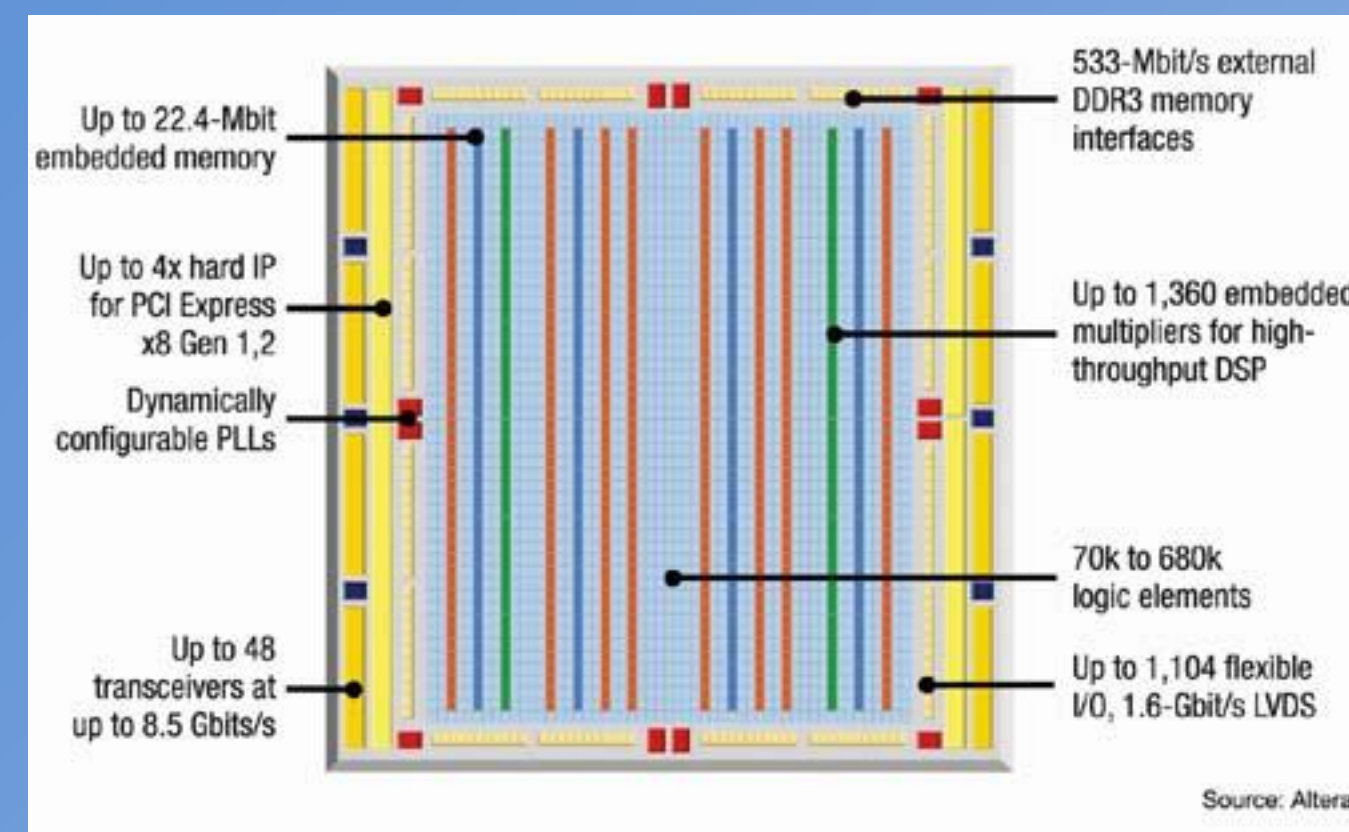


Reconfigurable Hardware for Database Application

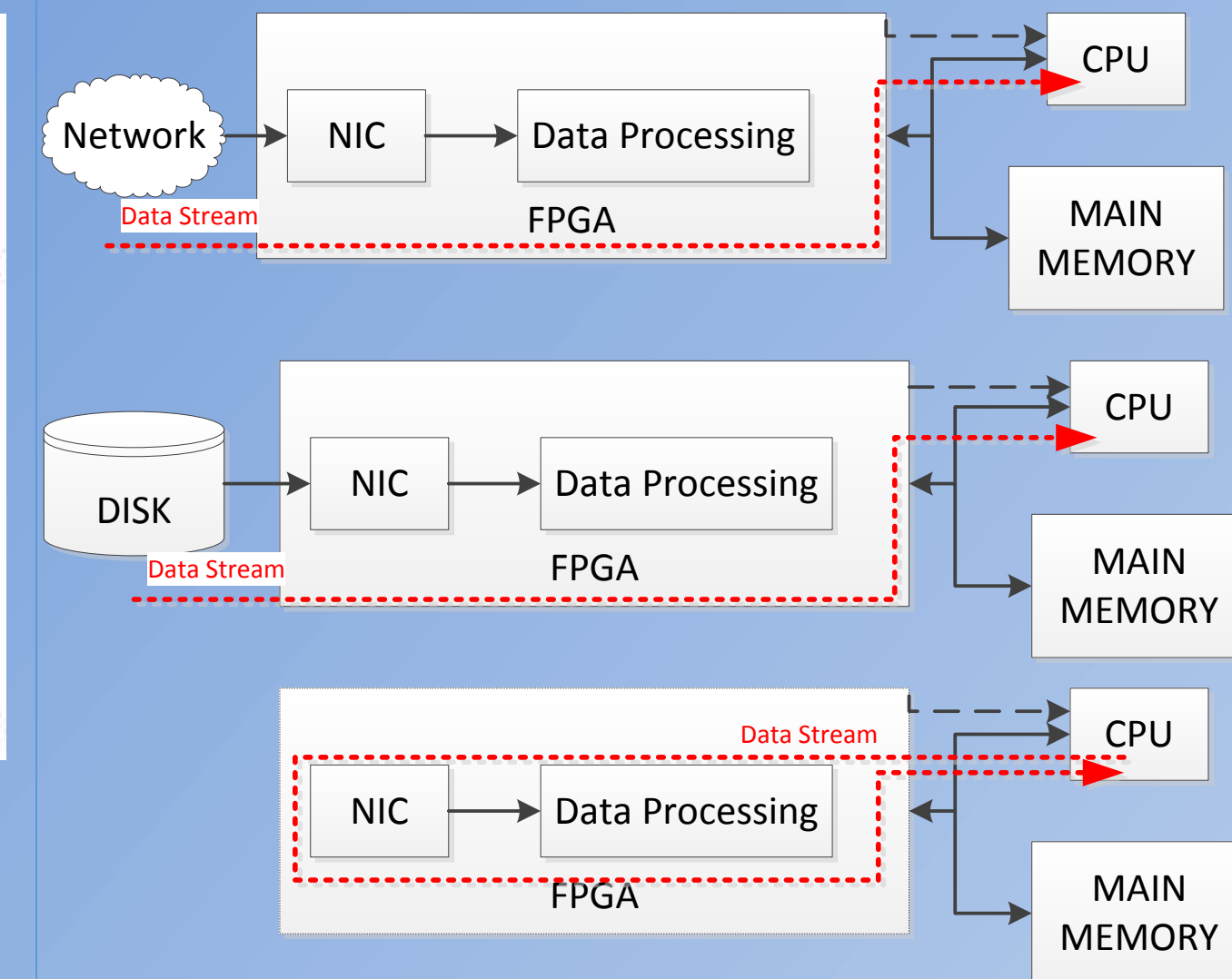
Damon Bruccoleri – Sponsor: Dr. Junping Sun

What is Reconfigurable Hardware?



The **FPGA** provides a fabric of hardware elements whose interconnects are soft programmable.

Now we just need algorithms and data!



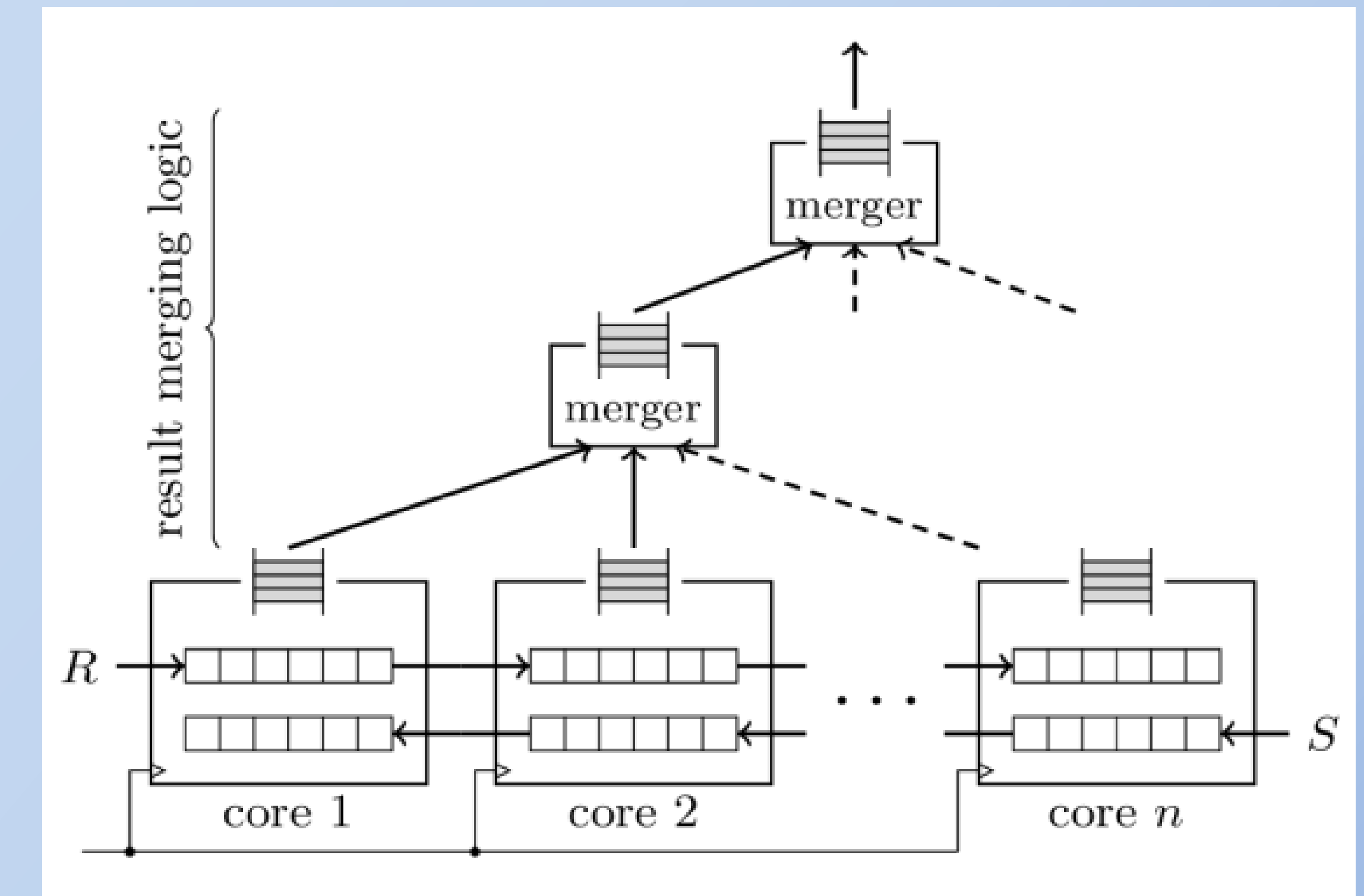
Proposed FPGA positioning within the computer. Communications via registers, DMA. Shared memory, interrupts...

ABSTRACT

RECONFIGURABLE HARDWARE PROVIDES OPPORTUNITIES TO REALIZE MANY DBMS TASKS AND ALGORITHMS AS HIGHLY PARALLEL HARDWARE IMPLEMENTATIONS. SEVERAL HARDWARE ALGORITHMS WERE EXAMINED AND HOW THEY MIGHT BENEFIT A DBMS.

A PROPOSAL FOR SEARCHING VERY LARGE DATASETS IS PROPOSED USING RECONFIGURABLE HARDWARE. THIS APPROACH IS BASED ON THE VENERABLE B+ TREE.

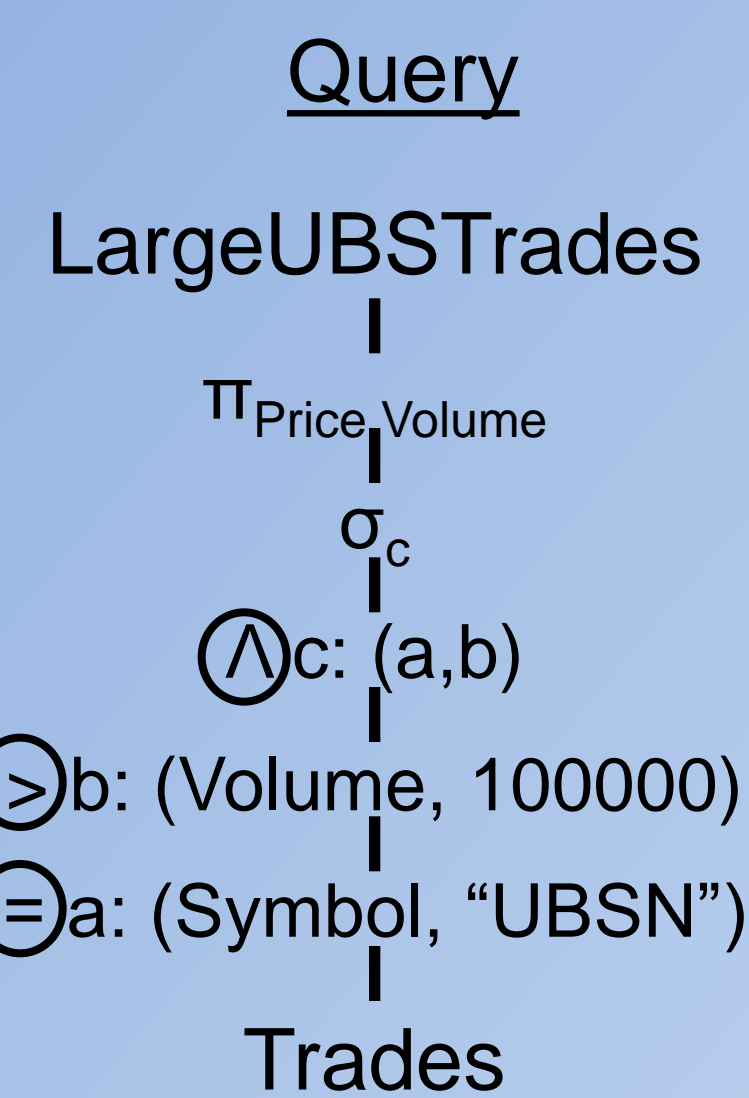
STREAM JOIN



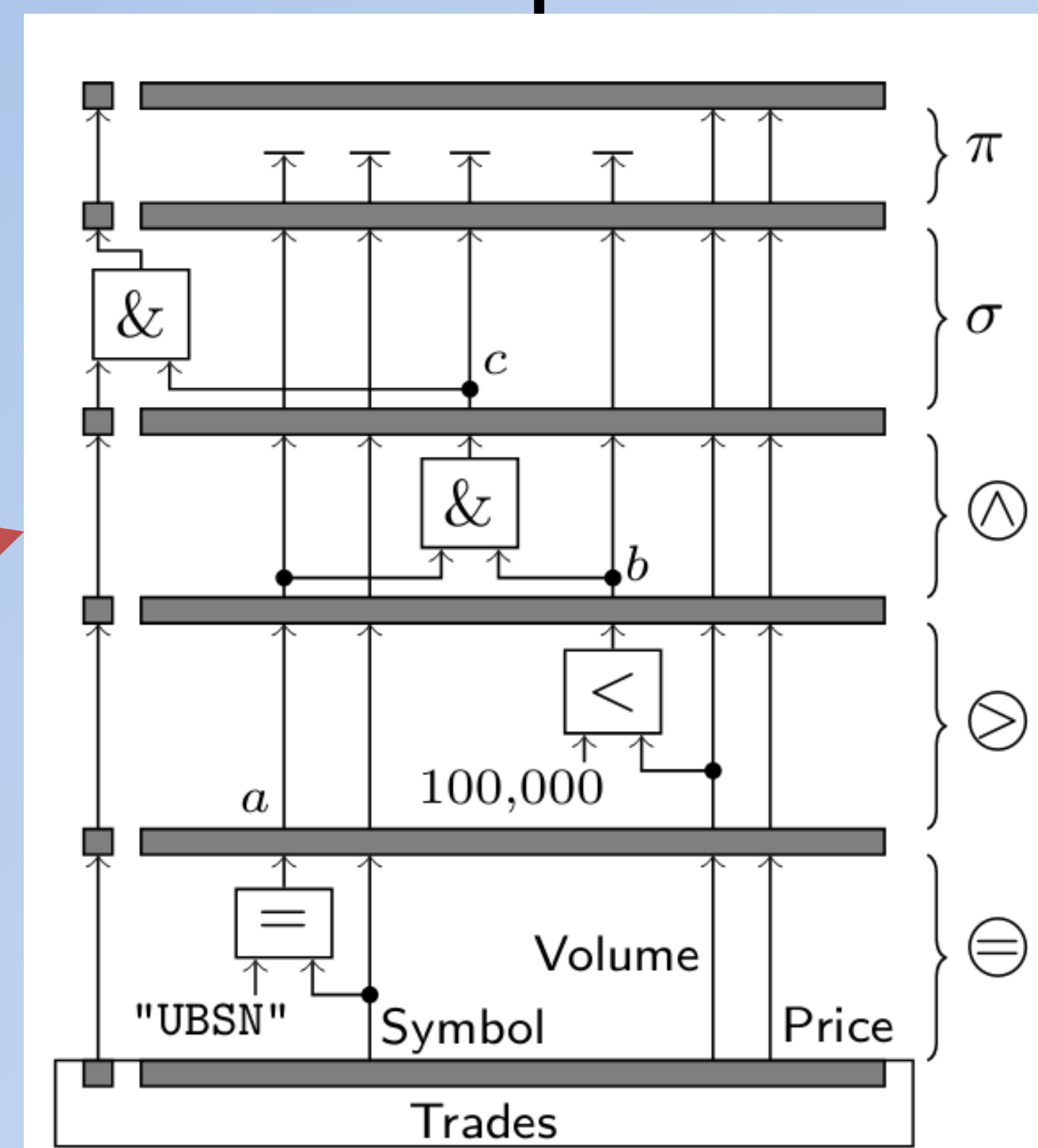
Relations R and S are evaluated over a join window.

```
SELECT Price, Volume
FROM Trades
WHERE Symbol = "UBSN" AND
      Volume > 100,000
INTO LargeUBSTrades
```

"Glacier" Hardware Query Compiler

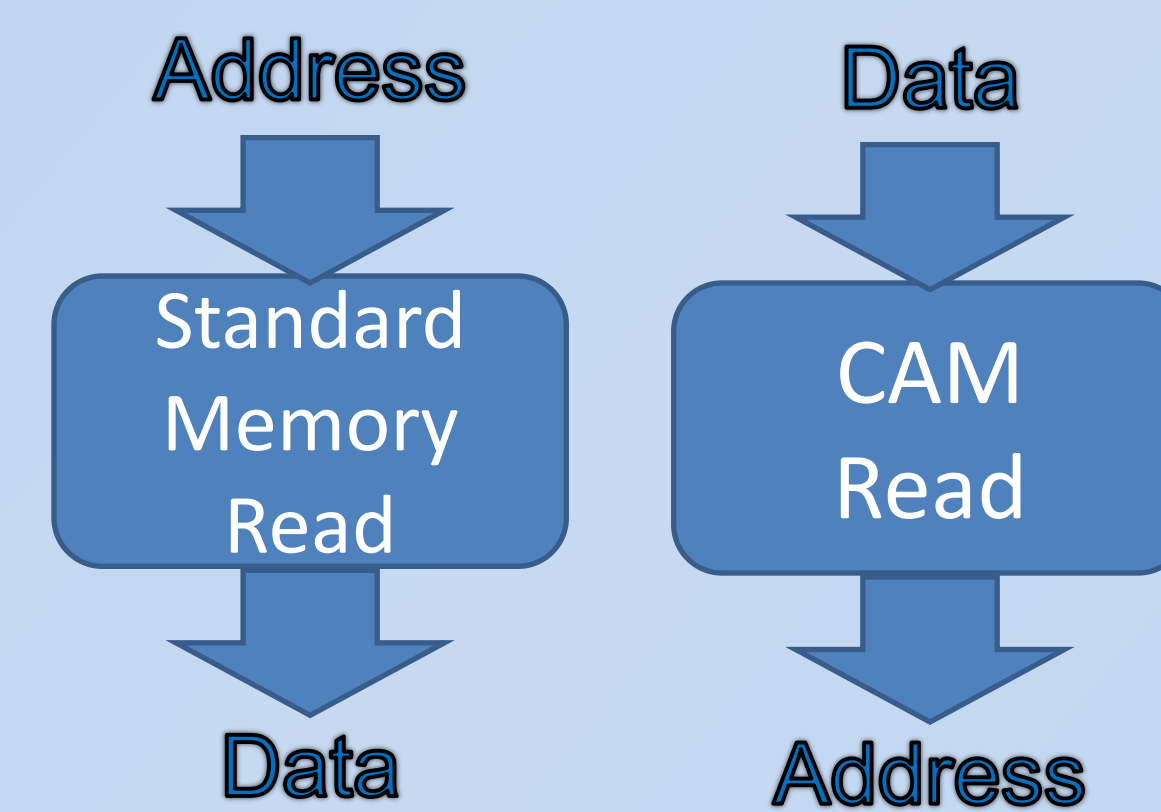


Algebraic Plan

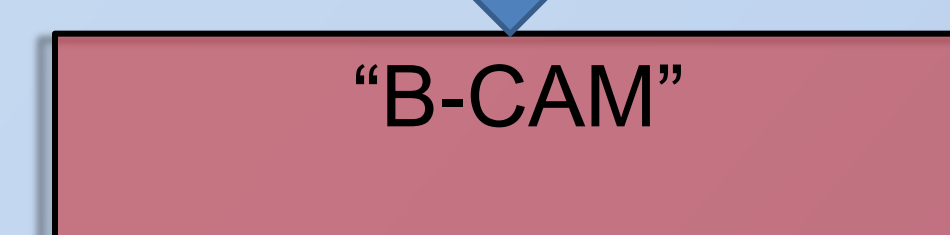


Synchronous Hardware

Content Addressable Memory CAM



Input: Search Key



Output: Pointer to record

PROBLEM STATEMENT

A CAM search has $O(1)$ time complexity but has a limited search size. The B+ tree can be used to provide search results for large database's but the speed could be improved by implementing parts of the algorithm in hardware.

It is proposed to accelerate the B+ tree search speed by implementing the node search algorithm in fast hardware for $O(1)$ time complexity. As with the B-tree, $\log_d n$ accesses to secondary storage are required.

B+ Tree

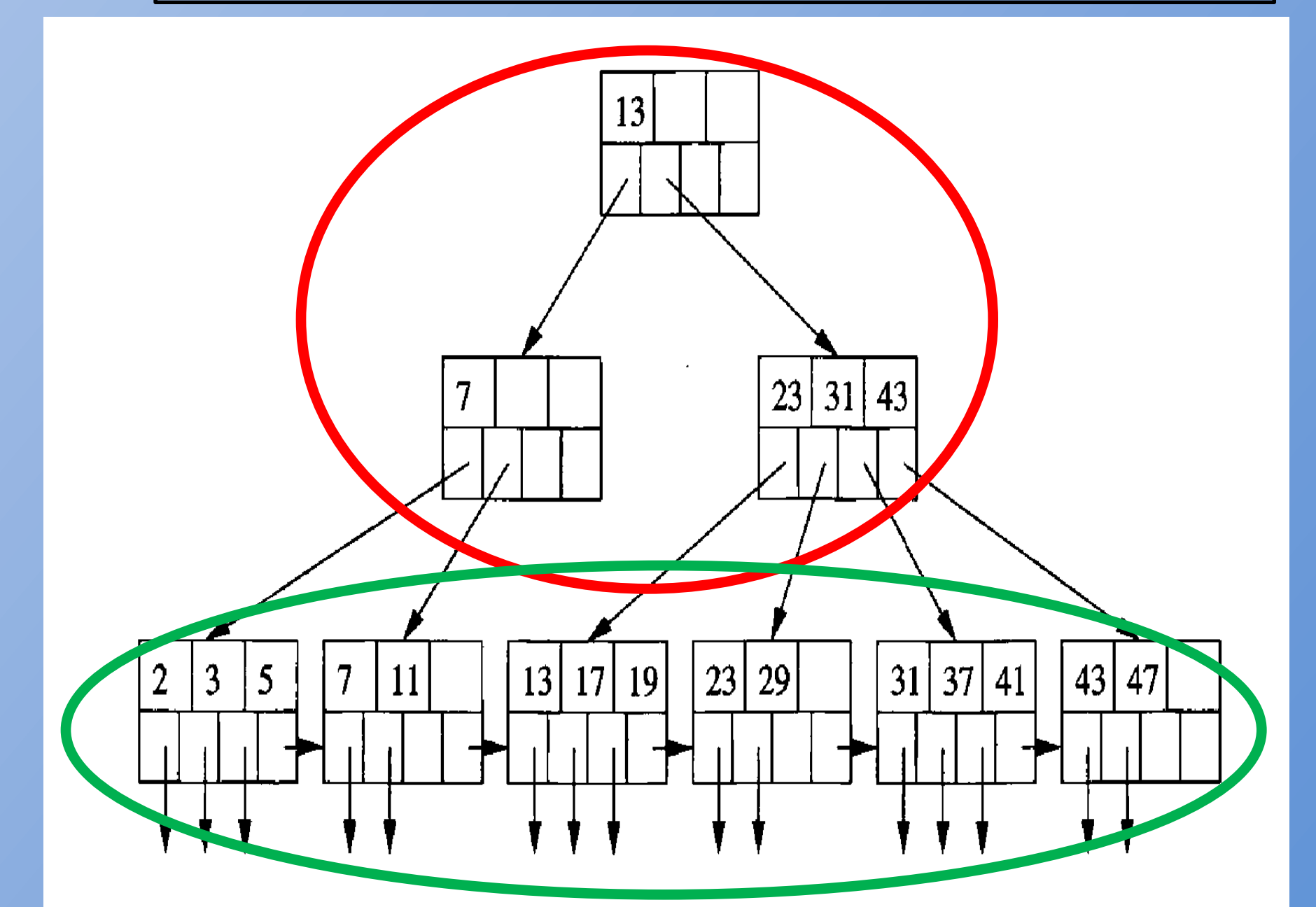
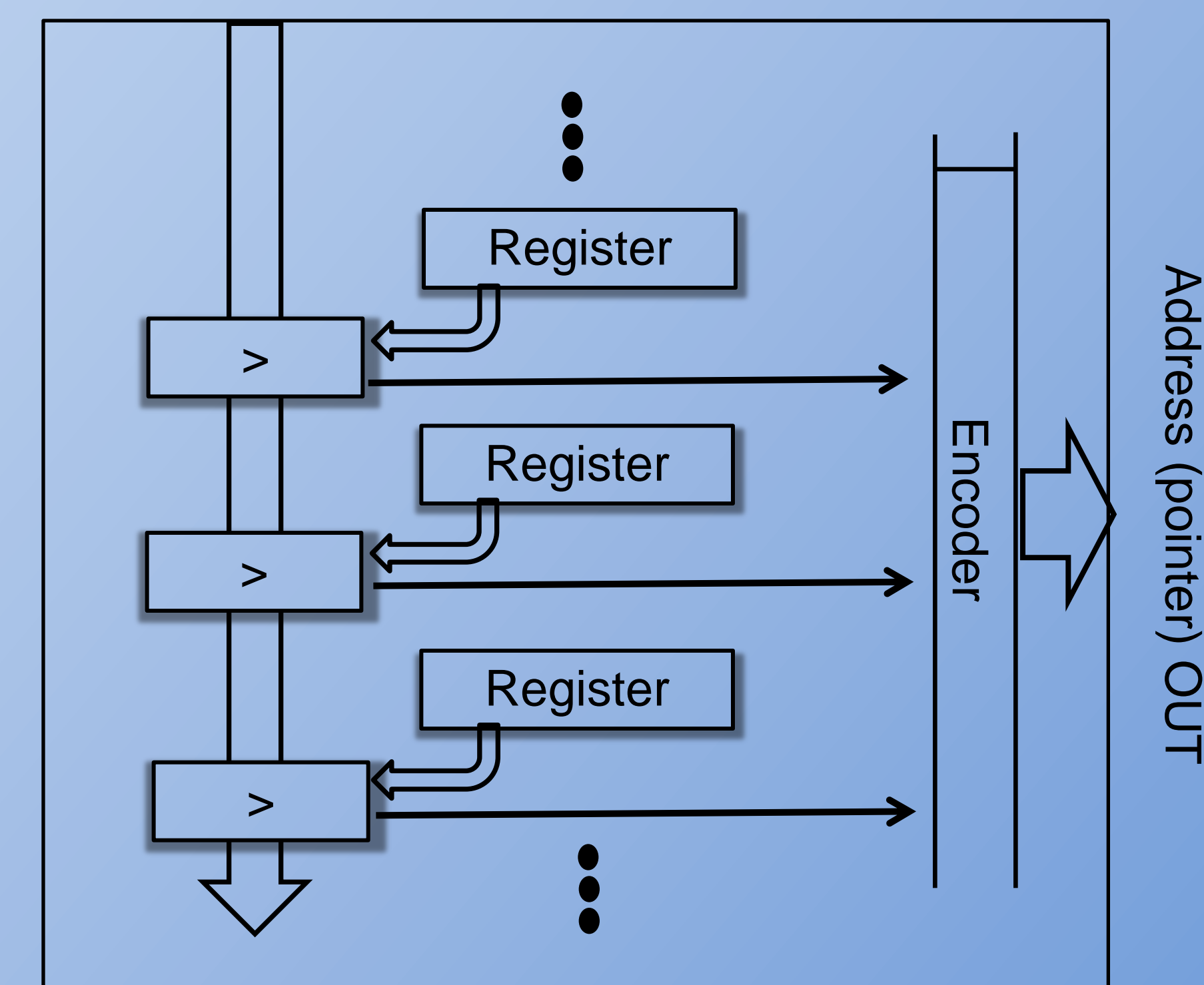
Iterate $\log_d n$ times = height "Bucket Search" on Internal Index blocks

"Equality Search" on Keys of sequence set

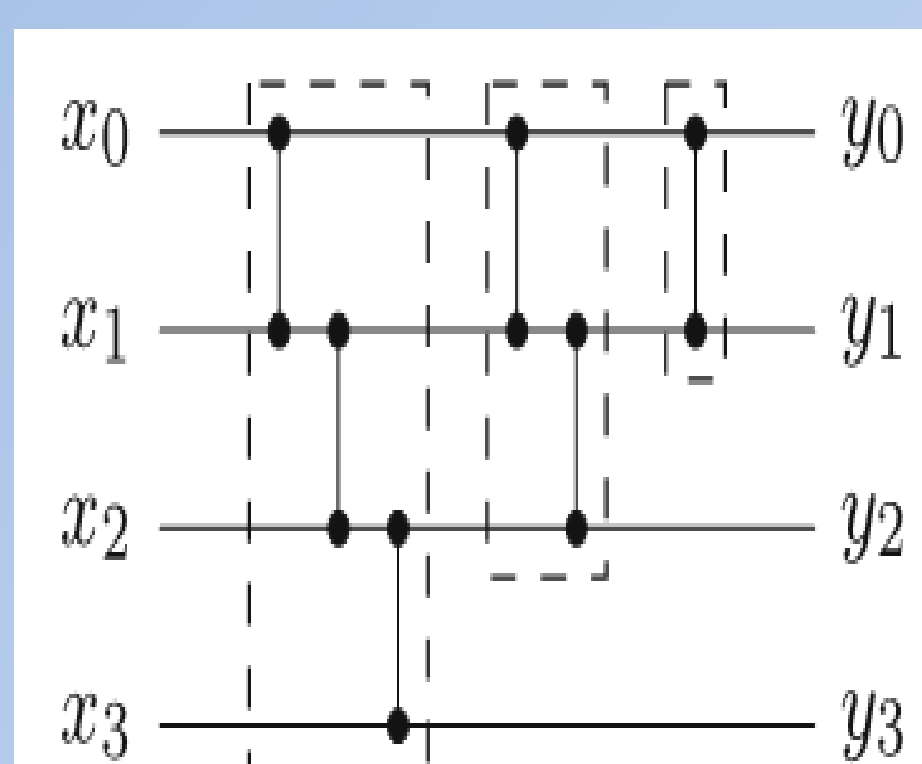
Retrieval Sequence set pointer

PROPOSED "BCAM"

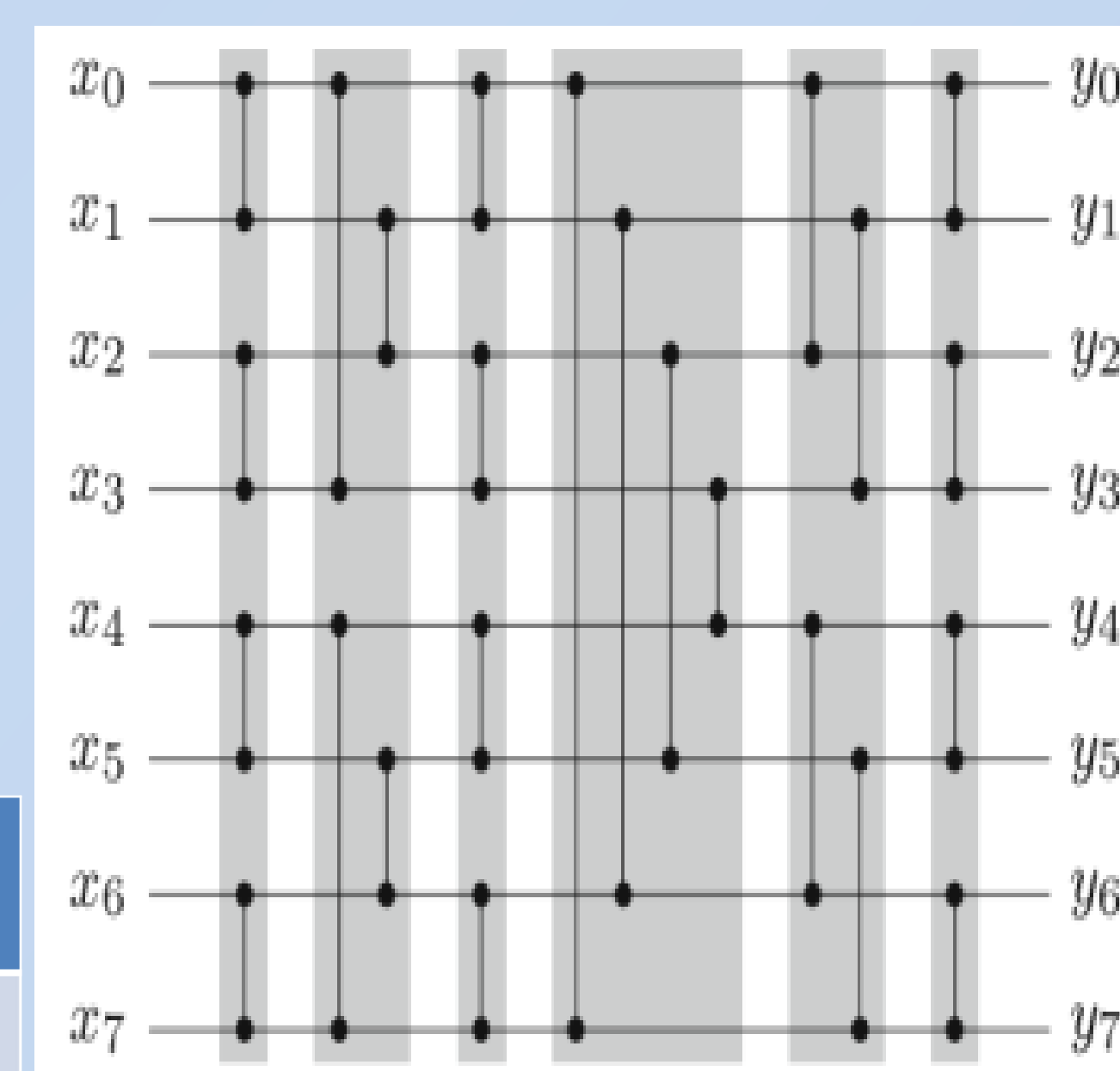
Search Data IN



Sorting & Merging



Bubble Sort



Bitonic Merge/Sort

	Bubble/Insertion	Bitonic Merge
Exact	$C(n) = \frac{N(N-1)}{2}$	$C(2^p) = (p^2 - p)2^{p-2}$
Asymptotic	$C(N) = O(N^2)$	$C(N) = O(N \log^2(N))$
N=8	$C(8) = 28$	$C(8) = 24$

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Mueller, R., & Teubner, J., (2011). How soccer players would do stream joins. *Proceedings of the 2011 SIGMOD Conference on Management of Data (ACM)*, 625-636.

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