No Crash Dump? No Problem!

Light-weight remote kernel crash reporting for settop boxes

David VomLehn, Technical Leader

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Imagine…

It's the last five minutes of the Superbowl...

The game is tied...

And...

...2 million set top boxes with your company's logo crash!

Ouch!

To Prevent That, We Need Information

- Need to be able to have a good chance of figuring out what went wrong but, in the embedded world, we have constraints…
  - – Little persistent storage
  - – Tight memory
  - – Low or non-existent bandwidth
  - – Need to get the device doing it’s job quickly
  - – Analysis needs to be quick, so text reports, please

Crash Dumps Are Great!

- Very common method of capturing failure information
- With all of kernel memory available, there is a good chance of figuring out what went wrong
- Copy of system memory written to mass storage device, possibly with holes and compression to minimize required resources
- Supported in Linux with kexec/kdump on many/most/all(?) platforms

Crash Dumps-Not For Everyone

- Even using hole elimination and compression, core dumps are big
- Dumping all that memory takes time
- Need separate solution for userspace failures
- Just saving crash dump files prior to analysis can take a lot of space
- Not human readable and incomprehensible to those with limited expertise

What needs to be done?

- Report – Generate and store data to use for analysis
- Reboot – Re-initialize the system so that devices are available
- Send – Send the report upstream (or store locally)

Report Excerpts

- Custom header

```
DIAG 0x03: Kernel Diagnostic Report: 2.0 (Linux)
DIAG 0x03: Reason: Fatal exception in interrupt
DIAG 0x03: RF MAC: 00:22:CE:71:FF:BC
DIAG 0x03: HW MODEL: 335, HW VER: 14
DIAG 0x03: Uptime: 0d:20h:46m:58s
DIAG 0x03: Linux Kernel Release: 2.6.24-1.2.25.101_full-highmem
DIAG 0x03: Linux Kernel Version: #0 PREEMPT Sat Jun 27 13:43:01 PDT 2009
```

- Standard Registers, printed with printk()

```
Cpu 0
$ 0   : 00000000 10000301 cccccccc 9efe5ea0
$ 4   : 9121848c 90845c24 00000101 00000101
```

- Log extract

```
 | [66090.760000] pmem: kPmem_IoctlCmdGet 1074556930
 | [66090.760000] pmem: ioctl returning stst = 0
 | [69690.159000] pmem: kpmem_Ioctl  400c7002
 | [69690.159000]
 | [69690.159000] pmem: kPmem_IoctlCmdGet 1074556930
```

- Much more…

```
Kernel Memory Statistics
------------------------
MemTotal:        468368 kB
MemFree:         370348 kB
Buffers:          30168 kB
Cached:           31852 kB
```

RRSR - Report/reboot/send/reboot

- Proposed by Eric Biederman
- Boots light-weight kernel (kdump), which doesn't really need to be Linux, without reset
- Pros:
  - Can write failure report to any device, even send upstream via network
  - Very flexible
- Cons:
  - Dedicated memory need for kdump
  - Need real kernel for full device operability, scripts, etc.
  - Not working when writing failure report from memory
  - Additional storage for light-weight kernel
  - Not available until after boot complete

RRS - Report/reboot/send

- When failure occurs, generate and write report to vlram (pseudo-device that uses RAM preserved during reboots)
  - In kernel space, call vlram_panic_write()
  - In user space, write() to /dev/mtd0
- Reboot system
- Read from /dev/vlram0
  - Send report upstream
  - Store report locally

Report/reboot/send, II

- Pros
  - Gets system working again ASAP
  - Failure report sending done in parallel with saving report or sending upstream
  - Though it requires dedicated vlram memory during reboot, it can be reused after report captured or sent
  - Can start sending in parallel to bringing up the user space application
  - Provides userspace reporting, too
- Cons
  - Risk of losing report during reboot due to memory corruption, multiple failures, etc.
  - Since only limited information is provided, unanticipated data isn’t available

RRS Components

- Series of small changes:

Panic-data	panic notifiers get register contents
vlram	pseudo-device to store data in persistent memory, i.e. memory preserved over reboots
conslogger	pseudo-console for recording and diverting console output
panic_log	generates the panic report, calling a cloud of functions to provide information

vlram (variable-length RAM devices)

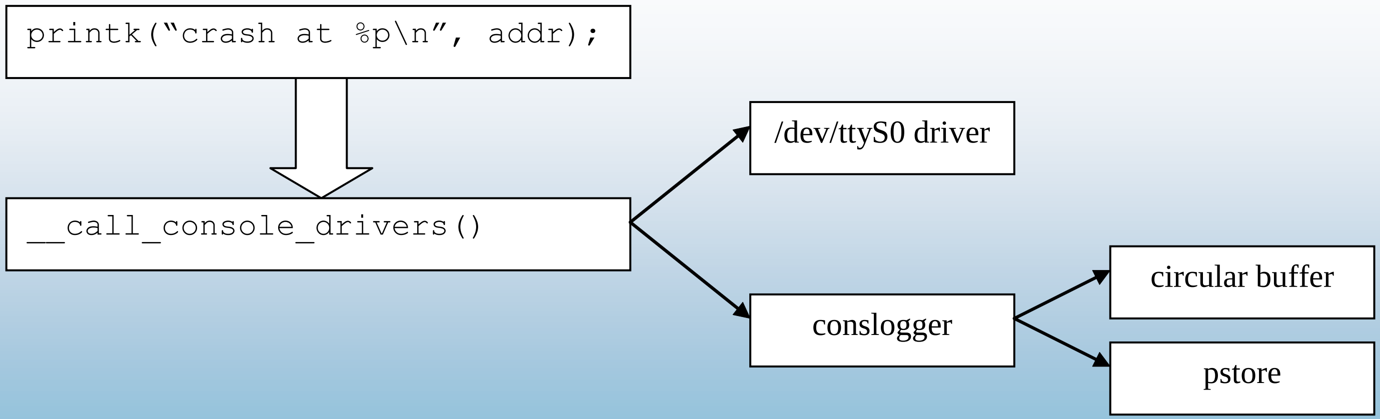
- Built on MTD:
  - Provides non-blocking reads and writes to the kernel
  - Device in /dev for user space access, /dev/mtd<n>
- Contract with bootloader and hardware to preserve contents and not overwrite area when booting
- Current implementation uses one section of DRAM to hold data, written with uncached writes
- Other implementations possible: SRAM, flash, NVM
- Also usable for providing panic log annotation

Conslogger

- Implemented as console device to obtain all console, i.e. printk(), output
- Three states:

Not logging	Output is ignored
Logging	Output stored in circular buffer for later printing
Diverting	Output passed function for storing (in vlram)

- Existing functions can be used without modification



Panic log

- Presently, this is platform-dependent
- Would be interesting to have an extensible core and standardize on some aspects of panic logs
- Needs a rich set of functions to call to report on the state of the system:
  - –The usual—registers, stack, instructions, modules
  - –State of the current process
  - –Lots more information about the system…

Additional panic log components

- IRQ logger
- /proc/meminfo information
- SoftIRQ times
- Timer times
- Biggest processes
- Current process info
  - stack dump
  - backtrace
  - /proc/<pid>/maps
  - process ancestry
  - registers
- Etc.

Status of patches

- panic-data & panic-data-<processor>: submitted
- conslogger: submitted
- vlram: prototype done, will submit soon
- panic-log: prototype done, submit soon
- other: prototypes done for the following:
  - plog-irq: IRQ history
  - plog-meminfo: /proc/meminfo data
  - plog-note: user space annotation

What’s next?

- More panic log components
  - slab top
  - concise list of current processes
  - registration of panic-log annotation, especially interesting for loadable kernel modules
  - And much more…

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Backup Material

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