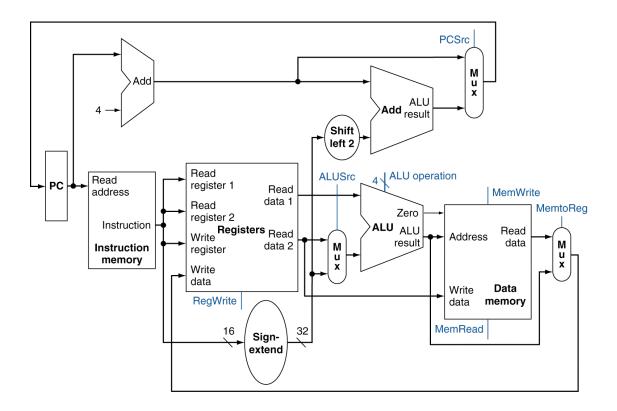
16.482 / 16.561: Computer Architecture and Design Summer 2015

Lecture 3: Key Questions May 26, 2015

1.	What are the steps required to execute an instruction?
2.	Generally speaking, what are processor datapath elements? What are control signals?



3. Describe the components of the single-cycle datapath shown above.

4. Describe the additional logic required to implement jump instructions.

5. Describe the basic operation of a pipelined datapath.

6. Does pipelining improve latency or throughput?

7. What is the maximum potential speedup of pipelining?

8. If one pipeline stage can run faster than the others, how does that affect the speedup?

9. Draw a basic pipeline diagram and describe the 5 stages.

10. Every pipelined instruction takes the same number of cycles. Why?

16.482/16.561: Computer Architecture & Design Summer 2015

Instructor: M. Geiger Lecture 3: Key Questions

11. Example: Say we have the following code:

Assume each pipeline stage takes 4 ns.

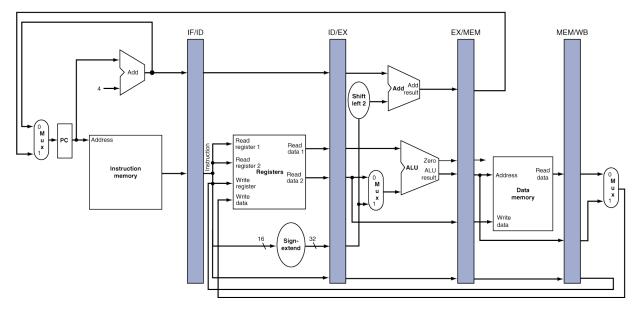
a. How much time will one loop iteration take on an ideal pipelined datapath (i.e., no delays between instructions)?

b. How much time will one loop iteration take on a single-cycle datapath?

c. How much faster is the pipelined datapath than the single-cycle datapath? Express your answer as a ratio, not an absolute difference.

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12. Describe how a pipelined datapath is divided into stages and how data is transferred between stages. (Refer to the figure below.)



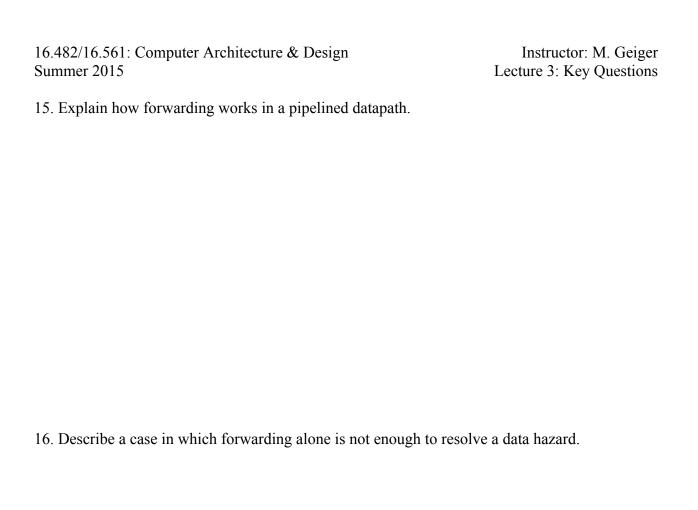
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13. Describe the three different types of pipeline hazards.

14. Example: What are no-ops? Given the following code, where are no-ops needed?

add \$t2, \$t3, \$t4 sub \$t5, \$t1, \$t2 or \$t6, \$t2, \$t7 slt \$t8, \$t9, \$t5



16.482/16.561: Computer Architecture & Design Summer 2015

Instructor: M. Geiger Lecture 3: Key Questions

17. Example: Let's revisit the following code:

loop:
 add \$t1, \$t2, \$t3
 lw \$t4, 0(\$t1)
 beq \$t4, \$t3, end
 sw \$t3, 4(\$t1)
 add \$t2, \$t2, 8
 j loop
end:

Again, assume each pipeline stage takes 4 ns.

a. How many cycles would one loop iteration take in a pipelined datapath without forwarding?

b. How many cycles would one loop iteration take in a pipelined datapath with forwarding?

18. Describe the reason processors may experience branch delays.