Help! My (Virtual) Penguin Is Sick!

Or

*Aptenodytes Patagonicus** Problems on z/VM

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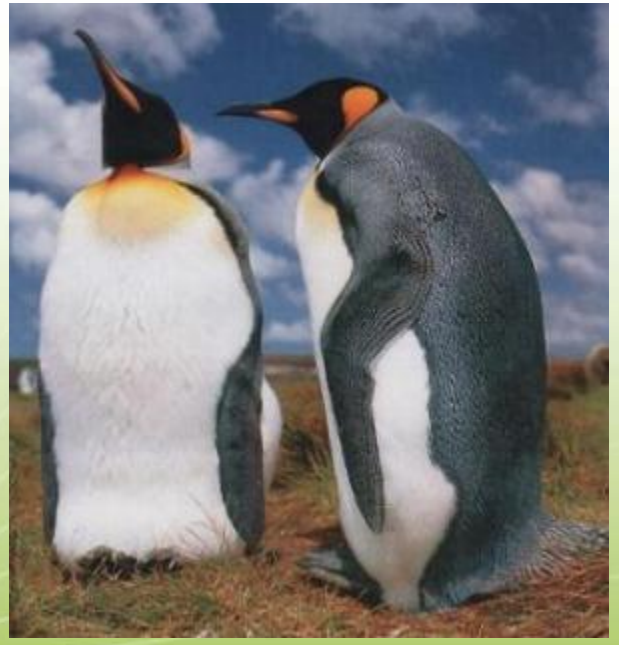

*** King Penguin, of course!**

Copyright Information

Why We're Here

The difference between
applications people and **systems** people:

Applications people worry about how it will work.

Systems people worry about how it will fail.

- If you support production, you're a systems person!

Agenda

We'll cover:

- Ways Linux can get sick
- Techniques to decide what's wrong
- Debugging information you can gather

We won't cover:

- Detailed use of debugging tools (gdb, et al.)
- Dump (core) analysis

➢ **Paramedic/first response functionality, not ER surgery or pathology lab forensic reports!**

Penguins and Bears, Oh My!

Penguin Diseases 101

The Modal Penguin Ailment

- "Why isn't my Linux virtual machine responding?", aka:
  1. Can I get from here to there?
  2. If I can get there, is there a "there" there?
  3. If there is a "there" there, is it open?

- Problems with these correspond to:
  - Networking problems
  - Linux issues
  - VM troubles

A Baseline is Useful!

- Linux guests vary widely
  - Networking configuration
  - Performance profile
  - Services provided
  - Etc., etc. etc.
- Keep ***written*** (and online) notes about production guests
  - IP address(es), network interfaces, routing, etc.
  - Typical/observed performance characteristics
  - Disk space usage
  - Etc., etc., etc.
- In a crisis, you need to know how things ***should*** look!

Network Issues

- Is it a network issue:
  - Between the user and VM?
  - Between the VM stack and the Linux virtual machine?
  - Within the Linux virtual machine?
- If you can’t get to the machine, it sure won’t respond!

VM Troubles

- Is the Linux virtual machine even logged on?
  - Someone might have logged it off, FORCEd it, etc.
- Is the virtual machine in a stopped state?
  - Users may disconnect from machines carelessly, leaving them stopped
- Is VM broken?
  - If VM is sick, Linux sure won't run!
- Is VM letting the virtual machine run?
  - CP might not be giving it resource

Linux Issues

- Is it a kernel problem within the Linux virtual machine?
  - Even Linux can have problems — OOMs (Out-Of-Memory errors), loops, or Oopses (kernel errors)
- Is a specific service (ssh, ftp, etc.) broken?
  - If that's the service the user is trying to use, Linux will appear to be down
- Is it resource exhaustion within Linux?
  - Insufficient disk space, or suffering from OOMs (Out-Of-Memory errors) can cause some/all Linux services to wait
- Is an application or service hogging resources within the Linux virtual machine?
  - Patience is a virtue…

Penguin Problem Identification

Taking Your Penguin's Temperature and Pulse

Linux Diagnostic Tools

- Linux provides various commands that allow you to diagnose your system:
  - **`ps`** (Process Status)
  - **`df`** (Display Filesystems)
  - **`free`** (memory usage display)
  - etc…
- Many of these just display data from the **`/proc`** filesystem
  - **`/proc`** is a pseudo-filesystem that offers a direct reflection of various system settings, counters, etc.
  - Much better than running control blocks in memory!
  - Files in **`/proc`** are accessed like any other file: cat, etc.
  - Writing to **`/proc`** files is one way to change some system settings on-the-fly

Diagnosing Network Issues

- Try to **`ping`** Linux from user's machine
  - If **`ping`** works, network and routing are complete between user and Linux
  - Helps if you know the Linux hostname/IP address
  - Also good to know whether Linux guest normally responds (some guests don't; some firewalls don't let ICMP echo through)
- Try **`traceroute`** to Linux from user's machine
  - **`traceroute`** failure at last hop before Linux implicates Linux networking
  - Helps if you know normal routing, so you know what the "last hop" is!
  - Note Linux, Windows, VM all have **`traceroute`**, spelled varying ways
- If Linux networking appears broken, log onto guest virtual machine, and then into Linux as **`root`**
  - May not be possible if local **`root`** login disabled (may be able to login as another user and **`su`** to **`root`**)

Diagnosing Network Issues (continued)

- Use **`ifconfig`** and/or **`netstat -i`** to examine network configuration and status
  - Bouncing connection sometimes helps (**`ifconfig down`**/**`ifconfig up`**)
- Use **`#CP QUERY VIRTUAL NIC`** to see if virtual NICs on Guest LANs are connected
- Use **`#CP QUERY LAN DETAILS`** to see what the Guest LAN looks like, including IP addresses assigned
  - Use **`#CP QUERY LAN DETAILS`** ***`lanname`*** if many LANs
- Use **`#CP QUERY VIRTUAL CTCA`** to see if virtual CTCAs are connected

Diagnosing Network Issues (continued)

- Try **`cat /proc/net/arp`**
  - Shows cached hardware addresses
  - If none, that tells you network isn't very happy
- If network is broadcast-capable (QDIO), **`ping`** the **`Bcast`** address shown by **`ifconfig`**:

```
ping -b -c 1 10.3.2.255
WARNING: pinging broadcast address
PING 10.3.2.255 from 10.3.2.2 : 56(84) bytes of data.
64 bytes from 10.3.2.2: icmp_seq=0 ttl=64 time=441 usec
```

  - **On 3270, remember to use `ping –c 1`, or `ping` will run forever (no "<Cntrl>C" possible on 3270!)**
  - If you get more than one response from your own IP address, then there's a duplicate on the network
- Learn to use **`tcpdump`** (or equivalent tool)
  - Beyond the scope of this presentation, but ***very*** powerful!

Diagnosing VM Troubles

- Is VM broken?
  - Try to log onto another VM userid
  - If that doesn't work, head for the machine room!
- Is network to/from VM healthy?
  - Try to **`ping`** and **`traceroute`** VM from your PC
  - Try to **`ping`** external host from VM
  - If you can get out but not back in, it's a routing problem external to VM
- Is the Linux virtual machine even logged on?
  - Log onto any VM userid and issue **`#CP QUERY USER`** ***`linuxid`***
  - If response is ***`linuxid`*** **`NOT LOGGED ON`**, there's your problem!

(Digression) VM SPOOLed Consoles

- VM lets you keep a copy of all console activity for a virtual machine
  - Conceptually similar to having **`root`** logged on using a hardcopy terminal
- Files are saved in VM system SPOOL space
- Closed on demand or automatically at system shutdown or user logoff
- ***Invaluable*** resource for determining abnormal virtual machine events
  - Slightly less useful for Linux, since many services do not log to console
- Still always worth checking!
  - Oopses, OOMs, some segfaults ***are*** logged to console

How To SPOOL the Console

- CP **SPOOL** command turns on SPOOLing:
  CP SPOOL CONSOLE START
  CP TERMINAL TIMESTMP ON useful: timestamps all output
- Various options control default destination userid, class, and filename/filetype
- Often useful to indicate date/time SPOOL started:
  CP SPOOL CONSOLE START TO * NAME *yyyymmdd hh:mm:ss*
  - Once file is closed, file timestamp will be ***close*** time, so this adds useful info
- May want to centralize console collection:
  CP SPOOL CONSOLE START TO CONSAVER NAME *yyyymmdd hh:mm:ss*

Finding (Open) VM SPOOLed Consoles

- To determine if a running virtual machine has its console SPOOLed:

  #CP QUERY PRT ALL *linuxid*

  - Look for open **CON** file:

```
ORIGINID FILE CLASS RECORDS  CPY HOLD DATE  TIME NAME TYPE
linuxid  6216 T CON nnnnnnnn 001 NONE OPEN- 0009 name type
```

  - Existence of file is useful data point

- To close the console and send it to yourself:

  #CP SEND CP *linuxid* CLOSE CONSOLE *yourid*
  (where ***yourid*** is your userid)

  - CP SEND requires privilege class C

Processing VM SPOOLed Consoles

- Result of previous command is message:
  RDR FILE *nnnn* SENT FROM *linuxid* CON WAS *mmmm* RECS *rrrr* …
- Note the "***nnnn***" value — that's the SPOOL file number in ***your*** virtual reader
- Issue CMS **PEEK** command to view the file:
  PEEK *nnnn* (FOR *
  - Places you in XEDIT session, viewing file contents
  - Large files may require some time to read, need larger virtual storage
  - Note: files may span days; **HCPMID6001I** appears each midnight
- Use CMS **RECEIVE** command to read file to disk
  - PF9 in **PEEK**, or:

  RECEIVE *nnnn fn ft fm*

Finding (Closed) VM SPOOLed Consoles

- To find SPOOLed consoles for non-running virtual machines (or to find consoles from previous logons):

  #CP QUERY RDR ALL *linuxid*
  #CP QUERY PRT ALL *linuxid*
  #CP QUERY RDR ALL XFER ALL *linuxid*

  - First two commands show files in ***linuxid*** 's virtual reader or printer
  - Last command shows files sent or transferred to other virtual machines
- Use CP **TRANSFER** command to transfer files to your reader:

  TRANSFER *ownerid* RDR *nnnn* *

  - Then follow same procedures as for newly closed file (**PEEK**, **RECEIVE**)

Notes About SPOOLed Consoles

- Consoles can get very large
  - For long-running guests with significant console activity, consider closing periodically to keep files manageable
  - Might close at midnight via simple **WAKEUP**-based service machine
  - Using **EOF** option causes automatic closure every 50,000 records (may or may not be desirable, depending on how you manage the files)
- Naming consoles rationally helps a lot
  - When SPOOLing them
  - **RECEIVE** them as "***userid yyyymmdd***", perhaps
- Vendor products exist to aid console management

When and Why Was Linux Logged Off?

- Examine operator's console to see when and why it was logged off:

  User *linuxid* LOGOFF AS *linuxid* USERS = *n*
  - means it was logged off "normally", either by a user command or by Linux itself after shutdown

  User *linuxid* LOGOFF AS *linuxid* USERS = *n* FORCED BY *vmid*
  means it was logged off through a **CP FORCE** command issued by ***vmid***

  User *linuxid* LOGOFF AS *linuxid* USERS = *n* FORCED BY SYSTEM
  - means it was logged off due to CP "timebomb" logoff, after being left in read for (usually) 15 minutes while disconnected

- Examine Linux guest console, look at bottom for more nuggets

Diagnosing VM Troubles

- If Linux virtual machine is logged on, is it stopped because it's in a **CP READ**?
  - Issue **CP SEND CP *linuxid* BEGIN** to start it (harmless at worst)
  - Also use **RUNNABLE EXEC** (see *Resources*) to check quickly
- How did it get there?
  - Linux virtual machine force disconnected (by system issue or because user closed emulator rather than issuing **#CP DISC**) when **RUN** is **OFF**
  - Linux virtual machine reconnected and left in **CP READ** (with **RUN OFF**)
  - **CP STOP** or **CP CPU ALL STOP** issued on Linux virtual machine
- Moral:
  - *Run your Linux virtual machines with **CP SET RUN ON**!!!*

Diagnosing VM Troubles

- Is VM giving the virtual machine any service?
  - CP might not be giving it resource
  - Likely if Linux virtual machine reconnect shows **`RUNNING`** with no keyboard response
  - If it seems normal at reconnect, hit ENTER a couple of times, look for **`VM READ`**, Linux **`login:`** prompt
  - If no read, or significant delay before login prompt, VM may not be running the virtual machine
- Basic understanding of scheduling and dispatching useful

Scheduler and Dispatcher 101

- Virtual machines must be **runnable** to do work
  - CP must be willing to **schedule** the virtual machine
  - CP must be willing to **dispatch** the virtual machine
- A virtual machine is in one of three lists:
  - **Dormant list**: virtual machine is not trying to do any work
  - **Dispatch list**: virtual machine is active and CP is allowing it to run
  - **Eligible list**: virtual machine is active, but CP is not allowing it to run

Scheduler and Dispatcher 101

- The scheduler decides whether there are enough resources to give a virtual machine some service
  - If not enough resources are available, virtual machine does not get scheduled
- The dispatcher gives virtual machines access to CPUs
  - If multiple virtual machines are active, they take turns
  - VM is ***very*** good at this — supports tens of thousands of active users with excellent response time

Dispatch Classes

Class 1 virtual machines:

- When a virtual machine is first dispatched, it is **class 1**
  - Such users are usually referred to as "**Q1 users**"
  - CP waits one class 1 elapsed timeslice (C1ETS) to see if it goes idle voluntarily
  - If virtual machine does not go idle within that timeslice, it is preemptively stopped from execution ("queue dropped") — sent back to the scheduler
  - C1ETS is dynamically calculated to keep a fixed % of users in class 1
  - C1ETS should be enough for short, interactive transactions (minor CMS commands)

Dispatch Classes

Class 2 virtual machines:

- If virtual machine does not go idle voluntarily in one Class 1 Elapsed Time Slice, it enters **class 2**
  - Such users are usually referred to as "**Q2 users**"
  - Next time CP runs it, it is given 8x C1ETS
  - If virtual machine does not leave the dispatch list within that amount of time, it is queue dropped (sent back to the scheduler)
  - Such users are presumed to be running a command, but not necessarily doing something "major"

Dispatch Classes

Class 3 virtual machines:

- If virtual machine does not go idle voluntarily within class 2 multiple of C1ETS, it enters **class 3**
  - Such users are usually referred to as "**Q3 users**"
  - Next time CP runs it, it is given 6x the class 2 timeslice (=48x C1ETS)
  - If virtual machine does not leave the dispatch list within that amount of time, it is queue dropped (sent back to the scheduler)
  - Such users are presumed to be running a long-running command

Dispatch Classes

Class 0 virtual machines:

- Users with **`OPTION QUICKDSP`** or **`SET QUICKDSP ON`** bypass some of the Q1/Q2/Q3 rules
  - Still subject to queue drops, but never get held in eligible list
- Interactive users (users who hit ENTER or PF/PA keys) also get a Q0 stay
  - Such users are called “hotshot” users
  - Still subject to queue drops, but “go to the head of the line” for a brief period
  - Return to their previous queue level after Q0 stay
- Users spinning on certain locks are also in Q0
  - Such “lockshot” users presumably are preventing other users from running

Leaving the Dispatch List

- Virtual machines leave the dispatch list because they:
  - Go idle voluntarily (load a wait PSW)
  - Hold execution waiting on a CP resource (paging, DIAGNOSE I/O)
  - Leave SIE emulation due to execution of a privileged instruction (privop)
- When virtual machine leaves dispatch list, a queue drop test timer is set (300ms)
  - If virtual machine resumes activity within that period, it is reinserted into previous place in queue — ***not*** into Q1 again (unless it came from there)!
  - Linux guests without the “notimer” patch never go idle long enough to get dropped from queue!

How This Plays Out…

- CP analyzes real resources, makes scheduling decisions
  - If not enough resource, virtual machines are held in Eligible list (E-list)
  - Assumption is that resource will become available soon
  - If resource not freed, E-listed virtual machines never get scheduled
- Dispatched virtual machines “should” go idle
  - Linux tends not to go idle (without “notimer” patch)
  - Linux virtual machines thus stay runnable all the time!
- CP considers machines with outstanding I/O to be active
  - Linux machines usually have a pending network I/O
  - Prior to APAR VM63282, this meant Linux machines never left queue!
  - With the APAR, network I/O is ignored for queue drop purposes

How Does This Go Wrong?

- Linux machines tend to:
  - Be quite large (virtual storage size)
  - Have a working set size close or equivalent to virtual storage size
  - Stay active (rarely/never go idle)
  - Not use shared pages (DCSS)
- Aggregate real storage requirements for Linux are thus much higher than the average CMS virtual machine
- If enough large Linux virtual machines are logged on, CP notices it will overcommit real storage
  - One or more such virtual machines “lose”, are E-listed — and stay there!

How Does This Manifest?

- System is running along fine
  - One guest too many is started
  - Things “just stop”!
- Remember the queue drop timer:
  - Guests never go idle (as far as CP can tell)
  - Never cycle out to scheduler, so E-listed guests stay there!

Detection

- **`CP INDICATE QUEUES EXPANDED`** command shows:

```
LINUX902       Q3 PS  00013577/00013567 .... -232.0 A00
LINUX901       Q3 PS  00030109/00030099 .... -231.7 A00
VSCS           Q1 R   00000128/00000106 .I.. -208.7 A00
LINUX201       Q3 PS  00031166/00029348 ..D. -1.072 A00
LINUX401       Q3 PS  00030214/00028874 ..D. -1.010 A00
VMLINUX3       Q3 IO  00052962/00051162 .... -.9398 A00
VMLINUX3 MP01  Q3 PS  00000000/00000000 ....  .0612 A00
LINUX123       E3 R   00177823/00196608 ....  5255. A0
```

  - **`HELP INDICATE QUEUES`** shows meaning of output
  - CP privilege class E required
  - **Note:** “deadline time” (sixth column) sometimes very large — and very bogus
  - Virtual machine **`LINUX123`** is not going anywhere anytime soon…

Remediation

- Buy more storage ($10K/GB — cheap!)
- Make sure “notimer” patch is installed
  - Obviously only meaningful if guests are nominally idle
  - Remember **`cron`** and other things may wake them up anyway
- Log off some guests
- Tune guest storage sizes
  - Linux uses “extra” storage for file buffers
  - Back off virtual storage size until guests swap, then add a bit more (or not)

Diagnosing Kernel Problems

- Log onto Linux guest to see if it's even alive:
  - Hit ENTER, look for **`VM READ`**, login prompt
  - No **`VM READ`** means Linux is "hung" (looping or otherwise busted)
  - No login prompt could just mean **`login`** isn't running (again, it helps to know what normal behavior is!)
  - Look at SPOOLed console for Oops messages
- "What's an Oops?"
  - A system ABEND, in VM terms: a kernel failure
  - Like VM, may or may not leave the system in a usable state
  - Examples: the kernel tries to access an invalid memory location
  - Doesn't necessarily indicate code bug — faulty hardware can cause an Oops

Basic Oops Analysis

- Utility **`ksymoops`** maps addresses in Oops output to kernel modules
  - Uses system map file, usually found in **`/boot`**
- Oops output used by **`ksymoops`** is in a file
  - Usually found in **`/var/log/messages`**
  - If **`syslogd`** not running, extract with **`dmesg`** utility (**`dmesg > oops.log`**)
  - If Linux not even that alive, cut & paste from console log, or type it back in!
- **Note:** If cascading Oopses, only first is usually relevant

Diagnosing Kernel Loops

- Use **#CP INDICATE USER *linuxid* EXPANDED** to watch guest CPU time
  - If increasing rapidly, guest may be looping (could just be busy, though)
  - Also note I/O counts, look for massive I/O load
- If loop suspected, log onto guest, use **CP TRACE**:
  - #CP TRACE INST RUN NOTERM PRINT
  - Let it run for a bit; monitor with **#CP QUERY PRT * ALL**
  - Then issue **#CP TRACE END** and **#CP CLOSE PRT ***, **RECEIVE** file
  - Analyze for repeated hits/patterns (or ask vendor to)

Diagnosing Broken Linux Services

- Use **`ps aux`** to show what services are running, pipe through **`grep`** to find target:

```
# ps aux | grep ssh
```

  - Finds any lines that mention "**`ssh`**" (may find the **`grep`** itself, too)

- Restart service that's not up and should be
  - Perhaps restart it anyway if it claims to be up but isn't responding!

Diagnosing Broken Linux Services

- Look at system log files
  - **`/var/log/messages`** may contain something interesting
- The **`dmesg`** utility also shows recent kernel messages
  - Looks at “kernel ring buffer” — sort of like a trace table, but just messages
- Look at logs for service in question
  - Alas, location not predictable — try **`/var/log/`*`servicename`** (prescribed by Linux Filesystem Hierarchy Standard, but not all applications behave)
  - Beware: Linux time and VM time may differ (timezone, drift)
  - Look in application directories, if you know what they are
  - Failing that, read the documentation (gasp) or code for the application
- Note: default logging levels often omit useful information
  - May need to set environment variable for next occurrence of problem

Diagnosing Resource Exhaustion

- If Linux runs short on a resource, results “may be unpredictable”
  - Well-behaved applications will fail in graceful ways
  - Severe and/or rapid resource depletion may prevent this
- Nothing unique about Linux resources that can be depleted:
  - Disk space
  - Memory
  - Page (swap) space
  - CPU

Diagnosing Disk Space Exhaustion

- "df" (Display Filesystems) shows filesystem status

```
# df -a –h
Filesystem              Size  Used Avail Use% Mounted on
none                    592M   94M  464M  17% /
none                       0     0     0    -  /proc
none                       0     0     0    -  /dev/pts
/dev/dasd/0000/part1    485M   17M  468M    4% /tmp
```

- Most interesting part is "Use%"
  - Filesystems above 90% may be suspect due to temporary file usage
  - Again, useful to know "normal" usage levels

Diagnosing Memory Exhaustion

- Some Linuxes take OOM (Out-Of-Memory) errors when insufficient “real” (virtual) memory is available
  - Applications can get OOMs
  - The kernel can get an OOM too (much more serious, usually game over!)
- OOMs are reported on Linux console:

  `Out of Memory: Killed process (`*`processname`*`)` (application OOM)
  `Out of memory and no killable processes` (kernel OOM)
- The ***`processname`*** is the name you would see from **`ps`**
  - May or may not be the process that was really using all the memory (may not be a real memory hog, just lots of small processes!)
- OOMs were removed as of kernel level 2.4.23
  - Now applications get individual memory allocation failures, must handle

Diagnosing Memory Exhaustion

- The **`free`** command displays system memory use:

```
# free -t
             total       used       free     shared    buffers     cached
Mem:        191092     185160       5932          0      13032      80548
-/+ buffers/cache:      91580      99512
Swap:       197176       2920     194256
Total:      388268     188092     200176
```

- "**`-/+ buffers/cache`**" line most interesting: shows usage without taking file buffers and cache into account
  - Those pages are reclaimable for system use (DPA, in VM terms)
  - If Swap space is mostly/entirely in use, expect application OOMs/hangs!

Diagnosing CPU Exhaustion

- As on many operating systems, a single application can grab enough CPU to slow Linux
  - Mechanisms exist to control this, of course, but are not enabled by default
- **`top`** command is the "performance monitor" tool
  - **`sar`** is a popular free alternative (see *Resources*)
  - Vendor tools exist, of course (RMF PM, Velocity, Perfman — see *Resources*)
  - Beware: **`top`** can take a long time to start up on a loaded system!
- **`uptime`** displays 1-, 5-, 15-minute CPU load averages
  - Look for rising trend to show recent problem
  - Values > 1.00 mean CPU is fully loaded (work is waiting)
  - Cannot tell whether rising values mean this Linux or another machine is using more CPU — could mean higher fraction of less available CPU

top Command Output


```
 4:26pm  up 5 days,  7:10,  2 users,  load average: 1.00, 1.00, 1.00
82 processes: 80 sleeping, 2 running, 0 zombie, 0 stopped
CPU states:  0.8% user, 14.0% system,  0.0% nice, 85.1% idle
Mem:  191092K av, 185808K used,   5284K free,      0K shrd, 12976K buff
Swap: 197176K av,   2920K used, 194256K free                80288K cached
  PID USER  PRI  NI  SIZE  RSS SHARE STAT %CPU %MEM   TIME COMMAND
 6250 root   17   0  1060 1060   844 R     5.9  0.5   0:01 top
 6142 root    9   0  2320 2320  1828 S     0.3  1.2   0:02 sshd
    1 root    9   0   556  540   492 S     0.0  0.2   0:02 init
    2 root    9   0     0    0     0 SW    0.0  0.0   0:00 kmcheck
    3 root    9   0     0    0     0 SW    0.0  0.0   0:00 keventd
  etc…
```

- Note that the, um, top command is **`top`** itself!
  - Shows up where it does because it's sampling all current resources
  - Look at other candidates, note "heavy hitters"
  - "**`top d 5`**" will auto-refresh every five seconds, show some trends
- See **`man`** page to interpret values, especially **`STAT`**
  - Note "**`0.0% nice`**" — negative value would mean some tasks have priority

Other Performance Measurements

- Look at **`/proc/loadavg`**
  - Fourth value is #processors/#processes running (e.g., **`2/81`**)
  - Fifth value is number of total processes started since system booted
  - If fifth value is changing rapidly, something is going on
- SNMP provides some data, depending on settings
  - Must be enabled, of course, and SNMP collector operating somewhere!
  - Make sure ***not*** to leave default public/private strings (passwords) in place (sounds obvious, but empirical evidence shows far too many folks do)!
- Linux I/O statistics may be useful
  - Enable by **`echo set on > /proc/dasd/statistics`**
  - Must be enabled ***before*** problem, of course, to be useful!
  - Statistics generated in **`/proc/dasd/statistics`**

Other Performance Measurements

- **`cat /proc/chandev`** shows current state of devices
  - Useful if other evidence suggests a problem with a device
- Learn CP commands that tell about the virtual machine:

`QUERY VIRTUAL ALL`	(lots of output!)
`QUERY VIRTUAL DASD`	(show all virtual DASD)
`QUERY VIRTUAL` ***`xxxx`***	(show a specific device)
`QUERY MDISK`	(show ownership of a virtual DASD)

- z/VM Performance Toolkit can provide some external performance measurement
  - Won't tell you what's going on inside Linux, but at least let you profile it
- **`iostat`** (partner to **`sar`**) also useful for I/O monitoring

VM Monitor Data

- z/VM generates monitor data on demand
  - Highly granular, very efficient mechanism
- Linux for zSeries can, too, as of recent IBM code drop
  - Still few (no?) tools to exploit it well
  - Stay tuned…

Penguin Forensics

Recording Evidence Before Burying the Body

First Failure Data Capture

- IBM has long promoted **First Failure Data Capture**:
  - Collecting useful debugging information when a problem first occurs
  - “Reboot and if it happens again let us know” is ***not*** FFDC!
  - VM, MVS, AIX, DB2, even Tivoli push FFDC
  - Even Windows XP Error Reporting can be considered FFDC
- As Linux matures, FFDC concepts are seeping in
  - Logging, trace tables, memory leak/overlay traps, more dump capabilities…
  - Still mostly not standard features, however — optional installs

Log Levels

- syslogd (syslog daemon) collects and writes messages from various services, applications
  - Of course, it has to be running to be useful!
  - Can centralize messages from multiple systems to single host
- Level of messages to be logged is configurable
  - Understanding logging levels for your services/applications is essential to ensuring FFDC
- Standard Linux syslogd isn't very smart/flexible
  - Insufficiently granular in many cases
  - Uses UDP, which means messages can get lost due to network congestion
  - Alternatives exist, such as syslog-ng (see **`www.balabit.com`**)

Cores

- Traditional *ix dumps were "**core files**"
  - Created when applications did something blatantly illegal
  - Created in current working directory, either **`core`** or **`core.`*`pid`*** (controlled by **`/proc/sys/kernel/core_uses_pid`**)
- Modern distributions typically ship with cores disabled
  - Most Linux users wouldn't know what to do with these large files!
  - May contain sensitive data from currently running application
- bash **`ulimit –c `*`size`*** enables for current login
  - **`ulimit –c unlimited`** means "dump everything"
  - **`ulimit –c`** displays current setting (value > 0 means enabled)
  - See **`man bash`** for details

Dumps

- As a VMer, I want to VMDUMP a wonky virtual machine:
  `#CP VMDUMP 0-END TO MAINT`
  - But none of the Linux dump tools want to read VMDUMPs!
  - Still, the VM Dump Tool is programmable, can certainly handle Linux dumps
- LKCD (lcrash) — Linux Kernel Crash Dump
  - Must be installed ***before*** the problem occurs
  - lcrash is the “IPCS” tool that helps you analyze the dump
- Standalone dump facilities available for zSeries Linux
  - IBM mini-manual: Using the Dump Tools (LNUX-1208-01) at
    `www.ibm.com/servers/eserver/zseries/os/linux/pdf/l39dmp24.pdf`
  - Analyze dumps with lcrash

Linux Debugging Tools

- Kernel breakpoint tools:
  - KProbes (Kernel Probes): **`www.ibm.com/linux/projects/kprobes/`**
  - DProbes (Dynamic KProbes): **`www.ibm.com/developerworks/oss/linux/projects/dprobes`**
- Kernel event (trace table) logging:
  - LTT (Linux Trace Toolkit): **`www.opersys.com/LTT/index.html`**
  - Strace (System call Trace): **`www.liacs.nl/~wichert/strace`**
- Memory debuggers:
  - YAMD (Yet Another Malloc Debugger): **`www.cs.hmc.edu/~nate/yamd/`**
  - NJAMD (Not Just Another Malloc Debugger): **`fscked.org/proj/njamd.shtml`**
- General debugger:
  - gdb (The GNU Project Debugger): **`www.gnu.org/software/gdb/gdb.html`**

Learning Linux Debugging Techniques

- Zapping Linux bugs:
  `www.eservercomputing.com/mainframe/articles/index.asp?id=675`
- Mastering Linux debugging techniques:
  `www.ibm.com/developerworks/library/l-debug/?n-l-8152`

FFDC: What To Save

- Linux data
  - System log files
  - Application log files
  - Any core files
  - Application configuration files
- VM data
  - VM console logs
  - CP command output
  - Trace files
  - Monitor data
  - Performance monitor reports
  - Any dumps
  - Guest directory entries

Conclusion

Summary

- To the VMer, Linux is obscure and opaque
- To the Linux expert, VM is the same!
- To provide proper support, learn to use the tools
  - Both VMers and Linux folks can learn from each other
- As always, use the community
  - **LINUX-390@marist.edu**: zSeries Linux mailing list
  - **VMESA-L@listserv.uark.edu**: z/VM mailing list

➢z/VM and Linux — even better together!

Resources

- **RMF PM**: `www.ibm.com/servers/eserver/zseries/zos/rmf/rmfhtmls/pmweb/pmlin.htm`
- **Velocity Software** (ESALPS): `www.velocitysoftware.com`
- **Perfman**: `www.perfman.com`
- **sar** (part of sysstat): `freshmeat.net/projects/sysstat/`
- **ksymoops**: `www.gnu.org/directory/devel/debug/ksymoops.html`
- **zSeries Linux**: `www.ibm.com/servers/eserver/zseries/os/linux/`
- **Performance tips**: `www.vm.ibm.com/perf/tips/linuxper.html`
- **RUNNABLE EXEC**:
  - Display virtual machine status; email me for a copy

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