

Lecture 24: Finishing Virtualization

Wednesday, March 6, 2019 9:05 AM

Outline

- AMAT with TLBs
- Other ways to reduce translation overhead
- Virtual memory and caches
- Virtualizing the whole system

Page table walk: 100 cycles

TLB hit ratio: 99.5%

L1 cache hit time: 1 cycle (includes TLB hit) 95% hit ratio

Memory access time: 50 cycles

4B per access + 4kB page

w/ perfectly seq. access

1 TLB miss + $\frac{4kB}{4B}$

1 miss + 1023 hits $\sim 99.9\%$
hit rate

→ w/o translation

Total AMAT = TLB miss time + "normal" AMAT

$$(1 - 99.5\%) \leftarrow 0.005 \times 100 \quad 1 + .05 (50)$$
$$\rightarrow 0.001 \quad 3.5$$
$$0.5 \quad .1$$

= 4 cycles

What is memory access overhead of translation?

$$\frac{4}{3.5} = 1.14 \rightarrow 14\%$$

99.5% \rightarrow 99.9%

$$AMAT = 3.6 \rightarrow AMAT \text{ Slowdown} \rightarrow \frac{3.6}{3.5} = 1.03 \rightarrow 3\%$$

Shows \rightarrow need high hit ratio for TLB and/or low page walk time

downsides
Incr area
Slower
Incr power

$\left\{ \begin{array}{l} \rightarrow \text{incr assoc} \\ \rightarrow \text{incr size} \end{array} \right.$

\rightarrow no "right" answer
depends on technology

\rightarrow Add 2nd TLB \rightarrow other caches

\rightarrow Smaller address size
for fewer levels

\rightarrow not use tree structure

\rightarrow fewer levels \rightarrow larger page size

RISC-V \rightarrow mega pages \rightarrow 4MB in Sv32

\rightarrow often used for workloads w/ high spatial locality

What if we virtualized entire system?

\rightarrow instead of virtualize proc \rightarrow we virtualize OSes

Why?

isolation \rightarrow stronger

What if you want to run windows App on Linux

Cloud → Amortize costs of hardware and many users on same machine

how?

- Guest/VM
- host / virtual machine monitor / UMM
- hypervisor
- ↳ run an OS like a process in some OS
 - ↳ give it a chunk of host virtual memory
 - ↳ exception caught by host, emulated to guest
 - ↳ system call
 - ↳ guest writes a privileged register
- huge overhead

Need → hardware support

↳

