

# PowerVM virtualization features overview

Version 1.0

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#### Agenda

- Disk virtualization
  - VSCSI
  - NPIV
  - Shared Storage Pool
  - Tuning
- Network virtualization
  - Shared Ethernet Adapter
  - SR-IOV
  - VNIC
- DPO



#### VSCSI overview



Vendor SAN storage associated with the FC adapter port is managed by the VIOS.

Disk drivers are installed at VIOS level.

Each SAN disk is individually mapped on a client partition.

Client partition use standard MPIO driver.



#### VSCSI dual vio servers configuration



Standard availability solution.

Failover mode only.

This configuration allows vendor disk driver updates without outage at partition level.

Drivers updates are performed only at VIOS Level.



### VSCSI performance: Power8 Switzerland customer example



Some customers was expecting lower performance with vscsi. It's wrong. Fully virtualized network sustains 800MB/s during backups. Virtual SCSI adapters are regularly reaching 3 GB/s.

## VSCSI: too many disks at vios level(customer example)

🌀 Grafana - pbvio1 nm 🗴 **alata** | - | - | - 2 C Docalhost: 3000/dashboard/db/pbyio1-nmon-report?panel/d=8&fullscreen&edit ☆ 🔿 🗉 9 pbvio1 nmon report \_ 🖹 🇳 < C ④ Aug 12, 2015 11:13:03 to Aug 12, 2015 12:12:06 ▼ Dashboards DISKWRITE Data Sources Main Ord ÷ Grafana admin 2015-08-12 11:26:0 Sign out nower 3 - power104 - power105 - power106 - power107 - power108 — power0 — power1 — power10 — power100 — power101 power109 - power11 - power110 - power111 - power112 - power113 - power114 - power115 power116 — power117 — power118 — power119 — power1 ver121 — nower122 power123 - power124 - power125 - power126 - power127 - power128 - power129 - power133 - power130 - power131 - power132 — nower133 — nower134 — nower135 — nower136 — nower1 wer139 nower14 power140 - power141 - power142 - power143 - power144 - power145 - power146 - power147 - power148 - power149 - power15 nower10: — power150 — power151 — power152 — power153 — power ver156 nower157 nower158 nower16 nower160 \_\_\_\_\_\_power161 \_\_\_\_\_power162 \_\_\_\_\_power163 \_\_\_\_\_power164 \_\_\_\_power165 \_\_\_\_\_power166 \_\_\_\_\_power166 — power168 — power169 - power170 - power1 /er173 nower178 — power179 — power188 — power180 — power181 — power182 — power183 — power184 ower108 power185 — power186 power187 power188 power195 — power196 — power197 — power198 — power199 — power2 — power20 — power200 — power201 — nower202 — nower203 power204 — power205 power212 - power213 - power214 - power215 - power216 - power217 - power218 - power219 - nower2 nower21 nower210 nower211 power221 — power222 — power2 - power229 - power233 - power230 - power231 - power232 - power233 - power234 - power235 - power236 — power22 — power220 ver225 \_\_\_\_\_\_nower226 nower227 - nower228 power24 ver242 — power243 — power244 — power245 — power246 — power247 — power248 — power249 — power250 — power250 — power251 — power252 — power253 nower237 Mer239 power257 power263 - power264 - power265 - power266 - power267 - power268 - power269 - power277 - power270 – nower274 power281 power282 — power283 — power284 nower285 — nower286 nower287 — nower271 — power302 — power303 — power304 — power305 power298 nower299 — power3 — power30 — power300 — power301 power313 — power314 — power315 — power316 — power317 — power318 — power319 — power32 — power320 — power321 — power322 – nower306 — nower309 /er311 nower312 nower326 wer329 — nower333 — nower330 — nower331 — nower332 — nower333 — nower334 — nower335 — nower336 — nower337 — nower338 — nower339 nower34 — nower323 — nower324 nower325 wer346 — power347 — power348 — power349 — power355 — power350 — power351 — power352 — power353 — power354 — power355 — power356 — power357 power364 - power365 - power366 - power367 - power368 - power369 - power377 - power370 — power372 wer12 — nower384 — nower386 nower387 – nower388 nower39 — nower375 nower378 wer398 - power399 - power404 - power400 - power400 - power401 - power402 - power403 - power404 - power405 - power406 — nower408 nower392 — nower395 nower407 nower412 ver415 — power416 — power417 — power418 — power419 — power42 — power420 — power421 — power422 — power423 — power424 — nower41 power426 ower13 er432 — nower433 nower434 — nower435 — nower436 power443 nower437 — nower/138 nower444 — power452 — power453 — power454 — power455 — power456 — power457 — power459 — power460 ower13 power135 – nower461 — power470 — power471 — power472 — power473 — power474 — power475 — nower476 — nower478 nower462 nower463 nower464 nower47 nower477 — power479 — power48 — power480 — power487 power490 — power491 — power492 — power493 — power494 — power495 nower496 power497 power498 power499 power5 - power50 - power500 nower48 power49

It's the main "issue" we see with vscsi. Disk management doesn't need to be difficult on Power. In this, example : 100+ partitions using vscsi. 600+ luns => Very difficult for system management, boot time, performance analysis or problem determination.



# performance: disk metrics



IO performance analysis needs to correlate multiple metrics from the same disk. Work become harder when you have thousands of disks.

![](_page_7_Picture_0.jpeg)

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  - NPIV
  - Shared Storage Pool
  - Tuning
- Network virtualization
  - Shared Ethernet Adapter
  - SR-IOV
  - VNIC
- DPO

![](_page_8_Picture_0.jpeg)

#### NPIV overview

![](_page_8_Figure_2.jpeg)

NPIV: N\_Port ID Virtualization.

It's a Fibre Channel hardware feature. Multiple Fibre Channel node port IDs can share a single physical N\_Port.

Each client partition has dedicated wwpns.

Disk drivers are installed at lpar level.

Load balancing available at lpar level.

Easiest virtualization solution for lan free backup.

![](_page_9_Picture_0.jpeg)

### NPIV dual vio servers configuration

![](_page_9_Figure_2.jpeg)

Load balancing at partition level.

Most common setup is 4 paths.

Disk drivers are installed at vios level.

![](_page_10_Picture_0.jpeg)

# NPIV load balancing

![](_page_10_Figure_2.jpeg)

![](_page_11_Picture_0.jpeg)

### **NPIV and Live Partition Mobility**

![](_page_11_Figure_2.jpeg)

Each virtual fibre channel adapter has 2 wwpns. Only one is active at one time. When LPM operation is performed, the partition will switch to use the inactive wwpn on the destination system. It will keep using it after the operation.

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![](_page_12_Picture_0.jpeg)

#### NPIV and Live Partition Mobility: SAN disk level validation

Before VIOS 2.2.4(Dec 2015), LPM validation was only validating if the inactive wwpn was able to connect on the same storage port than the active wwpn on each virtual fibre channel adapter.

If host mapping was not exactly the same for the inactive wwpn, problems arise.

If it's not possible to ensure the zoning and mapping recommendations are applied, use disk level validation. The validation will take more time but will ensure all disks are visible on the target system. It need to be enabled on all source vios :

chdev -dev vioslpm0 -attr src\_lun\_val=on

A good description of this feature is available here: disk-level-validation-for-lpm-of-npiv-lpar-2

![](_page_13_Picture_0.jpeg)

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### Shared storage pool overview

![](_page_14_Figure_2.jpeg)

A shared storage pool is a shared filesystem.

Logical Units are files in this filesystem.

This files are mapped through vscsi on client lpars.

Client Ipars manage them like standard MPIO disks.

Vendor disk drivers are installed at VIOS level.

VIOS are in cluster.

Cluster Aware AIX infrastructure is used, like in PowerHA. IP network is important in the cluster.

# Shared storage pool failure group

![](_page_15_Figure_2.jpeg)

Failure groups was introduced to provide mirroring feature to SSP.

Allow to mirror data between physical storages.

It's **not** disk to disk replication.

Easy setup.

![](_page_16_Picture_0.jpeg)

## Shared storage tiering

![](_page_16_Figure_2.jpeg)

Tiering was the most wanted feature.

Allow to dedicate disks to workload.

Easy data migration between tiers.

Compatible with failure groups.

Available in VIOS 2.2.4.10 and later.

![](_page_17_Picture_0.jpeg)

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![](_page_18_Picture_0.jpeg)

## Disk queue depth and FC adapter number of command elements

- The disk queue\_depth parameter define the number of slots available for in-flight IOs the disk can have at one moment.
   One in-flight IO is an IO request initiated to the storage which is still not completed.
   When the IO is completed, the slot in the queue is freed.
- If the queue is full, new IOs are put on the wait queue until a slot is freed.
   => performance impact.
- Allowable values for **queue\_depth** range from 1 to 256. Review with the storage vendor the recommended/supported value.
- Similarly a FC adapter has a queue for in-flight IOs. The number of slots is defined by **num\_cmd\_elems**.

![](_page_19_Picture_0.jpeg)

# Disk queue depth tuning

• Review the queue usage with iostat:

```
# iostat -D hdisk2 2 2
System configuration: lcpu=8 drives=13 paths=43 vdisks=22
           xfer: %tm act
hdisk2
                           bps
                                  tps
                                        bread
                                                bwrtn
                          0.0
                                 0.0
              0.0
                    0.0
                                        0.0
         read: rps avgserv minserv maxserv timeouts
                                                        fails
                    0.0
                          0.0
              0.0
                                0.0
                                                0
                                         0
        write: wps avgserv minserv maxserv
                                                         fails
                                              timeouts
              0.0 0.0 0.0
                                0.0
                                         0
                                                0
        queue: avgtime mintime maxtime avgwqsz avgsqsz
                                                            sqfull
                    0.0
              0.0
                          0.0
                                0.0
                                        0.0
                                               0.0
```

Look at :

• avgwqsz:

average size of wait queue size. It needs to be 0 for best performance.

• avgsqsz:

average service queue size. Allows you to see how many in-flights IOs are ongoing on the disk.

• sqfull:

Indicates the number of times the queue was full per second.

If possible, keep the default queue depth value used by your storage provider drivers and add disks. But keep a low number of disks if possible. Need to balance both requirements. It simplify performance problem troubleshooting.

![](_page_20_Picture_0.jpeg)

## Number of disks by FC adapter

• For best performance, you can apply this formula :

FC adapter number of command elements disk queue depth

It will give you a maximum number of disks you can assign without never overloading the physical adapter.

It's a conservative value.

• If your storage driver support load balancing the formula become:

 $number of \ FC \ adapters*(\frac{FC \ adapter \ number \ of \ command \ elements}{disk \ queue \ depth})$ 

![](_page_21_Picture_0.jpeg)

### Reference document : AIX/VIOS Disk and Adapter queue tuning

We cannot cover the full topic on queue tuning in this presentation.

For more informations and deeper technical details, read this document : AIX/VIOS Disk and Adapter queue tuning

IBM Americas Advanced Technical Skills

**AIX/VIOS Disk and Adapter IO Queue Tuning** 

**Dan Braden** 

IBM AIX Advanced Technical Skills

![](_page_22_Picture_0.jpeg)

## Vio servers rules 1/2

- Rules was introduced in VIOS 2.2.4.
- It allow to change default and current values for devices for better performance and availability.
- For example, rules related to fscsi set dynamic tracking and fast fail over:

padmin# rules -o list|grep fscsi

driver/iocb/efscsi	dyntrk	yes
driver/iocb/efscsi	fc_err_recov	fast_fail
driver/qliocb/qlfscsi	dyntrk	yes
driver/qliocb/qlfscsi	fc_err_recov	fast_fail
driver/qiocb/qfscsi	dyntrk	yes
driver/qiocb/qfscsi	fc_err_recov	fast_fail

 For example, it will set num\_cmd\_elems and max\_transfer\_size based on the physical adapter capabilities: padmin# rules -o list

adapter/pciex/df1060e21410410	max_xfer_size	0x400000
adapter/pciex/df1060e21410410	num_cmd_elems	4096
adapter/pci/df1080f9	max_xfer_size	0x400000
adapter/pci/df1080f9	num_cmd_elems	2048

![](_page_23_Picture_0.jpeg)

### Vio servers rules 2/2

- Applying default rules: rulescfgset
- Changing a default rule for a specific device: rules -o modify -l hdisk0 -a reserve\_policy=single\_path
- View differences between default rules and current settings: padmin# rules -o diff -s -d devParam.disk.fcp.mpioosdisk:reserve\_policy device=disk/fcp/mpioosdisk
   single\_path | no\_reserve
   single\_path | no\_reserve
   fail\_over | round\_robin
   devParam.adapter.pseudo.ibm\_ech:hash\_mode device=adapter/pseudo/ibm\_ech
   devParam.adapter.pciex.df1000fe:num\_cmd\_elems device=adapter/pciex/df1000fe
   devParam.adapter.pciex.df1000fe:max\_xfer\_size device=adapter/pciex/df1000fe
   dev0000 | 0x400000
   dev0000
   dev00000
   dev000
- Rules man page is very well documented and explain all the capabilities.

Rules are still new and don't cover all devices and settings but it's already a great improvement and simplify a lot the vio server tuning configuration.

![](_page_24_Picture_0.jpeg)

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![](_page_25_Picture_0.jpeg)

#### SEA FAILOVER

![](_page_25_Figure_2.jpeg)

Great improvement in shared ethernet adapter configuration in firmware 780: The control channel is automatically managed.

![](_page_26_Picture_0.jpeg)

#### SEA LOAD SHARING

![](_page_26_Figure_2.jpeg)

Most popular SEA configuration when multiple vlans are used.

![](_page_27_Picture_0.jpeg)

#### virtual adapter network buffer tuning

Change default virtual buffers values :

chdev -dev <VENT> -attr max\_buf\_huge=128 -perm
chdev -dev <VENT> -attr min\_buf\_huge=128 -perm

chdev -l <VENT> -a max\_buf\_large=128 -perm
chdev -dev <VENT> -attr min\_buf\_large=128 -perm

chdev -dev <VENT> -attr max\_buf\_medium=512 -perm
chdev -dev <VENT> -attr min\_buf\_medium=512 -perm

chdev -dev <VENT> -attr max\_buf\_small=4096 -perm
chdev -dev <VENT> -attr min\_buf\_small=4096 -perm

chdev -dev <VENT> -attr max\_buf\_tiny=4096 -perm
chdev -dev <VENT> -attr min\_buf\_tiny=4096 -perm

In a high network activity environment, you can set buffer values to maximum. This operation cannot be performed adapter online. Need to be done on vio servers and client partitions.

![](_page_28_Picture_0.jpeg)

#### Enabling TCP Segmentation offload and aggregation

#### **Virtual I/O Server configuration**

- largesend on SEA: enable TCP segmentation offload on emitted packets chdev -dev <SEA> -attr largesend=1
- large\_receive on SEA : enable TCP receive segment aggregation chdev -dev <SEA> -attr large\_receive=yes
- Already enabled by default on physical adapter

#### LPAR configuration

 mtu\_bypass on VETH : enable TCP segmentation offload chdev -l <enX> -a mtu\_bypass=on

![](_page_29_Picture_0.jpeg)

#### lsseas

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SEA : ha_mode state	ent18	anters	Sharing BACKUP_SI	H												
hecome	hackin	n/nrimary:	1/0													
priorit	V		2													
vlans flags			13 1662 THREAD	1666 16 LARGE SE	70 1674 10 ND LARGE	78 12 16 RECEIVE	63 1667 ACCOUN	1671 1 TING	675 1679	11 1664 1668	1672	1676 1680 10	1665 1669 10	673 1677 1684		
+						+										
ETHERC adapt er	phys.	_adapt ers			node	hash_m	ode	ju∎bo								
ent16 REAL A	ent 2	, ent 3, ent 6	, ent 7		8023ad	src_dst	_port	no								
adapt er	slot	hardware_	pat h		link	selected	_speed		running_s	peed	actor	_system	actor_sync	partner_system	partner_port	partner_sync
ent 2	(4	U2C4E.001	.DBJN914-	P2-C4-T3	Up	1000_Mbp	s_Full_	Duplex	1000_Mbps	Full_Duplex	6C-AE	-88-69-5E-2A	IN_SYNC	00-23-04-EE-BF-90	Øx231A	IN_SYNC
ent 3	C4	U2C4E.001	DBJN914-	P2-C4-T4	Up	1000 Mbp	s_Full	Duplex	1000 Hbps	Full Duplex	6C-AE	-88-69-5E-2A	IN_SYNC	00-23-04-EE-BF-90	Øx2318	IN_SYNC
ent 6	C4	U2C4E.001	.0830038-	P2-C4-T3	Up	1000 Mbp	s_Full	Duplex	1000_Hbps	Full_Duplex	6C-AE	-88-69-5E-2A	IN_SYNC	00-23-04-EE-BF-90	0x231C	IN_SYNC
ent 7	(4	U2C4E,001	.0830038-	P2-C4-T4	Up	1000_Mbp	s_Full_	Duplex	1000_Hbps	Full_Duplex	6C-AE	-88-69-5E-2A	IN_SYNC	00-23-04-EE-BF-90	0x231F	OUT_OF_SYNC
VIRTUA	L ADA	PTERS														
adapt er	slot	hardware	path		prior	ity acti	ve port	_vlan_i	d vswitcl	h no	de	vlan_tags_id	s			
ent 8	(10	U9117.MHD	.65ED82C-	V2-C10-T	1 2	Fals	e 10		vdcb	VE	в	1665, 1669, 16	73, 1677, 1684			
ent 9	C11	U9117.MMD	. 65ED82C-	V2-C11-T	1 2	Fals	e 11		vdcb	VE	В	1664, 1668, 16	72.1676.1680			
ent10	C12	U9117.MMD	.65ED82C-	V2-C12-T	1 2	True	12		vdcb	VE	в	1663, 1667, 16	71,1675,1679			
ent 11	(13	U9117.MMD	.65ED82C-	V2-C13-T	1 2	True	13		vdcb	VE	в	1662,1666,16	70,1674,1678			
CONTRO	L CHAI	INEL														
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ent12	C14	U9117.MHD	. 65ED82C-	V2-C14-T	1 99		vdcb									

![](_page_30_Picture_0.jpeg)

#### lsseas

# download site : https://github.com/chmod666org/lsseas

chmod666org / Iss	eas		O Unwatch ▼ 7	★ Star 5 🖇 Fork 1		
List informations and details	about PowerVM Shared	Ethernet Adapters				
🕝 10 commits	<b>₽ 1</b> branch	🟷 0 releases	ਜ਼ਿੰਦੇ <b>2</b> contributors	<> Code		
Branch: master -	eas / +		:=	() Issues 0		
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Chmod666org authored on Aug	6		latest commit a7091dd8f8 🔂	🗐 Wiki		
🖹 Isseas		Merge error	a month ago	de Pulse		
sea_auto_backup.PNG		Screenshots	7 months ago			
sea_auto_primary.PNG		Screenshots	7 months ago	jo di Graphs		
sea_no_ha_mode.PNG		Screenshots	7 months ago	HTTPS clone URL		
sea_sharing_control_channel_	ec.PNG	Screenshots	7 months ago	https://github.cc 🛃		
sea_sharing_control_channel_	no_ec.PNG	Screenshots	7 months ago	You can clone with HTTPS, SSH, or Subversion <b>(9</b> )		
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![](_page_31_Picture_0.jpeg)

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![](_page_32_Picture_0.jpeg)

#### **SR-IOV** overview

![](_page_32_Figure_2.jpeg)

#### **Single Root I/O Virtualization. PCIe standard.** Share physical port between multiple partitions.

Live Partition Mobility not supported.

ikr

#### SR-IOV and virtual ethernet great presentations

Alexander Paul	
paulalex@de.ibm.com	
Power Systems Engineer / Unix Performance	

IBM

# 10 Gigabit Ethernet Virtualization and Performance Update for AIX

2015 IBM Power Systems & System Storage Technical University 26-30 October | Cannes, France

![](_page_33_Picture_6.jpeg)

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#### PowerVM Single Root I/O Virtualization Fundamentals, Design and Configuration

2015 IBM Power Systems & System Storage Technical University 26-30 October | Cannes, France

![](_page_33_Picture_11.jpeg)

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![](_page_34_Picture_0.jpeg)

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![](_page_35_Picture_0.jpeg)

#### **VNIC** overview

![](_page_35_Figure_2.jpeg)

**Dedicated VNIC** allows Live Partition Mobility. It's a new kind of virtual adapters.

![](_page_36_Picture_0.jpeg)

#### VNIC

![](_page_36_Figure_2.jpeg)

VNIC configuration can become complex when each partition needs multiple vlan. In this example, for 2 vlans, you have 6 network adapters on your client partition.

![](_page_37_Picture_0.jpeg)

#### VNIC + SEA configuration(customer implementation)

![](_page_37_Figure_2.jpeg)

Here VNIC adapters are only used for a partition requesting a high performance level. SR-IOV is used to create SEA used by other partitions. **Note**: only one logical port with promiscuous mode by physical port. Mandatory for SEA.

![](_page_38_Picture_0.jpeg)

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![](_page_39_Picture_0.jpeg)

#### Dynamic Platform Optimizer (DPO)

- Optimizer is launched via HMC command-line interface
- DPO re-assigns memory and cores to partitions in order to attain better placement affinity
- Requested/protected partition lists
  - Sets of partitions can be prioritized or protected (untouched) by the DPO operation
  - DPO should NEVER be used to fix running LPARs that are not "DPO aware"
  - Use -xid to exclude running LPARs that are not "DPO aware" (AIX < 6.1.8 or 7.1.2)
  - use -- id to list "DPO aware" LPARs
- Notion of current and potential "affinity score"
  - Enables system administrator to make decisions about value of running optimizer

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#### DPO Effectiveness (P7+ 2Node 9117-MMD)

#### **3 IDLE Partitions Affinitized in 3 minutes**

- 15.5 GBs moved
- Total Memory for all 3 partitions involved in DPO operation = 28GB

#### BEFORE

![](_page_40_Figure_6.jpeg)

**AFTER** 

![](_page_41_Picture_0.jpeg)

#### DPO Command Reference

#### //show current system score

# lsmemopt -m <sysname> -o currscore
curr\_sys\_score=76

#### //project score if DPO is executed

# lsmemopt -m <sysname> -o calcscore
curr\_sys\_score=76,predicted\_sys\_score=86,requested\_lpar\_ids=none, protected\_lpar\_ids=none

#### //execute DPO on all partitions

# optmem -m <sysname> -t affinity -o start

#### //execute DPO on all partitions, lpar ID3 has highest priority

# optmem -m <sysname> -t affinity -o start -id 3

#### //execute DPO on all partitions, except lpar IDs 3 4 and 5

# optmem -m <sysname> -t affinity -o start -xid 3,4,5

#### //show progress

# lsmemopt -m <sysname> opt\_id=3,in\_progress=1,status=In progress,type=affinity, progress=47, requested\_lpar\_ids=none,protected\_lpar\_ids=none,impacted\_lpar\_ids=none

#### //abort DPO

# optmem -m <sysname> -o stop

![](_page_42_Picture_0.jpeg)

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