Hardware-Accelerated Graphics on Microkernels

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what's a microkernel?

a definition

. . . the near-minimum amount of software that can provide the mechanisms needed to implement an operating system (OS).

— *https://en.wikipedia.org/wiki/Microkernel*

what does that mean, really?

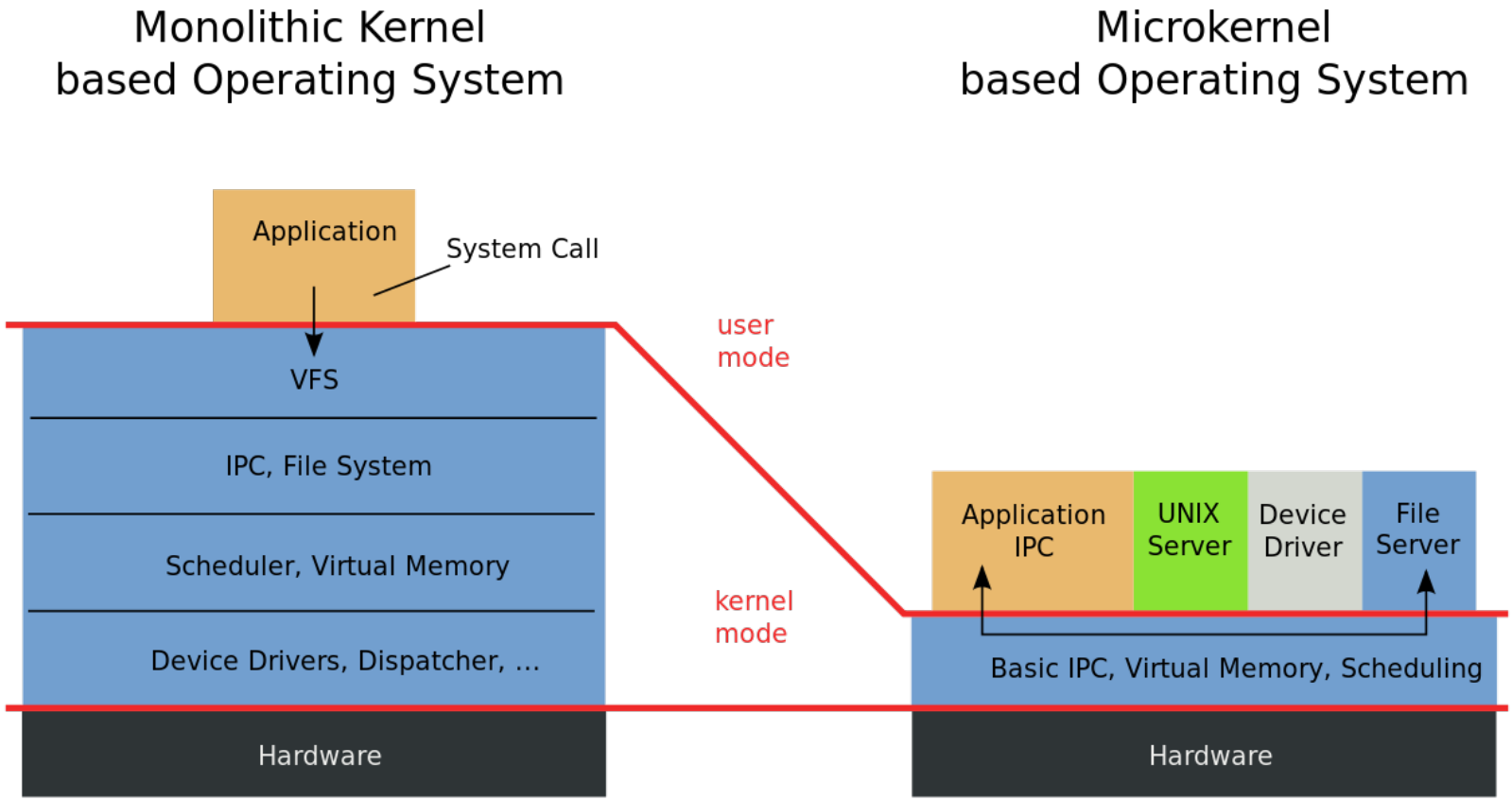

Figure 1:monolithic vs. microkernel (from Wikipedia, public domain)

who cares?

do you trust your kernel? are you sure it:

- doesn't crash, overrun buffers, write to random memory
- doesn't leak information to untrusted processes
- enforces full isolation between processes
- ensures the highest-priority process is the one that's running

seL4

a modern microkernel, 9k lines of formally verified C:

- proven not to overrun buffers or invoke undefined behavior
- proven to enforce *isolation* between processes
- proven to not access the wrong memory

cost of formal verification

optimistic cost estimate:

- over $1 trillion to write a formally verified Linux kernel

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- (but it's only 3x the SLOCCount estimate)

NOVA “microhypervisor”

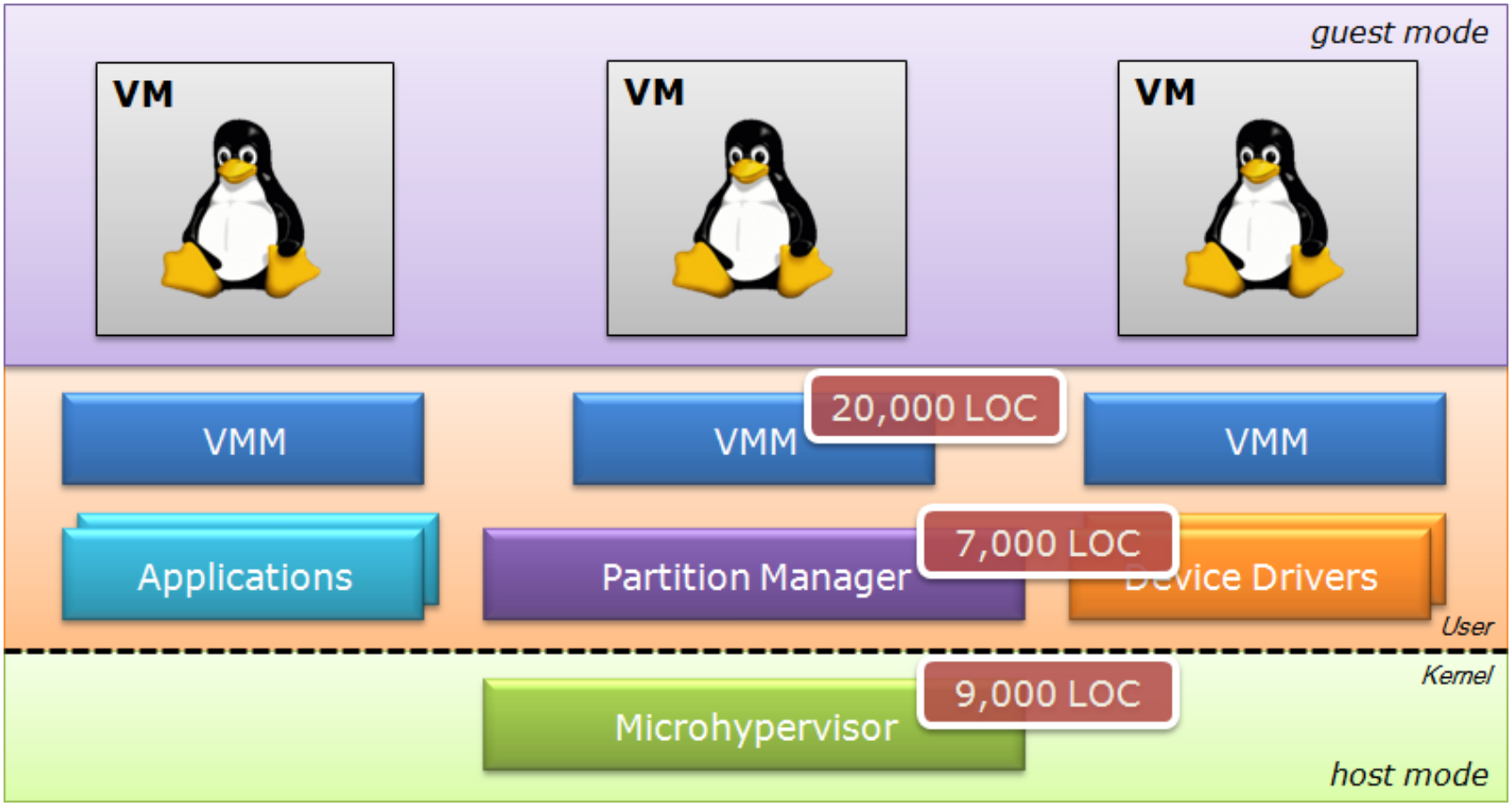

Figure 2:NOVA architecture

Genode: portable userspace for microkernels

microkernel $\Rightarrow$ no drivers in kernel

where do you get device drivers from?

- every research microkernel writes their own drivers

microkernel ⇒ no drivers in kernel

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"Genode" project:

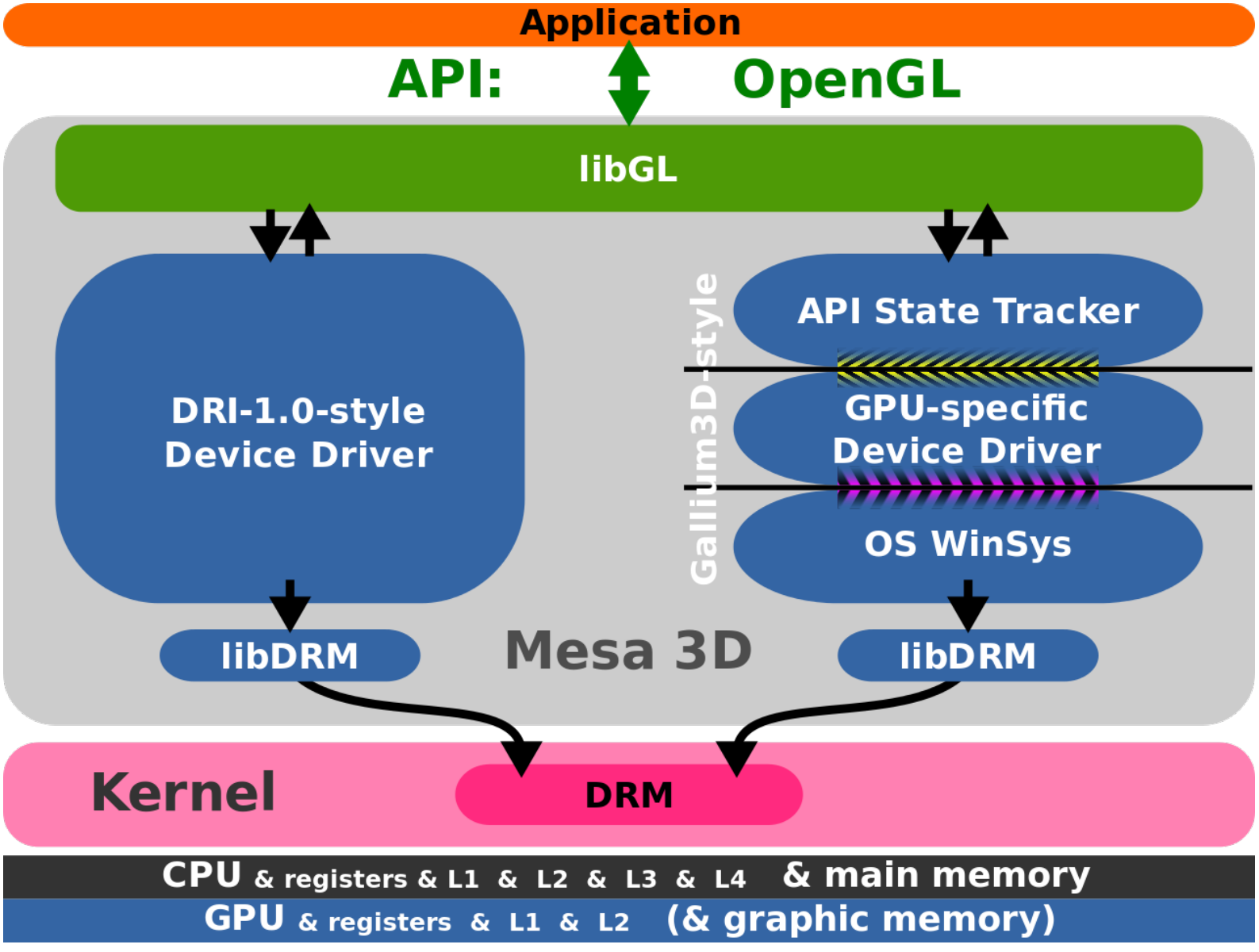
- drivers portable to 8+ microkernels
  - x86 and ARM
  - basic framebuffer and input drivers
  - sound, block, network, usb, uart
  - filesystems: FAT32, ext2, etc.
- POSIX-ish libc, Qt, and other porting aids for userspace
- VMs (in VirtualBox or Seoul) alongside native components

ready for prime-time?

some brave souls now run Genode with a Linux VM as their primary desktop (!)

microkernel-friendly graphics architecture

current Linux graphics architecture



straw-man microkernel graphics architecture

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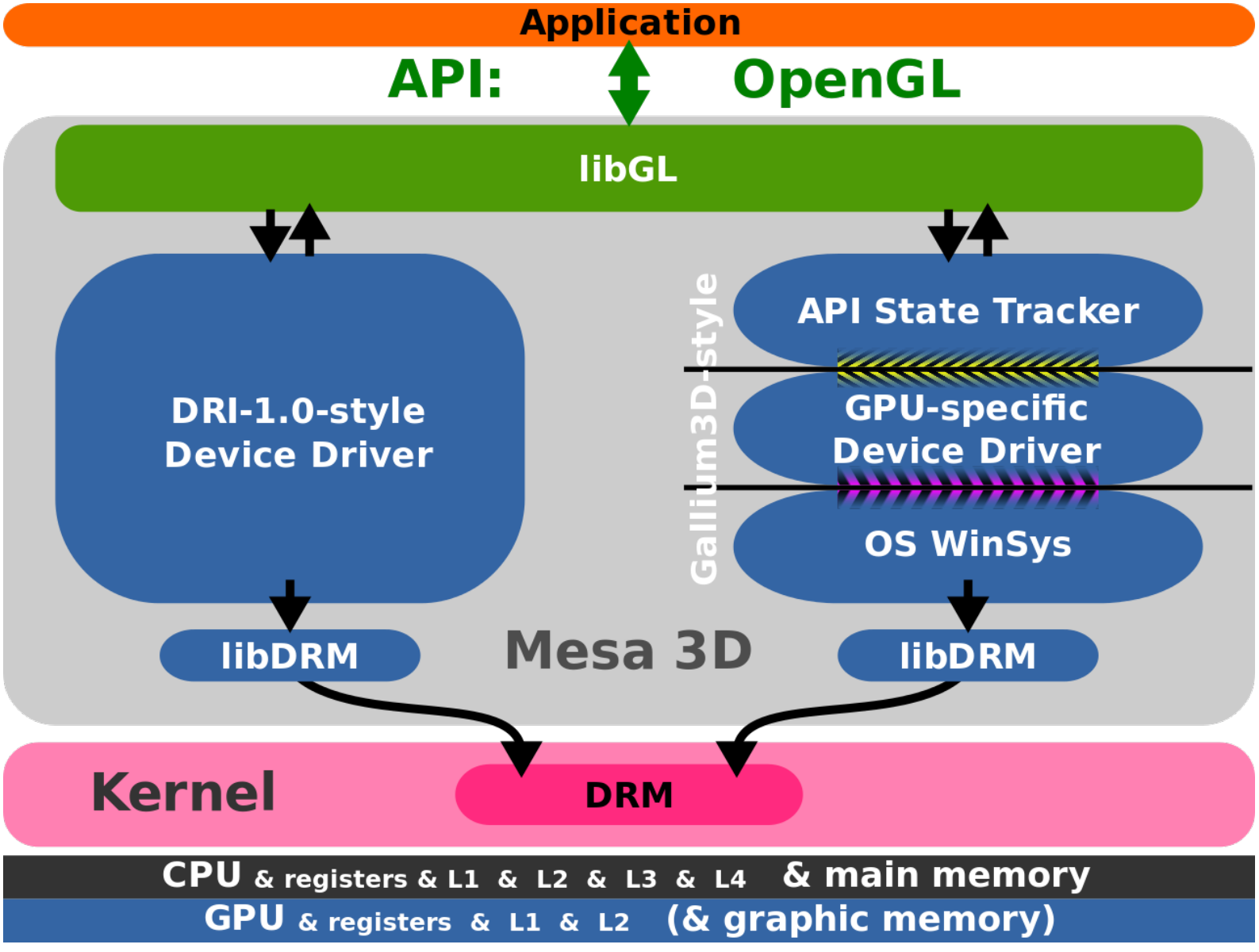

Mesa and i915 on Genode

- original work by Norman Feske of Genode Labs in 2010
- “proof of concept”:
  - wrap Linux i915 driver in compatibility glue
  - shove i915 in the GL client’s address space
  - give GL client direct hardware access
  - not quite what anyone wants, but proves the concept
- no Mesa changes needed
- clear path to a real graphics architecture

demo!

questions?

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