Unified error reporting -- A worthy goal?

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errors

- standardized errors
  - machine checks
  - pci-express errors
- platform errors
  - thermal errors
  - APEI
- storage errors
  - IO errors
  - SMART events
- network errors
  - link lost
- random errors from drivers
  - failover
- software errors
  - out of memory

scope

- concentrating on platform hardware errors for now
- the others possibly later
- but especially software errors are hard
  - because there are so many of them

what can you do with errors:

- log them
- categorize them: display critical ones on the desktop as pop up
- account them, keep statistics
  - that many errors on device X in last 24hours
- trigger events
  - e.g. when more than X errors in 24h call this shell script
  - which pages admin, support, triggers failover
  - or on a small home servers starts blinking the red LED
    - (after all what else is the "LED subsystem" good for?)

audiences

- desktop user
- normal system administrator
- expert
- automated analysis tool
- cluster logging

the desktop user

- don’t really understand errors
  - at best a very high level summary
- should not be unnecessarily concerned
  - needs classification, hiding
- graphical interface
- localization
- details should still be available for expert support

normal system administrator

- largely same as desktop user
- only really needs high level summary
- should not be unnecessary alarmed
- really wants to identify failed part
- graphical interface not as important
  - can access log files
  - but still useful if not intrusive
  - needs reporting to the console

expert / automatic tools

- compatibility crucial
- still want high level summary
  - but all the details should be available
- interface to other tools
  - might put error from a cluster in central database

so what’s wrong with printk?

- difficult to parse
- good errors are verbose
- printk is traditionally for 1-2 lines
  - most printks with more information are a mess
  - no clear record boundaries
- categorization / severity important
- good errors too verbose for kernel log

what’s good with printk

- it’s the standard
  - a lot of people know where to look
- there are lots of tools to handle it
  - including network servers
  - but often not very good
- should be used for some high level categorization
  - but only those errors that don’t make sense to hide

error metadata

- hardware errors
  - ultimative goal is to identify the failed part
  - various other information
- various other data useful
  - for example dropped event count
- advantage of standard records
  - they tend to be reasonably well documented
  - so you can point sophisticated users to documents
  - make it easier to process
- rich errors are important
  - need more data per error
  - but don’t display it all by default

why should some errors be hidden?

- some "errors" are normal and expected
  - if you ever saw a noisy SMART daemon...
  - or ECC memory has a expected corrected error rate
- let’s call them events
  - they’re not really errors
- hardware errors are often bursty
  - but individual events in a burst not too interesting
  - and on large clusters too much data
- they’re still useful to see trends
  - and should be accounted per component
  - don’t belong in normal kernel logs

error processing

- good error processing needs a lot of state
  - and also policy
  - GUI interfaces for important errors
  - or triggering events
- with triggers when exceeding thresholds
- complex decoding
  - identifying components using firmware help
  - probably not a good idea in the kernel
- one corner case is fatal errors where the kernel has to panic
  - the kernel needs to do limited decoding at least
  - but most errors are not fatal
- need user space for rich error processing
  - we already have it with klogd/syslogd
  - just too dumb

errors vs event tracing

- normal event tracing aimed at debugging
  - so higher overhead is ok
- error handling should be always on
  - has to work seamlessly in the background
- small footprint crucial
  - particularly in memory
  - and in dependencies
- requirements and tools are quite different
  - should not be mixed up
  - possibly reuse some infrastructure
  - but only if it has extremly low overhead

so what's the master plan?

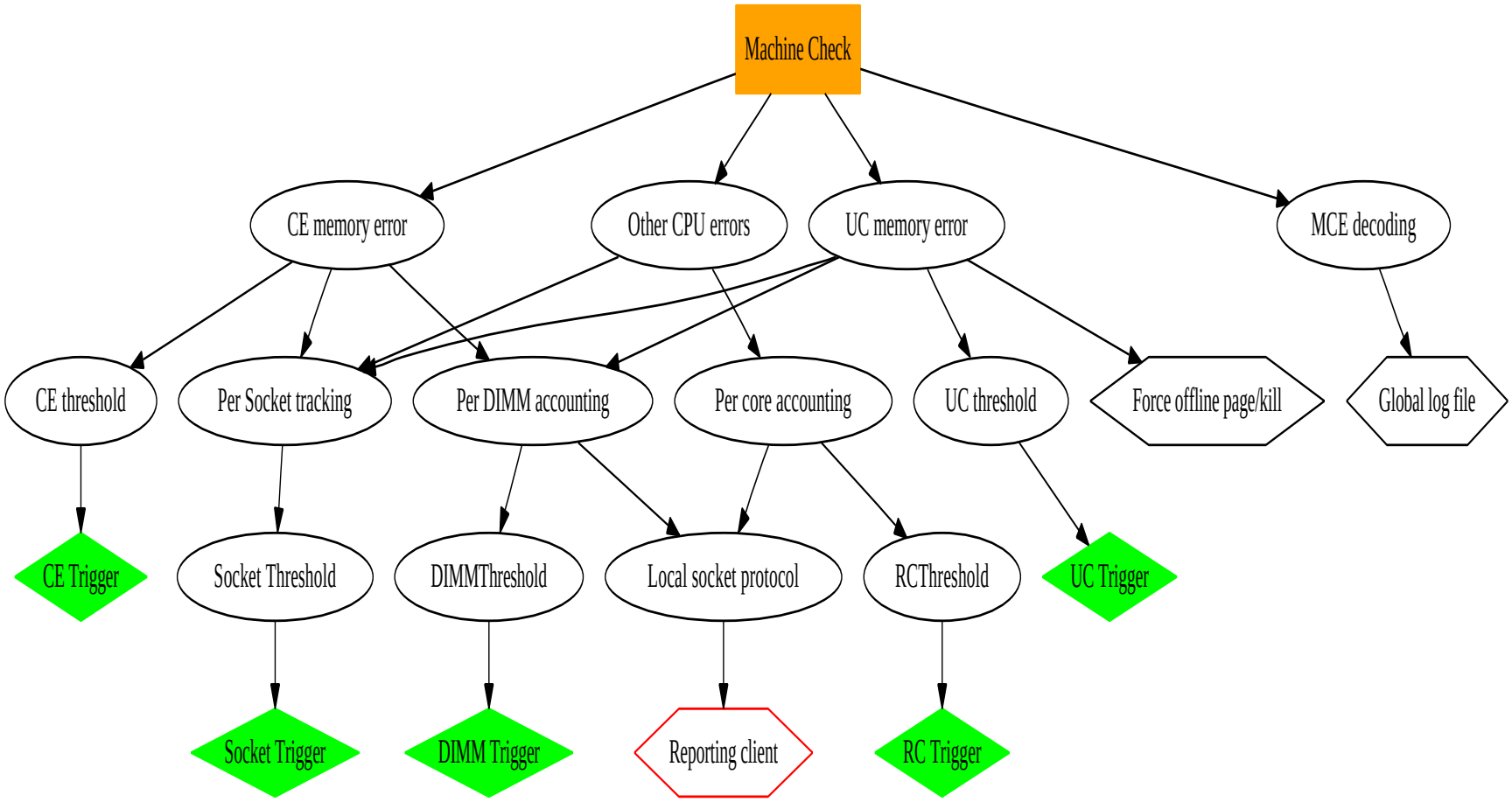
- right now for platform errors (MCE, APEI, PCI-AER)
- keep basic one line errors in printk with an identifier
  - but only for serious errors or occasionally output for trends
  - strictly rate limited
  - possibly extend KERN_* for severity
- but add structured record on second channel
  - similar to /dev/mcelog, but ascii in sysfs
  - few record types for different types
  - using standard formats (e.g. CPER)

master plan user space

- a standard error daemon
  - light weight to always run
  - has knowledge over basic error types
  - accounts events
  - hooks for automated action
  - simple network protocol interfaces

- extension of mcelog for more errors
  - PCI errors, APEI
  - more in the future?

mcelog


Machine Check
CE memory error
Other CPU errors
UC memory error
MCE decoding
CE threshold
Per Socket tracking
Per DIMM accounting
Per core accounting
UC threshold
Force offline page/kill
Global log file
CE Trigger
Socket Threshold
DIMMThreshold
Local socket protocol
RCThreshold
UC Trigger
Socket Trigger
DIMM Trigger
Reporting client
RC Trigger

Questions?

Backup

kernel error problems

- some happen from NMI like contexts
- have to use lockless data structures
  - can cause problems like livelocks
- requires preallocation, potentially wasting a lot of memory