Monitoring Linux Performance for the SQL Admin

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Centino systems

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Agenda

- Linux System Architecture
- SQL on Linux Architecture
- System Components
    - CPU/Processes
    - Memory/Pages
    - Disk/File Systems
- Monitoring Tools

Linux Architecture

User Space	Users	Interact with the Shell	Cause Problems :)
	Shell	Executes Your Commands…Your Interface to the Kernel	Commands, Editors…any User Program
Kernel Space	Kernel	Resource Management and Access	Process, Pages and File Systems
	Hardware	Physical Resources	CPU, Memory and Disk

SQLOS

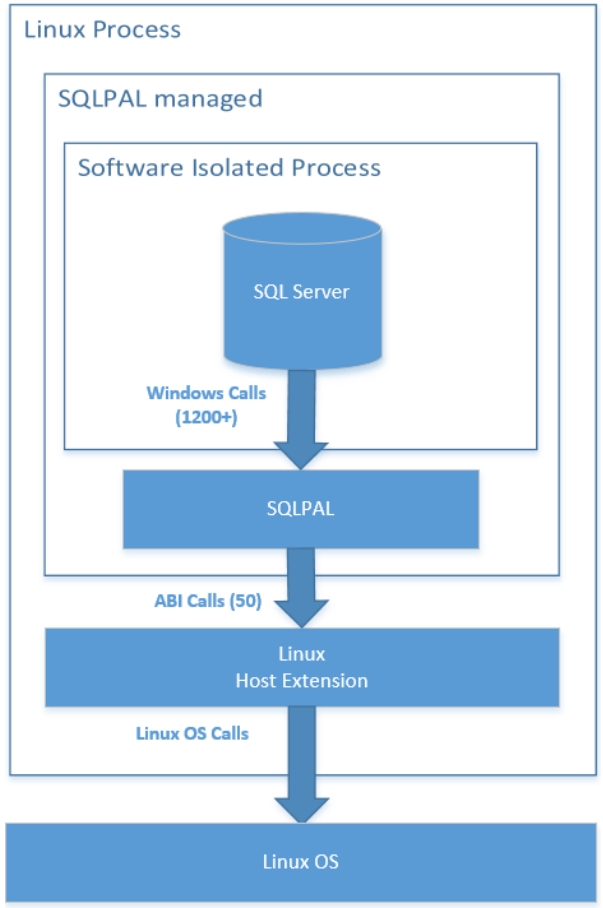
- **Scheduling**
  - Placing tasks into workers and getting access to the CPU
- **Synchronization**
  - Controlling access to system resources
- **I/O**
  - Scheduling of I/O both network and disk
- **Memory Management**
  - Allocation of memory to various system objects

Primary function is resource management specific to RDBMS

“A new platform layer in SQL Server 2005 to exploit new hardware capabilities and their trends” S. Oks

“Operating System support for Database Management” M. Stonebraker

SQL on Linux Architecture - Process Layout



From: https://blogs.technet.microsoft.com/dataplatforminsider/2016/12/16/sql-server-on-linux-how-introduction/

Shhhhhh - SQLPAL is Virtualization ;)

- **Process virtualization (not machine)**
  - Presenting another environment inside the process' context that's different than that of the hardware's operating environment

- But the environment is purpose built for SQL Server

- We need to understand that this is a hybrid Win32/Linux process and have a firm grasp of
  - Resource allocation and management in SQLPAL
  - How that turns into Linux OS performance

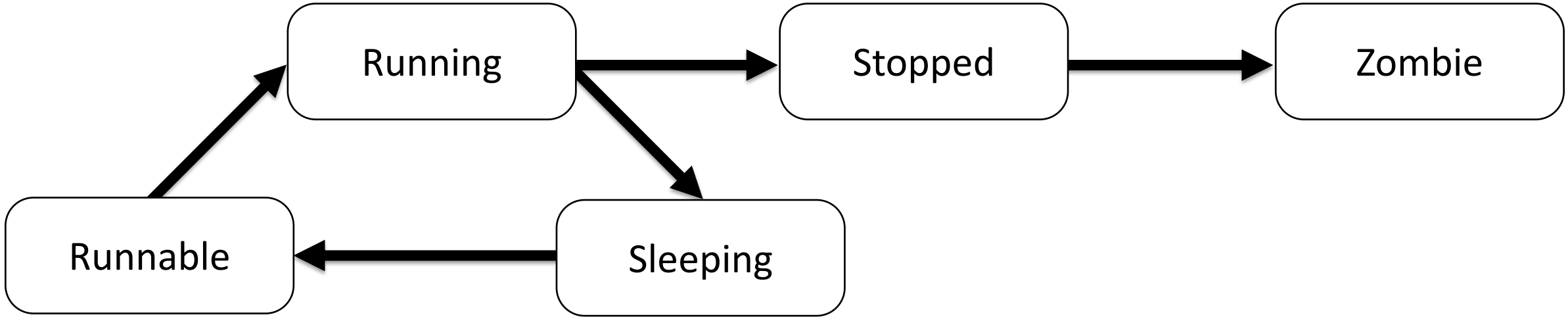
CPU and Processes

What is a Process

- Process
  - Executing program, program code, memory and resources
- Thread (LWP)
  - Shared access to resources
- Process and Thread Creation
  - `fork/exec` - parent process yields a child process with a PID
  - `clone` - same address space as thread creator, cheap and fast!
- Process Tree
  - The hierarchy of parent and it's child processes

What is a Process (con't)

- Process States



Process/Thread Scheduling

- Unit of scheduling is the thread
- Default scheduler is `SCHED_OTHER`/`SCHED_NORMAL`

- Time sharing scheduler
  - Preemptive
  - Dynamic priority list, based on niceness
  - Calculated quantum length based on priority
  - NUMA aware

CPU - What to look for?

- Percentage of what?
- Load average
- Run queue length and I/O waits
- Spikes aren’t bad
- Long waits

Tools to use for process monitoring

- `top/htop`
- `ps`
- `mpstat/pidstat`
- `dstat`
- `procfs`

Demos

- Processes and threads
- Run load average under CPU saturation
- Exploring `procfs`

Memory and Pages

Memory

- Memory Layout and Architecture
  - Physical and Virtual Memory
  - NUMA - free lists per node
  - Demand Paging
    - Allocation, Minor Page Fault
    - Swap out
      - Time and Pressure
    - Swap in, Major Page Fault
  - File System Cache and swappiness - http://red.ht/2cHg9Vk

Pages

- Regular pages - 4KB
- Transparent huge pages - 2MB
  - Increases memory I/O by decreasing TLB cache misses
- SQLOSv2
  - Can request large pages inside SQL Server…with trace flag 834
    - SQL will allocate memory on start up
    - When SQLPAL exposes 8GB+ to SQL Server
- As of today, no locked pages…but TF 835 is on?

Memory - What to look for?

- High consumers of space
  - Physical
  - Virtual
- External memory pressure on SQL Server
- Excessive swapping
  - swapping in/out

Tools to use for memory monitoring

- `/proc/meminfo`
- `free`
- `top/htop`
- `ps`
- `vmstat`
- `pidstat`

Demos

- Memory layout
- Isolating a memory hog
- Identifying external memory pressure
  - External memory pressure on SQL Server
- Excessive swapping
  - Swapping in/Swapping out

Disks and File Systems

File Systems

- XFS
  - Default file system - http://red.ht/2dBXccx
- EXT4
- Block size
  - Impact utilization and performance nominally
  - 4KB default block size

Disks - What to look for?

- Saturated disks and I/O subsystems
- Swapping
- Caching is your friend (generally, but not in an RDBMS)
- Baseline!

Tools to use for disk monitoring

- `iostat`
- `iotop`
- `pidstat`
- `dstat`

Demos

- Finding high I/O processes and measuring disk latency

Monitoring Tools

Baselining Tools

- Nearly everything we've talked about so far has been point in time…what about baselining?
  - `sar` - System Activity Reporter
  - `dstat` - writes to CSV

Tools for Monitoring SQL Server

- You have all of the same tools you're used to for SQL Server
  - Because of SQLOS we get
    - DMVs
    - Extended Events

New Tools Available for SQL on Linux

- New DMVs
- PSSDiag
  - https://blogs.msdn.microsoft.com/sqlcat/2017/08/11/collecting-performance-data-with-pssdiag-for-sql-server-on-linux/
- DBFS
  - https://github.com/Microsoft/dbfs
  - http://www.centinosystems.com/blog/sql/dbfs-command-line-access-to-sql-server-dmvs/
- Grafana
  - https://blogs.msdn.microsoft.com/sqlcat/2017/07/03/how-the-sqlcat-customer-lab-is-monitoring-sql-on-linux/

Metrics Captured by PSSDiag

- Don’t just listen to me…here’s what Microsoft is interested in
  - CPU - `mpstat`, `pidstat`
  - Disk - `iostat`, `iotop`
  - Memory - `free`, `sar`
  - Network - `sar`
  - DMV Data
  - System log information

Review

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Need more data?

- **Contact me!**
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- **Blog**
  - www.centinosystems.com/blog
- **Pluralsight**
  - **Understanding and Using Essential Tools for Enterprise Linux 7**
    - Linux basics, system architecture, file and directory management
  - **LFCE: Advanced Network and System Administration**
    - systemd, Performance and Tools
  - **SQL Server on Linux Administration Fundamentals**
    - Installation, Configuration, Linux for DBAs and Backup/Restore

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References

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- https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/7/html/performance_tuning_guide/index
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