Botching Up IOCTLs

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overview

- basics: testcases, interface type, ...
- technicalities for proper ABI design
- special topics like resource handling, signals, time, ...
basics: interface type

- (generic) IOCTL or syscall?
- read/write/poll on an FD
- sysfs, configfs, debugfs, ...
- extend existing subsystesm like perf
basics: real-world userspace

- tested, reviewed, ready for merging
- production code (corner cases, errors all handled)
- BUT: always merge kernel patches first
basics: testcases

- for everything
- FOR EVERYTHING
- focus on evil corner-cases
technicalities: struct ABI

- goal: no compat layer
- only use `__s32`, `__u32`, `__s64` and `__u64`
- if you have any 64 bit members: align/pad everything to 64 bit
- pointers are `__u64`
- `__attribute__((packed))` plus explicit padding when you screwed up
technicalities: input validation

• unchecked stack garbage breaks extendability
• unchecked evil input scores CVEs
• overflows (careful with variable-sized arrays)
• invalid combinations&values
• have testcases for everything
technicalities: flags

- have a flags parameter
- reject invalid flags with \texttt{EINVAL}
- have a testcase
- specifically check for: invalid flag combinations, unused values in bitfields and the next available flag
technicalities: compatibility

- hide big things for 1-2 kernel releases
- flags, driver caps, userspace caps for opt-in, interface revisions
- remember: it's only a regression when you get a bug report
technicalities: endianess

- it's horrible
- but the world is mostly little-endian
resources

- attach everything to a `struct file`
- consider standard file types like dma-buf, fences, ...
- support `O_CLOEXEC`
resources: sharing

- private namespace ok when there's tons of objects
- but don't reinvent resource passing/sharing
- consider uniqueness requirements
- proper `fstat()` unfortunately needs a full virtual fs
resources: access & revoke

- consider revoke support for global\&unshareable resources
- required for proper session switching
- priviledged operation
- properly isolate other objects (e.g. gpu buffers)
signals

- it's UNIX, no way to avoid them
- `man (7) signal`: „slow“ devices can return `-EINTR`, others restart by default
- „slow“ devices unclear distinction and autorestart are fragile
signals: solutions

- userspace simply handles -EINTR correctly in all cases
- or don't support signals when blocking
signals: killable waits

• nice, but
• process exit doesn't necessarily close file
• E.g. logind has dup'ed FD for revoke
• hard to test –EINTR code in the kernel
signals: „Stop worrying and ...“

- restarting makes testing error paths trivial
- the more interruptible waits you have the better
- duplicate all your functional tests with one where the main thread gets interrupted all the time
- inject \texttt{\textasciitilde\texttt{EINTR}}} for testing
signals: summary

- support full restarting
- shared `fooIoctl()` in userspace to enforce proper restarting even for `-EINVAL`
- exploit `-EINVAL` for testing error paths
- or only do blocking on pollable FDs
time: sampling

- make the clocksource clear to userspace, different clocks *will* mismatch
- prefer `CLOCK_MONOTONIC`
- allow userspace to sample hw clocks
- `__s64 seconds + __u64 nanoseconds` for structs (to match `ktime`), enforce normalization
time: waiting

- seriously consider pollable FDs
- support absolute timeouts
- convert relative to absolute for restarting
documentation

- prefer executable specs
- manpages for generic interfaces
- forget about Documentation/ABI ... maybe
summary

- real world user
- testcases, testcases, testcases
- don't screw up technicalities too badly, see http://blog.ffwll.ch/2013/11/botching-up-iocltls.html
- think about documentation