H-Store:

A Specialized Architecture for High-throughput OLTP Applications

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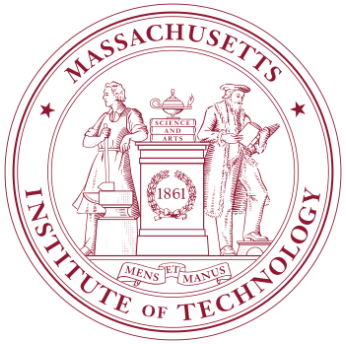
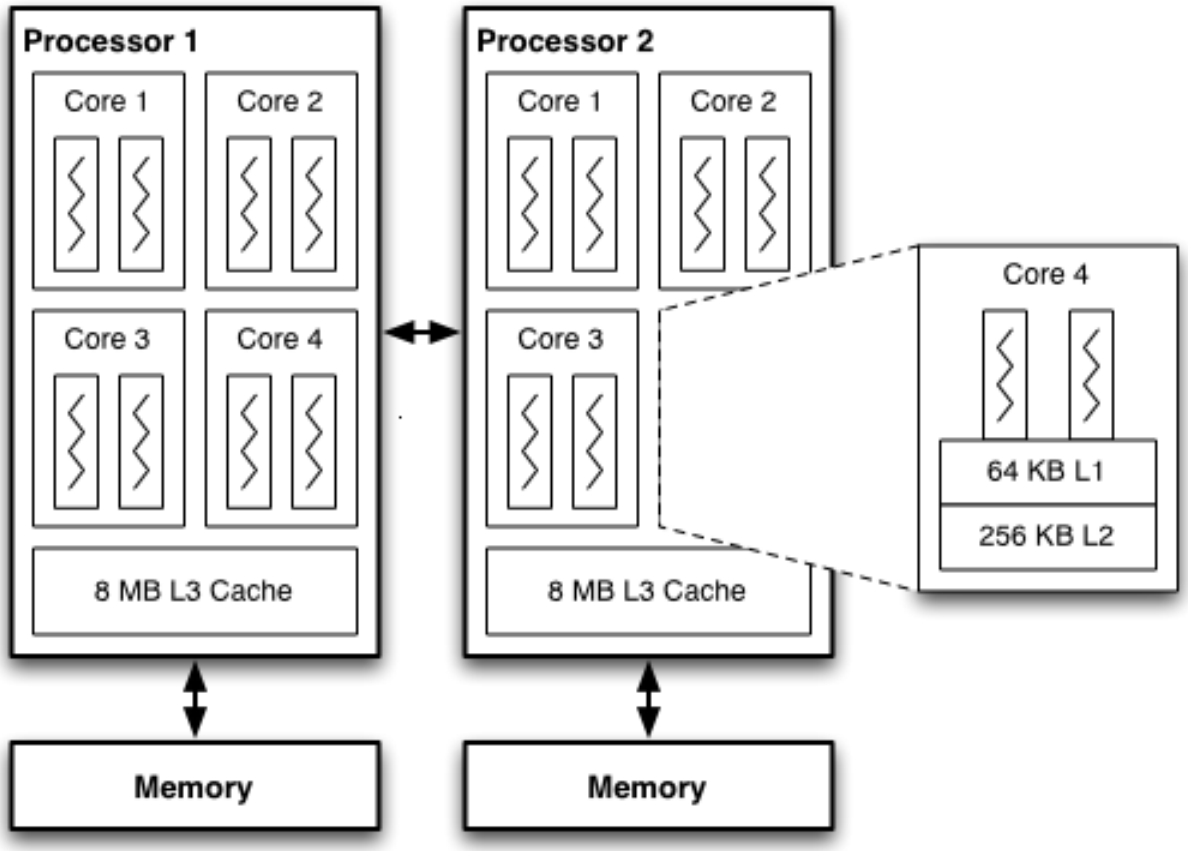


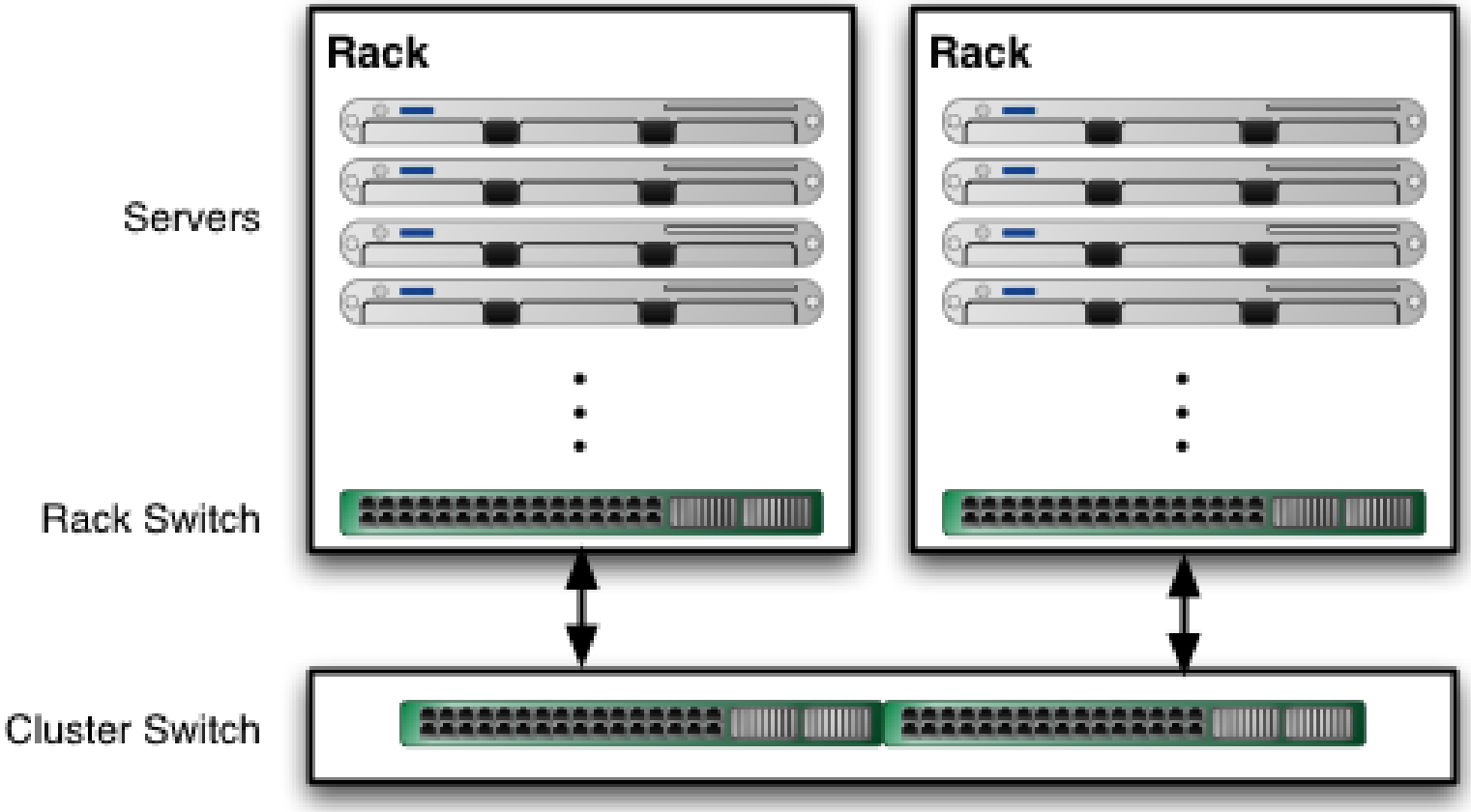
BROWN

Intel Xeon E5540 (Nehalem/Core i7)



Source: Intel 64 and IA-32 Architectures Optimization Reference Manual

Distributed Clusters



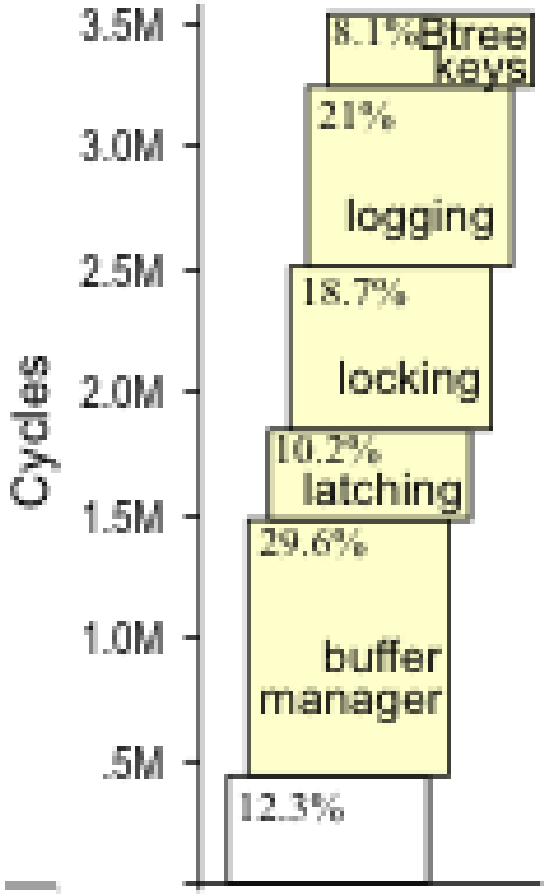
Scaling OLTP on Multi-Core?

Use a distributed shared-nothing design

How to Make a Faster OLTP DBMS

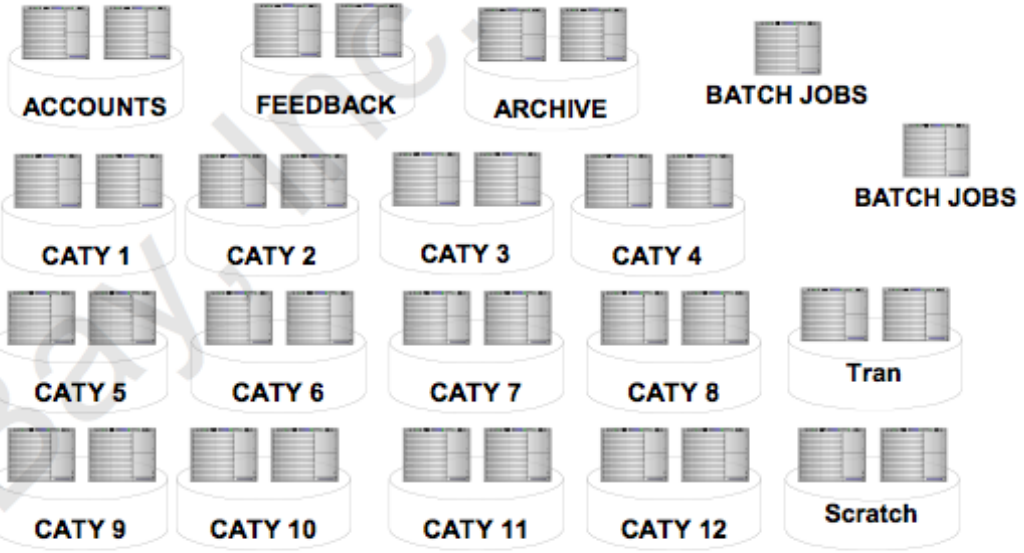
- Main memory storage
  - *Replication for durability*
- Explicitly partition the data
- Specialized concurrency control
  - *Stored procedures only*
  - *Single partition: execute one transaction at time*
  - *Multiple partitions: supported but slow*

OLTP: Where does the time go?



Source: S. Harizopoulos, D. J. Abadi, S. Madden, M. Stonebraker, "OLTP Under the Looking Glass", SIGMOD 2008.

Users Rely on Partitioning



December, 2002

Source: R. Shoup, D. Pritchett, "The eBay Architecture," SD Forum, Nov. 2006.

What about multi-core?

- **Traditional approach:**
  - ***One database process***
  - ***Thread per connection***
  - ***Shared-memory, locks and latches***
- **H-Store approach:**
  - ***Thread per partition***
  - ***Distributed transactions***

Example Microbenchmark

- One table per client

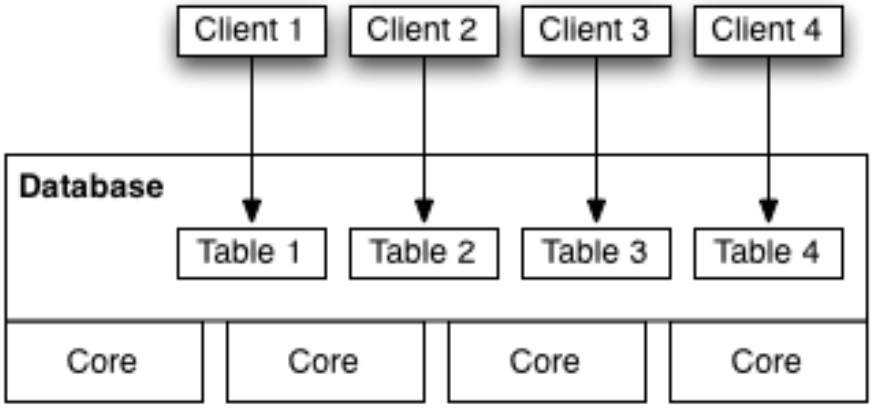
```
Table(id INTEGER, counter INTEGER)
```

- Each client executes the following query:

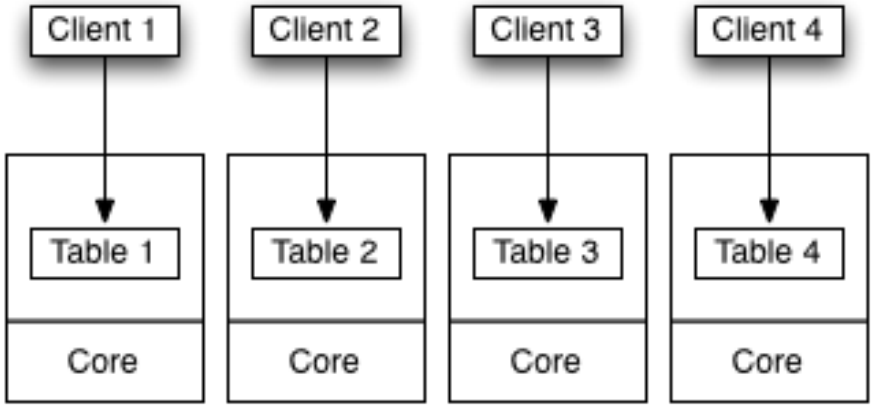
```
UPDATE Table
  SET counter = counter + 1
  WHERE id = 0;
```

- Add clients to find maximum throughput
- Data on RAM disk

Experimental Configuration

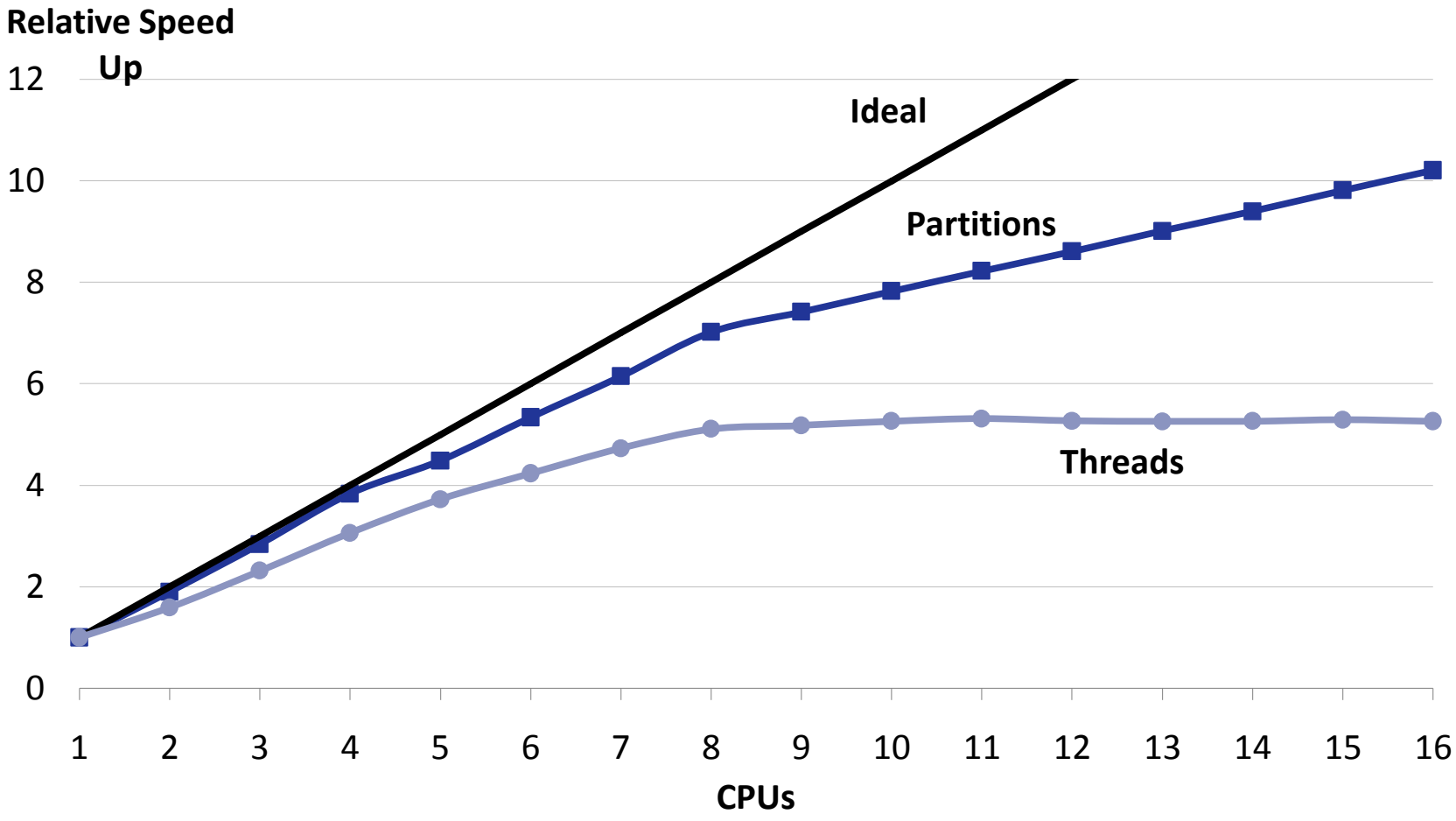


Threads



Partitions

Partitions versus Threads



Scalability Analysis

Partitions scale better than threads.

- **Threads: contention for shared resources** [1]
- **Partitions: memory bottleneck causes sublinear scaling**

H-Store: Not just for distributed shared-nothing clusters

[1] R. Johnson et al., "Shore-MT: A Scalable Storage Manager for the Multicore Era," EDBT 2009.

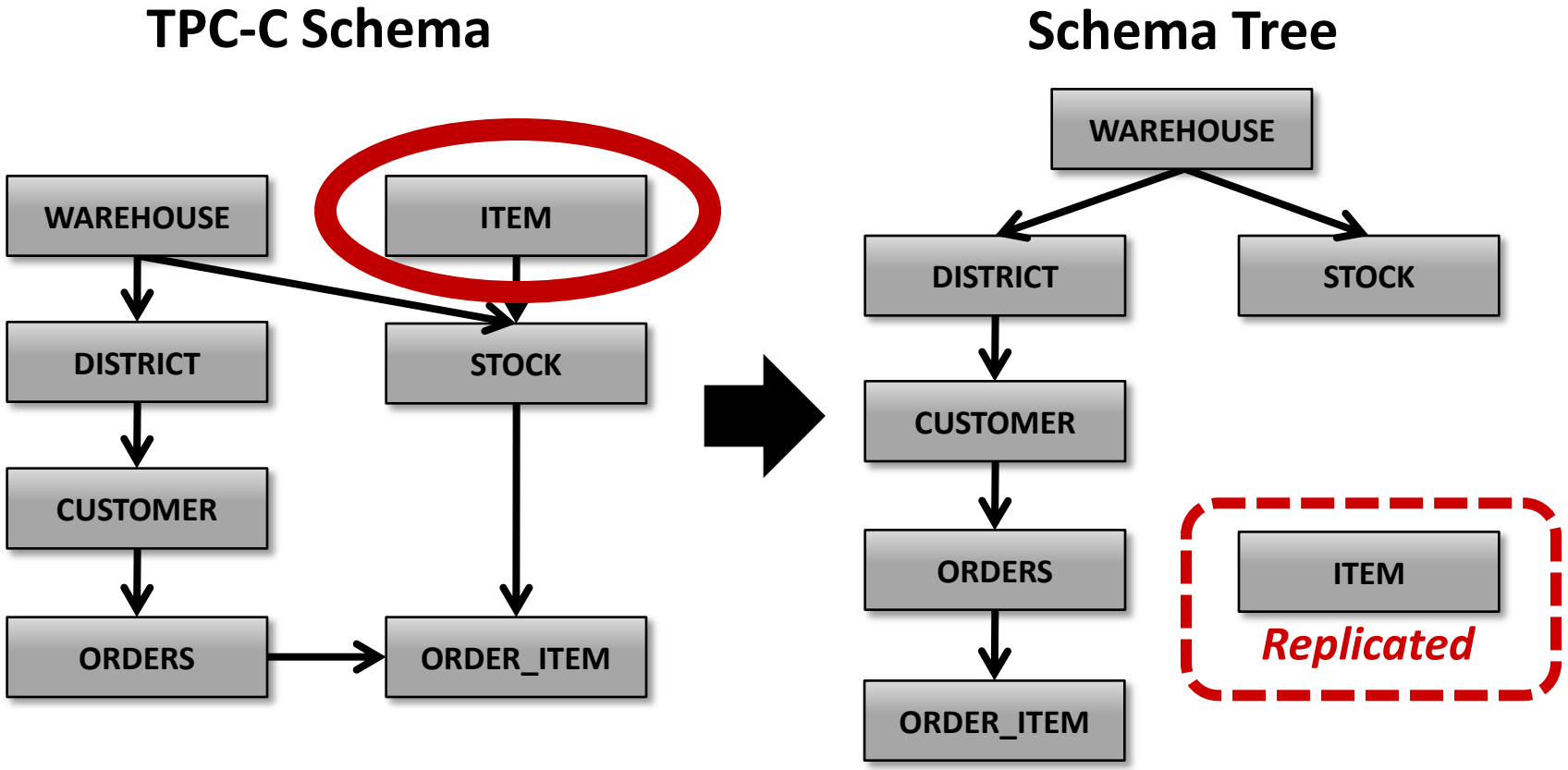
Multi-core Design Problem

- **How to automatically create a data placement scheme to improve multi-core throughput?**

- **Data Partitioning:**
  - ***Maximize the number of single-partition transactions.***
- **Data Placement:**
  - ***Maximize the number of single-node transactions.***

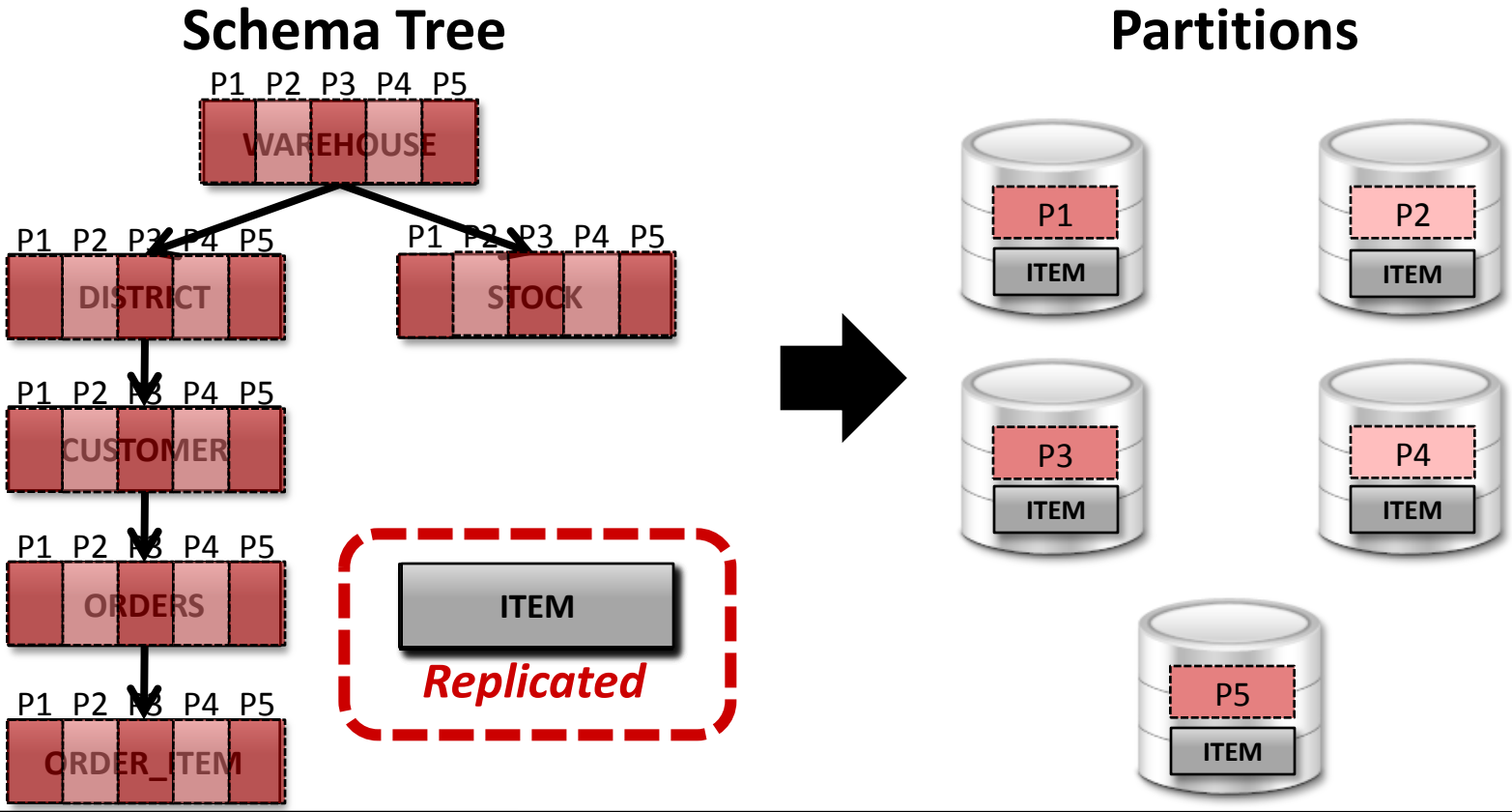
Database Partitioning

- **Select partitioning keys and construct schema tree.**



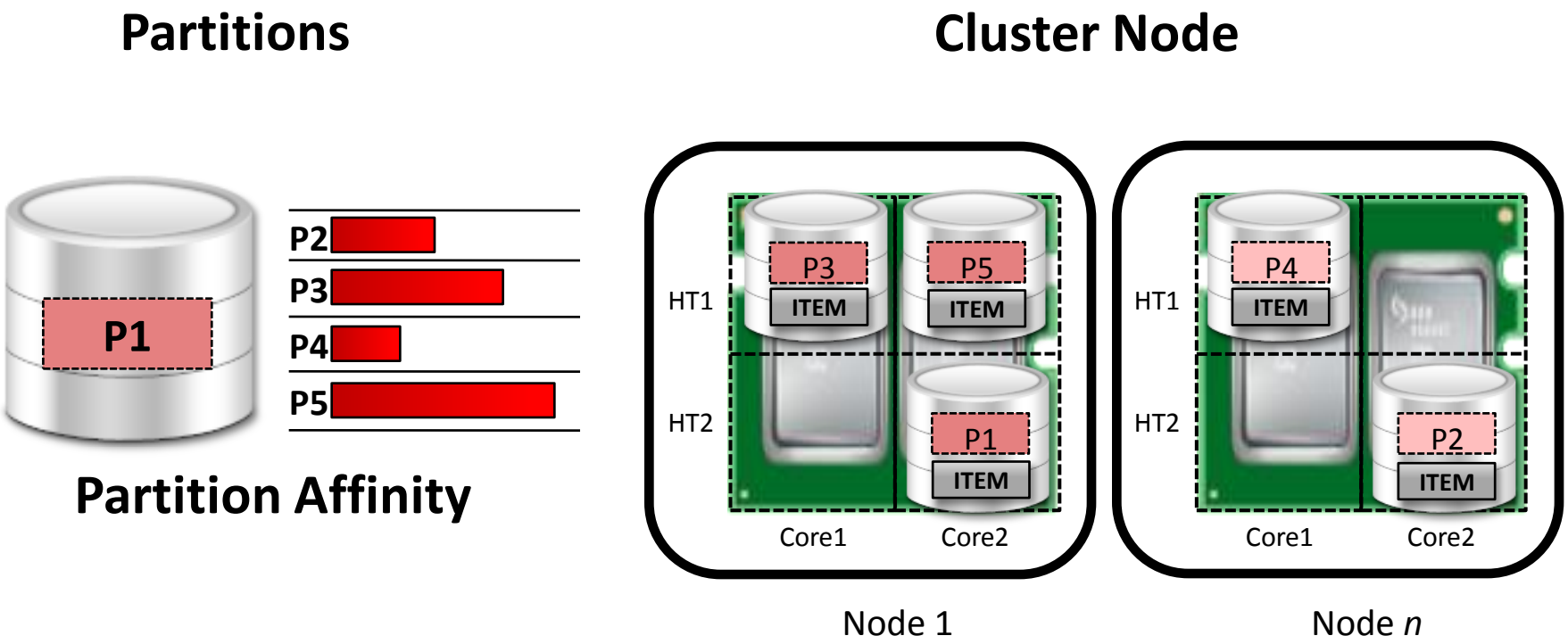
Database Partitioning

- Combine table fragments into partitions.



Data Placement

- **Assign partitions to cores on each node.**



H-Store's Future

- New Name. New Company.
- Six full-time developers.
- Open-source project (GPL)
- Beta by end of 2009
  - *Multiple deployments in financial service areas.*

More Information

- **H-Store Info + Papers:**
  - ***http://db.cs.yale.edu/hstore/***
- **VoltDB Project Information:**
  - ***http://www.voltdb.org/***