# Decomposition of Natural Join Based on Domain-Interval Fragmented Column Indices

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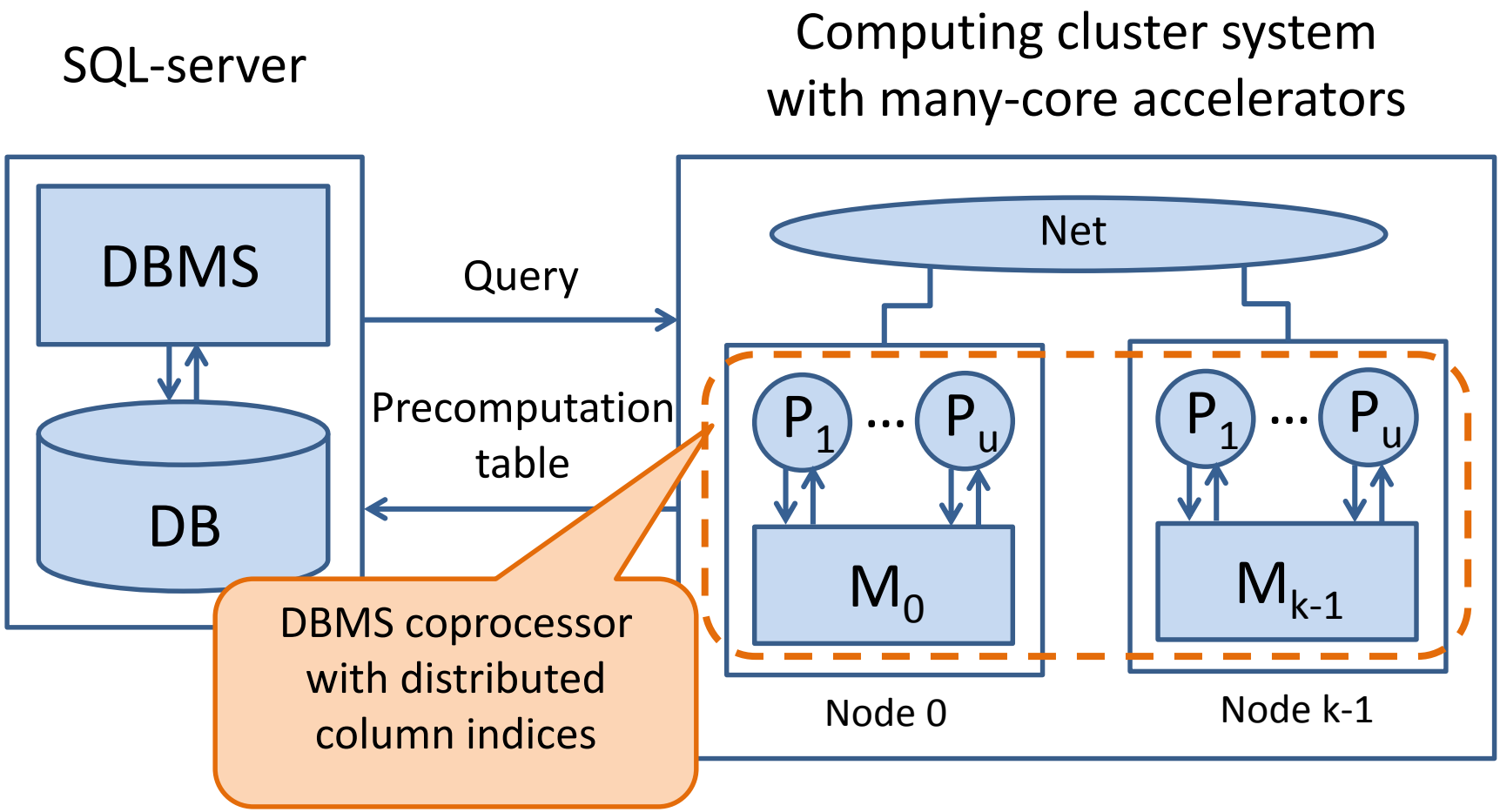
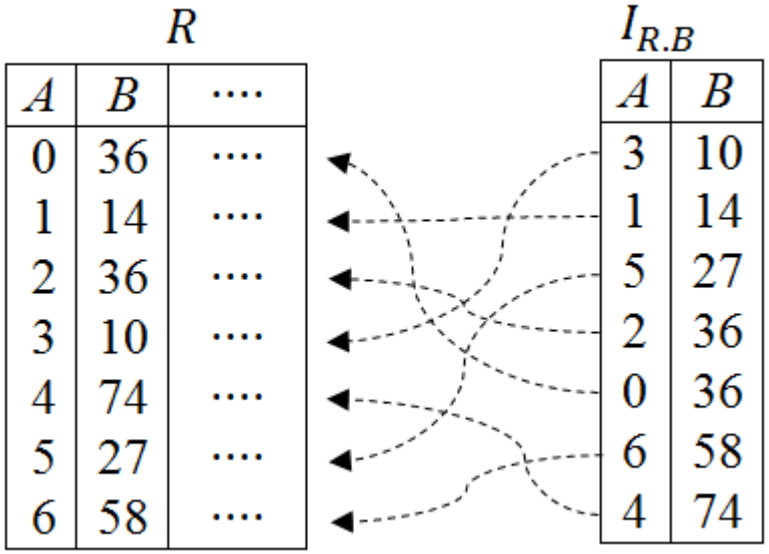
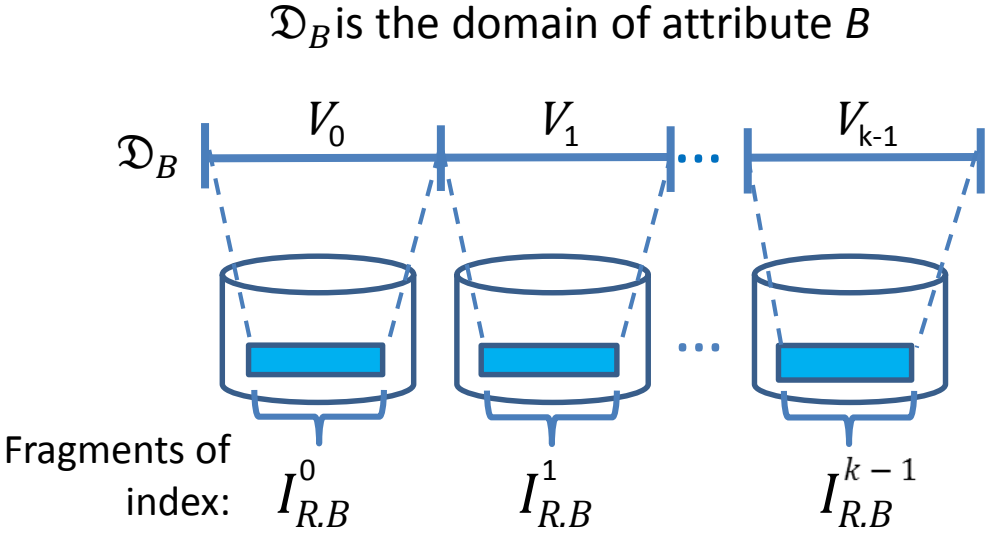
# Architecture



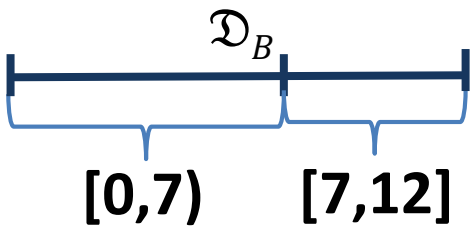
# Column Index and Domain-Interval Fragmentation

- ***The column index*** is a table with two columns *A* and *B*. The number of rows in the column index is equal to the number of rows in the indexed table. Column *B* of index contains all the values of column *B* in table *R* (including duplicates). These values are sorted in ascending order inside column index.

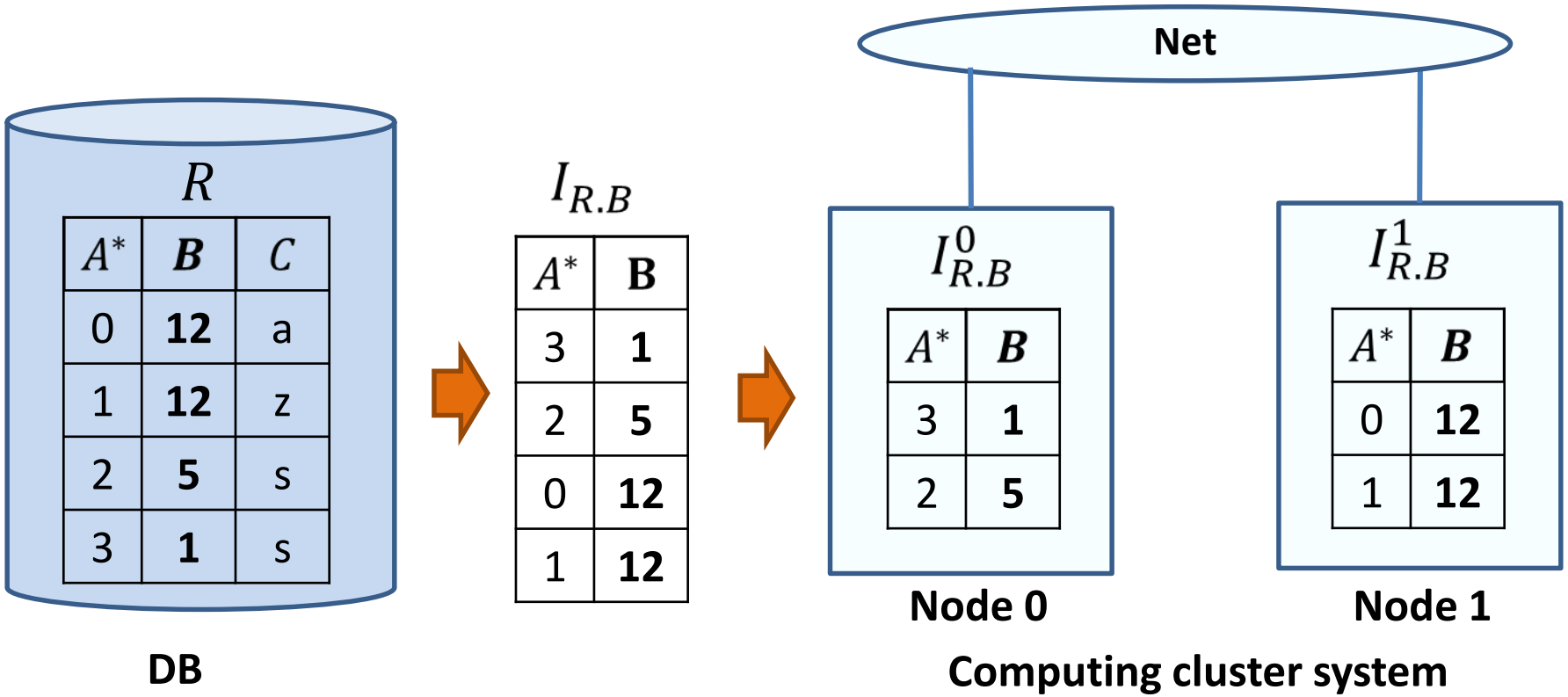


# Example of Fragmented Column Index




$$A\ fragment\ is \begin{cases} 0, \text{if } x.B \in [0,7) \\ 1, \text{if } x.B \in [7,12] \end{cases}$$



# Decomposition of Natural Join Operation R⋈S

$$A\ fragment\ is \begin{cases} 0, \text{if } x.B \in [0,7) \\ 1, \text{if } x.B \in [7,12] \end{cases}$$

$R$

| $A$ | $B$ | $C$ |
|---|---|---|
| 0 | 10 | Ni |
| 1 | 12 | Au |
| 2 | 5 | Pb |
| 3 | 1 | Ag |

$S$

| $A$ | $B$ | $D$ |
|---|---|---|
| 0 | 5 | Pb |
| 1 | 11 | Pb |
| 2 | 3 | Ni |
| 3 | 10 | Fr |
| 4 | 3 | Ag |

**Node 0**

$I^0_{R.B}$

| $A$ | $B$ |
|---|---|
| 3 | 1 |
| 2 | 5 |

$I^0_{S.B}$

| $A$ | $B$ |
|---|---|
| 2 | 3 |
| 4 | 3 |
| 0 | 5 |

**Node 1**

$I^1_{R.B}$

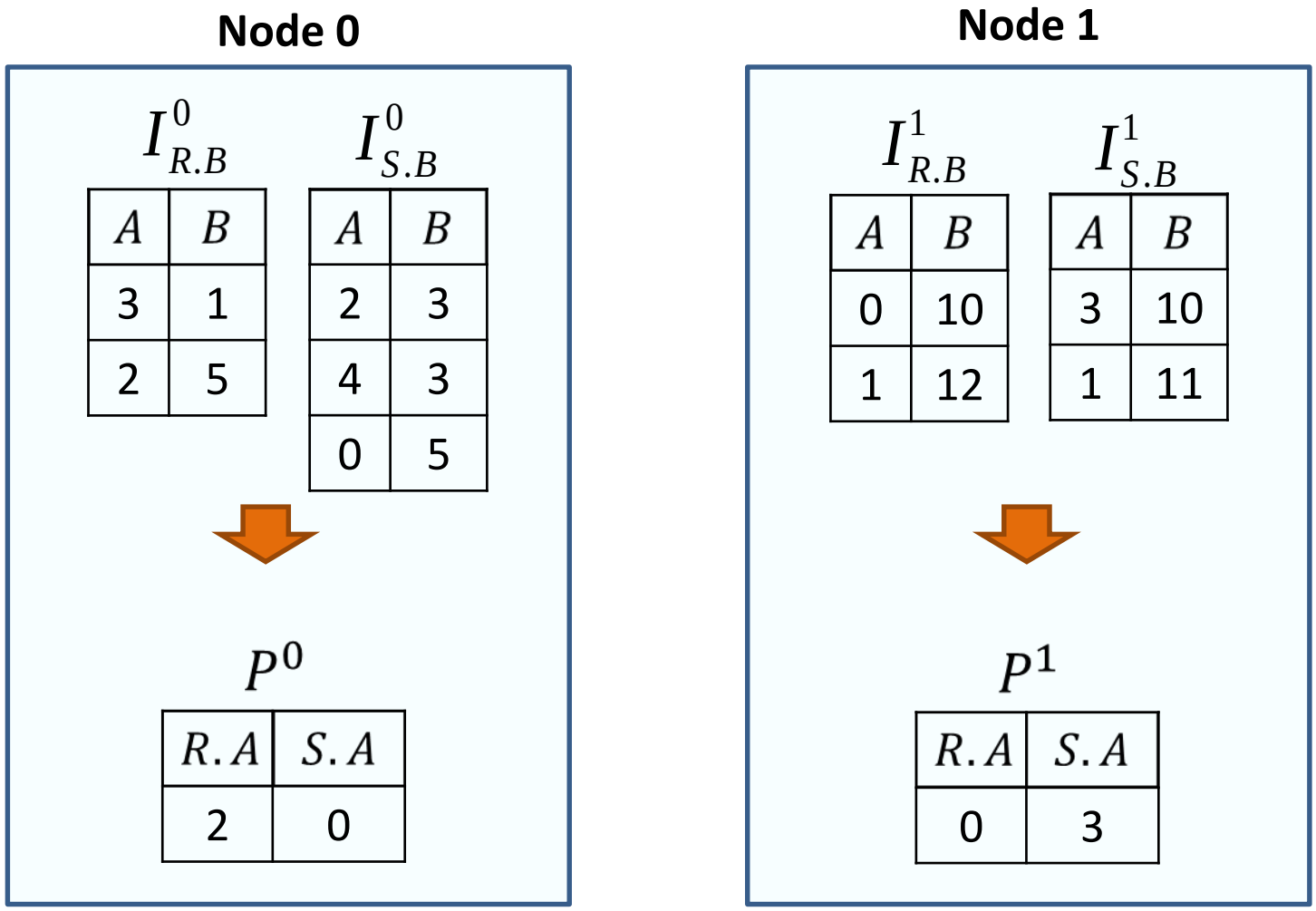
| $A$ | $B$ |
|---|---|
| 0 | 10 |
| 1 | 12 |

$I^1_{S.B}$

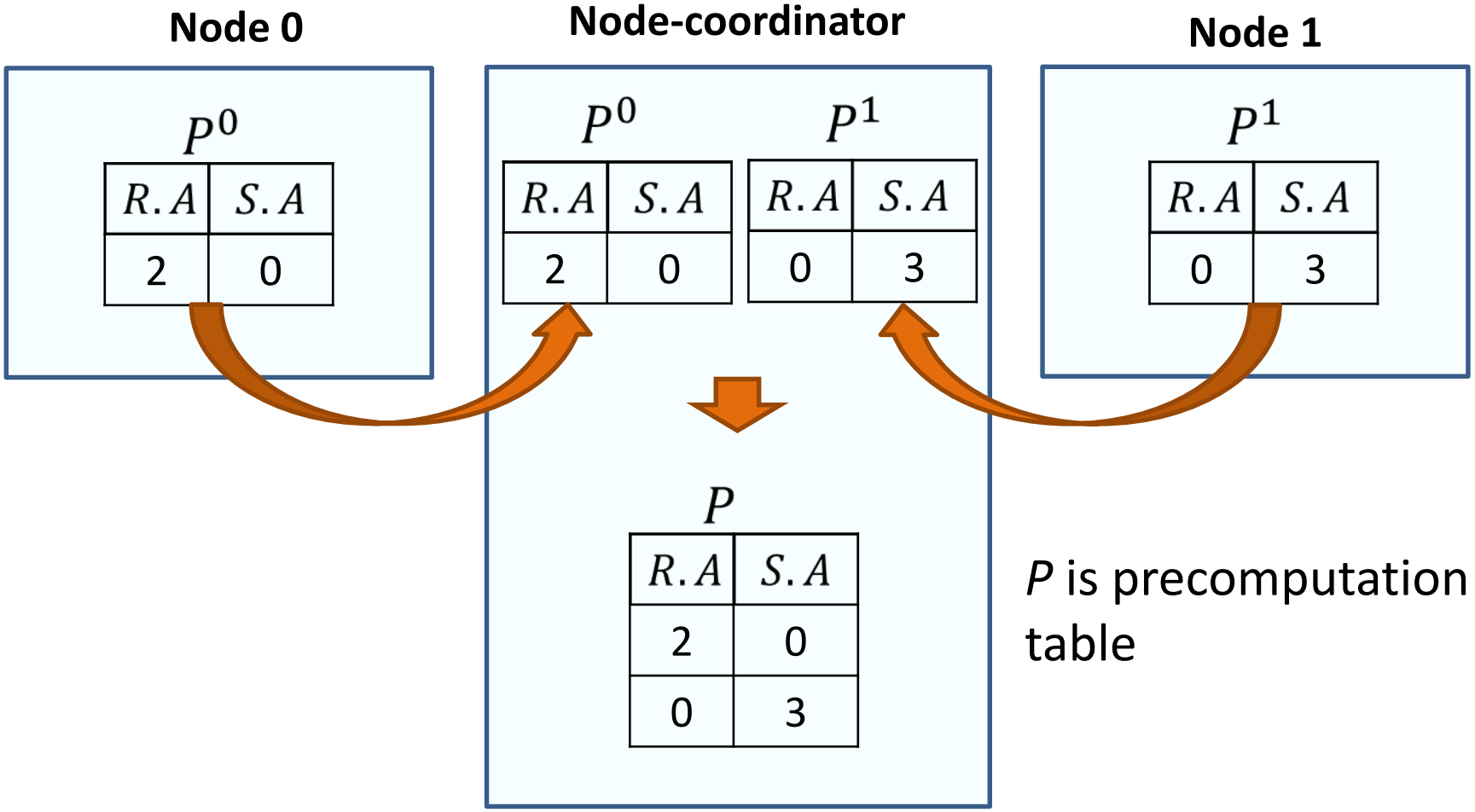
| $A$ | $B$ |
|---|---|
| 3 | 10 |
| 1 | 11 |

Column indices for attributes *B* of *R* and *S*

# Independent Join of Fragments

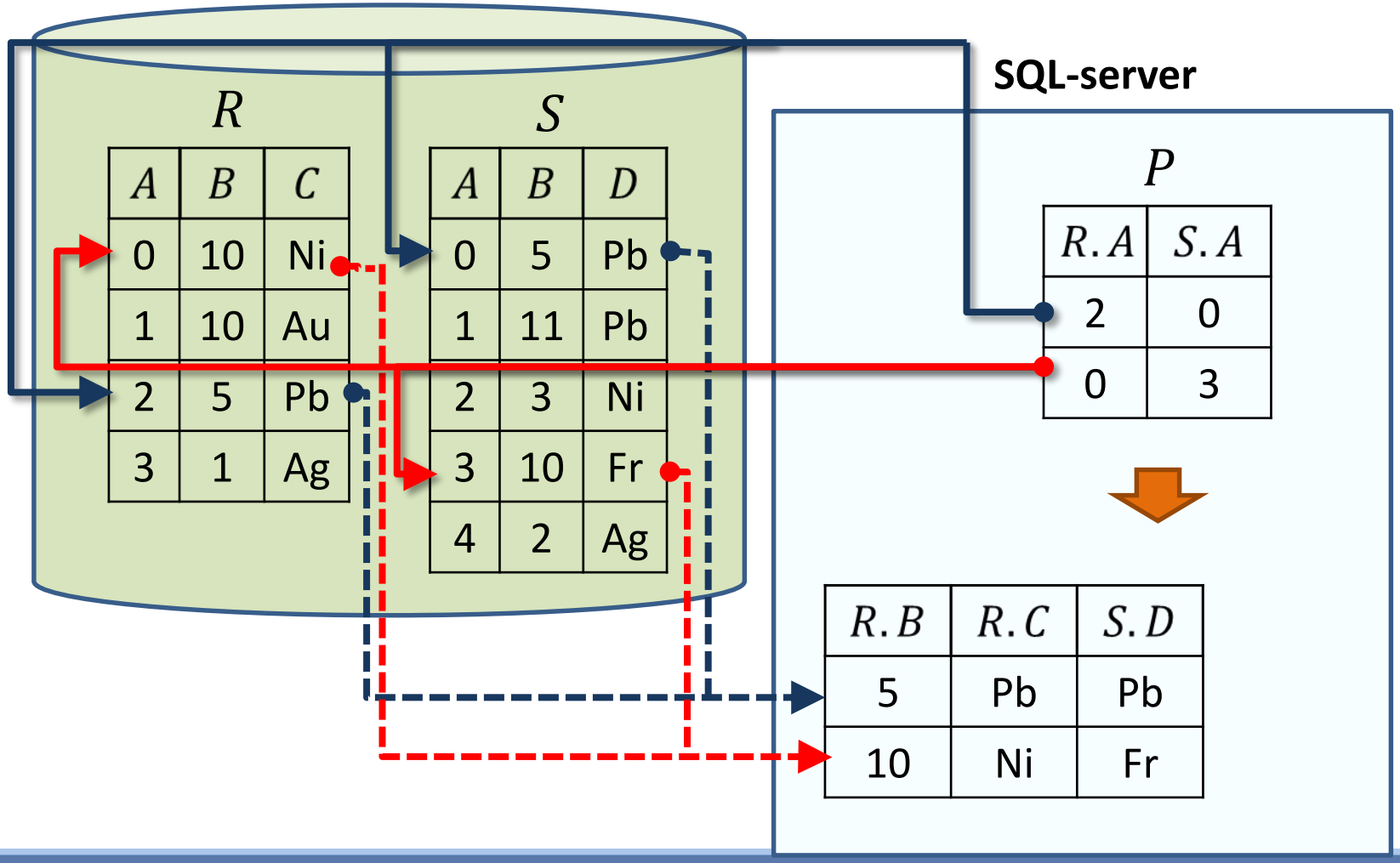


# Passing of Partial Result to SQL-server




*P* is precomputation table

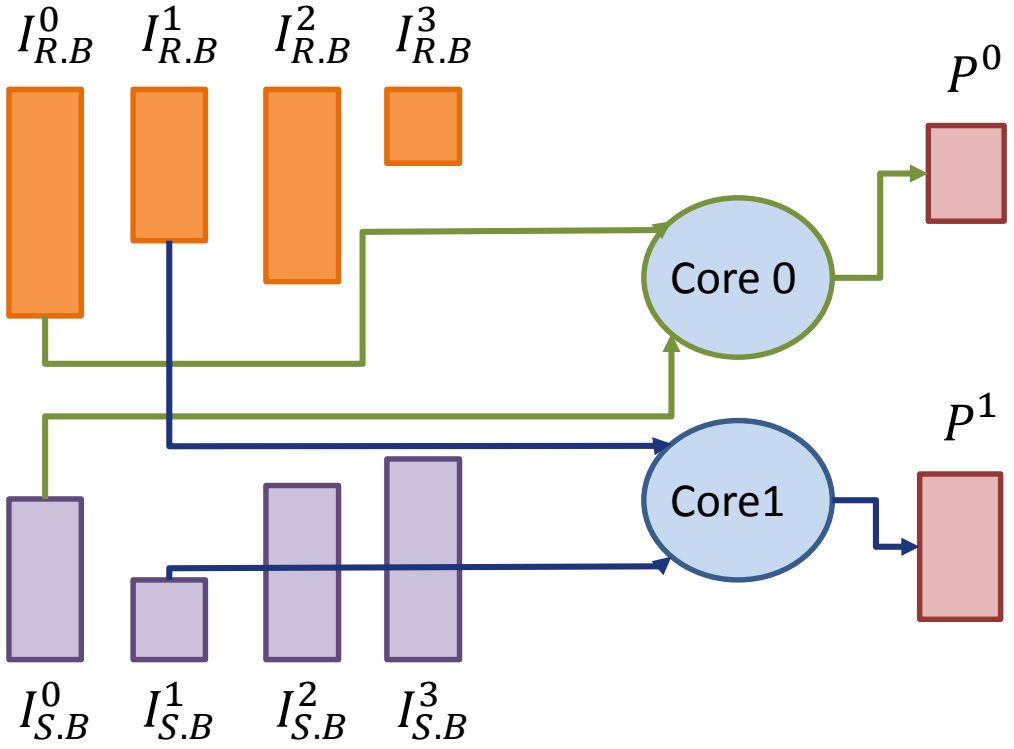
# Join on SQL-server by precomputation table



# Prototype of DBMS coprocessor

- Prototype work on one Intel Xeon Phi (60 cores per 1.1 MHz) in native mode.
- All column index fragments are stored in main memory in compressed form.

Number of fragments: 4
Number of threads: 2
Operation: R⋈S



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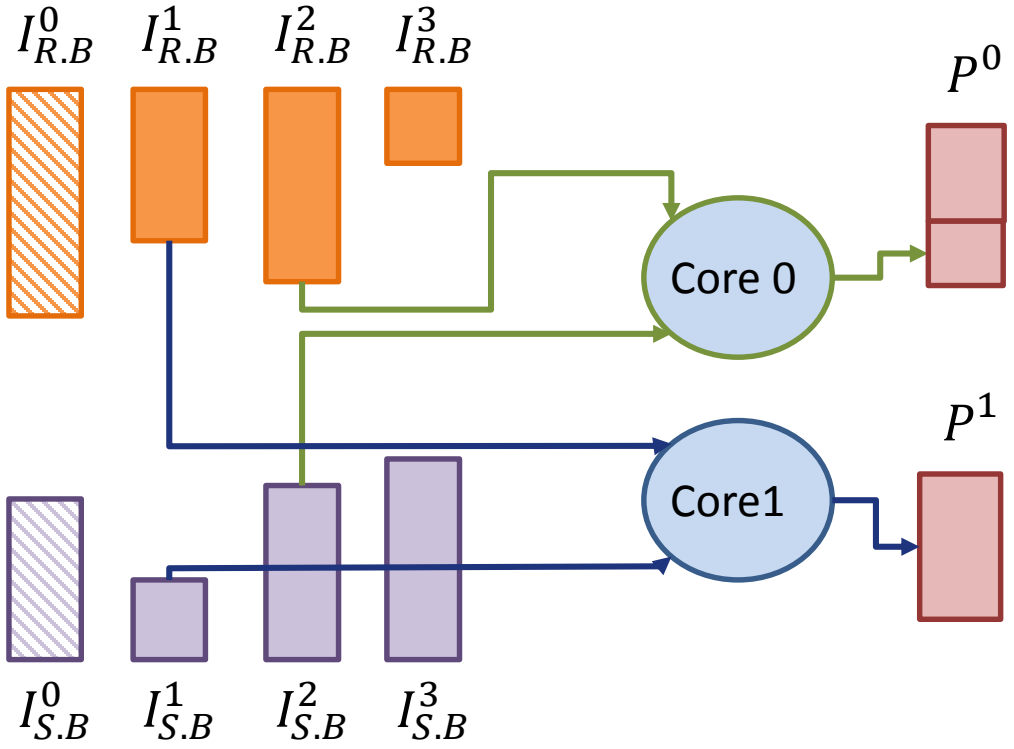

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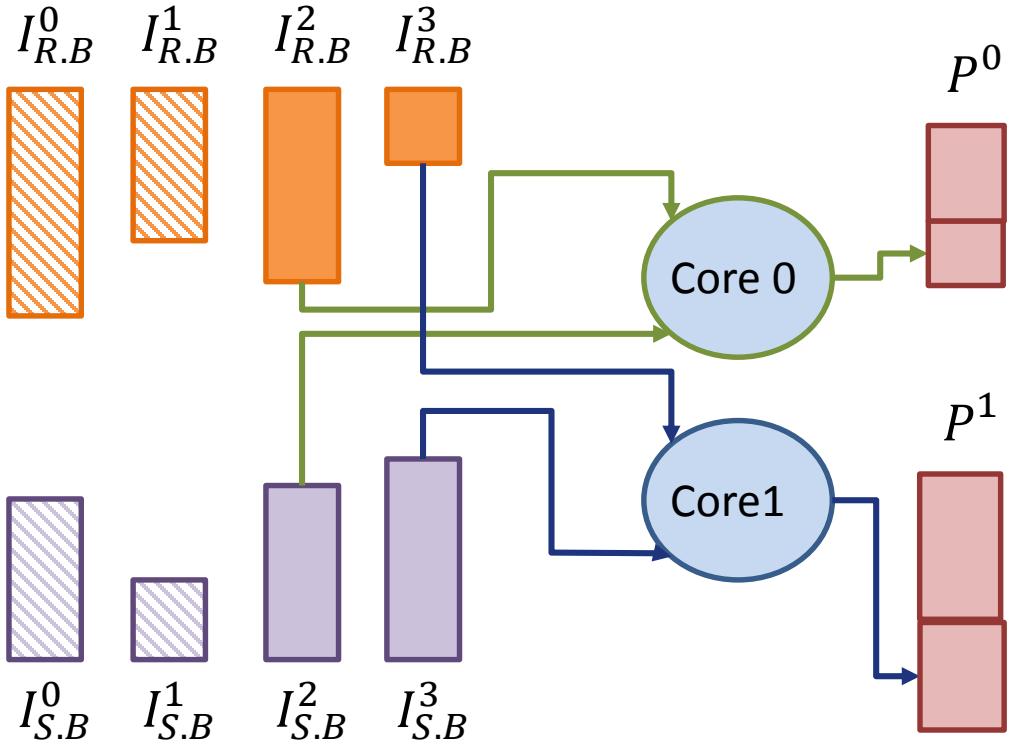
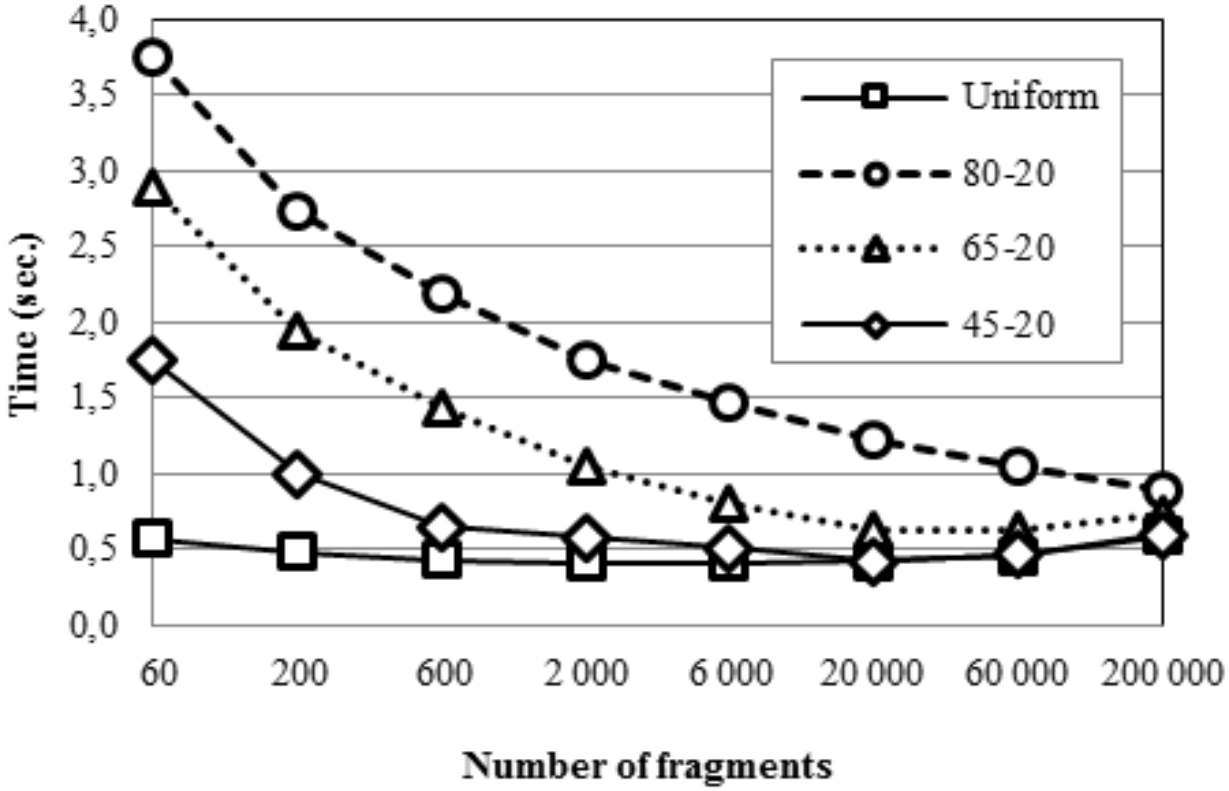


# Performance Evaluation

- R⋈S
- Number of tuples $I_{R.B}$ is 600 000
- Number of tuples $I_{S.B}$ is 60 000 000



# Conclusion

- We presented a decomposition of the natural join operator based on the column indices and the domain-interval fragmentation.
- Our approach was evaluated using the prototype DBMS coprocessor. Experiments showed its efficiency for a resource-intensive natural join operator.