



Computer Architecture II - SS 04
(due: 28.09.2004)

Exercise 1: (Find Last One Circuit)

(10 points)

The unary n -bit find last one circuit (FLO) with inputs $a[n-1:0]$ and outputs $b[n-1:0]$ and $zero$ calculates the following function:

$flo : \{0,1\}^n \rightarrow \{0,1\}^{n+1}$ with $b_i = 1$ iff $i = \max\{j \in \{0, \dots, n-1\} | a_j = 1\}$ and $zero = 1$ iff $a_i = 0 \forall i \in \{0, \dots, n-1\}$.

Build an find last one circuit with logarithmic delay and linear cost.

Exercise 2: (Reservation Station Control)

(15 points)

Each function unit has its own set of reservation stations assigned to it. The reservation stations form a queue for instructions and their operands. This queue originates in the decode/issue environment. In each cycle, any desired instruction can move from its reservation station into the function unit. For this purpose, all reservation stations are connected to a common bus (similar to the CDB). The bus and the reservation stations are controlled by the reservation station control.

New instructions are always issued in-order into the first reservation station (reservation station 0). The input values for reservation station 0 are generated by the decode/issue environment.

As soon as one or more instructions in the queue become valid, the oldest among these instructions is dispatched into the function unit and removed from the queue. The reservation station control calculates the necessary output enable signals.

In each cycle, an instruction in reservation station i moves into reservation station $i+1$, unless reservation station $i+1$ is full and cannot be freed by moving its content into reservation station $i+2$ or by dispatching the instruction into the function unit. The reservation station control calculates the necessary clock enable signals.

- Construct the necessary reservation station control circuit which gets as inputs $RS_i.full$, $FU.stall$ and $RS_i.valid$ with $i \in \{0, \dots, n_j - 1\}$ where n_j is the number of reservation stations for the given functional unit. $FU.stall$ denotes, that the functional unit is not able to receive new instructions.

The control should compute the $FU.full$, $RS.valid$ and $RS_i.doe$ signals. The $RS_i.doe$ signal is set iff the instruction in reservation station i is dispatched into the function unit, i.e. this signal is the output enable of reservation station i to the common bus. At most one $RS_i.doe$ signal should be active at any time. $FU.full$ is a signal to the decode/issue stage and should be turned on iff all reservation stations of the functional unit are full and no instruction gets dispatched into the function unit. The signal $RS.valid$ is active iff an instruction is dispatched into the function unit. This is true iff there is at least one valid reservation station and the function unit is not stalled.

Hint: Use the find last one circuit from exercise 1.