

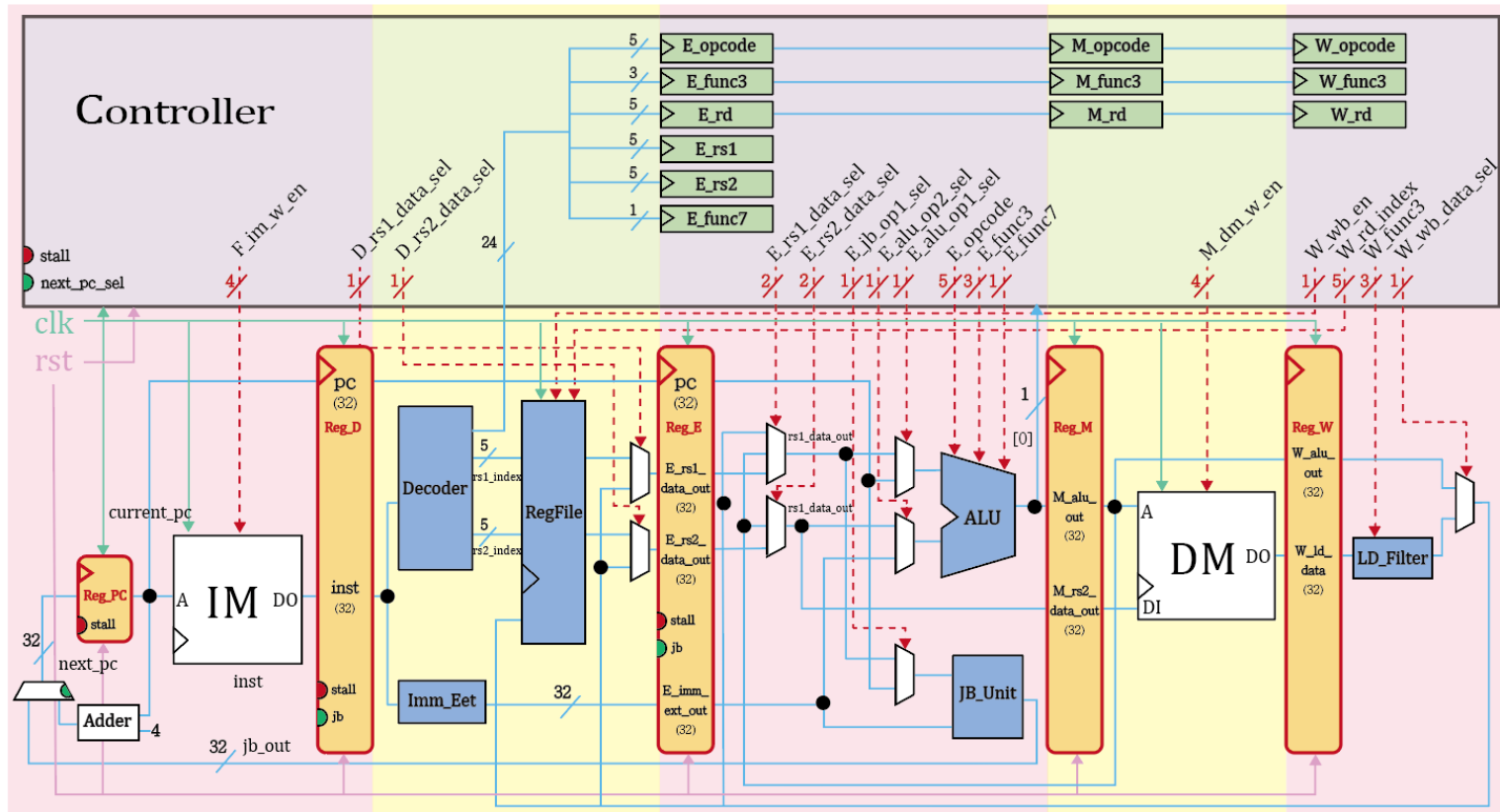
2022 計算機組織

Computer Organization

Lab 8 Report

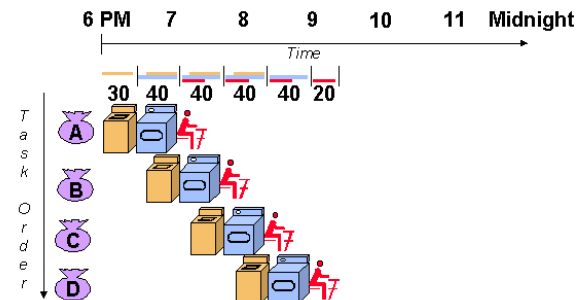
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1. Architecture Diagram



2. Explain why Pipeline can accelerate the CPU

因為當 instruction 進到下一個 stage 時，下一行的指令就可以繼續讀取，使用 Pipeline CPU 可以讓每一個 stage 在同時間內一起做事，減少每個 module 閒置的時間，每一行指令也可以即時更新資料。



3. Describe all the hazards you encountered and how you fixed them in your Pipeline CPU

Structure Hazard：當指令是 load 時候需要同時從 memory 讀取指令與 load data。

solution：將 SRAM 複製分成 im & dm 以解決同時獲取指令和 load data 的 memory access 問題。

Control Hazard：在確定 jump/branch 之前，後續指令已經進入 pipeline 裡面，造成跳轉錯誤。

solution：在 controller 產生 flush 訊號，以洗掉 pipeline 裡面 register 中的錯誤指令。

Data Hazard：如果下一行指令需要用到上一行指令的結果，則在上一行指令運算完成之前來不及寫回給下一行指令。

solution：將 MEM 階段和 WB 階段的結果寫回 ID 階段和 EX 階段。

4. Screenshot the successful result of prog0

```
DM['h9004'] = ffffffff8, pass
DM['h9008'] = 000000008, pass
DM['h900c'] = 000000001, pass
DM['h9010'] = 000000001, pass
DM['h9014'] = 78787878, pass
DM['h9018'] = 000091a2, pass
DM['h901c'] = 000000003, pass
DM['h9020'] = fefcfefd, pass
DM['h9024'] = 10305070, pass
DM['h9028'] = cccccccc, pass
DM['h902c'] = fffffffc, pass
DM['h9030'] = ffffcccc, pass
DM['h9034'] = 000000cc, pass
DM['h9038'] = 0000cccc, pass
DM['h903c'] = 00000d9d, pass
DM['h9040'] = 00000004, pass
DM['h9044'] = 00000003, pass
DM['h9048'] = 000001a6, pass
DM['h904c'] = 00000ec6, pass
DM['h9050'] = 2468b7a8, pass
DM['h9054'] = 5dbf9f00, pass
DM['h9058'] = 00012b38, pass
DM['h905c'] = fa2817b7, pass
DM['h9060'] = ff000000, pass
DM['h9064'] = 12345678, pass
DM['h9068'] = 0000f000, pass
DM['h906c'] = 0000f00, pass
DM['h9070'] = 000000f0, pass
DM['h9074'] = 0000000f, pass
DM['h9078'] = 56780000, pass
DM['h907c'] = 78000000, pass
DM['h9080'] = 00005678, pass
DM['h9084'] = 00000078, pass
DM['h9088'] = 12345678, pass
DM['h908c'] = ce780000, pass
DM['h9090'] = fffff000, pass
DM['h9094'] = fffff000, pass
DM['h9098'] = fffff000, pass
DM['h909c'] = fffff000, pass
DM['h90a0'] = fffff000, pass
DM['h90a4'] = fffff000, pass
DM['h90a8'] = 13579d7c, pass
DM['h90ac'] = 13578000, pass
DM['h90b0'] = fffff004, pass
```

```
*****
**                               **
** Waku Waku !!                 **
**                               **
** Simulation PASS !!           **
**                               **
*****
```

Simulation complete via `$finish(1)` at time 6965 NS + 2

`./top_tb.sv:114` `$finish;`

`xcelium> exit`

TOOL: `xmverilog` 22.03-s003: Exiting on Jan 17, 2023 at 17:23:22 CST

user: `~/C02022_Lab8/Lab8>`

5. Screenshot the successful result of prog1

```

DM['h9000'] = 00000000, pass
DM['h9004'] = 00000001, pass
DM['h9008'] = 00000001, pass
DM['h900c'] = 00000003, pass
DM['h9010'] = 00000003, pass
DM['h9014'] = 00000006, pass
DM['h9018'] = 00000008, pass
DM['h901c'] = 0000000a, pass
DM['h9020'] = 0000000a, pass
DM['h9024'] = 0000000b, pass
DM['h9028'] = 0000000c, pass
DM['h902c'] = 0000000f, pass
DM['h9030'] = 00000010, pass
DM['h9034'] = 00000012, pass
DM['h9038'] = 00000012, pass
DM['h903c'] = 00000017, pass
DM['h9040'] = 00000017, pass
DM['h9044'] = 00000017, pass
DM['h9048'] = 00000018, pass
DM['h904c'] = 0000001b, pass
DM['h9050'] = 0000001e, pass
DM['h9054'] = 00000025, pass
DM['h9058'] = 00000025, pass
DM['h905c'] = 00000026, pass
DM['h9060'] = 00000027, pass
DM['h9064'] = 00000028, pass
DM['h9068'] = 00000028, pass
DM['h906c'] = 00000029, pass
DM['h9070'] = 0000002b, pass
DM['h9074'] = 0000002d, pass
DM['h9078'] = 0000002d, pass
DM['h907c'] = 0000002e, pass
DM['h9080'] = 0000002f, pass
DM['h9084'] = 00000031, pass
DM['h9088'] = ffffffffce, pass
DM['h908c'] = ffffffffce, pass
DM['h9090'] = ffffffffdd1, pass
DM['h9094'] = ffffffffdd1, pass
DM['h9098'] = ffffffffdd2, pass
DM['h909c'] = ffffffffdd2, pass
DM['h90a0'] = ffffffffdd9, pass
DM['h90a4'] = ffffffffdd9, pass
DM['h90a8'] = ffffffffdd9, pass
DM['h90ac'] = ffffffffdd9, pass
DM['h90b0'] = ffffffffdd9, pass
DM['h90b4'] = ffffffffdd9, pass
DM['h90b8'] = ffffffffdd9, pass
DM['h90bc'] = ffffffffdd9, pass
DM['h90c0'] = ffffffffdd9, pass
DM['h90c4'] = ffffffffdd9, pass
DM['h90c8'] = ffffffffdd9, pass
DM['h90cc'] = ffffffffdd9, pass
DM['h90d0'] = 00000000, pass
DM['h90d4'] = ffffffffdd9, pass
DM['h90d8'] = ffffffffdd9, pass
DM['h90dc'] = ffffffffdd9, pass
DM['h90e0'] = ffffffffdd9, pass
DM['h90e4'] = ffffffffdd9, pass
DM['h90e8'] = ffffffffdd9, pass
DM['h90ec'] = ffffffffdd9, pass
DM['h90f0'] = ffffffffdd9, pass
DM['h90f4'] = ffffffffdd9, pass
DM['h90f8'] = ffffffffdd9, pass
DM['h90fc'] = ffffffffdd9, pass
DM['h9100'] = ffffffffdd9, pass
DM['h9104'] = ffffffffdd9, pass
DM['h9108'] = ffffffffdd9, pass
DM['h910c'] = ffffffffdd9, pass
DM['h9110'] = ffffffffdd9, pass
DM['h9114'] = ffffffffdd9, pass
DM['h9118'] = 00000000, pass
DM['h911c'] = 00000000, pass
DM['h9120'] = 00000000, pass
DM['h9124'] = 00000003, pass
DM['h9128'] = 00000009, pass
DM['h912c'] = 0000000f, pass
DM['h9130'] = 00000013, pass
DM['h9134'] = 00000016, pass
DM['h9138'] = 00000017, pass
DM['h913c'] = 00000017, pass
DM['h9140'] = 00000023, pass
DM['h9144'] = 0000002e, pass

*****
** Waku Waku !!
** Simulation PASS !!
*****

Simulation complete via $finish(1) at time 245395 NS + 2
./top_tb.sv:114 $finish;
xcelium> exit
TOOL: xmvverilog 22.03-s003: Exiting on Jan 17, 2023 at 17:24:36 CST (total: 00:00:01)
user:~/C02022 Lab8>

```