

# Guider: An Integrated Runtime Performance Analyzer

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## About Myself



- Senior Software Engineer at Hyundai Motor Company
- Performance Engineer analyzing and improving infotainment system
- Currently working on Guider project
- Interested in Linux, Python, Software Platform



# Contents



- Performance
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  - Tools
- Guider
  - Introduction
  - How to use
  - Performance Analysis
  - Guider on AGL
- Future Work

## Performance Optimization

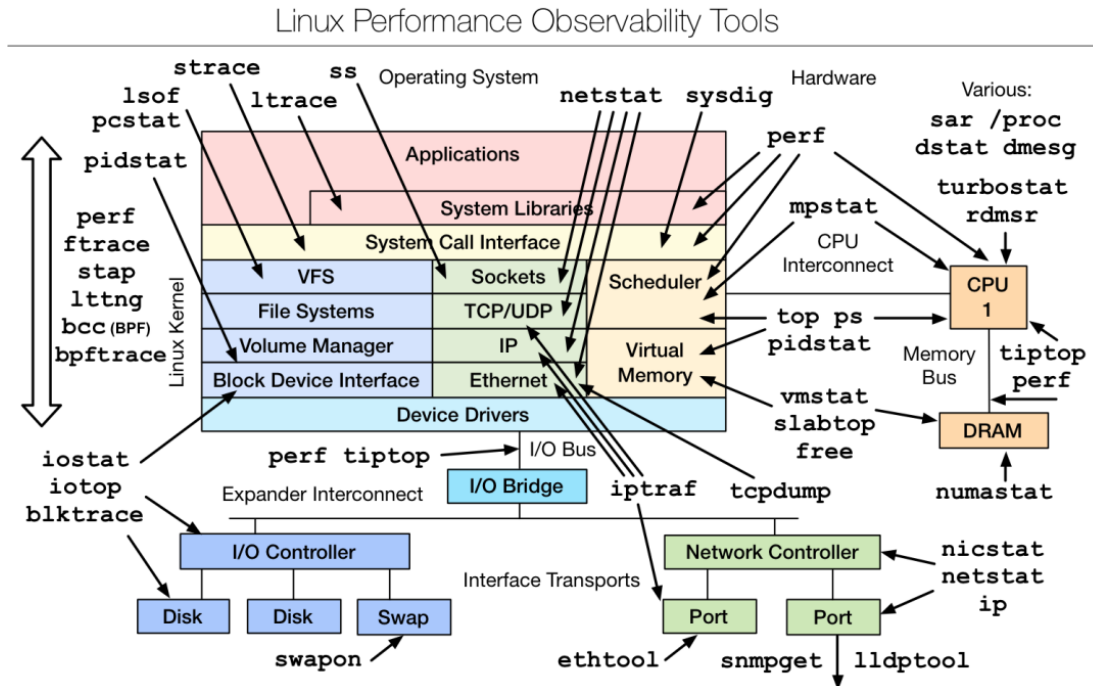
- Why?
  - Product quality (fast response)
  - Development cost (from choosing h/w platform)
  - Opportunity (update for new feature)
- When?
  - From designing architecture
  - Changing code
  - Until product release (or s/w update?)
- How?
  - Checking, Analyzing, Reducing, Comparing
    - Response time, resource usage
  - Using testcase, **tool**





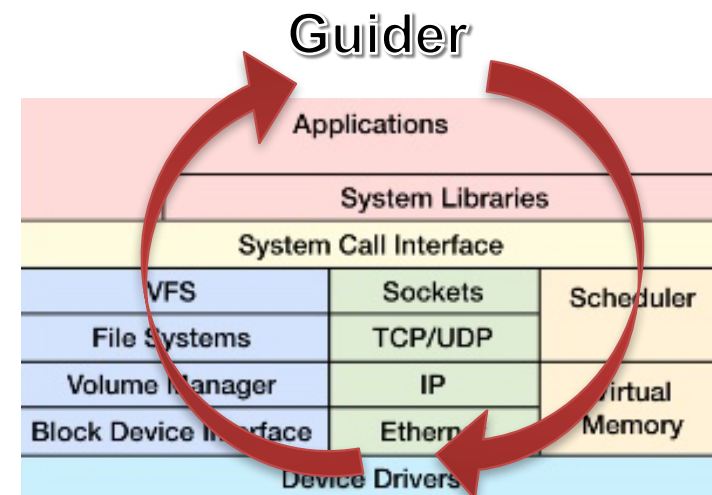
# Performance Tools

- Various performance tools on Linux
  - Too many to learn and use
  - Separated from each other
- How to analyze performance?
  - Manually
  - In combination within scripts
  - Profile repeatedly
- An automated solution
  - To collect as much data as possible
  - To summarize complex stats



## What is Guider?

- An integrated runtime performance analyzer based on Linux
  - **Monitoring** system resource and tasks in real-time
  - **Tracing** numerous system operations
  - **Visualizing** complex data
  - Providing highly readable report and **debugging features**
  - Controlling system factors
- Open sourced since 2015
  - Licensed under GPLv2
  - <https://github.com/iipeace/guider>



## What is Guider?

- Characteristic
  - System-wide
    - › Gather as much information as possible at once
    - › Even also available at function level
  - Easy
    - › No build, dependency, setting to launch Guider
    - › No hooking, modification, rebuild to target s/w
  - Accurate
    - › Elapsed time in ms
    - › Size in KB or MB
  - Light
    - › Require less system resource

## How to use Guider?

- Requirement

- Linux Kernel ( $\geq 2.6$ )
- Python ( $\geq 2.7$ )

- Installation

```
$ git clone https://github.com/iipeace/guider
```

```
# pip install guider
```

- ◆ <https://pypi.org/project/guider/>

```
$ bitbake guider
```

- ◆ <https://layers.openembedded.org/layerindex/recipe/95561/>

# How to use Guider?

- Commands

\$ guider -h

- Options and examples

\$ guider COMMAND -h

- Bug report and feedback

- <https://github.com/iipeace/issues>

```

/g.u.i.d.e.r ver.3.9.4 /
-----
Usage:
$ ./guider.py COMMAND|FILE [OPTIONS] [--help]

COMMAND:
[monitor]  top          <process>
            threadtop <thread>
            bgtop     <background>
            stacktop  <stack>
            perftop   <PMU>
            memtop    <memory>
            disktop   <storage>
            wstop     <memory>
            reptop    <json>
            filetop   <file>
            strace     <syscall>
            utrace    <usercall>

[profile]  record      <thread>
            funcrecord <function>
            filerecord <file>
            syscrecord <syscall>
            sysrecord  <system>
            mem        <page>

[visual]   draw        <image>
            cpudraw    <cpu>
            memdraw    <memory>
            vssdraw    <vss>
            rssdraw    <rss>
            leakdraw   <leak>
            iodraw     <I/O>
            convert    <text>

[util]     kill        <signal>
            pause     <thread>
            cpulimit  <cpu>
            setcpu    <clock>
            setsched  <priority>
            getaffinity <affinity>
            setaffinity <affinity>
            printenv  <env>
            readelf   <file>
            addr2line <symbol>

[run]      list        <list>
            start     <signal>
            send       <signal>
            event      <event>
            server     <server>
            client     <client>

[test]     alloctest  <mem>

Usage:
# ./guider.py top [OPTIONS] [--help]

Description:
Monitor process status

OPTIONS
-e <CHARACTER>          enable options
                        m:memory | b:block | p:pipe | e:encode
                        t:thread | c:wfc | s:stack | w:wss | d:disk
                        P:Perf | i:irq | S:ss | u:uss | f:float
                        a:affinity | r:report | W:wchan | h:handler
                        f:float | R:freport
-d <CHARACTER>          disable options
                        c:cpu | e:encode | p:print | P:perf
                        W:wchan | n:net | t:truncate | G:gpu
                        a:memAvailable

-o <DIR|FILE>           save output data
-u                     run in the background
-W                     wait for signal
-b <SIZE:KB>           set buffer size
-T <FILE>              set font path
-j <DIR|FILE>          set report path
-w <TIME:FILE[:VALUE]> set additional command
-x <IP:PORT>           set local address
-X <REQ@IP:PORT>       set request address
-N <REQ@IP:PORT>       set report address
-S <c:cpu/m:memory/p:pid/
                        b:block/w:wfc/n:new/
                        r:runtime/f:file>
                        sort by key

-P                     group threads in same process
-I <DIR|FILE>          set input path
-m <ROWS:COLS>        set terminal size
-a                     show all stats and events
-g <COMM|TID[:FILE]>   set filter
-l <SEC>              set interval
-R <INTERVAL:COUNT> set repeat count
-Q                     print all rows in a stream
-E <FILE>             set error log path
-H <LEVEL>            set function depth level
-k <COMM|TID[:CONT]>   set kill list
-z <MASK:TID[ALL[:CONT]]> set cpu affinity list
-Y <POLICY:PRIO|TIME
                        [:TID[ALL[:CONT]]>
                        set sched priority list
-v                     verbose

Example:
Monitor status of processes used cpu resource more than 1%
# ./guider.py top

- Monitor status of all processes sorted by memory(RSS)
# ./guider.py top -S m

- Report analysis results of processes to ./guider.out when SIGINT signal arrives
# ./guider.py top -o .

- Report analysis results of processes to ./guider.out with unlimited memory buffer
# ./guider.py top -o . -b 0

```

# Performance Analysis

- When monitoring the system status in **real-time**

```
[Top Info] [Time: 9506.550] [Inter: 1.0] [Ctxt: 10787] [Life: +0/-0] [IRQ: 7200] [Core: 8] [Task: 321/1210] [Load: 1.5/1.2/1.1] [RAM: 64303] [Swap: 65413]
[Cycle: 283.0M / Inst: 224.0M / IPC: 0.79 / CacheMiss : 7.0M(29%) / BrcMiss: 1.0M(3%) / Clk: 7.0G / MinFlt: 260 / MajFlt: 0]
```

ID	CPU (Usr/Ker/Blk/IRQ)	MemA(Diff/ User/Cache/Kern)	Swap (Diff/ I/O )	PgRclm	BlkRW	NrFlt	PrBlk	NrSIRQ	PgMlk	PgDrt	Network
Total	4 % ( 0 / 2 / 0 / 0 )	56497( 0/ 4428/ 4063/ 382)	0 ( 0 / 0/0 )	0/0	0/0	0	0	544	84	87	196/100

Process	( PID/ PPID/ Nr/ Pri)	CPU(Usr/Ker/Dly)	MemV(RSS/Txt/Shr/Swp)	Blk( RD / WR /NrFlt)	SID	PGID	FD	LifeTime	WaitChannel
vmware-vmx	( 5524/ 1570/ 25/C 0)	23( 0/ 22/ 1)	4199(652/ 13/635/ 0)	0( -/ -/ 0)	1996	1996	256	2:36:40	poll_schedule_timeout
guider	(11419/ 4550/ 1/C 0)	1( 0/ 0/ -)	61( 28/ 2/ 6/ 0)	0( -/ -/ 0)	4527	11419	512	0: 0: 4	RUNNING
compiz	( 1996/ 1570/ 12/C 0)	1( 0/ 0/ -)	1579(142/ 0/ 90/ 0)	0( -/ -/ 0)	1996	1996	64	2:38:16	poll_schedule_timeout
kworker/u16:3	(11341/ 2/ 1/C 0)	1( 0/ 1/ 0)	0( 0/ 0/ 0/ -)	0( -/ -/ 0)	-	-	64	0: 3:27	worker_thread

```
[Top Info] [Time: 9580.080] [Inter: 1.0] [Ctxt: 5636] [Life: +0/-0] [IRQ: 4572] [Core: 8] [Task: 323/1210] [Load: 0.9/1.1/1.1] [RAM: 64303] [Swap: 65413]
[Cycle: 307.0M / Inst: 243.0M / IPC: 0.79 / CacheMiss : 7.0M(30%) / BrcMiss: 1.0M(3%) / Clk: 7.0G / MinFlt: 1,036 / MajFlt: 0]
```

ID	CPU (Usr/Ker/Blk/IRQ)	MemA(Diff/ User/Cache/Kern)	Swap (Diff/ I/O )	PgRclm	BlkRW	NrFlt	PrBlk	NrSIRQ	PgMlk	PgDrt	Network
Total	4 % ( 0 / 1 / 0 / 0 )	56461( -4/ 4461/ 4079/ 382)	0 ( 0 / 0/0 )	0/0	0/0	0	0	479	84	92	196/100

Thread	( TID/ PID/ Nr/ Pri)	CPU(Usr/Ker/Dly)	MemV(RSS/Txt/Shr/Swp)	Blk( RD / WR /NrFlt)	Yld	Prmt	FD	LifeTime	Process
vmx-vcpu-0	( 5550/ 5524/ 25/C 0)	11( 0/ 11/ 0)	4199(652/ 13/635/ 0)	0( -/ -/ 0)	240	1	256	2:37:53	vmware-vmx
vmx-vcpu-1	( 5551/ 5524/ 25/C 0)	9( 0/ 9/ 0)	4199(652/ 13/635/ 0)	0( -/ -/ 0)	235	1	256	2:37:53	vmware-vmx
guider	(11477/11477/ 1/C 0)	5( 3/ 1/ -)	68( 35/ 2/ 6/ 0)	0( -/ -/ 0)	-	-	2048	0: 0: 2	guider
Xorg	( 1516/ 1516/ 2/C 0)	1( 1/ 0/ -)	468(115/ 2/ 54/ 0)	0( -/ -/ 0)	-	-	128	2:39:32	Xorg
gnome-terminal-	( 4012/ 4012/ 4/C 0)	1( 0/ 0/ -)	616( 50/ 0/ 39/ 0)	0( -/ -/ 0)	-	-	128	2:38:58	gnome-terminal-



# Performance Analysis

- When collecting the system stats in **background**

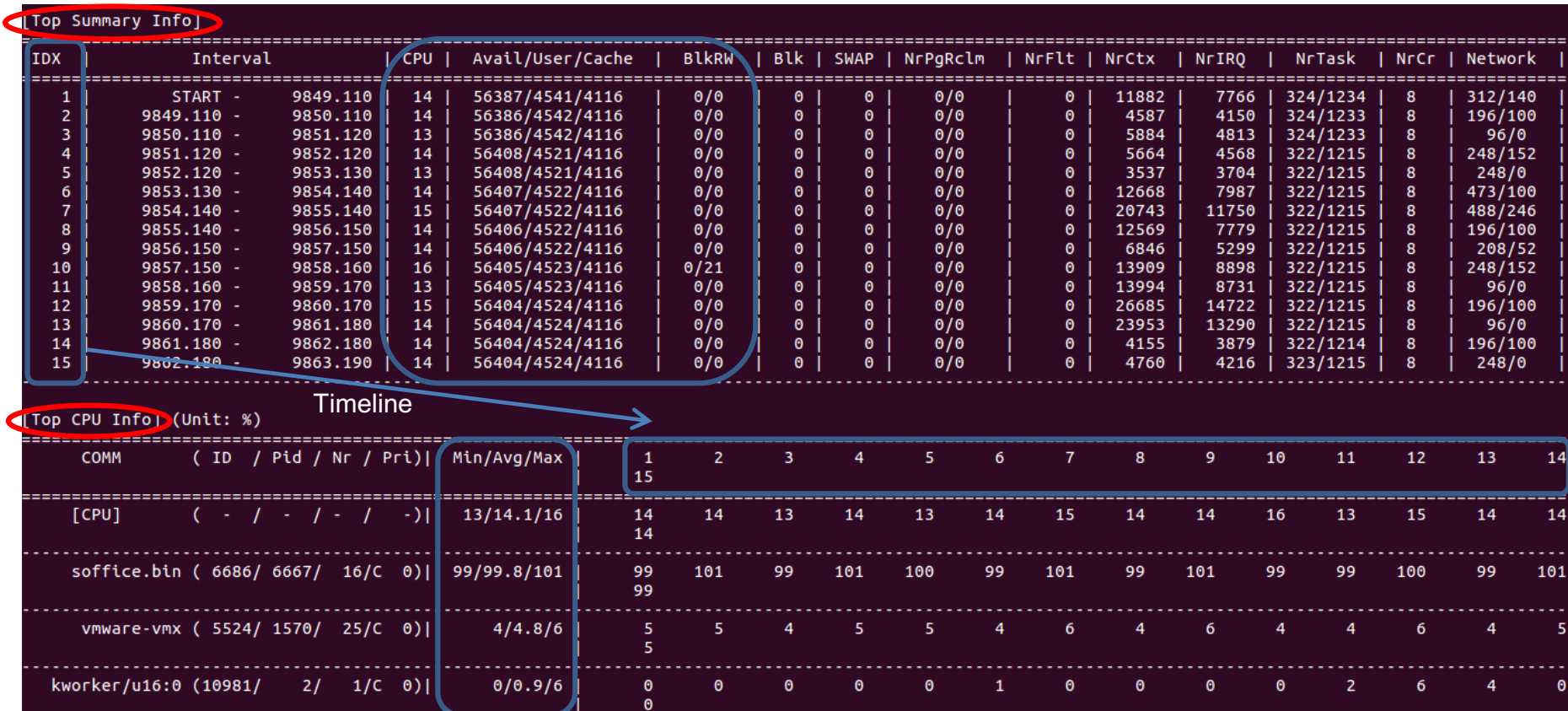
```
System Memory Info (Unit: MB)
=====
[ DESC ]      Memory      Swap      Buffer      Cache      Shared      Mapped      Active      Inactive PageTables      Slab      SlabRclm      SlabUnRclm      Mlocked
=====
[ TOTAL ]      64303      65413
[ FREE ]       55273      65413
[ AVAIL ]       56392      65413
=====
[ USE1 ]        7911         0        135        3731        2223        1322        5255        3147        100         249         109         139         0
[ USE2 ]        7899         0        135        3731        2223        1322        5244        3147         99         250         110         140         0
[ DIFF ]         -12         0         0         -1         -1         0         -12         -1         -1          1         0         0         0
=====

System Storage Info
=====
      DEV      NUM      READ      WRITE      TOTAL      FREE      USAGE      FAVL      FS      MountPoint <Option>
=====
/dev/loop0
/dev/loop1      7:0         0         0      91.0M         0      100%         0 squashfs /snap/core/6350 <ro,nodev,relatime>
/dev/loop2      7:1         0         0     145.0M         0      100%         0 squashfs /snap/notepadqq/855 <ro,nodev,relatime>
/dev/loop3      7:2         0         0      91.0M         0      100%         0 squashfs /snap/core/6405 <ro,nodev,relatime>
/dev/loop4      7:3         0         0      91.0M         0      100%         0 squashfs /snap/core/6259 <ro,nodev,relatime>
/dev/loop5      7:4         0         0     144.0M         0      100%         0 squashfs /snap/notepadqq/841 <ro,nodev,relatime>
/dev/sda1       8:1      76.0K      22.0M     171.0G     57.0G     66%      9.0M      ext4 /var/lib/docker/overlay2 <rw,relatime,errors=remount-ro,data=ordered>
/dev/sdb       8:16         0         0     916.0G    305.0G     66%     51.0M      ext4 /media/iipeace/445219df-443d-42a9-bf2b-1c94bbdfcb6a <rw,nosuid,nodev,relatime,data=ordered>
=====
TOTAL      76.0K      22.0M     1.0T    363.0G     66%     60.0M
```



# Performance Analysis

- When collecting the system stats in **background**



# Performance Analysis



- When collecting the system stats in **background**

```
(Top RSS Info) (Unit: MB)
```

COMM	( ID / Pid / Nr / Pri)	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
[FREE]	( - / - / - / -)	56408	56387	56386	56386	56408	56408	56407	56407	56406	56406	56405	56405	56404	56404	56404	56404
chrome	( 7698/ 3478/ 18/C 0)	1375	0	1374	1374	1374	1374	1374	1374	1374	1374	1374	1374	1375	1375	1375	1375
vmware-vmx	( 5524/ 1570/ 25/C 0)	652	652	652	652	652	652	652	652	652	652	652	652	652	652	652	652
soffice.bin	( 6686/ 6667/ 16/C 0)	433	433	433	433	433	433	433	433	433	433	433	433	433	433	433	433
chrome	( 3464/ 1570/ 46/C 0)	268	268	268	268	268	268	268	268	268	268	268	268	268	268	268	268
chrome	( 4462/ 3478/ 17/C 0)	211	0	0	0	0	0	0	211	211	211	211	211	211	211	211	211
chrome	( 4169/ 3478/ 16/C 0)	192	0	0	0	0	0	0	0	0	192	192	192	192	192	192	192

```
(Top Memory Details) (Unit: MB/KB/NR)
```

COMM	( ID / Pid )	Type	Cnt	VIRT	RSS	PSS	SWAP	HUGE	LOCK(KB)	PDRT(KB)	SDRT(KB)	NOPM(KB)
chrome	( 7698/ 3478)	[TOTAL]	5645	3849	1375	1279	0	0	0	1303204	17704	738676
		STACK	1	0	0	0	0	0	0	0	0	0
		SHM	32	285	34	6	0	0	0	2352	8628	0
		FILE	104	376	71	3	0	0	0	60	8284	201472
		ETC	3	0	0	0	0	0	0	0	0	0
		ANON	5505	3188	1270	1270	0	0	0	1300644	792	537204
vmware-vmx	( 5524/ 1570)	[TOTAL]	183	4198	653	637	0	0	0	623316	17376	1782536
		STACK	1	0	0	0	0	0	0	40	0	0
		SHM	8	2205	618	610	0	0	0	605448	17376	0
		FILE	49	123	20	12	0	0	0	1532	0	92032
		ETC	3	0	0	0	0	0	0	0	0	0
		ANON	122	1870	15	15	0	0	0	16296	0	1690504

# Performance Analysis

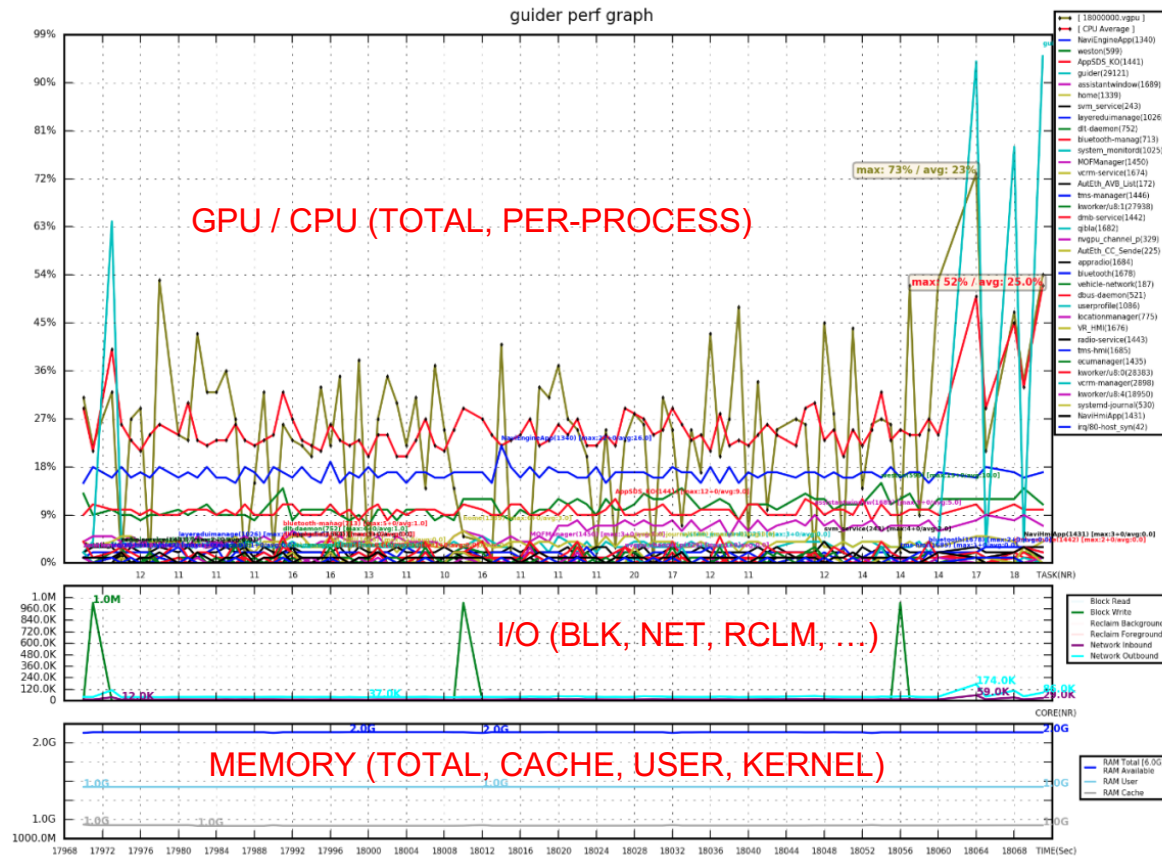
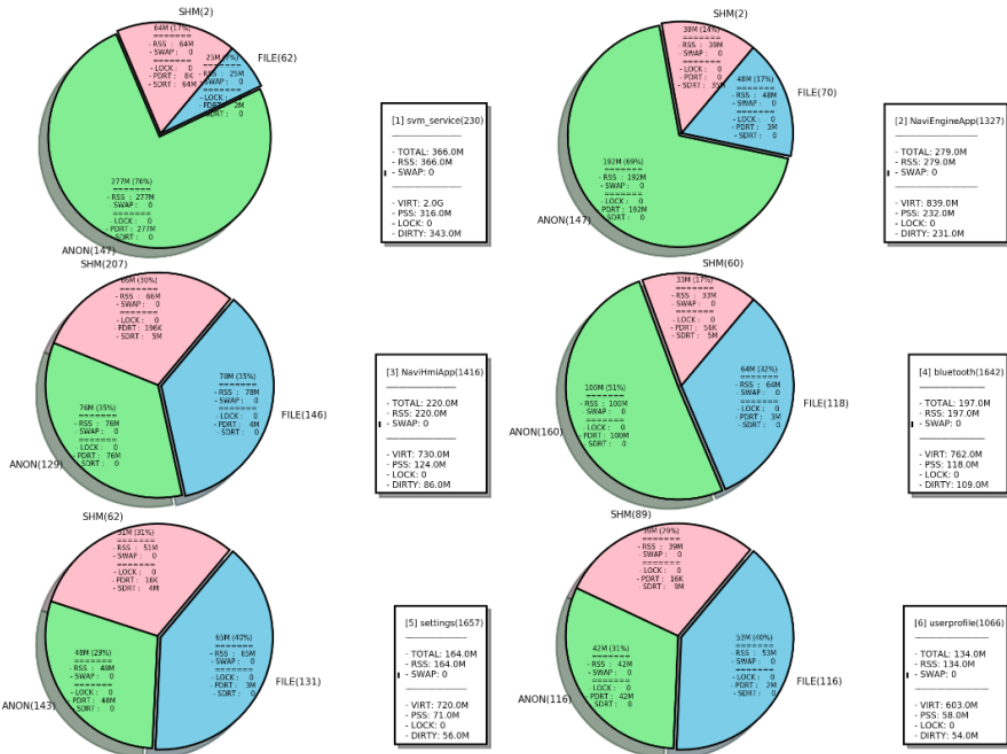
- When collecting the system stats in **background**

```
***** Detailed Statistics *****
[Top Info] [Time: 9863.190] [Inter: 1.0] [Ctxt: 4760] [Life: +0/-1] [IRQ: 4216] [Core: 8] [Task: 323/1215] [Load: 1.1/1.0/1.1] [RAM: 64303] [Swap: 65413]
[Cycle: 2.0G / Inst: 6.0G / IPC: 2.35 / CacheMiss : 4.0M(2%) / BrcMiss: 1.0M(0%) / Clk: 7.0G / MinFlt: 31 / MajFlt: 0]
=====
ID | CPU (Usr/Ker/Blk/IRQ)| MemA(Diff/ User/Cache/Kern)| Swap (Diff/ I/O )| PgRclm | BlkRW | NrFlt | PrBlk | NrSIRQ | PgMlk | PgDrt | Network |
-----
Total | 14 %(12 / 0 / 0 / 0 )|56404( 0/ 4524/ 4116/ 378)| 0 ( 0 / 0/0 )| 0/0 | 0/0 | 0 | 0 | 581 | 84 | 99 | 248/0 |
=====
Process ( PID/ PPID/ Nr/ Pri)| CPU(Usr/Ker/Dly)| MemV(RSS/Txt/Shr/Swp)| Blk( RD / WR /NrFlt)| SID | PGID | FD | LifeTime| WaitChannel |
-----
soffice.bin ( 6686/ 6667/ 16/C 0)| 99( 99/ 0/ 0)| 2135(433/ 0/138/ 0)| 0( -/ -/ 0)| 1654| 1654| 64| 2:17:17| RUNNING |
vmware-vmx ( 5524/ 1570/ 25/C 0)| 5( 0/ 4/ 0)| 4199(652/ 13/635/ 0)| 0( -/ -/ 0)| 1996| 1996| 256| 2:42:37|poll_schedule_timeout|
[+]python (11622/ 4550/ 1/C 0)| 0( 0/ 0/ -)| 20( 4/ 2/ -/ -)| 0( -/ -/ 0)| -| -| -| 0: 0: 1| - |
-----
[Top Info] [Time: 9862.180] [Inter: 1.0] [Ctxt: 4155] [Life: +0/-1] [IRQ: 3879] [Core: 8] [Task: 322/1214] [Load: 1.1/1.0/1.1] [RAM: 64303] [Swap: 65413]
[Cycle: 2.0G / Inst: 6.0G / IPC: 2.39 / CacheMiss : 5.0M(2%) / BrcMiss: 1.0M(0%) / Clk: 7.0G / MinFlt: 441 / MajFlt: 0]
=====
ID | CPU (Usr/Ker/Blk/IRQ)| MemA(Diff/ User/Cache/Kern)| Swap (Diff/ I/O )| PgRclm | BlkRW | NrFlt | PrBlk | NrSIRQ | PgMlk | PgDrt | Network |
-----
Total | 14 %(12 / 0 / 0 / 0 )|56404( 0/ 4524/ 4116/ 378)| 0 ( 0 / 0/0 )| 0/0 | 0/0 | 0 | 0 | 707 | 84 | 103 | 196/100 |
=====
Process ( PID/ PPID/ Nr/ Pri)| CPU(Usr/Ker/Dly)| MemV(RSS/Txt/Shr/Swp)| Blk( RD / WR /NrFlt)| SID | PGID | FD | LifeTime| WaitChannel |
-----
soffice.bin ( 6686/ 6667/ 16/C 0)| 101(101/ 0/ 0)| 2135(433/ 0/138/ 0)| 0( -/ -/ 0)| 1654| 1654| 64| 2:17:16| RUNNING |
vmware-vmx ( 5524/ 1570/ 25/C 0)| 5( 0/ 5/ 0)| 4199(652/ 13/635/ 0)| 0( -/ -/ 0)| 1996| 1996| 256| 2:42:36|poll_schedule_timeout|
chrome ( 3464/ 1570/ 46/C 0)| 2( 1/ 1/ -)| 1366(268/109/124/ 0)| 0( -/ -/ 0)| 1996| 1996|1024| 2:43:52|poll_schedule_timeout|
docker-containe ( 2791/ 2721/ 20/C 0)| 1( 1/ 0/ -)| 815( 10/ 7/ 7/ 0)| 0( -/ -/ 0)| 2791| 2791| 64| 2:44: 7| futex_wait_queue_me |
```

# Performance Analysis

- When visualizing complex data

guider memory chart

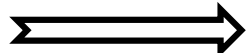
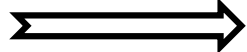
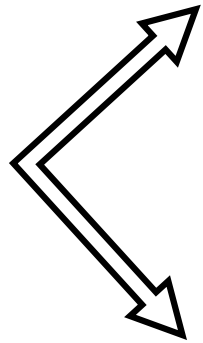




# Performance Analysis

- When visualizing various data in **real-time**

```
{  
  "task": {  
    "nrThread": 232,  
    "nrBlocked": 0,  
    "nrProc": 159  
  },  
  "mem": {  
    "available": 17442,  
    "kernel": 599,  
    "cache": 13291,  
    "free": 17442,  
    "anon": 718,  
    "file": 11399,  
    "total": 32050,  
    "slab": 1892,  
    "procs": {  
      "1": {  
        "text": 10,  
        "pid": 1354,  
        "rank": 1,  
        "comm": "mysqld",  
        "rss": 191  
      }  
    }  
  }  
}
```



< Guider stats in JSON format >

# Performance Analysis

- When tracing threads using **resources**

```
[Thread Info] [ Elapsed: 0.908 ] [ Start: 27858.151 ] [ ActiveThread: 102 ] [ ContextSwitch: 8590 ] [ LogSize: 2286 KB ] (Unit: Sec/MB/NR)
```

Thread Info		CPU Info					SCHED Info				BLOCK Info		MEM Info				
Name	Tid/ Pid	LF	Usage( %)	Prmt	Latc	Pri	IRQ	Yld	Lose	Steal	Mig	Read( MB/ Cnt)	Write( MB)	Sum(Usr/Buf/Ker)	Rcl	Wst	DRcl(Nr)
# CPU: 8																	
CORE/0	----	----	0.04( 4.0)	-	0.00	-	-	55	11	1	7	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
CORE/1	----	----	0.01( 1.3)	-	0.00	-	-	59	23	6	13	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
CORE/2	----	----	0.11( 12.2)	-	0.00	-	-	250	3	2	5	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
CORE/3	----	----	0.01( 1.2)	-	0.01	-	-	403	27	9	16	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
CORE/4	----	----	0.05( 5.8)	-	0.01	-	-	2829	15	1	18	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
CORE/5	----	----	0.08( 8.8)	-	0.00	-	-	270	17	3	9	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
CORE/6	----	----	0.04( 4.2)	-	0.01	-	-	258	3	2	7	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
CORE/7	----	----	0.01( 1.5)	-	0.00	-	-	100	7	0	20	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
# Hot: 103																	
[ TOTAL ]			0.36( 39.1)	4.89	0.04	-	-	4224	106	24	95	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
vmx-vcpu-1	5551/ 5524		0.10( 11.3)	0.00	0.00	0	-	212	0	0	0	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
vmx-vcpu-0	5550/ 5524		0.10( 10.5)	0.00	0.00	0	-	204	1	1	1	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
guider	19944/19944		0.03( 3.1)	0.00	0.00	-20	-	3	0	0	1	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
chrome	19066/19066		0.02( 2.5)	0.00	0.00	0	-	10	0	0	0	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
kworker/u16:2	18549/18549		0.02( 2.3)	0.74	0.00	0	-	2767	12	0	9	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
Xorg	1516/ 1516		0.01( 1.2)	0.00	0.00	0	-	107	0	0	4	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
compiz	1996/ 1996		0.01( 1.0)	0.00	0.00	0	-	27	3	3	3	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
chrome	3464/ 3464		0.01( 0.9)	0.00	0.00	0	-	93	1	0	3	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
Chrome_IOThread	3502/ 3464		0.01( 0.7)	0.00	0.00	0	-	16	0	1	4	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
vmx-svga	5548/ 5524		0.01( 0.6)	0.00	0.00	0	-	94	0	0	2	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
vmware-clk	19603/19603		0.00( 0.5)	0.00	0.01	0	-	439	0	2	3	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
chrome	4169/ 4169		0.00( 0.4)	0.00	0.00	0	-	1	0	0	0	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
chrome	7698/ 7698		0.00( 0.4)	0.00	0.00	0	-	5	0	0	2	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
gnome-terminal	4012/ 4012		0.00( 0.4)	0.00	0.00	0	-	8	0	0	1	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
chrome	4020/ 4020		0.00( 0.2)	0.00	0.00	0	-	6	0	0	1	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)
chrome	4462/ 4462		0.00( 0.2)	0.00	0.00	0	-	2	0	0	0	0.00( 0/ 0)	0.00( 0)	0( 0/ 0/ 0)	0	0	0.00( 0)

# Performance Analysis

- When tracing thread **events**

```
[Thread Creation Info] [Alive: +] [Die: -] [CreatedTime: //] [ChildCount: ||] [CpuUsage: <>] [WaitTimeForChilds: {}] [WaitTimeOfParent: []]
-----
bash(4550) <0.004> |2| {0.003}
- ls(19790) /0.644/ <0.003> [0.003]
+ guider(19791) /2.702/ <0.207>
-----

[Thread Signal Info]
-----
TYPE      TIME      SENDER( TID)  SIGNAL      RECEIVER( TID)
-----
SEND      0.647402   ls(19790)     SIGCHLD     bash( 4550)
RECV      0.647519   ls(19790)     SIGCHLD     bash( 4550)
SEND      0.677659   CORE/2(  0)  SIGALRM     Xorg( 1516)
RECV      0.677665   CORE/2(  0)  SIGALRM     Xorg( 1516)
SEND      2.734571   CORE/6(  0)  SIGALRM     Xorg( 1516)
RECV      2.734585   CORE/6(  0)  SIGALRM     Xorg( 1516)
SEND      2.909642   guider(19791) SIGINT      guider(19789)
RECV      2.909672   guider(19791) SIGINT      guider(19789)
-----

[Thread KERNEL Event Info]
-----
Event      Comm( Tid )  Usage      Count      ProcMax     ProcMin     InterMax    InterMin
-----
openfile   TOTAL( - )   0.001619   803        0.000013   0.000001   2.717830   0.000002
openfile   guider(19791) 0.001481   772        0.000013   0.000001   0.153699   0.000002
openfile   thnuclnt( 5553) 0.000037   9          0.000008   0.000002   1.000190   0.000028
openfile   ls(19790)    0.000035   10         0.000005   0.000002   0.000616   0.000047
openfile   guider(19789) 0.000027   6          0.000008   0.000001   2.717830   0.000064
openfile   thermald( 1038) 0.000026   4          0.000010   0.000005   0.000202   0.000090
openfile   vmware-vmx( 5524) 0.000013   2          0.000007   0.000006   1.000288   1.000288
-----

[Thread KERNEL Event History]
-----
EVENT      TYPE      TIME      COMM( TID)  CALLER      ELAPSED ARG
-----
openfile   ENTER    0.443533   thnuclnt( 5553) -
openfile   EXIT     0.443541   thnuclnt( 5553) do_sys_open 0.000008 1>"/etc/thnuclnt/thnuclnt.conf"
openfile   ENTER    0.443566   thnuclnt( 5553) -
openfile   EXIT     0.443569   thnuclnt( 5553) do_sys_open 0.000003 1>"/dev/tty"
openfile   ENTER    0.443600   thnuclnt( 5553) -
openfile   EXIT     0.443602   thnuclnt( 5553) do_sys_open 0.000002 1>"/dev/tty"
openfile   ENTER    0.644652   ls(19790)   -
openfile   EXIT     0.644657   ls(19790)   Sys_execve 0.000005 1>"/bin/ls"
openfile   ENTER    0.645146   ls(19790)   -
```



# Performance Analysis

- When tracing threads using **locks**

```
[Thread Futex Lock Info] [ Elapsed : 0.222 ] (Unit: Sec/NR)
```

Name( Tid/ Pid)	Elapsed	Process	Block	NrBlock	CallMax	Lock	LockMax	NrLock	NrWait	LBBlock	NrLBBlock	LastStat
a.out(10620/10617)	0.071	0.009	0.062	968	0.030	0.000	0.000	0	972	0.000	0	Running
a.out(10618/10617)	0.144	0.011	0.133	966	0.000	0.000	0.000	0	967	0.000	0	Wait
TaskSchedulerBa( 3490/ 3464)	0.122	0.000	0.122	1	0.122	0.000	0.000	0	1	0.000	0	Wait
chrome( 4020/ 4020)	0.017	0.000	0.017	1	0.017	0.000	0.000	0	1	0.000	0	Wait
chrome( 3702/ 3702)	0.186	0.000	0.186	1	0.186	0.000	0.000	0	1	0.000	0	Wait

```
[Thread Futex Lock History] (Unit: Sec/NR)
```

Time	Name( Tid/ Pid)	Core	Operation	Type	Elapsed	Target	Value	Timer
0.031848	a.out(10620/10617)	4	FUTEX_WAKE_OP	ALL	0.000001	604204	1	1
0.031851	a.out(10618/10617)	6		RET			0	
0.031857			FUTEX_WAKE_OP	ALL	0.000002	604204	1	1
0.031859	a.out(10618/10617)	6	FUTEX_WAKE	ALL	0.000000	6041c0	1	1
0.031860	a.out(10620/10617)	4	FUTEX_WAIT	RET	0.000011		0	
0.031860	a.out(10618/10617)	6	FUTEX_WAIT	ENT		604204	3411	0
0.031860	a.out(10620/10617)	4	FUTEX_WAKE	ALL	0.000000	6041c0	1	0

# Performance Analysis

- When tracing threads using **systemcalls**

```
[Thread Syscall Info] (Unit: Sec/NR)
```

Name( Tid)	Syscall( ID)	Elapsed	Count	Error	Min	Max	Avg
-----							
Chrome_ChildIOT( 4216)							
	recvmsg( 47)	0.000019	2	0	0.000005	0.000014	0.000009
	futex(202)	0.000011	1	0	0.000011	0.000011	0.000011
	epoll_wait(232)	0.000006	3	0	0.000001	0.000003	0.000002
	gettid(186)	0.000002	2	0	0.000001	0.000001	0.000001
-----							
Chrome_IOThread( 3502)							
	epoll_wait(232)	0.679655	20	0	0.000001	0.250315	0.033983
	write( 1)	0.000220	26	0	0.000002	0.000021	0.000008
	recvmsg( 47)	0.000191	19	0	0.000005	0.000019	0.000010
	gettid(186)	0.000046	54	0	0.000000	0.000002	0.000001
	sendto( 44)	0.000022	4	0	0.000003	0.000013	0.000006
	read( 0)	0.000012	3	0	0.000004	0.000004	0.000004
	futex(202)	0.000011	5	1	0.000001	0.000003	0.000002
-----							
Compositor(19075)							
	futex(202)	0.001675	3	0	0.000002	0.001671	0.000558
-----							
InputThread( 1542)							
	epoll_wait(232)	0.767386	14	0	0.019632	0.268425	0.054813
	write( 1)	0.000256	15	0	0.000014	0.000020	0.000017
	read( 0)	0.000123	47	32	0.000001	0.000007	0.000003
-----							
TaskSchedulerRe(20127)							
	futex(202)	0.000002	1	0	0.000002	0.000002	0.000002

# Performance Analysis

- When tracing threads using **systemcalls**

**Thread Syscall History** (Unit: Sec/NR)

Time	Name( TID)	Core	Syscall Sid	Type	Elapsed	Return Arguments
0.000408	vmx-vcpu-0( 5550)	2	ppoll 271	RET		0
0.000408	guider(20316)	7	close 3	ALL	0.000001	0 (4b)
0.000412	vmx-vcpu-0( 5550)	2	read 0	ALL	0.000002	EAGAIN (43, 7f3165f9bbe8, 8)
0.000417			ioctl 16	ENT		(f, 7d7, 0)
0.000428	guider(20316)	7	open 2	ALL	0.000016	75 (cc1340, 241, 1b6)
0.000446			fstat 5	ALL	0.000001	0 (4b, 7ffe47fa8ab0)
0.000450			fstat 5	ALL	0.000001	0 (4b, 7ffe47fa89a0)
0.000454			write 1	ALL	0.000157	1 (4b, 1712750, 1)
0.000611	vmx-vcpu-0( 5550)	2	ioctl 16	RET	0.000194	365
0.000614	guider(20316)	7	close 3	ALL	0.000001	0 (4b)
0.000616	vmx-vcpu-0( 5550)	2	ppoll 271	ENT		(7f3165f9bc60, 1, 7f3165f9bc30, 0, 8)
0.000652	guider(20316)	7	open 2	ALL	0.000018	75 (15a8d10, 241, 1b6)
0.000672			fstat 5	ALL	0.000002	0 (4b, 7ffe47fa88b0)
0.000676			fstat 5	ALL	0.000001	0 (4b, 7ffe47fa87a0)
0.000681			write 1	ALL	0.000147	1 (4b, 1712750, 1)
0.000831			close 3	ALL	0.000002	0 (4b)
0.000870			open 2	ALL	0.000013	75 (170a6b0, 241, 1b6)
0.000884			fstat 5	ALL	0.000002	0 (4b, 7ffe47fa88b0)
0.000888			fstat 5	ALL	0.000001	0 (4b, 7ffe47fa87a0)
0.000892			write 1	ALL	0.000039	1 (4b, 1712750, 1)
0.000934			close 3	ALL	0.000001	0 (4b)
0.000949			open 2	ALL	0.000011	75 (170e400, 241, 1b6)
0.000961			fstat 5	ALL	0.000001	0 (4b, 7ffe47fa88b0)
0.000965			fstat 5	ALL	0.000000	0 (4b, 7ffe47fa87a0)
0.000968			write 1	ALL	0.000039	1 (4b, 1712750, 1)
0.001010			close 3	ALL	0.000001	0 (4b)
0.001027			open 2	ALL	0.000014	75 (cc1340, 241, 1b6)
0.001043			fstat 5	ALL	0.000001	0 (4b, 7ffe47fa88b0)
0.001047			fstat 5	ALL	0.000000	0 (4b, 7ffe47fa87a0)
0.001050			write 1	ALL	0.000167	1 (4b, 1712750, 1)
0.001220			close 3	ALL	0.000001	0 (4b)
0.001293			select 23	ENT		(0, 0, 0, 0, 7ffe47fa8e70)
0.001398	vmx-vcpu-0( 5550)	2	ppoll 271	RET	0.000782	0

# Performance Analysis

- When tracing functions using **cpu**

```
[Function CPU-Tick-Stack Info] [Cnt: 663] [Interval: 22ms] (USER)
```

Usage	Function	Binary
99.2%	(4)cpuTest	/home/iipeace/work/test/a.out
+ 100.0%	<(3)startTest [ /home/iipeace/work/test/a.out ] <(2)main [ /home/iipeace/work/test/a.out ] <(1)__libc_start_main@GLIBC_2.2.5 [ /lib/x86_64-linux-gnu/libc-2.23.so ]	

```
[Function CPU-Tick-Symbol Info] [Cnt: 663] [Interval: 22ms] (USER)
```

Usage	Function	Binary
99.2%	cpuTest	/home/iipeace/work/test/a.out
0.3%	main	/home/iipeace/work/test/a.out
0.3%	__libc_start_main@GLIBC_2.2.5	/lib/x86_64-linux-gnu/libc-2.23.so
0.3%	startTest	/home/iipeace/work/test/a.out

```
[Function CPU-Tick-Stack Info] [Cnt: 663] [Interval: 22ms] (KERNEL)
```

Usage	Function
99.5%	<- USER
0.2%	<- __save_stack_trace <- save_stack_trace <- __ftrace_trace_stack
0.2%	<- __rb_reserve_next <- ring_buffer_lock_reserve <- ftrace_trace_userstack <- trace_buffer_unlock_commit_regs <- trace_event_buffer_commit <- trace_event_raw_event_mm_page_alloc <- __alloc_pages_nodemask <- alloc_pages_vma <- __handle_mm_fault <- handle_mm_fault <- __do_page_fault <- do_page_fault <- page_fault
0.2%	<- __unwind_start <- __save_stack_trace <- save_stack_trace

# Performance Analysis



- When tracing functions using memory

```
[Function Alloc-Only-Page Info] [Total: 10400KB] [Alloc: 10452KB(2612)] [Free: 212KB(52)] (USER)
=====
Usage ( Usr / Buf / Ker ) | Function | LifeTime | Binary
-----|-----|-----|-----
10256K( 10240/ 0/ 16) | 0x172af8 | AVR: 2.642 / MIN: 2.631 / MAX: 2.652 | /lib/x86_64-linux-gnu/libc-2.23.so
+ 10256K( 10240/ 0/ 16) | 16) | <- startTest [/home/iipeace/work/test/a.out] <- main [/home/iipeace/work/test/a.out]
  <- __libc_start_main@GLIBC_2.2.5 [/lib/x86_64-linux-gnu/libc-2.23.so]
-----|-----|-----|-----
12K( 12/ 0/ 0) | 0xc607 | AVR: 2.653 / MIN: 2.653 / MAX: 2.653 | /lib/x86_64-linux-gnu/ld-2.23.so
+ 12K( 12/ 0/ 0) | 0) | <- 0x40db [/lib/x86_64-linux-gnu/ld-2.23.so] <- 0x19632 [/lib/x86_64-linux-gnu/ld-2.23.so]
-----|-----|-----|-----
4K( 0/ 0/ 4) | time@GLIBC_2.2.5 | AVR: 2.653 / MIN: 2.653 / MAX: 2.653 | /lib/x86_64-linux-gnu/libc-2.23.so
+ 4K( 0/ 0/ 4) | 4) | <- 0x40db [/lib/x86_64-linux-gnu/ld-2.23.so] <- 0x19632 [/lib/x86_64-linux-gnu/ld-2.23.so]
-----|-----|-----|-----
[Function Alloc-Only-Page Info] [Total: 10400KB] [Alloc: 10452KB(2612)] [Free: 212KB(52)] (KERNEL)
=====
Usage ( Usr / Buf / Ker ) | Function | LifeTime
-----|-----|-----
10400K( 10320/ 0/ 80) | __alloc_pages_nodemask | AVR: 2.643 / MIN: 2.631 / MAX: 2.654
+ 10268K( 10268/ 0/ 0) | <- alloc_pages_vma <- __handle_mm_fault <- handle_mm_fault <- __do_page_fault <- do_page_fault <- page_fault
+ 24K( 24/ 0/ 0) | <- alloc_pages_vma <- wp_page_copy <- do_wp_page <- __handle_mm_fault <- handle_mm_fault <- __do_page_fault
  <- do_page_fault <- page_fault
+ 20K( 0/ 0/ 20) | <- alloc_pages_current <- pte_alloc_one <- __pte_alloc <- __handle_mm_fault <- handle_mm_fault <- __do_page_fault
  <- do_page_fault <- page_fault
+ 16K( 0/ 0/ 16) | <- alloc_pages_current <- pte_alloc_one <- __handle_mm_fault <- handle_mm_fault <- __do_page_fault <- do_page_fault
  <- page_fault
-----|-----|-----
```



# Performance Analysis



- When tracing **functions using storage**

```
[Function Read-Block Info] [Size: 1200KB] [Cnt: 18] (USER)
=====
Usage__ | _____ Function_____ | _____ Binary_____ | _____ Source_____
-----|-----|-----|-----|-----|-----
1200K |      __read@GLIBC_2.2.5          | /lib/x86_64-linux-gnu/libc-2.23.so          | ??
+ 1200K | <- startTest [/home/iipeace/work/test/a.out] <- main [/home/iipeace/work/test/a.out]
      <- __libc_start_main@GLIBC_2.2.5 [/lib/x86_64-linux-gnu/libc-2.23.so]
-----|-----|-----|-----|-----|-----

[Function Read-Block Info] [Size: 1200KB] [Cnt: 18] (KERNEL)
=====
Usage__ | _____ Function_____
-----|-----|-----|-----|-----|-----
1200K |      generic_make_request_checks
+ 472K | <- generic_make_request <- submit_bio <- ext4_mpage_readpages <- ext4_readpages <- __do_page_cache_readahead <- ondemand_readahead
      <- page_cache_sync_readahead <- generic_file_read_iter <- ext4_file_read_iter <- new_sync_read <- __vfs_read <- vfs_read <- Sys_read
      <- do_syscall_64 <- entry_SYSCALL_64_after_hwframe
+ 464K | <- generic_make_request <- submit_bio <- ext4_mpage_readpages <- ext4_readpages <- __do_page_cache_readahead <- ondemand_readahead
      <- page_cache_sync_readahead <- generic_file_read_iter <- ext4_file_read_iter <- new_sync_read <- __vfs_read <- vfs_read <- Sys_read
      <- do_syscall_64 <- entry_SYSCALL_64_after_hwframe
+ 188K | <- generic_make_request <- submit_bio <- ext4_mpage_readpages <- ext4_readpages <- __do_page_cache_readahead <- ondemand_readahead
      <- page_cache_sync_readahead <- generic_file_read_iter <- ext4_file_read_iter <- new_sync_read <- __vfs_read <- vfs_read <- Sys_read
      <- do_syscall_64 <- entry_SYSCALL_64_after_hwframe
+ 76K  | <- generic_make_request <- submit_bio <- ext4_mpage_readpages <- ext4_readpages <- __do_page_cache_readahead <- ondemand_readahead
      <- page_cache_sync_readahead <- generic_file_read_iter <- ext4_file_read_iter <- new_sync_read <- __vfs_read <- vfs_read <- Sys_read
      <- do_syscall_64 <- entry_SYSCALL_64_after_hwframe
-----|-----|-----|-----|-----|-----
```

# Performance Analysis

- When tracing functions using lock

```
[Function Lock-Try Info] [Cnt: 2137] (USER)
=====
Usage | Function | Binary | Source
-----|-----|-----|-----
2075 | pthread_cond_wait@GLIBC_2.3.2 | /lib/x86_64-linux-gnu/libpthread-2.23.so | ??
+ 2075 | <- start_thread [/lib/x86_64-linux-gnu/libpthread-2.23.so]
-----
51 | __lll_lock_wait | /lib/x86_64-linux-gnu/libpthread-2.23.so | ??
+ 51 | <- start_thread [/lib/x86_64-linux-gnu/libpthread-2.23.so]
-----
8 | runtime.futex | /usr/bin/dockerd | ??
+ 3 | <- runtime.notesleep [/usr/bin/dockerd] <- runtime.stopm [/usr/bin/dockerd] <- runtime.findrunnable [/usr/bin/dockerd]
+ 2 | <- runtime.schedule [/usr/bin/dockerd] <- runtime.park_m [/usr/bin/dockerd] <- runtime.mcall [/usr/bin/dockerd]
+ 1 | <- runtime.notetsleep_internal [/usr/bin/dockerd] <- runtime.notetsleep [/usr/bin/dockerd] <- runtime.sysmon [/usr/bin/dockerd]
+ 1 | <- runtime.notesleep [/usr/bin/dockerd] <- runtime.stopm [/usr/bin/dockerd] <- runtime.findrunnable [/usr/bin/dockerd]
+ 1 | <- runtime.schedule [/usr/bin/dockerd] <- runtime.goexit0 [/usr/bin/docker-containerd] <- runtime.mcall [/usr/bin/dockerd]
+ 1 | <- runtime.notetsleep_internal [/usr/bin/dockerd] <- runtime.notetsleepg [/usr/bin/dockerd] <- runtime.timerproc [/usr/bin/dockerd]
+ 1 | <- runtime.goexit [/usr/bin/dockerd]
+ 1 | <- runtime.notetsleep_internal [/usr/bin/dockerd] <- runtime.notetsleep [/usr/bin/dockerd] <- runtime.sysmon [/usr/bin/dockerd]
+ 1 | <- runtime.mstart1 [/usr/bin/dockerd] <- runtime.mstart [/usr/bin/dockerd] <- 000000000081bc43 [/usr/bin/docker-containerd]
-----
3 | pthread_cond_timedwait@GLIBC_2.3.2 | /lib/x86_64-linux-gnu/libpthread-2.23.so | ??
-----

[Function Lock History] [Lock: 2137] [Unlock: 0]
=====
Event | TARGET | COMM ( TID ) | CORE | TIME
-----|-----|-----|-----|-----
FUTEX_WAIT | 604204 | a.out( 10519) | 005 | 93328.110651 |
-----
[User] | pthread_cond_wait@GLIBC_2.3.2[/lib/x86_64-linux-gnu/libpthread-2.23.so]
[Kernel] | <- start_thread[/lib/x86_64-linux-gnu/libpthread-2.23.so]
[Kernel] | syscall_trace_enter <- do_syscall_64 <- entry_SYSCALL_64_after_hwframe
-----
FUTEX_WAIT | 604204 | a.out( 10518) | 004 | 93328.110701 |
```



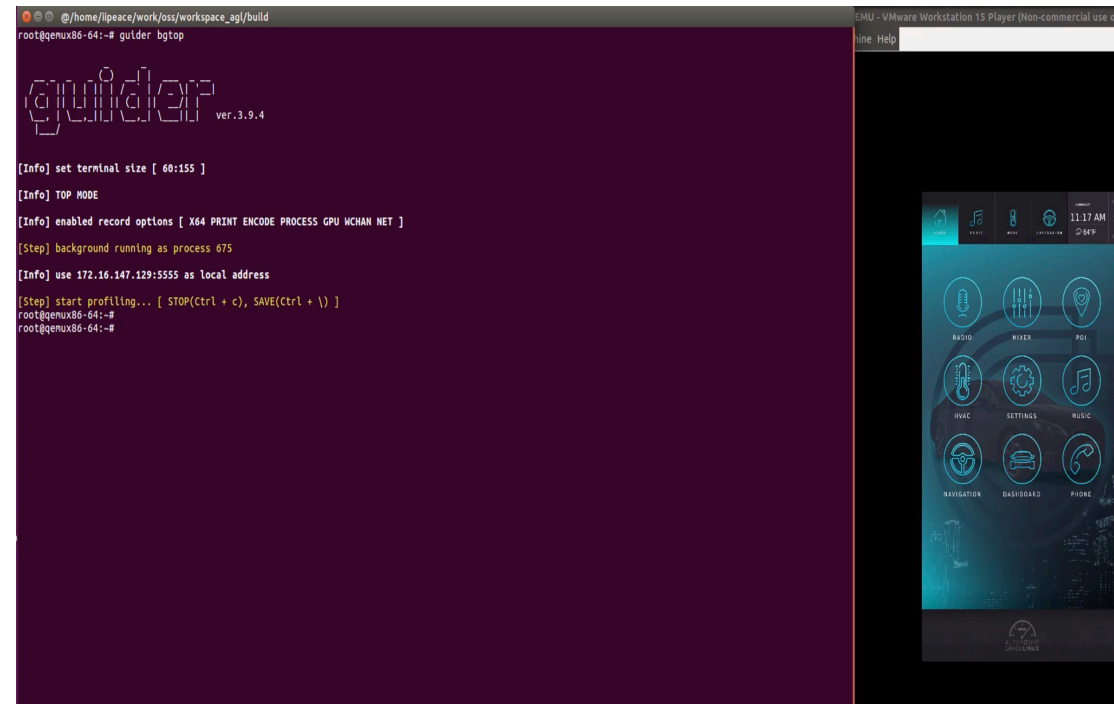
## Performance Analysis

- When controlling tasks and setting up a test environment
  - kill: sending signal
  - pause: pausing task
  - limitcpu: limiting maximum cpu usage of threads
  - setcpu: fixing clock of cpu cores
  - setsched: applying cpu scheduler policy including deadline scheduler
  - affinity: configuring cpu affinity of threads
  - list: showing guider processes
  - send: sending signal to guider processes
  - event: generating guider event
  - alloctest: allocating physical memory for test

```
[util]    kill      <signal>  
         pause   <thread>  
         cpulimit <cpu>  
         setcpu  <clock>  
         setsched <priority>  
         getaffinity <affinity>  
         setaffinity <affinity>  
         printenv <env>  
         readelf <file>  
         addr2line <symbol>  
  
[run]    list     <list>  
         start  <signal>  
         send   <signal>  
         event  <event>  
         server <server>  
         client <client>  
  
[test]  alloctest <mem>
```

# Guider on AGL

- Hands-on
  - Environment
    - S/W
      - ◆ AGL Demo Platform for QEMU
        - ◆ BB\_VERSION 1.34.0
        - ◆ DISTRO\_VERSION 5.1.0
    - H/W (vmware setting)
      - ◆ Intel® Core i7-6700 3.4GHz
        - ◆ 2 Cores
      - ◆ RAM 2GB
      - ◆ Storage 2GB
  - Video
    - [Local Link](#)
    - [Web link](#)



## Future Work

- utrace
  - Real-time user-level function tracing command
  - Available now from version 3.9.4 (experimental)
  - Goal
    - To trace all user-level functions including executable files
    - To detect function-level events and control threads automatically
- GUIder Agent
  - GUI-based guider agent (client) **Need your contribution!** 😊
  - Goal
    - To provide easy operation and real-time visualization
    - To enable remote control between heterogeneous OS by network

Guider: an integrated runtime performance analyzer

Thanks :)

<https://github.com/iipeace/guider>