Bridging the Archipelago between Row-Stores and Column-Stores for Hybrid Workloads

John C. Merfeld – 2 / 7 / 19

BACKGROUND

(getting everyone on board with jargon)

We should know these “words”

- DBMS –
- OLTP –
- OLAP –
- HTAP –

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Workloads

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- NSM –
- DSM –

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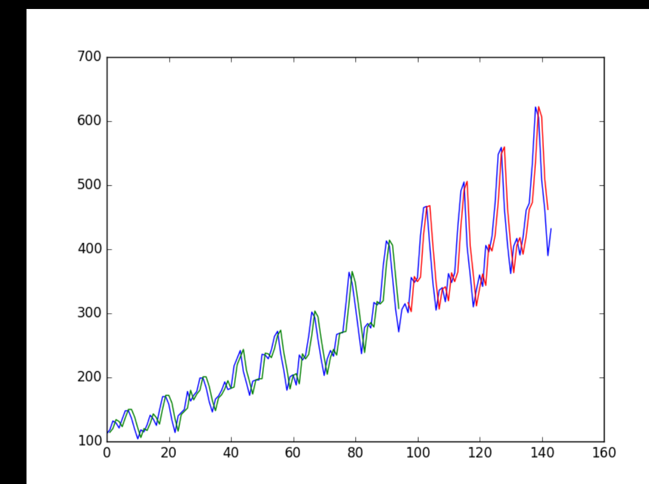
- NSM – *n*-ary Storage Model (Why is this good for writes?)
- DSM – Decomposed Storage Model

Storage models

Here's your pneumonic device

O L **T** P



O L **A** P

Tea is **hot**

You Analyze **history**

new data
(Updates and writes)

History is **(c)old**
(Scans and aggregations)

n-ary Storage

Decomposed Storage

THE PROBLEM

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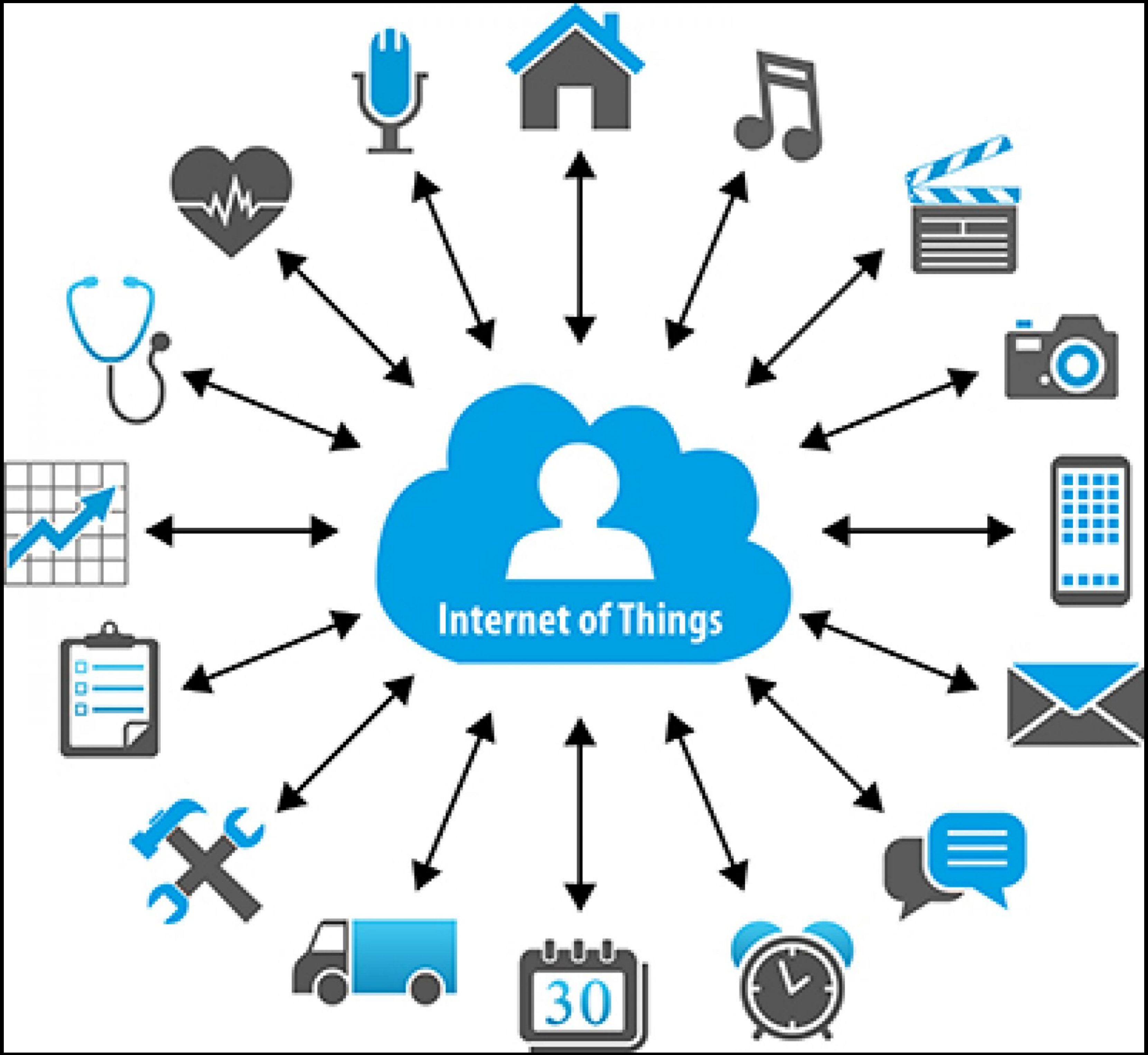
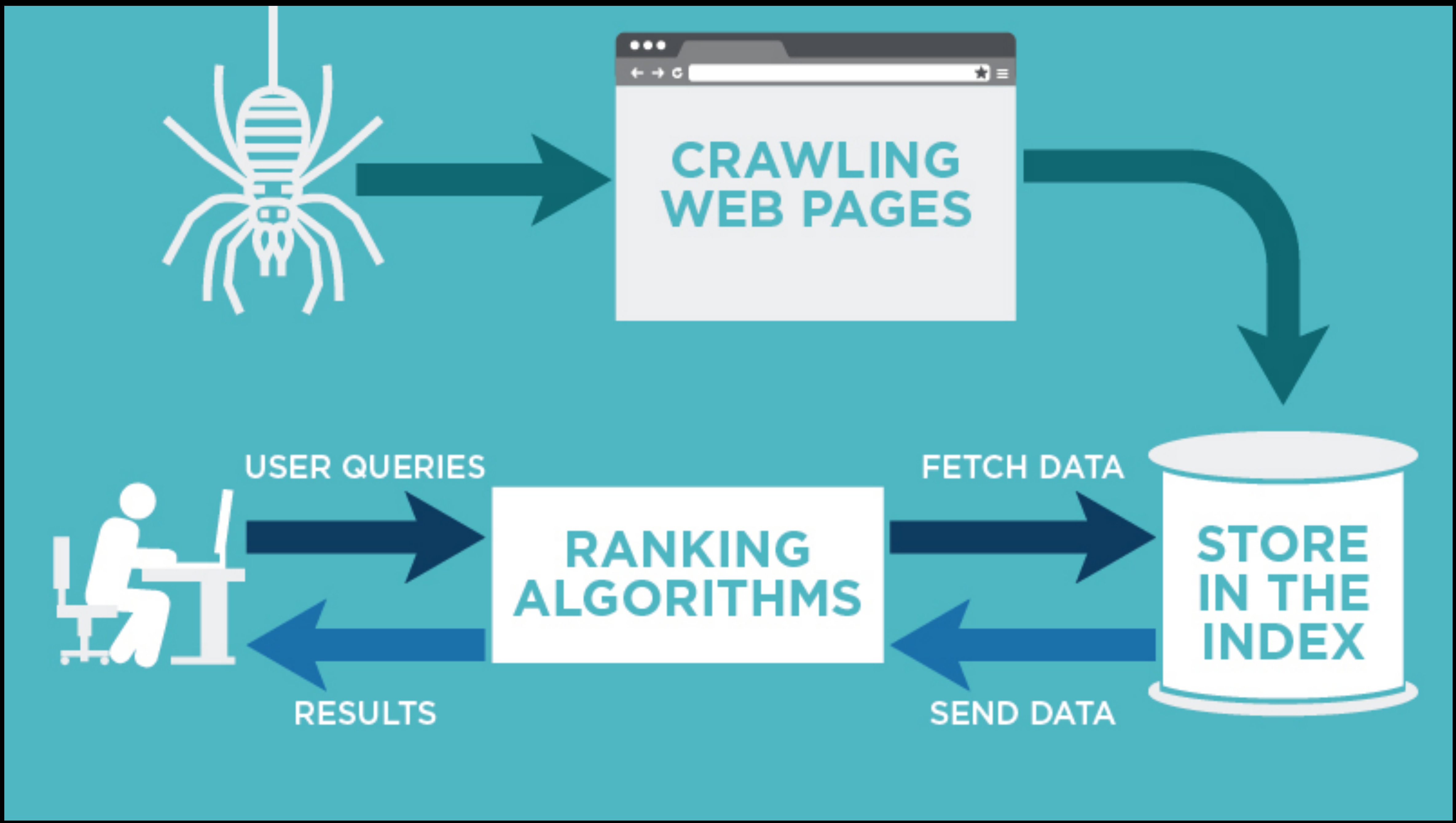
- Examples?

You might work with IoT sensors



Or you might run a search engine



Or you might feel positively about the concept of money

One approach is to physically separate the use cases

System A gives data to System B at… some point!	System A	System B
Workload	OLTP	OLAP
Storage Model	n-ary	Decomposed
Data stored as…	Rows	Columns
Used for…	Inserts & Updates	Reads

Is this really HTAP?

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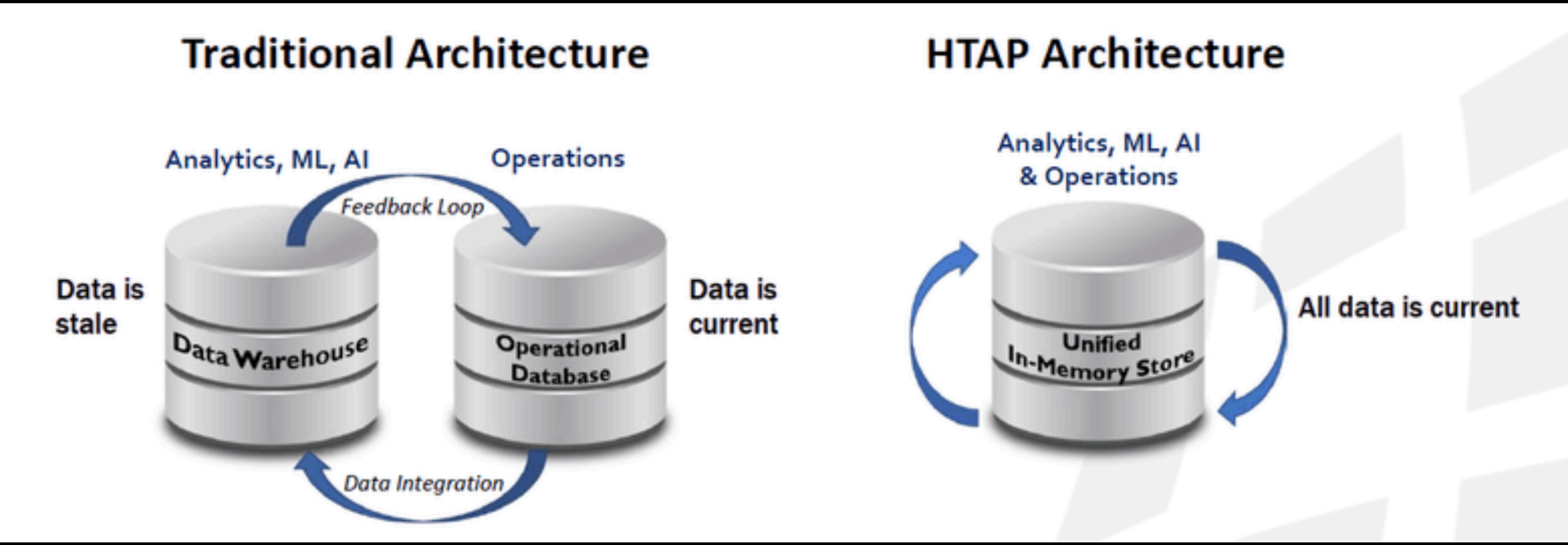
Separating the use cases defeats the purpose of HTAP



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- What are they?
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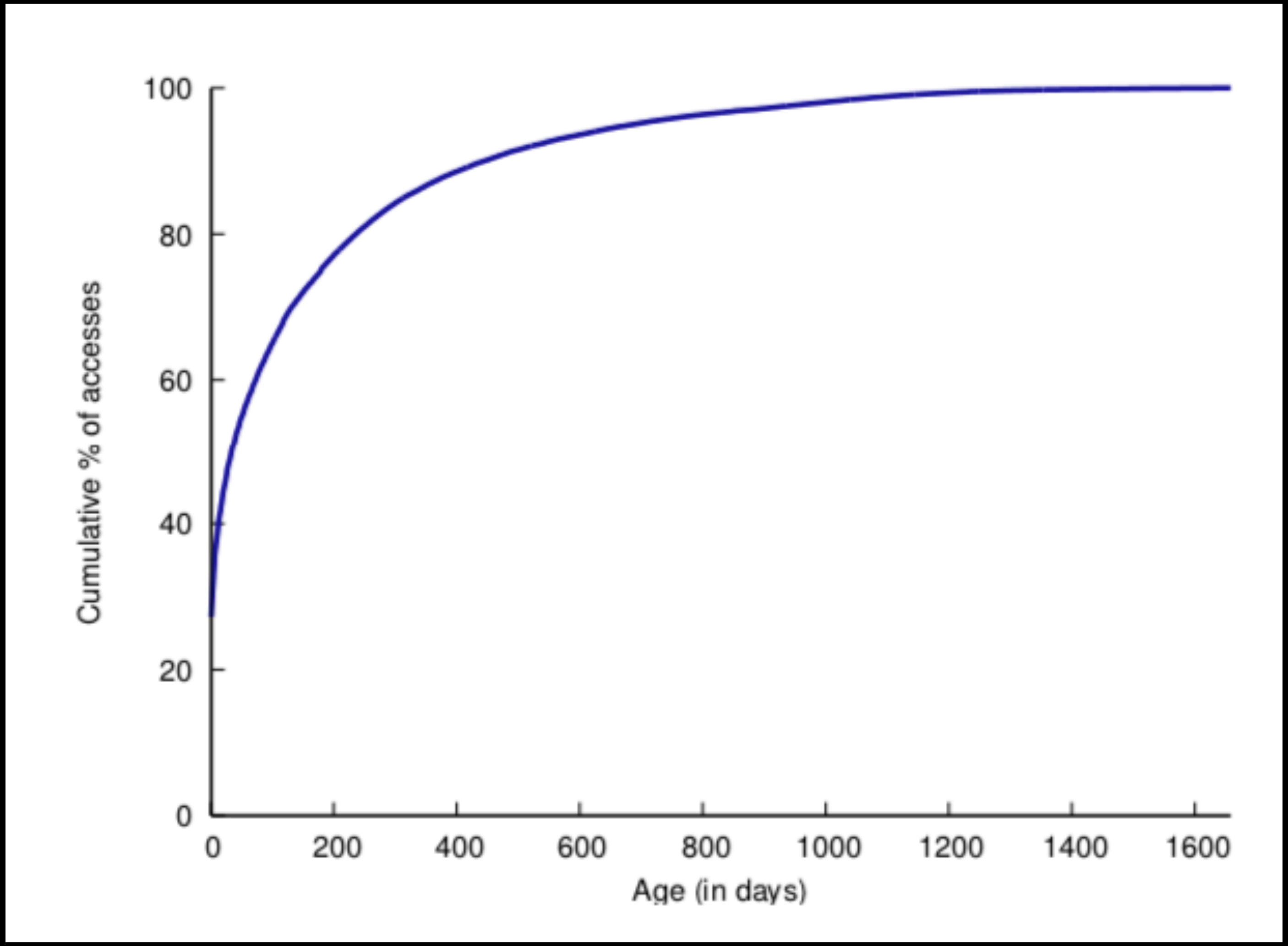
        - Twice the software
            - Twice the people!
                - (at least twice the cost…)

THE SOLUTION

A flexible storage model (FSM) takes the "temperature" of tuples



Source: D. Beaver, S. Kumar, H. C. Li, J. Sobel, P. Vajgel, and F. Inc. *Finding a needle in haystack: Facebook's photo storage*. In *OSDI*, 2010.

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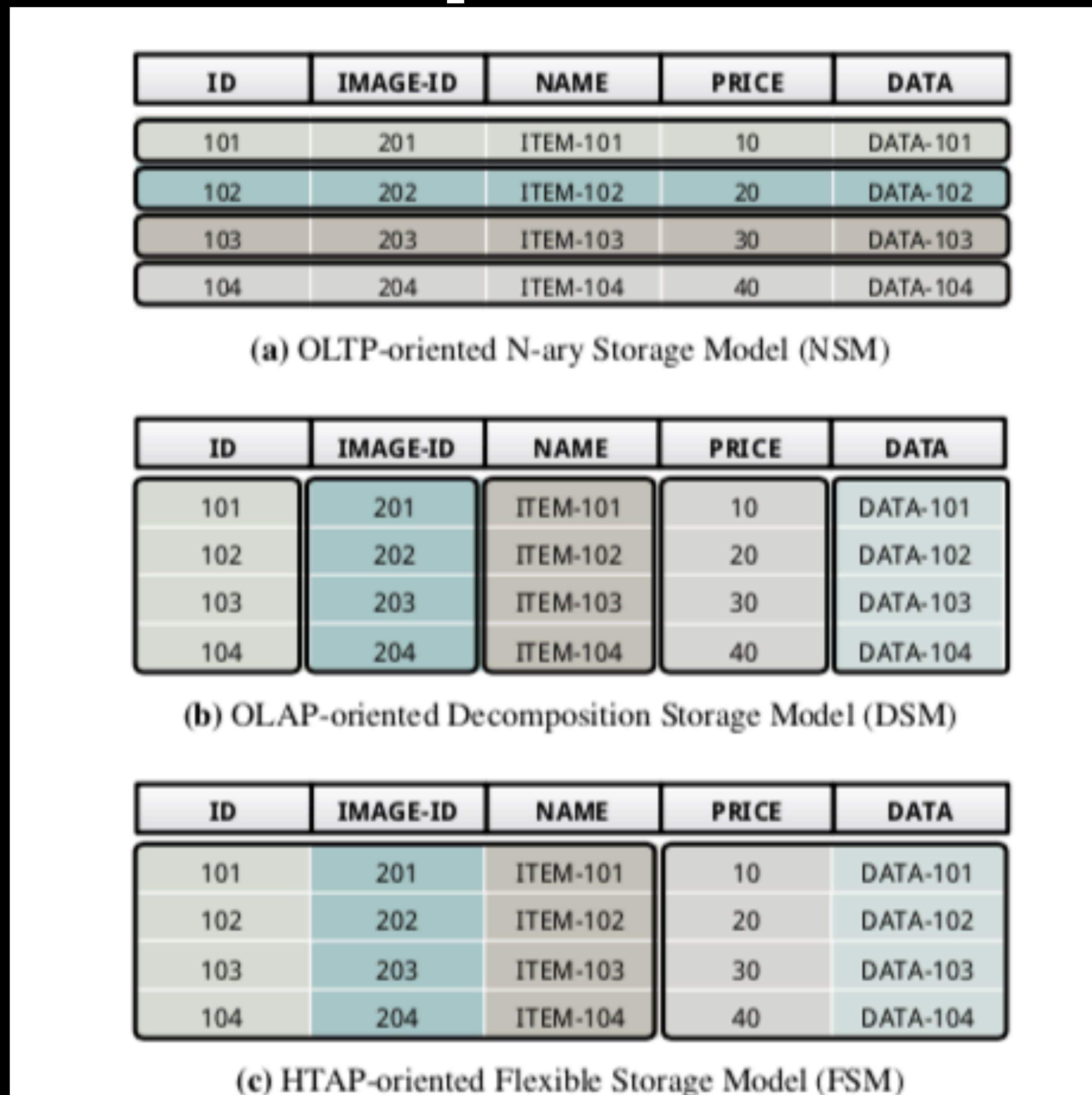


(a) OLTP-oriented N-ary Storage Model (NSM)

(b) OLAP-oriented Decomposition Storage Model (DSM)

(c) HTAP-oriented Flexible Storage Model (FSM)

A “tile” is part row, part column

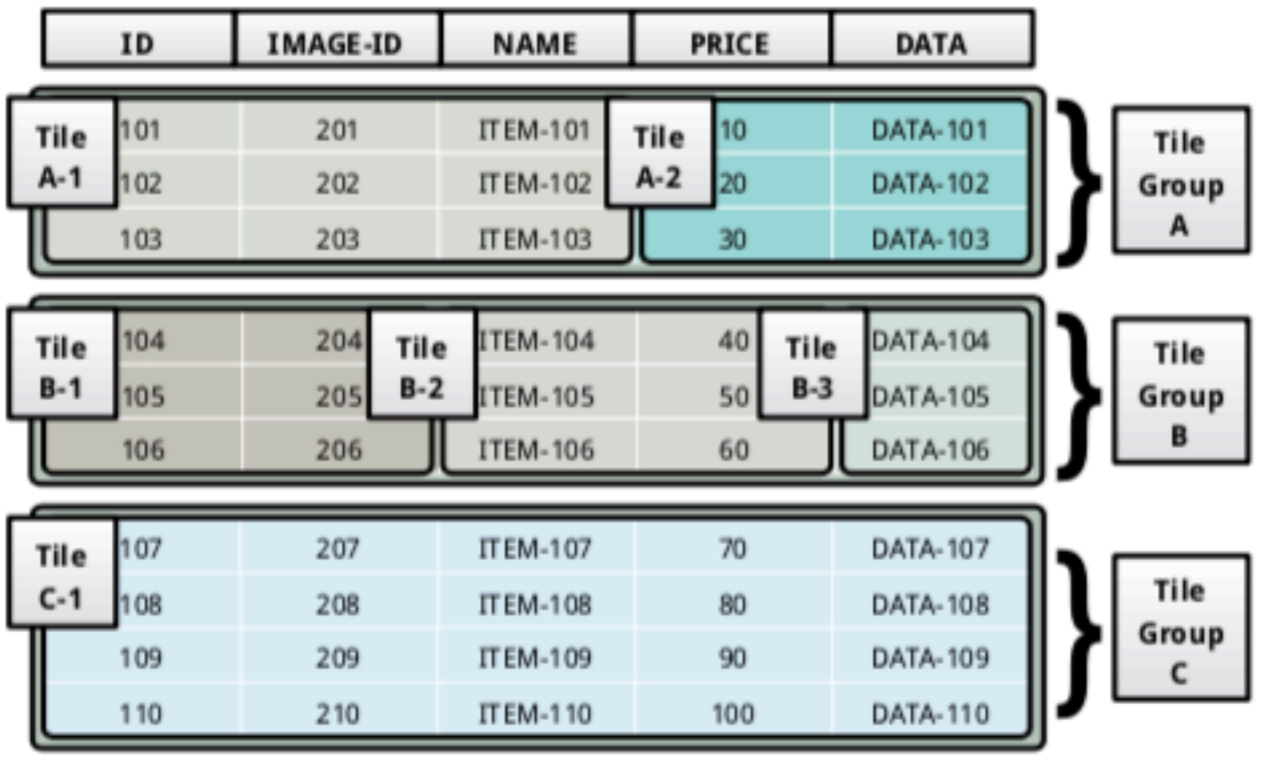


Figure 3: Physical Tile – An example storage layout of a table composed of physical tiles. This table comprises of three tile groups (A, B, C).

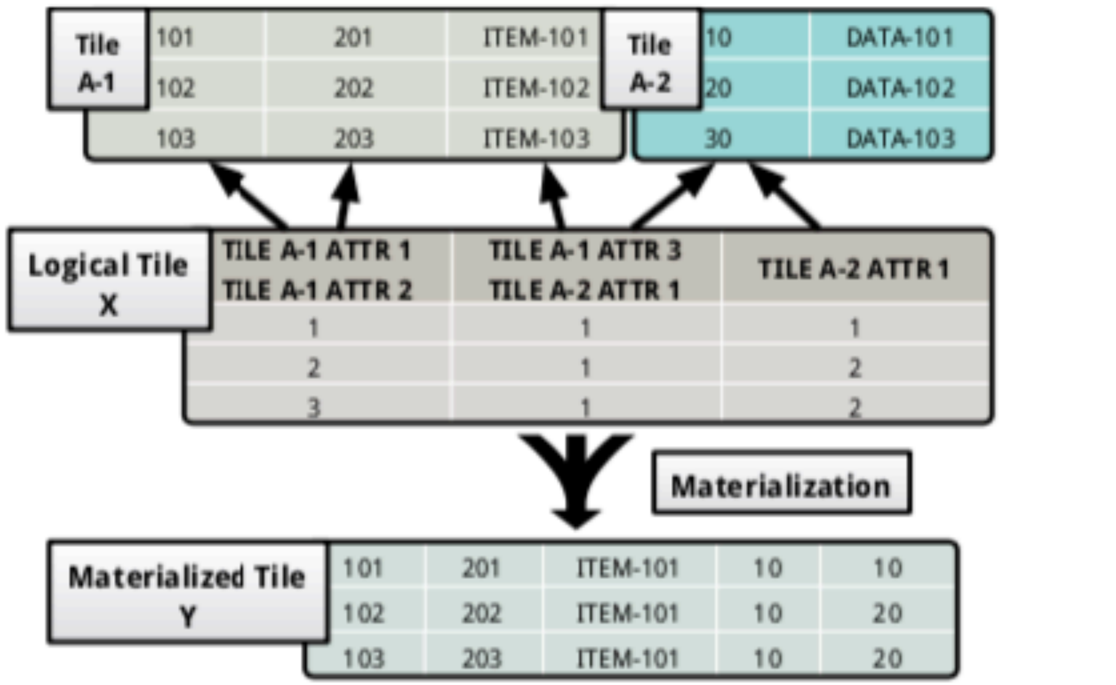
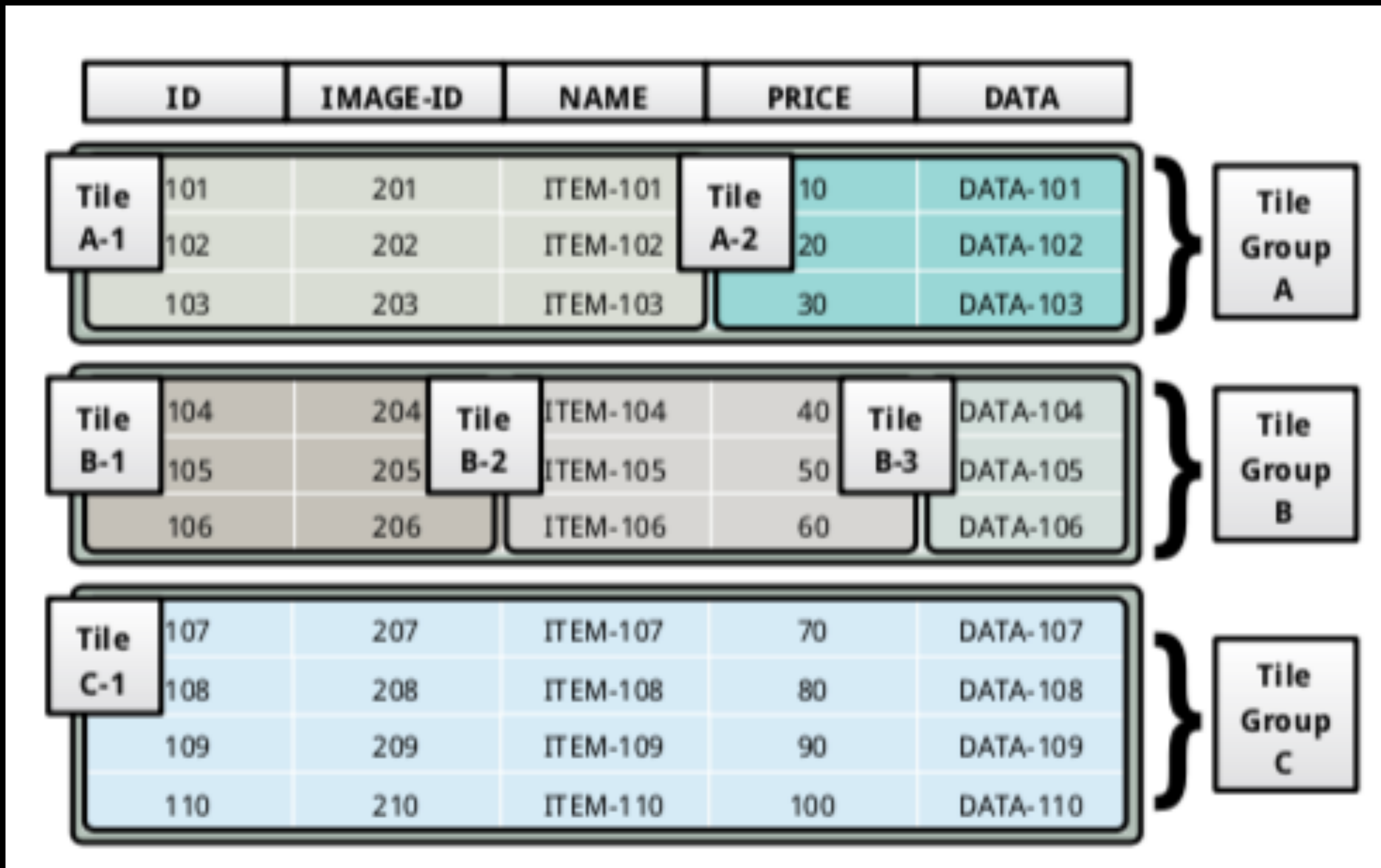


Figure 4: Logical Tile – An example of a logical tile representing data spread across a couple of physical tiles (A-1, A-2).

“Physical tiles” store subsets of tuple attributes



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Oh, we can’t?

Why can’t we just put physical tiles in our favorite DBMS?

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- Two words:

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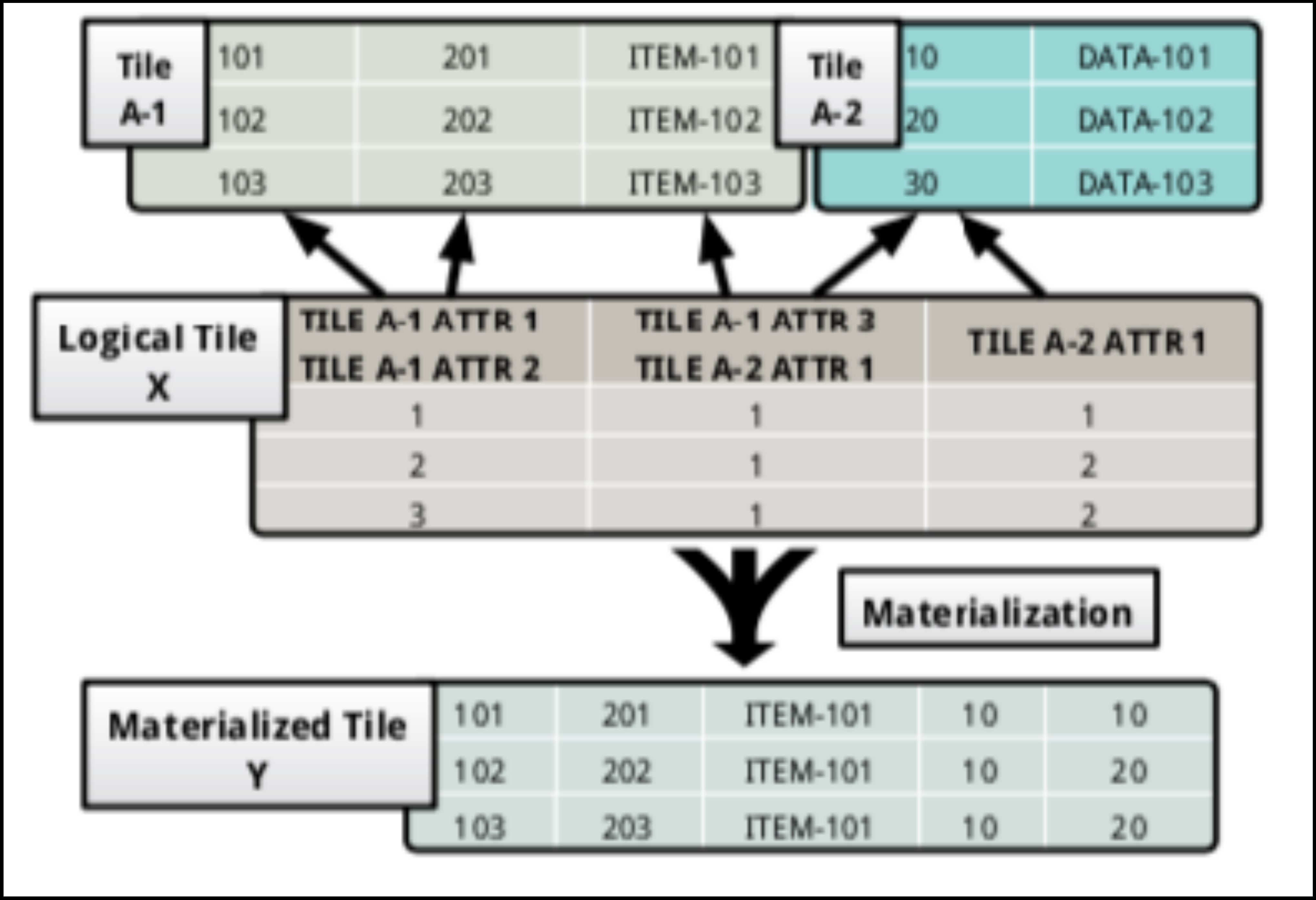
Query execution!

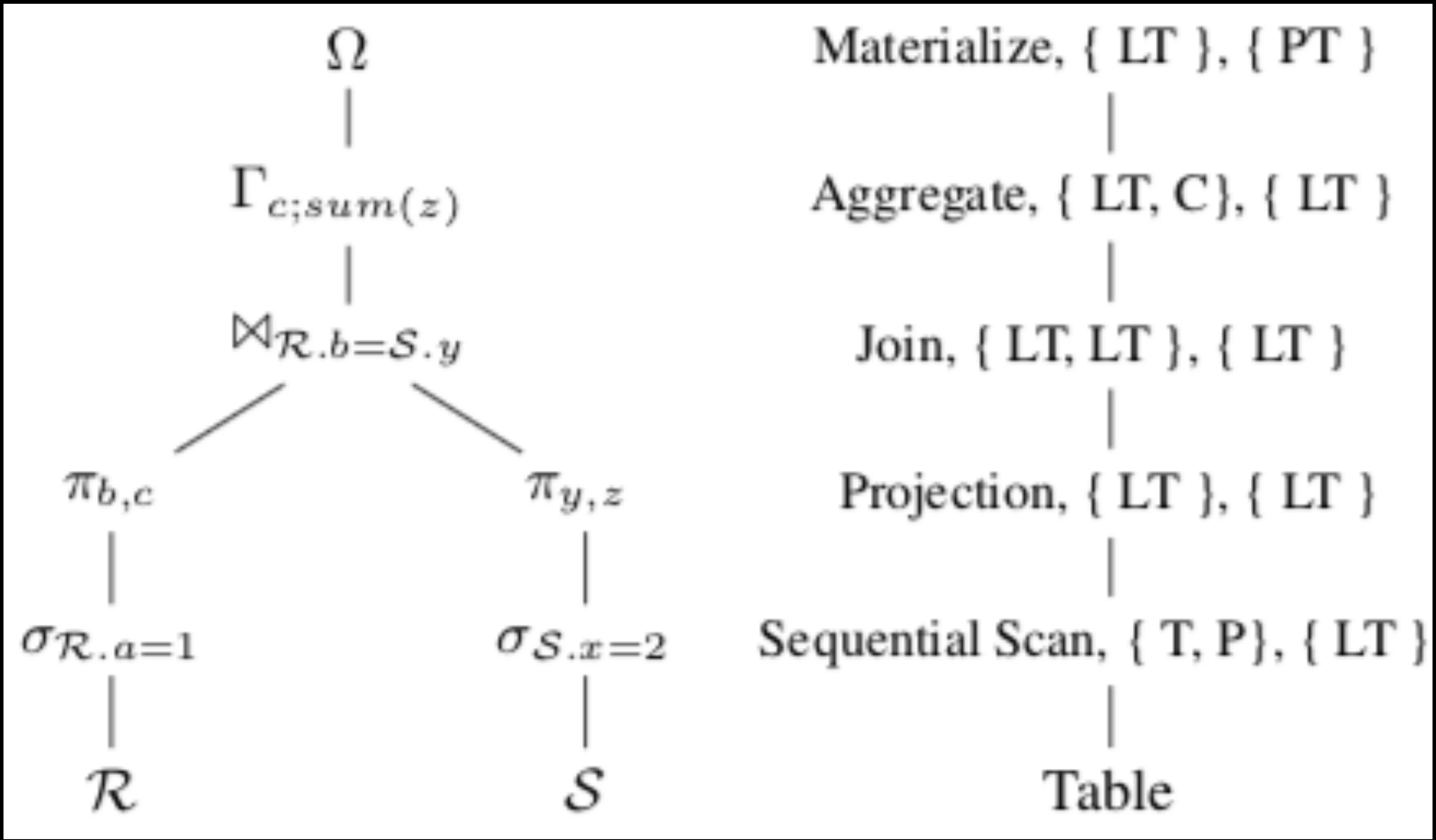
“Logical tiles” store information about multiple physical tiles



Logical tile columns contain sets of physical tiles columns

- The underlying physical data are released during materialization

“Tile algebra” is an abstracted extension of relational algebra



Tile algebra offers several advantages

Tile algebra offers several advantages

- Single execution engine
- Vectorized processing (tiles instead of tuples)
- DBMS can optimize what materializes when and what goes in the cache

The paper goes into detail about concurrency protocols

- And if you care about that, I invite you to read the paper!

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    - Record the cost of the queries too

These statistics are used to re-partition the tables into new tiles

- Clustering algorithm chooses which attributes belong together in physical tiles
- Greedy algorithm groups tiles together based on how "important" they are to workloads
- This is done incrementally to amortize the cost

EVALUATION

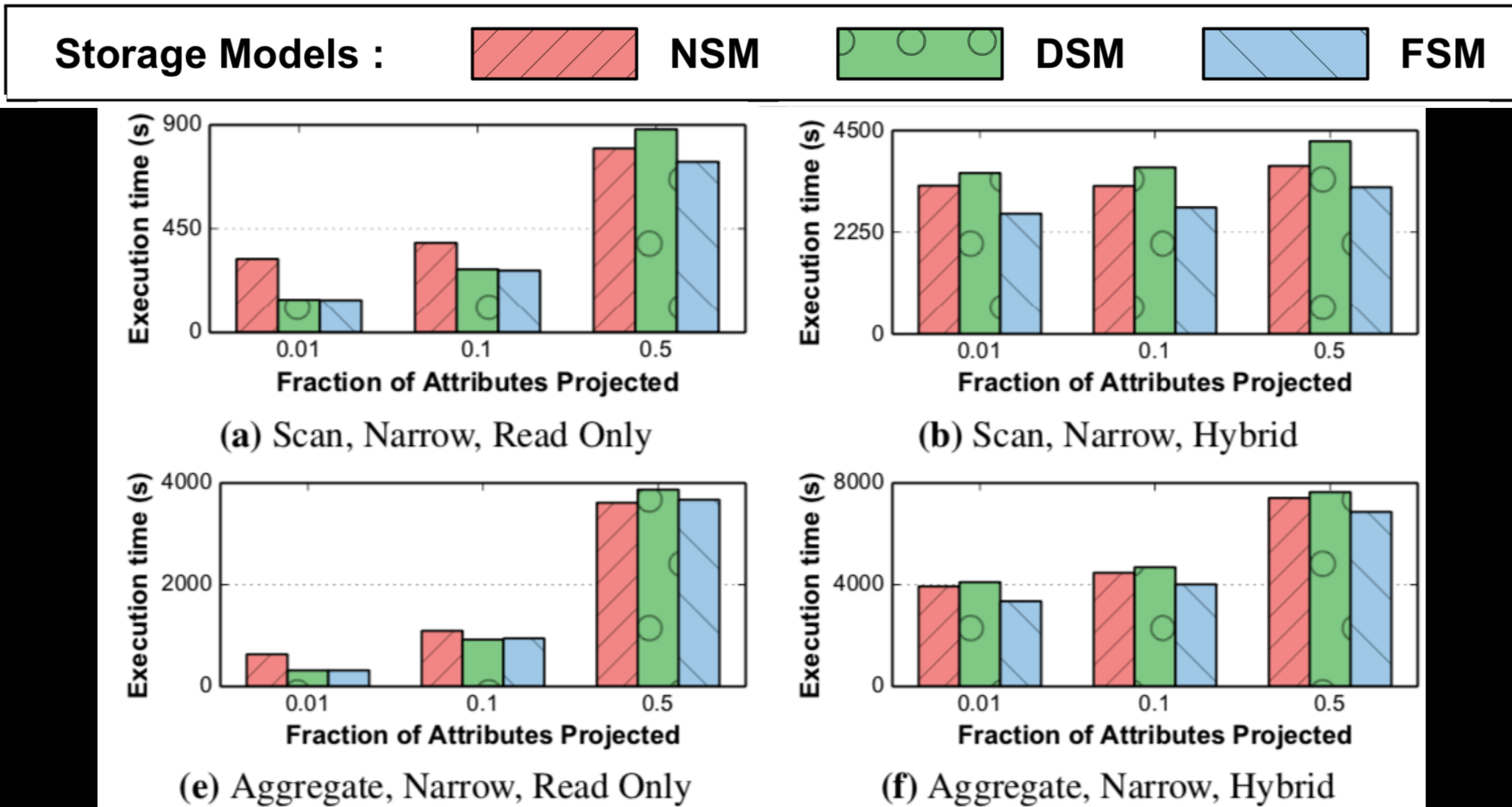
(NSM vs. DSM vs. FSM)

The system was evaluated using workloads based on these queries

Q_1: **INSERT INTO** R **VALUES** $(a_0, a_1, \ldots, a_p)$
Q_2: **SELECT** $a_1, a_2, \ldots, a_k$ **FROM** R **WHERE** $a_0 < \delta$
Q_3: **SELECT** MAX(a_1),...,MAX(a_k) **FROM** R **WHERE** $a_0 < \delta$
Q_4: **SELECT** $a_1 + a_2 + \ldots + a_k$ **FROM** R **WHERE** $a_0 < \delta$
Q_5: **SELECT** X.a_1,...,X.a_k,Y.a_1,...,Y.a_k
FROM R **AS** X, R **AS** Y **WHERE** X.a_i < Y.a_j

Note that different values for k and δ alter the projectivity and the selectivity of the queries, respectively. We use different workloads comprised of these query types to evaluate the impact of the storage models on the performance of the DBMS.

Narrow => 50 attributes; Hybrid => 1M writes per read



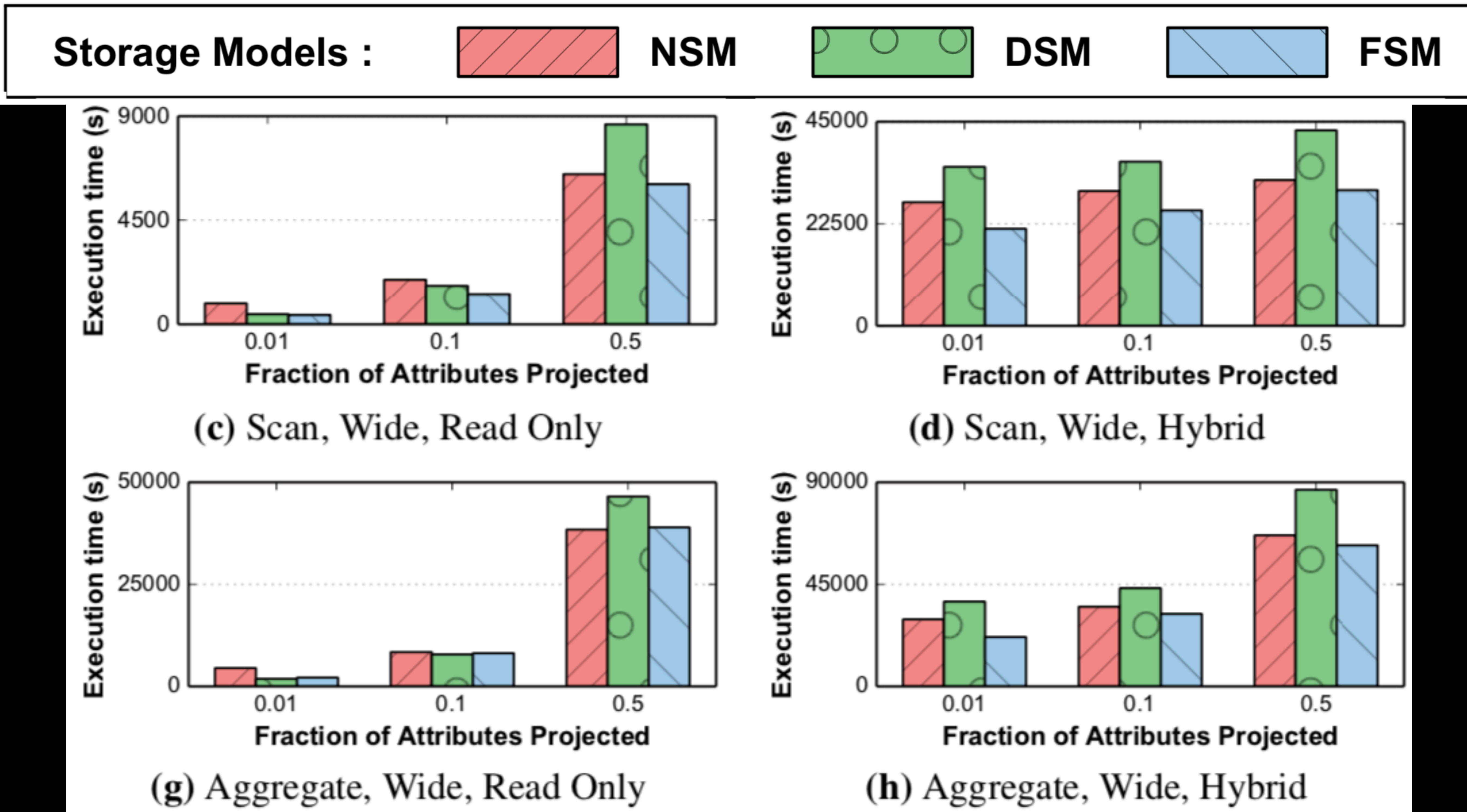
(a) Scan, Narrow, Read Only

(b) Scan, Narrow, Hybrid

(e) Aggregate, Narrow, Read Only

(f) Aggregate, Narrow, Hybrid

Wide => 500 attributes; Aggregate => MAX(x, y, z, …)



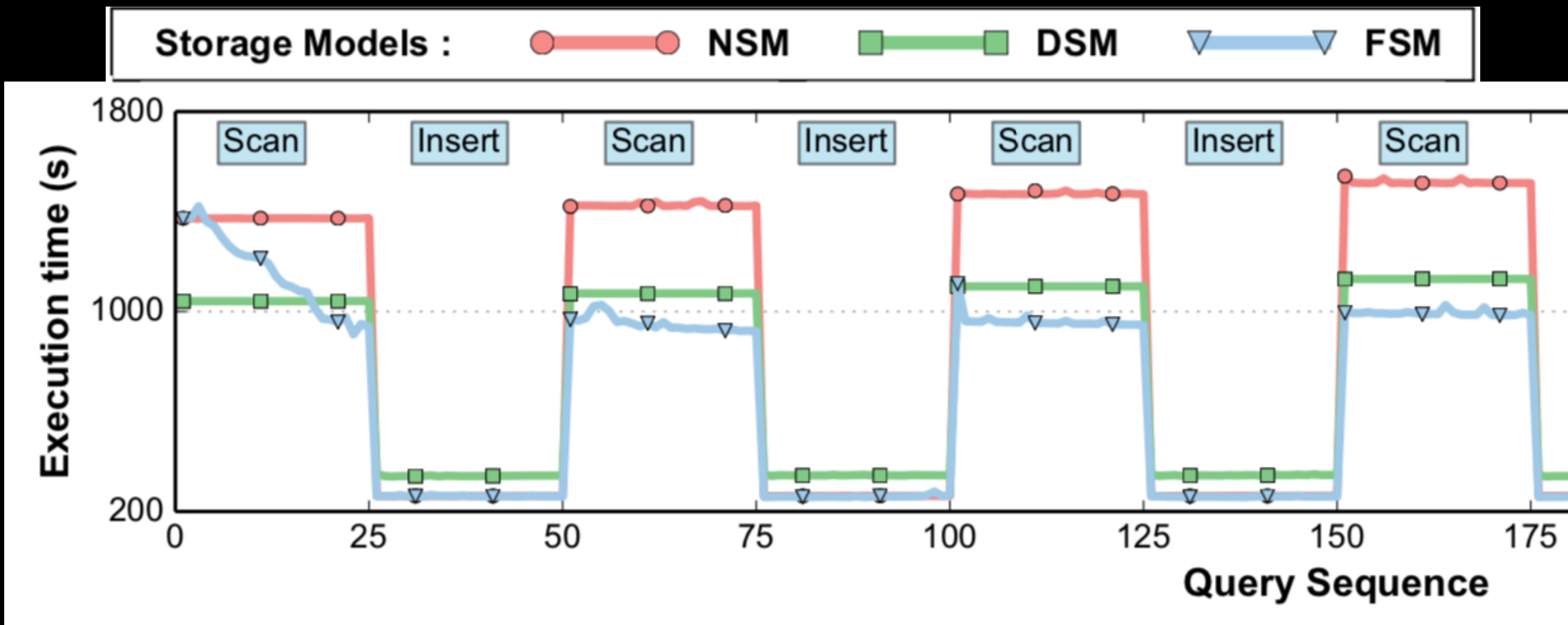
(c) Scan, Wide, Read Only

(d) Scan, Wide, Hybrid

(g) Aggregate, Wide, Read Only

(h) Aggregate, Wide, Hybrid

We can see how FSM learns over time



CONCLUSION

I think the paper did a pretty good job of…

- Demonstrating the importance of the problem and their solution
- (Usually) going into the right amount of detail
- Talking about different ways to implement each step
- Conducting a lot of difference experiments

I wish the paper had…

- Done more join queries besides a few self-joins (**major**)
- Said either way more or slightly less about tiles
  (I know they said way more in the appendix, but… yikes)
- Benchmarked their approach against another HTAP solution
  (there was some hand waving in their critiques of such systems)