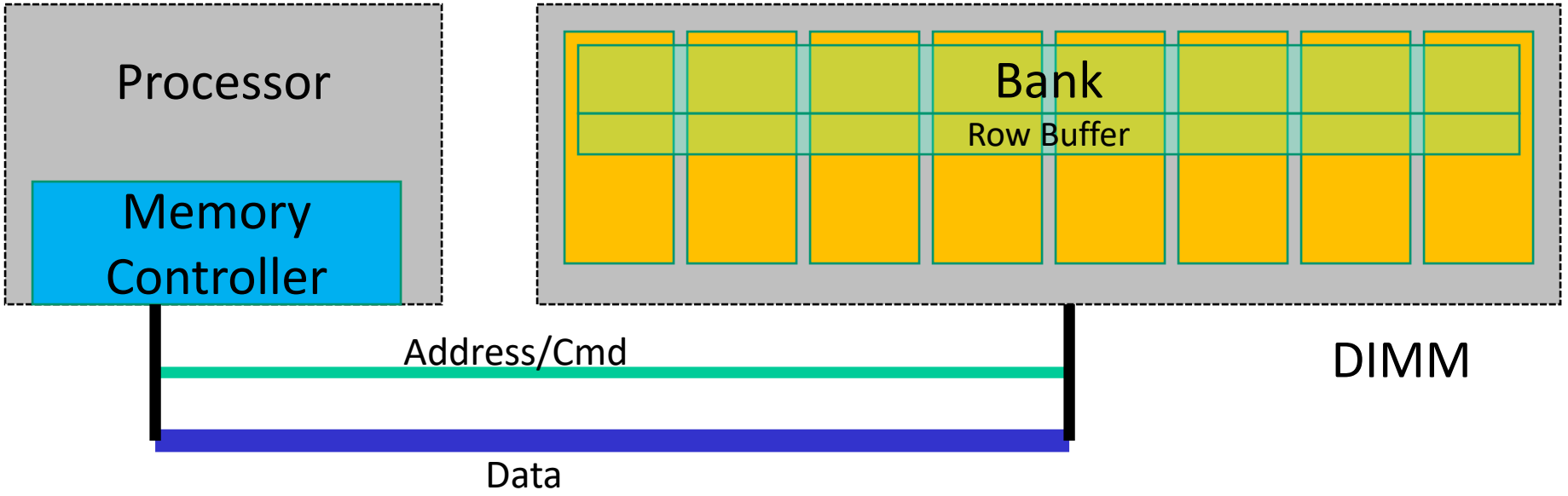
Lecture 24: Memory, Security

- Today's topics:
  - Main memory system
  - Hardware security intro

Off-Chip DRAM Main Memory

- Main memory is stored in DRAM cells that have much higher storage density
- DRAM cells lose their state over time – must be refreshed periodically, hence the name *Dynamic*
- A number of DRAM chips are aggregated on a DIMM to provide high capacity – a DIMM is a module that plugs into a bus on the motherboard
- DRAM access suffers from long access time and high energy overhead

Memory Architecture



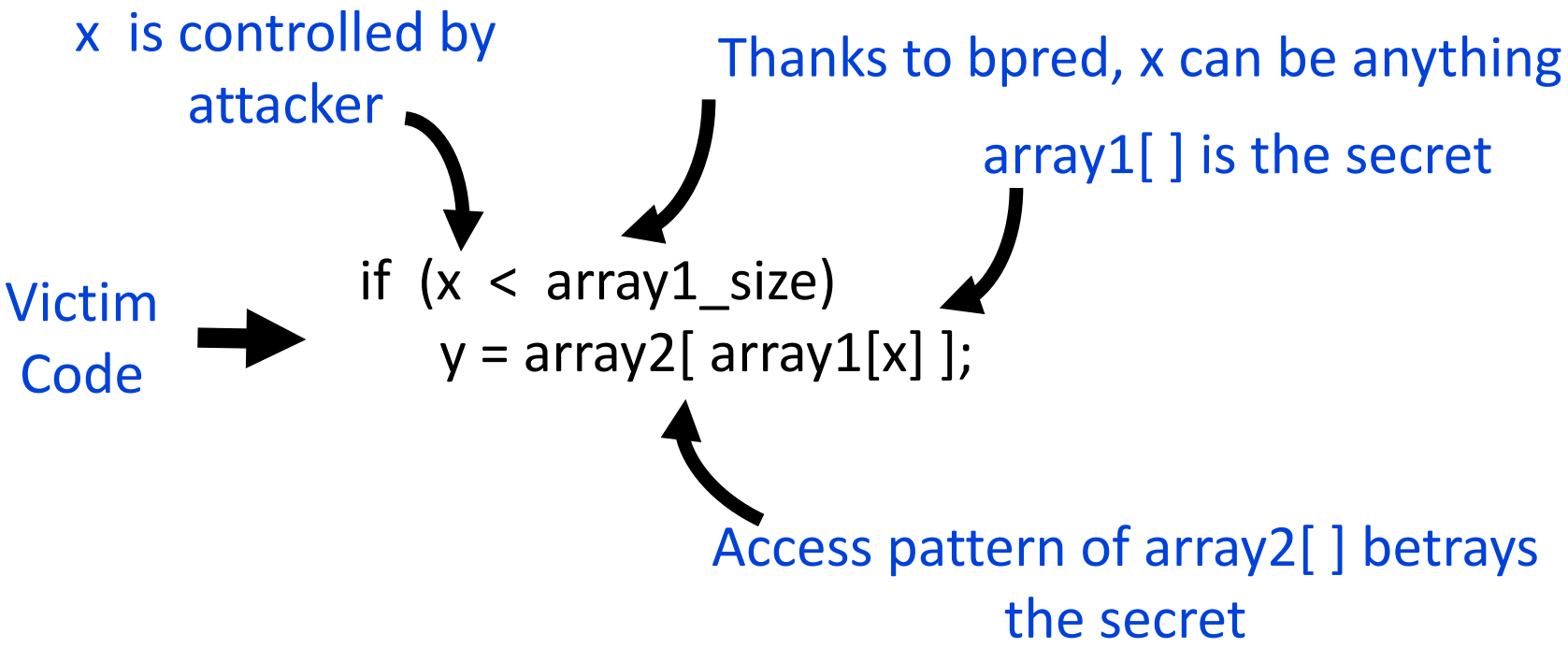
- DIMM: a PCB with DRAM chips on the back and front
- The memory system is itself organized into ranks and banks; each bank can process a transaction in parallel
- Each bank has a row buffer that retains the last row touched in a bank (it's like a cache in the memory system that exploits spatial locality) (row buffer hits have a lower latency than a row buffer miss)

Hardware Security

- Software security: key management, buffer overflow, etc.
- Hardware security: hardware-enforced permission checks, authentication/encryption, etc.
- Security vs. Privacy
- Information leakage, side channels, timing channels
- Meltdown, Spectre, SGX

Meltdown

Spectre: Variant 1



Spectre: Variant 2

Attacker code

Label0: if (1)

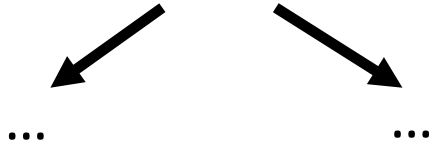
Label1: …

Victim code

R1 ← (from attacker)

R2 ← some secret

Label0: if (…)



Victim code

Label1:

lw [R2]