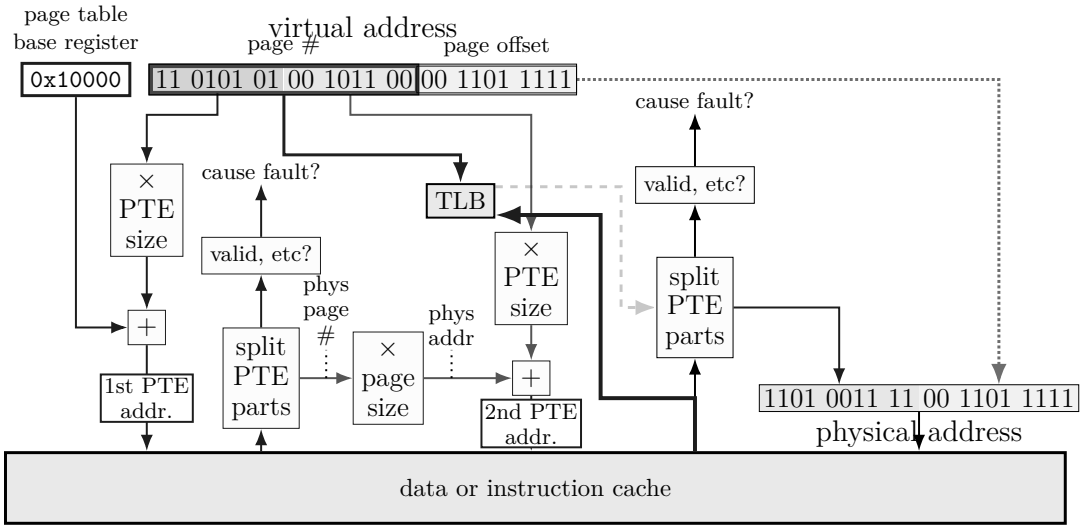
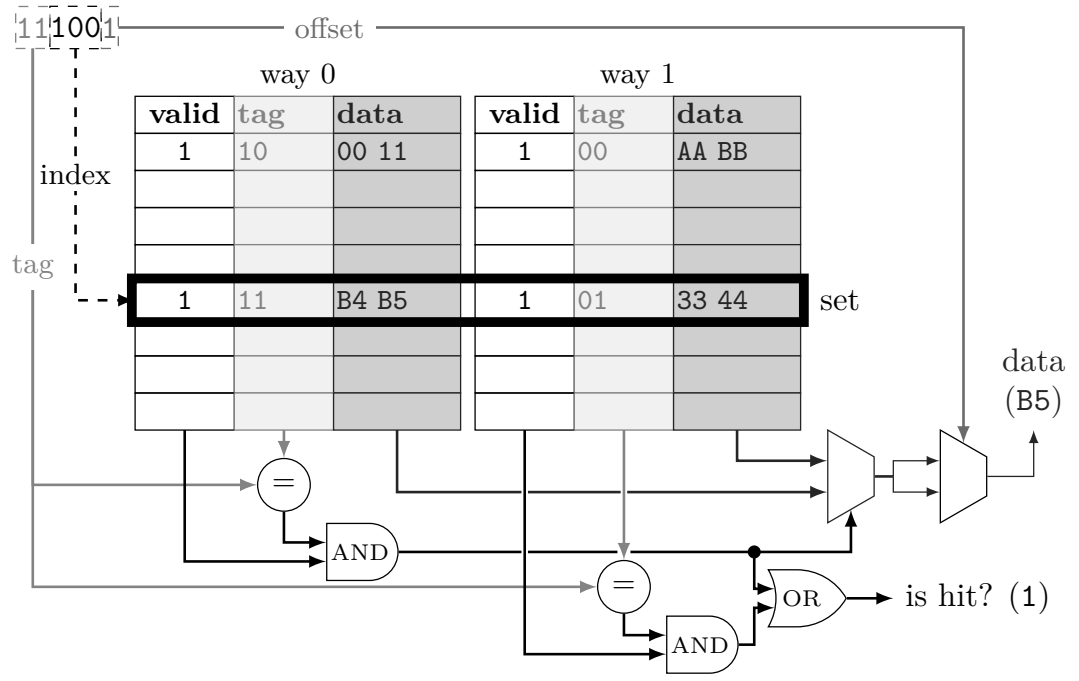
1 page table lookup



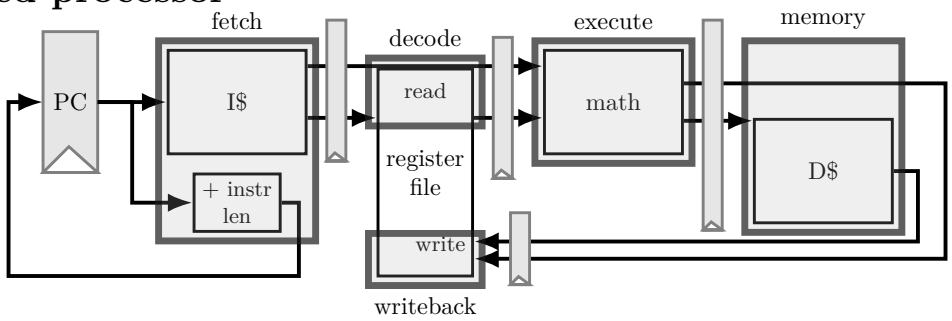
2 cache organization



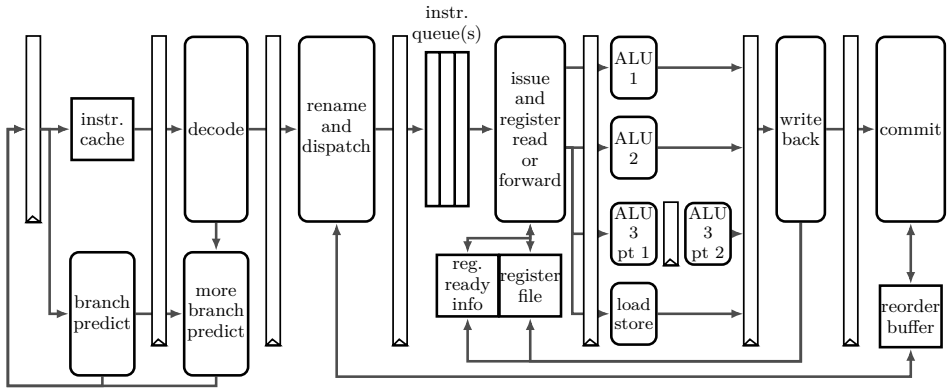
3 networking layers

application	HTTP, SSH, SMTP, …	URLs, …	…	application-defined meanings
transport	TCP, UDP, …	port numbers, …	segments, datagrams	reach correct program, reliablity/streams
network	IPv4, IPv6, …	IP addresses, …	packets	reach correct machine (across networks)
link	Ethernet, Wi-Fi, …	MAC addresses, …	frames	coordinate shared wire/radio
physical	…	…	…	encode bits for wire/radio

4 pipelined processor



5 OOO processor



6 selected POSIX functions

- given `lock` is a `pthread_mutex_t` and `cv` is `pthread_cond_t`
  - mutex lock/unlock: `pthread_mutex_lock(&lock)`; `pthread_mutex_unlock(&lock)`;
  - `pthread_cond_wait(&cv, &lock)` — unlock lock + wait on cv's queue; when woken up, relock lock and return; can be woken up early by 'spurious wakeup'
  - `pthread_cond_signal(&cv)` — wake up one waiting thread from cv's queue
  - `pthread_cond_broadcast(&cv)` — wake up all waiting threads from cv's queue
  - create new process copying current: `fork()` — return new pid in parent (old), 0 in child (new)
  - `pipe(fds)` — create a pipe, set fds[0] to the file descriptor for the read end, fds[1] for the write end
  - `waitpid(pid, 0, NULL)` wait for the child process with ID `pid` to terminate
  - `kill(pid, signal_number)` — send signal `signal_number` to process `pid`
  - `sigaction(signal_number, &act_struct, NULL)` — configure signal handler for the specified signal based on the information in `act_struct`

7 classic Spectre pattern

```
if (x < array1_size)    // bounds check, skipped by branch prediction
    y = array2[array1[x] * 4096]; // access cache set dependent on array1[x]
```

8 assembly

- `OPq %r8, %r9`: perform OP (example: add) on `%r8` and `%r9`, put a resulting number (if any) in `%r9`
- `movq X, Y`: move 64-bit value from X to Y
- `%r8`, `%rax`, etc. — 64-bit register
- `(%r8)` — the value in memory at an address equal to the value of `%r8`