Extended OS

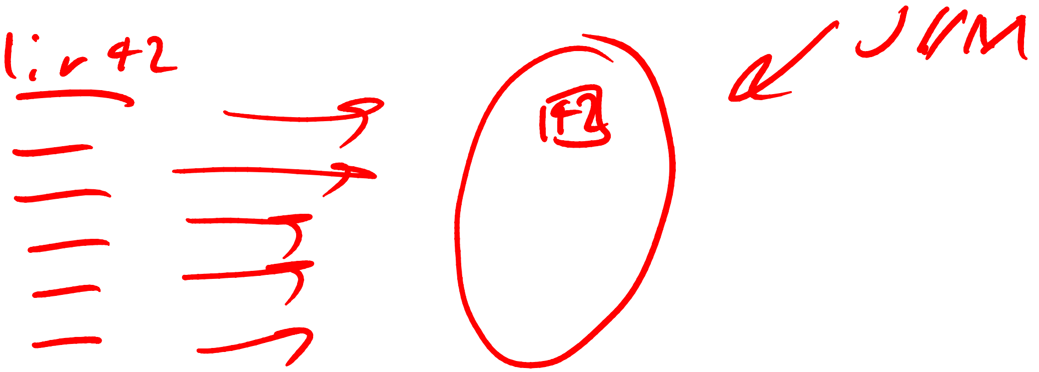
OS is an extended virtual machine

- Multiplexes the “machine” between applications
  - Time sharing, multitasking, batching
- Provided a higher-level machine for
  - Ease of use
  - Portability
  - Efficiency
  - Security
  - Etc.…

JAVA – Higher-level Virtual Machine

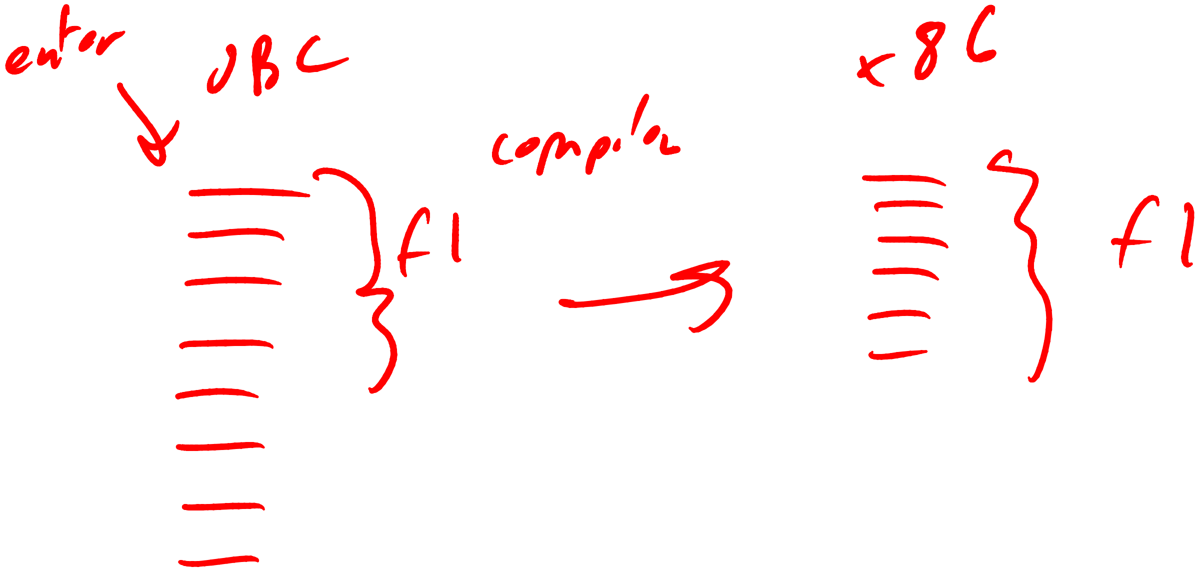
- write a program once, and run it anywhere
  - Architecture independent
  - Operating System independent
- Language itself was clean, robust, garbage collection
- Program compiled into bytecode
  - Interpreted or just-in-time compiled.
  - Lower than native performance

Interpretation



JIT

Just-in-time



Issues

- Legacy applications
- No isolation nor resource management between applets
- Security
  - Trust JVM implementation? Trust underlying OS?
- Performance compared to native

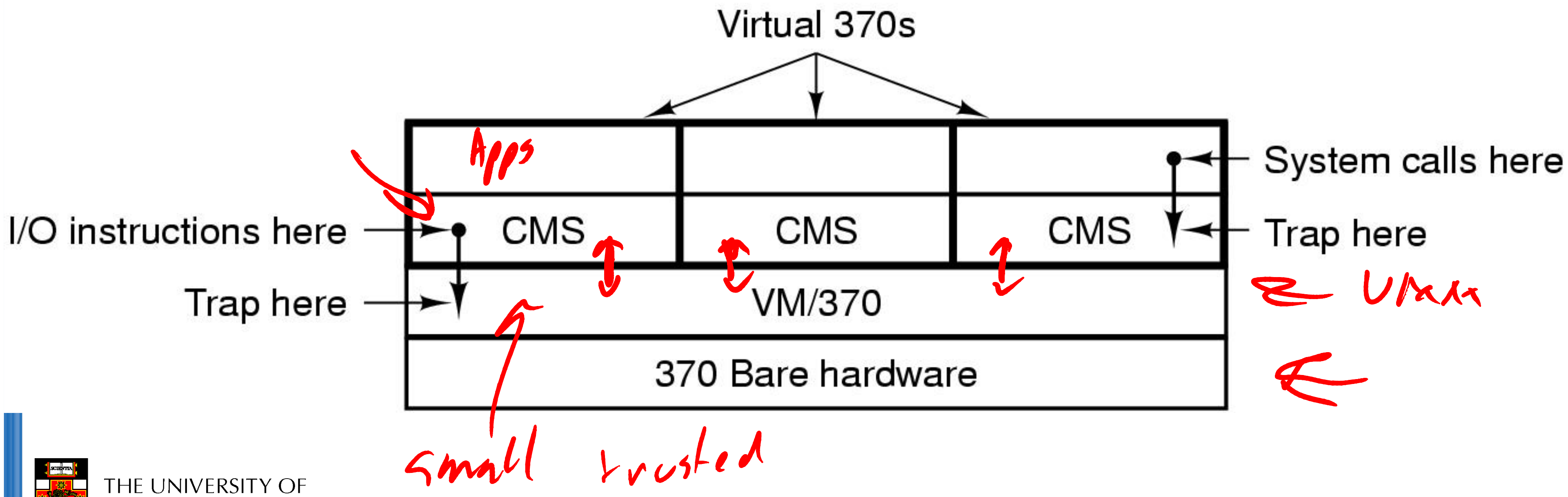
Is the OS the “right” level of extended machine?

- Security
  - Trust the underlying OS?
- Legacy application and OSs
- Resource management of existing systems suitable for all applications?
- What about activities requiring “root” privileges

Virtual Machine Monitors

- Provide scheduling and resource management
- Extended “machine” is the actual machine interface.

IBM VM/370


Virtual 370s
Apps
System calls here
I/O instructions here
CMS
CMS
CMS
Trap here
Trap here
VM/370
≈ VMM
370 Bare hardware
small trusted

Advantages

- Legacy OSes (and applications)
- Concurrent OSes
  - Linux – Windows
  - Primary – Backup
- Security
  - VMM (hopefully) small and correct
- Performance near bare hardware
  - For some applications

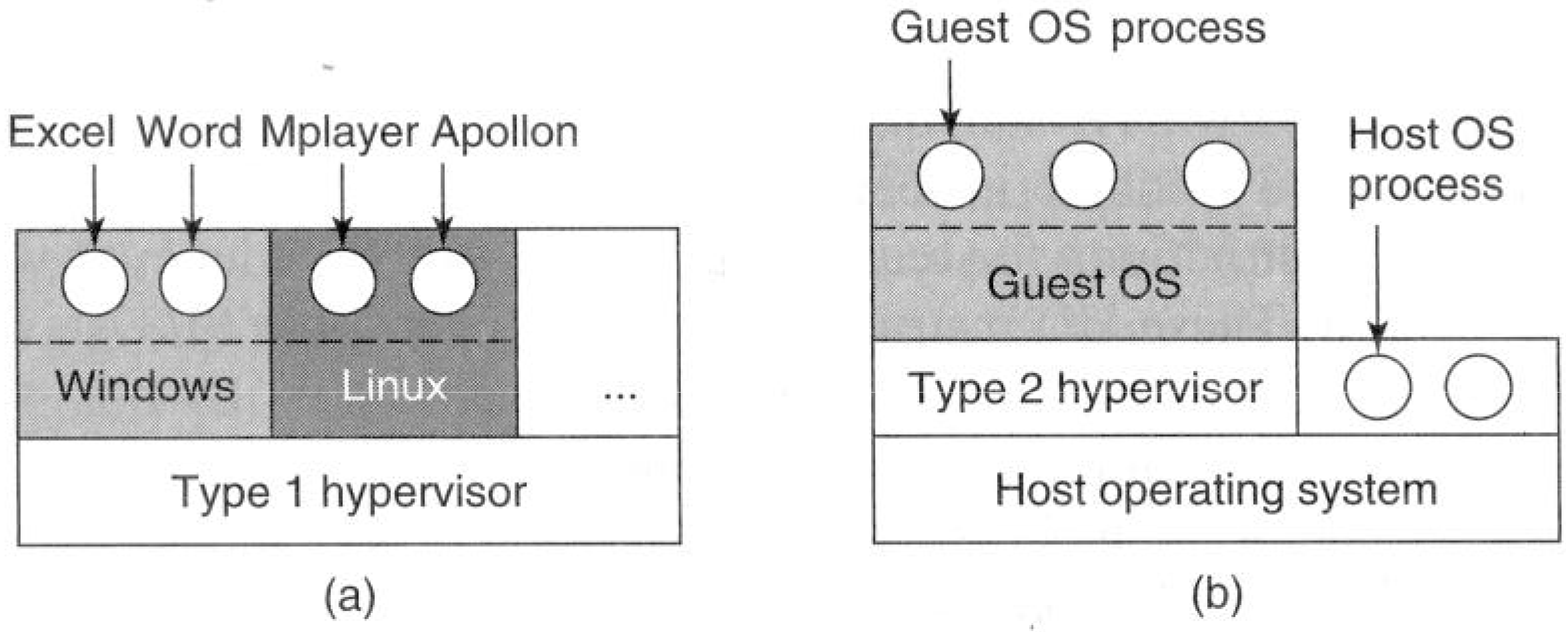


Figure 1-29. (a) A type 1 hypervisor. (b) A type 2 hypervisor.

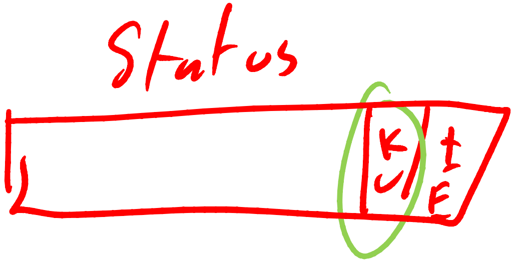
Virtual R3000???

- Interpret
  - System/161
    - slow
  - JIT dynamic compilation

- Run on the real hardware??

Issues

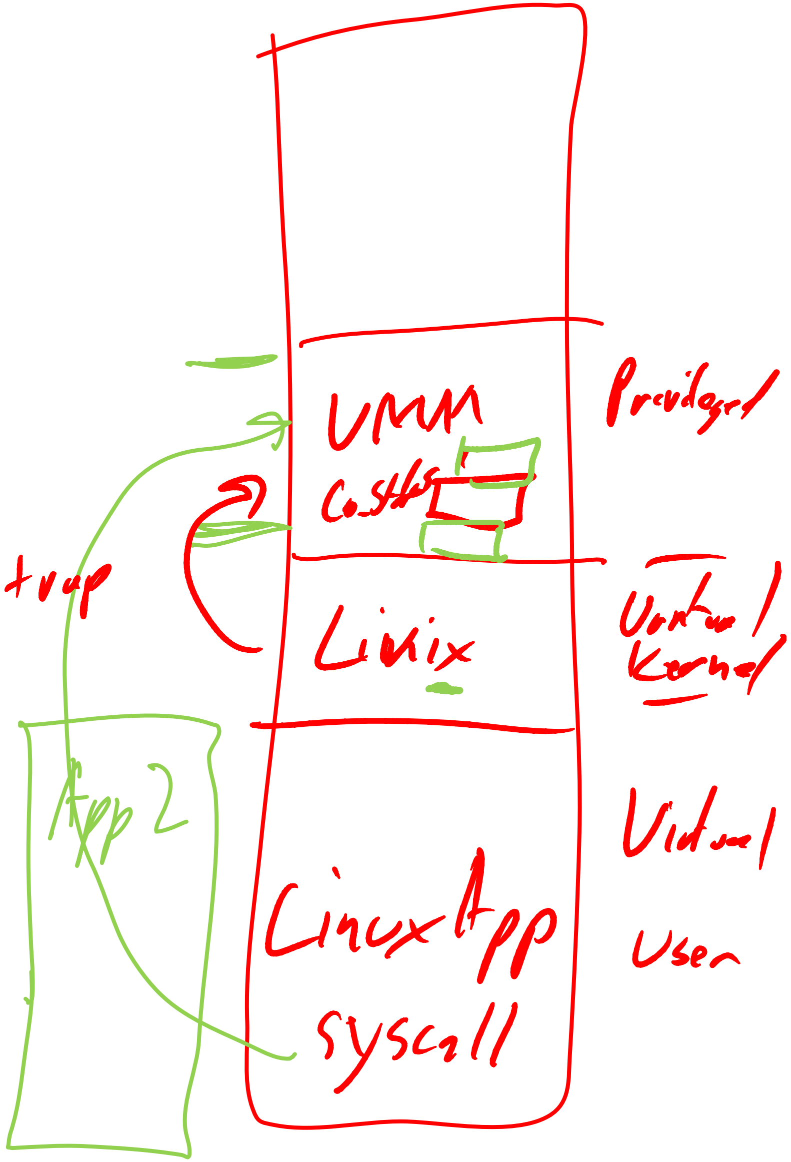
- Privileged registers (CP0)
- Privileged instructions
- Address Spaces
- Exceptions (including syscalls, interrupts)
- Devices



mfc0 r1, c0_status

→ nop

real user-mode


trap
VMM
c0_status
Linux
App 2
Linux App
syscall
Privileged
Virtual Kernel
Virtual User