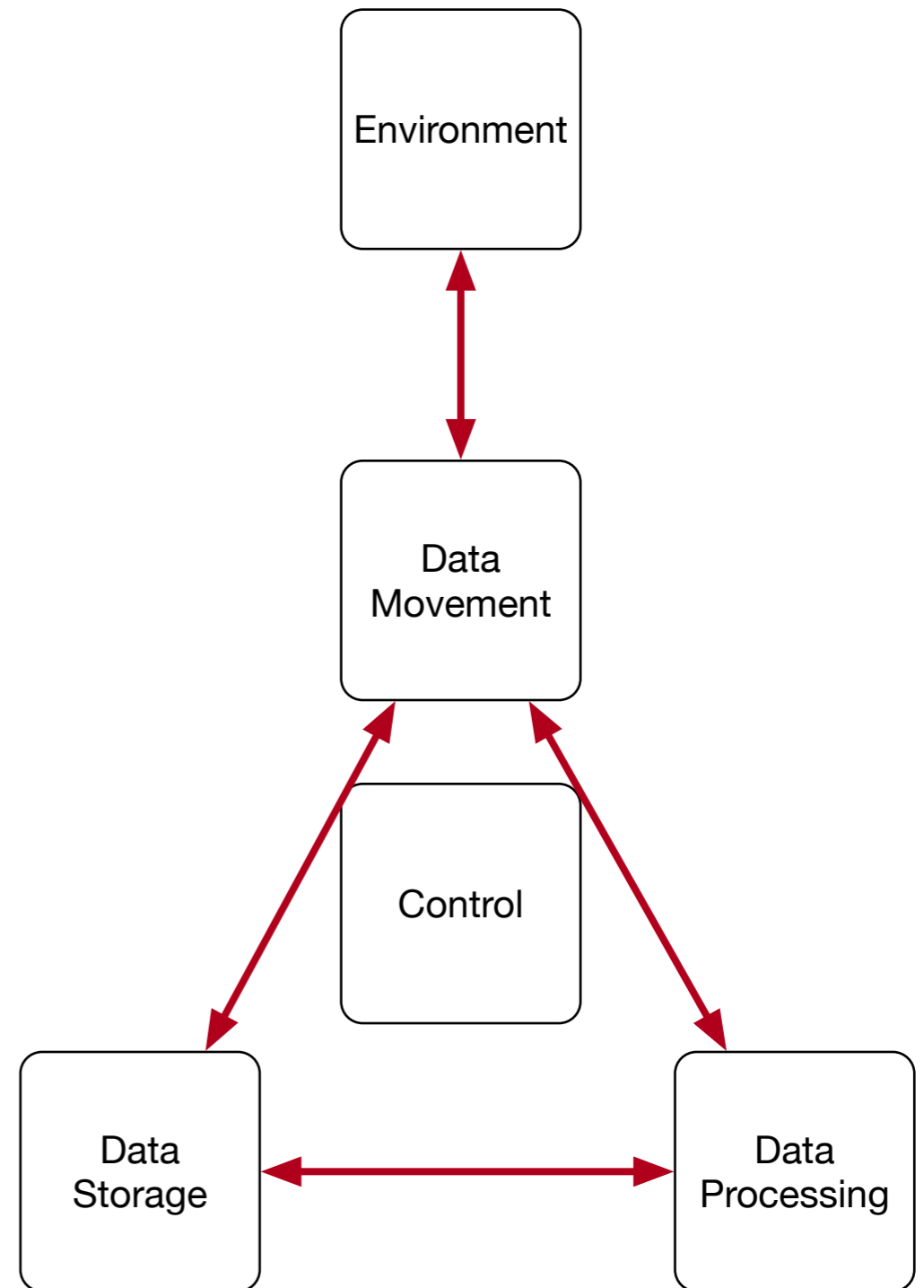


# Computer Organization

Thomas Schwarz, SJ

# Structure and Function

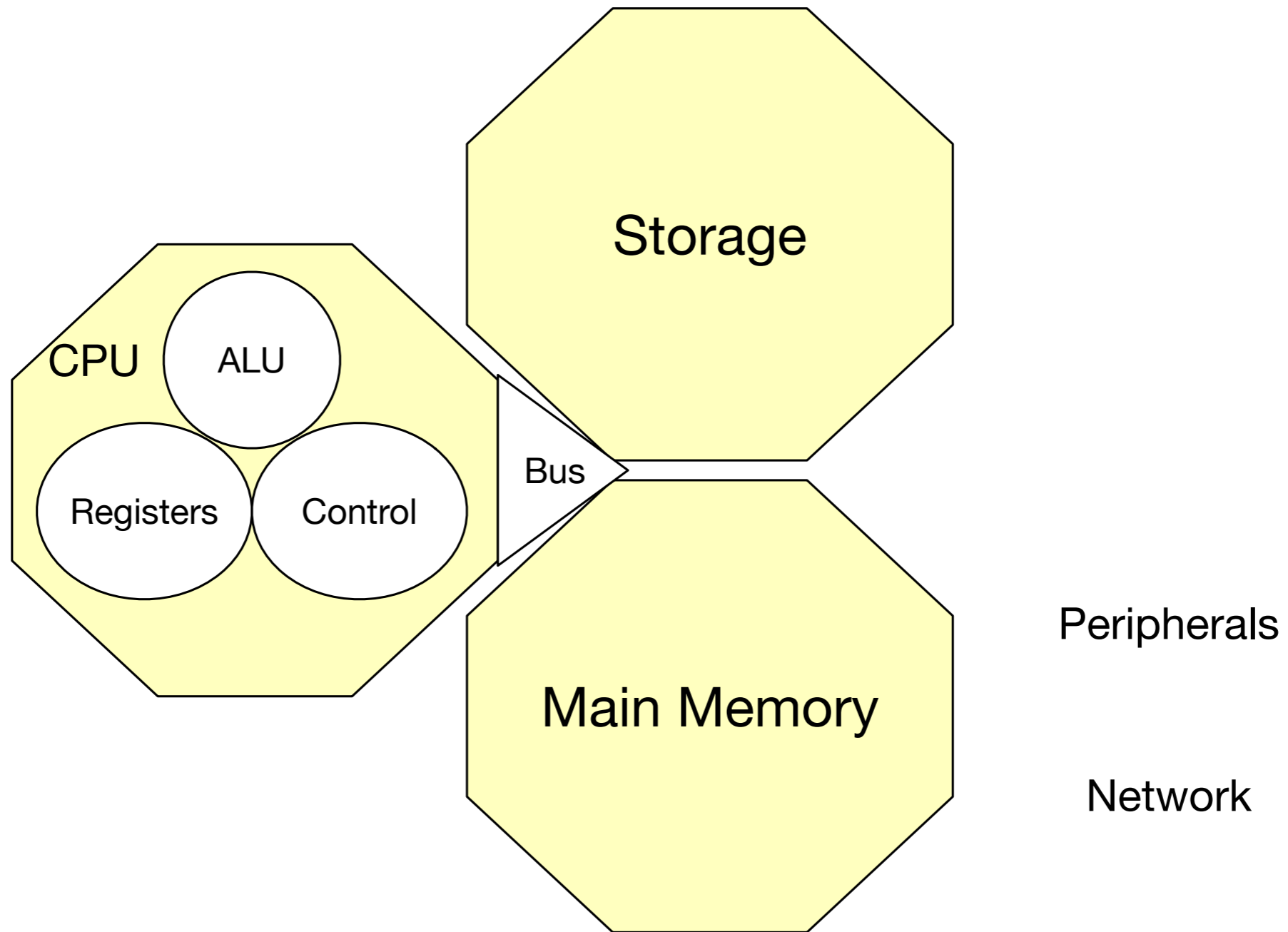
- Structure of Data Interaction



# Structure and Function

- Structure
  - Central Processing Unit:
    - ALU - Arithmetic-Logical Unit
    - Registers: fast memory
    - Control
  - Storage: Hard disk drives, Solid State Drives
  - Bus
  - Peripherals: keyboards, keypads, mouse, ...
  - Networking

# Structure and Function



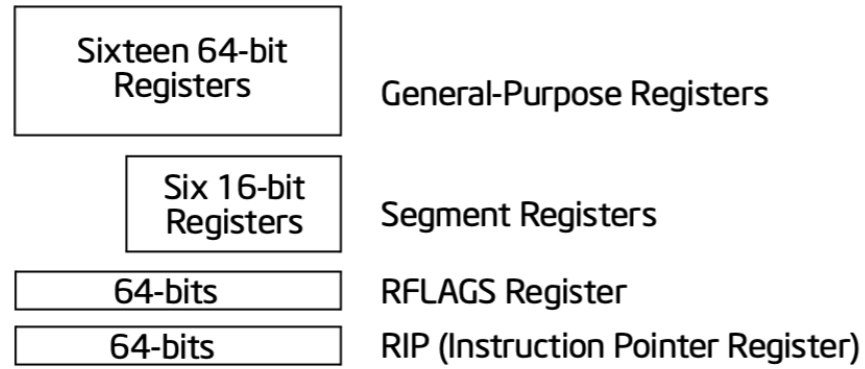
# Structure and Function

- Arithmetic Logical Unit:
  - Carries out arithmetic and logical operations
  - Which one is determined by the op-code
  - Operands are stored in registers
  - Result is stored in a register

# Structure and Function

- Registers
  - Quickly accessible location to store few data
  - Intel Core i7
    - General purpose registers and registers used for extensions:
      - Multimedia: Same Instruction to Many Data (SIMD): MMX MDM registers
      - Floating point FP
      - Vector extensions: YMM: 256 bits

### Basic Program Execution Registers



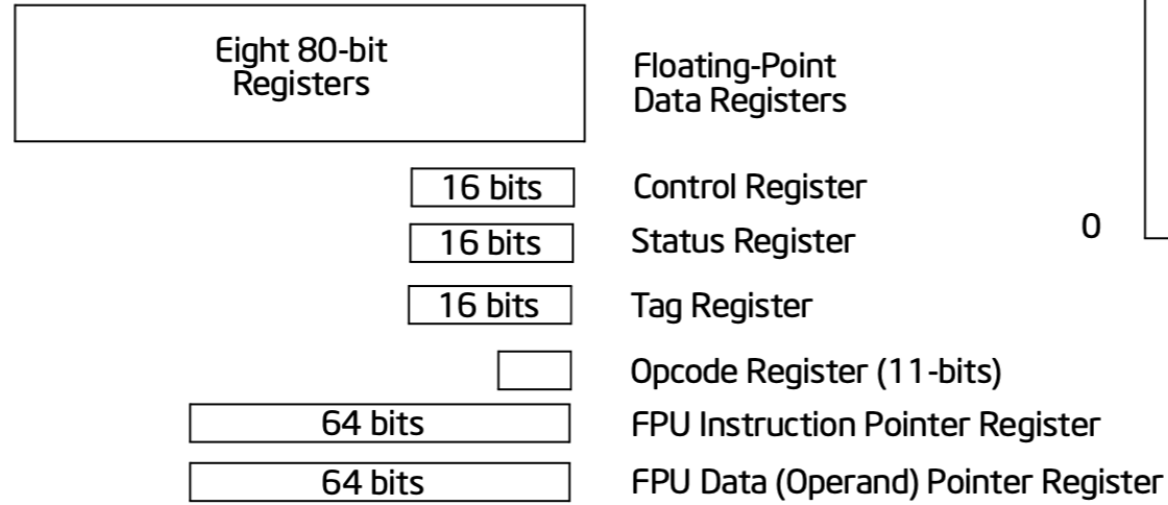
### Address Space

$2^{64} - 1$



0

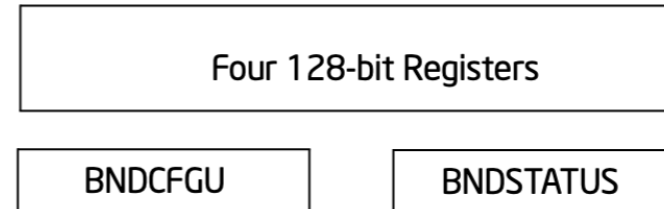
### FPU Registers



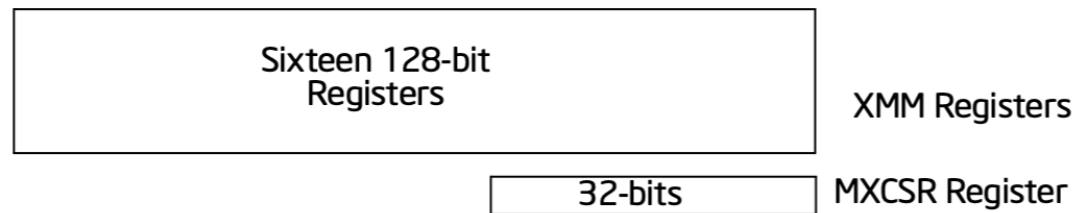
### MMX Registers



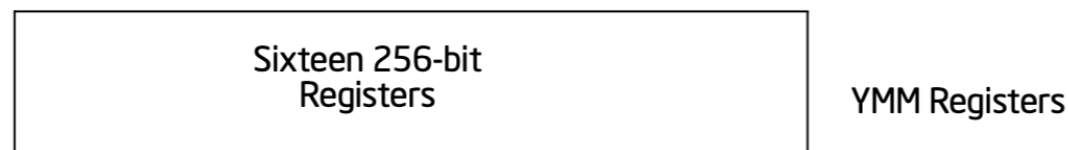
### Bounds Registers



### XMM Registers



### YMM Registers

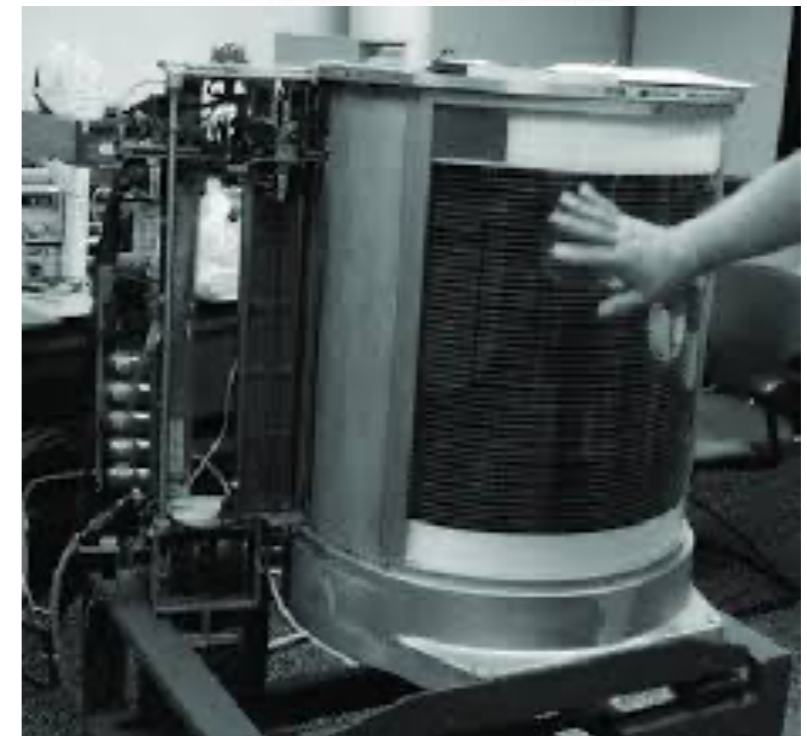
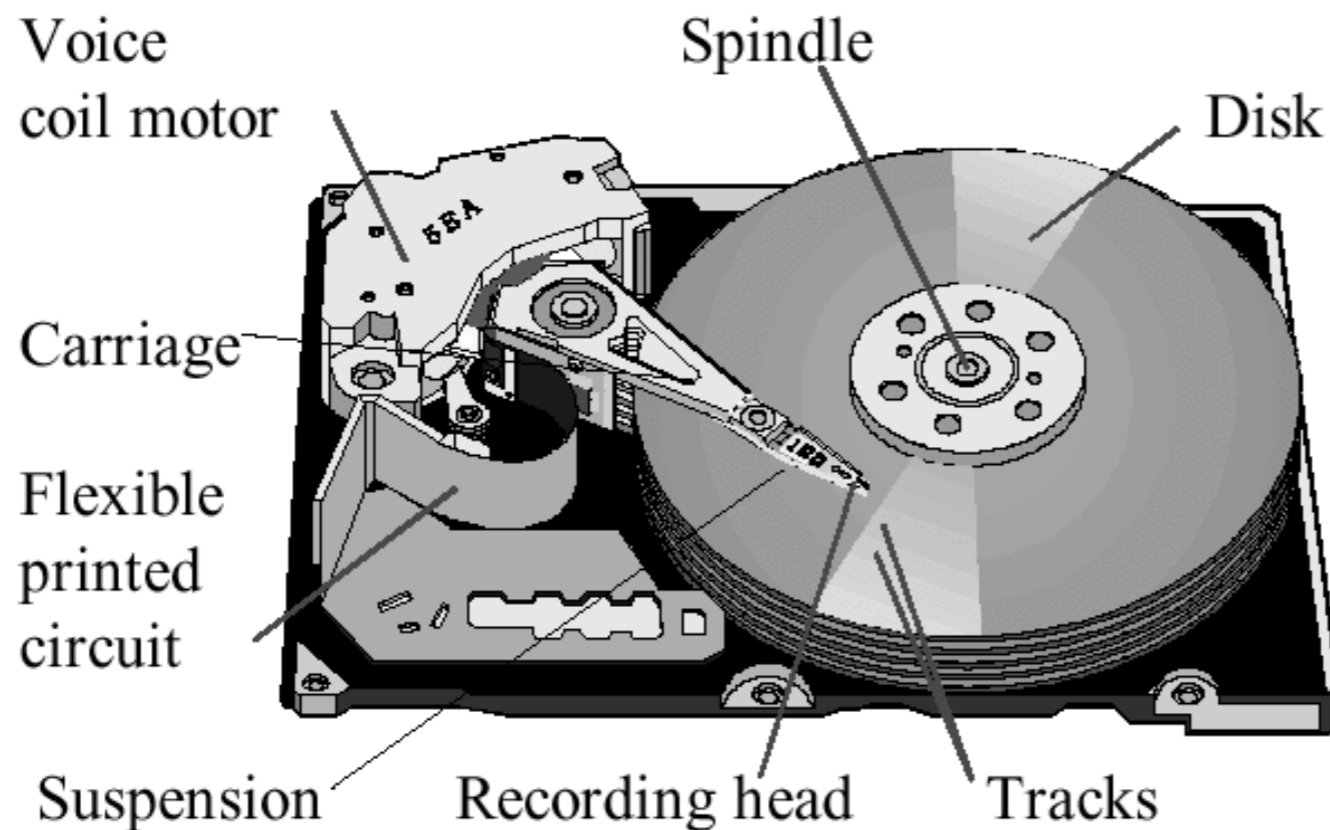






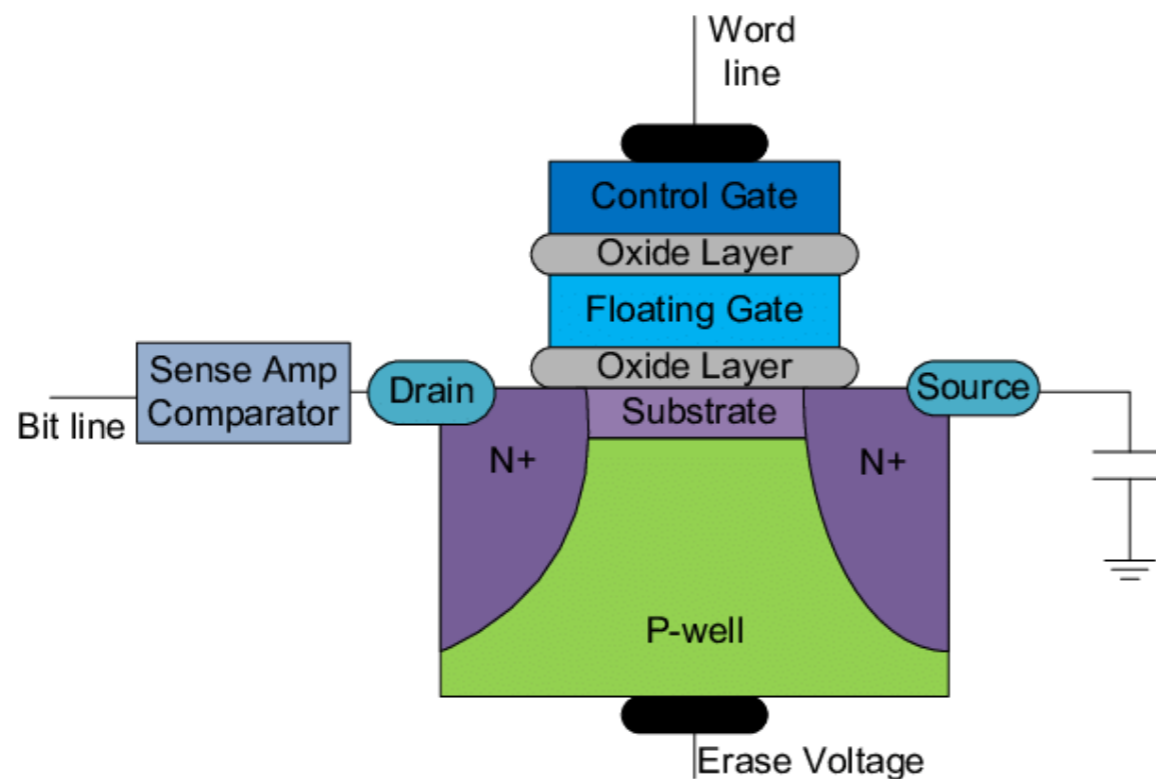
# Structure and Function

- Storage
  - Hard Disk Drive
    - Stores on magnetic media



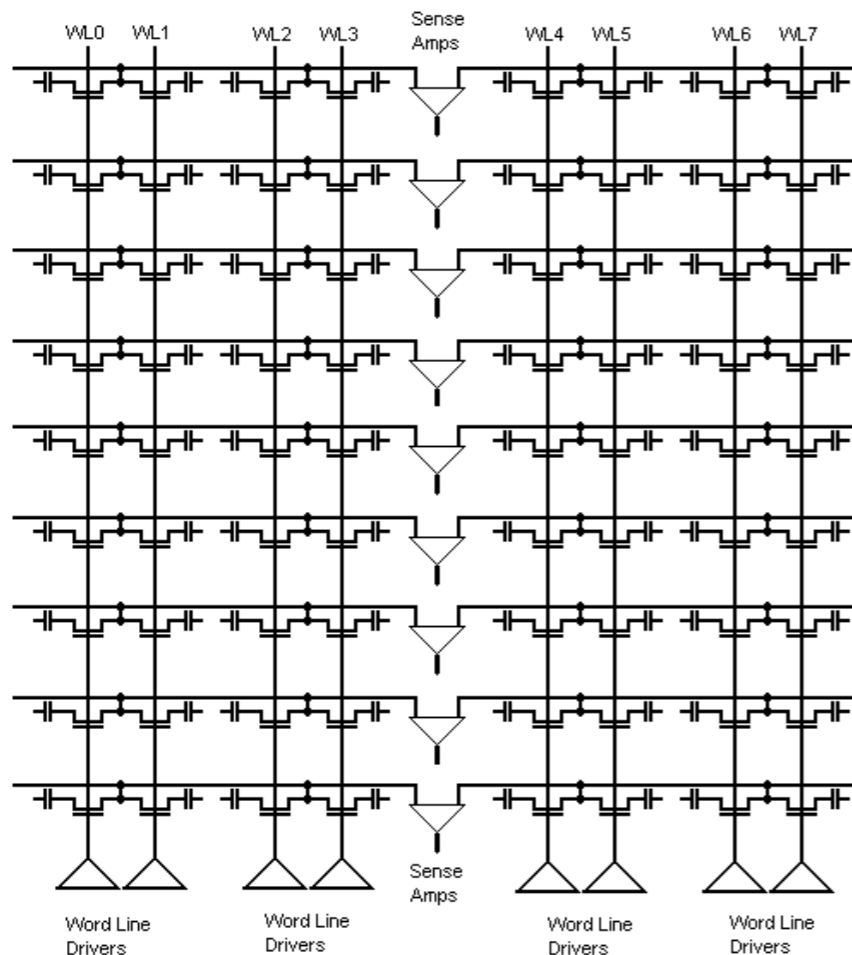
# Structure and Function

- Storage
  - SSD - Solid State Drive
    - Uses Flash memory

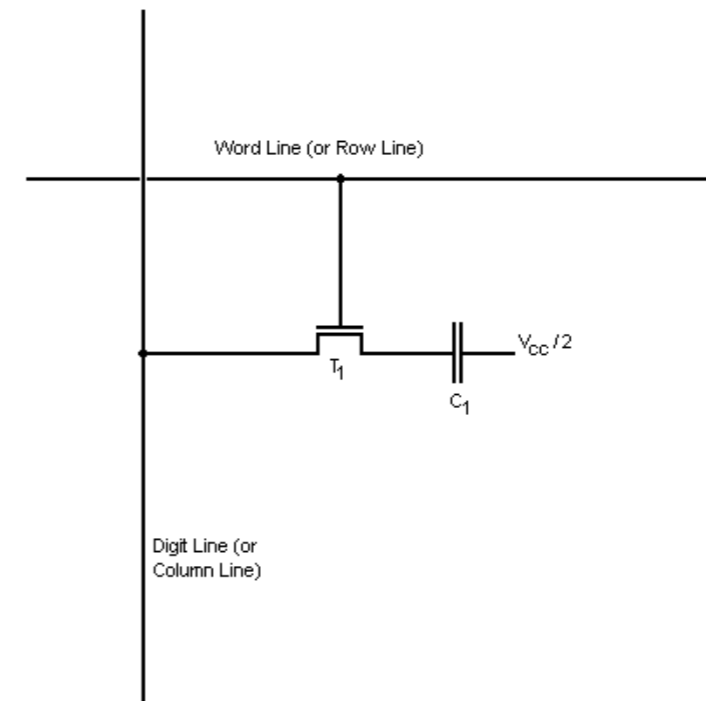


# Structure and Function

- Memory
  - Uses DRAM



**DRAM array**



**DRAM cell**

# Structure and Function

- Memory Hierarchy
  - HDD: cheap ( $< 0.002\$ / \text{GB}$ ), slow: 250 MB/sec streaming
  - SSD: cheap ( $< 0.01\$ / \text{GB}$ ), slow: 2500 MB/sec streaming
  - RAM: expensive (5.00\$ / GB), fast: (17,600 MB/sec)
  - Registers: super-expensive, very fast

# Structure and Function

- Caching:
  - Maintain a copy of frequently used data from the larger level in the faster level
  - Temporal locality: Data recently accessed is more likely to be accessed again
  - Spatial locality: Data next to data recently accessed is more likely to be accessed again