BYOC\_HW6 Simulation 2:

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Answer the following questions.

B.1) What are the limitations due to the pipeline latency of the following combinations:

* lw after add where the add Rd is the lw Rs
* lw after add where the add Rd is the lw Rt
* add after lw where the lw Rt is the add Rt
* beq after lw where the lw Rt is the beq Rs

Use a similar figure to Fig.2 and Fig. 3 to demonstrate your answers. Explain your answer!

B.1.a - lw after add where the add Rd is the lw Rs [ e.g., lw $4,16($3) ]

WB

EX

ID

IF

WB

EX

ID

IF

WB

EX

ID

IF

add **$3**,$5,$8

WB

EX

ID

IF

WB

EX

ID

IF

CK

MEM

MEM

MEM

MEM

MEM

EX

B.1.b - lw after add where the add Rd is the lw Rt

WB

EX

ID

IF

WB

EX

ID

IF

WB

EX

ID

IF

add **$3**,$5,$8

WB

EX

ID

IF

WB

EX

ID

IF

CK

MEM

MEM

MEM

MEM

MEM

EX

B.1.c - add after lw where the lw Rt is the add Rt

WB

EX

ID

IF

WB

EX

ID

IF

WB

EX

ID

IF

lw **$3**,16($10)

WB

EX

ID

IF

WB

EX

ID

IF

CK

MEM

MEM

MEM

MEM

MEM

EX

B.1.d - beq after lw where the lw Rt is the beq Rs

WB

EX

ID

IF

WB

EX

ID

IF

WB

EX

ID

IF

lw **$3**,16($10)

WB

EX

ID

IF

WB

EX

ID

IF

CK

MEM

MEM

MEM

MEM

MEM

EX

B.2) What are the limitations of all cases of B.1 after you add he Data Forwarding? . Explain your answer!

B.2.a - lw after add where the add Rd is the lw Rs

WB

EX

ID

IF

WB

EX

ID

IF

WB

EX

ID

IF

add **$3**,$5,$8

WB

EX

ID

IF

WB

EX

ID

IF

CK

MEM

MEM

MEM

MEM

MEM

EX

B.2.b - lw after add where the add Rd is the lw Rt

WB

EX

ID

IF

WB

EX

ID

IF

WB

EX

ID

IF

add **$3**,$5,$8

WB

EX

ID

IF

WB

EX

ID

IF

CK

MEM

MEM

MEM

MEM

MEM

EX

B.2.c - add after lw where the lw Rt is the add Rt

WB

EX

ID

IF

WB

EX

ID

IF

WB

EX

ID

IF

lw **$3**,16($10)

WB

EX

ID

IF

WB

EX

ID

IF

CK

MEM

MEM

MEM

MEM

MEM

EX

B.2.d - beq after lw where the lw Rt is the beq Rs

WB

EX

ID

IF

WB

EX

ID

IF

WB

EX

ID

IF

lw **$3**,16($10)

WB

EX

ID

IF

WB

EX

ID

IF

CK

MEM

MEM

MEM

MEM

MEM

EX

B.3) How many times do we perform the instruction following a jal instruction? Explain in detail. What are the implications? If this is a problem, what do you suggest in order to solve it?

B.4) How soon after jal instruction can we issue a jr $31 instruction in order to return to the right location in the code? Give the answer before data forwarding is added and then after the data forwarding is added. . Explain your answer!

No data forwarding:

WB

EX

ID

IF

WB

EX

ID

IF

WB

EX

ID

IF

jal routine1

WB

EX

ID

IF

WB

EX

ID

IF

CK

MEM

MEM

MEM

MEM

MEM

EX

With data forwarding:

WB

EX

ID

IF

WB

EX

ID

IF

WB

EX

ID

IF

jal routine1

WB

EX

ID

IF

WB

EX

ID

IF

CK

MEM

MEM

MEM

MEM

MEM

EX