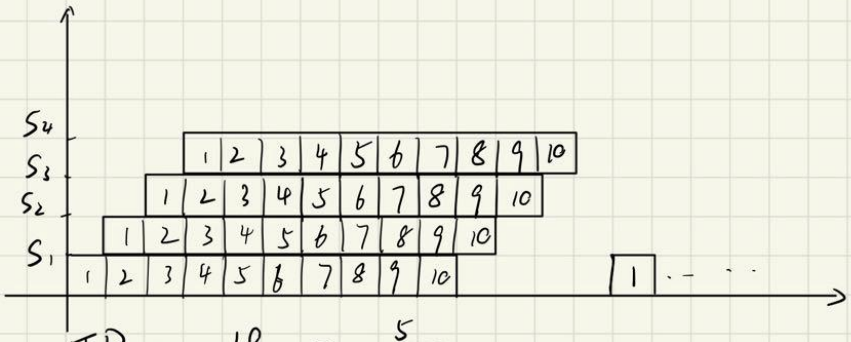
5-1. (1) $n(\Delta t + 2\Delta t + 3\Delta t) = 6n\Delta t$

(2) $\Delta t + n \cdot 2\Delta t + (n-1) \cdot 3\Delta t + 3\Delta t$

$= \Delta t + 2n\Delta t + (3n-3)\Delta t + 3\Delta t = (5n+1)\Delta t$

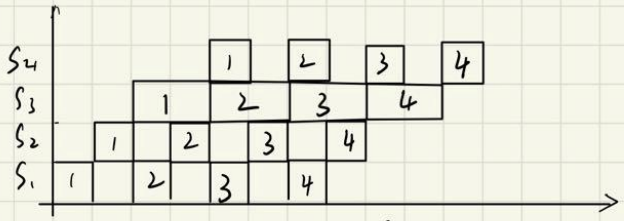
(3) $\Delta t + 2\Delta t + (n-2) \cdot 3\Delta t + 3\Delta t + 3\Delta t = (3n+3)\Delta t$

5-3.



$TP = \frac{10}{140t} = \frac{5}{70t}$

5-4.



$TP = \frac{4}{220t} = \frac{2}{110t}$

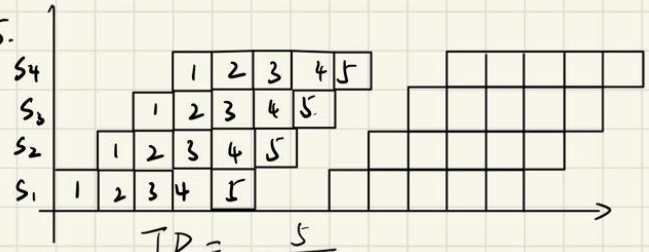
$Efficiency = \frac{4 \times 100t}{4 \times 220t} = 45.5\%$

应减少流水段3经过时间，减少到 Δt

此时 $TP = \frac{4}{140t} = \frac{2}{70t}$

$Efficiency = \frac{4 \times 80t}{4 \times 140t} = 57.1\%$

5-5.



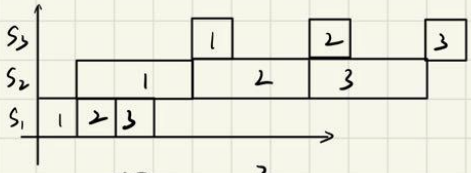
$TP = \frac{5}{70t}$

$S_P = \frac{5 \times 40t + 20t}{70t} = \frac{22}{7}$

$Efficiency = \frac{5 \times 40t}{4 \times 70t} = \frac{5}{7}$

5-6. 一种是将瓶颈段再细分，一种是将瓶颈段重复设置

(1)



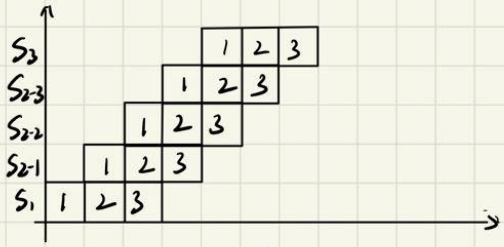
3条指令：$TP = \frac{3}{110t}$

$Efficiency = \frac{30t + 30t + 3 \times 30t}{110t \times 3} = \frac{5}{11}$

30条指令：$TP = \frac{30}{20t + 30 \times 30t} = \frac{15}{460t}$

$Efficiency = \frac{30 \times 20t + 30 \times 30t}{920t \times 3} = \frac{25}{46}$

(2) 若将瓶颈段再细分



3条: $TP = \frac{3}{70t}$

$Efficiency = \frac{3 \times 50t}{7 \times 50t} = \frac{3}{7}$

30条: $TP = \frac{30}{50t + 20t} = \frac{15}{170t}$

$Efficiency = \frac{15}{17}$

(3) 连续指令越多，效率提升越明显

5-12. $F=\{1,3,4,8\}$

$C=(10001101)$

冲突向量右移2位：$00100011 \vee 10001101 = 10101111$

冲突向量右移5位：$00000100 \vee 10001101 = 10001101$

冲突向量右移6位：$00000010 \vee 10001101 = 10001111$

冲突向量右移7位：$00000001 \vee 10001101 = 10001101$

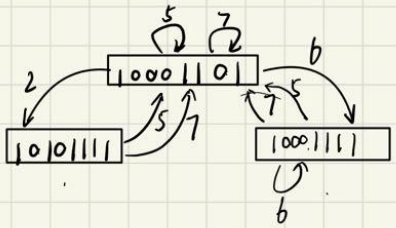
中间冲突向量 10101111 右移5位：$00000101 \vee 10001101 = 10001101$

中间冲突向量 10101111 右移7位：$00000001 \vee 10001101 = 10001101$

中间冲突向量 10001111 右移5位：$00000100 \vee 10001101 = 10001101$

中间冲突向量 10001111 右移6位：$00000010 \vee 10001101 = 10001111$

中间冲突向量 10001111 右移7位：$00000001 \vee 10001101 = 10001101$



调度方案	平均间隔拍数
(5)	5
(7)	7
(2,5)	3.5
(2,7)	4.5
(6,5)	5.5
(6,7)	6.5

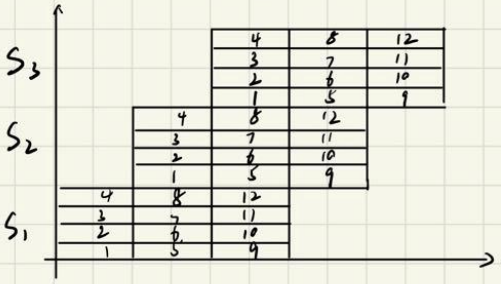
最小平均延迟为3.5个

最大吞吐率为$\frac{2}{7}$，调度方案为(2,5)

$$TP = \frac{6}{(2\times2+3\times7)\Delta t} = \frac{6}{25\Delta t}$$

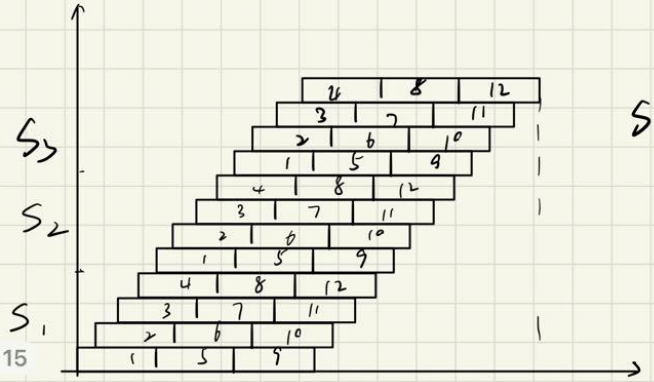
5.17 常规标量流水处理机

m=4 的超标量处理机



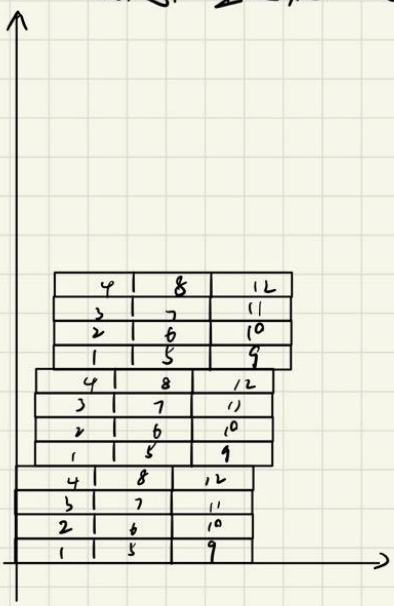
$$SP = \frac{140t}{50t} = \frac{14}{5}$$

m=4 的超流水线处理机



$$SP = \frac{140t}{57.5\Delta t} = 2.43$$

m=4 的超标量超流水处理机



$$SP = \frac{140t}{3.50t} = 4$$