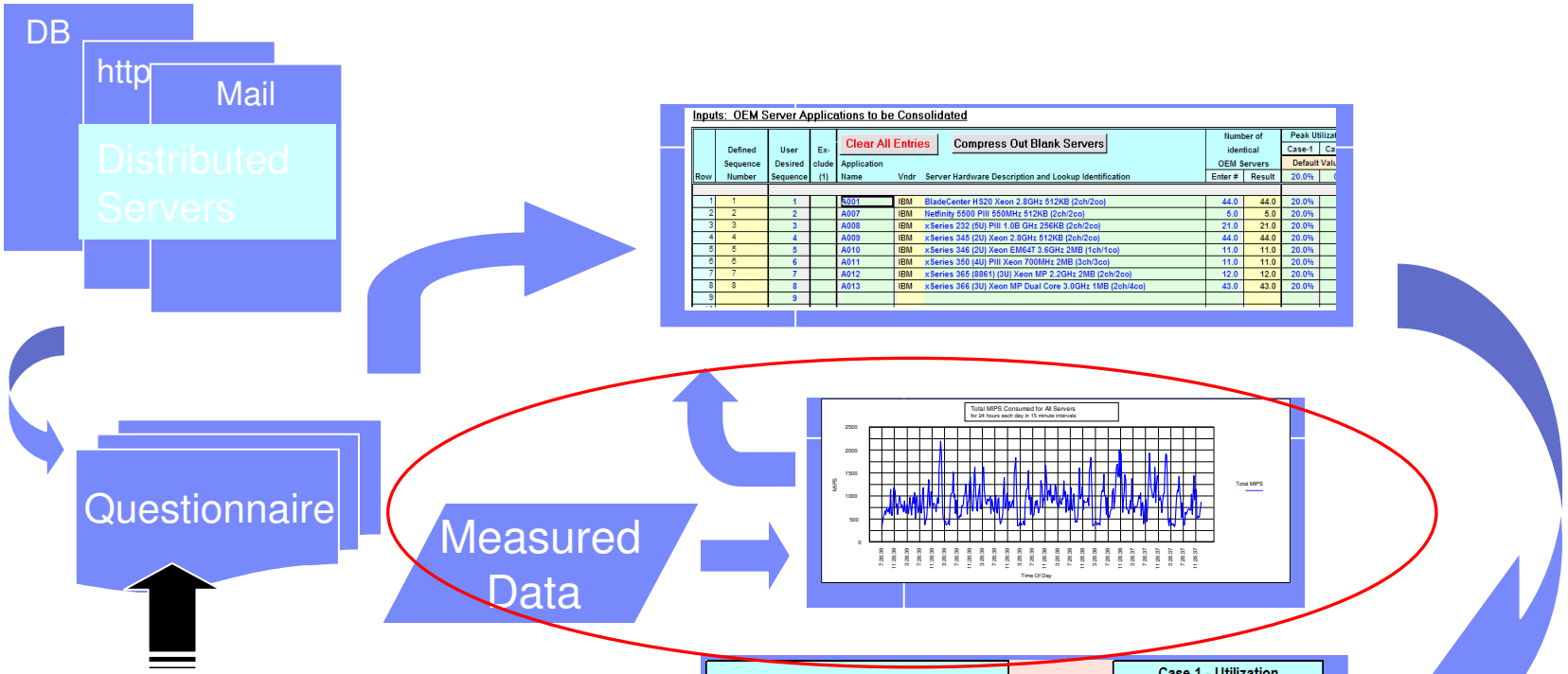
Inputs: OEM Server Applications to be Consolidated

Clear All Entries | Compress Out Blank Servers

Row	Defined Sequence Number	User Desired Sequence	Ex-clude (1)	Application Name	Vndr	Server Hardware Description and Lookup Identification	Number of identical OEM Servers Enter #	Result	Peak Utilizat Case-1 Default Valu 20.0%
1	1	1		A001	IBM	BladeCenter HS20 Xeon 2.8GHz 512KB (2ch/2co)	44.0	44.0	20.0%
2	2	2		A007	IBM	Netfinity 5500 PIII 550MHz 512KB (2ch/2co)	5.0	5.0	20.0%
3	3	3		A008	IBM	xSeries 232 (5U) PIII 1.0B GHz 256KB (2ch/2co)	21.0	21.0	20.0%
4	4	4		A009	IBM	xSeries 345 (2U) Xeon 2.8GHz 512KB (2ch/2co)	44.0	44.0	20.0%
5	5	5		A010	IBM	xSeries 346 (2U) Xeon EM64T 3.6GHz 2MB (1ch/1co)	11.0	11.0	20.0%
6	6	6		A011	IBM	xSeries 350 (4U) PIII Xeon 700MHz 2MB (3ch/3co)	11.0	11.0	20.0%
7	7	7		A012	IBM	xSeries 365 (8861) (3U) Xeon MP 2.2GHz 2MB (2ch/2co)	12.0	12.0	20.0%
8	8	8		A013	IBM	xSeries 366 (3U) Xeon MP Dual Core 3.0GHz 1MB (2ch/4co)	43.0	43.0	20.0%
9		9							

Processor	Feature	MSU	Capacity	Case 1 - Utilization Peaks are Complimentary	Concurrent
zSeries 800					
2066-0E1	1W	7	37.61	2,014%	2,028%
2066-0A1	1W	13	75.00	1,010%	1,017%
2066-0B1	1W	20	107.90	702%	707%
2066-0X2	2W	28	153.72	493%	496%

System z Linux Server Consolidation
Sizing Process - SCON with SURF



Processor	Feature	MSU	Capacity	Case 1 - Utilization	
				Peaks are	
				Complimentary	Concurrent
zSeries 800					
2066-0E1	1W	7	37.61	2,014%	2,028%
2066-0A1	1W	13	75.00	1,010%	1,017%
2066-0B1	1W	20	107.90	702%	707%
2066-0X2	2W	28	153.72	493%	496%

Type of Questions:
- Servers make & model
- Speed (MHz)
- Peak Average Utilization (%)
- Workload type (i.e. DB,Mail,http)

Oracle Database Memory sizing

- Obtain Oracle SGA and PGA sizes from all database instances
  - Prefer Advisory sizes from multiple AWR reports.
- Calculate individual guest storage requirements (assume MB):

  Sum of (optimized) SGA and PGA settings +
  256 MB for ASM +
  512 MB for Linux +
  512 MB for Oracle Enterprise Manager 12c agent (if used) +
  threads and process memory +
  10%* **
- Apply a z/VM memory over commit factor such as 1.2 or 1.5.
- System z memory = real memory for guests + memory for z/VM and expanded storage (4 GB).

*Increase estimate when Oracle SGA is large and there are expected to be hundreds of dedicated server connections or use hugepages with Oracle 11gR2
** A large overall virtual storage requirement may result in larger Page Tables in Linux which require extra guest storage. Consider hugepages but without AMM.

PGA Memory Advisory from an Oracle AWR report

PGA Memory Advisory

- When using Auto Memory Mgmt, minimally choose a pga_aggregate_target value where Estd PGA Overalloc Count is 0

PGA Target Est (MB)	Size Factr	W/A MB Processed	Estd Extra W/A MB Read/ Written to Disk	Estd PGA Cache Hit %	Estd PGA Overalloc Count
896	0.13	148,138.91	182,994.64	45.00	1,297
1,792	0.25	148,138.91	173,054.91	46.00	1,197
3,584	0.50	148,138.91	30,487.16	83.00	0
5,376	0.75	148,138.91	30,487.16	83.00	0
7,168	1.00	148,138.91	29,701.39	83.00	0
8,602	1.20	148,138.91	12,032.42	92.00	0
10,035	1.40	148,138.91	12,032.42	92.00	0
11,469	1.60	148,138.91	12,032.42	92.00	0
12,902	1.80	148,138.91	12,032.42	92.00	0
14,336	2.00	148,138.91	12,032.42	92.00	0
21,504	3.00	148,138.91	12,032.42	92.00	0
28,672	4.00	148,138.91	12,032.42	92.00	0
43,008	6.00	148,138.91	12,032.42	92.00	0
57,344	8.00	148,138.91	12,032.42	92.00	0

It appears that the allocated memory of 7,168 MB may be twice as large as required for this Oracle instance.

(Pull v$pgastats to find maximum)

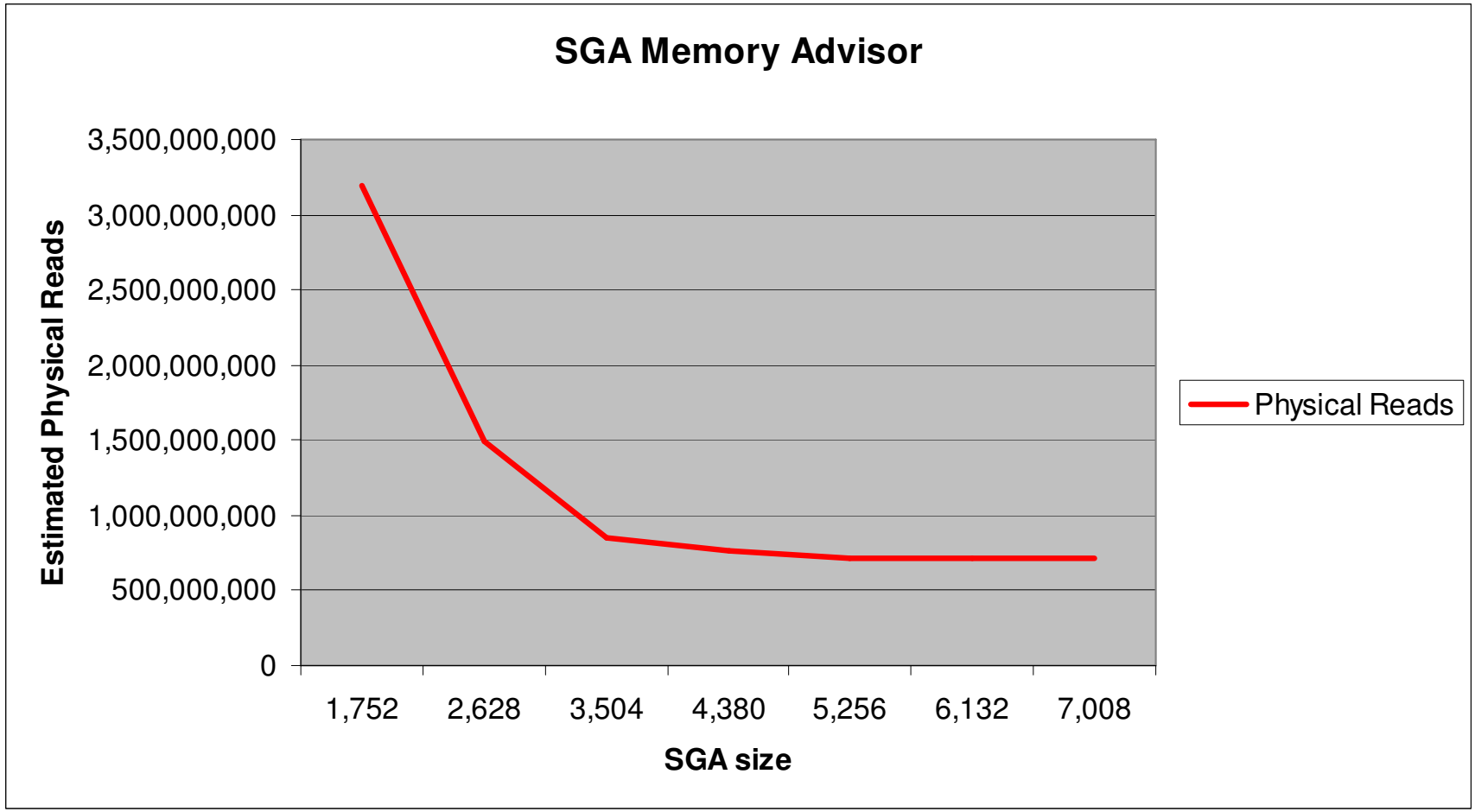
SGA Target Advisory from an Oracle AWR report

SGA Target Advisory

SGA Target Size (M)	SGA Size Factor	Est DB Time (s)	Est Physical Reads
2,304	0.25	317,428	14,503,025
4,608	0.50	282,694	11,631,530
6,912	0.75	270,413	10,965,119
9,216	1.00	263,535	10,396,434
11,520	1.25	258,791	10,003,449
13,824	1.50	255,418	9,725,864
16,128	1.75	252,915	9,517,935
18,432	2.00	252,150	9,454,517

It appears that the allocated memory of 9,216 MB might be reasonable.

SGA Memory Advisor - Charted



Threads for dedicated servers

Determine the number of dedicated threads and multiply that by 4.5 MB for required real memory to include in guest sizing.

The logons current below may give a hint about number of threads in use if dedicated.

Instance Activity Stats - Absolute Values

- Statistics with absolute values (should not be diffed)

Statistic	Begin Value	End Value
session cursor cache count	20,573	21,027
opened cursors current	186	91
workarea memory allocated	870,391	3,575
logons current	124	30

Obvious comments about sizing

- Garbage in, garbage out.
- Choose appropriate time frames that represent reasonable capacity usage
- Do not make guesses about the sizing input
- Get the IFL capacity, I/O subsystem setup, and the memory amounts at the proper levels before starting any testing
- Engage an IBM System z - Oracle specialist or IBM Techline to assist with sizing

Proof of Concept (PoC)

PoC part 1

- Engage a System z - Oracle specialist to assist with PoC planning
- Attend education if possible
- Verify all applications included in the PoC are certified on System z
  - Oracle's E-Business Suite (DB only), PeopleSoft (DB only), and Siebel (DB only)
- Obtain IFLs and memory as per the sizing process
  - No zIIPs, zAAPs or CP's for this environment
  - Choose I/O subsystem (i.e., ECKD or SCSI)
- Install z/VM and z/VM Performance Toolkit
- Install Linux
  - Choose certified levels of SUSE or Red Hat
    Go to support.oracle.com (id and password required) – notes 1082253.1, 741646.1, 1290360.1
  - Verify required Oracle modules have been installed
    RPM checkers available – support.oracle.com note 1086769.1
  - Consider using VDISK for first and second swap spaces
- Use Oracle Orion to validate the I/O subsystem even before a Oracle database is installed
  - Performs Oracle database like I/O

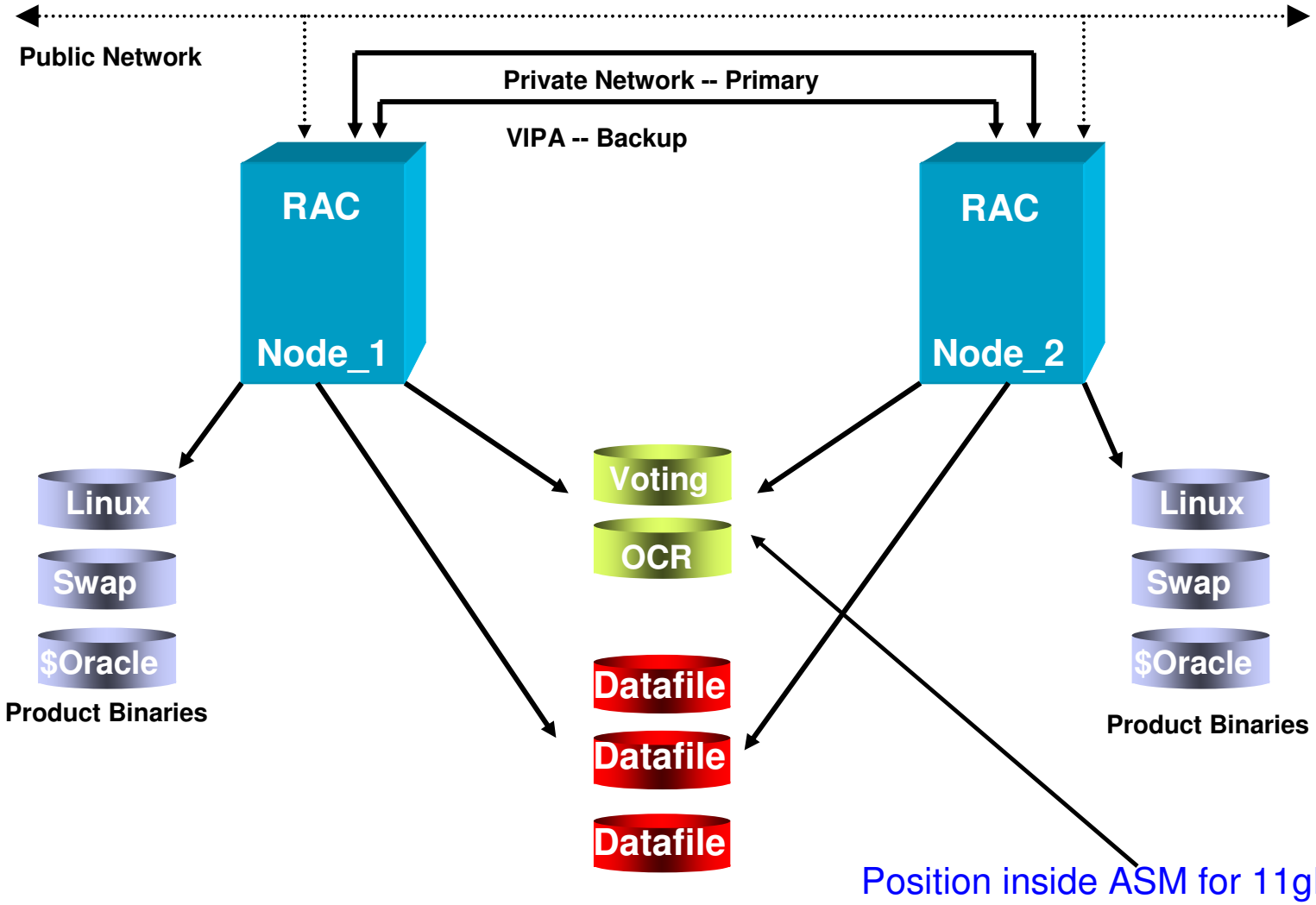
Education/Workshops – WSC

- LXOR6 (Wildfire Workshops)
- Customizing Linux and the Mainframe for Oracle DB Applications
  - For clients considering a move of Oracle to Linux on System z
  - Topics include hardware technologies, software components, best practices, performance and tuning, performance tools, linux distributions, tools and services for sizing
  - Two person teams installing VM, Linux (SUSE or RHEL), and Oracle
- No charge, Client Team Registration
- Offered in Various Cities across North America
  - Chicago, September 25 – 27
  - Boston (Waltham), October 23 – 25
  - Atlanta, TBD
- 2.5 days, Attendees responsible for travel expenses
- Combination Lectures and Lab Exercises

Disk or DASD options

- Disk: XIV or SCSI
  - For Oracle database
- DASD (3390 or ECKD)
  - Use for z/VM, Linux and Oracle binaries
  - For Oracle database
  - Performance
    - Best – HyperPav subsystem on DASD and HyperPav driver support in Linux distribution
      SLES 11 update 1
    - Good – HyperPAV or PAV on DASD subsystem. Additional setup work in z/VM and Linux required
    - Decent – No PAV. Setup work in z/VM and Linux

Overview of Major RAC Components



Storage – Testing with Oracle Orion - 1

ORION Simulates Oracle reads and writes, without having to create a database
and helps to isolate I/O issues. When a database is optimally configured you can expect to get up to 95% of the thorughput of Orion.

./orion_zlinux -run oltp -testname mytest -num_disks 2 -duration 30 -simulate raid0

```
ORION VERSION 11.2.0.0.1
Commandline: -run oltp -testname mytest -num_disks 2 -duration 30 -simulate raid0
This maps to this test: Test: mytest
Small IO size: 8 KB Large IO size: 1024 KB
IO Types: Small Random IOs, Large Random IOs
Simulated Array Type: RAID 0   Stripe Depth: 1024 KB
Write: 0% Cache Size: Not Entered
Duration for each Data Point: 30 seconds
Small Columns:,      2,      4,      6,      8,     10,     12,     14,     16,     18,     20,     22,     24,     26,
     28,     30,     32,     34,     36,     38,     40
Large Columns:,      0 Total Data Points: 22

Name: /dev/dasdq1       Size: 2461679616
Name: /dev/dasdr1       Size: 2461679616
2 FILEs found.
Maximum Small IOPS=5035* @ Small=40 and Large=0
Minimum Small Latency=0.55 @ Small=2 and Large=0
```

* Results are NOT representative of normal DASD performance

Storage – Testing with Oracle Orion - 2

-run oltp -testname mytest -num_disks 2 -duration 30 -simulate raid0

This maps to this test:
Test: mytest
Small IO size: 8 KB Large IO size: 1024 KB
IO Types: Small Random IOs, Large Random IOs
Simulated Array Type: RAID 0 Stripe Depth: 1024 KB
Write: 0%
Cache Size: Not Entered
Duration for each Data Point: 30 seconds
Small Columns:, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40
Large Columns:, 0
Total Data Points: 22

Name: /dev/sda1 Size: 10737401856
Name: /dev/sdb1 Size: 10737401856
2 FILEs found.
Maximum Small IOPS=24945 @ Small=24 and Large=0
Minimum Small Latency=0.60 @ Small=12 and Large=0

Download - http://www.oracle.com/technology/software/tech/orion/index.html

Storage – Testing with Oracle Orion - 3

- Be careful with the Orion options you choose. The writes are destructive.
- Perform Orion testing before installing the Oracle database to validate the I/O subsystem

OR

Moving data is like moving water – must have adequate flow throughout

AWR – I/O statistics

Tablespace	Filename	Reads	Av Reads/s	Av Rd(ms)	Av Blks/Rd	Writes	Av Writes/s	Buffer Waits	Av Buf Wt(ms)
[illegible]	[illegible]	10,790,012	222	12.28	2.25	4,845,015	100	411	54.38
[illegible]	[illegible]	10,311,731	212	11.87	2.37	4,758,474	98	591	63.45
[illegible]	[illegible]	2,030,575	42	22.91	1.23	2,551,704	53	3,857	141.84
[illegible]	[illegible]	1,190,077	24	27.58	1.21	1,477,830	30	2,897	23.93
[illegible]	[illegible]	1,143,880	24	19.50	1.18	1,593,814	33	2,904	87.73

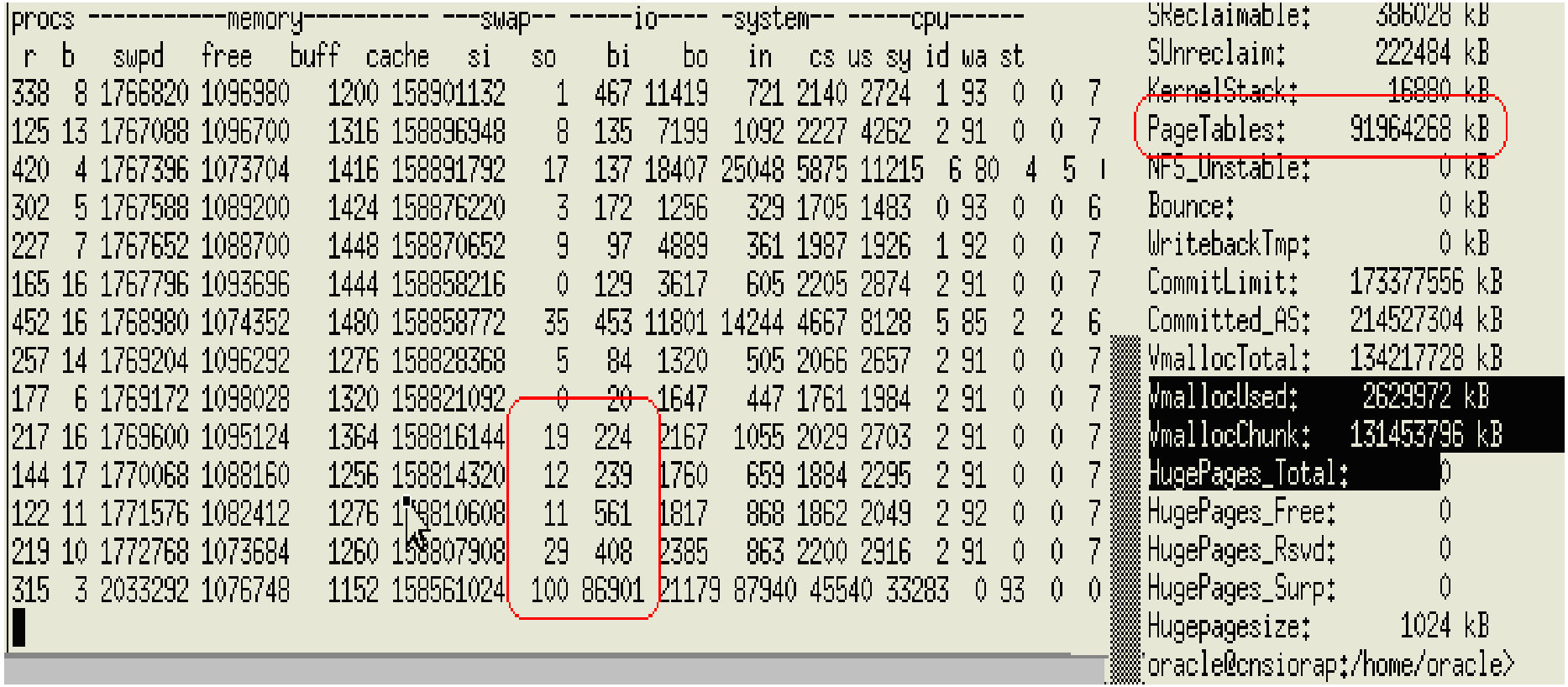
PoC part 2

- Install Oracle database –11gR2 (11.2.0.3) or 10gR2 (10.2.0.5)
  - Consider starting with Oracle ASM versus LVM ext3 files
    - Utilize UDEV rules rather than ASMLIB – see Oracle support note **ID 1350008.1** , 1089399.1
  - If using ext3 then verify Oracle init.ora has the following settings:
    filesystemio_options = setall (direct I/O)
    disk_asynch_io=true
    to eliminate Linux double caching which wastes storage and CPU resources

    Calculate kernel parmeters shmmax and shmall for each guest.
- Consider using Linux Hugepages for large SGAs (Oracle DB 11gR2 only)
  - The more connections the larger the page table reduction.
  - Limitations: No AMM.
- Create appropriate disk multipathing for XIV, V7000 or SCSI
  - Consider running Orion again to test multipathing
    - See Oracle support note ID 1350008.1
- Load database from another Oracle database source
  - Use transportable tablespace or database for metadata when endian formats are the same http://en.wikipedia.org/wiki/Endian
  - Additional steps, like rman conversions, are required for unlike endian formats
  - Import/export may be required when the source database is older than 10gR2
  - Recreate statistics for optimizer use after loading into new environment

Oracle without HugePages
Linux 4K Page Tables after 70 minutes

Linux Swap and Page Tables using 87.7 GB of Memory!



```
procs -----------memory---------- ---swap-- -----io---- -system-- -----cpu------
 r  b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa st
338  8 1766820 1096980   1200 158901132    1  467 11419   721 2140 2724  1 93  0  0  7
125 13 1767088 1096700   1316 158896948    8  135  7199  1092 2227 4262  2 91  0  0  7
420  4 1767396 1073704   1416 158891792   17  137 18407 25048 5875 11215  6 80  4  5  1
302  5 1767588 1089200   1424 158876220    3  172  1256   329 1705 1483  0 93  0  0  6
227  7 1767652 1088700   1448 158870652    9   97  4889   361 1987 1926  1 92  0  0  7
165 16 1767796 1093696   1444 158858216    0  129  3617   605 2205 2874  2 91  0  0  7
452 16 1768980 1074352   1480 158858772   35  453 11801 14244 4667 8128  5 85  2  2  6
257 14 1769204 1096292   1276 158828368    5   84  1320   505 2066 2657  2 91  0  0  7
177  6 1769172 1098028   1320 158821092    0   20  1647   447 1761 1984  2 91  0  0  7
217 16 1769600 1095124   1364 158816144   19  224  2167  1055 2029 2703  2 91  0  0  7
144 17 1770068 1088160   1256 158814320   12  239  1760   659 1884 2295  2 91  0  0  7
122 11 1771576 1082412   1276 158810608   11  561  1817   868 1862 2049  2 92  0  0  7
219 10 1772768 1073684   1260 158807908   29  408  2385   863 2200 2916  2 91  0  0  7
315  3 2033292 1076748   1152 158561024  100 86901 21179 87940 45540 33283  0 93  0  0
```

```
SReclaimable:     386028 kB
SUnreclaim:       222484 kB
KernelStack:       16880 kB
PageTables:     91964268 kB
NFS_Unstable:          0 kB
Bounce:                0 kB
WritebackTmp:          0 kB
CommitLimit:   173377556 kB
Committed_AS:  214527304 kB
VmallocTotal:  134217728 kB
VmallocUsed:     2629972 kB
VmallocChunk:  131453796 kB
HugePages_Total:       0
HugePages_Free:        0
HugePages_Rsvd:        0
HugePages_Surp:        0
Hugepagesize:       1024 kB
oracle@cnsiorap:/home/oracle>
```

Oracle using HugePages after two hours

```
[oracle@cnsiorap:/home/oracle>
MemTotal:       260209484 kB
MemFree:        10453276 kB
Buffers:           60092 kB
Cached:          3911428 kB
SwapCached:            0 kB
Active:          3540228 kB
Inactive:        3016924 kB
Active(anon):    3513552 kB
Inactive(anon):        0 kB
Active(file):      26676 kB
Inactive(file):  3016924 kB
Unevictable:        7872 kB
Mlocked:            7872 kB
SwapTotal:      43272816 kB
SwapFree:       43272816 kB
Dirty:                20 kB
Writeback:             0 kB
AnonPages:       3218740 kB
Mapped:           129036 kB
Shmem:            299404 kB
Slab:             254420 kB
SReclaimable:      31316 kB
SUnreclaim:       223104 kB
KernelStack:       17360 kB
PageTables:       389768 kB
NFS_Unstable:          0 kB
Bounce:                0 kB
WritebackTmp:          0 kB
CommitLimit:    53774356 kB
Committed_AS:    5860460 kB
VmallocTotal:   134217728 kB
VmallocUsed:      2629972 kB
VmallocChunk:   131433316 kB
HugePages_Total:   233600
HugePages_Free:    77309
HugePages_Rsvd:    47998
HugePages_Surp:        0
Hugepagesize:       1024 kB
```

```
 0  1      0 10458852  59956 3942708    0    0  3971 14633 6235 15858  9  1 80 10  0
 0  5      0 10458228  59964 3942700    0    0  4139 11295 6041 15235  9  1 80 10  0
 1  4      0 10458132  59964 3942712    0    0  3765 14725 6246 15765  8  1 81  9  0
 0  2      0 10457500  59972 3942704    0    0  3957 10909 5922 15024  9  1 80 10  0
 0  3      0 10457416  59972 3942712    0    0  3491 15451 6199 15713  8  1 82  8  0
 1  1      0 10457376  59980 3942712    0    0  3931  9919 5842 14763  9  1 81  9  0
 0  3      0 10448640  59980 3942728    0    0  3525 14445 6229 15595  8  1 82  9  0
 1  2      0 10449476  59980 3942744    0    0  4037 10345 5895 15057  9  1 80 10  0
 0  3      0 10448076  59988 3942736    0    0  3667 15081 6271 15912  9  1 81  9  0
 1  1      0 10451036  59988 3942728    0    0  3715 10472 5935 14777  8  1 82  8  0
 0  2      0 10451892  59988 3942728    0    0  3915 14064 6265 15958  9  1 80 10  0
 0  1      0 10450884  60004 3942720    0    0  3256 12665 5917 14908  8  1 84  7  0
 8  1      0 10449416  60004 3942724    0    0  4080 11723 6165 15571  9  1 80 10  0
15  0      0 10451084  60012 3942720    0    0  3715 10644 5862 15008  8  1 82  8  0
 5  3      0 10450120  60012 3942724    0    0  3664 14157 6289 15810  8  1 82  8  0
 1  2      0 10449976  60012 3942724    0    0  4152 10243 5955 15021  9  1 80 10  0
 1  5      0 10456096  60020 3942724    0    0  3333 13889 6190 15468  8  1 82  8  0
 2  4      0 10458024  60020 3942720    0    0  4176  9695 5917 14960  9  1 79 11  0
 0  2      0 10457412  60028 3942716    0    0  3661 14596 6273 15871  8  1 81  9  0
procs -----------memory---------- ---swap-- -----io---- -system-- -----cpu------
 r  b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa st
 0  3      0 10458256  60028 3942720    0    0  3965 10697 5980 15029  9  1 81  8  0
 0  5      0 10458264  60028 3942720    0    0  3704 14120 6231 15743  8  1 82  9  0
 1  3      0 10459016  60036 3942708    0    0  3880 10425 5931 14894  9  1 81  9  0
```

Page tables: 0.371 GB and No Swap

Endian formats

```
SQL> COLUMN PLATFORM_NAME FORMAT A32;
SQL> SELECT * FROM V$TRANSPORTABLE_PLATFORM;
PLATFORM_ID PLATFORM_NAME                    ENDIAN_FORMAT
----------- -------------------------------- --------------
1 Solaris[tm] OE (32-bit)                    Big
2 Solaris[tm] OE (64-bit)                    Big
7 Microsoft Windows IA (32-bit)              Little
10 Linux IA (32-bit)                         Little
6 AIX-Based Systems (64-bit)                 Big
3 HP-UX (64-bit)                                      Big
5 HP Tru64 UNIX                              Little
4 HP-UX IA (64-bit)                          Big
11 Linux IA (64-bit)                         Little
15 HP Open VMS                               Little
8 Microsoft Windows IA (64-bit)              Little
9 IBM zSeries Based Linux                    Big
13 Linux x86 64-bit                          Little
16 Apple Mac OS                              Big
12 Microsoft Windows x86 64-bit              Little
17 Solaris Operating System (x86)                     Little
18 IBM Power Based Linux                     Big
20 Solaris Operating System (x86-64)         Little
19 HP IA Open VMS                            Little
```

PoC part 3

- Run PoC testing
  - Collect performance data by enabling:
    - z/VM Performance Toolkit
      Note that you must now think about virtualization versus dedicated resources
    - sar and iostat data from the Linux on z guest(s)
    - AWR reports from the Oracle database
  - Review performance reports
    - z/VM Performance Toolkit
      - Understand CPU, memory, and paging consumption for the LPAR
      - Review virtual machine consumption of resources
      - Evaluate I/O performance
      - Verify VDISK usage
    - Linux using sar and iostat data
      CPU, memory, swapping, and I/O performance for each guest
    - Oracle AWR report and Oracle Enterprise Manager screens
      I/O performance
      SGA and PGA usage via automatic memory management (see previous chart)
      Normal DBA tuning review
        - Review for poor performing SQL
        - Locking and latching
- Rerun PoC if changes are made
  - Does the PoC validate the initial sizing?

PoC part 4

- Think in terms of virtualization – different mind set
- Does that Oracle database require all of that memory it had in the non-virtualized environment?
- Should you have a active/passive/stand by setup in the same z/VM?
  - Optimize use of resources
- Did the guests get properly prioritized with respect to other guests in z/VM?
- What workloads are peaking at the same time
  - CPU peak
  - Memory load
  - I/O subsystem
- DBA's, Linux admins, and z/VM sys progs must work as a team in any virtualized environment

AWR – other statistics

Top 5 Timed Events

Event	Waits	Time(s)	Avg Wait(ms)	% Total Call Time	Wait Class
db file sequential read	6,073,284	74,443	12	35.5	User I/O
CPU time		64,668		30.8	
log file sequential read	173,131	8,093	47	3.9	System I/O
log file parallel write	189,657	3,668	19	1.7	System I/O
gc current grant 2-way	2,697,994	2,469	1	1.2	Cluster

Operating System Statistics

Statistic	Total
BUSY_TIME	6,905,787
IDLE_TIME	1,288,223
IOWAIT_TIME	886,823
NICE_TIME	4,077
SYS_TIME	268,498
USER_TIME	6,493,552
LOAD	4
RSRC_MGR_CPU_WAIT_TIME	0
PHYSICAL_MEMORY_BYTES	33,711,116,288
NUM_CPUS	4

SQL ordered by Elapsed Time

- Resources reported for PL/SQL code includes the resources used by all SQL statements called by the code.
- % Total DB Time is the Elapsed Time of the SQL statement divided into the Total Database Time multiplied by 100

Elapsed Time (s)	CPU Time (s)	Executions	Elap per Exec (s)	% Total DB Time	SQL Id	SQL Module	SQL Text
180,654	58,111	12	15054.53	86.10	[illegible]	[illegible]	BEGIN [illegible]
88,004	35,905	174	505.77	41.94	[illegible]	[illegible]	BEGIN :1 := [illegible]
25,374	3,294	167	151.94	12.09	[illegible]	[illegible]	INSERT ALL [illegible]
16,124	2,939	174	92.67	7.68	[illegible]	[illegible]	INSERT INTO [illegible]
12,080	5,048	3,519	3.43	5.76	[illegible]	[illegible]	INSERT INTO [illegible]
8,754	4,475	167	52.42	4.17	[illegible]	[illegible]	UPDATE [illegible]
8,313	1,293	167	49.78	3.96	[illegible]	[illegible]	INSERT INTO [illegible]
6,177	1,484	167	36.99	2.94	[illegible]	[illegible]	INSERT INTO [illegible]
5,545	2,357	15,590,673	0.00	2.64	[illegible]	[illegible]	SELECT [illegible]
3,590	216	163	22.02	1.71	[illegible]	[illegible]	INSERT INTO [illegible]
3,275	1,682	167	19.61	1.56	[illegible]	[illegible]	UPDATE [illegible]

Back to SQL Statistics
Back to Top

SQL ordered by CPU Time

- Resources reported for PL/SQL code includes the resources used by all SQL statements called by the code.
- % Total DB Time is the Elapsed Time of the SQL statement divided into the Total Database Time multiplied by 100

CPU Time (s)	Elapsed Time (s)	Executions	CPU per Exec (s)	% Total DB Time	SQL Id	SQL Module	SQL Text
58,111	180,654	12	4842.56	86.10	[illegible]	[illegible]	BEGIN [illegible]
35,905	88,004	174	206.35	41.94	[illegible]	[illegible]	BEGIN :1 := [illegible]
5,048	12,080	3,519	1.43	5.76	[illegible]	[illegible]	INSERT [illegible]
4,475	8,754	167	26.79	4.17	[illegible]	[illegible]	UPDATE [illegible]
3,294	25,374	167	19.73	12.09	[illegible]	[illegible]	INSERT ALL [illegible]
2,939	16,124	174	16.89	7.68	[illegible]	[illegible]	INSERT INTO [illegible]
2,357	5,545	15,590,673	0.00	2.64	[illegible]	[illegible]	SELECT [illegible]
1,682	3,275	167	10.07	1.56	[illegible]	[illegible]	UPDATE [illegible]
1,484	6,177	167	8.89	2.94	[illegible]	[illegible]	INSERT [illegible]
1,293	8,313	167	7.75	3.96	[illegible]	[illegible]	INSERT [illegible]
216	3,590	163	1.33	1.71	[illegible]	[illegible]	INSERT INTO [illegible]

Production Readiness

Production Readiness

- Did the PoC validate the initial sizing
  - If not, attempt to resize or use PoC information as the basis for estimation
- Did the PoC test the availability requirements established during the requirements phase (i.e., Oracle MAA)
  - Standalone DB
  - RAC with Active/Active or Active/Passive
  - Use of multiple physical System z machines
  - Data Guard for Disaster Recovery
- Is there sufficient IFL capacity, memory, and I/O capacity for production
  - Are you ready to measure capacity usage over the long term.
- Are the latest Oracle patches applied?
- Consider z/VM prioritization to appropriately manage the large number of guests

Summary

- Sizing in advance is important; really, it is.
- Optimize virtualization benefits with regard to allocation of resources
- PoCs with smaller and less important Oracle databases might be a good start
- Oracle database on Loz can handle ERP sized databases
  - PeopleSoft
  - Siebel
  - E-Business suite
- Oracle database on Loz can handle data warehouse applications
- IBM and Oracle continue to work together and invest in improving the Oracle on Linux on z solution

Information Sources

- http://www.ibm.com/redbooks
  - SG24-6482-00 Experiences with Oracle Database 10g on Linux for zSeries
  - SG24-7191-00 Experiences with Oracle 10gR2 Solutions on Linux for System z
  - SG24-7573-00 Using Oracle Solutions on Linux on System z
  - SG24-7634-00 Experiences with Oracle Solutions on Linux for IBM System z
  - REDP-4788-00 Installing Oracle 11gR2 RAC on Linux on System z
- http://linuxmain.blogspot.com
- http://www.vm.ibm.com/perf/tips
  - General z/VM Tuning Tips
- http://www-124.ibm.com/developerworks/oss/linux390/index.shtml
  - Lot's of information on Linux for System z
- http://www-128.ibm.com/developerworks/linux/linux390/perf/index.html
  - Hints and Tips for tuning Linux on System z
- http://www.zseriesoraclesig.org
  - Special Interest Group of Oracle users on the mainframe (z/OS and Linux)
- http://www.mail-archive.com/linux-390%40vm.marist.edu/
  - Marist List Server

My Oracle Support Notes

- 1306465.1 - Getting Started - 11gR2 Grid Infrastructure, ASM and DB (IBM: Linux on System z)
- 1290644.1 - Requirements for Installing Oracle 11gR2 on SLES11 on IBM: Linux on System z (s390x)
- 1306889.1 - Requirements for Installing Oracle 11gR2 on RHEL 5 on IBM: Linux on System z (s390x)
- 1308859.1 - Requirements for Installing Oracle 11gR2 RDBMS on SLES 10 SP3 on IBM: Linux on System z (s390x)
- 1086769.1 - Ensure you have prerequisite rpms to install Oracle Database and AS10g(midtier) on IBM: Linux on System z (s390x)

System z Social Media

- System z official Twitter handle:
  - @ibm_system_z
- Top Facebook pages related to System z:
  - Systemz Mainframe
  - IBM System z on Campus
  - IBM Mainframe Professionals
  - Millennial Mainframer
- Top LinkedIn Groups related to System z:
  - Mainframe Experts Network
  - Mainframe
  - IBM Mainframe
  - System z Advocates
  - Cloud Mainframe Computing
- YouTube
  - IBM System z

- Leading Blogs related to System z:
  - Evangelizing Mainframe (Destination z blog)
  - Mainframe Performance Topics
  - Common Sense
  - Enterprise Class Innovation: System z perspectives
  - Mainframe
  - MainframeZone
  - Smarter Computing Blog
  - Millennial Mainframer

Questions?

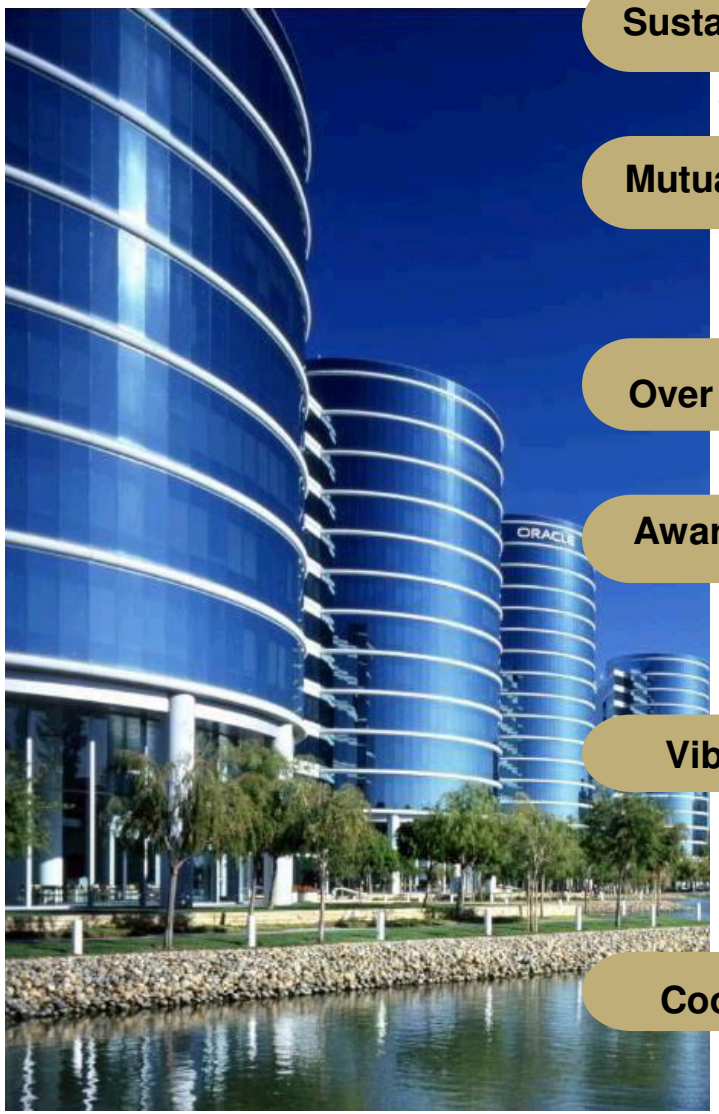
Survey and Handouts


Thank
You

Topics -- Oracle Solutions On Linux on z

- Backup Charts

IBM Oracle Alliance – a Shared Commitment to Client Value



Sustained Collaboration for Customers

- Oracle 25 Years, PeopleSoft 23 Years, JD Edwards, 35 Years, Siebel 13 Years

Mutual Executive Commitment

- Dedicated, Executive-led Alliance teams
- Regular Senior executive reviews and functional Executive interlocks

Over 140K Total Joint Customers Worldwide

- Hardware and Software support via Applications Unlimited, over 30,000 Application joint customers

Award Winning Oracle Services Practice

- Over 5,500 Successful Joint Services Projects
- > 10,000 Oracle skilled resources worldwide
- IBM Solution Workbench For Oracle

Vibrant Technology Collaboration

- Continued joint development delivering Oracle SW optimized for IBM HW
- Substantial investment in skills and resources
- Dedicated International Competency Center

Cooperative Customer Support Process

- Dedicated On-Site Resources
- Significant Program Investments

Oracle Applications for System z Servers

		IBM Data Server on DB2 z/OS and or Linux*	Oracle DB Server on Linux
ERP & CRM Solutions	Oracle PeopleSoft Enterprise	* Version 9.0 & 9.1 /Tools 8.50,8.51 & 8.52 DB2 v8, v9.1 , V10 Database on z/OS * Batch Server Supported on z/OS & Linux	* Version 9.0 & 9.1 /Tools 8.50, 8.51 & 8.52 Oracle 10gR2, 11gR2
	Oracle Siebel CRM Applications	* Version 8.0 & 8.1.1 DB2 v8, v9.1 on z/OS DB2 v9.1, v9.7 on Linux * Version 8.1.1.7 + DB2 v 9.1, v9.7 on Linux DB2 v8, v9, v10 on z/OS * Version 8.1.1.8 DB2 v9.1, v10 on z/OS DB2 v9.1, v9.7 on Linux	* Version 8.0 & 8.1.1 Oracle 10gR2, 11gR2
	Oracle E-Business Suite	Not Applicable Oracle DB/FMW	* Version R12.1.2, 12.1.3 Oracle 10gR2, 11gR2

* Note: Multi-Platform "Split Tier" Configuration – Only the Database runs on System z Servers unless otherwise noted

Oracle Industry Applications for System z Servers

		IBM Data Server on DB2 z/OS and or Linux*	Oracle DB Server on Linux
Higher Education	**Oracle PeopleSoft Campus Solutions**	Not planned	**•Version 9.0 /Tools 8.50, 8.51. 8.52** Oracle 10gR2, 11gR2
Public Sector	**Oracle Siebel Public Sector and Loyalty Management**	**** Version 8.2.2.1*** *DB2 v9.1, v10 on z/OS* *DB2 v9.7 on Linux* *•Version 8.1.1.8:* *DB2 v9 , v10 on z/OS* *DB2 v9.1, 9.7 on Linux on System z*	*** Version 8.1.1.8, 8.2.2.1** Oracle 10gR2, 11gR2
Insurance and Cross Industry	**Oracle Insurance**	***Documaker Version 11.5, 12.0*** *DB2 v8, v9.1 z/OS*	Not planned
	Oracle Cross Industry	**Not Applicable Oracle DB/FMW**	***Oracle Policy Automation v10.3*** *Oracle WebLogic 11gR1 with Oracle DB 11gR2*

** Note: Multi-Platform "Split Tier" Configuration – Only the Database runs on System z Servers unless otherwise noted*

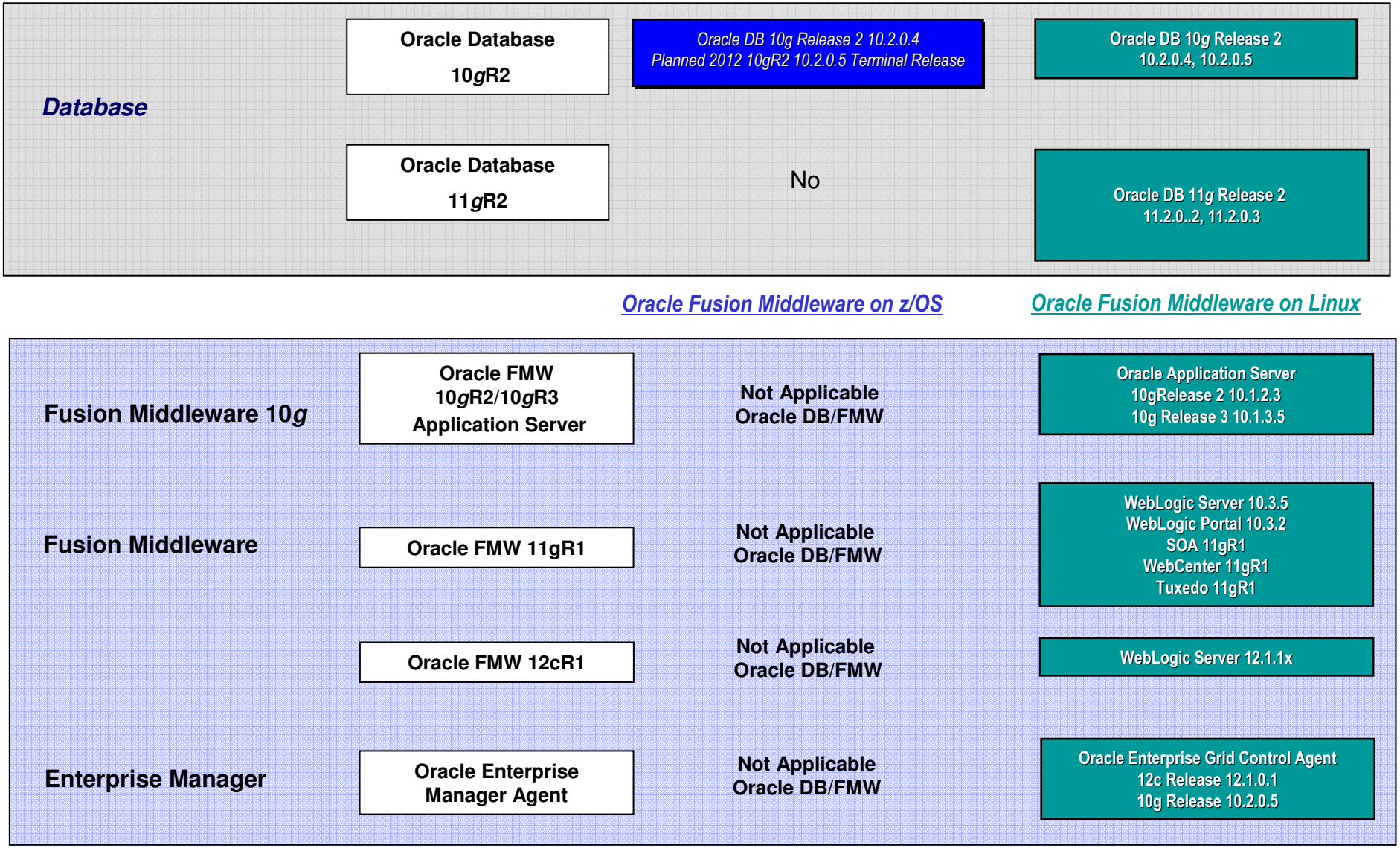
Oracle Applications for System z Servers

	IBM Data Server on DB2 z/OS and or Linux*	Oracle DB Server on Linux

** Note: Multi-Platform "Split Tier" Configuration – Only the Database runs on System z Servers unless otherwise noted*

Hyperion Enterprise Performance Management	**Oracle Enterprise Performance Management**	**** Version 11.1.2.2*** *DB2 v10 z/OS as Data Source*	**** Version 11.1.2.2*** *Oracle 10g, Oracle 11gR2 as Data Source & Repository*
		**** Version 11.1.1.4*** *DB2 v10 z/OS as Data Source*	Not planned
OBIEE Solutions:	**Oracle Business Intelligence Enterprise Edition**	**** Version 11gR1 v11.1.1.6*** *DB2 V9.1, 9.5 Linux on z as Data Source* *DB2 V9.7 Linux on z as Data Source & Repository*	**** Version 11gR1 v11.1.1.6*** *Oracle 10g (10.2.0.4, 10.2.0.5)* *11g Release 2 (11.2.0.2)* *as Data Source & Repository*
		**** Version v10.1.3.4.2*** *DB2 v8, 9.1 z/OS as Data Source* *DB2 v9.1, 9.5, DB2 9.7 Linux on z as Data Source*	**** Version v10.1.3.4.2*** *Oracle 10g (10.2.0.4, 10.2.0.5)* *11g Release 2 (11.2.0.2)* *as Data Source & Repository*
Golden Gate:	**Oracle GoldenGate**	***Version 11.1.1.1.0 for z/OS*** *DB2 v10/9.1/8.1 for z/OS*	*Version 11.1.1.1.0 for Linux on z* *Oracle 10g (10.2.0.4, 10.2.0.5)* *11g Release 2 (11.2.0.2)*

Oracle Technology Solutions for System z Servers



IBM and Oracle's Commitment to Oracle on Linux for System z

To meet the rapid growth of Linux, server virtualization and IT Optimization, IBM and Oracle have increased development and support investments to deliver complete, open and integrated solutions to our customers. Specifically, IBM and Oracle have:

- **IBM and Oracle have expanded porting resources to make Oracle technology infrastructure current and complete for Linux on System z ("LoZ")**
- **IBM is investing in >40 development and tech staff to bring LoZ solutions to market**
- **IBM is investing in hardware resources for Oracle development on LoZ**
- **IBM dedicated resources to engage customers in design, proof-of-concept and benchmark activities**
- **Aligned our technical support organizations to simplify problem resolution**
  - Dedicated Oracle System z team in Oracle Support
- **Published IBM and Oracle customer collateral covering various topics regarding Oracle on Linux on System z**

Why System z for Oracle:

- High Availability Requirements
- Open Standards and Linux
- Disaster Recovery Requirements
- Customer Data on Mainframe
- Increased Performance Requirements
- Utilization of IFL Specialty Engines
- TCO versus Total Cost of Acquisition
- ‘Green’ Value from Mainframe
- zEnterprise servers can virtualize everything with up to 100% utilization rates
- System z has the highest security rating or classification for any commercial server

Oracle Database 11*g* Release 2 on Linux for IBM System z Servers

- In 1Q 2011 Oracle delivered as scheduled 11g Release 2 (11.2.0.2) Database for Linux on IBM System z Servers
  - Oracle Real Applications Clustering (RAC) is included
- Oracle has been delivered on Linux for System z since 2002 (9i, 10*gR1 and* 10*g*R2).
- Customers have implement both large and small databases on Linux for System z
- Oracle 11*g* Release 2, along with the standard features, has many new options that are detailed in the document Oracle® Database New Features Guide 11*g* Release 2 (11.2) E17128-04.
  - New features include:
    - Real Application Testing which provides the capability to capture live workloads and rerun them to access capacity needs, and consolidation benefits.
    - Huge page support, which provides more efficient operation of the Linux OS by reducing memory used by page tables.

Oracle's Dedicated Level 2 System z Support

Enhancement to existing Support for Linux on System z Servers

- Manager, Raimund Reng
- System z skilled and knowledgeable
- WW Support
- Level 2 support team
- Request z team connected when z environment problems
- Joint User/Oracle/IBM Conference Calls
- Webcasts, Oracle z support update

Oracle's New Patch Set Support Update

Enhancement to existing Support for Linux on System z Servers

Patch Set Update – Linux on z

- **Policy Change on Patch Set Update (PSU)**
  - Beginning with the October 2009 Critical Patch Update release, Oracle will now deliver Patch Set Updates for all platforms on the release date including Linux on z.
- **What is a PSU and when is it provided?**
  - PSU is a bundle of patches Oracle recommends to apply. It consists of CPU, Generic patch bundle, RAC patch bundle and Data Guard patch bundles
  - Quarterly released
- **Benefit for Linux on z Customers**
  - Verified and tested before provided to the customer
  - Easy database maintenance
  - Recommended patches now also available for Linux on z
  - Reduces problem situation and downtime.
- **What About Critical Patch Updates (CPUs)?**
  - In the future single Critical Patch Updates are only available on request via service reqwuest (SR)

Raimund Reng, Oracle Support – September 2009

My Oracle Support Communities

- Migration from the older Forum format
- Actively managed and moderated
- Encourages user posts
- Spotlight and highlight posts
- Specific community for System z customers
- Accessed via My Oracle Support (Metalink)
  - support.oracle.com, click on Community, Subscribe to and Click on zSeries Platforms
- Announcements will be made in Community Featured Section !
  - “Webinars” One hour “brownbag” type presentations given by Oracle Support
  - First one planned in December 2010
  - Topic will be ASM
- Join the Oracle Linux on z community and help to shape the future:
  - Provide feedback
  - Exchange ideas
  - Get answers
  - Expand networks
  - Share successes

Workshops – WSC

- **LXOR6 (Wildfire Workshops)**
- **Customizing Linux and the Mainframe for Oracle DB Applications**
  - **For clients considering a move of Oracle to Linux on System z**
  - **Topics include hardware technologies, software components, best practices, performance and tuning, performance tools, linux distributions, tools and services for sizing**

- **No charge, Client Team Registration**
- **Offered in Various Cities across North America**
  - **April 24, Las Vegas (Collaborate, 1 Day Lab)**
  - **2Q 2012 TBA**
- **2.5 days, Attendees responsible for travel expenses**
- **Combination Lectures and Lab Exercises**

International zSeries Oracle SIG

- Independent User Organization
  - President, Mike Zechman
  - Worldwide user participation
  - No cost to be a member
  - Oracle and IBM Participation
- Annual Conference
  - Next is April 2012, Las Vegas, Mandalay Bay
- Longest running still active Oracle User Group
- Official recognition and involvment by Oracle and IBM
- Website www.zseriesoraclesig.org
  - Presentations, Links, Bulletin Board

Customers running Oracle on Linux on IBM System z

- **Hundreds of customers running Oracle on Linux on IBM System z**
  - Various sizes and deployments
  - Across industries
  - Active volunteer led System z Oracle User Group (www.zseriesoraclesig.org)
- **Small System z customer example**
  - Oil and Gas industry services provider
  - Serves 4,200 companies, 44,000 users, $80B in transaction detail yearly
  - Was Windows, Dell, Linux
  - Issues – rapid company growth, server sprawl, cost control, hardware outages
  - Solution – z10 BC, 3 IFLs, 24 GB
    - SLES10, Oracle 10g EE
    - Databases: 7 production, 400 GB – 3 TB, 7 virtual servers/database

Customers running Oracle on Linux on IBM System z

- **Large System z customer example**
  - Large government installation
  - 100 IFLs, z10 EC Oracle RAC environment across 2 z10 EC servers with Oracle ASM
  - 35 TB Database and 45 TB Flash Recovery Area
  - Project is getting very high I/O throughput inserting 5.79 billion records in a 7 hour window and updating another 320 million records (exceeds 5 year SLA)

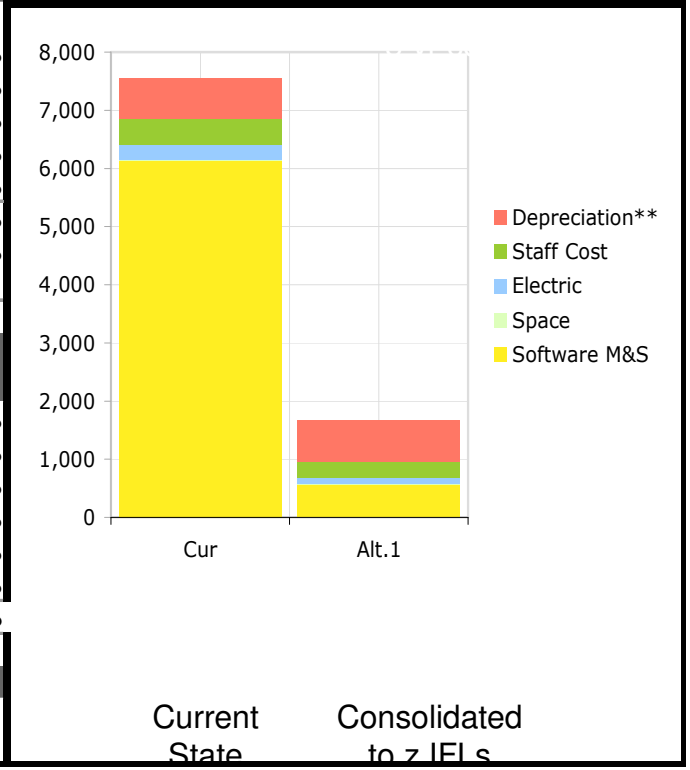
Customers running Oracle on Linux on IBM System z

- **Large System z customer example**
  - Leading systems integrator and IT consulting firm
  - z990 x 2, z9 EC S54 x 4, z10 EC E64 x 1 (192GB to 256GB per box)
  - 32 IFLs per z990, 54 IFLs per z9 EC, 64 IFLs per z10 EC
  - All Linux
  - 5 LPARs per CEC (4 for Oracle, 1 for management)
    - 16 shared IFLs per LPAR, 45 GB Memory per LPAR
  - 4 nodes RAC running on same CEC with HiperSockets interconnect
  - 2,000 – 3,000 transactions per second at peak
  - Response time less than 1 sec (threshold 5 sec)
  - DB Size – >5 TB for online and ~50 TB for data warehouse
  - Benefits – TCO, Extreme high availability, scalability
  - Planning z196 upgrade

IBM zLinux vs. x86 Consolidation Study – Save ~$6M over 5 Years (1)

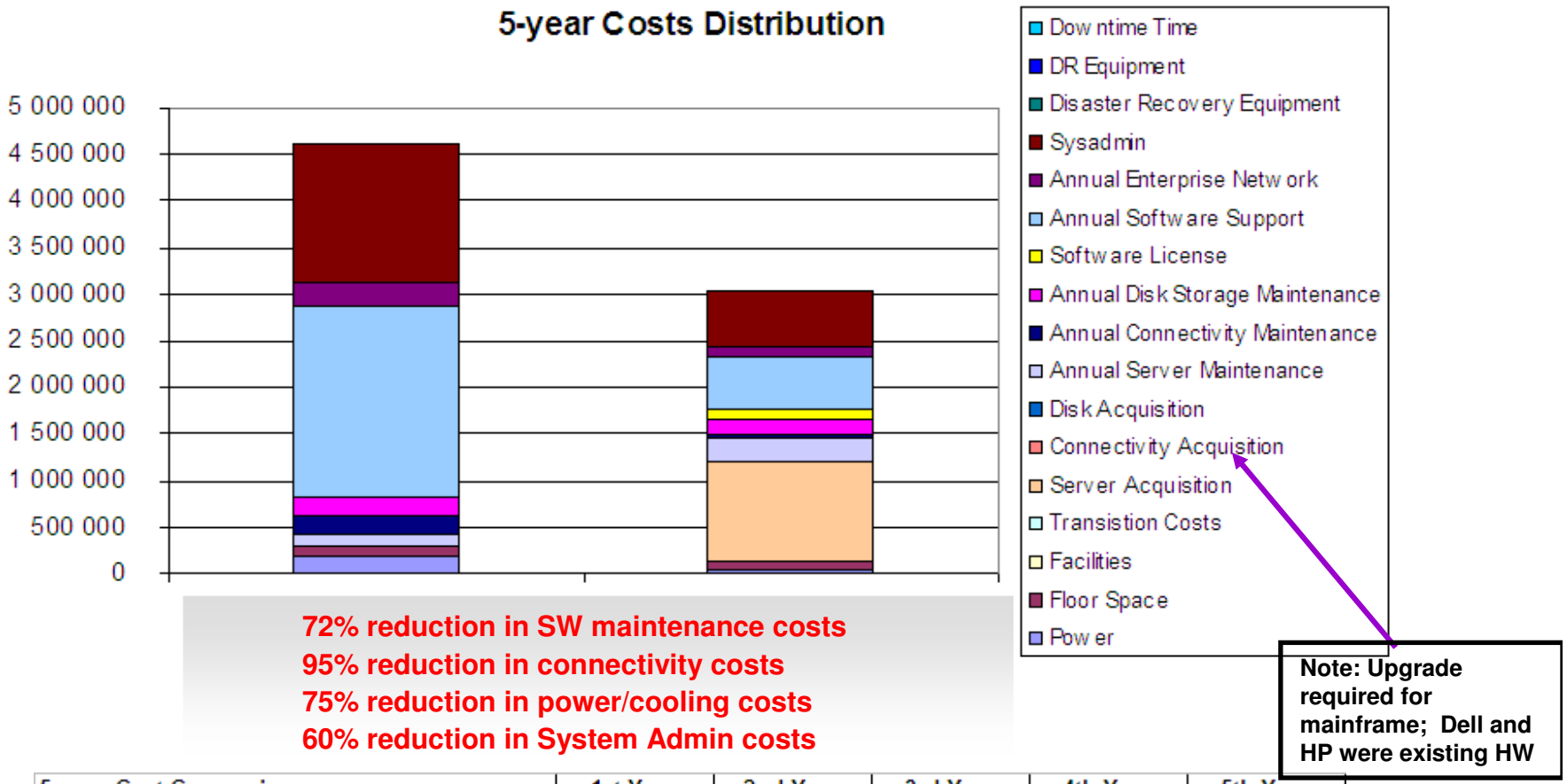
Potential cost savings projections below are based on modeling a US Financial Institution's current state data for their Oracle DB environment running on x86/Linux vs. Linux on zEnterprise

Sizing	Current	AltCase1 9:1	Change
Server Type	Mixed - x86	**z196-ELS-1bk**	
Total Cores/ IFLs	352	6	-98%
Used Cores/ IFLs	352	6	-98%
Total Sockets/ IFLs	153	6	-96%
#Logical Servers	53	53	0%
#Physical Servers (or #IFLs)	51	6.00	-88%
Total RIP Capacity(installed)	275,129	27,464.6	-90%
Total RIP Workload(used)	22,233	22,233.1	0%
Ave %Utilization	8%	81%	
Estimate # Network Ports	103	4	
Annual Operating Costs (AOC)			
Software M&S	$1,226,324	$113,424	-91%
Hardware Maint*	$0	$0	0%
Space	$4,297	$1,543	-64%
Electric	$49,901	$21,574	-57%
Staff Cost	$90,167	$54,512	-40%
Depreciation**	$140,525	$144,309	3%
Total AOC	**$1,511,214**	**$335,362**	**-78%**
Est Potential Savings /Yr		$1,175,852	
5 Year Projection			
OTC + 5x AOC	**$7,556,070**	**$1,676,809**	
5 Yr Savings		$5,879,261	



(1) Notes:
- Existing server utilization based on customers reported distributed server utilization rates
- Financial results based on 5 year depreciation mode l and include IBM System z ELS bundle (including HW, HW maintenance and virtualization software costs)
- RIP = Relative Indicator of Performance (across platform) and is based upon 3rd party and IBM observed performance analysis

Large Bank Saves $1.5M with Oracle on System z vs. 45 Oracle x86 Servers



72% reduction in SW maintenance costs
95% reduction in connectivity costs
75% reduction in power/cooling costs
60% reduction in System Admin costs

Note: Upgrade required for mainframe; Dell and HP were existing HW

5-year Cost Comparison	1st Year	2nd Year	3rd Year	4th Year	5th Year
x86	923 625	1 847 250	2 770 874	3 694 499	4 618 124
System z	1 482 559	1 871 822	2 261 085	2 650 348	3 039 611
Delta	558 934	24 572	-509 789	-1 044 151	-1 578 513

Prices are in USD. Prices may vary in other countries.

details on next chart

Large Bank Saves $1.5M with Oracle on System z, Reduces Space and Energy Requirements **(Details for Previous Chart)**

	FROM…	TO…
Current hardware infrastructure	45 x86 (HP + Dell)	IBM System z10 Enterprise Class (z10™ EC)
Footprints	45	1
Cores	111	4 IFLs
Avg utilization	Less than 10%	60%
Peak utilization	35%	85%
# DBs, size of DB	111 Oracle DB	111 Oracle DB
Application	Oracle 10G databases	Oracle 10G databases
OS	Linux	Linux + z/VM
Energy usage		75% less
Floor Space usage		28% less
TCO: 5 years	$4.62M	$3.04M / savings: $1.58M

Summary of Benefits:

- 111-to-4 core reduction, 45:1 footprint reduction
- Up to 72% software maintenance cost reduction
- Improved application reliability, and efficient Disaster Recovery capabilities

Prices are in USD. Prices may vary in other countries.

Financial Client Consolidates 61 Sun and HP Servers to System z10 and Saves 96% on Power and Cooling

	FROM…	TO…
Current hardware infrastructure	Sun and HP servers	z10 EC™
Footprints	61	1
Cores/Memory	442 cores / 1440 GB	16 IFLs / 82GB
Avg Utilization	13.3%	40%
Peak Utilization	28.7%	92%
# DBs, size of DB	61	61
Application	Oracle databases	Oracle databases
OS	Sun Solaris, HP-UX, Linux	Linux
Savings: Power & cooling (Whr) Heat (BTUs/hr)	 345,618 Whr 737,030 BTUs/hr	 14,766 Whr - 96% 39,648 BTUs/hr - 95%

Summary of Benefits: Software savings, energy requirements reduced, better utilization

Questions for Oracle Database consolidation

General questions:

- Are you using more than 10 Oracle DB x86 servers?
- Is your department considering or complying with mandates to use open source software to help lower software licensing costs?
- Are you having difficulty meeting peak time demand and SLAs?
- Do you need higher levels of uptime for your customers?
- Would you like to increase the productivity of your IT staff and enable them to manage even more server images?
- Would you like to take advantage of many reliability and systems management best practices that do not exist on distributed systems platforms?

CIOs:

- What are you planning to do to reduce rising Oracle licensing costs?
- Are you aware that server consolidation can significantly reduce both hardware and software licensing costs?
- Can you support business needs for rapid change?
- How much cost and time does your organization spend on manual processes?
- Are you concerned about data centre growth in terms of space and

Information Sources

- http://www.oracle.com/ibm
  - Oracle IBM Partner Relationship
- http://otn.oracle.com
  - Oracle Select “Downloads”
- http://www.vm.ibm.com/perf/tips
  - General z/VM Performance & Tuning Tips, Capacity planning
- https://support.oracle.com
  - Oracle Support Webpage (My Oracle Support)
- http://www-124.ibm.com/developerworks/oss/linux390/index.shtml
  - Lot’s of information on Linux for zSeries, IBM DeveloperWorks
- http://www-128.ibm.com/developerworks/linux/linux390/perf/index.html
  - Hints and Tips for tuning Linux on System z
- http://www.zseriesoraclesig.org
  - Special Interest Group of Oracle users on the mainframe (z/OS and Linux)
- http://www.mail-archive.com/linux-390%40vm.marist.edu/
  - Marist List Server
- http://www.ibm.com/redbooks
  - SG24-6482-00 Experiences with Oracle Database 10g on Linux for zSeries
  - SG24-7191-00 Experiences with Oracle 10gR2 Solutions on Linux for System z
  - SG24-7573-00 Using Oracle Solutions on Linux on System z
  - SG24-7634-00 Experiences with Oracle Solutions on Linux for IBM System z