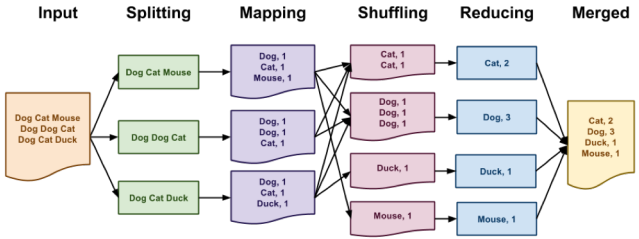
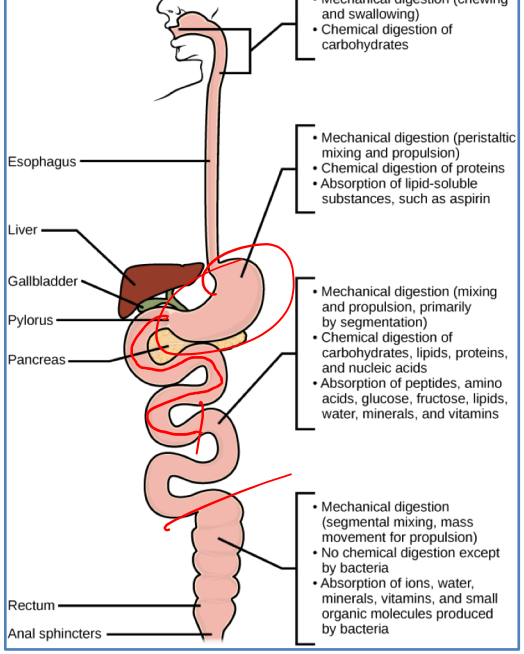
CSE 141: Introduction to Computer Architecture

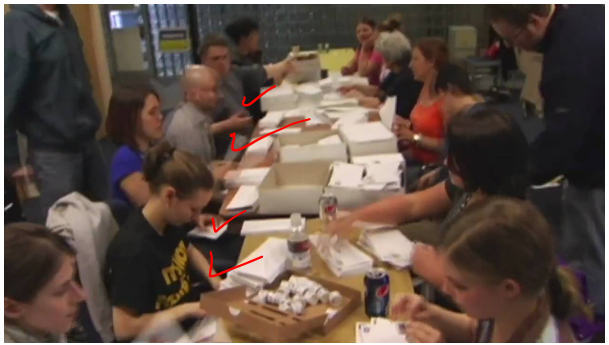
Pipelines

First things first:
Pipelines are the coolest.

- Seriously, this idea is everywhere



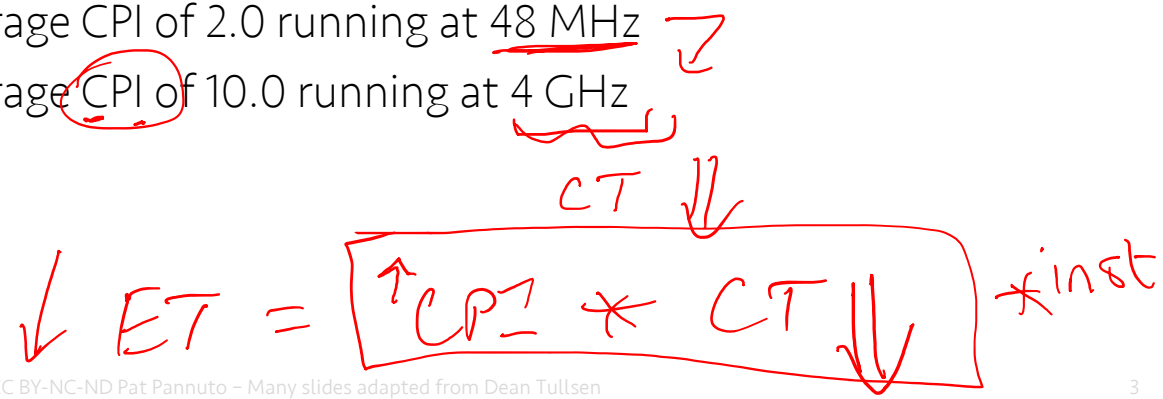




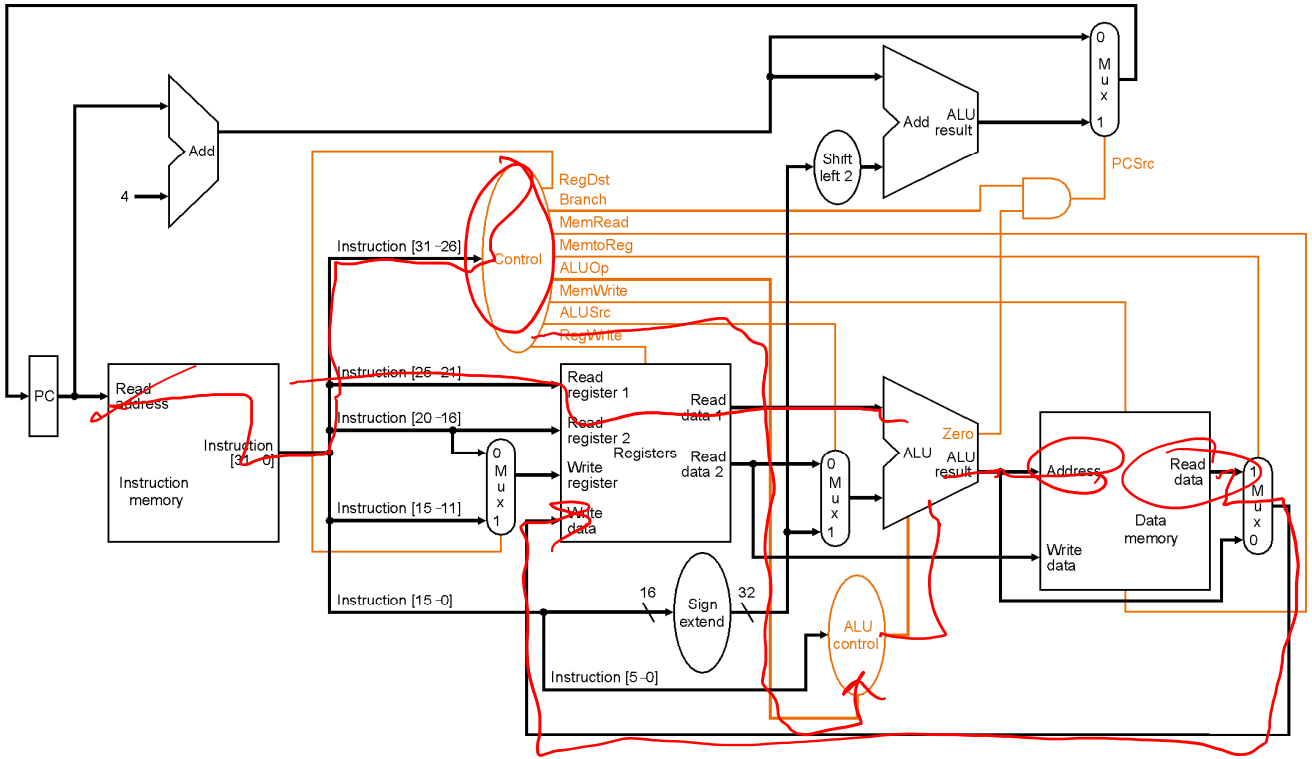
THE key idea of pipelining

- Throughput >>> latency
- Computers are very useful because they do a lot of things well
  - It is much less important how well any one thing is done

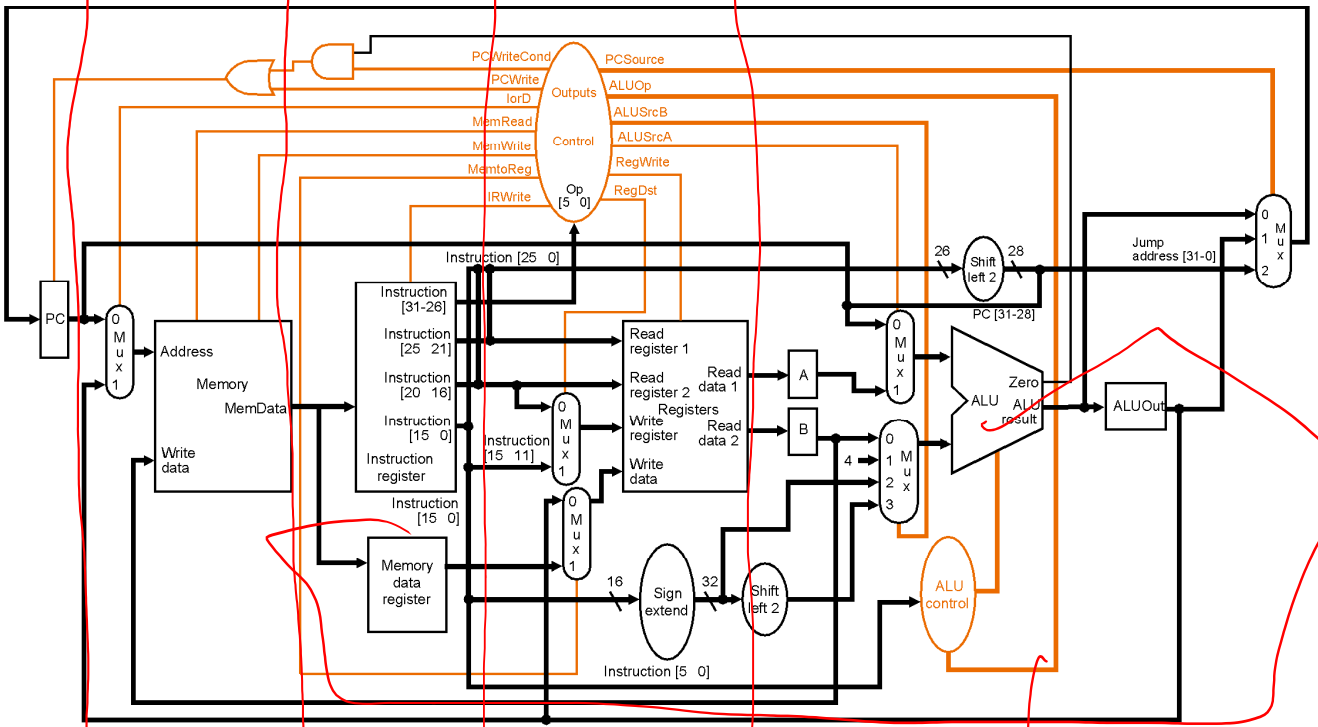
- Which is faster?
  - A machine with average CPI of 2.0 running at 48 MHz
  - A machine with average CPI of 10.0 running at 4 GHz



Review -- Single Cycle CPU

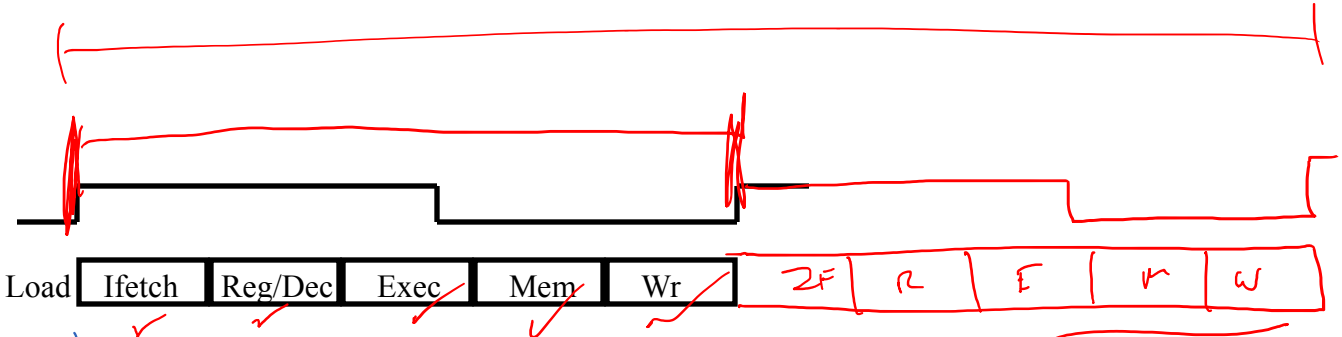


(not quite) Review -- Multiple Cycle CPU

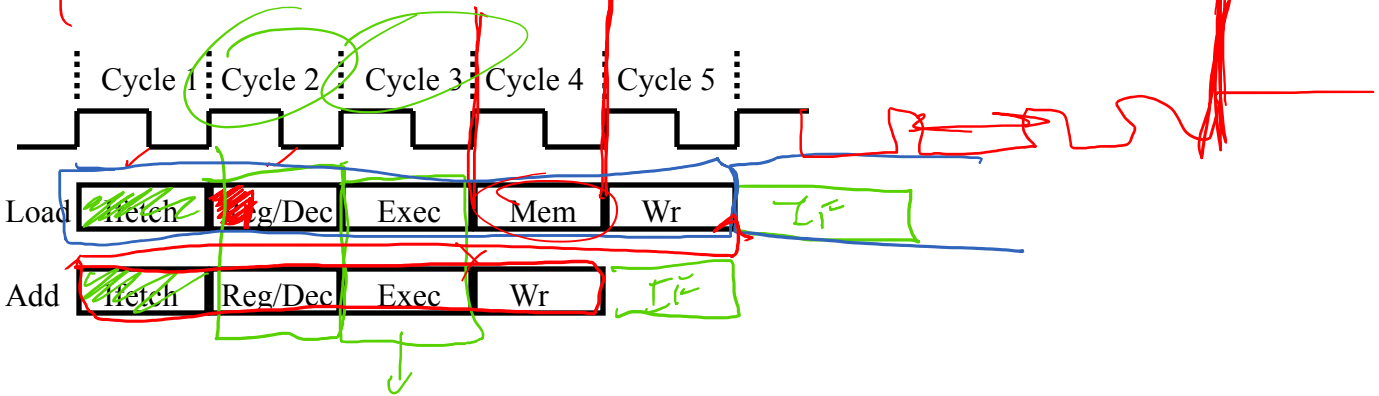


Review -- Instruction Latencies

Single-Cycle CPU



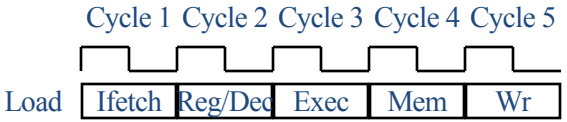
Multiple Cycle CPU



Instruction Latencies and Throughput

Single-Cycle CPU

Multiple Cycle CPU

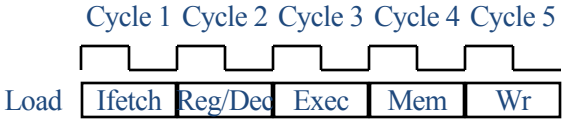


Pipelined CPU

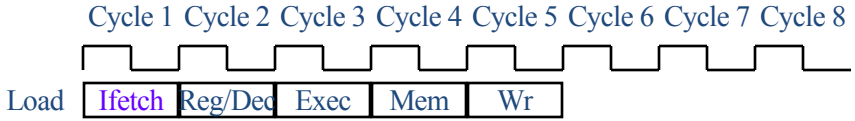
Instruction Latencies and Throughput

Single-Cycle CPU

Multiple Cycle CPU



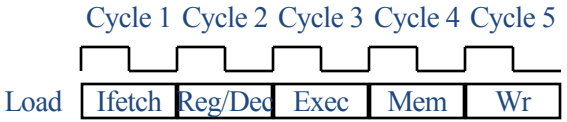
Pipelined CPU



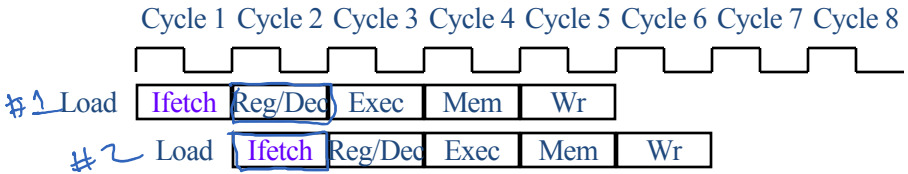
Instruction Latencies and Throughput

Single-Cycle CPU

Multiple Cycle CPU

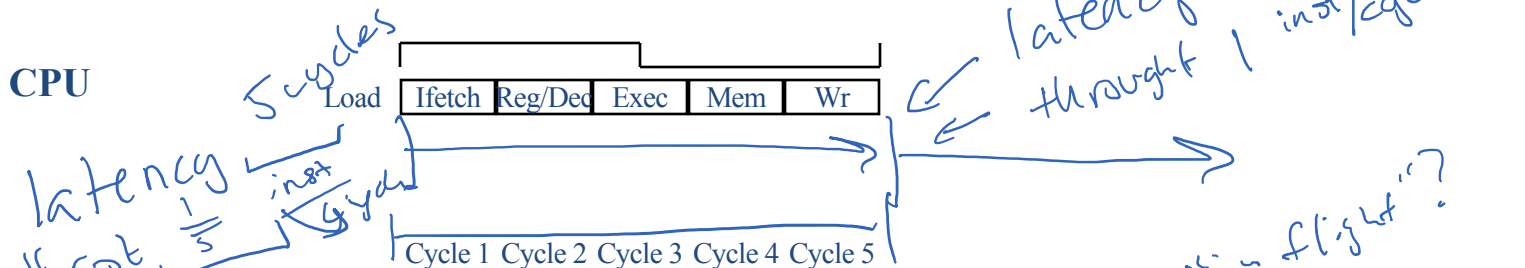


Pipelined CPU

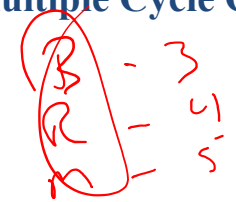


Instruction Latencies and Throughput

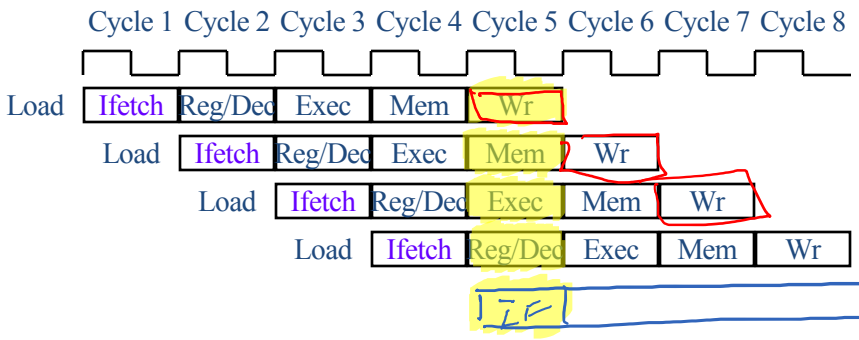
Single-Cycle CPU



Multiple Cycle CPU



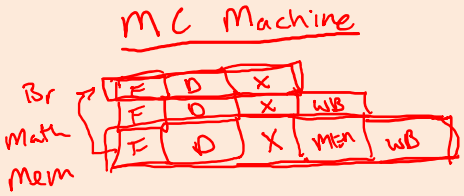
Pipelined CPU



Pipelining Advantages

- Higher *maximum* throughput
- Higher *utilization* of CPU resources

- But, more complicated *datapath*, more complex control(?)



Poll Q: What affects throughput?
Peak throughput depends on…

	Single Cycle	Multi-Cycle	Pipeline
A	Longest Instruction	Cycle Time	Average Instruction
B	Longest Instruction	Cycle Time	Longest Instruction
C	Longest Instruction	Average Instruction	Cycle Time
D	Average Instruction	Longest Instruction	Cycle Time
E	*None of the above*		