

Efficient Priority-Queue Data Structure for Hardware Implementation

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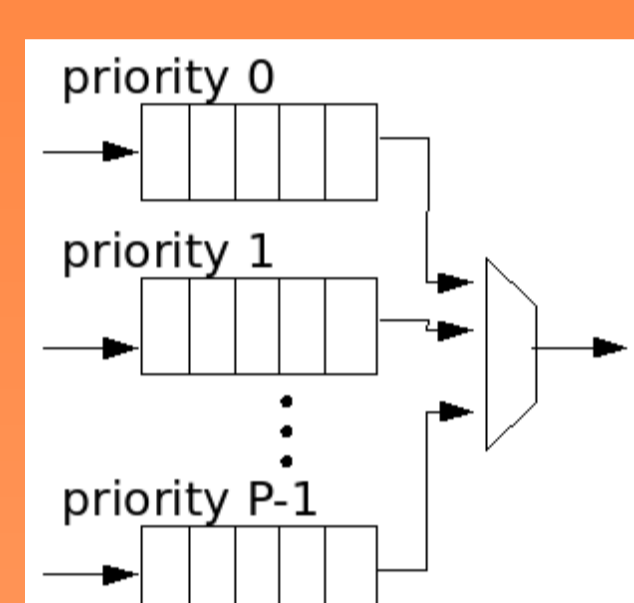
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Background

What is a Priority-Queue?

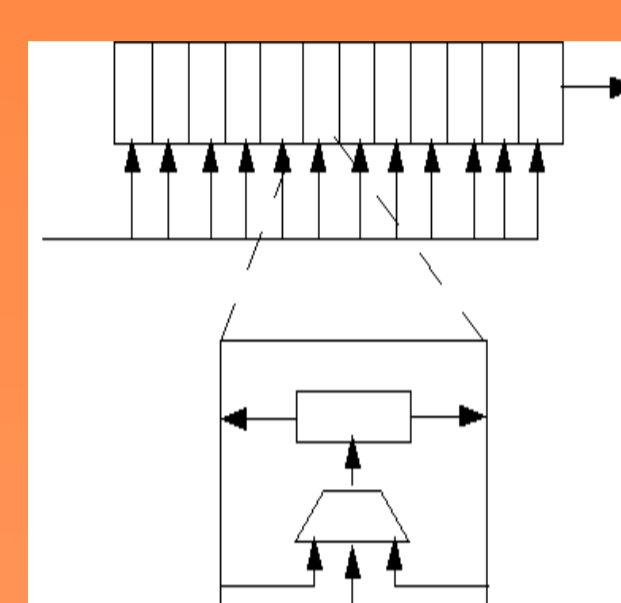
- It sorts items according to priority level
- Items are retrieved in FIFO order within each priority level
- Used in switches to sort packets into Quality of Service levels
- Also applicable to fixed-priority scheduling of software tasks

Architecture 1: Multi-FIFO



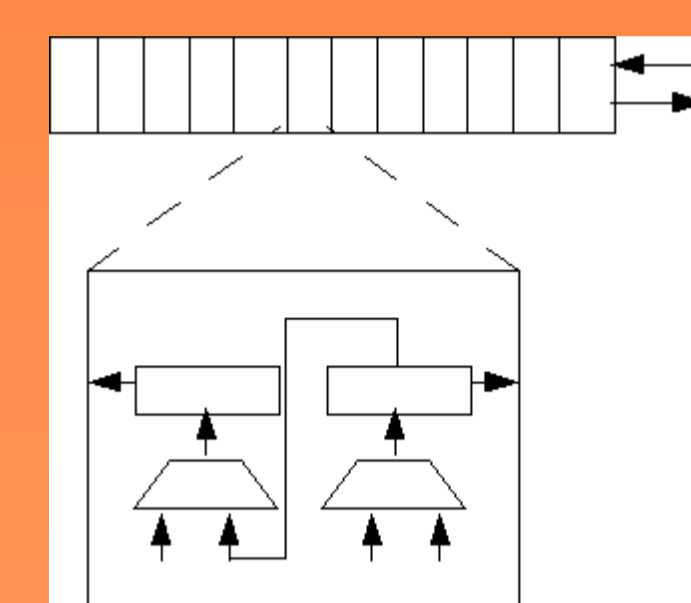
- Advantages:
- fast enqueue
- Disadvantages:
- slow dequeue
 - size $\propto N \cdot P$

Architecture 2: Shift Register



- Advantages:
- simple dequeue
- Disadvantages:
- bus loading for enqueues
 - comparator and mux per reg

Architecture 3: Systolic Array

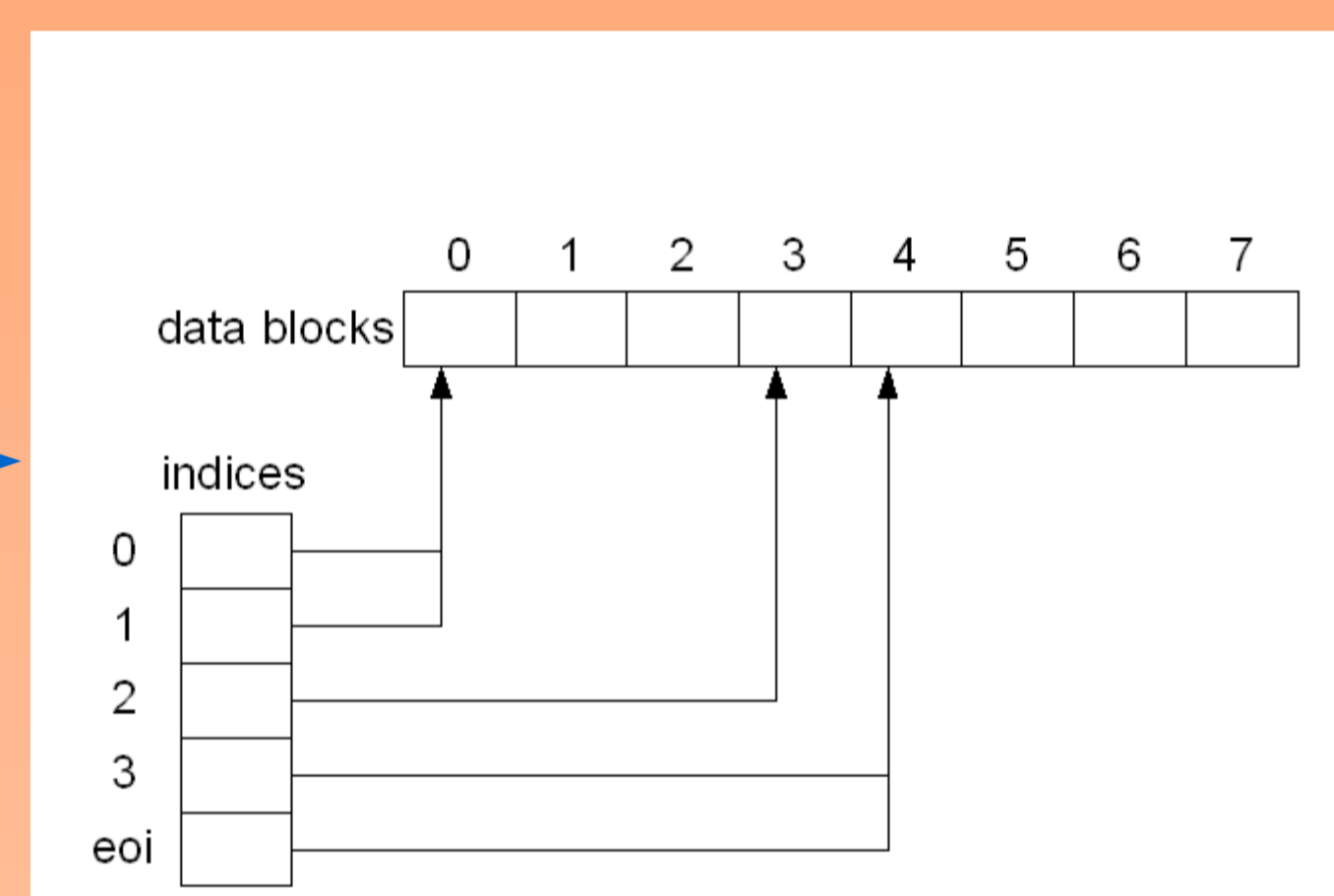


- Advantages:
- fast enqueue, dequeue
- Disadvantages:
- 2 comparators and 2 muxes per register

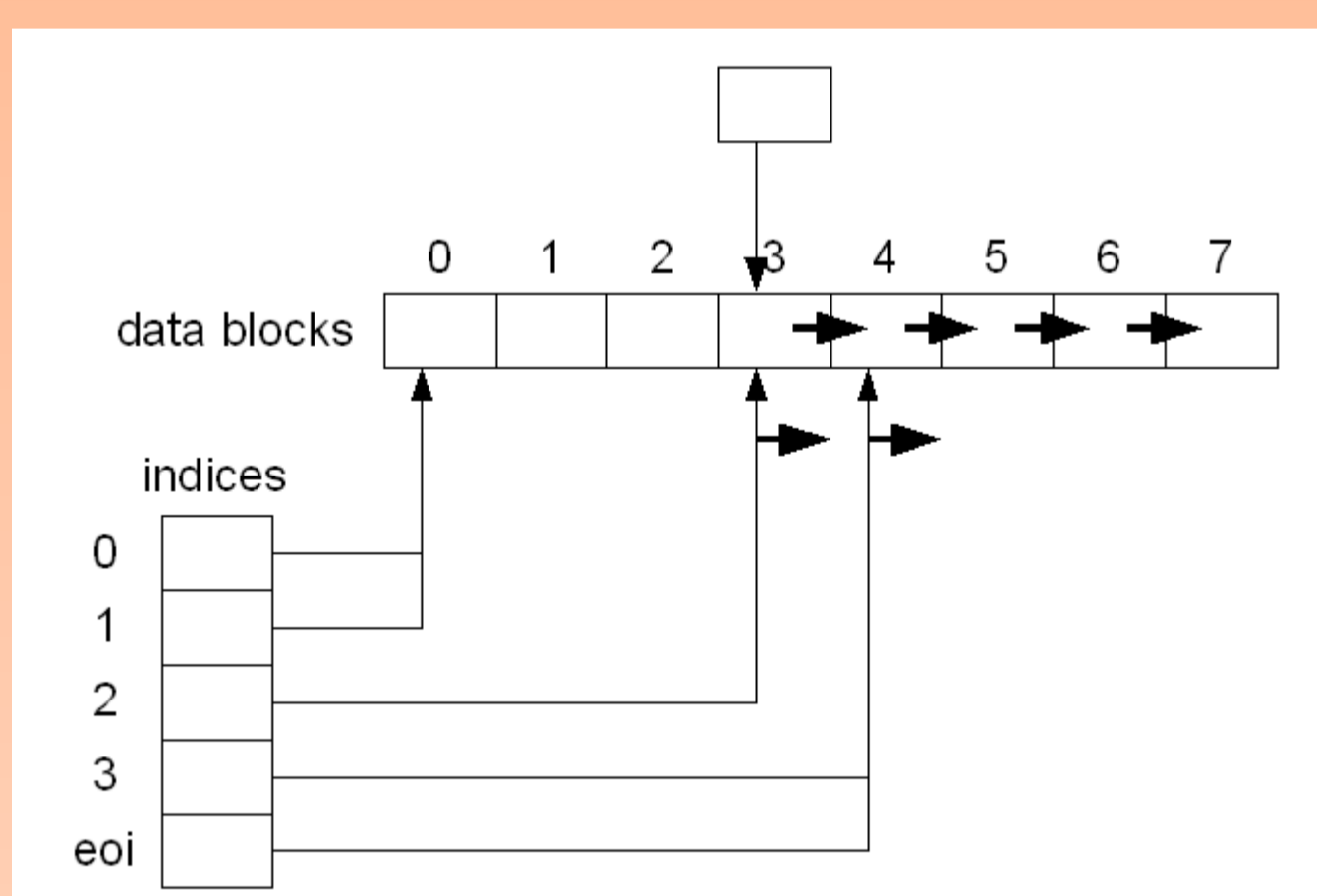
Design

Concept

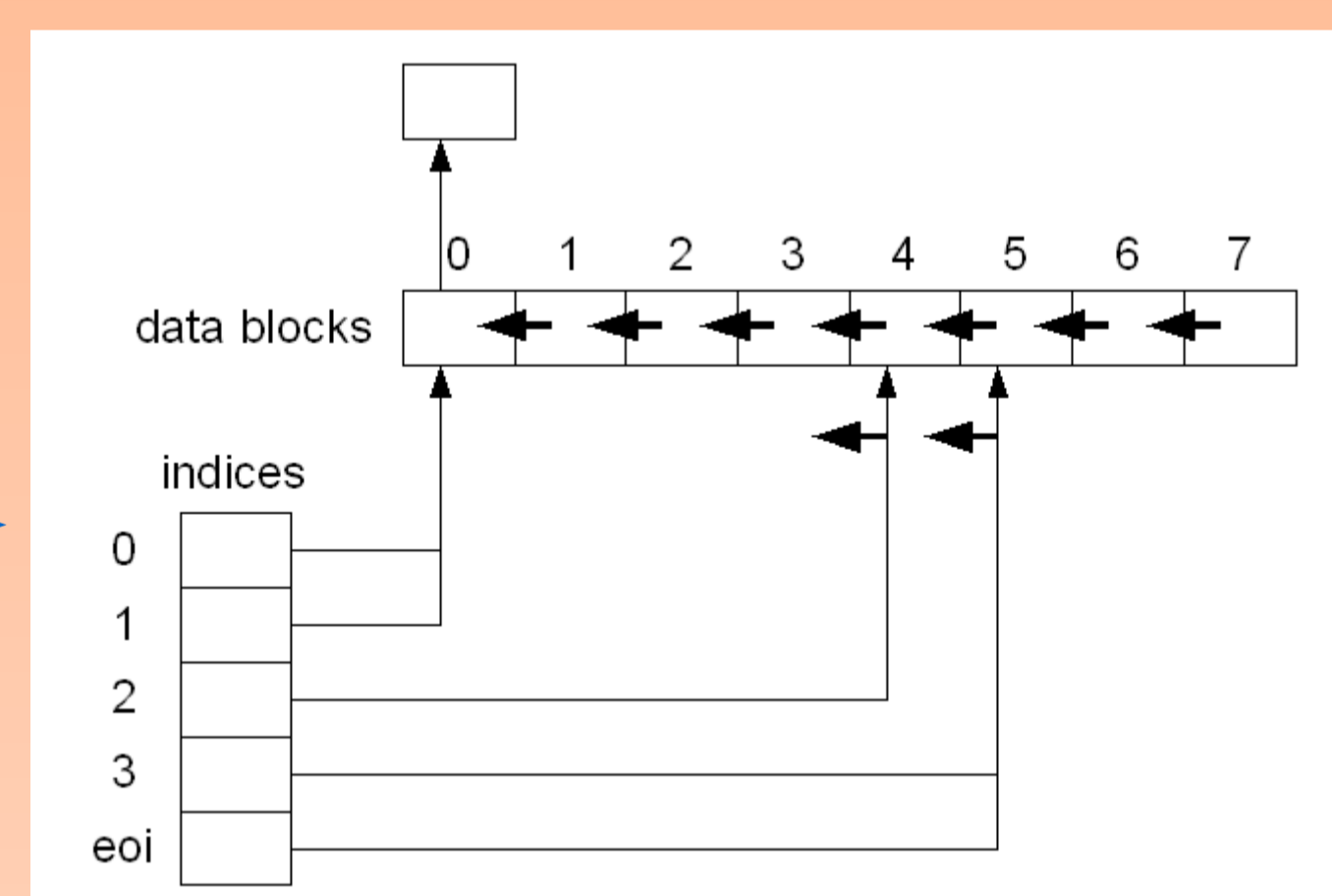
- all queues share same array
- each queue (priority) has an index to its first element
- example to right:
 - priority 1 – 3 items
 - priority 2 – 1 item
 - priority 0,3 - empty



initial

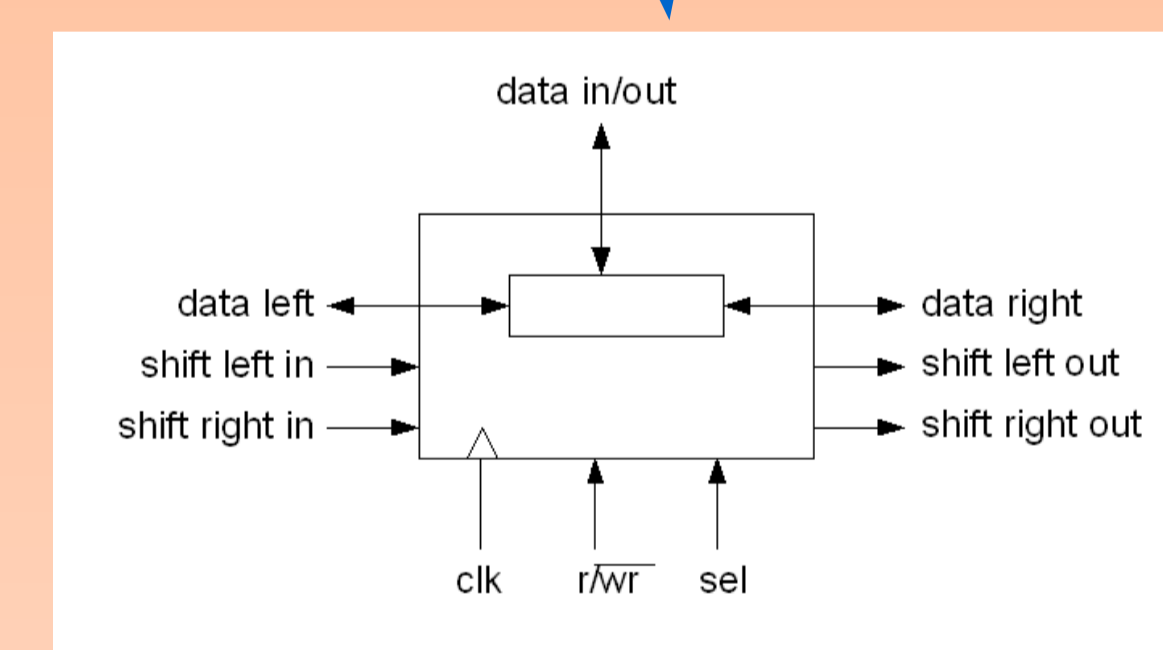
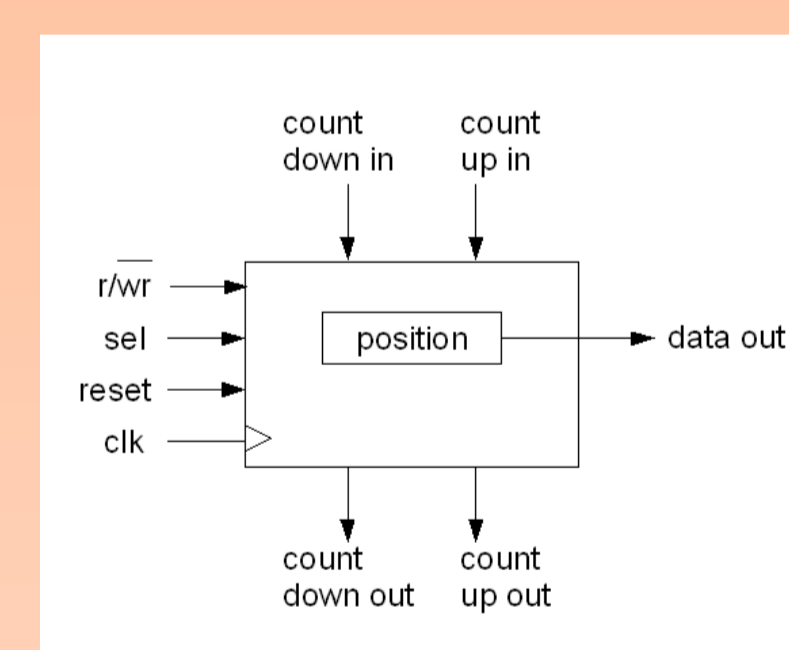
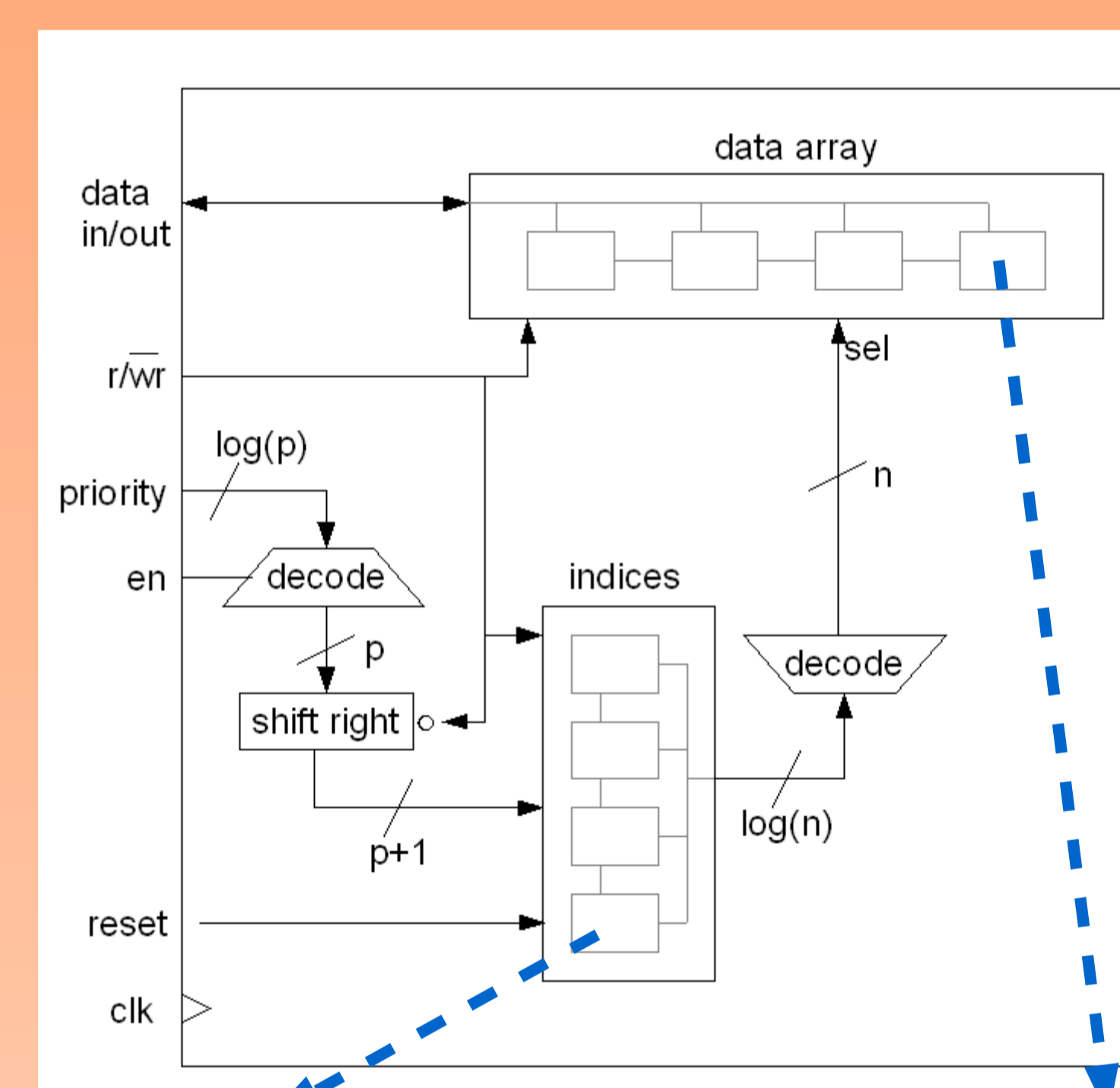


enqueue priority 1



dequeue priority 0

Architecture



Results

- enqueue operation uses index of next queue to mark insertion point
- dequeue at priority 0 gets item from highest-priority non-empty queue
- no comparators results in fast enqueue/dequeue and small size

Synthesis Results for Virtex II Pro 70

FPGA Slices

Priorities	Array Size			
	16	32	64	256
4	215	498	1194	5748
16	341	669	1257	5806
32		858	1500	5797
64			1751	7032

Clock Rate (MHz)

Priorities	Array Size			
	16	32	64	256
4	115.2	87.9	56.5	29.7
16	87.9	71.4	52.1	24.8
32		70.7	54.5	25.7
64			44.9	19.9

- compares well with systolic array in both size and speed
- speed much better than multi-FIFO results although size much bigger

- will be used for scheduling and wait queues in hybrid OS