Translation Lookaside Buffer (TLB)

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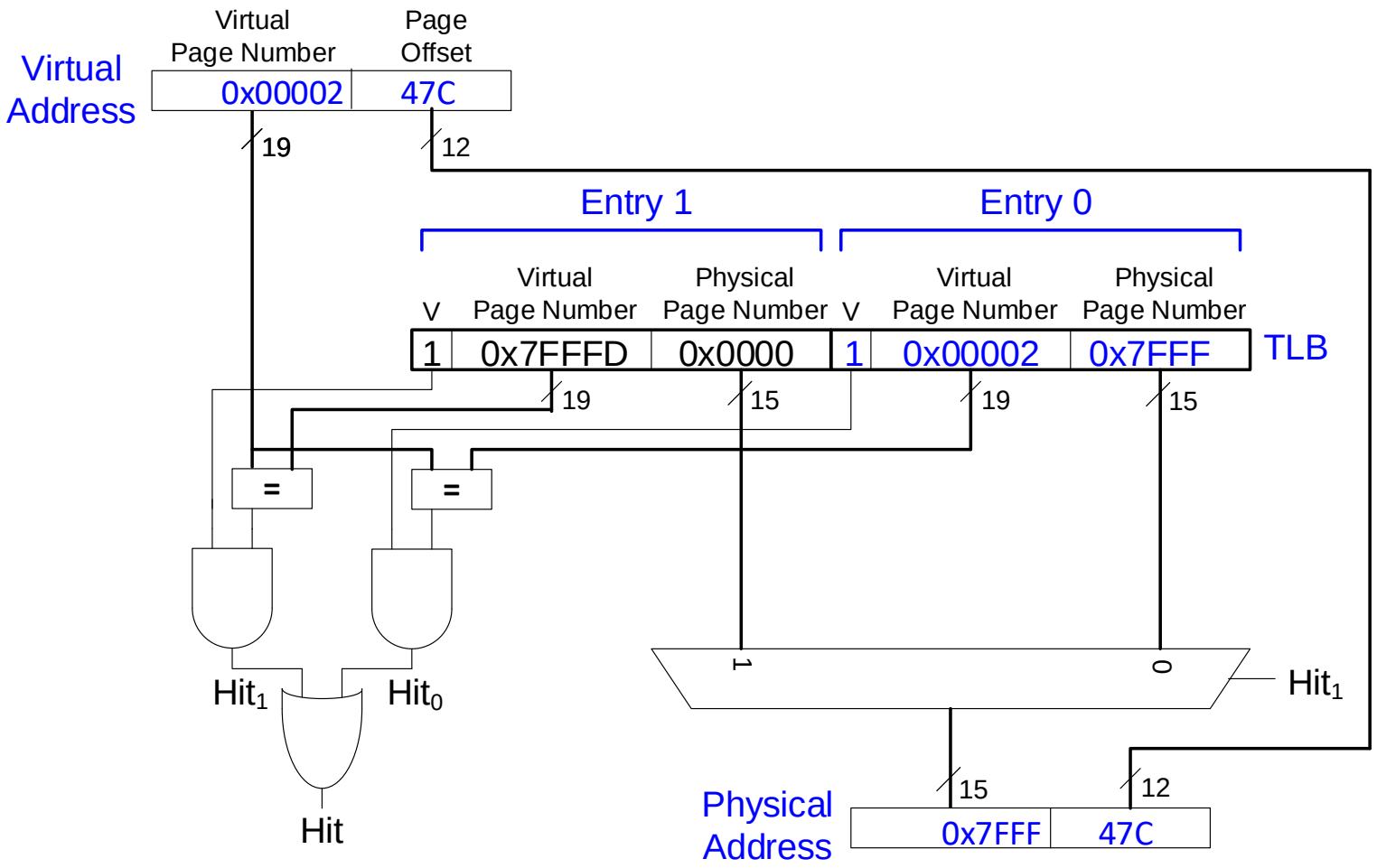
- Small cache of most recent translations
- Reduces number of memory accesses for *most* loads/stores from 2 to **1**

TLB

- **Page table accesses:** high temporal locality
  - Large page size, so consecutive loads/stores likely to access same page
- **TLB**
  - **Small:** accessed in < 1 cycle
  - Typically **16 - 512 entries**
  - **Fully associative**
  - **> 99%** hit rates typical
  - **Reduces number of memory accesses** for most loads/stores from 2 to 1

Example: 2-entry TLB



Virtual Memory Summary

Memory Protection

- **Multiple processes** (programs) run at once
- Each process has its **own page table**
- Each process can use **entire virtual address space**
- A process can only access a **subset of physical pages**: those mapped in its own page table

Virtual Memory Summary

- Virtual memory increases **capacity**
- A subset of virtual pages in physical memory
- **Page table** maps virtual pages to physical pages – address translation
- A **TLB** speeds up address translation
- Different page tables for different programs provides **memory protection**