

# **ECS404 Computer Systems and Networks**

Computer Architecture  
Week 4 Pt 1: The Memory Hierarchy

# Aims

- This video provides an introduction to the week by discussing the hierarchy of different kinds of memory in a typical computer.

# Learning Objectives

- Understand the concept of the memory hierarchy, and be able to list and rank the components of a typical example

# Memory

- Remember that computers store information in various places:
  - cpu registers
  - Short-term memory: RAM
  - Long-term memory: disk, flash memory

# Memory Hierarchy

- The **memory hierarchy** is the list of memory components and storage devices that form part of a computer's architecture, ranked by response time from the point of view of the component.

# Basic memory hierarchy

- Top: CPU registers
- Middle: Main memory (RAM)
- Low: Long-term memory: disk

# Basic memory hierarchy: technologies

- Top: CPU registers: inverter-based memory cells (SRAM)
- Middle: Main memory (RAM): DRAM
- Low: Long-term memory: disk: magnetic disk, flash memory

# Basic memory hierarchy: timings

Technology	Access time	\$ per GB
SRAM semiconductor	0.5-2.5ns	500-100
DRAM semiconductor	50-70ns	10-20
Flash semiconductor	5,000-50,000ns	0.75-1.00
Magnetic disk	5,000,000-20,000,000ns	0.05-0.10



# Ranking mechanisms that correlate

- Response time
- **Cost per GB**

Why use slow memory if fast memory is cheaper?

# Ranking mechanisms that correlate

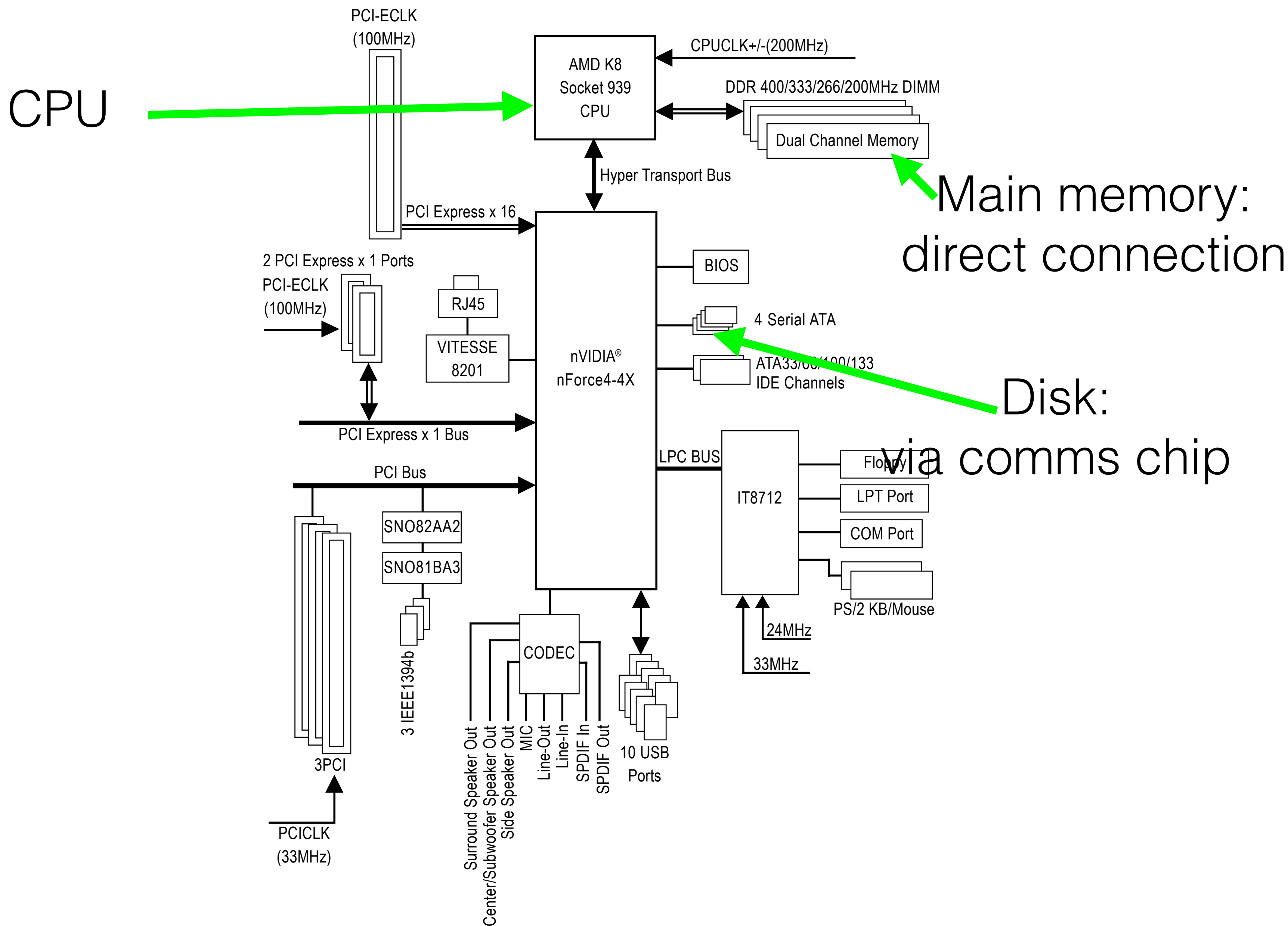
- Response time
- Cost per GB
- **Size**

Why use small if you can get large for the same price?

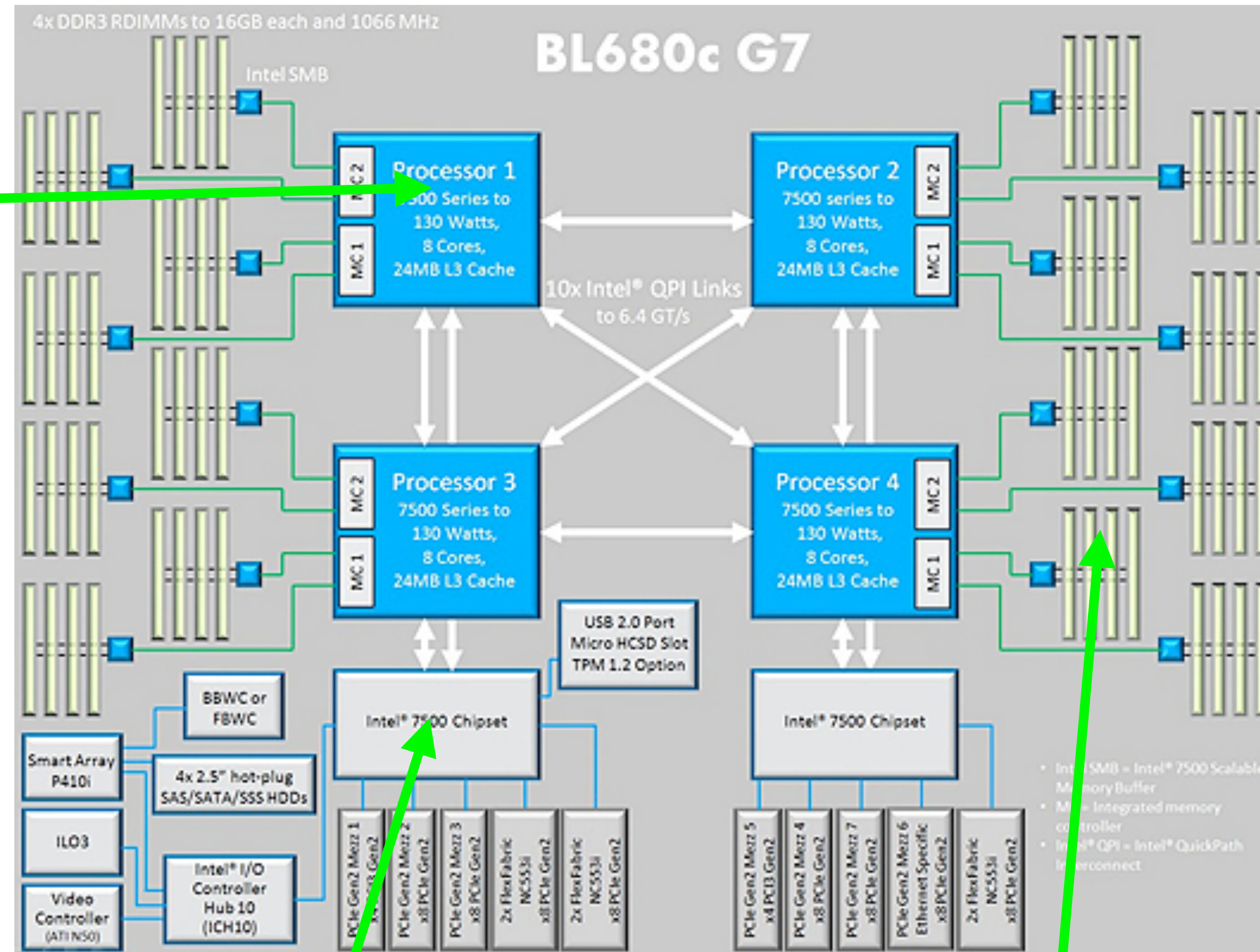
# Ranking mechanisms that correlate

- Response time
- Cost per GB
- Size
- **Proximity to the cpu in architecture**

Block Diagram



CPU



Disk:  
via comms chip

Main memory:  
direct connection

# What does having a memory hierarchy do for you?

- Layers provide different functionality.
- Larger lower layers give some of the effect of having larger higher layers that you cannot afford.

# Memory hierarchy: a complication

- There are also intermediate layers (caches): we'll talk about these later.

# Summary