



# OpenVMS Integrity Boot Environment


Thomas Siebold, Senior Software Consultant  
Business Critical Systems  
Transition Engineering and Consulting Group  
thomas.siebold@hp.com

© 2005 Hewlett-Packard Development Company, L.P.  
The information contained herein is subject to change without notice




## Topics

- Hardware
  - Systems
  - Options
- Boot Environment
  - EFI
  - Disk structure
  - Booting

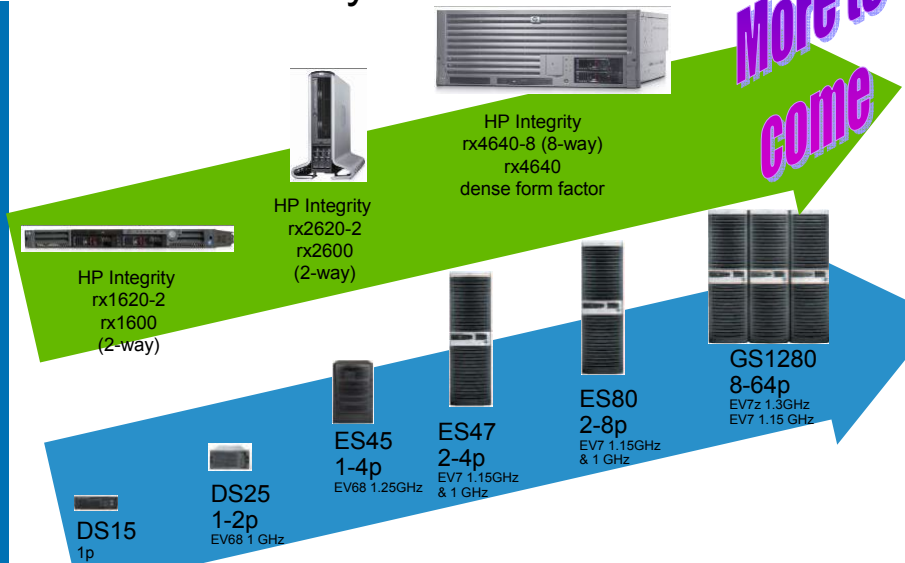


# Hardware -Systems -Options

OpenVMS v8.2  
orderable today on these servers



*More to come*



Model	Configuration	Processor
HP Integrity rx1620-2	rx1600 (2-way)	EV68 1GHz
HP Integrity rx2620-2	rx2600 (2-way)	EV68 1.25GHz
HP Integrity rx4640-8	rx4640 dense form factor	EV7 1.15GHz & 1GHz
DS15	1p	EV68 1GHz
DS25	1-2p	EV68 1GHz
ES45	1-4p	EV68 1.25GHz
ES47	2-4p	EV7 1.15GHz & 1GHz
ES80	2-8p	EV7 1.15GHz & 1GHz
GS1280	8-64p	EV7z 1.3GHz, EV7 1.15GHz

4



## Firmware Revisions

<u>System</u>	<u>Syst. F/W</u>	<u>BMC</u>	<u>MP</u>
• rx1600 (Nemesis)	1.10	2.33	E.02.29
• rx1620 (Onyx)	2.11	3.48	E.03.13
• rx2600 (Long's Peak)	2.31	1.52	E.02.29
• rx2620 (Badger Peak)	3.10	3.47	E.03.13
• rx4640/Madison&Hondo	2.13	2.37	E.02.29
• rx4640/Mad9M	3.11	3.47	E.03.13

5



## CPUs supported

Rx1600	1.0Ghz
Rx1620	1.3 (3MB), 1.6 (3MB) [Mad9m]
Rx2600	1.0, 1.3, 1.4, 1.5
Rx2620	1.3 (3), 1.6 (3), 1.6 (6) [Mad9m]
Rx4640	1.3 (3/6), 1.6 (3/6), Hondo 1.1
Rx4640	1.5 (4), 1.6 (6), 1.6 (9) [Mad9m]

6



## Memory expansion

- Rx1600/1620: 512MB – 16 GB
- Rx2600/2620: 1GB – 24GB
- Rx4640: 1GB – 64 GB/128GB (4Gb DIMMs)

7





## Options

- Single and 4 port 10/100 Tulip (A5230A, A5506B)
- Broadcom 5701 Gbit copper and fiber NICs (A6847A, A6825A)
- Intel Gbit copper and fiber NICs (A7011A, A7012A)
- Qlogic 2-port FC adapter (A6826A)
- U320 2p SCSI adapter (A7173A)
- Radeon 7500 graphics card (AB551A)
- FC/Broadcom 5703 copper and fiber combo cards (A9782A [Fiber], A9784A [Copper])
- Fermat 6402 and 6404 2 and 4 port U320 RAID controllers (A9890A, A9891A) [schedule - around May, 2005, on OpenVMS/Itanium; January, 2005 on Alpha]

8

and now for something NEW....  
„EFI“



 invent

## The Extensible Firmware Interface

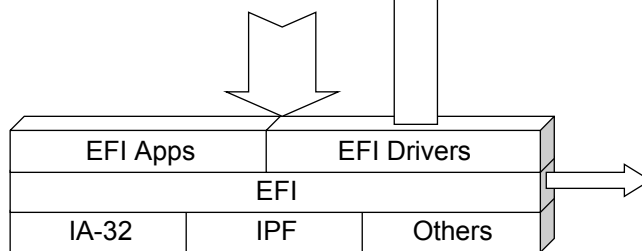
- A new standard from Intel
- Replaces BIOS
- EFI firmware on the system
  - Includes a user interface called the “shell”
  - EFI commands native in the firmware
  - Interface to the system hardware
  - Runs EFI applications from the EFI system partition

10



## Benefits of EFI abstraction

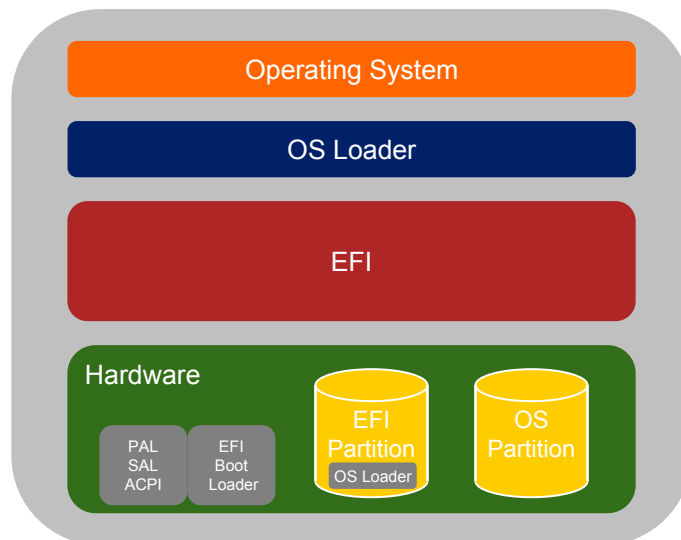
- Abstraction of OS from firmware
- Abstraction free of legacy interfaces
- Coherent, scalable platform interface
- No Collision
- No Space Limitation
- Support Speedy Boot
- Provide Drivers to OS



11



## EFI structural model

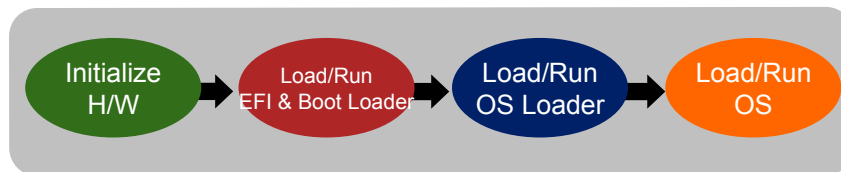


12



## EFI operational model

- Boot starts with hardware initialization
- Continues with a sequence of loads
  - Each successive loader is a bit “smarter“
- Culminates in the loading of an operating system



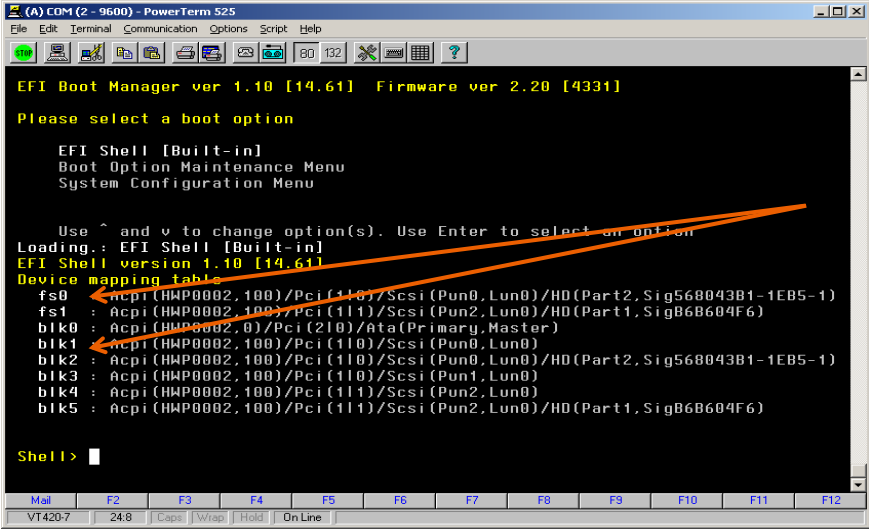
13



## EFI system partition

- An EFI system partition is a FAT32 file system
- EFI directory in the root directory `\efi`
- Vendors use subdirectories to store their OS loaders and applications
- On HP OpenVMS I64 systems, the boot loader filename is `vms_loader.efi` and is located in `fs0:\efi\vms`

14

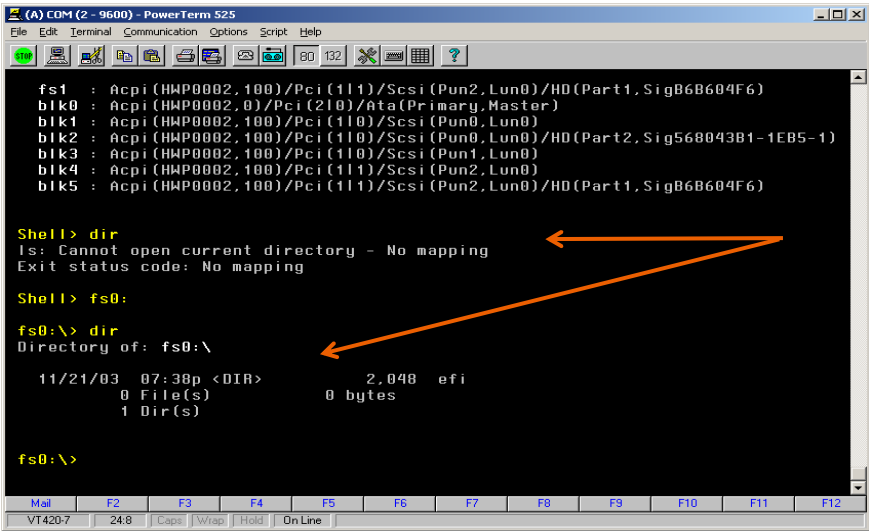


The screenshot shows the HP EFI Shell interface. At the top, it displays "EFI Boot Manager ver 1.10 [14.61] Firmware ver 2.20 [4331]". Below this, it prompts the user to "Please select a boot option" and lists "EFI Shell [Built-in]", "Boot Option Maintenance Menu", and "System Configuration Menu". A message indicates "Use ^ and v to change option(s). Use Enter to select an option". The "Loading.: EFI Shell [Built-in]" and "EFI Shell version 1.10 [14.61]" messages are followed by the "Device mapping table":

```
fs0 : Acpi (HWP0002,100)/Pci (110)/Scsi (Pun0, Lun0)/HD (Part2, Sig568043B1-1EB5-1)
fs1 : Acpi (HWP0002,100)/Pci (111)/Scsi (Pun2, Lun0)/HD (Part1, SigB6B604F6)
blk0 : Acpi (HWP0002,0)/Pci (210)/Ata (Primary, Master)
blk1 : Acpi (HWP0002,100)/Pci (110)/Scsi (Pun0, Lun0)
blk2 : Acpi (HWP0002,100)/Pci (110)/Scsi (Pun0, Lun0)/HD (Part2, Sig568043B1-1EB5-1)
blk3 : Acpi (HWP0002,100)/Pci (110)/Scsi (Pun1, Lun0)
blk4 : Acpi (HWP0002,100)/Pci (111)/Scsi (Pun2, Lun0)
blk5 : Acpi (HWP0002,100)/Pci (111)/Scsi (Pun2, Lun0)/HD (Part1, SigB6B604F6)
```

The prompt "Shell >" is visible at the bottom. The HP logo and "invent" tagline are in the top right corner.

15



The screenshot shows the HP EFI Shell interface. It displays the same "Device mapping table" as the previous slide. Below the table, the user enters "Shell > dir", which results in the message "Is: Cannot open current directory - No mapping" and "Exit status code: No mapping". The user then enters "Shell > fs0:", followed by "fs0:\> dir", which shows the contents of the fs0 partition:

```
Directory of: fs0:\
11/21/03 07:38p <DIR>          2,048  efi
0 File(s)
1 Dir(s)
```

The prompt "fs0:\>" is visible at the bottom. The HP logo and "invent" tagline are in the top right corner.

16



## EFI system partition files

```

(A) COM (2 - 9600) - PowerTerm 525
File Edit Terminal Communication Options Script Help
fs0:\efi> dir
Directory of: fs0:\efi
11/21/03 07:38p <DIR>          2,048 .
11/21/03 07:38p <DIR>          2,048 ..
11/21/03 07:38p <DIR>          2,048 vms
0 File(s)          0 bytes
3 Dir(s)


fs0:\efi> cd vms
fs0:\efi\vms> dir
Directory of: fs0:\efi\vms
11/21/03 07:38p <DIR>          2,048 .
11/21/03 07:38p <DIR>          2,048 ..
11/21/03 07:38p <DIR>          2,048 tools
11/21/03 07:38p                1,609,728 ipb.exe
11/21/03 07:38p                334,848 vms_loader.efi
11/21/03 07:38p                165,888 vms_set.efi
11/21/03 07:38p                162,816 vms_show.efi
4 File(s)        2,273,280 bytes
3 Dir(s)
    
```

17

## OpenVMS I64 system disk format

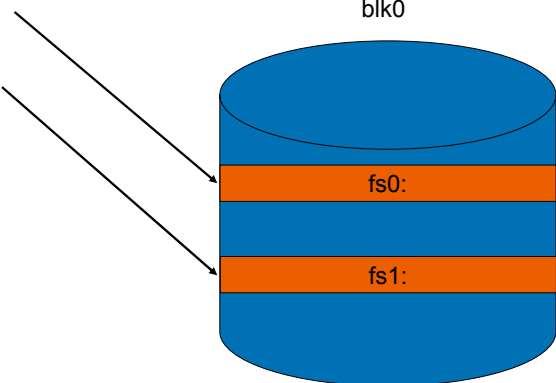
- EFI requires GUID Partition Table (GPT) disk format
  - GUID = Globally Unique Identifier
- EFI requires one FAT32 partition
  - Contains EFI system partition files
- OpenVMS requires ODS-2 or ODS-5 format disk with Files-11 file structure
- OpenVMS does not support partitioned disks!
- Both formats co-exist, independent of each other

18



### Hybrid system disk: EFI view

- GPT format with one or more FAT32 partitions
  - EFI system partition
  - Diagnostics partition (optional)
- Remaining space marked allocated




blk0

fs0:

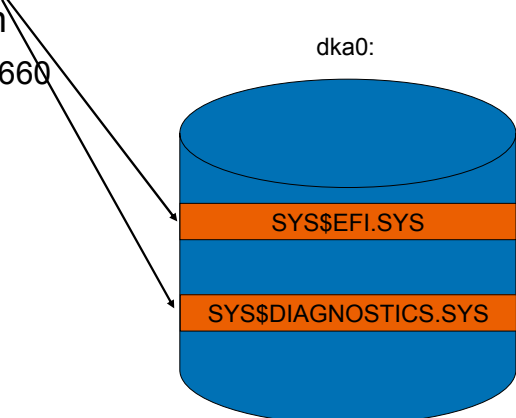
fs1:

19



### Hybrid system disk: OpenVMS view

- ODS Files-11 format disk
- One container file for each FAT32 partition
- Optical media use ISO9660 format instead of GPT




dka0:

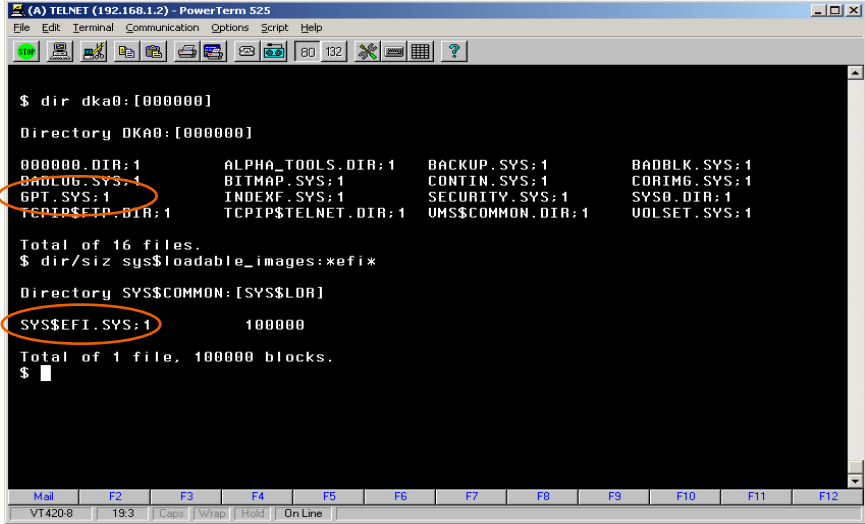
SYS\$EFI.SYS

SYS\$DIAGNOSTICS.SYS

20

## OpenVMS view of EFI system partition





```

(A) TELNET (192.168.1.2) - PowerTerm 525
File Edit Terminal Communication Options Script Help

$ dir dka0:[000000]

Directory DKA0:[000000]

000000.DIR:1      ALPHA_TOOLS.DIR:1  BACKUP.SYS:1      BADBLK.SYS:1
BADLOG.SYS:1    BITMAP.SYS:1       CONTIN.SYS:1     CORIMG.SYS:1
GPT.SYS:1       INDEXF.SYS:1       SECURITY.SYS:1    SYS0.DIR:1
TCP$FTP.DIR:1   TCPIP$TELNET.DIR:1  UMS$COMMON.DIR:1  UOLSET.SYS:1


Total of 16 files.
$ dir/siz sys$loadable_images:*efi*

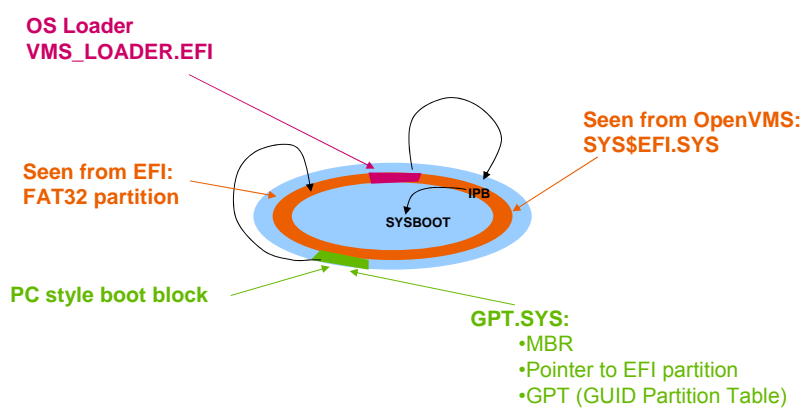
Directory SYS$COMMON:[SYS$LDR]

SYS$EFI.SYS:1    100000

Total of 1 file, 100000 blocks.
$
    
```

## Hybrid system disk: dual view





**OS Loader**  
VMS\_LOADER.EFI

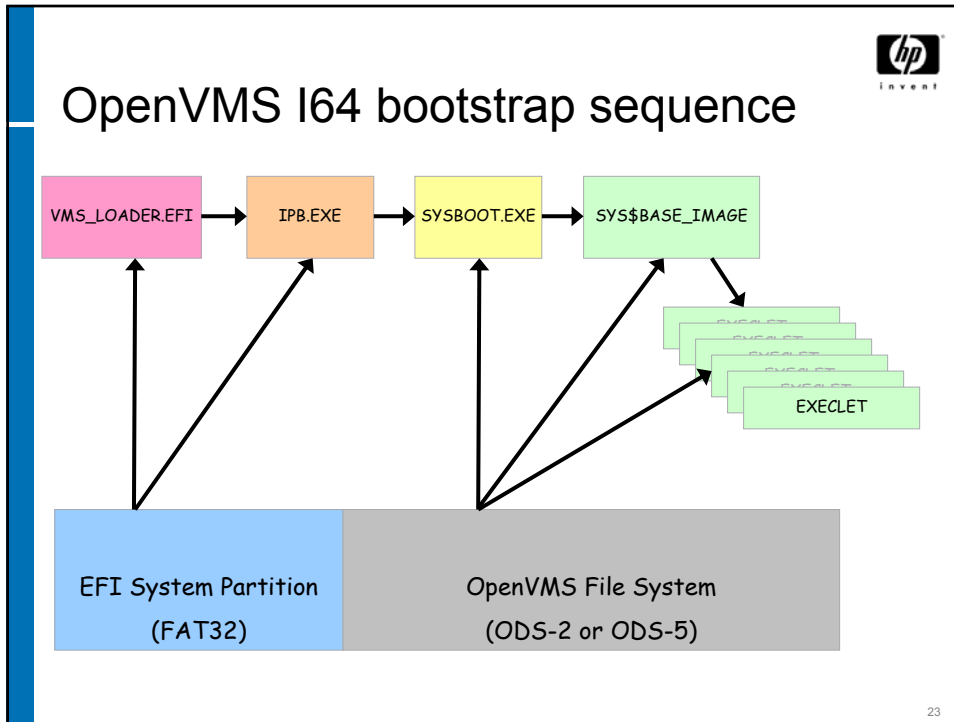
**Seen from EFI:**  
FAT32 partition

**Seen from OpenVMS:**  
SYS\$EFI.SYS

**PC style boot block**

**GPT.SYS:**

- MBR
- Pointer to EFI partition
- GPT (GUID Partition Table)



23

## Booting OpenVMS I64

The screenshot shows a TELNET terminal window titled "(A) TELNET (192.168.1.2) - PowerTerm S25". The user is in the directory `fs0:\>` and has navigated to `efi\vms`. The terminal displays the following commands and output:

```

fs0:\> cd efi\vms
fs0:\efi\vms> dir
Directory of: fs0:\efi\vms

04/26/04 02:14p <DIR>          2,048 .
04/26/04 02:14p <DIR>          2,048 ..
04/26/04 02:14p <DIR>          2,048 tools
04/26/04 02:14p                1,927,680 ipb.exe
04/26/04 02:14p <DIR>          2,048 update
04/26/04 02:14p                351,744 vms_loader.efi
04/26/04 02:14p                190,464 vms_set.efi
04/26/04 02:14p                185,856 vms_show.efi
4 File(s)      2,655,744 bytes
4 Dir(s)

```

The user then executes the `vms_loader` command, which displays the following boot message:

```

fs0:\efi\vms> vms_loader

hp OpenVMS Industry Standard 64 Operating System, Version XA9S-T32
© Copyright 1976-2004 Hewlett-Packard Development Company, L.P.

```

The HP logo and 'invent' tagline are visible in the top right corner.

24



## Integrity Servers – Hardware Overview



- No “Vax like” or “Alpha like” console
- Has multiple consoles:
  - Management Processor (MP)
  - Baseboard Management Console (BMC)
  - Both attempt to be common across the entire hardware range
- Uses Extensible Firmware Interface (EFI) rather than BIOS.

26



## MP console

- Runs with box level power, even with system off.
- Local, remote (modem) and network connectivity
- Console configuration (terminal type, etc.)
- Network configuration (hostname, IP address, etc.)
- Multiple console sessions (one writer, many readers)
- Provides ability to copy files over the network (firmware updates)

27



## BMC

- Runs with main board powered up
- Local connectivity (9 pin serial)
- Power up, self tests
- Device detection
- Console configuration
- No graphics console

28



## EFI

- Mini operating system
- FAT formatted file system (FAT12, FAT16 and FAT32), VMS presents FAT16 partition to EFI
- Boot menu and defaults
- Environment variables (VMS\_FLAGS, etc.)
- VMS\_LOADER.EFI finds and loads IPB.EXE
- IPB.EXE understands the OpenVMS file system, EFI does not.

29



## Boot and Device detection

- EFI boot loader from FAT partition (hidden as a container file on the system disk)
- Boot flags passed through environment variables
- Reads executive into memory
- Passes control to the executive
- The system uses ACPI (Advanced Configuration and Power Interface) for device detection by the firmware
- Devices appear as a set of CSRs (Control and Status Registers) in physical memory – the I/O space.

30



## Boot and Device detection

- Devices have interrupt vectors which connect a device interrupt request to the device driver interrupt service routine. Device data obtained from ACPI data.
- ACPI data indicates device type.
- SYSMAN IO AUTO will query ACPI data to find devices and set up OpenVMS device drivers to communicate with the hardware
- ***Now Let's take a look, how the past 6 slides look at real life....***

31



## Booting VMS from the EFI Shell

- Select EFI Shell from the boot menu
- Set Boot flags environment variable, stored in NVRAM
  - IA64 flag values are generally the same as Alpha and VAX
  - Shell> set vms\_flags "0,0"
- Select disk and directory
  - Shell> fs0:
  - fs0:> cd efilvms
- Start the boot of VMS
  - fs0:> vms\_loader
- Override environment variable
  - fs0:> vms\_loader –flags 0,1

32





## VMS\_SHOW

- EFI utility to associate VMS device name with EFI pathnames

```
fs0:\efi\vms> vms_show devices
VMS: EIA0
EFI: Acpi(000222F0,0)/Pci(3|0)/Mac(00306E3829B5)

VMS: DKA0
EFI: fs0: Acpi(000222F0,100)/Pci(1|0)/Scsi(Pun0,Lun0)

VMS: EWA0
EFI: Acpi(000222F0,100)/Pci(2|0)/Mac(00306E38B938)

VMS: DKC200
EFI: fs1: Acpi(000222F0,200)/Pci(1|0)/Scsi(Pun2,Lun0)
```

33



## VMS\_SET

- EFI utility to allow selection of dump devices and HLL debugger port:

```
fs0:\efi\vms> vms_set dump_dev dka0,dkc200
VMS: DKA0
EFI: fs0: Acpi(000222F0,100)/Pci(1|0)/Scsi(Pun0,Lun0)

VMS: DKC200
EFI: fs1: Acpi(000222F0,200)/Pci(1|0)/Scsi(Pun2,Lun0)

fs0:\efi\vms> vms_show dump_dev
VMS: DKA0
EFI: fs0: Acpi(000222F0,100)/Pci(1|0)/Scsi(Pun0,Lun0)

VMS: DKC200
EFI: fs1: Acpi(000222F0,200)/Pci(1|0)/Scsi(Pun2,Lun0)
```

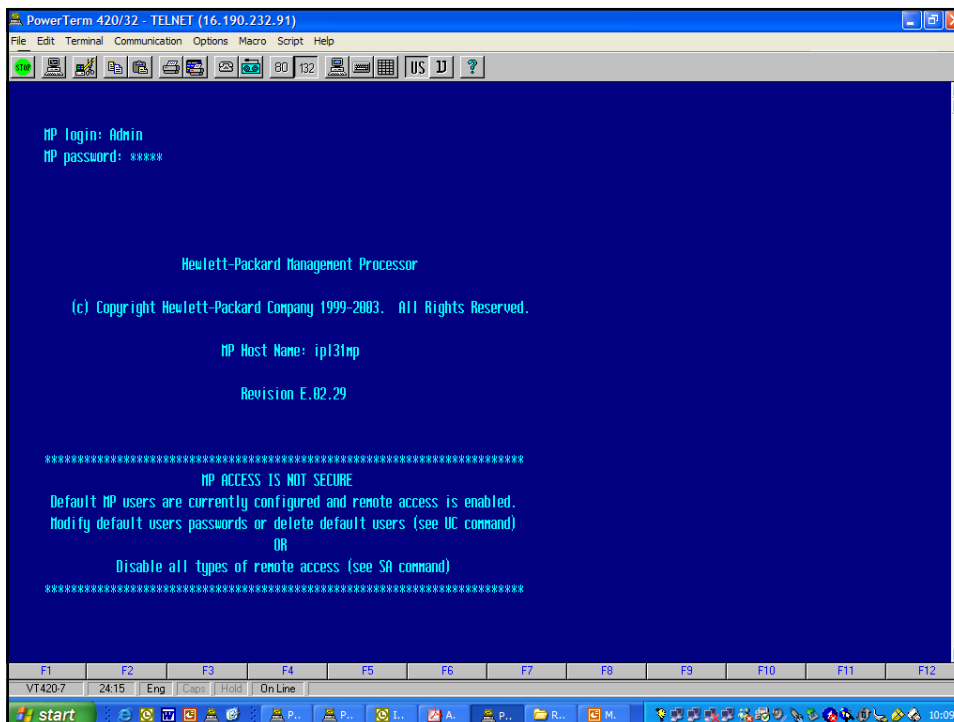
34

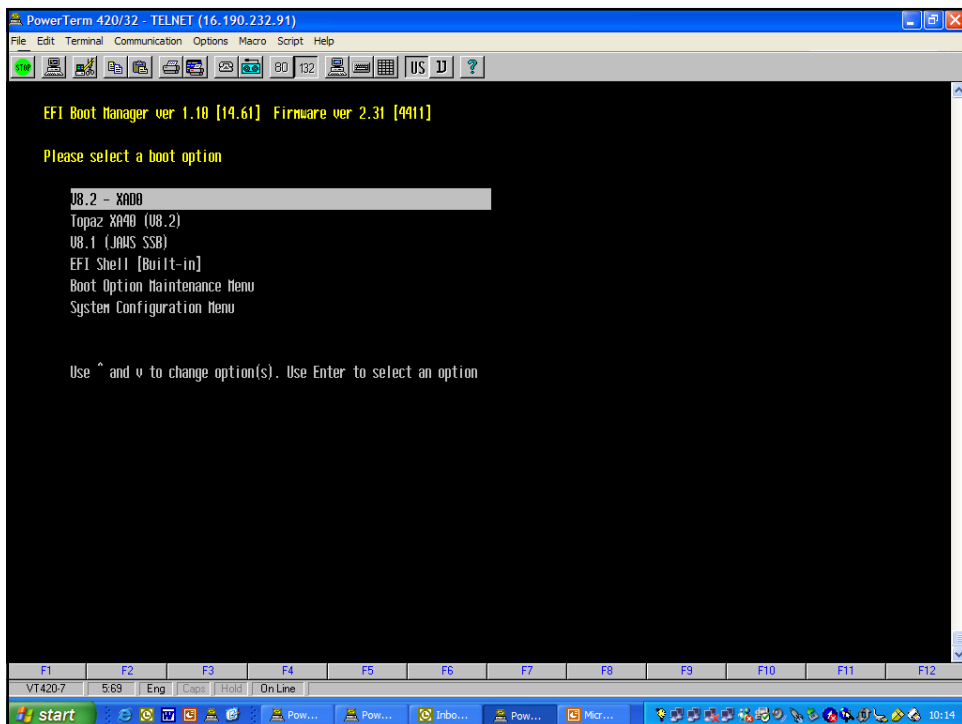
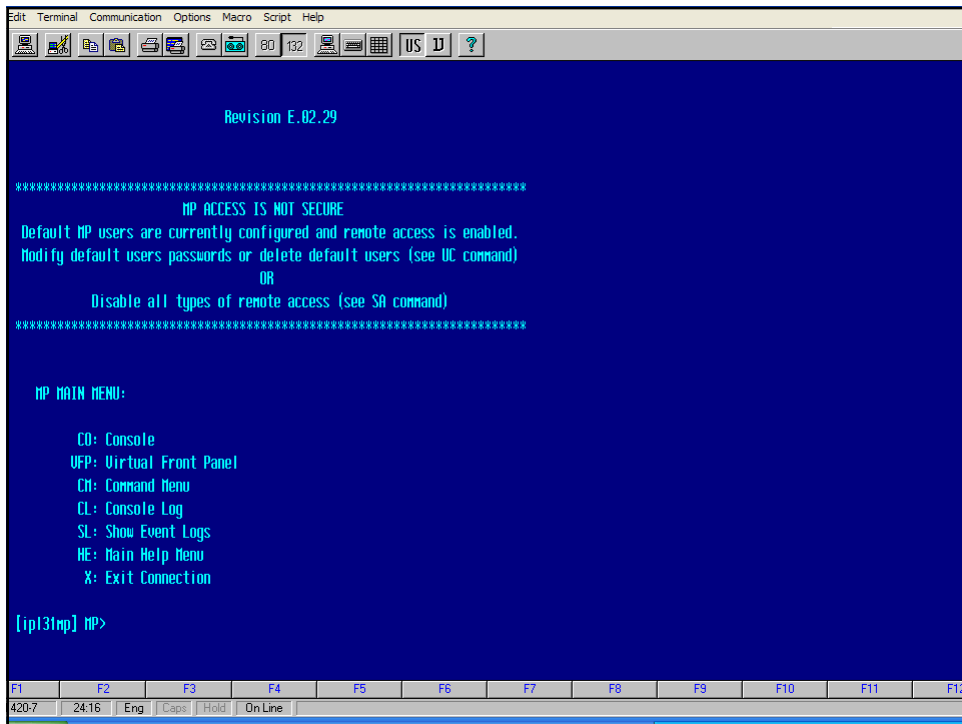


## Forcing a system crash

- History
  - On VAX and early Alpha system, ^P was detected by special hardware and handled by the console
  - Commodity serial ports pushed ^P detection in console software, if IPL < DEVICE\_IPL
- EFI console ignores ^P, no way to return to EFI Shell
- IA64 VMS console terminal driver handles ^P
  - Calls XDELTA, if loaded
  - Prompts for forced crash, if IPL < DEVICE\_IPL
- Remote console command generates Transfer of Control signal (BMC:TOC, MP:TC)
  - Handled by IA64 VMS as a non-maskable exception and

35





```

PowerTerm 420/32 - TELNET (16.190.232.91)
File Edit Terminal Communication Options Macro Script Help
VT420-7 24.9 Eng Caps Hold On Line
start [taskbar icons] 10:16

Topaz X840 (U8.2)
U8.1 (JAUS SSB)
EFI Shell [Built-in]
Boot Option Maintenance Menu
System Configuration Menu

Use ^ and v to change option(s). Use Enter to select an option
Loading.: EFI Shell [Built-in]
EFI Shell version 1.10 [14.61]
Device mapping table
fs0 : Acpi (HWP0002,100)/Pci (110)/Scsi (Pun0,Lun0)/HD (Part1,Sig9A2AB0A1-1150-1109-B8EF-AA000400FEFF)
fs1 : Acpi (HWP0002,100)/Pci (110)/Scsi (Pun1,Lun0)/HD (Part1,Sig5188AC91)
fs2 : Acpi (HWP0002,100)/Pci (111)/Scsi (Pun2,Lun0)/HD (Part1,Sig51089BA1-B9FE-1108-B52C-AA000400FEFF)
blk0 : Acpi (HWP0002,0)/Pci (210)/Ata (Primary,Master)
blk1 : Acpi (HWP0002,100)/Pci (110)/Scsi (Pun0,Lun0)
blk2 : Acpi (HWP0002,100)/Pci (110)/Scsi (Pun0,Lun0)/HD (Part1,Sig9A2AB0A1-1150-1109-B8EF-AA000400FEFF)
blk3 : Acpi (HWP0002,100)/Pci (110)/Scsi (Pun1,Lun0)
blk4 : Acpi (HWP0002,100)/Pci (110)/Scsi (Pun1,Lun0)/HD (Part1,Sig5188AC91)
blk5 : Acpi (HWP0002,100)/Pci (111)/Scsi (Pun2,Lun0)
blk6 : Acpi (HWP0002,100)/Pci (111)/Scsi (Pun2,Lun0)/HD (Part1,Sig51089BA1-B9FE-1108-B52C-AA000400FEFF)
blk7 : Acpi (HWP0002,100)/Pci (111)/Scsi (Pun2,Lun0)/HD (Part2,Sig51089BA0-B9FE-1108-B52B-AA000400FEFF)
blk8 : Acpi (HWP0002,100)/Pci (111)/Scsi (Pun2,Lun0)/HD (Part3,Sig51089BA1-B9FE-1108-B52B-AA000400FEFF)
fs0:\>
    
```

```

PowerTerm 420/32 - TELNET (16.190.232.91)
File Edit Terminal Communication Options Macro Script Help
VT420-7 24.15 Eng Caps Hold On Line
start [taskbar icons] 10:17

1 Dir(s)

fs0:\> cd efi
fs0:\efi> cd vms
fs0:\efi\vms> dir
Directory of: fs0:\efi\vms

09/27/04 09:49a <DIR>          2,048 .
09/27/04 09:49a <DIR>          2,048 ..
09/27/04 09:49a <DIR>          2,048 tools
09/27/04 09:49a                3,102,720 ipb.exe
09/27/04 09:49a <DIR>          2,048 update
09/27/04 09:49a                838,656 vms_loader.efi
09/27/04 09:49a                294,224 vms_bcfg.efi
09/27/04 09:49a                218,112 vms_set.efi
09/27/04 09:49a                215,040 vms_show.efi
5 File(s)    4,618,752 bytes
4 Dir(s)

fs0:\efi\vms>
    
```

```
PowerTerm 420/32 - TELNET (16.190.232.91)
File Edit Terminal Communication Options Macro Script Help
VT420-7 24.1 Eng Caps Hold On Line
start [Taskbar icons] 10:20

09/27/04 09:49a <DIR>      2,048  tools
09/27/04 09:49a          3,102,720  ipb.exe
09/27/04 09:49a <DIR>      2,048  update
09/27/04 09:49a          838,656  vms_loader.efi
09/27/04 09:49a          249,229  vms_bcfg.efi
09/27/04 09:49a          218,112  vms_set.efi
09/27/04 09:49a          215,040  vms_show.efi
      5 File(s)  4,618,752 bytes
      4 Dir(s)

fs0:\efi\vms> set vms_flags "0,1"

fs0:\efi\vms> vms_loader

SYSBOOT> set niscs_load_pea0 1

SYSBOOT> c

hp OpenVMS Industry Standard 64 Operating System, Version XA10-T3Z
© Copyright 1976-2004 Hewlett-Packard Development Company, L.P.
```

From this point on....  
VMS is VMS is VMS.....

