



# Using z/VM in a SCSI Environment

01/20/2005

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## Agenda

- Overview
- FBA Emulation
- C SCSI Driver Stack
- System Structure
- Configuration Elements
- Commands
- Configuration File Statement
- HCD
- Install
- Software/Firmware Requirements
- IPL
- Dump and Service
- Monitor Records
- Performance
- Trademarks



## Overview

- VM provides native support for SCSI disks for paging, spooling, and other system data
- Support is provided by configuring SCSI disk LUNs to VM as 9336 FBA 512-byte block DASD
- VM guests (such as CMS, GCS, and VSE) may keep data on SCSI disk LUNs without requiring the guest software to have SCSI disk drivers
- IPL, Dump, and Service from/to SCSI disk LUNs is provided to achieve a SCSI-only VM environment
- SCSI-only as well as mixed SCSI and ECKD environments are supported
- Available with z/VM 5.1.0 (9/2004)

## FBA Emulation

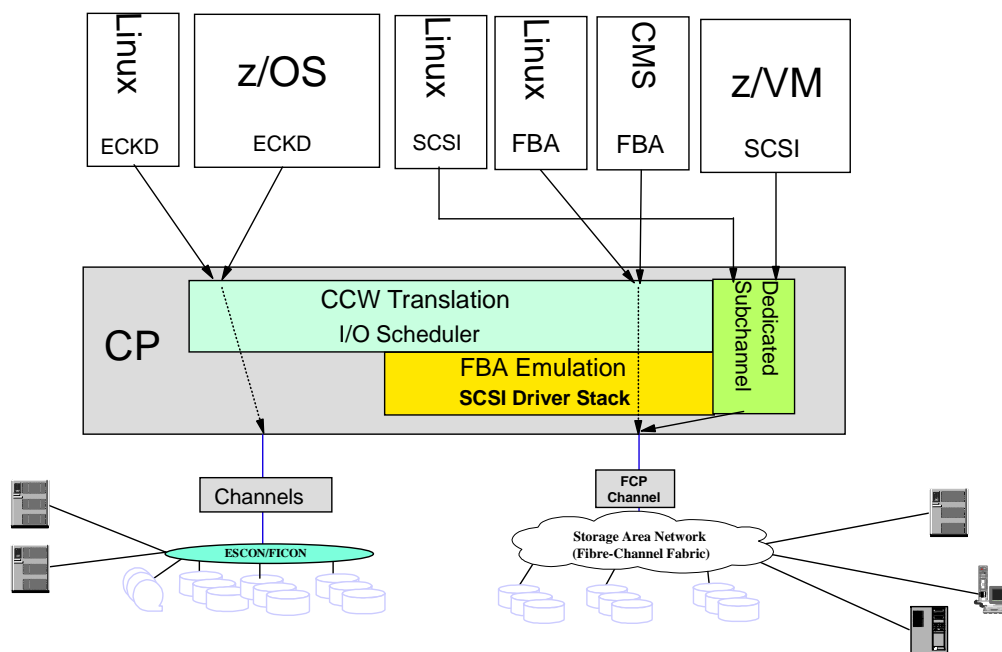
- SCSI Disks are emulated as 9336 Model 20 FBA DASD
- FBA Emulation is used to reduce effort in supporting SCSI disks as well as allowing any operating system or application that supports a 9336 to utilize SCSI disks without change
- Emulated 9336 disk sizes supported are:
  - ▶ 1TB for CP with APAR VM63534
    - ✓ Exception: CP PAGE, SPOL, and DRCT allocations must remain below the 64GB mark on a CP formatted volume since internal addressing of these slots is limited to  $2^{24}$  4K pages.
  - ▶ 381GB for CMS/GCS
    - ✓ This includes software functions dependent on CMS functions such as DIRMAINT MOVE, COPY, ERASE and DFSMS MOVE, COPY, CHECK.
- VM officially supports IBM TotalStorage 2105 and 2107 (DS8000) SCSI disks as emulated 9336 DASD. However, other SCSI disks may also work since a generic SCSI driver is provided in addition to the TotalStorage drivers.
  - ▶ VM63534 is required for 2107 (DS8000) support

- ▶ Supported 1TB disk is 2,147,483,640 512-byte blocks.
- ▶ Supported 381GB disk is 799,999,992 512-byte blocks.
- ▶ Page 16,777,215 is the last allowed page for PAGE, SPOL, and DRCT allocations.
- ▶ Allocations PERM, TDSK, and PARM may be placed above page 16,777,215.
- ▶ The 2105 and 2107 drivers are specifically tuned for these TotalStorage disks.
- ▶ The generic SCSI driver may work with other disk hardware if the hardware doesn't require a device dependent driver.

## C SCSI Driver Stack

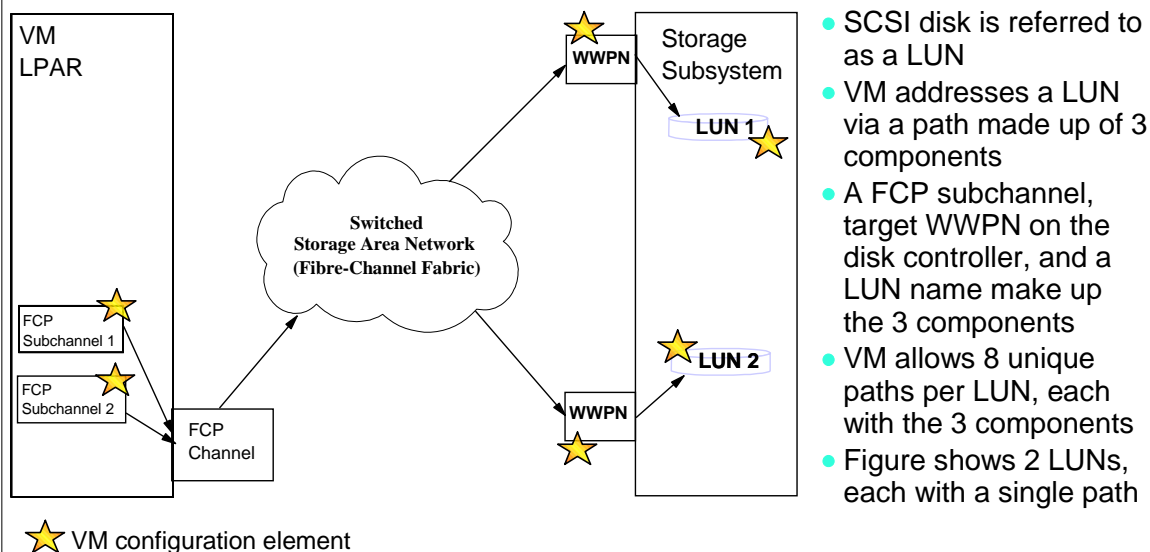
- A SCSI driver stack written in the C programming language has been coded to drive I/O to SCSI LUNs over FCP subchannels
- This is the first time for C in the CP Nucleus of VM. Therefore, C infrastructure (i.e., linkage and memory stack) has been added with this project. This will allow future CP projects to be written in C.
- This C SCSI driver stack exists in the real I/O layer of the CP component of VM (see next slide).
- An FBA channel program emulator intercepts real Start I/O (SSCH) requests from the real I/O dispatcher of VM and *transforms* these channel programs into API calls to the C SCSI driver stack
- Ending status from the C SCSI driver stack is in turn *transformed* into appropriate z/Architecture and FBA status to be returned to the originator of the FBA I/O request

## System Structure



- ▶ Dedicated FCP subchannel support in z/VM 4.3.0 and up is used to run second-level guests that contain native support for SCSI disks
- ▶ This includes z/VM 5.1.0 and z/Linux

## Configuration Elements



- ▶ WWPN is World Wide Port Name
- ▶ WWPN is worldwide unique
- ▶ Only a Shared Switched Network is supported.
- ▶ Point-to-Point, Fibre-Channel Arbitrated Loop, and Virtual Switched Network FCP topologies are not supported.

## Commands

- New SET EDEVICE command provided to configure a SCSI disk LUN to the VM system as an emulated 9336 FBA DASD
- New QUERY EDEVICE command provided to obtain information related to SCSI disk LUNs defined to VM as emulated FBA DASD
- New DELETE EDEVICE command provided to remove a SCSI disk LUN from the VM system that has been previously defined as an emulated FBA DASD



## Commands ...

Privilege Class: B

```
>>-SET--EDEvice--rdev----->
>.-TYpe--FBA--ATTRibutes-.-2105-.-.-----| Paths |-.--><
|                                           |-2107-| '-.-ADD----.-PATH-| Paths |-'|
|                                           '-SCSI-'  '-DElete-'  |
'-CLEAR----->
```

**Paths:**

```
<-----<
|--FCP_DEV--nnnn--WWPN--wwwwwwwwwwwwwww--LUN--1111111111111111--|
```

**Note:** You can specify a maximum of 8 "paths" to the device.

Upcoming Support: TotalStorage 1750 (DS6000) support will be available when APAR VM63535 GAs

## Commands ...

### SET EDEVICE Tips:

- ▶ ATTRIBUTES keyword tells VM which SCSI driver to use
- ▶ FCP\_DEV is the real device number associated with an FCP subchannel that has connectivity to the LUN
- ▶ All 16 digits of the WWPN and LUN must be specified. Otherwise, the VM command parser will add leading zeros causing the path to be invalid. For example, LUN 5150 must be specified as 5150000000000000.
- ▶ An EDEVICE must be varied off-line to ADD, DEL, or CLEAR path information.
- ▶ An EDEVICE takes up a slot in VM's real device space. That is, there can't exist another real device with the same real device number.
- ▶ Once an EDEVICE is defined, it is managed on VM like a real 9336 FBA. CP commands such as VARY, ATTACH, and QUERY execute as if the emulated disk were a real FBA. This applies also to user directory and system configuration file statements.

## Commands ...

Privilege Class: B

```
                <-----<
>>-Query-EDEvice-.-.-rdev-----.-.-.-><
      | '-rdev1-rdev2-' '-DETAILS-' |
      '-ALL-----'
```

## Commands ...

### Query edevice responses

```
q edev 607  
EDEV 0607 TYPE FBA ATTRIBUTES 2105  
Ready;
```

```
q edev 607 details  
EDEV 0607 TYPE FBA ATTRIBUTES 2105  
PATHS:  
FCP_DEV: 8100 WWPN: 5005076300C604DA LUN: 5137000000000000  
FCP_DEV: 8200 WWPN: 5005076300C604DA LUN: 5137000000000000  
Ready;
```

## Commands ...

Privilege Class: B

```
>>--DELEte--EDEVice--.-rdev-----.---><  
      '-rdev1-rdev2-'
```

Note: An EDEVICE must be varied off-line to use the DELETE command.

## Configuration File Statement

New SYSTEM CONFIG file statement performing same function as SET EDEVICE command

```
>>-EDEVice--rdev---TYpe--FBA--ATTRibutes--.-2105-.--| Paths |--><
                                     |-2107-|
                                     '-SCSI-'

Paths:
<----->
|--FCP_DEV--nnnn--WWPN--wwwwwwwwwwwwwwww--LUN--1111111111111111--|
```

**Note:** You can specify a maximum of 8 "paths" to the device.

## HCD

HCM GUI interface to VM's HCD support will allow an EDEV to be created with up to 8 unique paths.

Define Device: <=> OS Configuration Parameters

Device Number: 8891      OS Config: CT1  
 Number of devices: 1      Type: VM  
 Type: FBASCSI      Description: TCFT

OK  
 Cancel  
 Help

Parameter	Value	Req	Description
ATTR	2105	<input checked="" type="checkbox"/>	Name of SCSI Device attribute set
FCPDEV	2A00	<input checked="" type="checkbox"/>	Associated FCP device
FCPDEV -2	2A01		Associated FCP device
FCPDEV -3			Associated FCP device
FCPDEV -4			Associated FCP device
FCPDEV -5			Associated FCP device
FCPDEV -6			Associated FCP device
FCPDEV -7			Associated FCP device
FCPDEV -8			Associated FCP device
WWPN	5005076300C204DA	<input checked="" type="checkbox"/>	World Wide Port Number
WWPN -2	5005076300CE04DA		World Wide Port Number
WWPN -3			World Wide Port Number
WWPN -4			World Wide Port Number

- ▶ VM HCD support can also be used to define emulated devices (EDEVs)
- ▶ HCM GUI takes input similar to SET EDEVICE command and EDEVICE configuration file statement

# HCD

## GUI continued

WWPN -5	<input type="text"/>		World Wide Port Number	<input type="button" value="?"/>	<input type="button" value="▲"/>
WWPN -6	<input type="text"/>		World Wide Port Number	<input type="button" value="?"/>	
WWPN -7	<input type="text"/>		World Wide Port Number	<input type="button" value="?"/>	
WWPN -8	<input type="text"/>		World Wide Port Number	<input type="button" value="?"/>	
LUN	<input type="text" value="E15E00030000C00"/>	<input checked="" type="checkbox"/>	Logical Unit Number	<input type="button" value="?"/>	
LUN -2	<input type="text" value="E15C00030000C00"/>		Logical Unit Number	<input type="button" value="?"/>	
LUN -3	<input type="text"/>		Logical Unit Number	<input type="button" value="?"/>	
LUN -4	<input type="text"/>		Logical Unit Number	<input type="button" value="?"/>	
LUN -5	<input type="text"/>		Logical Unit Number	<input type="button" value="?"/>	
LUN -6	<input type="text"/>		Logical Unit Number	<input type="button" value="?"/>	
LUN -7	<input type="text"/>		Logical Unit Number	<input type="button" value="?"/>	
LUN -8	<input type="text"/>		Logical Unit Number	<input type="button" value="?"/>	<input type="button" value="■"/>
OFFLINE	<input type="checkbox"/>		Device considered online or offline at IP.	<input type="button" value="?"/>	<input type="button" value="▼"/>

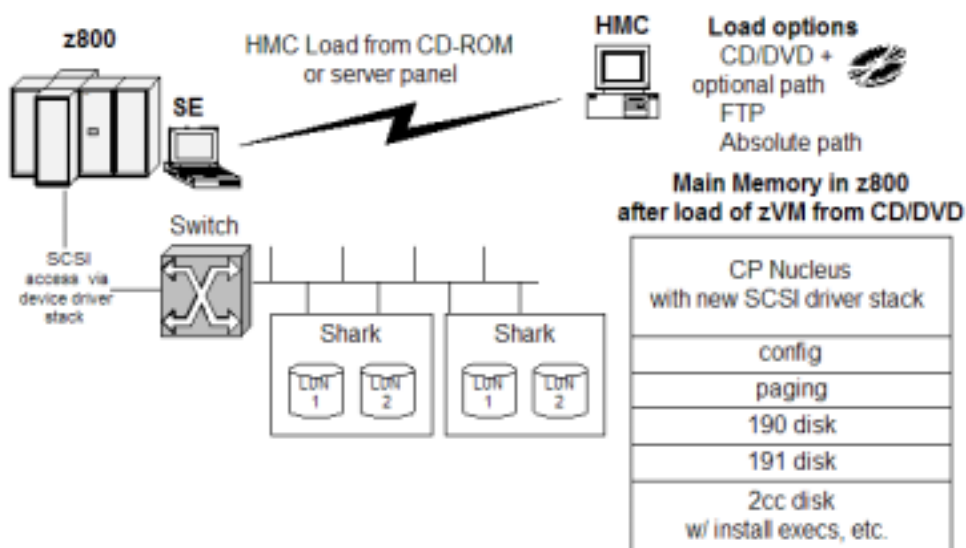


## Install

- For customers without a **non-SCSI** Enterprise tape drive (e.g., 3490 or 3590), install is done via DVD from the Hardware Management Console (HMC).
- HMC software with DVD Load and Integrated 3270 console support is required. A 512MB LPAR is also required.
- Install uses a special HMC hardware interface to bring in the VM starter system. The starter system uses a RAM disk to get itself and the install procedure started. Install writes the VM system and other files out to SCSI disk using FBA emulation (see next slide).
- SCSI install is done to 4 disks; 2 1GB LUNs and 2 3.5GB LUNs
- Install is business as usual for customers with an Enterprise tape drive
- Second-level install is also supported for customers without an Enterprise tape drive but requires electronic transfer (via FTP) of the install files to the first-level system. This transfer is done automatically from the install DVD by the installation utility.
- Install from DVD is also available for 3390 models 3 and 9. 2 install DVDs are available; 1 for SCSI, 1 for 3390.

- ▶ The VM starter system on the DVD can also be used as an emergency tool utility
- ▶ z/VM Guide for Automated Installation and Service provides details on the installation procedure
- ▶ In addition to an FTP server, second-level installs also require a 64MB virtual machine with class B thru G privileges

## Install ...



- ▶ VM starter system is brought up via the 'Load from CD-ROM or Server' panel on the HMC. This panel is found by double-clicking the 'Single Object Operations' icon on the CPC RECOVERY window.
- ▶ VM starter system automatically comes up on userid MAINT. It is on MAINT that the install execs are run.

## HMC SE Requirements

- The Hardware Management Console (HMC) must be communicating with the Support Element (SE). The HMC can only communicate with versions of the SE that are equal to or lower than the HMC. For example, HMC version 1.8.0 can communicate with a SE at version 1.7.3, or 1.8.0, but it can not communicate with a SE at version 1.8.2.
- The following minimum SE levels are required to install from DVD:
  - ✦ zSeries 800 - Support Element (SE) version 1.7.3, Engineering Change (EC) J11213, change level 146 or higher must be active.
  - ✦ zSeries 890 - Support Element (SE) version 1.8.2. No Licensed Internal Code changes are required.
  - ✦ zSeries 900 - Support Element (SE) version 1.7.3, Engineering Change (EC) J11213, change level 146 or higher must be active.
  - ✦ zSeries 990 - Support Element (SE) version 1.8.0, Engineering Change (EC) J12560, change level 054 or higher must be active. Or, Support Element (SE) version 1.8.2. No Licensed Internal Code changes are required.

## FCP Firmware Requirements

- The following zSeries driver levels and FCP channel code levels are the minimum required to run z/VM 5.1.0 with SCSI disks:
  - ▶ zSeries 800 - Driver D3G with FCP Code 0.28, MCL J11233 #014
  - ▶ zSeries 890 - Driver D55 with FCP Code 3.04, MCL J13471 #003
  - ▶ zSeries 900 - Driver D3G with FCP Code 0.28, MCL J11233 #014
  - ▶ zSeries 990 - Driver D52 with FCP Code 2.07, MCL J12951 #004 for *GA2 level z990*
  - ▶ zSeries 990 - Driver D55 with FCP Code 3.04, MCL J13471 #003 for *GA3 level z990*
- Driver changes require a POR. FCP code changes on z890 and z990 at Driver D55 are concurrent. Otherwise, CHPID must be recycled off to on.

## TotalStorage Server Firmware Requirements

- 2105 Model F - LIC EC Identification Number: 2.3.2.108,  
EC Level: SC40723
- 2105 Model 800 - LIC EC Identification Number: 2.4.1.58,  
EC Level: SC40908
- 2107 (DS8000) - (Base Level)

## IPL

- Once installed, VM can be IPLed from a SCSI LUN using the Load panel on the SE or HMC
  - ▶ Select SCSI radio button. Fill in FCP subchannel, WWPN, and LUN.
  - ▶ Boot Program Selector is 0 and Boot Record Logical Block Address is 00000000000000C8 (16 characters)
- Stand-Alone Program Loader (SAPL) continues to be the VM IPL interface
- SAPL contains its own generic, stripped down SCSI stack so that it can read the VM load module from disk into memory. Once SAPL passes control to VM, FBA emulation is used to do all SCSI I/O.
- VM IPL parameter PDVOL must be specified for a SCSI IPL. It indicates the EDEVICE number of the SYSRES. If not specified, the system stops with a wait state 6505. PDVOL can be entered on the SAPL screen (PDVOL=xxxx) or 'burned in' by the SALIPL utility.
- Second-level IPL of z/VM 5.1.0 from a SCSI LUN works via existing support that went into z/VM 4.4.0 for Linux Guest IPL from SCSI
  - ▶ Setup target WWPN, LUN, Boot Program Selector, and Boot Record Logical Block Address with CP SET LOADDEV command
  - ▶ IPL virtual address of FCP subchannel to kickoff the load

- ▶ HMC/SE Load Address field for first-level IPL is the FCP subchannel providing access to the SCSI LUN
- ▶ HMC/SE Load Parameter for first-level or second-level IPL is the console address for SAPL to use. Use 'SYSG' on a first-level IPL to designate the integrated 3270 console.
- ▶ Second-level IPL uses same Boot Program Selector and Boot Record Logical Block Address as a first-level IPL

## SALIPL

- The SALIPL utility continues to be used to setup SAPL for IPL.
- SALIPL now writes to blocks 5-207 if the device is a FBA (SCSI or not). SALIPL previously wrote to blocks 5-31. This affects the size of the RECOMP area for a CMS minidisk containing SAPL. It also affects the placement of allocations such as PAGE and SPOL when SAPL is put on a CP formatted volume.
- SALIPL must run in a virtual machine to setup a SCSI disk for IPL. SALIPL can be run against either:
  - ▶ A virtual device, such as a fullpack minidisk, on an emulated FBA DASD
  - ▶ A virtual FCP subchannel where new SALIPL parameters WWPN and LUN designate the target SCSI disk
- The SYSRES device and device containing the PARM area must be the same for a SCSI IPL. This isn't the case for an ECKD IPL.
- A second-level SCSI IPL can either be done by issuing the IPL command against a virtual FCP subchannel with access to the LUN or against a virtual device on an emulated FBA DASD. First-level IPLs are SCSI-only since FBA emulation doesn't exist on the hardware.

## Dump and Service

- Support has been added to take an ABEND dump (i.e., hard, soft, SNAPDUMP, VMDUMP) to a SCSI LUN. Stand-alone dump to SCSI is not supported.
- Dumps can be submitted to VM Level 2 electronically via FTP for customers without a **non-SCSI** Enterprise tape drive (e.g., 3490 or 3590)
- Dumps can be copied to tape via FBA emulation for customers with an Enterprise tape drive using existing tools such as the CMS TAPE command
- Service is obtained electronically, for example via the VM Service Update Facility (VMSUF), for customers without an Enterprise tape drive
- Service is applied by existing tools without change using FBA emulation (i.e., put service files on FBA emulated SCSI disk and run existing tools)
- Service is business as usual for customers with an Enterprise tape drive or 2074 CDROM

► z/VM Service Guide provides details on applying service



## Monitor Records

- **MRMTRDEV** (Device Configuration Data record in Monitor Domain)
  - ▶ Changed the reserved byte at the end of the record to a new flag byte called MTRDEV\_EDEVTYPE. This byte is a code associated with the type of SCSI device. For example, SCSI disk over FCP protocol. Also added the following information to the bottom of the record:
    - WWPN(s)
    - FCP subchannel(s)
    - LUN Address
    - Attribute Name
- **MRIODDEV** (Device Activity record in I/O Domain)
  - ▶ Added new flag byte called IODDEV\_EDEVTYPE at the end of the record. This byte is a code associated with the type of SCSI device. Added IODDEV\_RDEVDEV (real device number) to the end of the record. Previously, the record only contained RDEVSID (subchannel id) which isn't unique for SCSI devices. Adding RDEVDEV enables Monitor to uniquely identify the device.
- **MRIODVON** (Vary On Device record in I/O Domain)
  - ▶ Changed the reserved byte at the end of the record to a new flag byte called IODVON\_EDEVTYPE. This byte is a code associated with the type of SCSI device. Also added WWPN, FCP subchannel, and LUN path information.

- ▶ **\_EDEVTYPE** in all records has the same byte code definition.
- ▶ **RDEVSID** for an emulated device is inherited from one of the FCP subchannels defined on the SET EDEVICE command or EDEVICE configuration file statement.
- ▶ **WWPN**, **FCP subchannel**, and **LUN path** information in record **MRIODVON** is similar to the information in **MRMTRDEV**.

## Monitor Records

- **MRIODDTD** (Detach Device record in I/O Domain)
  - ▶ Added IODDTD\_RDEVDEV (real device number) to the end of the record so that Monitor can uniquely identify the device.
- **MRIOVVOF** (Vary Off Device record in I/O Domain)
  - ▶ Added IOVVOF\_RDEVDEV (real device number) to the end of the record so that Monitor can uniquely identify the device.
- **MRSTOASS** - (Auxiliary Shared Storage Management record in Storage Domain)
  - ▶ Added STOASS\_RDEVDEV (real device number) to the end of the record so that Monitor can uniquely identify the device.
- **MRSTOATC** - (Page/Spool Area of a CP Volume record in Storage Domain)
  - ▶ Added STOATC\_RDEVDEV (real device number) to the end of the record so that Monitor can uniquely identify the device.
- **MRMTRPAG** - (Paging Configuration Data record in Monitor Domain)
  - ▶ Added MTRPAG\_RDEVDEV (real device number) to the end of the record so that Monitor can uniquely identify the device.

- ▶ `_RDEVDEV` is the 'real' device number defined on the SET EDEVICE command or EDEVICE configuration file statement.
- ▶ It was only added to monitor records that did not already contain `_RDEVDEV`.

## Monitor Records

- **MRSEKSEK** - (Seek Data record in Seek Domain)
  - ▶ Added SEKSEK\_RDEVDEV (real device number) to the end of the record so that Monitor can uniquely identify the device.
  
- **MRIODSZI** (New I/O Domain Monitor Record 24)
  - ▶ This is the SCSI Device Activity Record and will be cut in addition to the existing MRIODDEV record. The first 20 bytes of the record will contain the standard header for monitor records. The rest of the record will contain the following:
    - RDEVDEV
    - Bytes in a block (512)
    - -> amount of time device is active
    - -> kbytes/sec transfer rate
    - -> #transfers to/from disk
    - -> #blocks read from disk
    - -> #blocks written to disk
    - -> #seek operations
    - -> I/O queue depth
    - Statistics on per path basis (same as -> arrows)

## Performance Toolkit

Updated to display performance stats from new and FBA 'emulated' Monitor data

**IBM**  
*Performance Toolkit for VM*

**SCSI device performance data (GDLVMK4)**  
 Select a device for I/O device details

Command Refresh Systems Menu Help

Auto-Refresh

Interval 16:37:47-16:38:48, on 2004/11/18 (CURRENT interval

Device Number	Bytes per block	Activity/sec			Blocks		Percent Connect
		KByte	Trans fers	Seeks	Read	Written	
<u>150B</u>	512	0	.000	.000	.000	.000	0
<u>517C</u>	512	0	.000	.000	.000	.000	0
<u>5319</u>	512	0	.000	.000	.000	.000	0
<u>550D</u>	512	0	.000	.000	.000	.000	0
<u>6660</u>	512	0	292.4	.000	.000	22716	0
<u>6663</u>	512	0	168.4	.000	.000	13080	0

Example of format of EDEVs 6660 and 6663

## Performance Toolkit

Format  
example  
continued  
showing  
more  
output

**IBM**  
*Performance  
Toolkit for VM*

**Performance Details for a Single I/O Device (GDLVMK4)**

Command
Refresh
Systems
Menu
Return
Help
 Auto-

Refresh

**Interval 16:39:00-16:39:48, on 2004/11/18**

Detailed Analysis for Device 6663 ( dedicated to PERFSVMK as 6663 )

Device type : 9336	Function pend. : .0ms	Device busy : 0%
VOLSER :	Disconnected : .0ms	I/O contention: 0%
Nr. of LINKs: 0	Connected : 14.4ms	Reserved : 0%
Last SEEK : 19871	Service time : 14.4ms	SENSE SSCH : 0
SSCH rate/s : .0	Response time : 14.4ms	Recovery SSCH : 0
Avoided/s : .0	CU queue time : .0ms	Throttle del/s: ...

Status: **ONLINE**

Path(s) to device 6663: 7C  
Channel path status : ON

No active MDISKs on this volume - no SEEKs analysis possible

## Performance

### Negatives

- Significant path length increase, so one needs to insure proper planning for enough processor cycles to handle the I/O rate
- Monitoring capabilities are not as strong as traditional ECKD in isolating problems at the channel, control unit, and device levels.
- FCP paths are not expected to be significantly faster than FICON (from a hardware perspective)
- Further increases the VM "overhead" numbers for Linux guests

### Positives

- Allows exploitation of minidisk cache
- Allows minidisks on SCSI to be shared
- Improves performance measurement capabilities compared to FCP subchannels dedicated to a guest
- FCP paths are faster than ESCON
- Greater flexibility in size of minidisks based on SCSI devices tending to be larger in general
- Allows potential use of other tuning options not available for dedicated FCP subchannels:
  - ✦ SET THROTTLE
  - ✦ SET IOPRIORITY

## Performance Recommendations

- Continue to use dedicated FCP subchannels for Linux guests except when:
  - ✦ sharing minidisks can add disk and administrative savings
  - ✦ significant common data exists in read-mostly usage and minidisk cache can benefit
  - ✦ other VM minidisk management capabilities add significant value
  
- Continue to use traditional ECKD DASD for paging and spooling except when:
  - ✦ little paging and spooling activity exists
  - ✦ sufficient processor resources are available to handle increased path length
  
- Continue to use traditional ECKD DASD for CMS minidisks except when:
  - ✦ I/O to CPU ratios are low (minidisk cache helps lower this ratio)
  - ✦ sufficient processor resources are available to handle increased path length
  
- Apply APAR VM63534 which implements support for QDIO architecture ('chained SBALs') which increases I/O throughput on large data moves
  
- Consider the new z/VM native SCSI support when:
  - ✦ no ECKD DASD is available
  - ✦ it would facilitate moving off of ESCON channels to FCP
  - ✦ large minidisks are desired

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### Notes:

Performance is in Internal Throughput Rate (ITR) ratio based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here.

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