Linux Process Management

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https://github.com/swacademy/fss/tree/main/Linux

Program in Linux

- Refers to a set of instructions or code designed to perform a specific task or set of tasks on a computer.
- Key aspects
  - Open Source
  - Command-Line Interface(CLI) Programs
  - Graphical User Interface(GUI) Programs
  - Package Management
  - Compatibility
  - Variety of Applications
  - Community Support
- Kinds
  - System Programs
  - Application Programs

Program in Linux (Cont.)

- Refers to any piece of software that can be executed.
- Includes
  - Executable Binaries
  - Scripts
  - Applications
  - System Daemons and Services
- Can install programs from package managers like ***apt*** (for Debian-based systems) or ***yum*** (for Red Hat-based systems), compile them from source, or run them as scripts.

PATH

- Way to search programs
  - **`$ echo $PATH`**
- When the command is executed, the system does the following:
  - Find specified path
  - Search the ***$PATH*** variable for program

```
ubuntu@ubuntu-desktop:~$ echo $PATH
/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin
ubuntu@ubuntu-desktop:~$
```

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Process

- Is a fundamental concept representing a running instance of a program.
- When start a program on a Linux system, it becomes a process.
- Each process in Linux has a unique identifier called a Process ID (***PID***) and contains the program's executable code, its current activity (or ***state***), and the resources assigned to it.
- Key aspects
  - Process ID (PID)
  - Parent and Child Processes
  - Process State
  - Resources
  - Execution Context
  - Environment
  - Priority and Scheduling
  - System Calls and User Space

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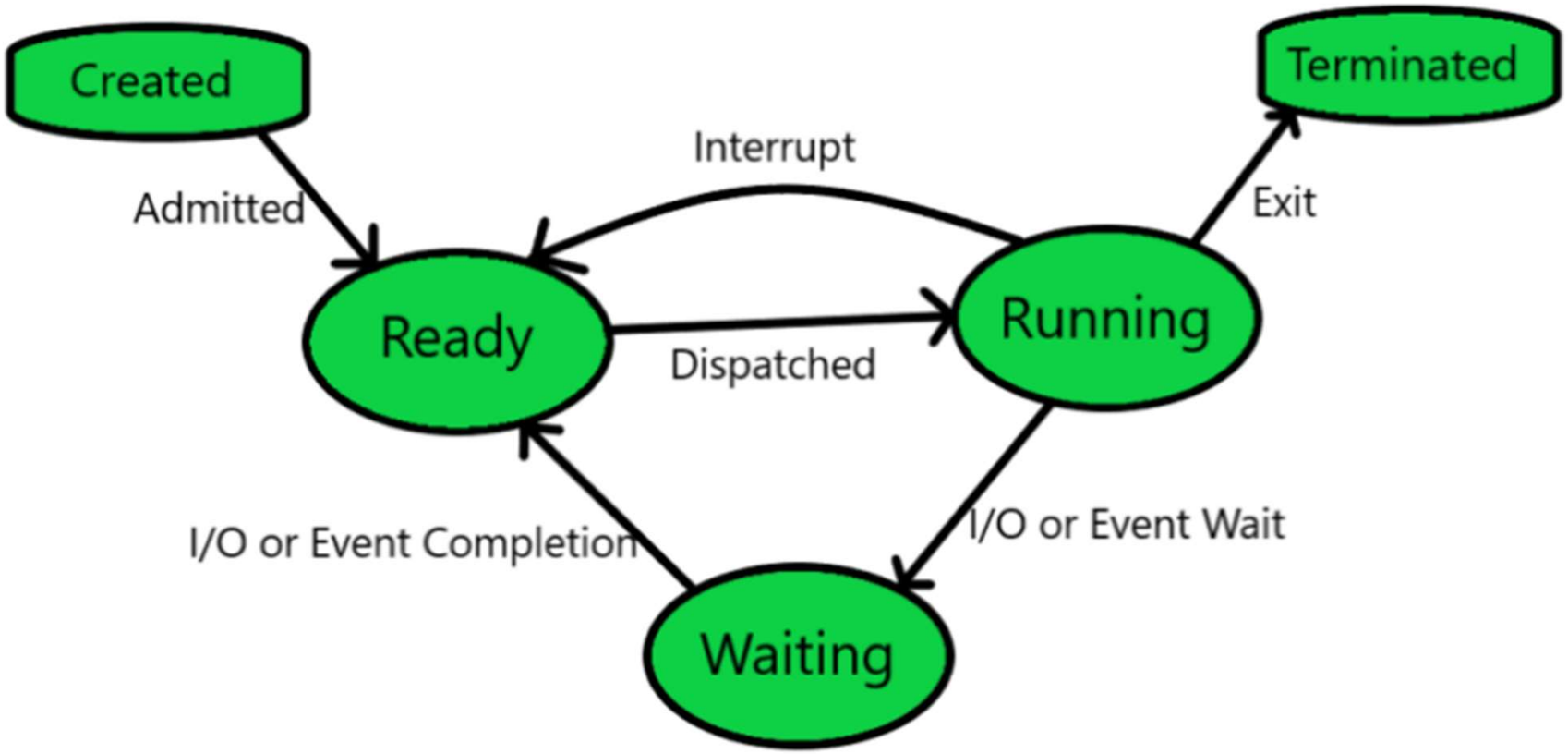
Process state



https://tecadmin.net/linux-process-status/

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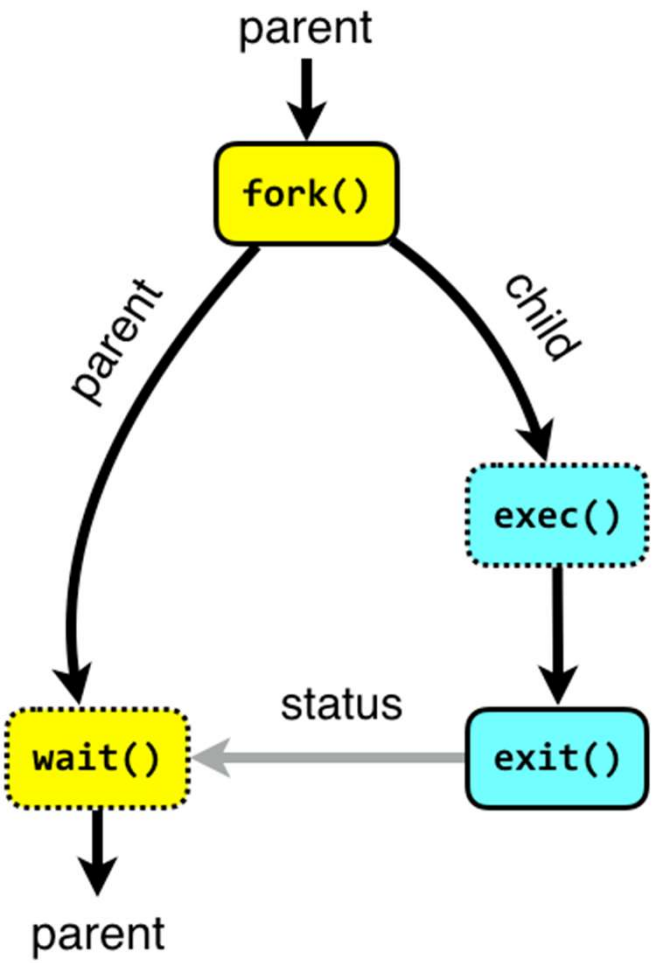
Process management



https://www.it.uu.se/education/course/homepage/os/vt18/module-2/process-management/

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`ps` Command

- Is a standard utility used to display information about the currently running processes on a system.
- Stands for ***p***rocess ***s***tatus.
- Is widely used for monitoring the system's processes
- Is an essential tool for system administration and troubleshooting.
- Provides various details about
  - PID
  - TTY
  - TIME
  - CMD
  - USER
  - %CPU, %MEM

```
ubuntu@ubuntu-desktop:~$ ps
    PID TTY          TIME CMD
  14305 pts/2    00:00:01 bash
  19639 pts/2    00:00:00 ps
ubuntu@ubuntu-desktop:~$
```

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`ps` Command (Cont.)

- Options and Flags
  - **`-e`** or **`-A`** : List all processes
  - **`-f`** : Show processes in a hierarchical format
  - **`-u [username]`** : Display processes for a specific user
  - **`aux`** : Combining multiple flags
    - **`a`** : Show processes for all users
    - **`u`** : Display the process's user/owner
    - **`x`** : Include processes not attached to a terminal
  - **`-p [PID]`** : Selecting processes by PID
- Piping with *grep*
  - To find a specific process, can pipe the output of **`ps`** into **`grep`**

```
$ ps aux | grep [processName]
```

ubuntu

`pidof` Command

- Is a simple utility used to find the process ID (PID) of a running program.
- Syntax
  - `$ pidof [programName]`
- Example
  - `$ pidof apache2`

```
ubuntu@ubuntu-desktop:~$ pidof sshd
14304 14268 14257 14221 13977
ubuntu@ubuntu-desktop:~$
```

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`pstree` Command

- Is a useful tool for displaying the process hierarchy, showing how processes are related to each other in a tree structure.

```
systemd─┬─VBoxService───7*[{VBoxService}]
        ├─accounts-daemon───2*[{accounts-daemon}]
        ├─2*[agetty]
        ├─atd
        ├─cron
        ├─dbus-daemon
        ├─irqbalance───{irqbalance}
        ├─2*[iscsid]
        ├─lvmetad
        ├─lxcfs───2*[{lxcfs}]
        ├─networkd-dispat───{networkd-dispat}
        ├─nginx───2*[nginx]
...
```

https://linuxize.com/post/pstree-command-in-linux/

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top Command

- Is a real-time system monitor that provides a dynamic view of running processes and system resource usage.

```
top - 14:05:08 up 1 min,  1 user,  load average: 2.56, 1.69, 0.67
Tasks: 281 total,   1 running, 280 sleeping,   0 stopped,   0 zombie
%Cpu(s):  8.8 us,  3.0 sy,  0.0 ni, 88.2 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
MiB Mem :   3928.7 total,    499.8 free,   1481.0 used,   1948.0 buff/cache
MiB Swap:   2048.0 total,   2048.0 free,      0.0 used.   2197.6 avail Mem

    PID USER      PR  NI    VIRT    RES    SHR S  %CPU  %MEM     TIME+ COMMAND
   2190 bosko     20   0 4507960 369540 129716 S  19.3   9.2   0:07.05 gnome-shell
   1544 bosko     20   0 1012080  86956  50644 S   5.0   2.2   0:01.67 Xorg
   7510 bosko     20   0 1142728  72280  48040 S   4.0   1.8   0:01.25 nautilus
   6555 bosko     20   0  817396  50692  38188 S   2.0   1.3   0:00.46 gnome-termin+
    932 root      20   0 1094548  41044  18844 S   0.3   1.0   0:02.78 snapd
   1207 mysql     20   0 2077480 385408  35440 S   0.3   9.6   0:00.77 mysqld
   1509 bosko      9 -11 1674144  19956  15216 S   0.3   0.5   0:00.99 pulseaudio
   1813 bosko     20   0  158232   2708   2340 S   0.3   0.1   0:00.10 VBoxClient
   2756 bosko     20   0  980444  78352  48848 S   0.3   1.9   0:02.74 snap-store
      1 root      20   0  168184  12196   8440 S   0.0   0.3   0:01.00 systemd
      2 root      20   0       0      0      0 S   0.0   0.0   0:00.00 kthreadd
      3 root       0 -20       0      0      0 I   0.0   0.0   0:00.00 rcu_gp
```

https://phoenixnap.com/kb/top-command-in-linux

`top` Command (Cont.)

- Options
  - **`-h`** or **`help`**
  - **`-v`** or **`version`**
  - **`-b`** : Runs in batch mode, useful for sending output to a file or another program.

```
ubuntu@ubuntu-desktop:~/CompanyA$ top -hv
  procps-ng 3.3.17
Usage:
  top -hv | -bcEeHiOSs1 -d secs -n max -u|U user -p pid(s) -o field -w [cols]
ubuntu@ubuntu-desktop:~/CompanyA$
```

https://phoenixnap.com/kb/top-command-in-linux

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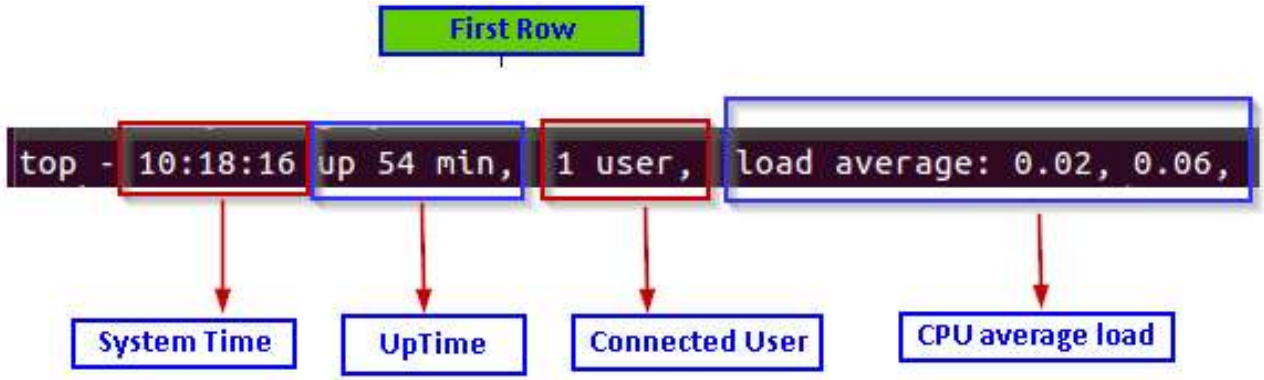
top Command (Cont.)

- First Row



- Current system time (10:18:16)
- Uptime of the system(up 54 min)
- Count of logged in users (1 user)
- Average CPU load (load average: 0.02, 0.06) : 0.02 in last minute and 0.06 in last five minutes.

https://www.sqlshack.com/helpful-linux-commands-for-sql-server-dbas-top/

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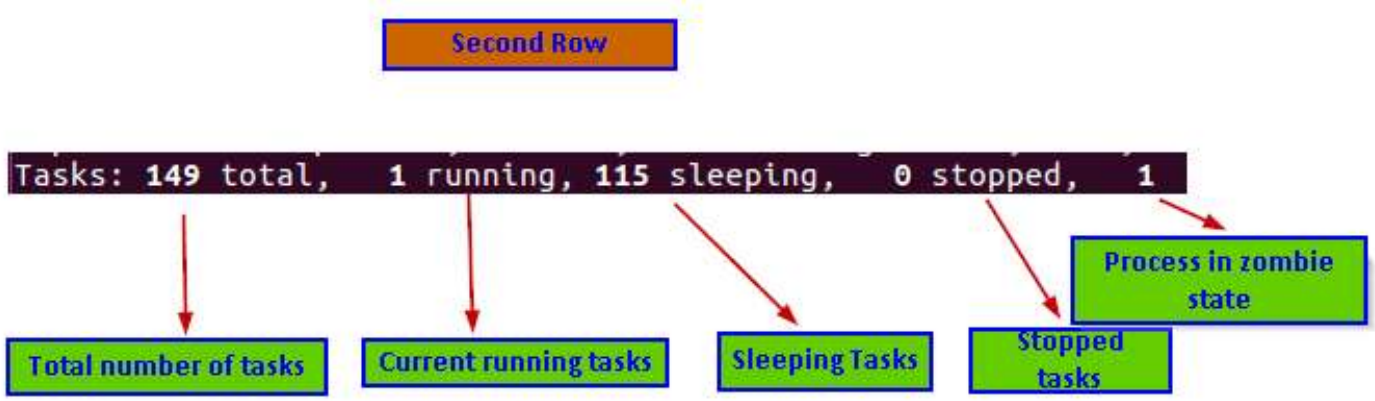
top Command (Cont.)

- Second Row



  - Total number of tasks
  - A number of currently running tasks
  - A total number of tasks in a sleeping state
  - Total number of stopped tasks
  - A total number of processes in a zombie state

https://www.sqlshack.com/helpful-linux-commands-for-sql-server-dbas-top/

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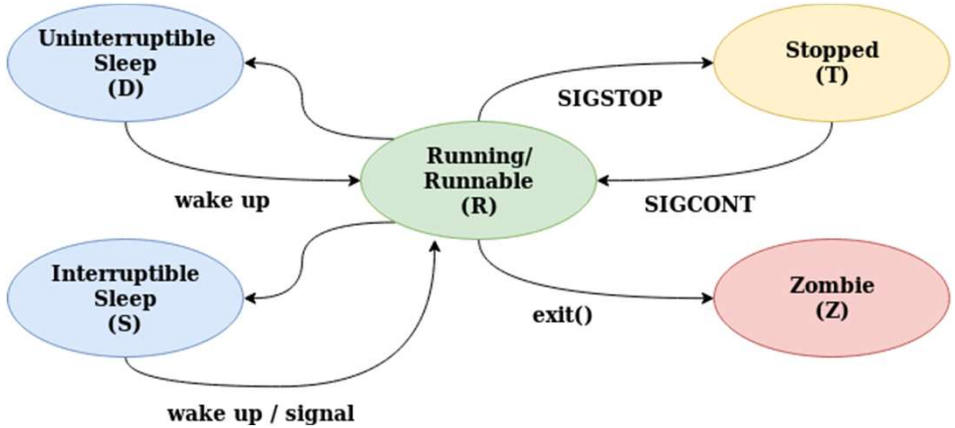
top Task state



- R(Running)
  - The process is either running or ready to run.
- S(Sleeping)
  - The process is sleeping, waiting for an event or resource.
- D(Uninterruptible Sleep)
  - Waiting for I/O completion, cannot be interrupted.
- Z(Zombie)
  - Completed process, awaiting collection by its parent.

```
top - 20:12:28 up  3:13,  1 user,  load average: 0.00, 0.00, 0.00
Tasks:  90 total,   1 running,  49 sleeping,   0 stopped,   0 zombie
%Cpu(s):  0.2 us,  0.2 sy,  0.0 ni, 99.3 id,  0.0 wa,  0.0 hi,  0.0 si,  0.3 st
KiB Mem :  3977796 total,  3359996 free,   122140 used,   495660 buff/cache
KiB Swap:        0 total,        0 free,        0 used.  3634520 avail Mem
```

- T(Stopped)
  - Process has been stopped, typically by a job control signal.
- t(Tracing Stop)
  - Process is stopped by a debugger during tracing.

https://www.systranbox.com/how-to-find-stale-processes-in-linux/

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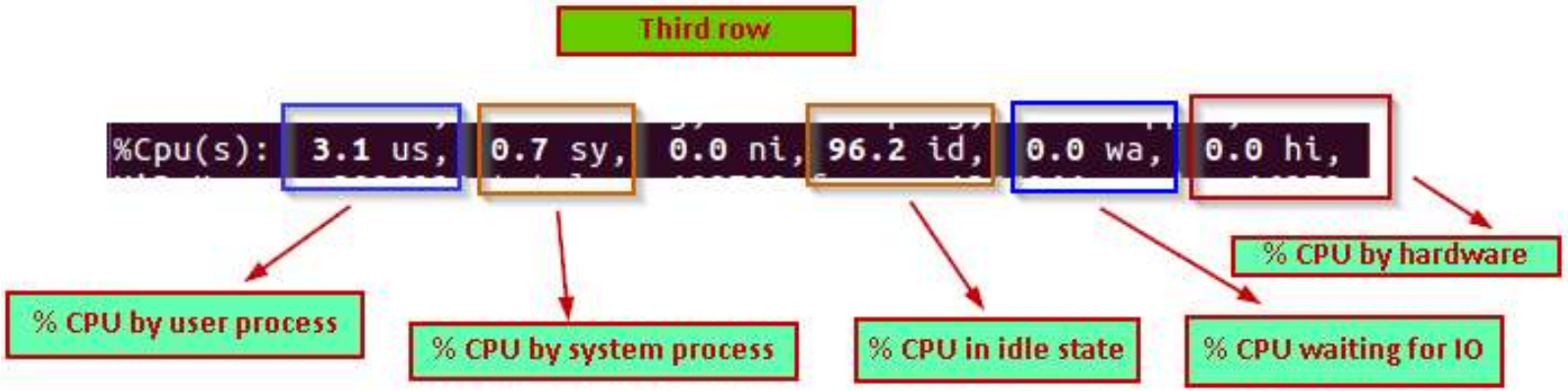
top Command (Cont.)

- Third Row

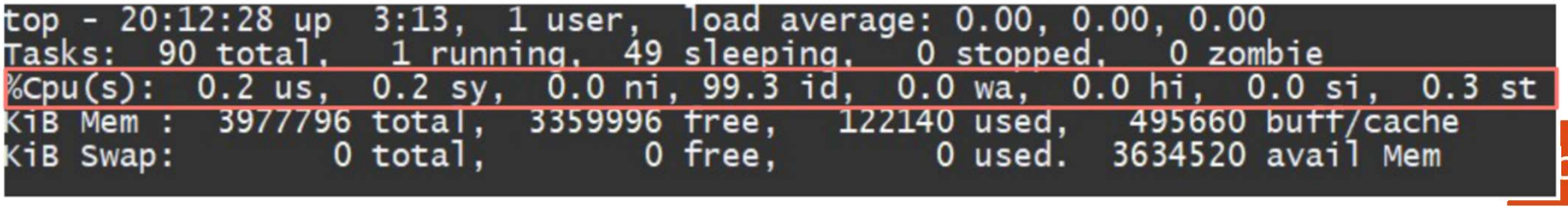


- 3.1 us % CPU used by the user processes
- 0.7 sy % CPU used by the system processes
- 96.2 id % CPU by in idle state
- 0.0 wa % CPU waiting for IO
- 0.0 hi % CPU time by hardware interrupts

https://www.sqlshack.com/helpful-linux-commands-for-sql-server-dbas-top/

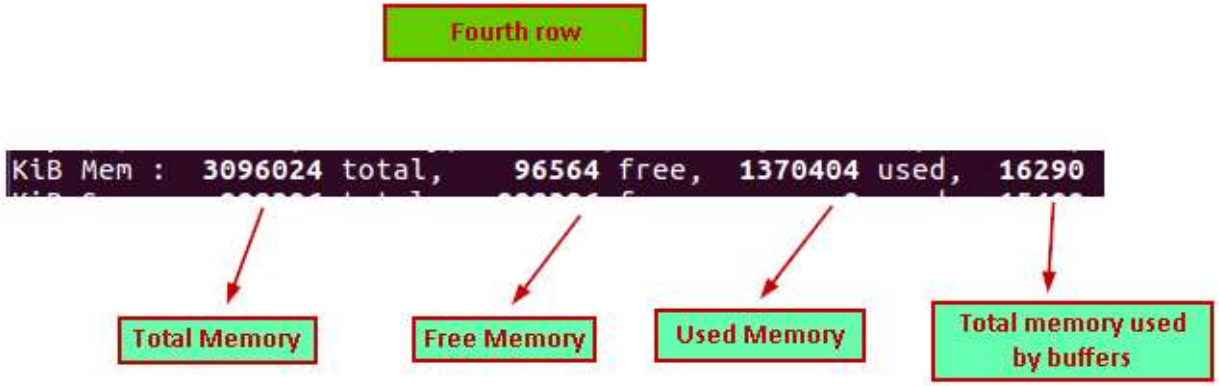
top CPU value

Value	Description
us (User Time)	Time CPU spends executing processes in user mode.
sy (System Time)	Time spent on system/kernel tasks.
ni (Nice Time)	Time spent on user processes with a positive nice value.
id (Idle Time)	CPU time when no tasks are running.
wa (I/O Wait)	Time waiting for I/O operations to complete.
hi (Hardware Interrupts)	Time dealing with hardware interrupts.
si (Software Interrupts)	Time handling software interrupts.
st (Steal Time)	Time that a virtual CPU waits for a real CPU (in virtualized environments).



top Command (Cont.)

- Fourth Row



- 3096024 total: Total system memory in KB
- 96564 free: Available memory in KB
- 370404 used: Used memory in KB
- 16290: Memory used by the buffer cache in KB

https://www.sqlshack.com/helpful-linux-commands-for-sql-server-dbas-top/

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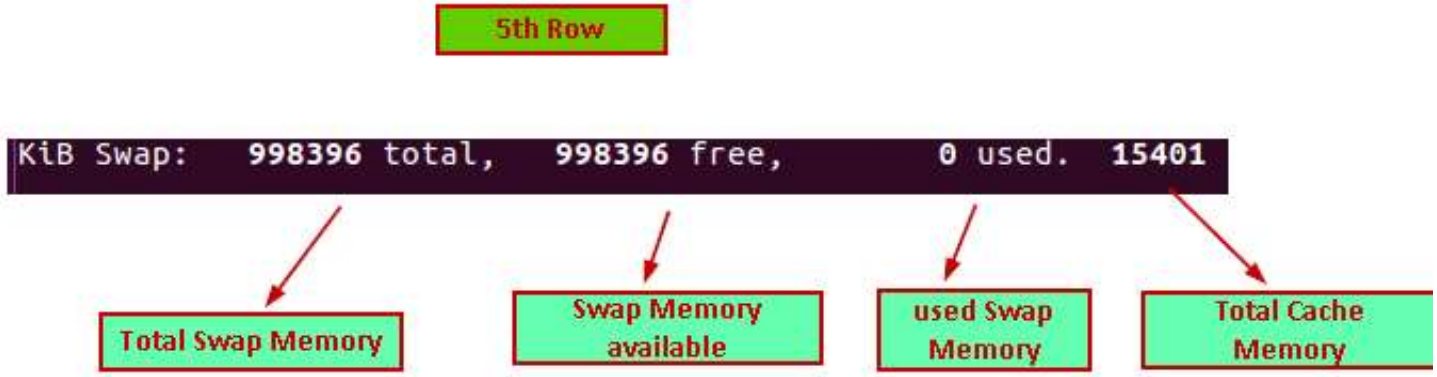
top Command (Cont.)

- Fifth Row



- 998396 total: Total swap memory in KB
- 988396 free: Available swap memory in KB
- 0 used: Currently used swap memory in KB
- 15401: Total Cache memory

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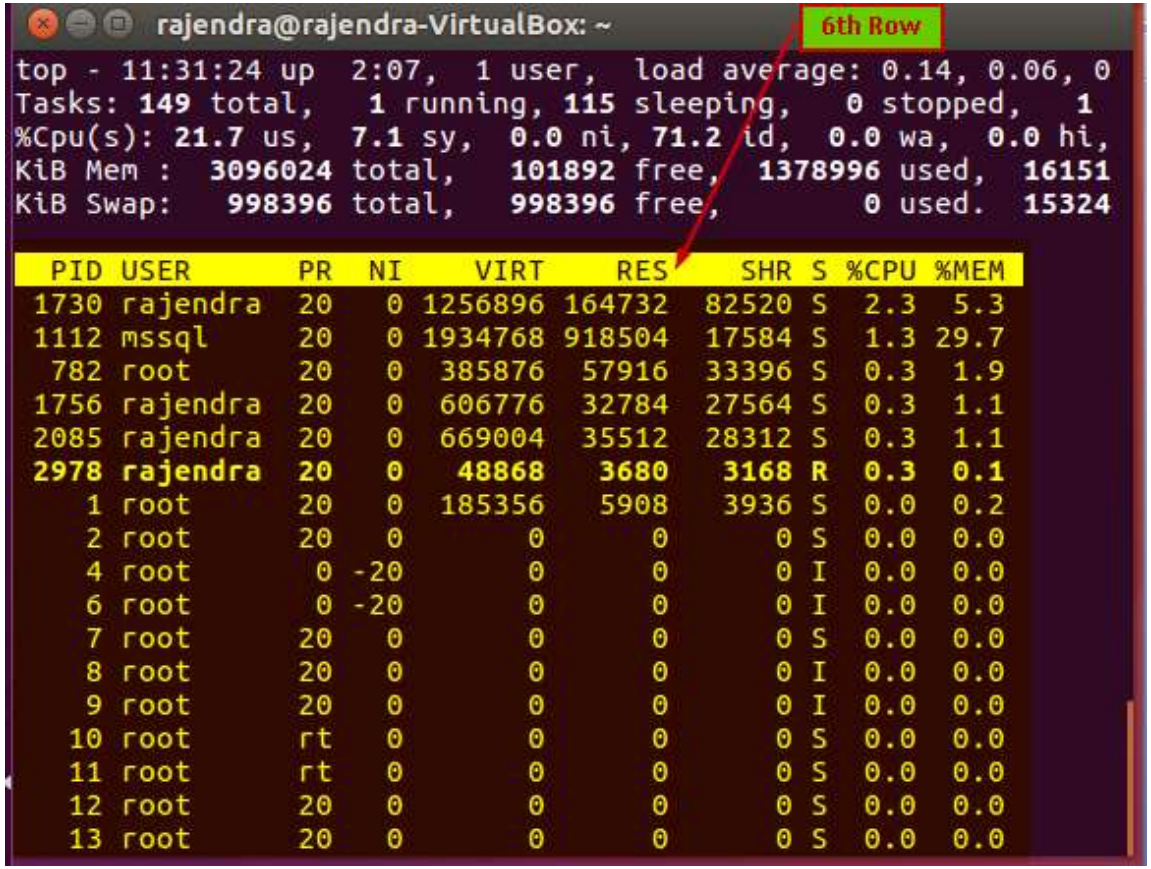
top Command (Cont.)

- Sixth Row



- **PID**: this is the process id of the running process
- **User**: It is the user id for which the process is running
- **PR**: it is the process priority. We can see value 'rt' in this column as well. RT means the process is running real-time

https://www.sqlshack.com/helpful-linux-commands-for-sql-server-dbas-top/

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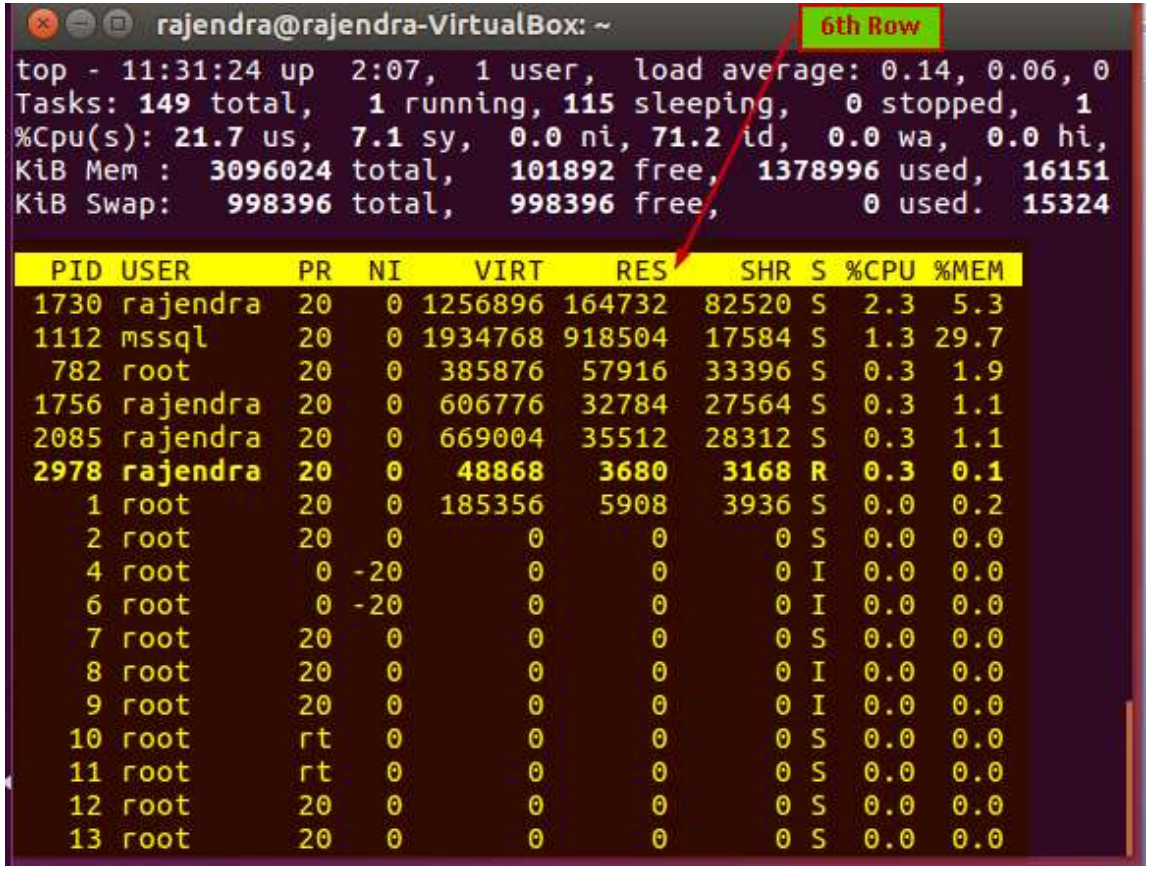
top Command (Cont.)

- Sixth Row (Cont.)



- **Ni**: It is the nice value of the process running. The negative value on this column shows high priority. Nice value range is -20 to 19 in which -20 is the highest and 19 lowest value
- **VIRT**: It is the virtual memory in KB used the process
- **RES**: it is the physical memory in KB used by that particular process

https://www.sqlshack.com/helpful-linux-commands-for-sql-server-dbas-top/

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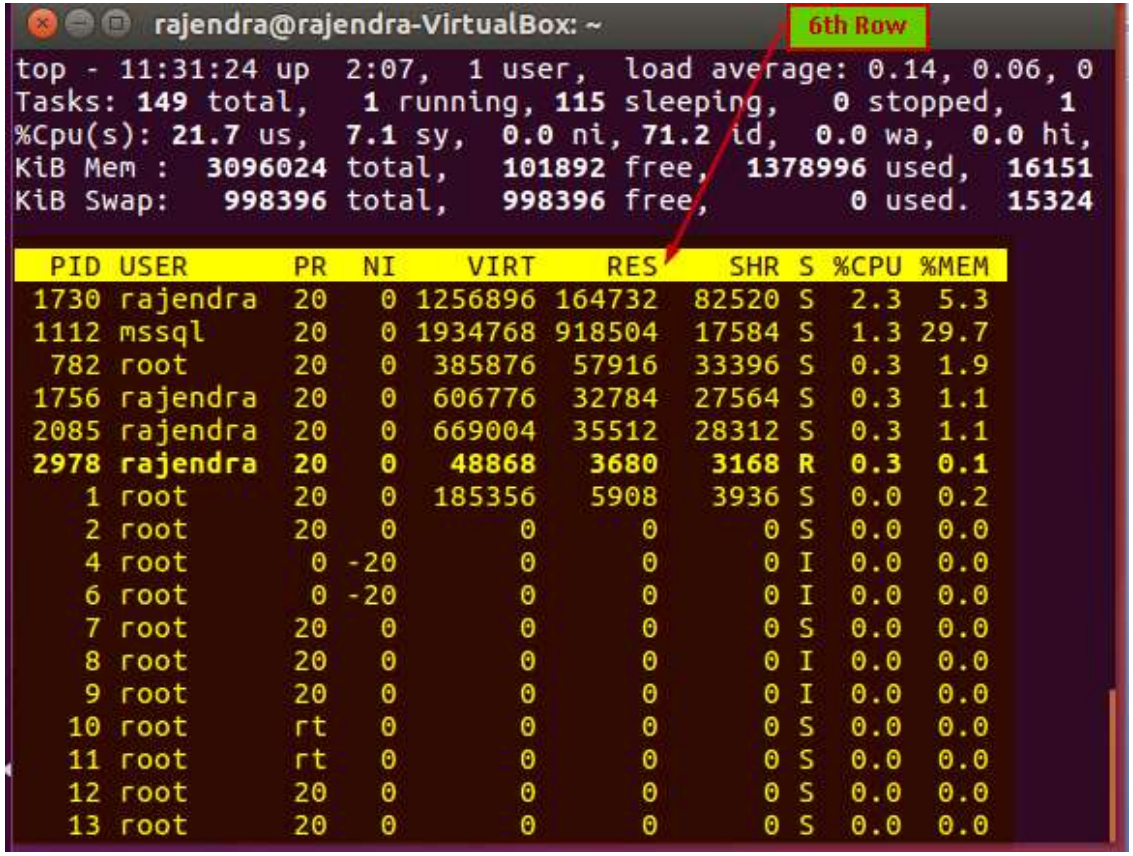
top Command (Cont.)

- Sixth Row (Cont.)



- **SHR**: it is the shared memory used by the process in KB
- **S**: it defines process status(S- Sleeping, R- running, I- idle, Z-Zombie)
- **%CPU**:% CPU used by the process
- **%MEM**: % memory used by the process

https://www.sqlshack.com/helpful-linux-commands-for-sql-server-dbas-top/

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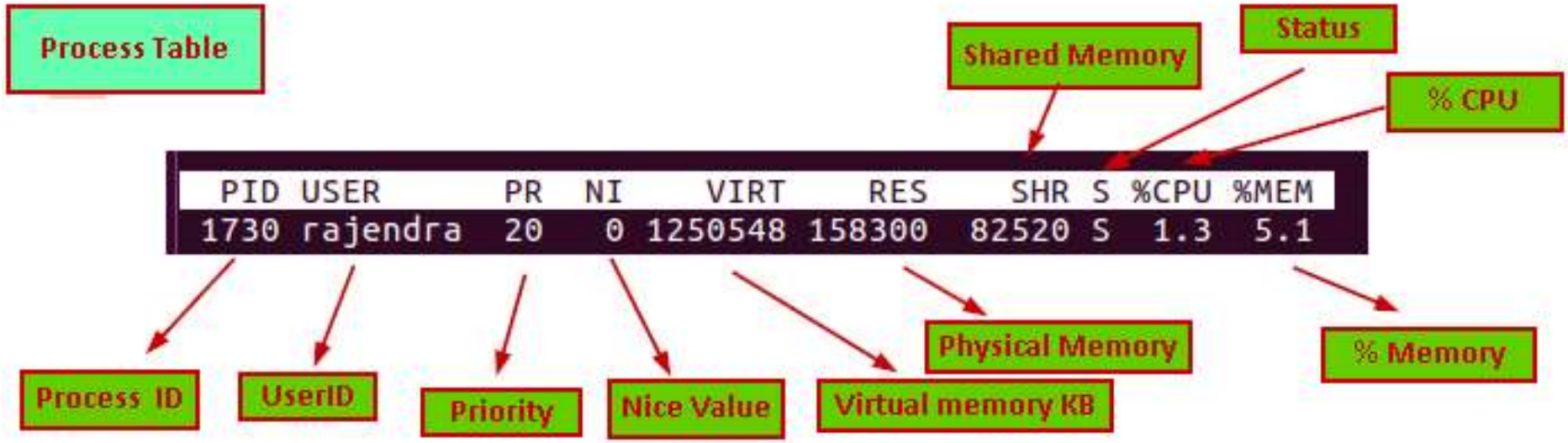
top Command (Cont.)

- Sixth Row (Cont.)



https://www.sqlshack.com/helpful-linux-commands-for-sql-server-dbas-top/

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`kill` Command

- Sends signals to processes, primarily used to terminate processes.
- By default, it sends ***SIGTERM*** (signal 15), asking a process to stop gracefully.
- If unresponsive, ***SIGKILL*** (signal 9) forcefully terminates it.
- Usage
  - `$ kill [signal_option] [PID]`
- Options
  - `-9` for ***SIGKILL***
  - `-15` for ***SIGTERM***

```
jayesh@jayesh-VirtualBox:~$ kill -l
 1) SIGHUP       2) SIGINT       3) SIGQUIT      4) SIGILL       5) SIGTRAP
 6) SIGABRT      7) SIGBUS       8) SIGFPE       9) SIGKILL     10) SIGUSR1
11) SIGSEGV     12) SIGUSR2     13) SIGPIPE     14) SIGALRM     15) SIGTERM
16) SIGSTKFLT   17) SIGCHLD     18) SIGCONT     19) SIGSTOP     20) SIGTSTP
21) SIGTTIN     22) SIGTTOU     23) SIGURG      24) SIGXCPU     25) SIGXFSZ
26) SIGVTALRM   27) SIGPROF     28) SIGWINCH    29) SIGIO       30) SIGPWR
31) SIGSYS      34) SIGRTMIN    35) SIGRTMIN+1  36) SIGRTMIN+2  37) SIGRTMIN+3
38) SIGRTMIN+4  39) SIGRTMIN+5  40) SIGRTMIN+6  41) SIGRTMIN+7  42) SIGRTMIN+8
43) SIGRTMIN+9  44) SIGRTMIN+10 45) SIGRTMIN+11 46) SIGRTMIN+12 47) SIGRTMIN+13
48) SIGRTMIN+14 49) SIGRTMIN+15 50) SIGRTMAX-14 51) SIGRTMAX-13 52) SIGRTMAX-12
53) SIGRTMAX-11 54) SIGRTMAX-10 55) SIGRTMAX-9  56) SIGRTMAX-8  57) SIGRTMAX-7
58) SIGRTMAX-6  59) SIGRTMAX-5  60) SIGRTMAX-4  61) SIGRTMAX-3  62) SIGRTMAX-2
63) SIGRTMAX-1  64) SIGRTMAX
jayesh@jayesh-VirtualBox:~$
```

`nice` & `renice` Command

- Are used to adjust the scheduling priority of processes.
- nice
  - Sets the priority of a new process.
  - A higher nice value means a lower priority, and the range typically goes from *-20* (highest priority) to *19* (lowest).
  - Usage
    - `$ nice -n [nice_value] [command]`
- renice
  - Alters the priority of existing processes.
  - It requires the process ID (PID) and can change the nice value of a process that's *already running*.
  - Usage
    - `$ renice [nice_value] -p [PID]`

ubuntu

`jobs` Command

- Is used to display the status of jobs in the current shell session.
- what's job
  - Refers to a process that was started by the shell and can be running, stopped, or terminated.
- `jobs` shows the job ID, state (like running or stopped), and the command that initiated the job.
- Particularly useful for managing background and suspended jobs, helping users keep track of multiple processes they've initiated in their shell session.

`jobs` Command (Cont.)

- How to use
  - List Jobs
    - Type jobs in the terminal.
    - This will display a list of current jobs with their status (running, stopped, etc.).
  - Job Control
    - Can bring a job to the foreground with **`fg %[job_id]`** or send it to the background with **`bg %[job_id]`**.
  - Job IDs
    - Jobs are referenced by their job ID, which is displayed next to each job by the jobs command.

`at` Command

- Schedules commands or scripts to be executed at a later time.
- Specify the time for execution in a variety of formats, and at then runs the provided commands at that time.
- Example
  - `$ at now + 2 hours`
- How to use
  1. Schedule a Job: Enter at followed by the time for the job. For example, `at 5pm` or `at now + 1 hour`.
  2. Enter Commands: After pressing Enter, you'll get a prompt. Type the command(s) you want to execute.
  3. End Input: Press `Ctrl+D` to save the job.

`cron` Command

- Is not directly used but refers to the **`cron`** daemon and **`crontab`** files that handle scheduled tasks.
- Cron jobs are tasks scheduled to run automatically at specified intervals.
- Use the **`crontab`** command to create, edit, list, or remove **`cron`** jobs.
- How to use
  - **`$ crontab -e`** for edit the current user's crontab
  - **`$ crontab -l`** for listing current cron jobs
- Crontab format
  - minute hour day month weekday command

`cron` Command (Cont.)

- Crontab format
  - minute hour day month weekday command
- Minute ➔ 0-59
- Hour ➔ 0-23
- Day of Month ➔ 1-31
- Month ➔ 1-12
- Day of Week ➔ 0-7 (both 0 and 7 are Sunday)
- Command

Lab. 프로세스 관리