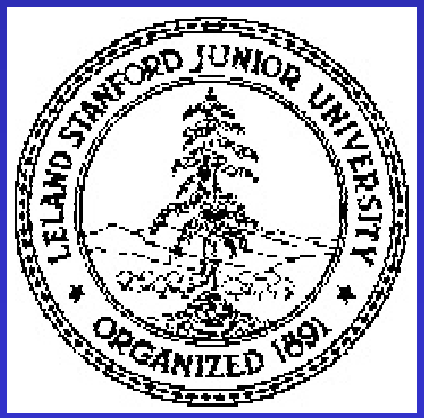
Techniques for Fast Packet Buffers



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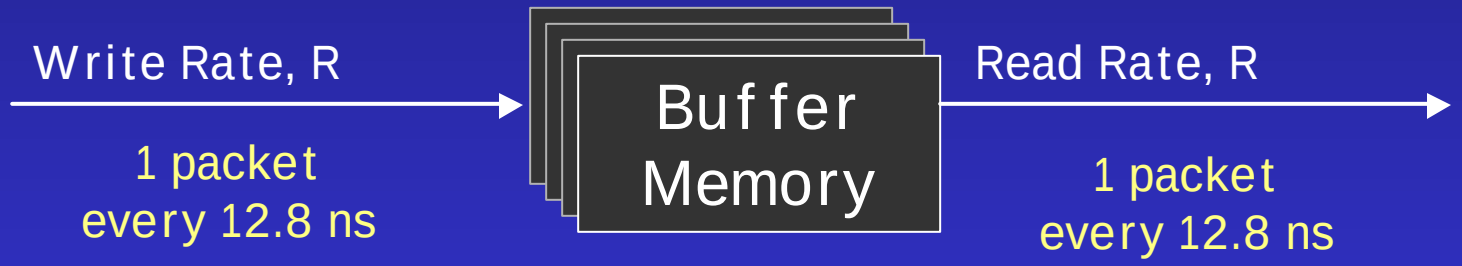
Packet Buffer Architecture

Goal

Determine and analyze techniques for building high speed (>40Gb/s) electronic packet buffers.

Example

OC768c = 40Gb/s; RTT*BW = 10Gb; 64 byte packets



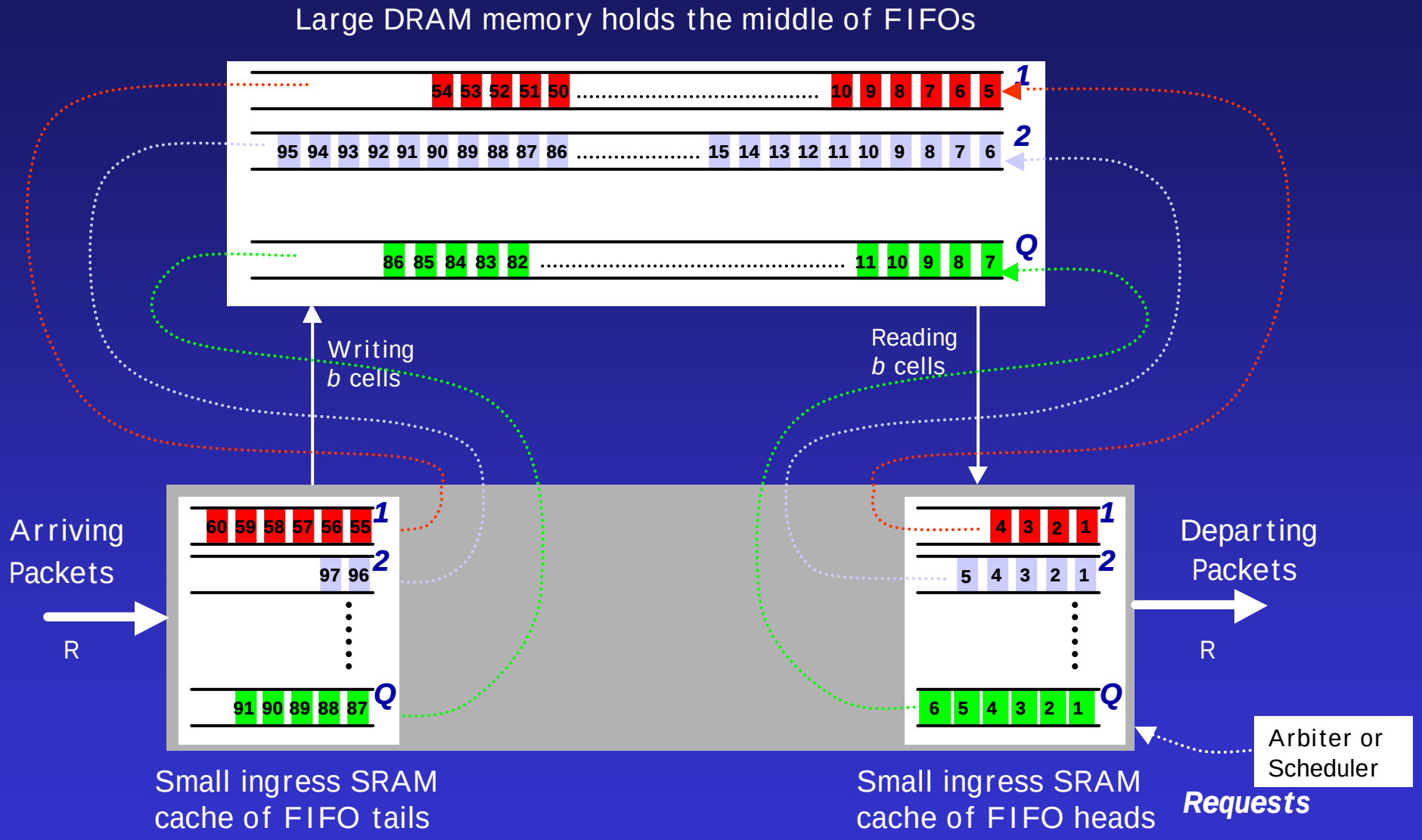
Use SRAM?

+ fast enough random access time, but
- too expensive, and
- too low density to store 10Gb of data.

Use DRAM?

+ high density means we can store data, but
- too slow (typically 50ns random access time)

Memory Hierarchy



Questions

How large does the SRAM cache need to be:

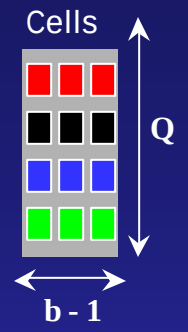
1. To guarantee that a packet is immediately available in SRAM when requested, or
2. To guarantee that a packet is available within a maximum bounded time?

This talk…

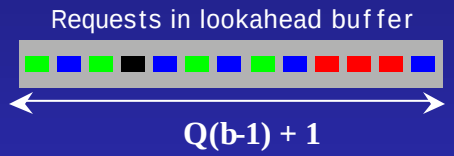
What Memory Management Algorithm (MMA) should we use?

Earliest Critical Queue First (ECQF-MMA)

1. In SRAM: A Dynamic Buffer of size Q(b-1)



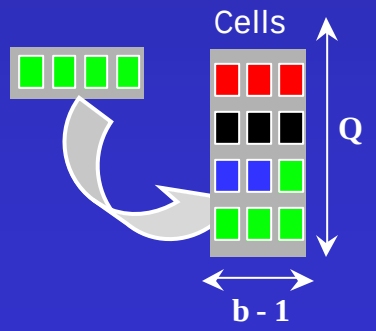
2. Lookahead: Arbiter requests for future Q(b-1) + 1 slots are known



3. Compute: Find out the queue which will runs into "trouble" earliest

4. Replenish: "b" cells for the "troubled" queue

green!



Example of ECQF-MMA: Q=4, b=4

t = 0; Green Critical

t = 1

t = 2

t = 3

t = 4; Blue Critical

t = 5

t = 6

t = 7

t = 8; Red Critical

Results
Single Address Bus

1. Patient Arbiter: ECQF-MMA (earliest critical queue first), minimizes the size of SRAM buffer to Q(b-1) cells; and guarantees that requested cells are dispatched within Q(b-1)+1 cell slots.

2. Impatient Arbiter: MDQF-MMA (maximum deficit queue first), with a SRAM buffer of size Qb[2 +ln Q] guarantees zero latency.

Implementation Numbers
(64byte cells, b = 8, DRAM T = 50ns)

1. VOQ Switch - 32 ports

- Brute Force : Egress. SRAM = 10 Gb, no DRAM
- Patient Arbiter : Egress. SRAM = 115kb, Lat. = 2.9 us, DRAM = 10Gb
- Impatient Arbiter : Egress. SRAM = 787 kb, DRAM = 10Gb
- Patient Arbiter(MA) : No SRAM, Lat. = 3.2us, DRAM = 10Gb

2. VOQ Switch - 32 ports, 16 Diffserv classes

- Brute Force : Egress. SRAM = 10Gb, no DRAM
- Patient Arbiter : Egress. SRAM = 1.85Mb, Lat. = 45.9us, DRAM 10Gb
- Impatient Arbiter : Egress. SRAM = 18.9Mb, DRAM = 10Gb
- Patient Arbiter(MA) : No SRAM, Lat. = 51.2us, DRAM = 10Gb