# 习题课

第五次 第六次作业

陈航

嵌入式系统实验室
EMBEDDED SYSTEM LABORATORY
SUZHOU INSTITUTE FOR ADVANCED STUDY OF USTC

# P255 3.14

```
        DADDIU R4, R1, #800
foo:    L.D    F2, 0(R1)
        MUL.D  F4, F2, F0
        L.D    F6, 0(R2)
        ADD.D  F6, F4, F6
        S.D    F6, 0(R2)
        DADDIU R1, R1, #8
        DADDIU R2, R2, #8
        DSLTU  R3, R1, R4
        BNEZ   R3, foo
```

2 stalls

6 stalls

2 stalls

4 stalls

2 stalls

2 stalls

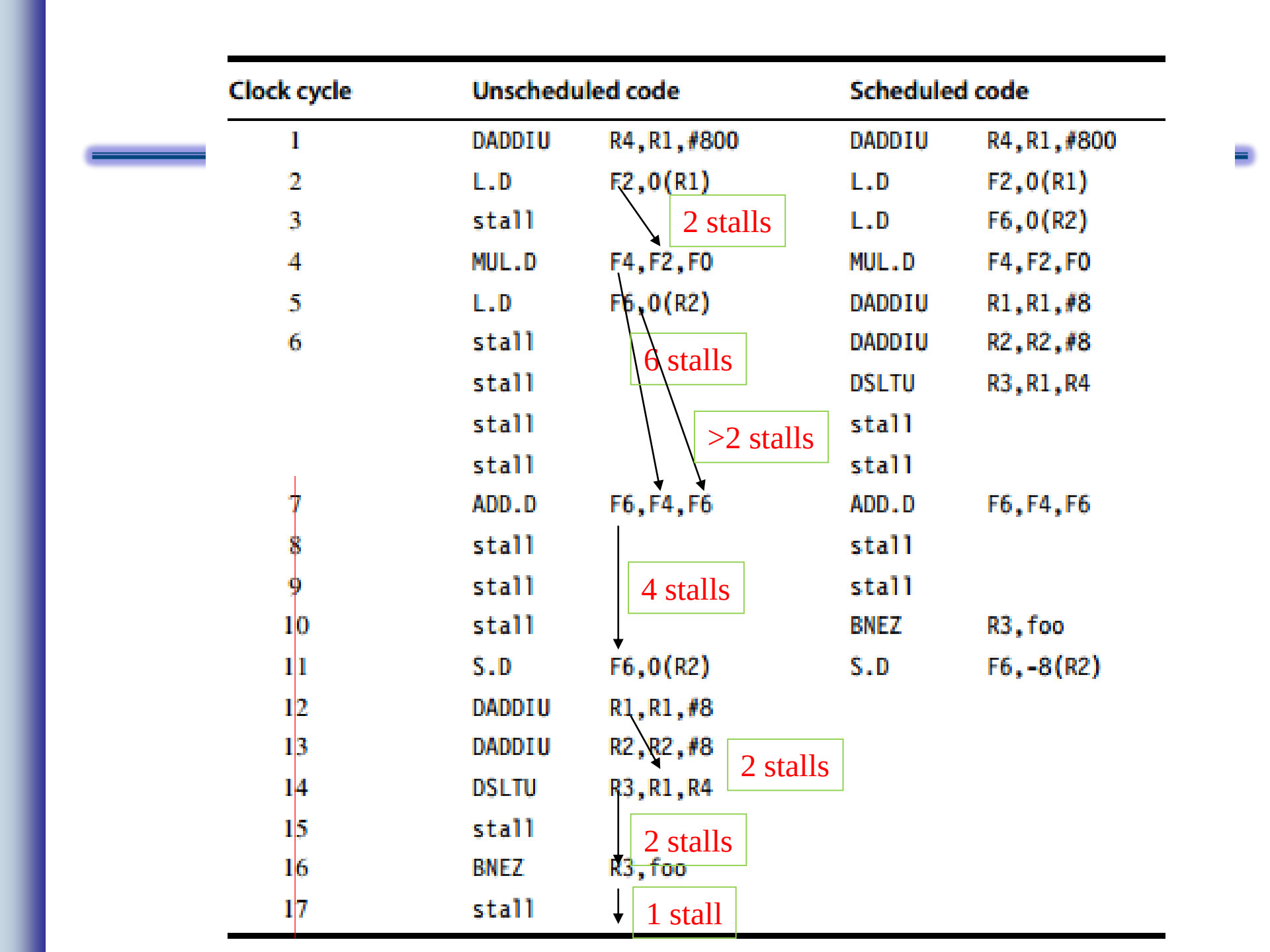
1 stall

嵌入式系统实验室

EMBEDDED SYSTEM LABORATORY

SUZHOU INSTITUTE FOR ADVANCED STUDY OF USTC

| Clock cycle | Unscheduled code | | Scheduled code | |
|---|---|---|---|---|
| 1 | DADDIU | R4,R1,#800 | DADDIU | R4,R1,#800 |
| 2 | L.D | F2,0(R1) | L.D | F2,0(R1) |
| 3 | stall | | L.D | F6,0(R2) |
| 4 | MUL.D | F4,F2,F0 | MUL.D | F4,F2,F0 |
| 5 | L.D | F6,0(R2) | DADDIU | R1,R1,#8 |
| 6 | stall | | DADDIU | R2,R2,#8 |
| | stall | | DSLTU | R3,R1,R4 |
| | stall | | stall | |
| | stall | | stall | |
| 7 | ADD.D | F6,F4,F6 | ADD.D | F6,F4,F6 |
| 8 | stall | | stall | |
| 9 | stall | | stall | |
| 10 | stall | | BNEZ | R3,foo |
| 11 | S.D | F6,0(R2) | S.D | F6,-8(R2) |
| 12 | DADDIU | R1,R1,#8 | | |
| 13 | DADDIU | R2,R2,#8 | | |
| 14 | DSLTU | R3,R1,R4 | | |
| 15 | stall | | | |
| 16 | BNEZ | R3,foo | | |
| 17 | stall | | | |



# P257 3.15

| Iteration | Instruction | Issues at | Executes/ Memory | Write CDB at | Comment |
|---|---|---|---|---|---|
| 1 | L.D F2,0(R1) | 1 | 2 | 3 | First issue |
| 1 | MUL.D F4,F2,F0 | 2 | 4 | 19 | Wait for F2<br>Mult rs [3–4]<br>Mult use [5–18] |
| 1 | L.D F6,0(R2) | 3 | 4 | 5 | Ldbuf [4] |
| 1 | ADD.D F6,F4,F6 | 4 | 20 | 30 | Wait for F4<br>Add rs [5–20]<br>Add use [21–29] |
| 1 | S.D F6,0(R2) | 5 | 31 | | Wait for F6<br>Stbuf1 [6–31] |
| 1 | DADDIU R1,R1,#8 | 6 | 7 | 8 | |
| 1 | DADDIU R2,R2,#8 | 7 | 8 | 9 | |
| 1 | DSLTU R3,R1,R4 | 8 | 9 | 10 | |
| 1 | BNEZ R3,foo | 9 | 11 | | Wait for R3 |
| 2 | L.D F2,0(R1) | 10 | 12 | 13 | Wait for BNEZ<br>Ldbuf [11–12] |
| 2 | MUL.D F4,F2,F0 | 11 | ~~14~~<br>19 | 34 | Wait for F2<br>Mult busy<br>Mult rs [12–19]<br>Mult use [20–33] |
| 2 | L.D F6,0(R2) | 12 | 13 | 14 | Ldbuf [13] |
| 2 | ADD.D F6,F4,F6 | 13 | 35 | 45 | Wait for F4<br>Add rs [14–35]<br>Add use [36–44] |
| 2 | S.D F6,0(R2) | 14 | 46 | | Wait for F6<br>Stbuf [15–46] |
| 2 | DADDIU R1,R1,#8 | 15 | 16 | 17 | |
| 2 | DADDIU R2,R2,#8 | 16 | 17 | 18 | |
| 2 | DSLTU R3,R1,R4 | 17 | 18 | 20 | |
| 2 | BNEZ R3,foo | 18 | 20 | | Wait for R3 |
| 3 | L.D F2,0(R1) | 19 | 21 | 22 | Wait for BNEZ<br>Ldbuf [20–21] |
| 3 | MUL.D F4,F2,F0 | 20 | ~~23~~<br>34 | 49 | Wait for F2<br>Mult busy |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Mult rs [21–34]<br>Mult use [35–48] |
| 3 | L.D F6,0(R2) | 21 | 22 | 23 | Ldbuf [22] |
| 3 | ADD.D F6,F4,F6 | 22 | 50 | 60 | Wait for F4<br>Add rs [23–49]<br>Add use [51–59] |
| 3 | S.D F6,0(R2) | 23 | 55 | | Wait for F6<br>Stbuf [24–55] |
| 3 | DADDIU R1,R1,#8 | 24 | 25 | 26 | |
| 3 | DADDIU R2,R2,#8 | 25 | 26 | 27 | |
| 3 | DSLTU R3,R1,R4 | 26 | 27 | 28 | |
| 3 | BNEZ R3,foo | 27 | 29 | | Wait for R3 |

嵌入式系统实验室
EMBEDDED SYSTEM LABORATORY
SUZHOU INSTITUTE FOR ADVANCED STUDY OF USTC

# P259 3.19

a. 对于非条件分支指令，其下一条指令直接存储在BTB中，因此省去了通过地址取指令的过程，因此节省了1 cycle

b. 考虑如下指令

```
    jmp L1
    …
L: mov r1, r0
```

在对应5% unconditional branch，90% hit rate, 2 cycyles penalty for a buffer miss中，其性能提升为：

嵌入式系统实验室
EMBEDDED SYSTEM LABORATORY
SUZHOU INSTITUTE FOR ADVANCED STUDY OF USTC

5%*(90%*(-1) + 10%*2) = -0.035

为了使得BTB帮助机器获得性能提升，即：buffer中存储的指令所带来的收益要比因buffer miss所带来的penalty要大，设hit rate = x ,那么：

x*(-1) + (1-x)*2 < 0

解得： x > 2/3 = 66.7%

嵌入式系统实验室
Embedded System Laboratory
Suzhou Institute for Advanced Study of USTC