Practical Experiences With Software Crash Analysis in TV

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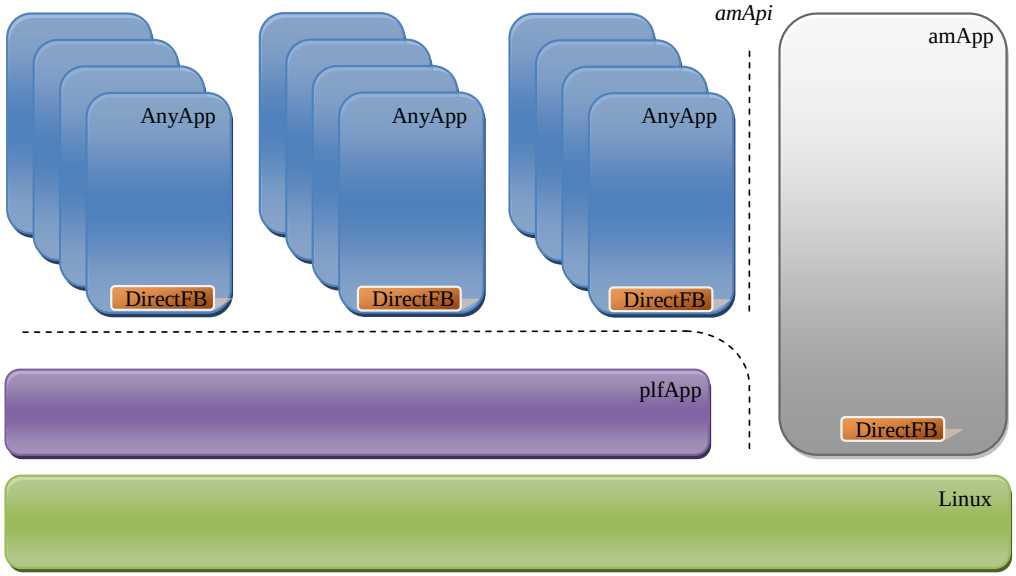
Overview

- Context
- One-slide overview of tooling approach
- Practical usecases

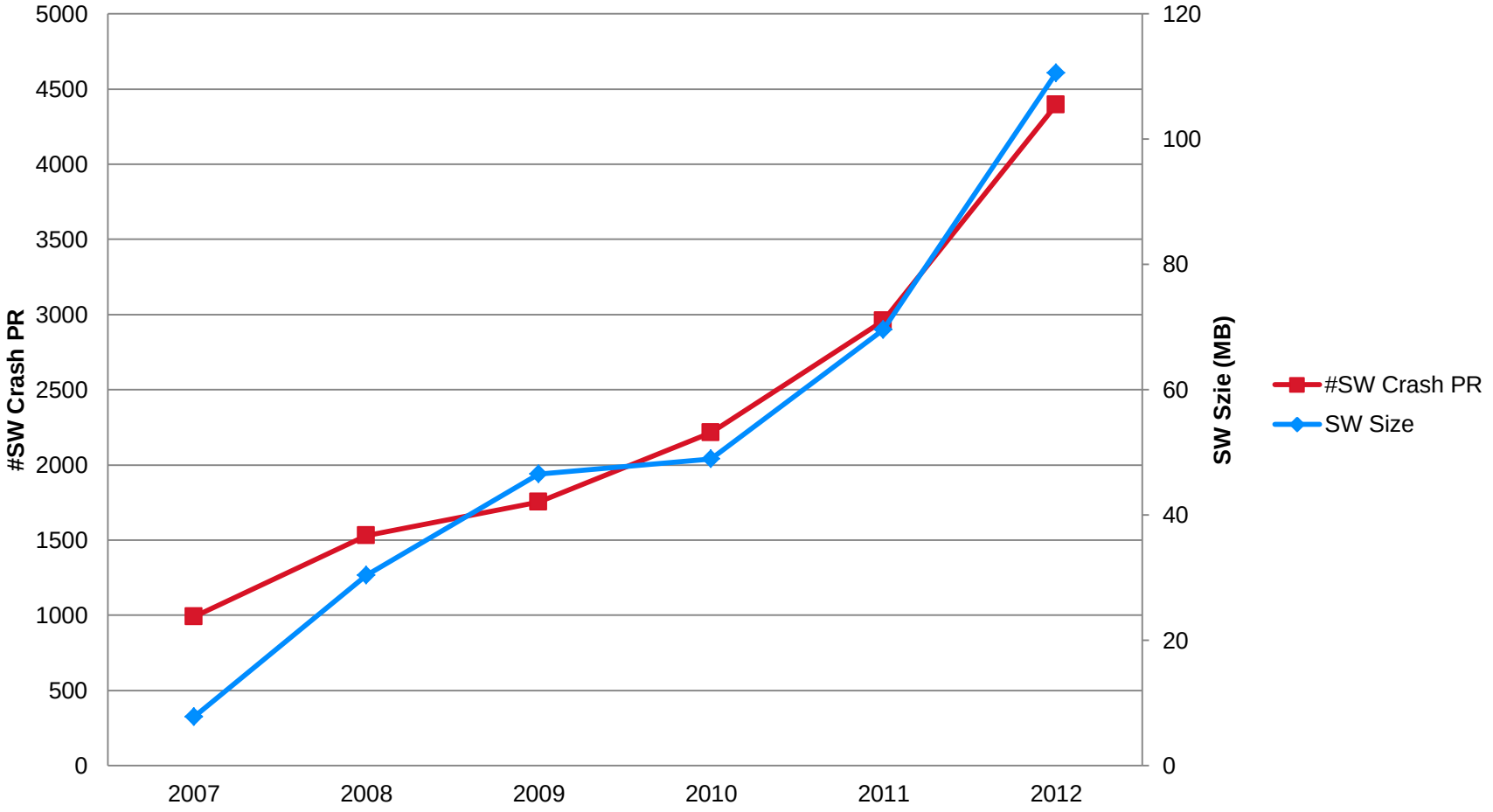
Context: SPACE SW Architecture



SPlit Application arChitecturE

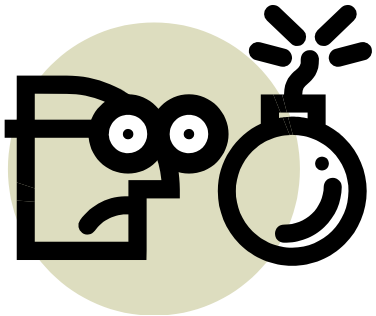
- Applications are isolated in dedicated processes
- The resources in the system are explicitly and centrally managed
- The client applications are system context unaware
- The lifecycle, focus and visual layout of the client applications is centrally managed

Problem: Increasing # SW crashes

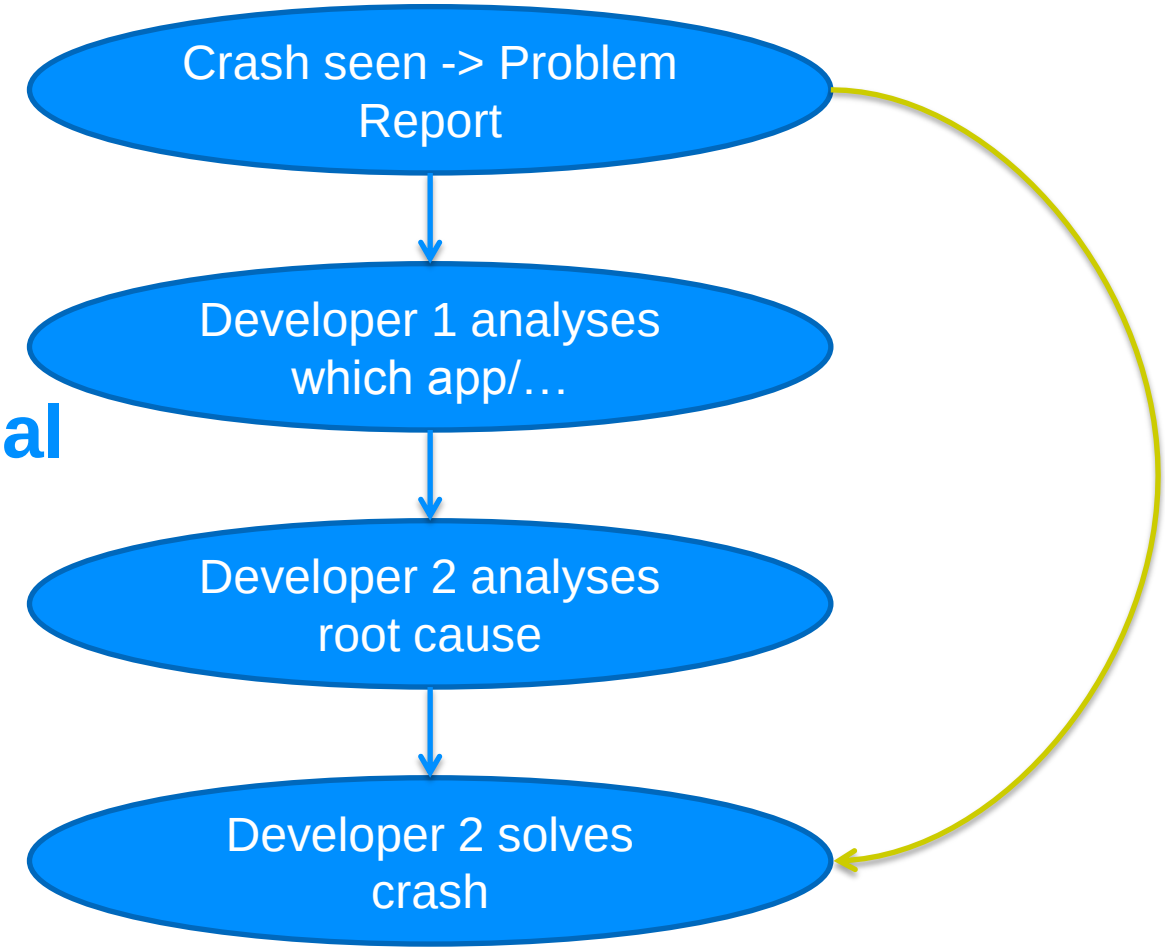


Problem: Increasing # SW crashes

- Increasing number of SW crashes found during QA testing
- Lot of effort spent to analyse and solve these
- Leads to longer time to mature SW
- Leads to longer time to market



Crash Analysis and Resolution Flow



Normal Flow

Desired Flow

How to reach desired flow

- Detect crashes in SW
- Dump as much of information on crash as possible
- Good analysis and visualization tools of dumps
  - To dispatch to correct developer
  - To indicate root cause
- Continuously improve tooling
  - Analyse problems in the long flow
  - Investigate what can be changed to reach the desired flow

Roles

- QA testing
  - Black box functional tests, duration tests (overnight, weekend)
  - File problem reports with attached post mortem dumps.

- Developers
  - Write functional code, follow SPACE architecture
    - following execution architecture rules
  - Debug using post mortem info / debug tooling

- “Execution Architecture” team
  - Create tooling for post mortem info & debug
  - Blessed with solving the ‘hard’ crashes
  - Set execution architecture rules
  - Special thanks for their contribution to this presentation!
    - Nico De Ceulaer, Pieter Van Loocke, …

One slide overview

- Fault Detection
  - Signal detection
  - Watchdogs
  - Kernel crashes
- Fault Information Reporting
  - UART, various circular buffers capturing events, stack backtracing, standard Linux info, memory usage monitoring
- Fault Storage
  - NAND Flash post mortem dumps, UART logs, EPROM NVM
- Fault Recovery
  - Various degrees of reboot
- Fault Retrieval
  - Via USB, service, ethernet…
- Fault Analysis
  - Website for dump translation, PR (cross-)analysis
  - TimeDoctor Visualisation

Examples of software crashes

1. Signals
2. Watchdog (worker thread not responding)
3. Watchdog (blocked through other thread)
4. Watchdog (CPU overload)
5. Watchdog (deadlock)
6. Linux Out of Memory

Example 1: SIGSEGV/… backtrace

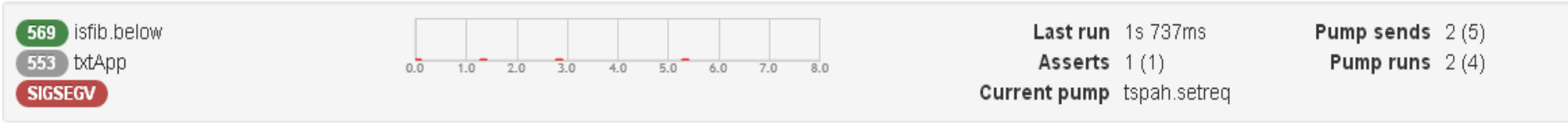
- Crash:
  - Null pointer dereference/…
- Detect:
  - Install signal handler in all applications
- Dump:
  - Stacktrace of thread causing signal
  - Dump on internal flash
  - Testers copy dump from flash and attach to problem report
- Analysis
  - Automatic translation of backtrace in problem report

Example 1: SIGSEGV/… backtrace

- Standard solution: using glibc backtrace in signal handler

- Proprietary kernel based backtrace used
- Mainly due to historical reasons
- Other advantages:
  - Combines userspace and kernel space stack
  - Backtrace also available when in uninterruptable sleep or when signals are blocked

Example 1: SIGSEGV/… backtrace



context_switch	vmlinux_app_flash	linux-2.6.35.13/kernel/sched.c:2920
schedule	vmlinux_app_flash	linux-2.6.35.13/kernel/sched.c:3870
futex_wait_queue_me	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:1702
futex_wait	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:1820
do_futex	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:2561
sys_futex	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:2636
handle_sys	vmlinux_app_flash	linux-2.6.35.13/arch/mips/kernel/scall32-o32.S:59
__pthread_cond_wait	libpthread-2.13	glibc/nptl/pthread_cond_wait.c:156
SendAndReceive	liberrlib	space/plf/tvplf/ceos/comp/ceoserrlibpriv/errlib_mcom.c:306
errlib__dmpcom_DumpException	liberrlib	space/plf/tvplf/ceos/comp/ceoserrlibpriv/errlib_mcom.c:526
ExceptionHandler	liberrlib	space/plf/tvplf/ceos/comp/ceoserrlibpriv/errlib_mdetect.c:1018
		0x0
txpst_AddToWanted	txtApp	space/app/txt/Hsvtxt/comp/txplf/comp/txsto/txsto_requestlist.c:198
txpst_MovePageToWanted	txtApp	space/app/txt/Hsvtxt/comp/txplf/comp/txsto/txsto_requestlist.c:626
txsto__req_SuggestPage	txtApp	space/app/txt/Hsvtxt/comp/txplf/comp/txsto/txsto_pagestore.c:2330
		0x0

Example 1: SIGSEGV/… backtrace

Backtrace:

txpst_AddToWanted	txtApp	space/app/txt/Hsvtxt/comp/txplf/comp/txsto/txsto_requestlist.c:198
txpst_MovePageToWanted	txtApp	space/app/txt/Hsvtxt/comp/txplf/comp/txsto/txsto_requestlist.c:626
txsto__req_SuggestPage	txtApp	space/app/txt/Hsvtxt/comp/txplf/comp/txsto/txsto_pagestore.c:2330
		0x0

Patch:

```
190a191,192
>       if(pckt_ptr != NULL)
>       {
197a200,201
>               if(next_ptr != NULL)
>               {
198a203
>               }
208a214
>       }
```

Example 2: Watchdog (worker thread not responding)

- TV software works with worker threads (called pump engines) executing tasks (called pumps).
- All tasks must be finished within certain amount of time.
- Otherwise this is assumed to be an error and the TV is restarted.
- Reason: Avoid that the user manually has to unplug and replug the TV to recover from endless running task.

Example 2: Watchdog (worker thread not responding)

- Crash:
  - Watchdog due to task in endless loop/…
- Detect:
  - Every worker thread feeds watchdog
- Dump:
  - Dump backtrace of worker thread that caused watchdog (standard solution: raise signal to thread causing watchdog)
- Analysis:
  - Translate backtrace

Example 2: Watchdog (worker thread not responding)

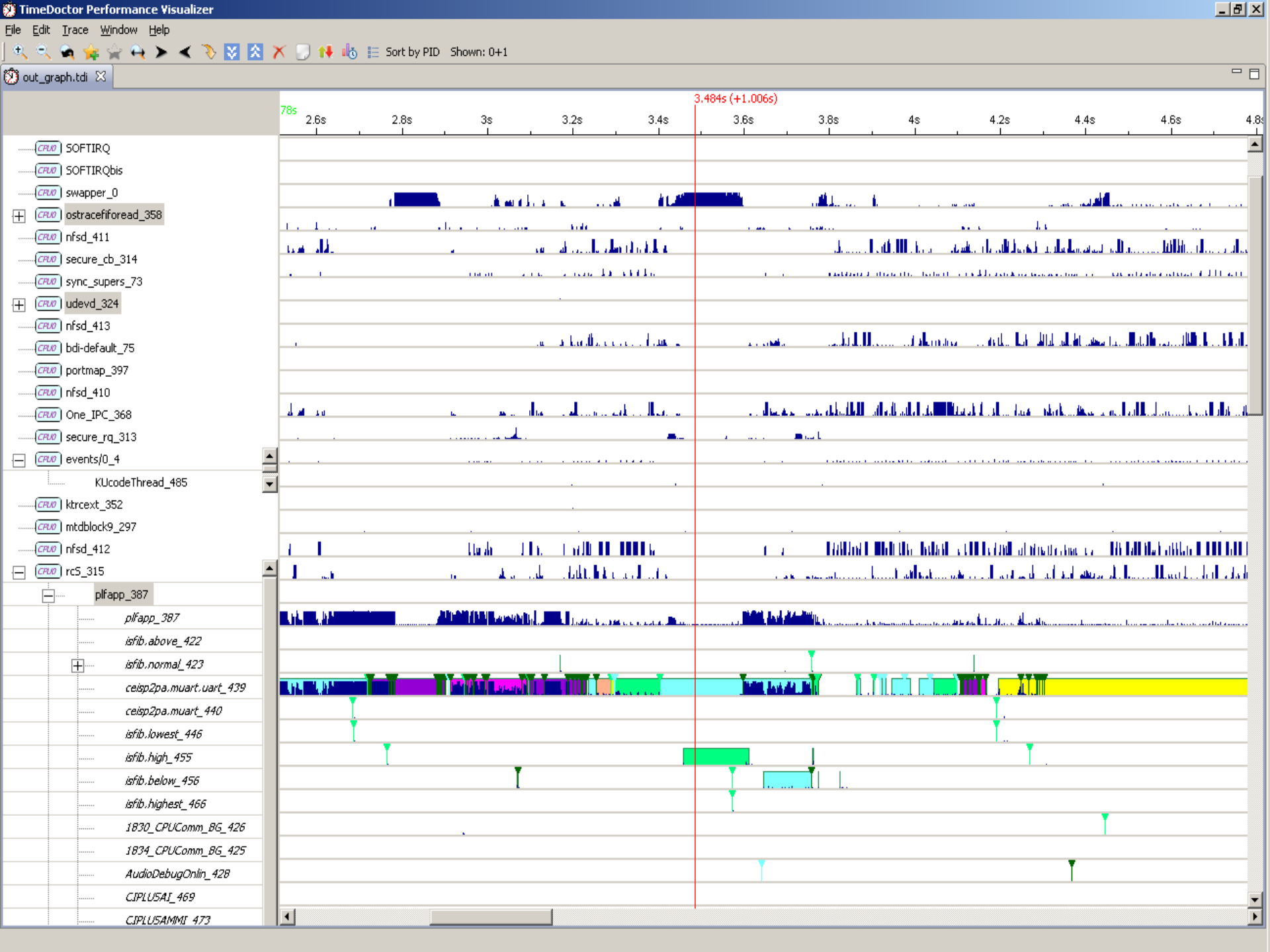
context_switch	vmlinux_flash	linux-2.6.35.13/kernel/sched.c:2920
schedule	vmlinux_flash	linux-2.6.35.13/kernel/sched.c:3870
schedule_timeout	vmlinux_flash	linux-2.6.35.13/kernel/timer.c:1437
__down_common	vmlinux_flash	linux-2.6.35.13/kernel/semaphore.c:221
__down_interruptible	vmlinux_flash	linux-2.6.35.13/kernel/semaphore.c:243
down_interruptible	vmlinux_flash	linux-2.6.35.13/kernel/semaphore.c:84
ioctl	libc-2.13	0x14
CPUComm_CallEx	libCPUComm	/home/coverity/svn/DCP_SYS_Fusion_TestRI/HAL_Fusion/CpuComm/Src/thal_cpucomm_api.c:605
Trid_Util_CPUComm_Call	libCPUComm	/home/coverity/svn/DCP_SYS_Fusion_TestRI/HAL_Fusion/CpuComm/Src/thal_cpucomm_api.c:677
SX5_Video_Open	libhalvideo	/home/coverity/svn/DCP_SYS_Fusion_TestRI/HAL_Fusion/Video/Src/sx5_video_api.c:1556
plfDigVdec_SetDmxHandle	libpapi	0x220
plfTsDmx_SetVideoChannel	libpapi	0x20c
papi_src_src_ApplySourceSettings	libpapi	0x1438
plfapp__isrc_src_ApplySourceSettings	plfapp	space/plf/tvplf/ceplf/prod/plfapp/plfapp_mpapifilter.c:25801
FinishApplySourceSettings	plfapp	space/plf/tvplf/ceplf/comp/plfconnmgr/plfconnmgr_mctrl.c:1192
ApplySourceSettings	plfapp	space/plf/tvplf/ceplf/comp/plfconnmgr/plfconnmgr_mctrl.c:1167
plfconnmgr__src_ApplySourceSettings	plfapp	space/plf/tvplf/ceplf/comp/plfconnmgr/plfconnmgr_mctrl.c:582
plfresgate__lsapply_src_ApplySourceSettings	plfapp	space/plf/tvplf/ceplf/comp/plfresgate/plfresgate_mlaststat.c:172
RestoreLastStatus	plfapp	space/plf/tvplf/ceplf/comp/plflaststat/plflaststat_m.c:425
LastStatusHandler	plfapp	space/plf/tvplf/ceplf/comp/plflaststat/plflaststat_m.c:359
Execute	libcesgpi	space/plf/tvplf/ceos/comp/GPI/comp/cesgpipmp/cesgpipmp_m.c:841
EngineTask	libcesgpi	space/plf/tvplf/ceos/comp/GPI/comp/cesgpipmp/cesgpipmp_m.c:1045

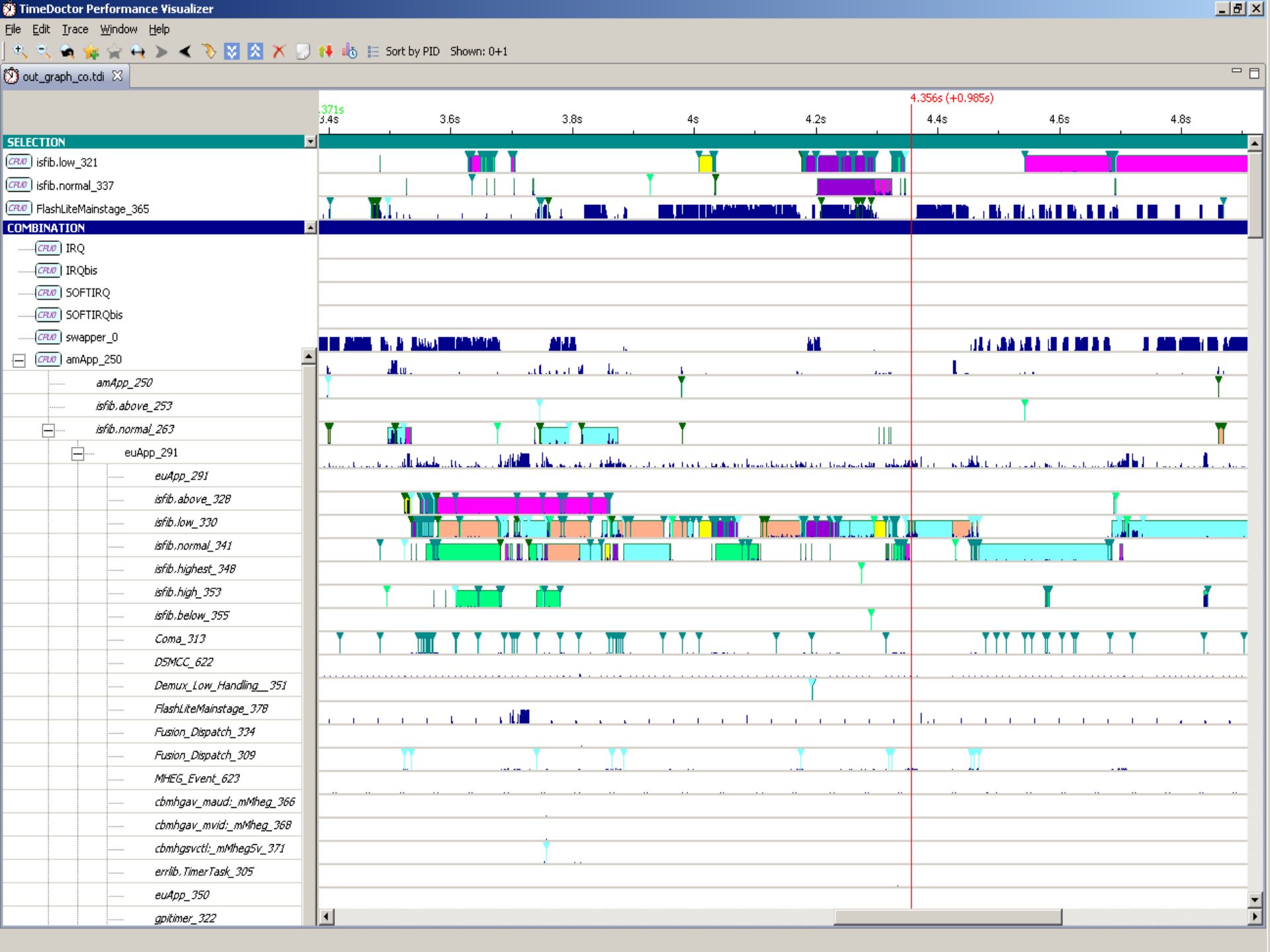
Example 3: Watchdog (blocked on other thread)

- Crash:
  - Watchdog due to task waiting on another task
- Detect:
  - Every worker thread feeds watchdog
- Dump:
  - Dump backtrace of all threads
    (standard solution: raise signal to all threads)
  - Dump trace of last events in system
- Analysis:
  - Translate backtrace
  - Visualize last x seconds

Example 3: Watchdog (blocked on other thread)

- Propietary tracing format which logs
  - In kernel (using tracepoint):
    - Task switches in kernel
    - Interrupt handling
    - Syscalls
    - Signals
  - In userspace:
    - Pump execution
    - RPC calls between applications
- Modified timedoctor is used for visualization
  - http://sourceforge.net/projects/timedoctor/


TimeDoctor Performance Visualizer
File Edit Trace Window Help
Sort by PID Shown: 0+1
out_graph.tdi
3.484s (+1.006s)
78s
2.6s
2.8s
3s
3.2s
3.4s
3.6s
3.8s
4s
4.2s
4.4s
4.6s
4.8s
SOFTIRQ
SOFTIRQbis
swapper_0
ostracefiforead_358
nfsd_411
secure_cb_314
sync_supers_73
udevd_324
nfsd_413
bdi-default_75
portmap_397
nfsd_410
One_IPC_368
secure_rq_313
events/0_4
KUcodeThread_485
ktrcext_352
mtdblock9_297
nfsd_412
rcS_315
plfapp_387
plfapp_387
isfib.above_422
isfib.normal_423
ceisp2pa.muart.uart_439
ceisp2pa.muart_440
isfib.lowest_446
isfib.high_455
isfib.below_456
isfib.highest_466
1830_CPUComm_BG_426
1834_CPUComm_BG_425
AudioDebugOnlin_428
CIPLUSAI_469
CIPLUSAMMI_473

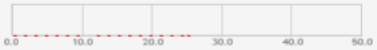

TimeDoctor Performance Visualizer
File Edit Trace Window Help
Sort by PID Shown: 0+1
out_graph_co.tdi
4.356s (+0.985s)
3.4s
3.6s
3.8s
4s
4.2s
4.4s
4.6s
4.8s
SELECTION
isfib.low_321
isfib.normal_337
FlashLiteMainstage_365
COMBINATION
IRQ
IRQbis
SOFTIRQ
SOFTIRQbis
swapper_0
amApp_250
amApp_250
isfib.above_253
isfib.normal_263
euApp_291
euApp_291
isfib.above_328
isfib.low_330
isfib.normal_341
isfib.highest_348
isfib.high_353
isfib.below_355
Coma_313
DSMCC_622
Demux_Low_Handling__351
FlashLiteMainstage_378
Fusion_Dispatch_334
Fusion_Dispatch_309
MHEG_Event_623
cbmhgav_maud:_mMheg_366
cbmhgav_mvid:_mMheg_368
cbmhgsvctl:_mMhegSv_371
errlib.TimerTask_305
euApp_350
gpitimer_322

Example 3: Watchdog (blocked on other thread)

Example 3: Watchdog (blocked on other thread)

Example 3: Watchdog (blocked on other thread)

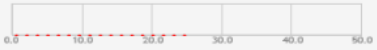
451 isfib.low
441 nettvApp
ERROR



Last run 14s 675ms
Current pump mplfabs.avntf
Pump sends 4 (20)
Pump runs 4 (19)
IPC calls 4 (4)

context_switch	vmlinux_app_flash	linux-2.6.35.13/kernel/sched.c:2920
schedule	vmlinux_app_flash	linux-2.6.35.13/kernel/sched.c:3870
ioctl	libc-2.13	0x14
OneQueue_Receive	libone-1.6	dfb/core/DirectFB.git/lib/One/One.c:384
IComaComponent_One_Call	libicomacomponent_one	dfb/libs/FusionDale.git/one/icomacomponent_one.c:338
icplfapiconn__urlsrcvid_CloseUrl	libicplfapiconn	space/plf/plfApi/comp/plfapiconn/ipc/build/sde4lib/icplfapiconn/icplfapiconn_mlib.c:14682
olsmedobj__tmlUrlSrc2_CloseUrl	nettvApp	space/app/nettv/comp/olsmedobj/olsmedobj_mmap.c:495
olsmedobj__vpl_CloseUrl	nettvApp	space/app/nettv/comp/olsmedobj/olsmedobj_m.c:459
olsjapi__vplN_OnEndOfRendering	nettvApp	space/app/nettv/comp/olsmedobj/olsmedobj_mmobj.c:2765
NtfHandler	nettvApp	space/app/nettv/comp/olsmedobj/olsmedobj_m.c:1091
Execute	libcesgpi	space/plf/tvplf/ceos/comp/GPI/comp/cesgpipmp/cesgpipmp_m.c:841
EngineTask	libcesgpi	space/plf/tvplf/ceos/comp/GPI/comp/cesgpipmp/cesgpipmp_m.c:1045

457 isfib.normal
441 nettvApp



Last run 14s 683ms
Current pump olsjapi.mobj
Pump sends 2 (18)
Pump runs 2 (17)

context_switch	vmlinux_app_flash	linux-2.6.35.13/kernel/sched.c:2920
schedule	vmlinux_app_flash	linux-2.6.35.13/kernel/sched.c:3870
futex_wait_queue_me	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:1702
futex_wait	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:1820
do_futex	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:2561
sys_futex	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:2636
handle_sys	vmlinux_app_flash	linux-2.6.35.13/arch/mips/kernel/scall32-o32.S:59
__lll_lock_wait	libpthread-2.13	glibc/nptl/sysdeps/unix/sysv/linux/lowlevellock.c:46
__pthread_mutex_lock	libpthread-2.13	glibc/nptl/pthread_mutex_lock.c:61
cesgpitphostrtk2__pxrtk_MutexLock	libcesgpi	space/plf/tvplf/ceos/comp/GPI/comp/cesgpitphostrtk2/cesgpitphostrtk2_mposix.c:964
olsmedobj__medstate_GetCurrentState	nettvApp	space/app/nettv/comp/olsmedobj/olsmedobj_mmobj.c:3161

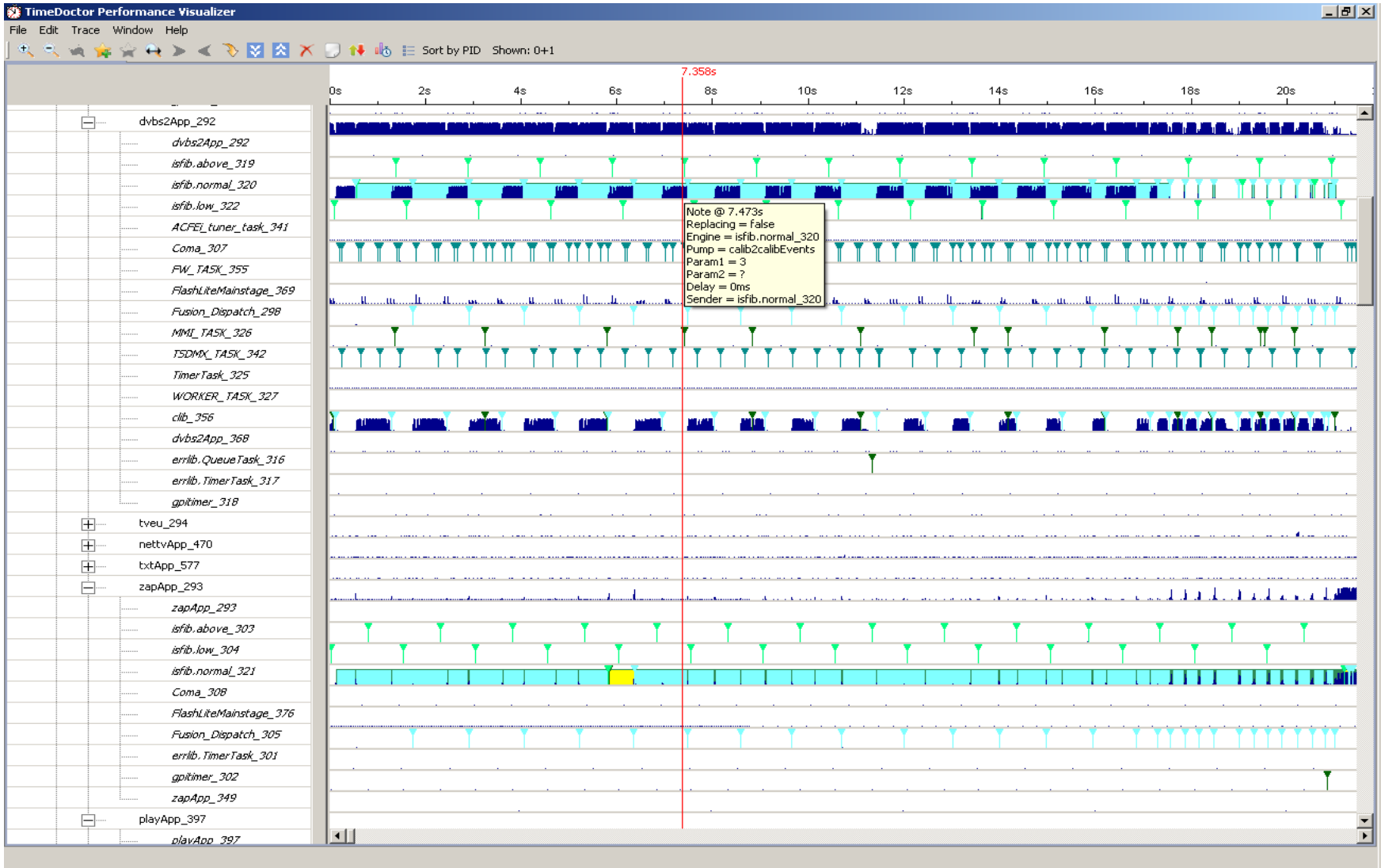
Example 3: Watchdog (blocked on other thread)

context_switch	vmlinux_flash	linux-2.6.35.13/kernel/sched.c:2920
schedule	vmlinux_flash	linux-2.6.35.13/kernel/sched.c:3870
schedule_timeout	vmlinux_flash	linux-2.6.35.13/kernel/timer.c:1437
__down_common	vmlinux_flash	linux-2.6.35.13/kernel/semaphore.c:221
__down_interruptible	vmlinux_flash	linux-2.6.35.13/kernel/semaphore.c:243
down_interruptible	vmlinux_flash	linux-2.6.35.13/kernel/semaphore.c:84
ioctl	libc-2.13	0x14
CPUComm_CallEx	libCPUComm	home/coverity/svn/DCP_SYS_Fusion_TestRI/HAL_Fusion/CpuComm/Src/thal_cpucomm_api.c:605
Trid_Util_CPUComm_Call	libCPUComm	home/coverity/svn/DCP_SYS_Fusion_TestRI/HAL_Fusion/CpuComm/Src/thal_cpucomm_api.c:677
SX5_Video_Close	libhalvideo	home/coverity/svn/DCP_SYS_Fusion_TestRI/HAL_Fusion/Video/Src/sx5_video_api.c:1600
__gst_videodec_close	libgstproxydecoder	space/plf/trident/import/PLF/aw/Comps/plfConnectivity/Comps/GStreamer/plugins/ProxyDecoder/gstvideo
gst_videodec_close	libgstproxydecoder	space/plf/trident/import/PLF/aw/Comps/plfConnectivity/Comps/GStreamer/plugins/ProxyDecoder/gstvideo
__proxy_decoder_close	libgstproxydecoder	space/plf/trident/import/PLF/aw/Comps/plfConnectivity/Comps/GStreamer/plugins/ProxyDecoder/gstproxy
gst_proxy_decoder_change_state	libgstproxydecoder	space/plf/trident/import/PLF/aw/Comps/plfConnectivity/Comps/GStreamer/plugins/ProxyDecoder/gstproxy
gst_element_change_state	libgstreamer-0.10	space/plf/trident/import/PLF/aw/Comps/plfConnectivity/Comps/GStreamer/Core/gstreamer-0.10.32/gst/gstelement.c:2652
gst_element_set_state_func	libgstreamer-0.10	space/plf/trident/import/PLF/aw/Comps/plfConnectivity/Comps/GStreamer/Core/gstreamer-0.10.32/gst/gstelement.c:2608
gst_element_set_state	libgstreamer-0.10	space/plf/trident/import/PLF/aw/Comps/plfConnectivity/Comps/GStreamer/Core/gstreamer-0.10.32/gst/gstelement.c:2509
gst_bin_element_set_state	libgstreamer-0.10	space/plf/trident/import/PLF/aw/Comps/plfConnectivity/Comps/GStreamer/Core/gstreamer-0.10.32/gst/gstbin.c:2191
gst_bin_change_state_func	libgstreamer-0.10	space/plf/trident/import/PLF/aw/Comps/plfConnectivity/Comps/GStreamer/Core/gstreamer-0.10.32/gst/gstbin.c:2490

Example 4: Watchdog (CPU overload)

- Crash:
  - Watchdog due to task taking longer due to CPU consumed by other threads
- Detect:
  - Every worker thread feeds watchdog
- Dump:
  - Dump backtrace of all threads (standard solution: raise signal to all threads)
  - Dump trace of last events in system
- Analysis:
  - Translate backtrace
  - Visualize last x seconds

Example 4: Watchdog (CPU overload)



Example 5: Watchdog (deadlock)

- Crash:
  - Watchdog due to task blocked on lock
- Detect:
  - Every worker thread feeds watchdog
- Dump:
  - Dump lock status as much as possbile
- Analysis:
  - Show status of locks in backtraces

Example 5: Watchdog (deadlock)

context_switch	vmlinux_app_flash	linux-2.6.35.13/kernel/sched.c:2920
schedule	vmlinux_app_flash	linux-2.6.35.13/kernel/sched.c:3870
ioctl	libc-2.13	0x14
fusion_skirmish_prevail	libfusion-1.6	dfb/core/DirectFB.git/lib/fusion/lock.c:142
fd_messenger_lock	libfusiondale-1.6	dfb/libs/FusionDale.git/src/core/messenger.h:141
IFusionDaleMessenger_AllocateData	libfusiondale-1.6	dfb/libs/FusionDale.git/src/messenger/ifusiondalemessenger.c:304
hsvprefixhsvchanlib__sendevt_SendEvent	libhsvchanlib	space/app/eu/hsvchanlib/prod/hsvchanlib/hsvchanlib_m.c:623
hsvprefixhsvpgdat__ipgdb_Update	libhsvchanlib	space/app/eu/hsvchanlib/comp/hsvpgdat/hsvpgdat_mpgdb.c:425
mSetScalarAttributeNat64	libhsvchanlib	space/app/eu/hsvchanlib/comp/hsvpgdat/hsvpgdat_mpgdat.c:1255
hsvprefixhsvpgdat__pgdat3_StoreChannelDataNat64	libhsvchanlib	space/app/eu/hsvchanlib/comp/hsvpgdat/hsvpgdat_mpgdat.c:1197
CreateChannelNode	euApp	space/app/eu/euint/comp/eucontentlib/eucontentlib_m.c:1757
AddNodesInParts	euApp	space/app/eu/euint/comp/eucontentlib/eucontentlib_m.c:670
PumpHandler	euApp	space/app/eu/euint/comp/eucontentlib/eucontentlib_m.c:827
Execute	libcesgpi	space/plf/tvplf/ceos/comp/GPI/comp/cesgpipmp/cesgpipmp_m.c:841
EngineTask	libcesgpi	space/plf/tvplf/ceos/comp/GPI/comp/cesgpipmp/cesgpipmp_m.c:1045

Example 5: Watchdog (deadlock)

context_switch	vmlinux_app_flash	linux-2.6.35.13/kernel/sched.c:2920
schedule	vmlinux_app_flash	linux-2.6.35.13/kernel/sched.c:3870
futex_wait_queue_me	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:1702
futex_wait	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:1820
do_futex	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:2561
sys_futex	vmlinux_app_flash	linux-2.6.35.13/kernel/futex.c:2636
handle_sys	vmlinux_app_flash	linux-2.6.35.13/arch/mips/kernel/scall32-o32.S:59
__lll_lock_wait	libpthread-2.13	glibc/nptl/sysdeps/unix/sysv/linux/lowlevellock.c:46
__pthread_mutex_lock	libpthread-2.13	glibc/nptl/pthread_mutex_lock.c:82
cesgpitphostrtk2__pxrtk_ProcessSharedSemAcquire	libcesgpi	space/plf/tvplf/ceos/comp/GPI/comp/cesgpitphostrtk2/cesgpitphostrtk2_mposix.c:1569
GlobalLock	libca	space/prod/am/cehtv/prod/CaLib/ca_m.c:724
ca__ca_ReadNode	libca	space/prod/am/cehtv/prod/CaLib/ca_m.c:2364

Source | 5 | 10 | 15 | Assembly | 5 | 10 | txt | Webgit | Cgit | Opengrok

```
2364        LOCK();
```

eucontentlib__pgdatN_OnChannelRemoved	euApp	space/app/eu/euint/comp/eucontentlib/eucontentlib_m.c:1188
mChannelLibEventListen	libhsvchanlib	space/app/eu/hsvchanlib/prod/hsvchanlib/hsvchanlib_m.c:1013
fd_messenger_port_reaction	libfusiondale-1.6	dfb/libs/FusionDale.git/src/core/messenger_port.c:796
_fusion_reactor_process_message	libfusion-1.6	dfb/core/DirectFB.git/lib/fusion/reactor.c:592
fusion_dispatch_loop	libfusion-1.6	dfb/core/DirectFB.git/lib/fusion/fusion.c:1118

Example 6: Out Of Memory

- Problem:
  - Standard Linux OOM killer would remove forensic evidence from debug dumps. We must collect all info *before* it kicks in
- Detect:
  - Poll free memory (minus buffers and cached)
    - Heuristic value of required free memory defined
- Dump:
  - Dump memory status of all applications and libraries
    - Proprietary tool parsing kpagemap

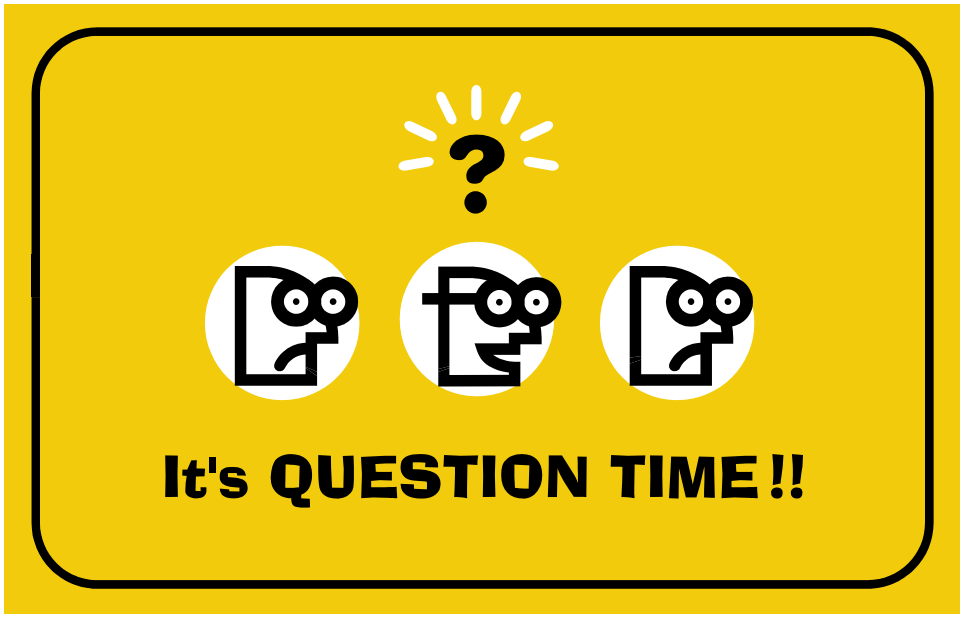
Example 6: Out Of Memory

owner	unknown	code	data	heap	bss	stack	shared	file	other	TOTAL
+recordApp	0.0	20.0	8.0	1068.0	0.0	200.0	0.0	0.0	60.0	1356.0
+ytlbApp	0.0	0.0	12.0	280.0	0.0	160.0	0.0	0.0	0.0	452.0
+epgApp	0.0	72.0	24.0	2684.0	0.0	257.0	0.0	0.0	3988.0	7025.0
+txtApp	0.0	16.0	12.0	1420.0	0.0	272.0	0.0	0.0	1552.0	3272.0
+oskbApp	0.0	8.0	8.0	1424.0	0.0	180.0	1.0	0.0	16.0	1637.0
+upgApp	0.0	12.0	12.0	1412.0	0.0	192.0	0.0	0.0	60.0	1688.0
+dfuApp	0.0	8.0	4.0	2832.0	0.0	172.0	0.0	0.0	4.0	3020.0
+nettvApp	0.0	196.0	28.0	241264.0	0.0	1329.0	16.0	0.0	820.0	243653.0
+ecdApp	0.0	12.0	8.0	208.0	0.0	180.0	0.0	0.0	80.0	488.0
+playApp	0.0	12.0	28.0	1936.0	0.0	252.0	1.0	0.0	1196.0	3425.0
...										
-libdl-2.13.so	0.0	0.0	88.0	0.0	4.0	0.0	0.0	0.0	0.0	92.0
-librt-2.13.so	0.0	4.0	84.0	0.0	0.0	0.0	0.0	0.0	0.0	88.0
-libgcc_s.so.1	0.0	19.0	84.0	0.0	0.0	0.0	0.0	0.0	0.0	103.0
-libpthread-2.13.so	0.0	69.0	88.0	0.0	88.0	0.0	0.0	0.0	0.0	245.0
-libutil-2.13.so	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
-libcrypt-2.13.so	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
-libnsl-2.13.so	0.0	4.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0
-libnss_files-2.13.so	0.0	4.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0
-libnss_nis-2.13.so	0.0	4.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0
-libc-2.13.so	0.0	617.0	251.0	0.0	340.0	0.0	0.0	0.0	0.0	1208.0
-ld-2.13.so	0.0	99.0	227.0	0.0	8.0	0.0	0.0	0.0	0.0	334.0

Summary

- Reduce Time-To-Market by efficient software crash analysis
- Add information to crash dumps
- Improve analysis
- Continuous improvement based on experience

Questions?



Appendix: Resources

- jointSPACE
  - http://jointspace.sourceforge.net/
- TimeDoctor
  - http://sourceforge.net/projects/timedoctor/