ADMIN Network & Security Webcast

Partnered with OpenSystems Media

Best Practices for System Management in the Hyperscale Cloud

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Dell's PowerEdge C Server Line

MODERATOR

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Agenda

I. A quick tour of the viewer tools

II. Introduction

III. Presentation

IV. Questions and Answers

Best Practices for System Management in Hyperscale Clouds

Michael Stumpf

System Management & Tools, PowerEdge-C

Agenda

- Hyperscale cloud environments
- Techniques
- Command line tools
- Health monitoring
- Best practices

Cloud Computing

Yes, it's the latest industry trend…

But this one isn't all ponies and rainbows!

So, what does "Cloud Computing" actually mean?

- **In a nutshell, the goal is to put together a lot of**
  - **Efficient**
  - **Cheap**
  - **Dense**
  - **Computing capability & storage**
- That is "just manageable enough"
- **Don't pay for features you don't need/won't use**

Cloud Computing Environments

- Failures will occur
  - Plan for them
  - Minimize impact
  - Minimize total cost
  - Replace it; throw old one on the junk pile
- Failure is expected, so single points of failure are ok
- Software stack expects, detects, and handles failure
  - Hadoop
- Why pay 10x for 99.999% uptime?
  - Is 5.26 minutes per year downtime realistic?

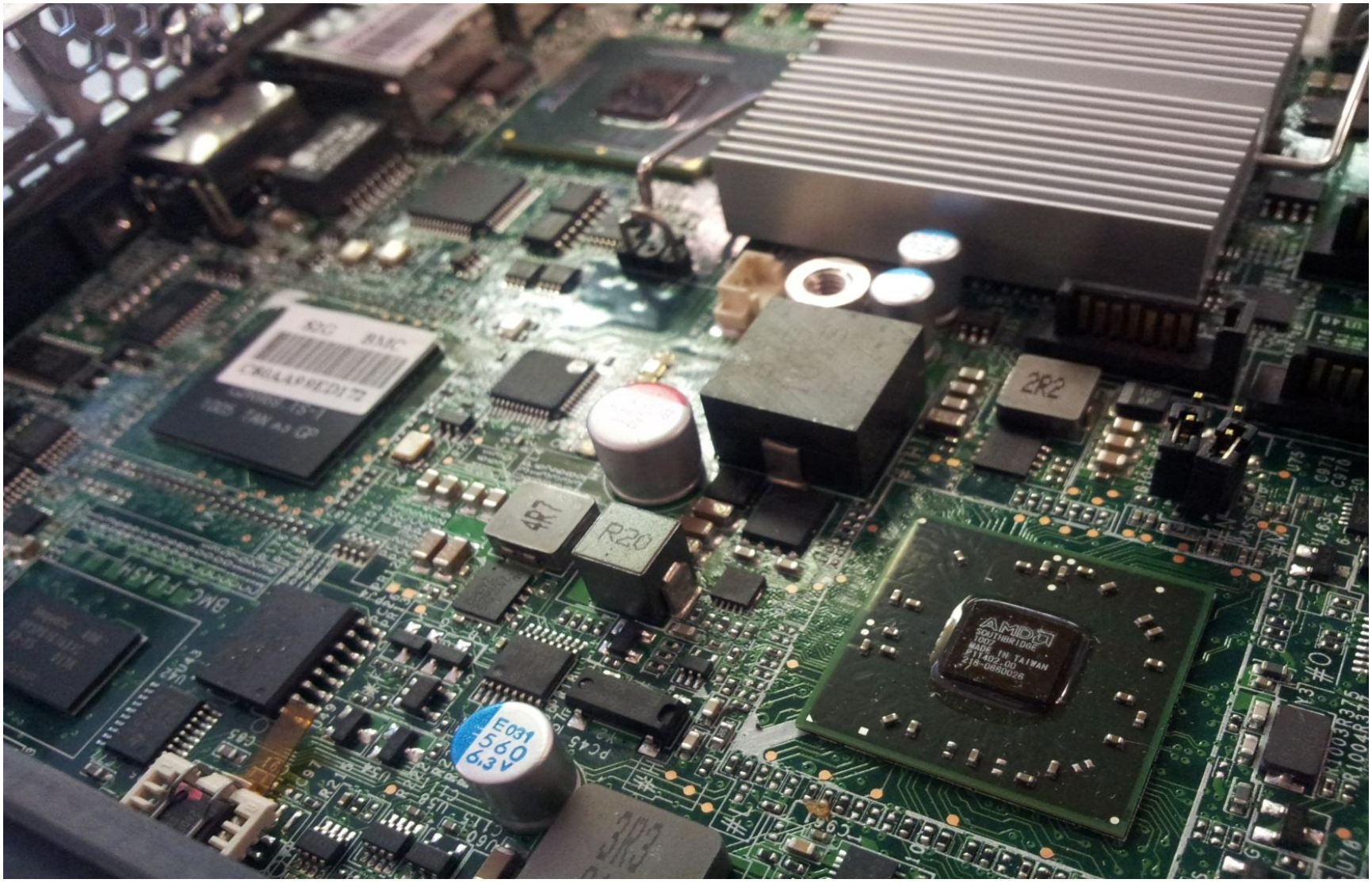
BMC (Baseboard Management Controller)

- BMC is really ideal for Cloud Computing
  - Cheap, bolt-on, auxiliary maintenance & monitoring
  - Out-of-band management
  - Present on every server node
  - Always-on
  - Power host on/off
  - Provides virtual KVM, media, serial port over IP
  - Monitors server node health
  - Allows for physical separation of management traffic

- Enables totally virtualized server management
  - Put BMC on the network,
  - Then server is fully remotely manageable (Even bare metal!)

PowerEdge C6105 Server

4 separate servers in 2U
Power-efficient AMD Opteron 4000 processors
4 separate BMCs



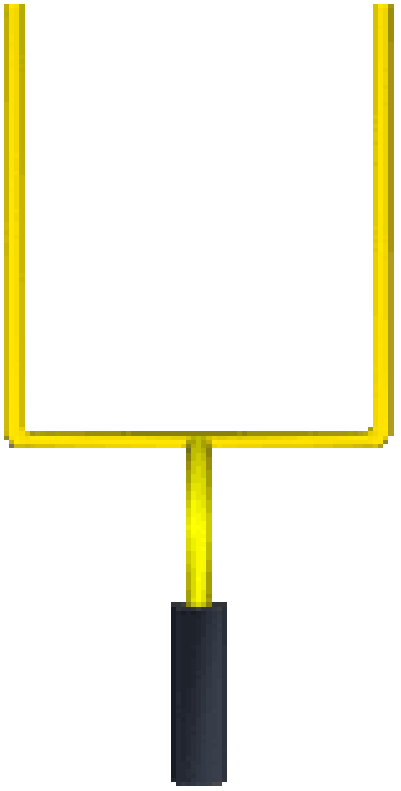
First Goals: The "Get My Server Manageable" Plan

- Get BMC on network
  - setup IP, or
  - collect MAC address and setup DHCP daemon

- Access it remotely
  - IPMI over LAN
  - Serial-over-LAN (via BMC)
  - Virtual Console
  - Virtual Media
  - Serial port (physical; cheap!)
  - IP KVM ($$$$$)

Then,

- Configure it
- Remotely install an OS (kickstart file)
  - Or use a read-only, centralized network-based PXE image (if practical!)
- Set up monitoring



PXE Boot (boot from Network)

- Uses DHCP to get IP address
- MAC address is linked to a boot image
- PXE pulls boot image with TFTP
- It's always a good idea to make PXE first boot device
  - Can simply bypass with timeout and "localboot"
  - Helps mechanize discovery, provisioning, FA/crash cart
- Driven by symlinks on TFTP/PXE server
  - Newer approaches exist (iPXE)
  - They're faster, sexy, and usually work
  - When they don't, you're in trouble
  - PXE will always work
- Construct states:
  1. Discovery/Inventory
  2. Test/Burn-in
  3. Update firmware (BIOS, BMC, Storage, Fans, etc)
  4. Provision (tailor to a purpose)
  5. OS Install
  6. Deprovision (prepare for removal)
  7. Failure Analysis

This approach scales

PXE Boot: Crowbar

- Dell's Crowbar implements this strategy today
  - http://github.com/dellcloudedge/crowbar/wiki
- Bare metal to fully functioning cloud in *under 2 hours*
- Open; Apache 2 license
- *Not restricted* to Dell hardware
- Embodies Dell's Cloud experience

Configure the server (Provision)

- PXE image (runs out of ramdisk)
  - Mounts NFS share, or uses ftp (ncftp is handy) to pull over your custom scripts
  - Unbundles & runs scripts
  - Optionally feed back results upstream

- Things to set:
  - Custom BIOS settings
  - Custom BMC settings
  - Custom Storage adapter settings
  - Update firmwares (if needed)
  - Storage configuration (array creation)

- After provisioning, a kickstart file will automate OS install
  - Warning: environment is very thin
  - services like IPMI will not be available
  - **Recommended**: do not combine OS install with Provisioning stage

IPMI Tools

Many choices. Each has a different focus.

- **ipmitool** – what I use & script. Easy to build. Good all-around.
- freeipmi – contains ipmiping; useful for probing
- ipmiutil – contains idiscover; useful for scanning a network

FAQ: How do I scan the network for BMCs?

- Does it ping? + Does it respond to IPMI? → This is a BMC
- BMC should be able to identify its host
- Useful for discovery, provisioning, detecting unexpected changes on network

FAQ: How do I encrypt IPMI traffic?

- Force IPMI 2.0 mode. With ipmitool, add argument "`-Ilanplus`"

IPMI Cheat Sheet

```
# Start IPMI service on a RHEL/CentOS-style server (usually installed, but not enabled)
service ipmi start

# Check power state; power on
ipmitool power status
ipmitool power on

# Issue ACPI shutdown (soft shutdown to OS)
ipmitool chassis power soft


# Reset the BMC itself ("management channel")
ipmitool mc reset cold

# Activate serial-over-LAN (type ~? for help; type ~. to exit)
ipmitool sol activate


# Print the FRU (Who made this device?  What is it?  Model/Serial/etc)
ipmitool fru print


# View the SEL (System Event Log) (brief, or verbose)
ipmitool sel list
ipmitool sel list –v

# View the SDR (Sensor Data Repository) in different ways(including verbose)
ipmitool sensor
ipmitool sdr list
ipmitool sdr elist
ipmitool sdr list –v
```

IPMI Cheat Sheet, continued

```
# See BMC LAN configuration
ipmitool lan print 1

# Change the BMC LAN configuration (DHCP/static IP, netmask, gateway, etc)
ipmitool lan set 1 ipsrc static
ipmitool lan set 1 ipaddr 192.168.0.5
ipmitool lan set 1 netmask 255.255.255.0
ipmitool lan set 1 defgw ipaddr 192.168.0.5

# User maintenance
ipmitool user list 1                              # Show user list (channel #1)
ipmitool user set name 5 fred           # Assign user #5 to login name "fred"
ipmitool user set password 5 fredpwd    # Assign user #5 to have password "fredpwd"
ipmitool user priv 5 4 1                # Give user #5 to have full admin privileges
ipmitool user enable 5                  # Activate the user, so they can issue commands remotely

# Blink the identification light
ipmitool chassis identify force                   # Turn light on
ipmitool chassis identify 0             # Turn it off


# Raw IPMI commands
ipmitool raw <<command>>                # Standard IPMI:  netfn command ...
```

IPMI Network Scanning

Recipes to determine if an IP is a BMC:

- ipmitool – slowest; ~20 seconds per IP

```
root@pbj2:~# ipmitool -Ilan -H192.168.8.100 -Unotauser -Pnotapassword channel authcap 1 1
Error: Unable to establish LAN session
Unable to Get Channel Authentication Capabilities
root@pbj2:~# echo $?
1
```

- ipmiping – fast, ~2 seconds per IP

```
root@pbj2:~# ipmiping -t2 -c1 192.168.8.100
ipmiping 192.168.8.100 (192.168.8.100)
response timed out: rq_seq=56
--- ipmiping 192.168.8.100 statistics ---
1 requests transmitted, 0 responses received in time, 100.0% packet loss
root@pbj2:~# echo $?
1
root@pbj2:~# ipmiping -t2 -c1 192.168.8.101
ipmiping 192.168.8.101 (192.168.8.101)
response received from 192.168.8.101: rq_seq=11
--- ipmiping 192.168.8.101 statistics ---
1 requests transmitted, 1 responses received in time, 0.0% packet loss
root@pbj2:~# echo $?
0
```

- idiscover – very fast; uses broadcast or GetChannelAuthCap

```
root@pbj2:~# idiscover -i eth2
idiscover ver 1.7
Discovering IPMI Devices:
01| response from |  192.168.8.101      |
02| response from |  192.168.8.159      |
03| response from |  192.168.25.103     |
04| response from |  192.168.8.107      |
idiscover: 1 pings sent, 4 responses
```

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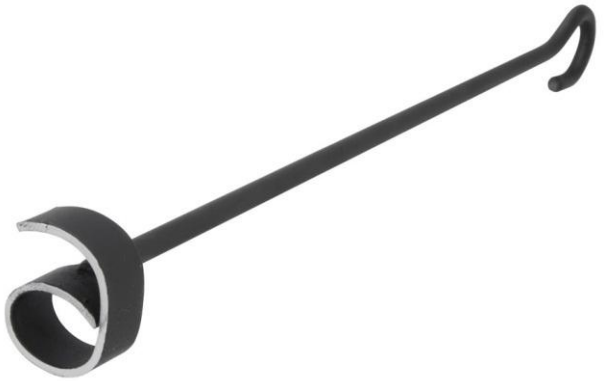
Burn-in



Explicit Stress/Validation Tools

- CPU: cpuburn: http://freecode.com/projects/cpuburn
- Memory: memtester: http://pyropus.ca/software/memtester/
- Memory: memtest86+: http://www.memtest.org/
- Memory/IO: stressapptest: http://code.google.com/p/stressapptest/

```
# Allocate 256MB of memory and run 8 "warm copy" threads, and 8 cpu load threads. Exit after 20 seconds.
stressapptest -s 20 -M 256 -m 8 -C 8 -W

# Run 2 file IO threads, and autodetect memory size and core count to select
# allocated memory and memory copy threads.
stressapptest -f /tmp/file1 -f /tmp/file2
```

- Storage: badblocks: http://e2fsprogs.sourceforge.net/

```
# Destructive test, 3 passes, test 128 blocks at once.  Block size 4096.
badblocks -v -w -s -c 128 -b 4096 -p 3 /dev/sda
```

- Storage: smartmontools: http://sourceforge.net/apps/trac/smartmontools

```
# Usually worth a look.  Reads SMART data.  Can be hard to interpret; various hd vendors use it differently
Smartctl --all /dev/sda
```

Metering tools (that also create stress)

- Storage: bonnie++: http://www.coker.com.au/bonnie++/
- Storage: iometer: http://www.iometer.org/
- Networking: iperf: http://iperf.sourceforge.net/

Command Line Tools

Some people prefer GUIs…

- Give me Unix-style, single purpose tools success/failure
  - Scriptable & scale well
  - Easy to reconfigure & change
  - These are the instrumentation steps to plug into a GUI anyway

- Encapsulate common operations as small tools:
  - Server quick overview (1 line)
  - Server full state
  - Server inventory
  - Server healthy? (1 line: yes/no)
  - Server full health info, including sensor readings

- Once built, splice small script together to view projects or racks
  - hadoop-rackA1, hadoop-rackA2, etc

PowerEdge C tools: Inventory & State

```
root@pbj2:~# ./info.amd
  192.168.8.119 (shd,dhcp) | C6105. 1 | power  on :  72 W | BIOS:    1.7.6 | BMC:     1.18 | FCB:     1.15
  192.168.8.121 (ded,dhcp) | C6105. 2 | power  on :  72 W | BIOS:    1.7.1 | BMC:     1.14 | FCB:     1.15
  192.168.8.123 (shd,dhcp) | C6105. 3 | power  on :  84 W | BIOS:    1.7.1 | BMC:     1.14 | FCB:     1.15
  192.168.8.125 (ded,dhcp) | C6105. 4 | power  on : 108 W | BIOS:    1.7.1 | BMC:     1.14 | FCB:     1.15
  192.168.8.127 (shd,dhcp) | C6145. 1 | power  on : 228 W | BIOS:     2.02 | BMC:      1.3 | FCB:     1.18
  192.168.8.129 (ded,dhcp) | C6145. 2 | power  on : 228 W | BIOS:     1.01 | BMC:      1.3 | FCB:     1.18
```

```
root@pbj2:~# bmc -H192.168.8.121 allinfo
....:....:....:....:....:...

Power is                              : on
Platform type                         : C6105
Node number in chassis                : 2
Power drawn by this node              : 72 Watts
Power drawn by whole chassis          : 348 Watts
AC restore policy                     : always-on
BIOS version                          : 1.7.1
BMC version                           : 1.14
FCB version                           : 1.15
FCB PIC version                       : PIC18
ipmitool version                      : 1.8.11
bmc tool version                      : 2012-02-01 17:24:50
BMC hostname                          : bmc-.02
BMC IP source                         : dhcp
BMC IP address                        : 192.168.8.121
BMC subnet mask                       : 255.255.128.0
BMC VLAN setting                      : disabled
BMC NIC mode (which physical port)    : dedicated
Service tag                           :
Asset tag (set by customer)           : 12345678901234567890
PPID (unique board serial num)        : CN03M4R4717030710161
Security: all_but_ipmi_disabled       : no
Security: ikvm_disabled               : no
Security: http_disabled               : no
Security: ssh_telnet_disabled         : yes
BMC Web GUI enabled                   : yes
BMC Web GUI http port                 : 80
BMC Web GUI https port                : 443
```

Dashboard Script

```
root@pbj2:~# cat info.amd
#!/bin/bash
bmc -H192.168.8.119 info        # 6105.1
bmc -H192.168.8.121 info        # 6105.2
bmc -H192.168.8.123 info        # 6105.3
bmc -H192.168.8.125 info        # 6105.4

bmc -H192.168.8.127 info        # 6145.1
bmc -H192.168.8.129 info        # 6145.2
```

Command Line Tools: pdsh

pdsh (parallel distributed shell): http://sourceforge.net/projects/pdsh/

Run a task (including fanout) in parallel across many hosts. Here is a crash course:

- Build pdsh

```
./configure --without-rsh --with-ssh
make
make install
# Put this in your .bash-profile:
export PDSH_RCMD_TYPE=ssh
```

- Set up SSH keys

```
# Create SSH key pair & copy to remote host.  "No passphrase" is most convenient.
ssh-keygen -t dsa
ssh-copy-id username@remotehost.com
```

- Create file "cluster" with list of hosts (1 per line)

```
# cat ./cluster
192.168.8.150
192.168.8.152
```

- Use it!

```
# pdsh -w^cluster df
192.168.8.150: Filesystem           1K-blocks      Used Available Use% Mounted on
192.168.8.150: /dev/ram0              2015824   1280376    735448  64% /
192.168.8.150: tmpfs                  6145172         0   6145172   0% /dev/shm
192.168.8.152: Filesystem           1K-blocks      Used Available Use% Mounted on
192.168.8.152: /dev/mapper/VolGroup00-LogVol00
192.168.8.152:                      459081360  11901756 423483428   3% /
192.168.8.152: /dev/sda1               101086     12541     83326  14% /boot
192.168.8.152: tmpfs                  6145140         0   6145140   0% /dev/shm
```

- Decent summary can be found at: http://www.grid5000.fr/mediawiki/index.php/PDSH

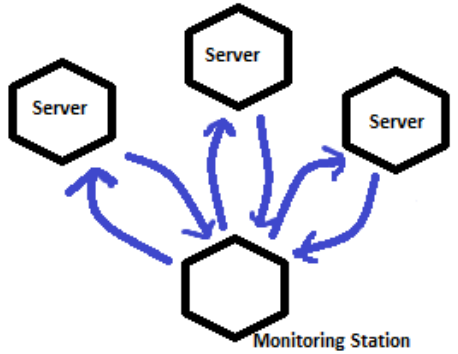
Health Monitoring

Monitoring need not be complicated. Two options:

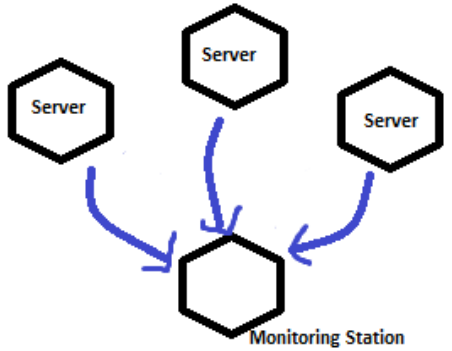
- Out-of-band
  - Very easy to setup
  - Completely agentless; OS agnostic
  - BMC watches sensors for issues
  - Monitor by polling (once/minute is enough)
  - Management traffic is physically separable
  - Impartial observer

- In-band
  - Agent runs on the production OS
  - A great example is collectd (http://collectd.org)
  - Can collect literally any data; utilization and app stats
  - May be “good enough” (hung apps require reset too)

- Either way, be sure to poll the SEL.
  - System Event Log shows permanent log of events as they occur (assert/deassert)
- And monitor storage



Out-of-band (BMC-based)



In-band (Agent-based)

BMC Health monitoring

```
root@pbj2:~# ip -H192.168.8.119 sdr elist
CPU0_Vcore       | 10h | ok  |  3.0 | 0.87 Volts
CPU1_Vcore       | 11h | ok  |  3.1 | 0.87 Volts
P5V              | 28h | ok  |  7.5 | 5.07 Volts
CPU0_Temp        | 44h | ok  |  3.2 | 26 degrees C
CPU1_Temp        | 45h | ok  |  3.3 | 26 degrees C
MB_TEMP          | 40h | ok  |  7.1 | 28 degrees C
FCB_FAN1         | 6Bh | ok  | 25.2 | 5200 RPM
FCB_FAN2         | 6Ch | ok  | 25.3 | 5200 RPM
FCB_FAN3         | 6Dh | ok  | 25.4 | 5200 RPM
FCB_FAN4         | 6Eh | ok  | 25.5 | 5200 RPM
Watchdog         | D5h | ok  |  6.1 |
EventLog         | D0h | ok  |  6.2 |
CPU0_PROC_HOT    | 58h | ok  |  3.6 | State Asserted
CPU1_PROC_HOT    | 59h | ok  |  3.7 | State Asserted
CPU0             | C0h | ok  |  3.4 | Presence detected
CPU1             | C1h | ok  |  3.5 | Presence detected
Power_Button     | D4h | ok  | 12.1 |
NB_TEMP          | 41h | ok  |  7.2 | 39 degrees C
P3V3             | 15h | ok  |  7.4 | 3.30 Volts
P0_DIMM_TEMP     | 4Ch | ok  |  8.1 | 28 degrees C
P1_DIMM_TEMP     | 4Dh | ok  |  8.2 | 32 degrees C
Chassis_Ambient  | 54h | ok  | 25.6 | 24 degrees C
DDRP0_Voltage    | 12h | ok  |  8.15 | 1.52 Volts
DDRP1_Voltage    | 13h | ok  |  8.16 | 1.51 Volts
PowerUnit        | C9h | ok  | 19.1 |
DIMM_A0          | 80h | ok  | 32.1 |
DIMM_A1          | 81h | ok  | 32.2 |
DIMM_A2          | 82h | ok  | 32.3 |
DIMM_B0          | 83h | ok  | 32.4 |
DIMM_B1          | 84h | ok  | 32.5 |
DIMM_B2          | 85h | ok  | 32.6 |
DIMM_C0          | 86h | ok  | 32.7 |
DIMM_C1          | 87h | ok  | 32.8 |
DIMM_C2          | 88h | ok  | 32.9 |
DIMM_D0          | 89h | ok  | 32.10 |
DIMM_D1          | 8Ah | ok  | 32.11 |
DIMM_D2          | 8Bh | ok  | 32.12 |
Critical_INT     | A5h | ok  |  6.3 |
System Event     | D1h | ok  |  6.4 |
PSU1             | CBh | ok  | 19.1 | Presence detected, Power Supply AC lost
PSU2             | CCh | ok  | 19.2 | Presence detected
MB_12V_Current   | CAh | ok  | 25.8 | 6 Amps
PSU1_OUT_Current | 70h | ok  | 25.9 | 0 Amps
PSU2_OUT_Current | 71h | ok  | 25.10 | 29 Amps
Outlet_TEMP      | 42h | ok  |  7.7 | 44 degrees C
PCIE_Error       | E3h | ok  | 36.1 |
CPU_Bus_Error    | E6h | ok  | 36.2 |
SR56X0_Error     | E7h | ok  | 36.3 |
```

Strategy:

- **Issue this command**
- **Look for non "ok" or "ns" status**
- **Once per minute should be enough**

Health Monitoring, ii (Bonus points)

- Nagios provides a graphical console front-end
- Bonus points if you
  - feed sensor data into a db, and
  - Apply visualization tools like Cacti (uses RRDtool)
    - May discover non-obvious trends (hot spots in the Data Center)
- A service-level monitor is also nice
  - OS can appear alive, but App stack is dead
  - Monitoring may be very app-specific
  - Framework like Munin works well (http://munin-monitoring.org/)

Best Practice: Tuning & Incremental Rollout

- Build proof of concept rather than speculate
  - Theoretical knowledge only goes so far with such complex systems
  - Workload patterns drive the architecture
  - Sometimes, impossible to know until you actually start

- If possible, scale up slowly (staged rollout)
  - 5%, 20%, 50%, 100%
  - Shake out bugs & limit their impact
  - Gives you opportunity to limit scope of physical changes, if required
  - Will become apparent if ratios are right

    (CPU-cores :: amount of RAM :: Number/type of Hard Drive)
  - Optimizations can be made for future orders

Best Practices, continued

- badblocks, 3 passes @ 100% clean saves a lot of trouble with drives (detect early mortality)

- If it's not broken, don't touch it
  - Old firmware is ok
  - Unless it isn't
  - You'll know if it isn't
  - Upgrades always carry risk

Updating Mass Numbers of Machines

Two Major Strategies: BMC or PXE

- BMC (manage by IPMI)
  - Managed out-of-band, from a central point
  - Simple in concept
  - Limited as to what it can do (settings, firmware)
  - May be able to carry out updates without host reboots

- PXE image to carry out actions
  - More complicated
  - Higher upfront effort, lower effort each use
  - Tailored to each vendor's hardware
  - No limits on scope, or what can be done
  - Requires reboots & *some* downtime
  - **Test on 1, then 5%, before rolling out to all**

- pdsh / pdcp is great for small/simple tasks

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Questions and Answers

System Management in the Hyperscale Cloud

Ask Dell's Michael Stumpf

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Thanks for joining us.

More information on AMD's cloud offerings can be found at www.AMD.com/cloud

You'll find an archive of this event at:

http://ecast.opensystemsmedia.com/

Send us your comments on the presentation:

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