Database Scalability with Parallel Databases

Boston MySQL Meetup

Monday, December 10, 2012

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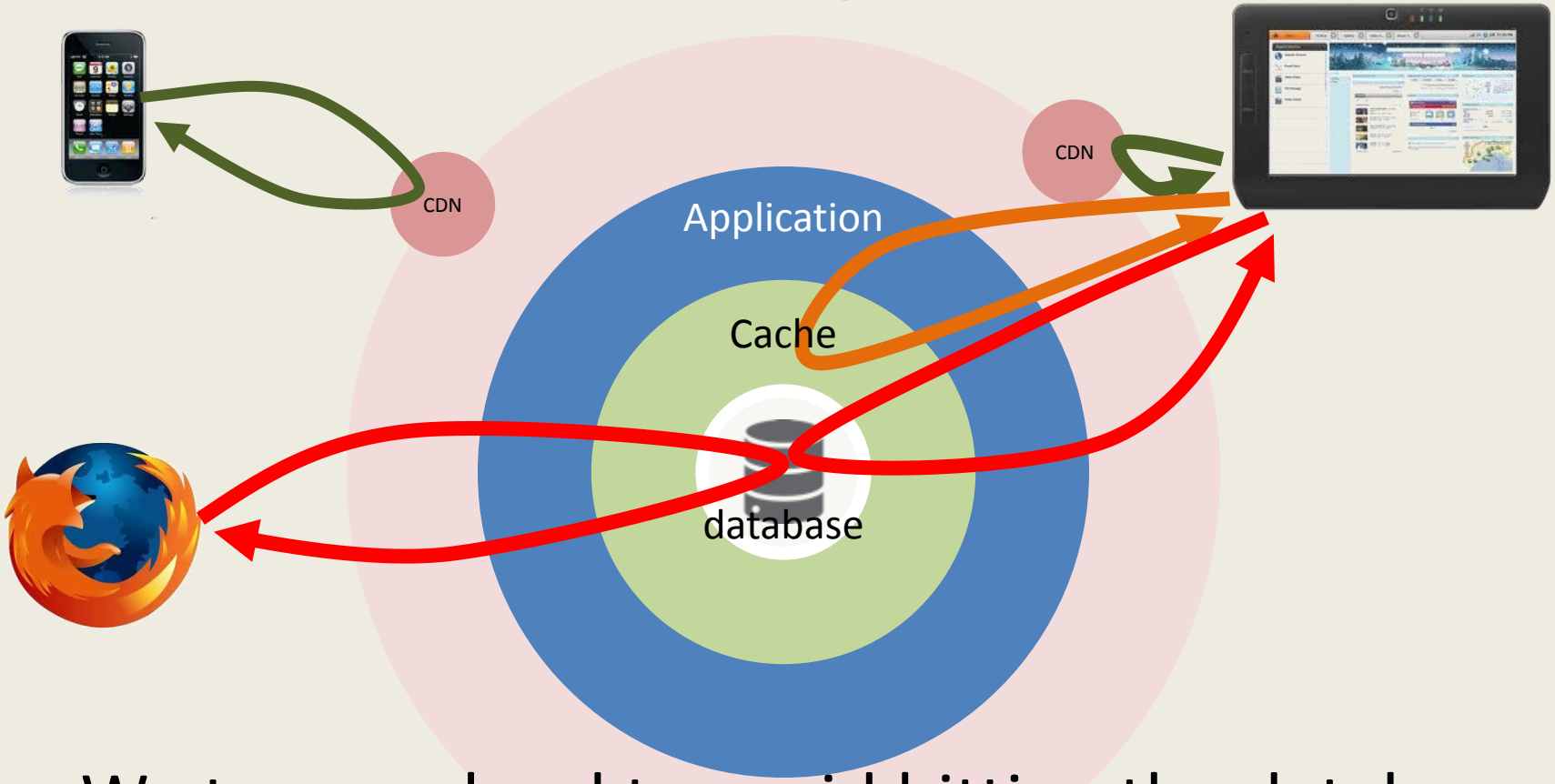
What should I do while you yabber along for 1 hour?

1. Eat Pizza …
2. Ask questions, and keep me honest
3. Tweet about us, include #parelastic or #mysql and you will be part of the demo!

The background



- We try very hard to avoid hitting the database
  - But there are times when you cannot avoid it!

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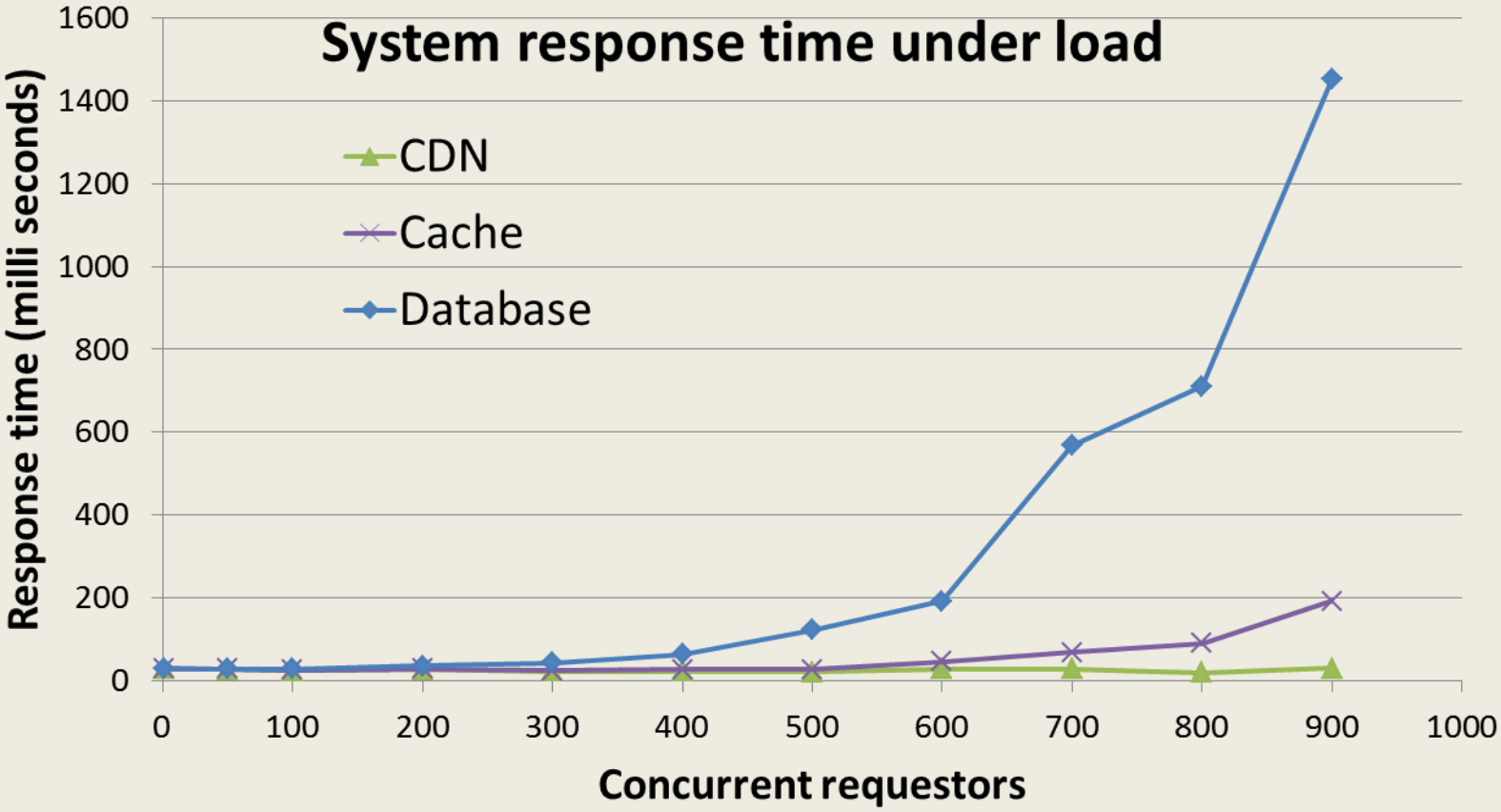
Why?



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Some alternatives

- Scale Up
- Scale Out

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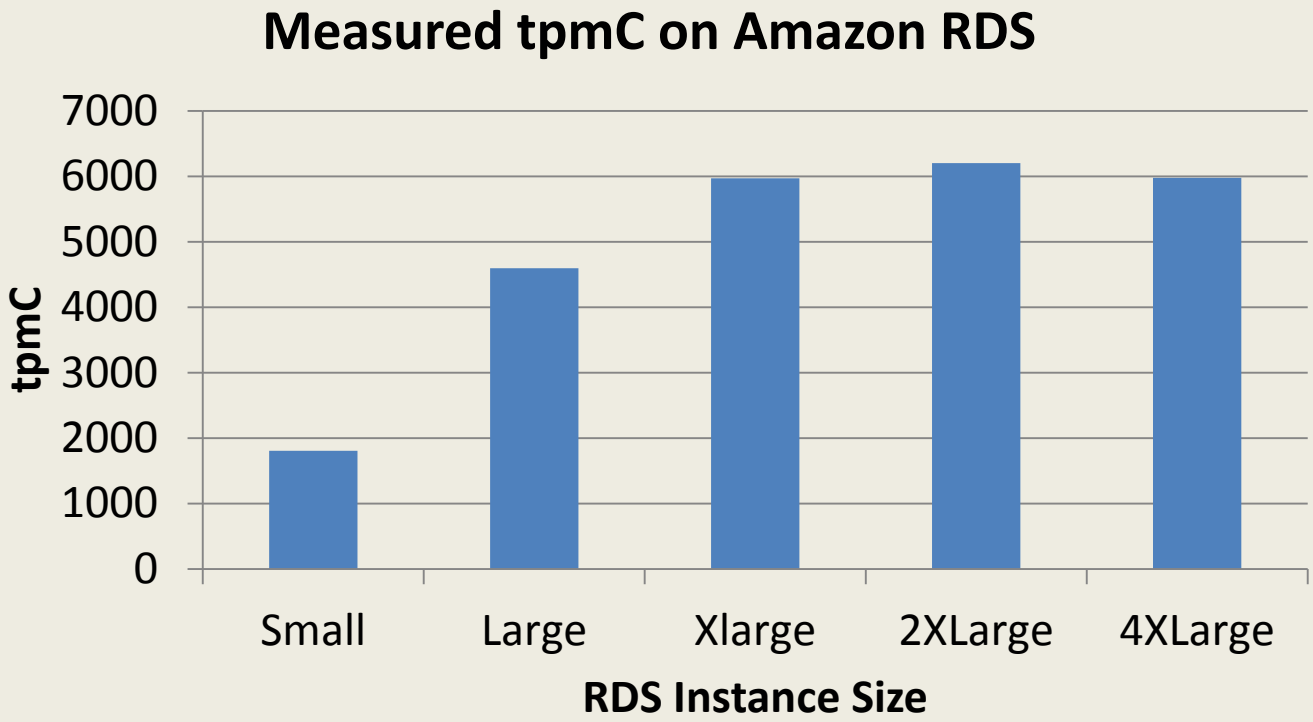
Viability of scale-up (1)



Source: Amazon RDS TPC-C Benchmark. Md. Borhan Uddin, Bo He, Radu Sion, Cloud Computing Center, SUNY Stony Brook.
Viewed online http://digitalpiglet.org/research/sion2010cloud-rds.pdf

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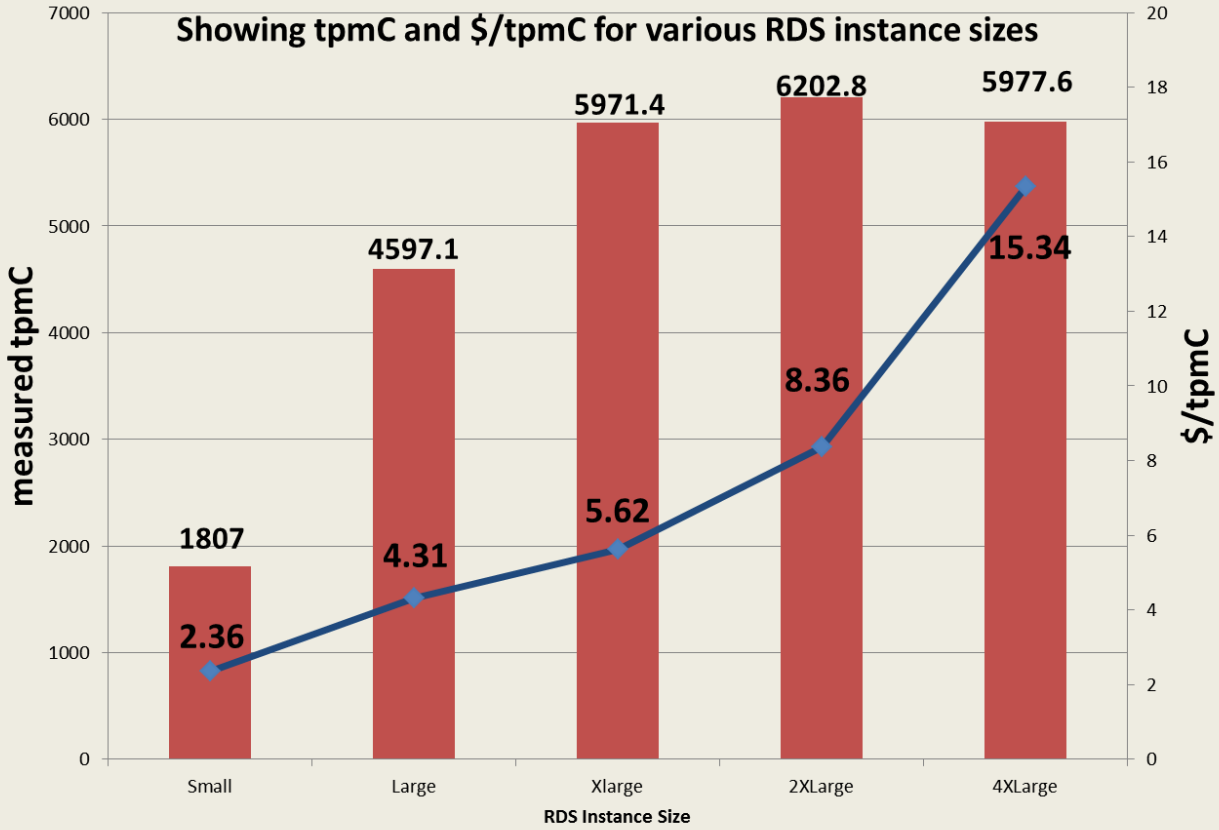
Viability of scale-up (2)



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Viewed online http://digitalpiglet.org/research/sion2010cloud-rds.pdf

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Database Scale Out: It's been around!

- [1986] The Case for Shared Nothing (Michael Stonebraker)
- [1991] Parallel database systems: the future of high performance database systems (David Dewitt, Jim Gray)
- [2004] MapReduce: simplified data processing on large clusters (Jeffrey Dean, Sanjay Ghemawat)
- [1984] Teradata releases the world's first parallel data warehouses and data marts.
- [1997] Teradata customer creates world's largest production database at 24 terabytes.
- [2001-3] Netezza, Vertica, Greenplum, Datallegro, …
- [2004] MapReduce
- [2010] ParElastic

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What is a parallel database?

- A system that seeks to improve performance through the parallelization of various operations such as scanning, restriction, aggregation, sorting, loading, index management, and system recovery.
- Typically based on the “Shared Nothing” architecture
  - Shared disk is also common
  - Shared memory is less common
- Often for Analytics (Netezza, Vertica, …)
  - But not always (Oracle Exadata)

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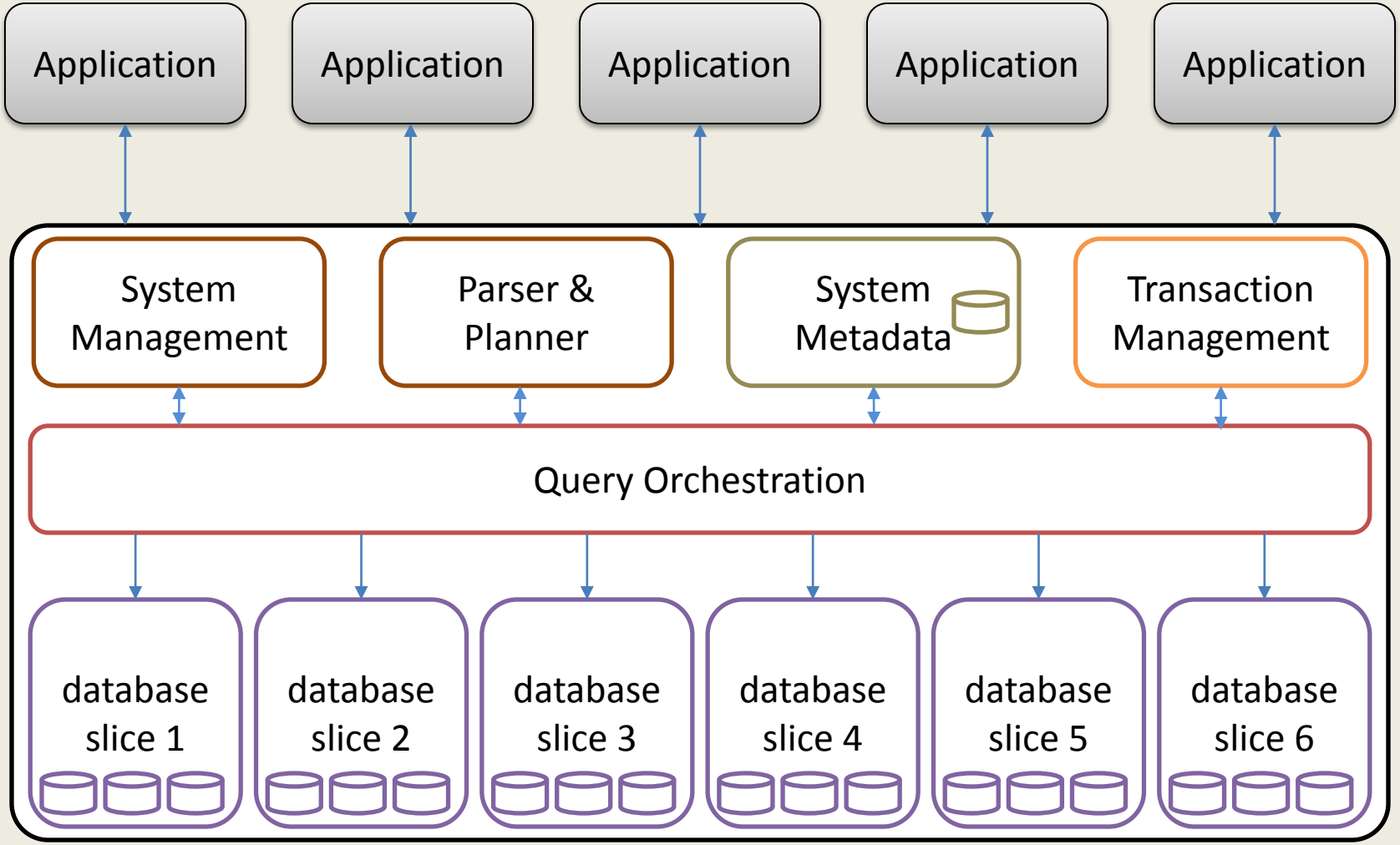
A “shared-nothing” parallel database



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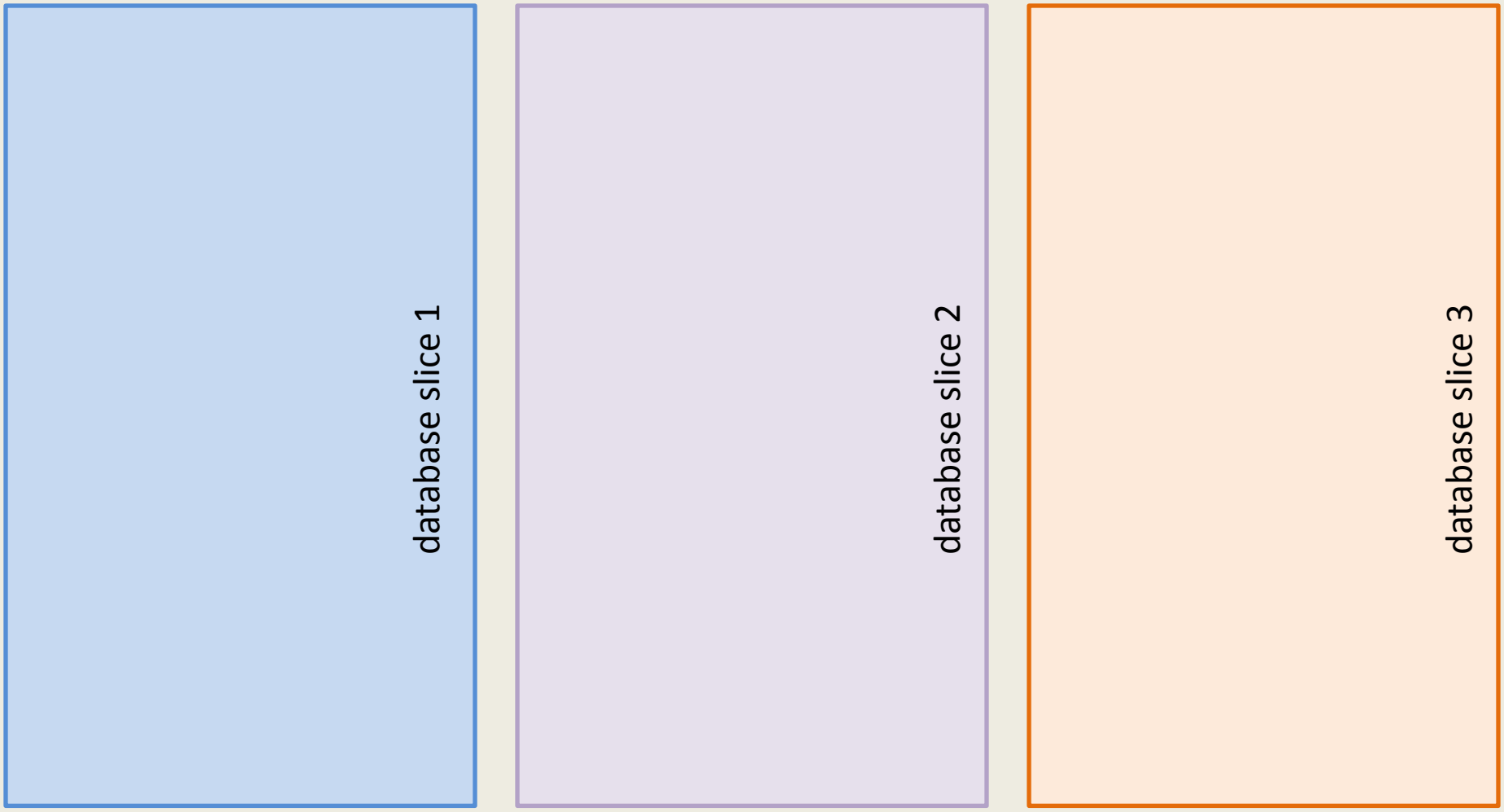
How it works: The scenario



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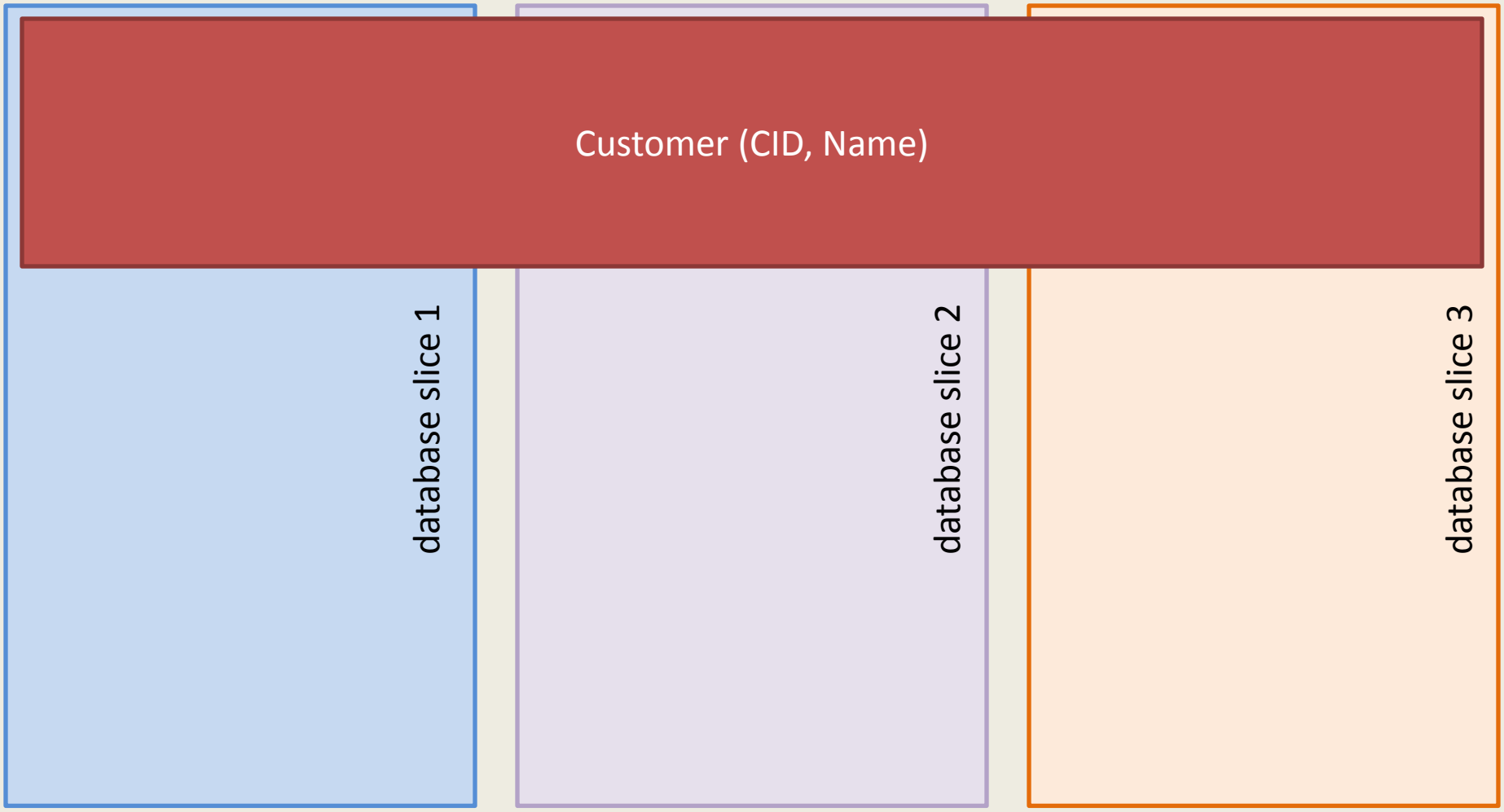

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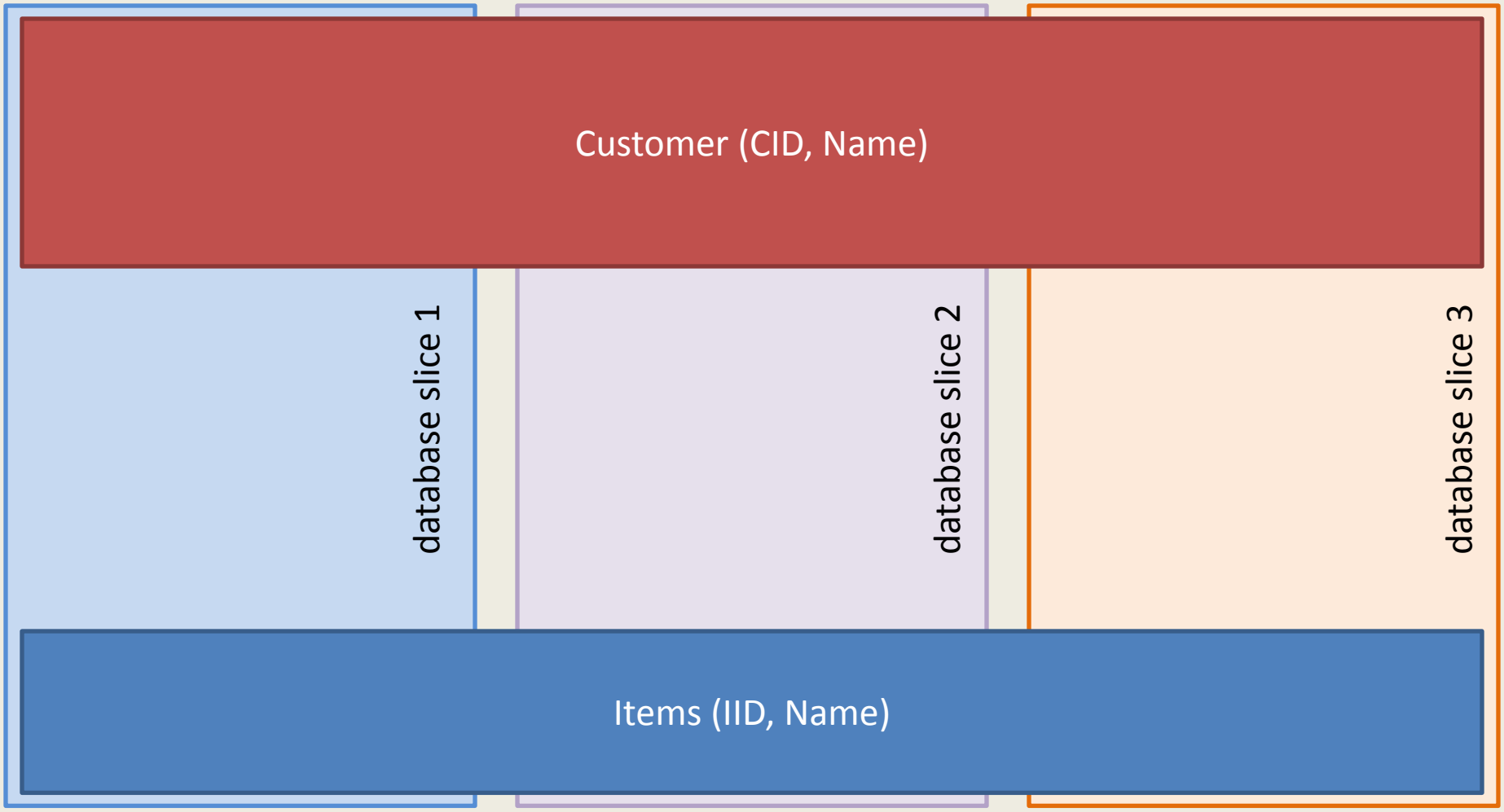

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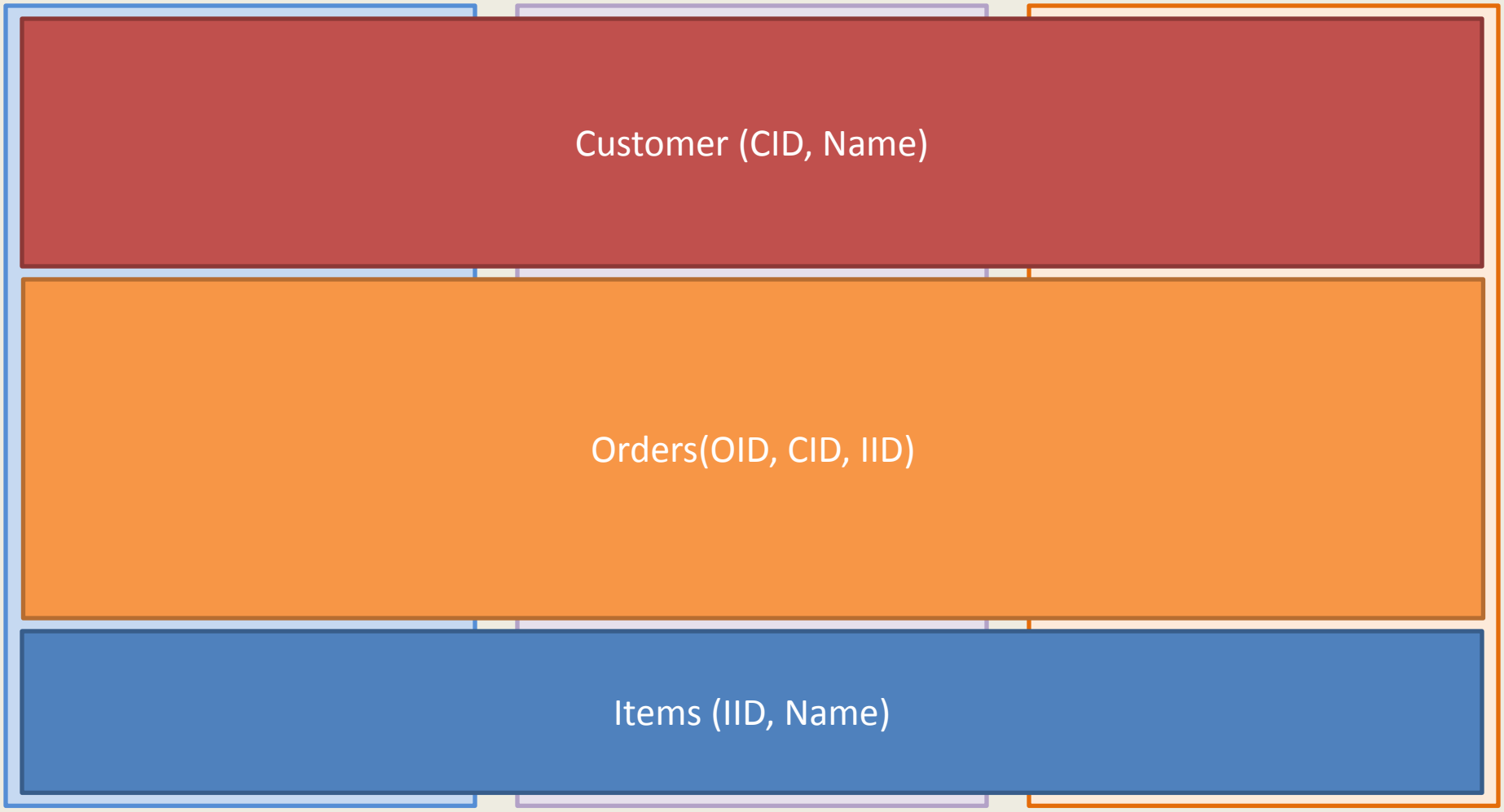

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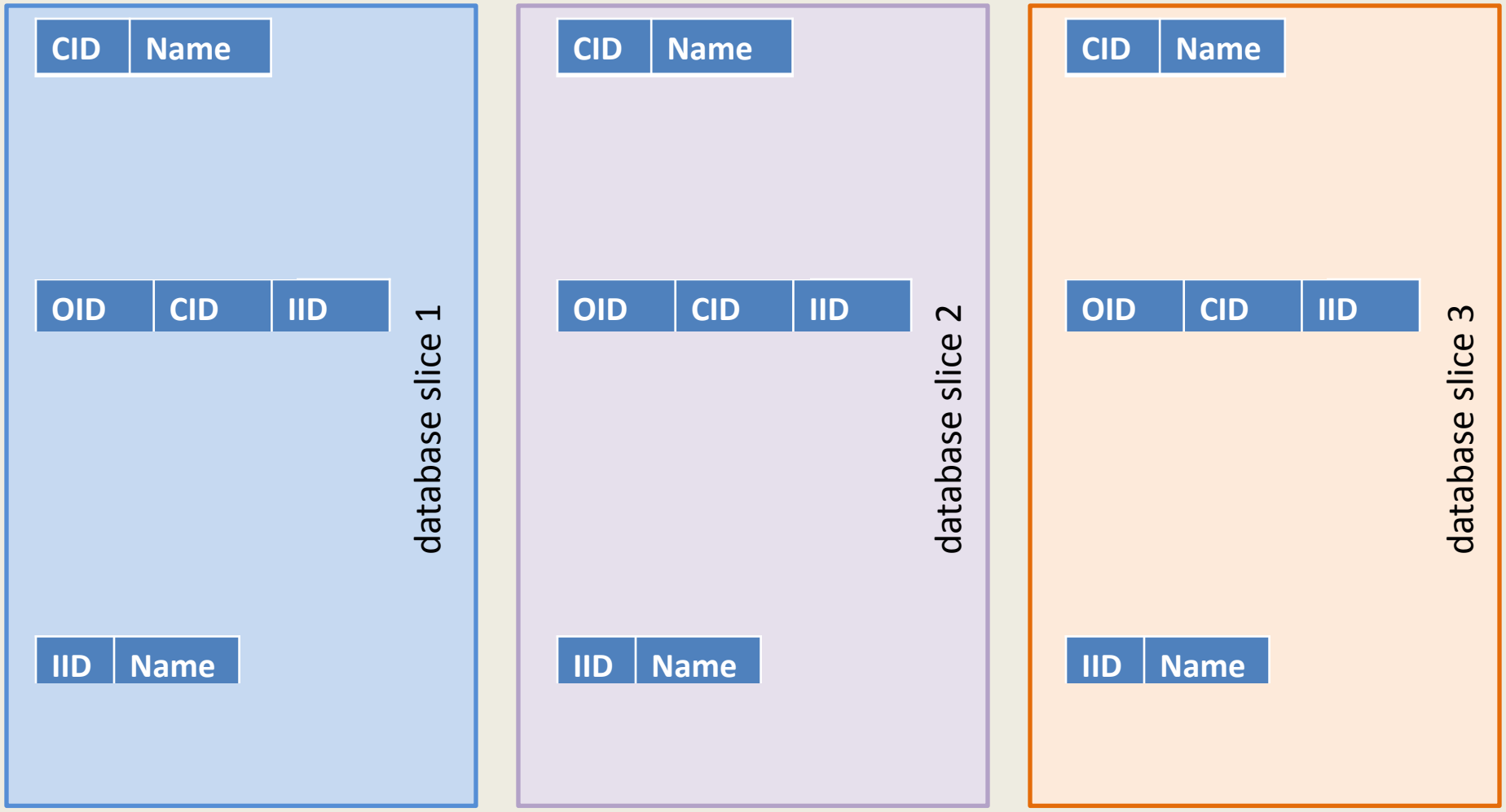

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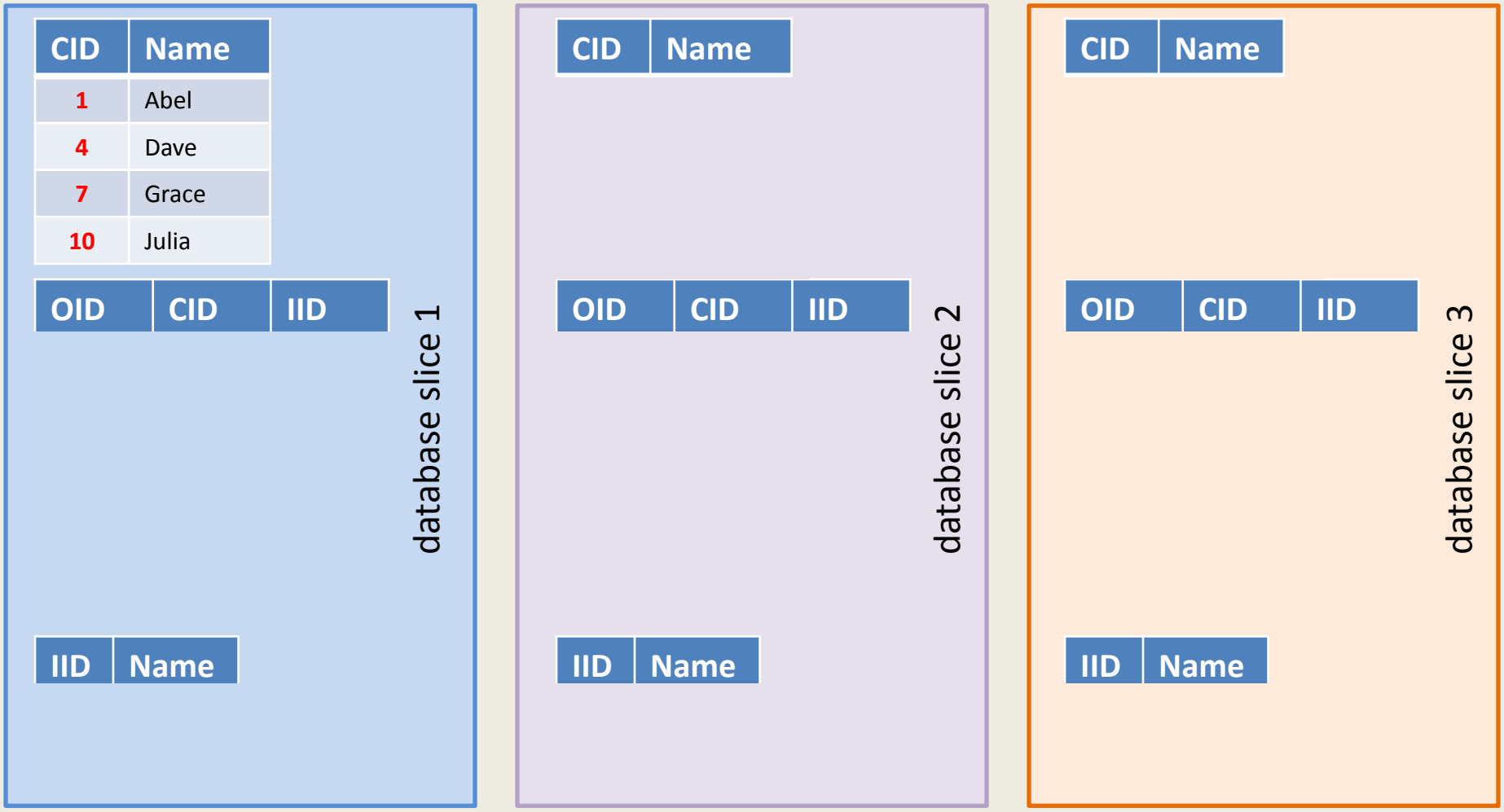

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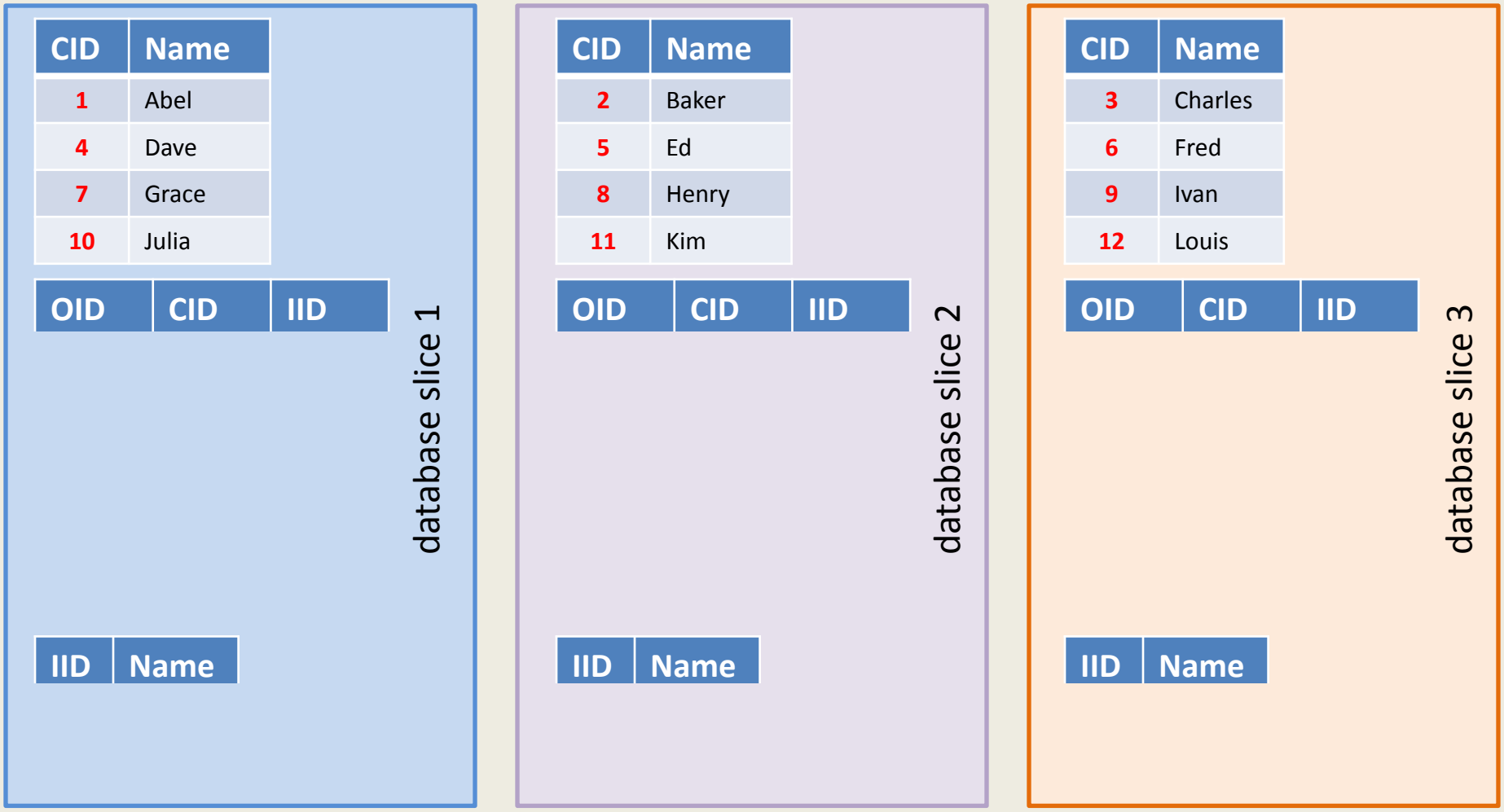

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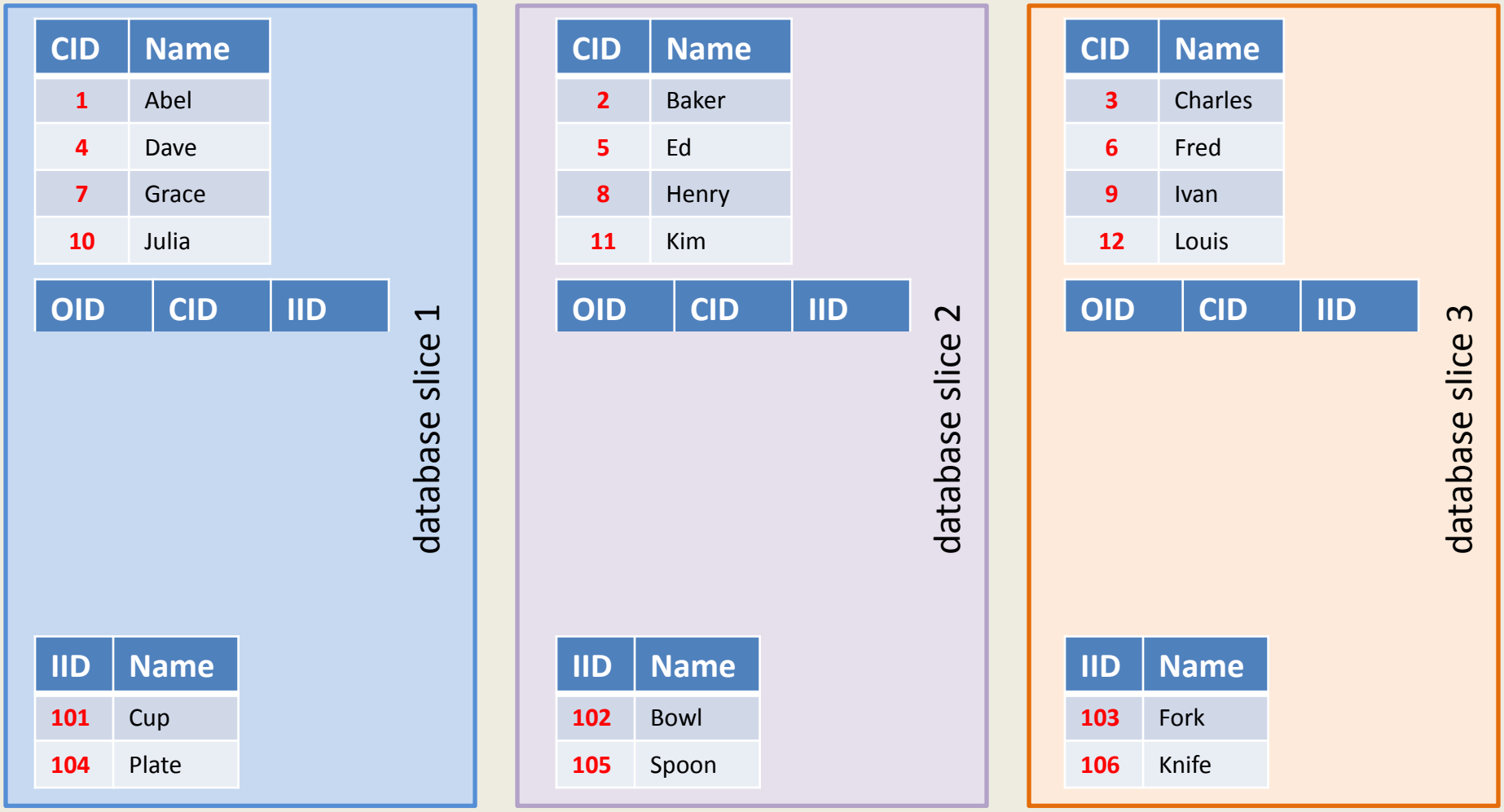

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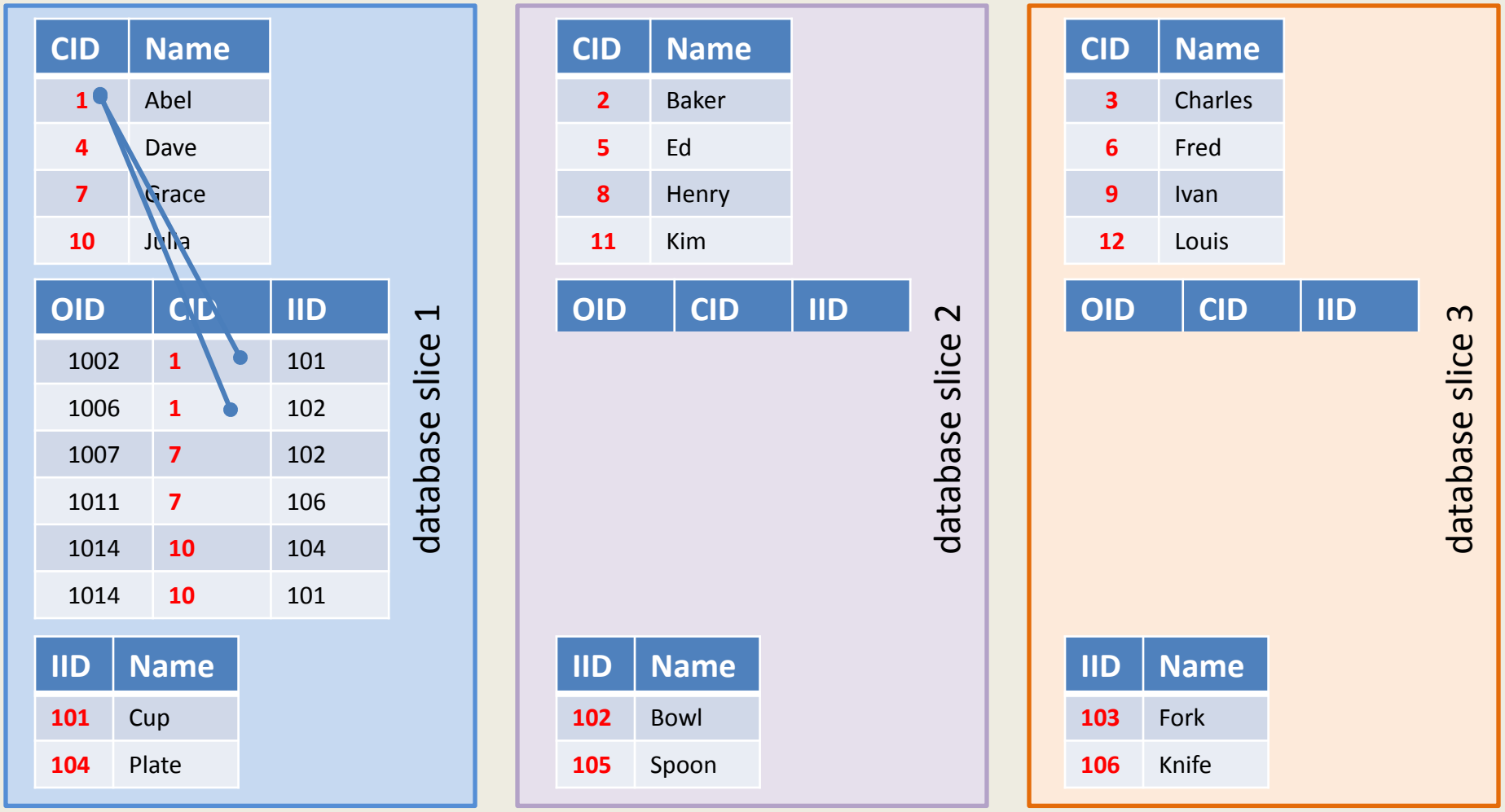

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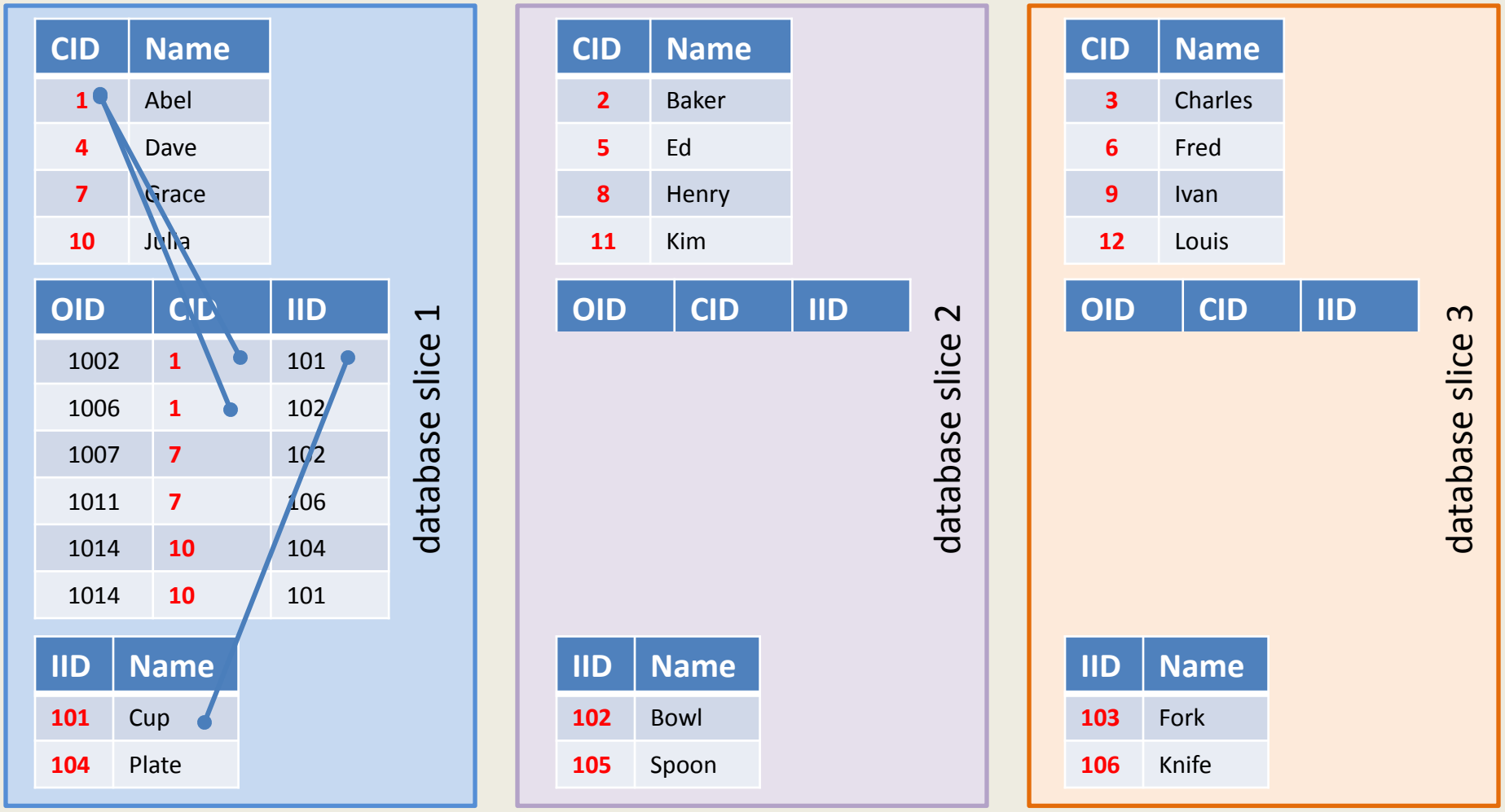

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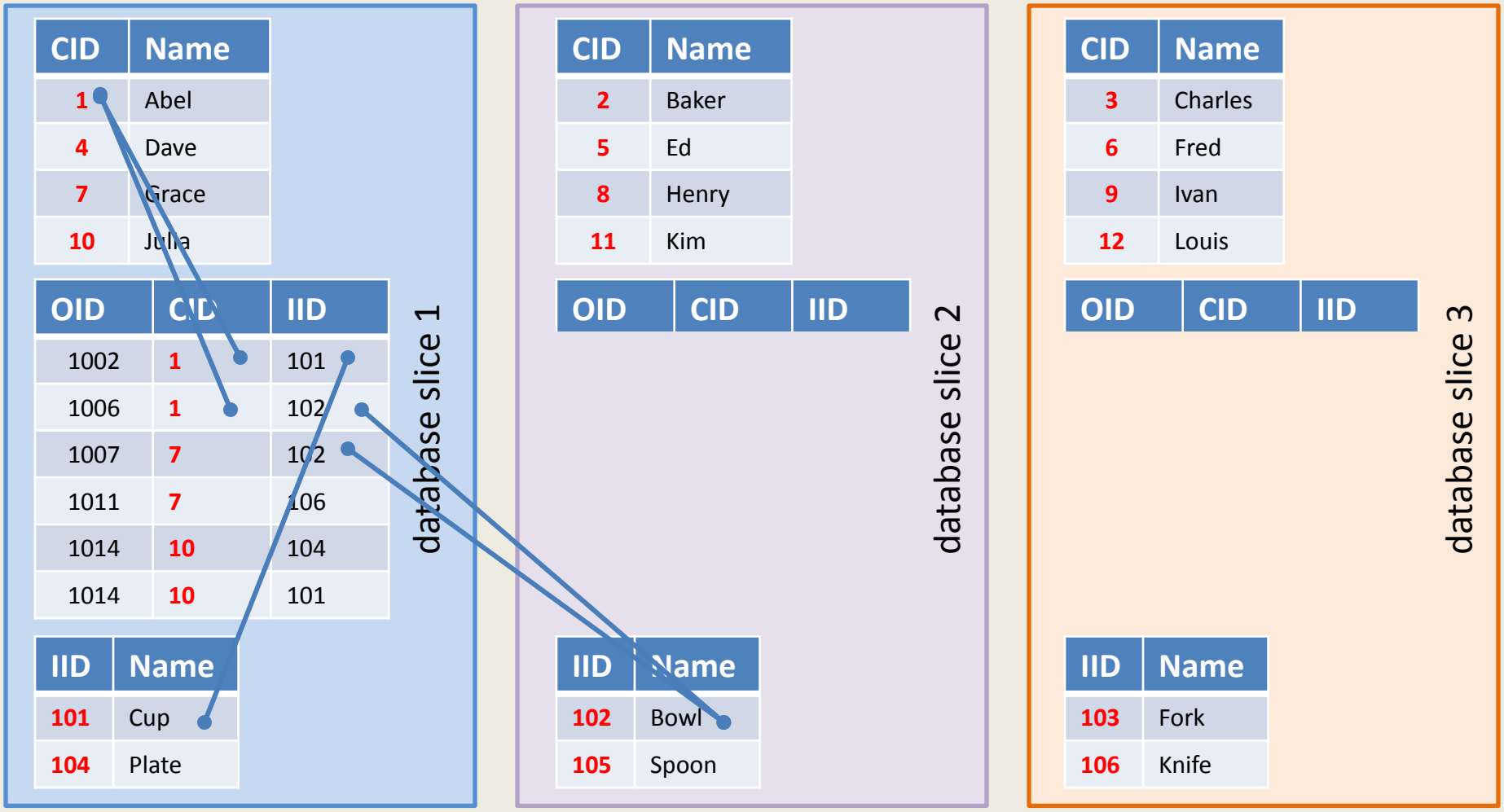

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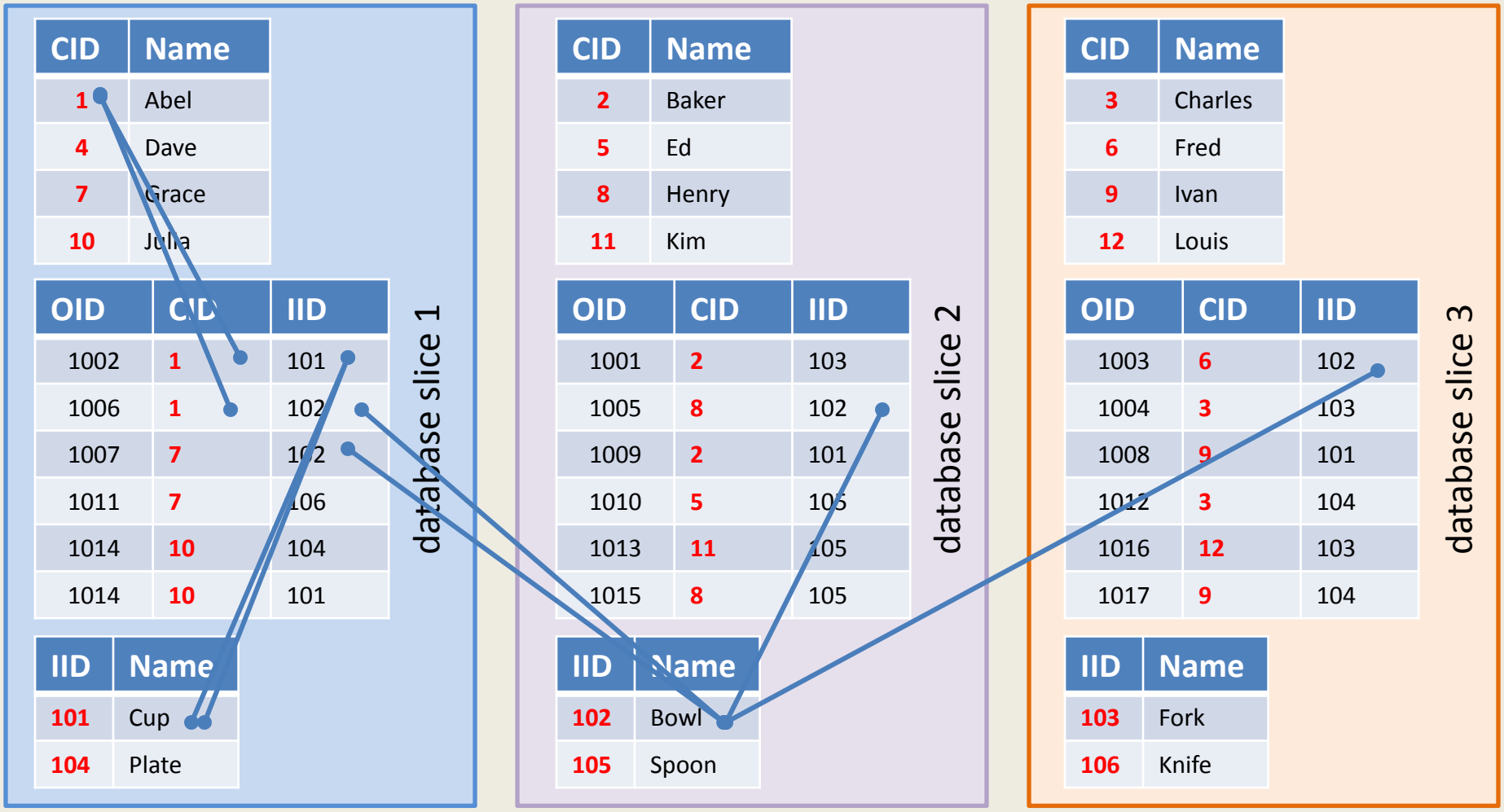

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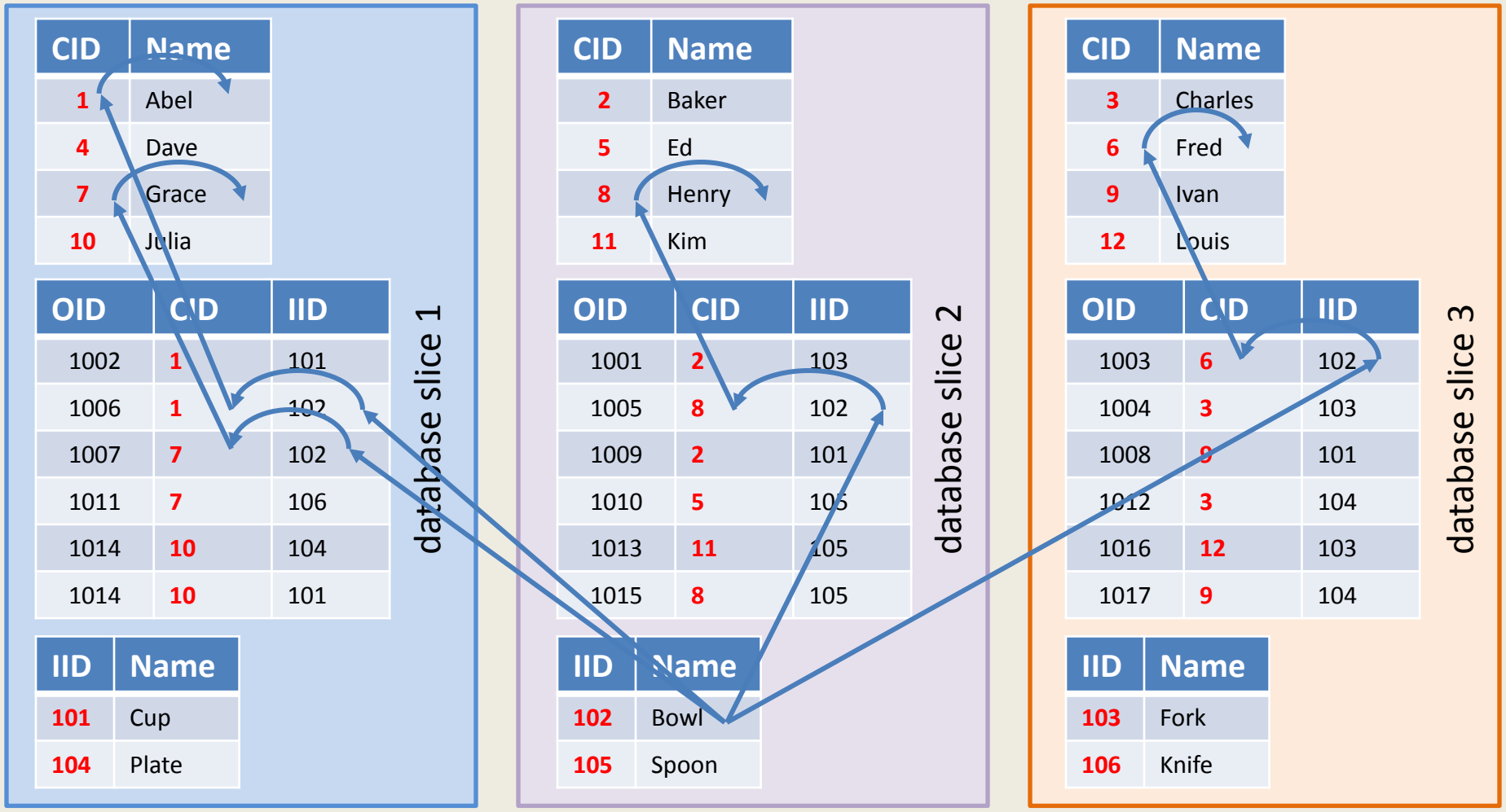
Who bought a bowl?




```
SELECT C.NAME FROM CUSTOMERS C, ORDERS
O, ITEMS I WHERE C.CID = O.CID AND
O.IID = I.IID AND I.NAME = 'Bowl';
```

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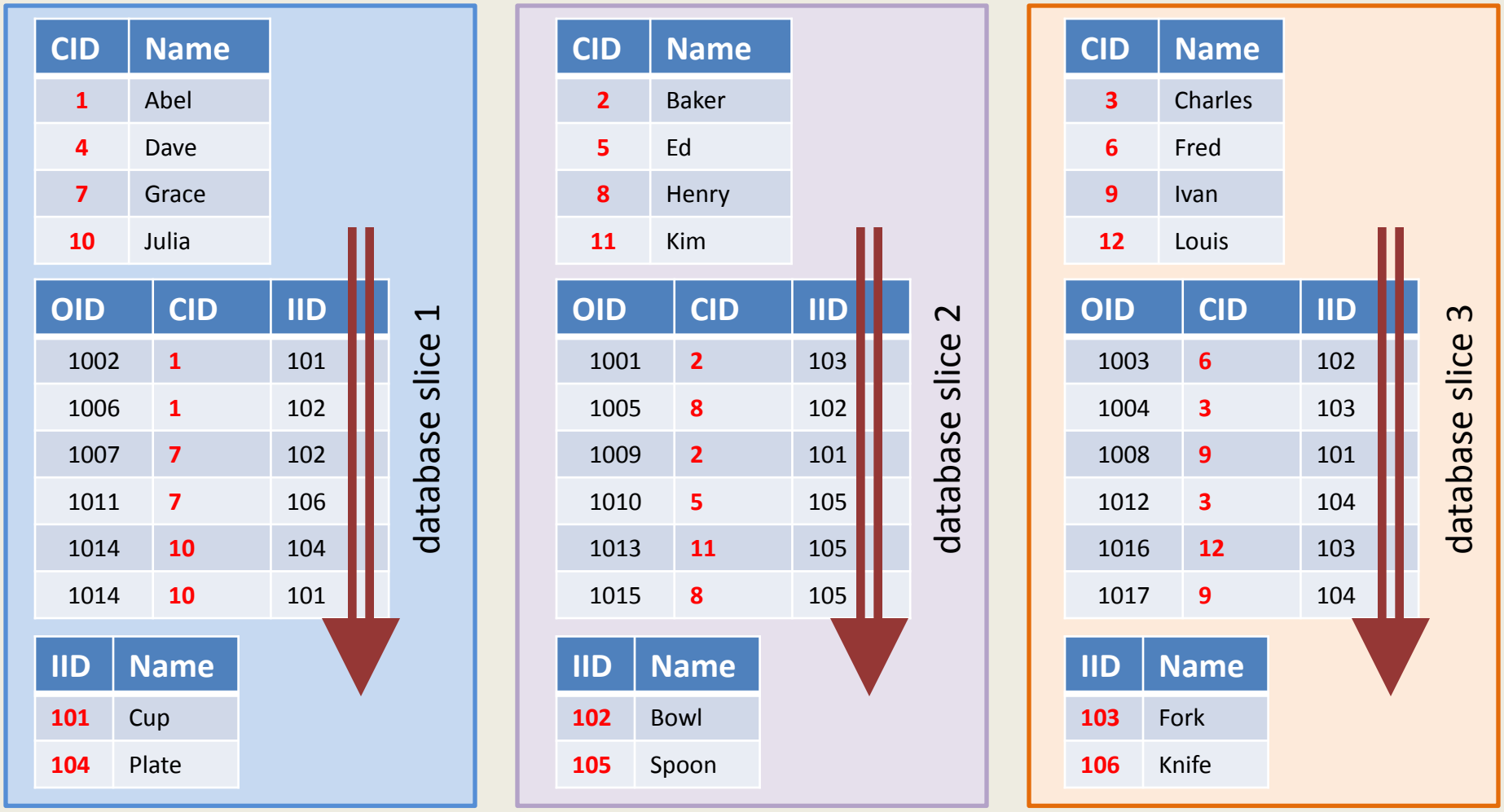
Scanning in parallel



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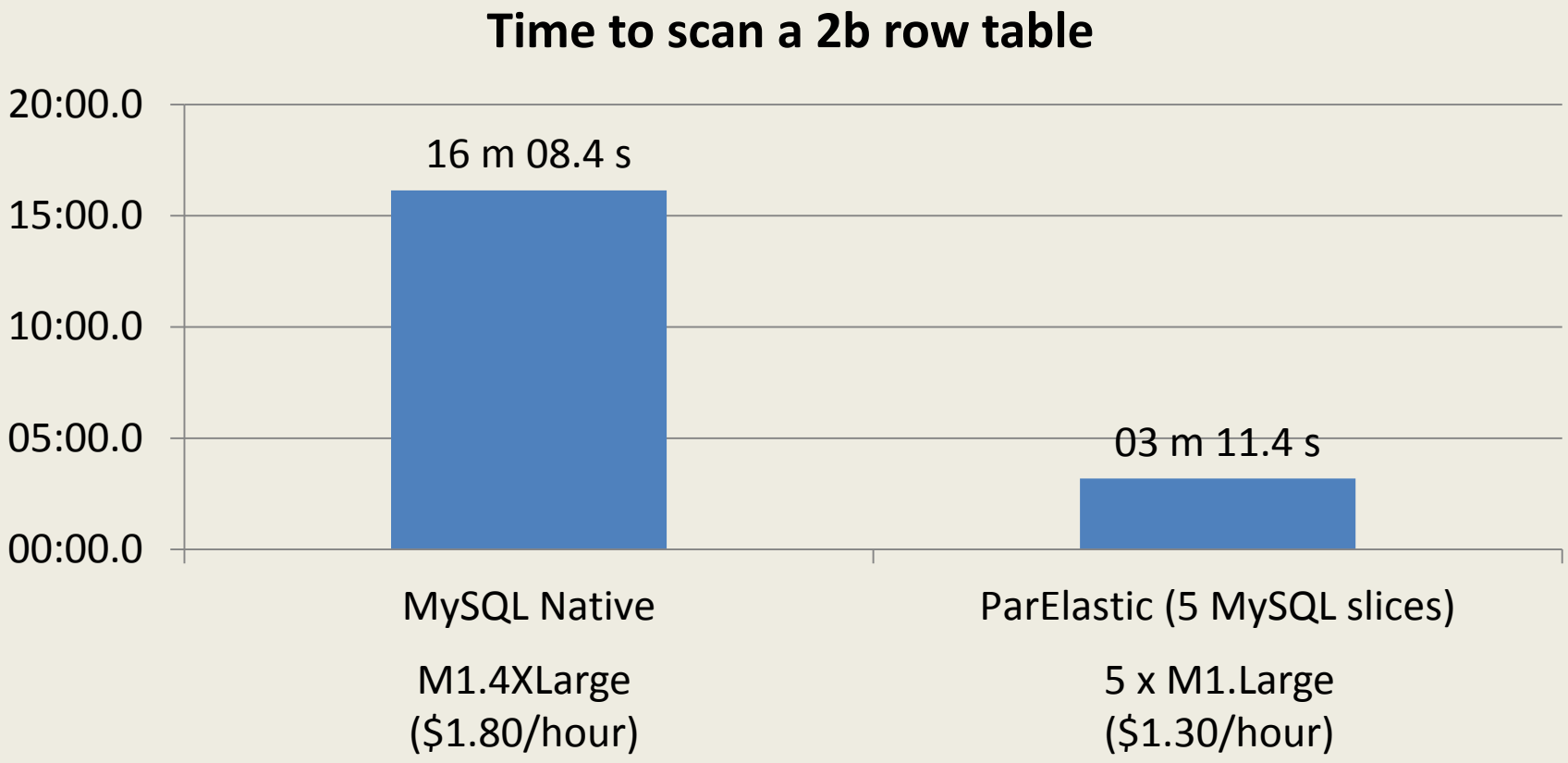

Note: Amazon EC2 pricing for spot instances, December 2012. m1.4xlarge $1.80/hour, m1.large $0.26/hour

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Counting rows in a table

- Table is distributed on a number of database sites
- I want to count the number of rows in the table

```
SELECT COUNT(*)
FROM CUSTOMERS;
```

Counting rows in a table

```
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```

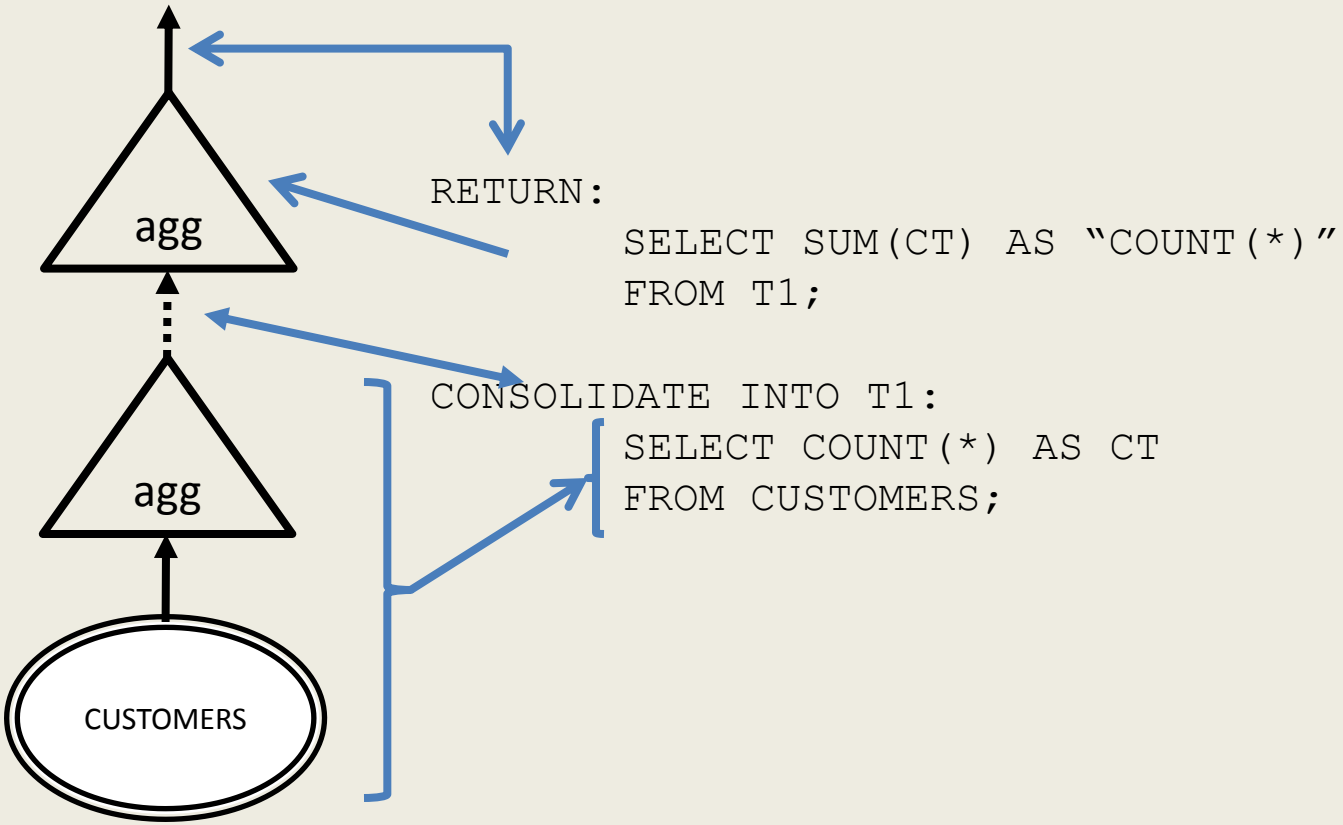

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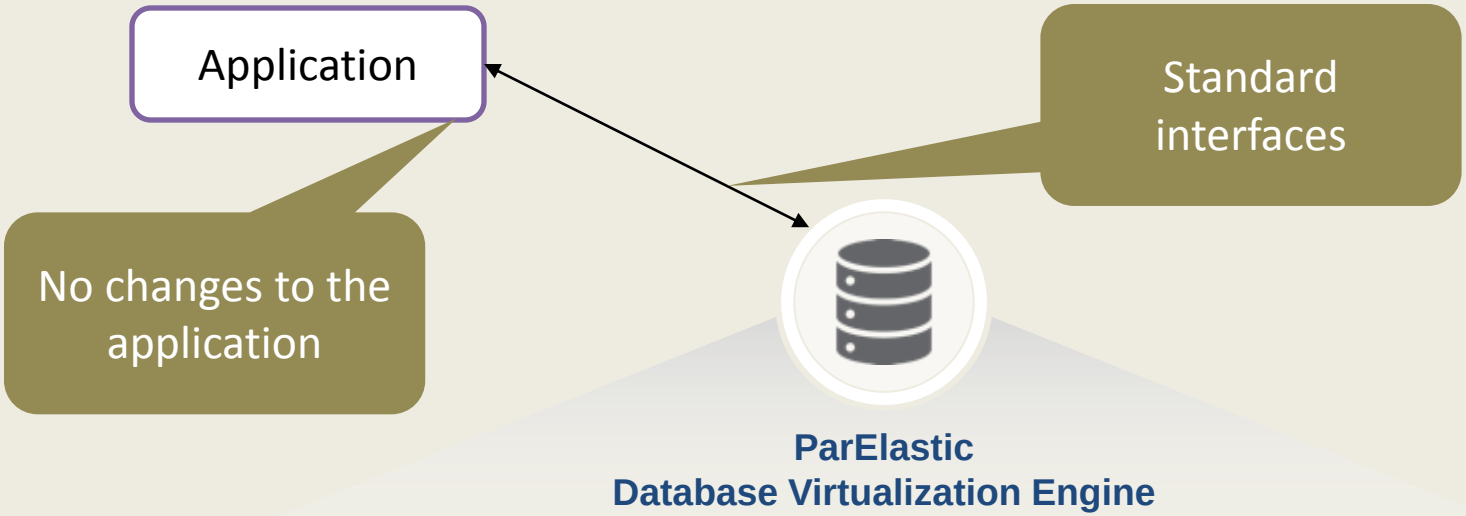
ParElastic: A parallel database



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A simple join

```
SELECT C.NAME
FROM CUSTOMERS C, ORDERS O, ITEMS I
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        AND O.IID = I.IID
        AND I.NAME = 'Bowl';
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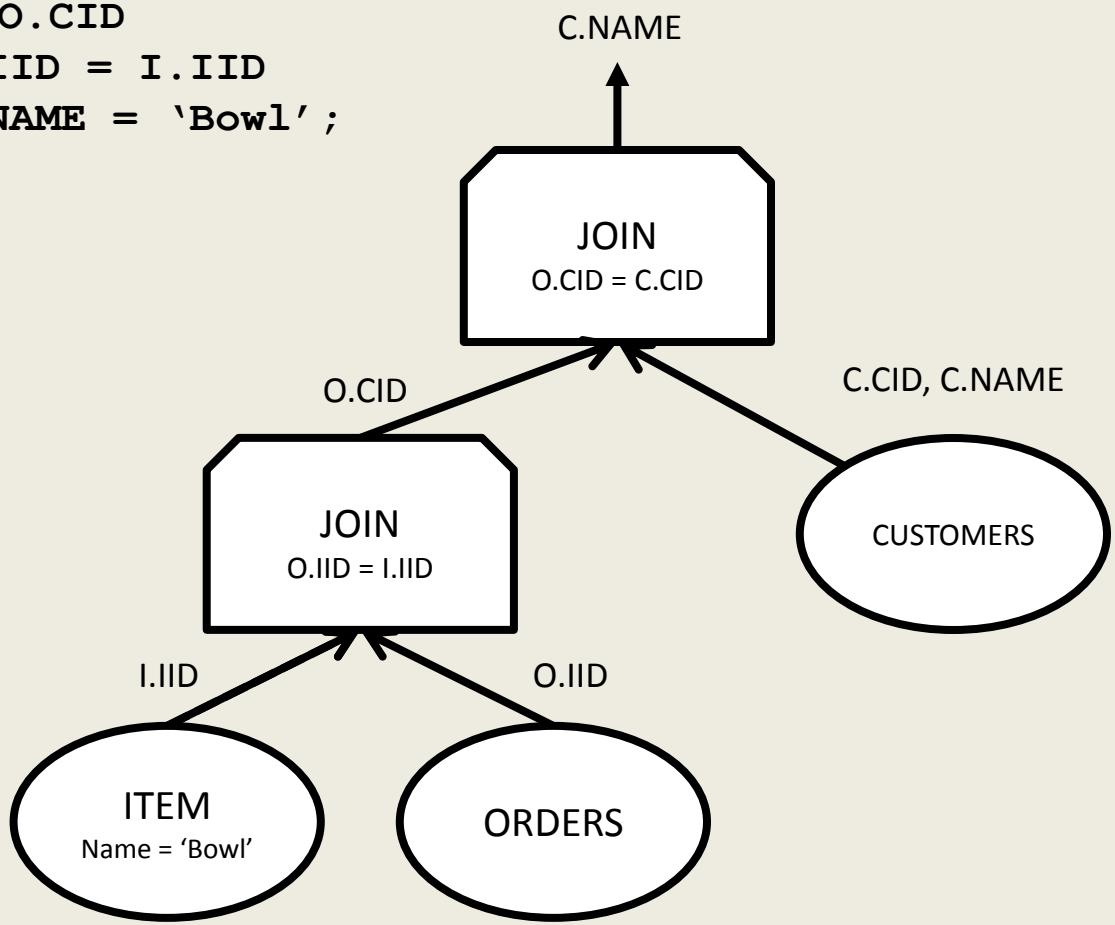

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The parallel (distributed) join

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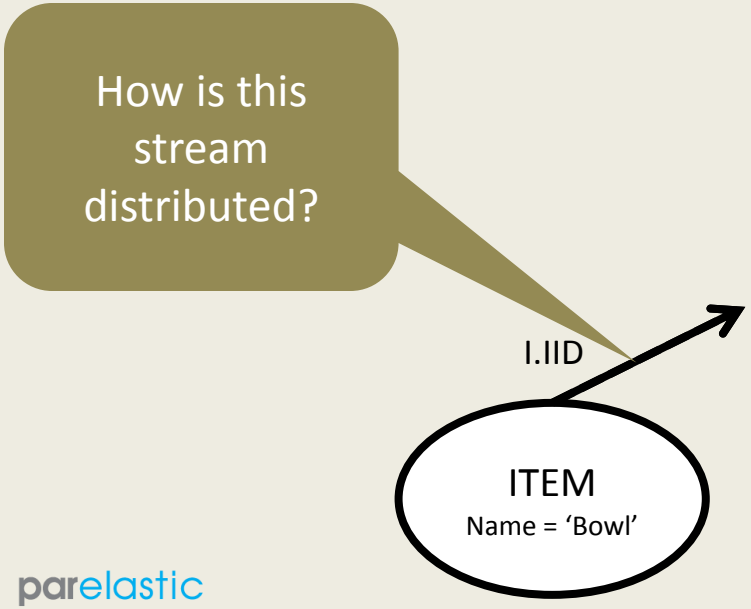

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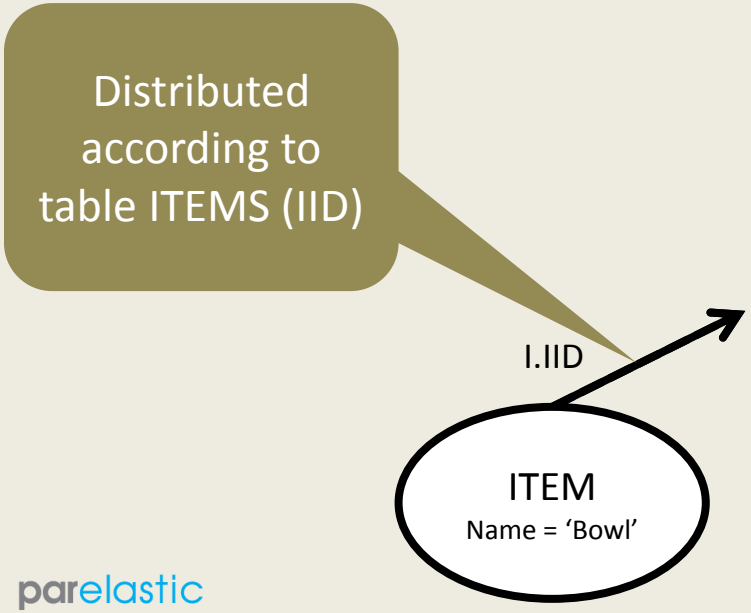

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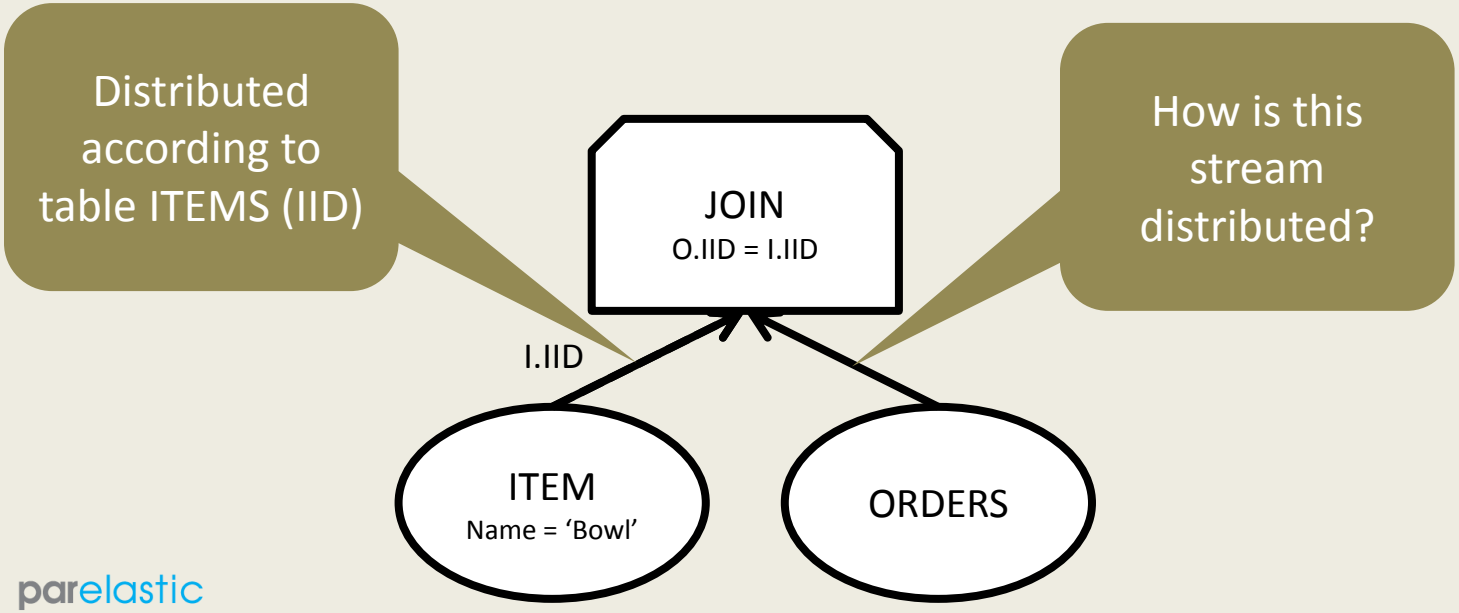

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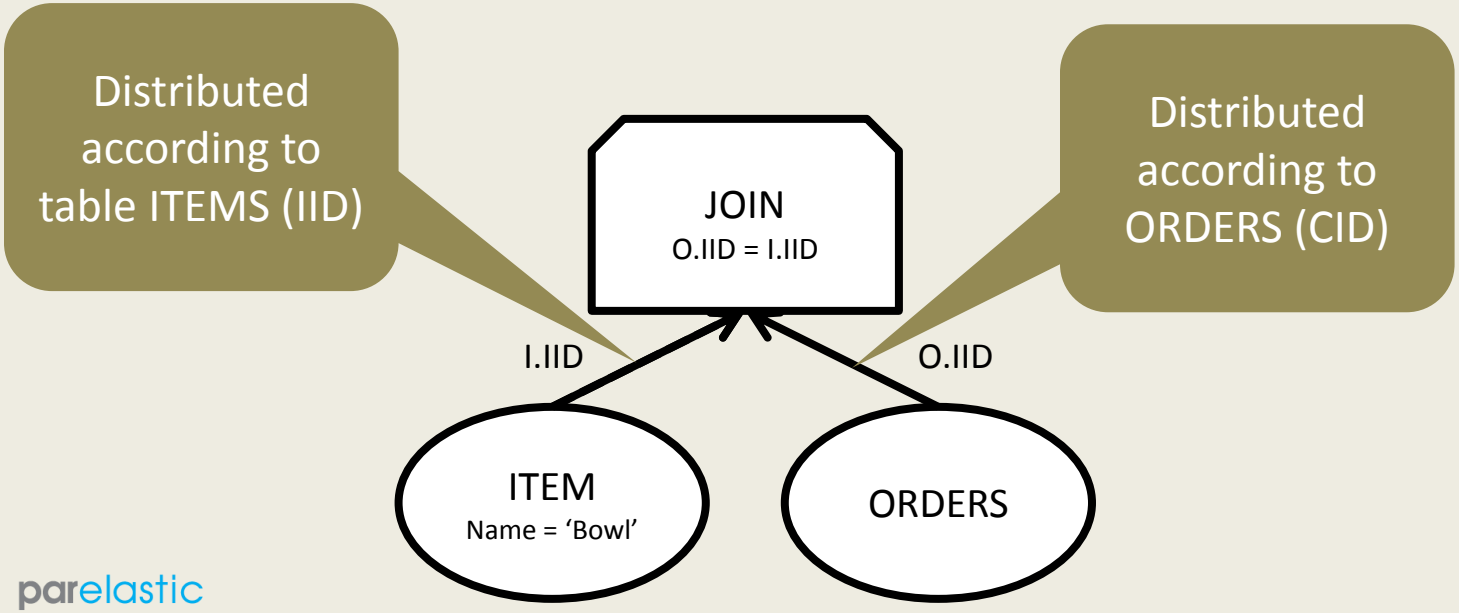

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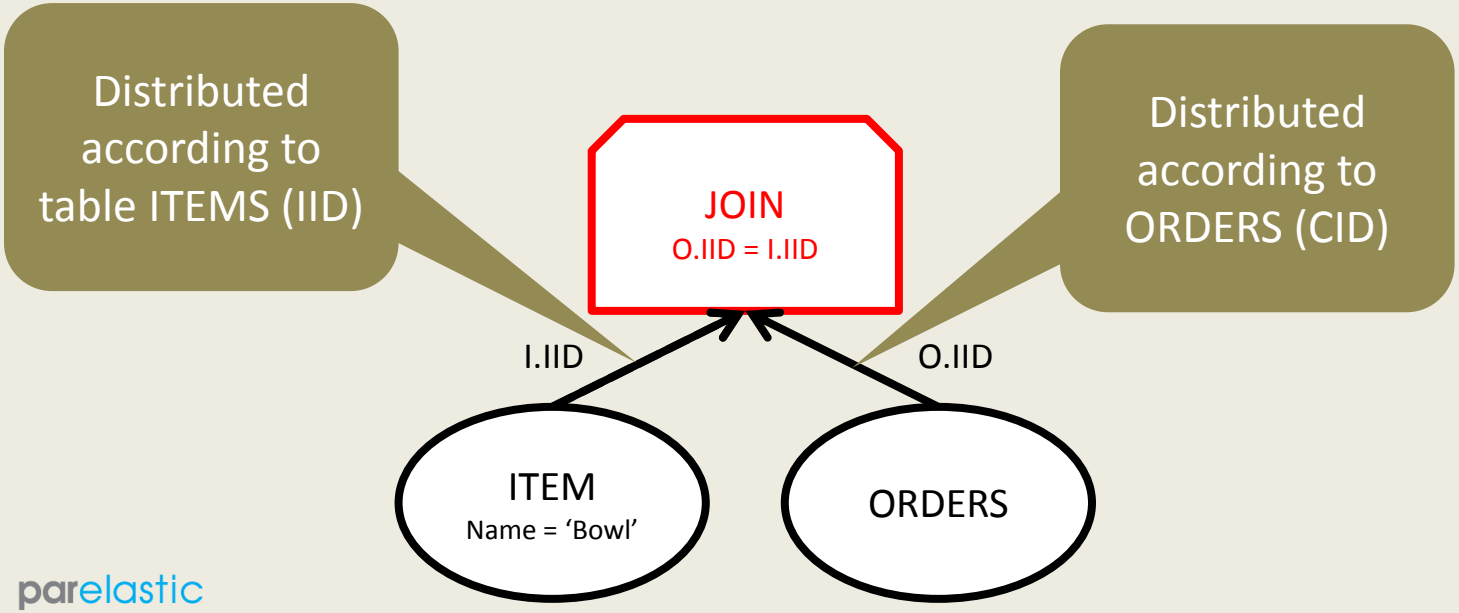

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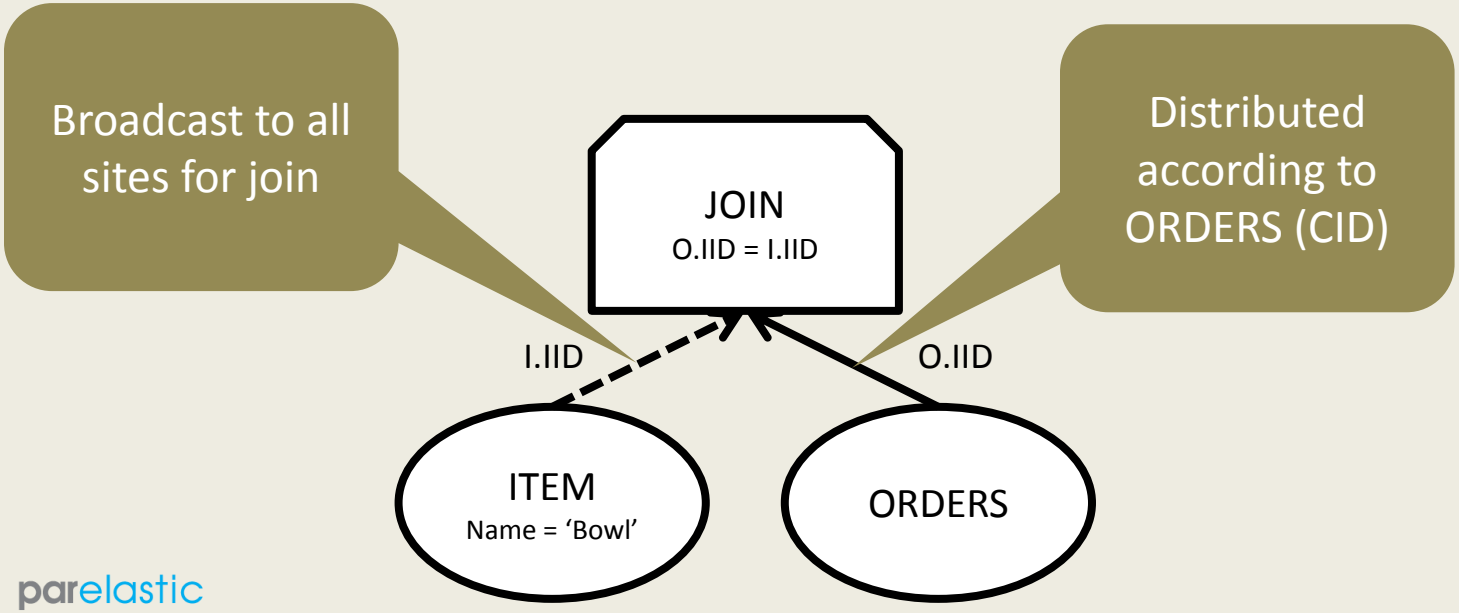

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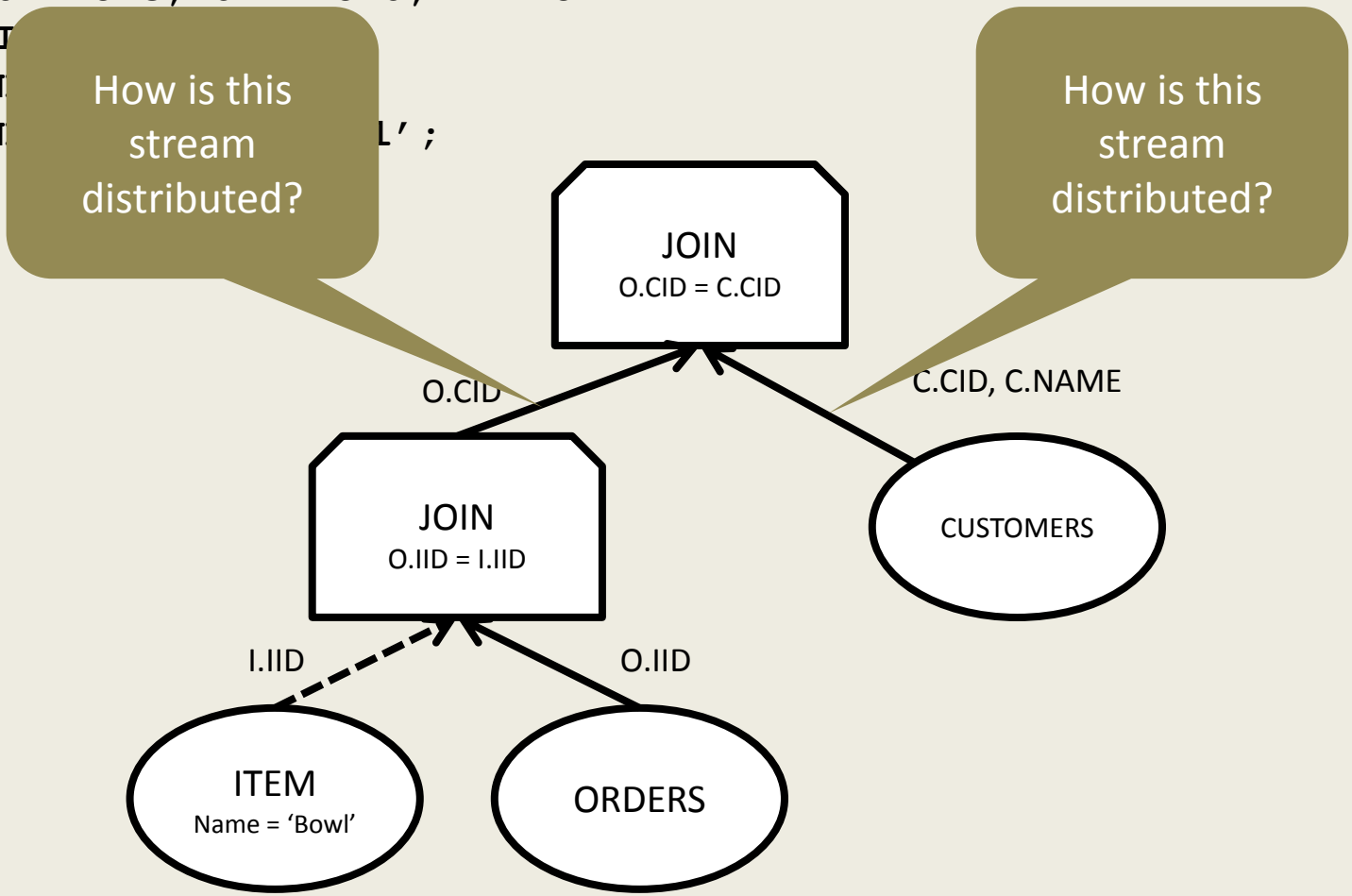
The parallel (distributed) join

```
SELECT C.NAME
FROM CUSTOMERS C, ORDERS O, ITEMS I
WHERE C.CI
        AN
        AN                    l';
```



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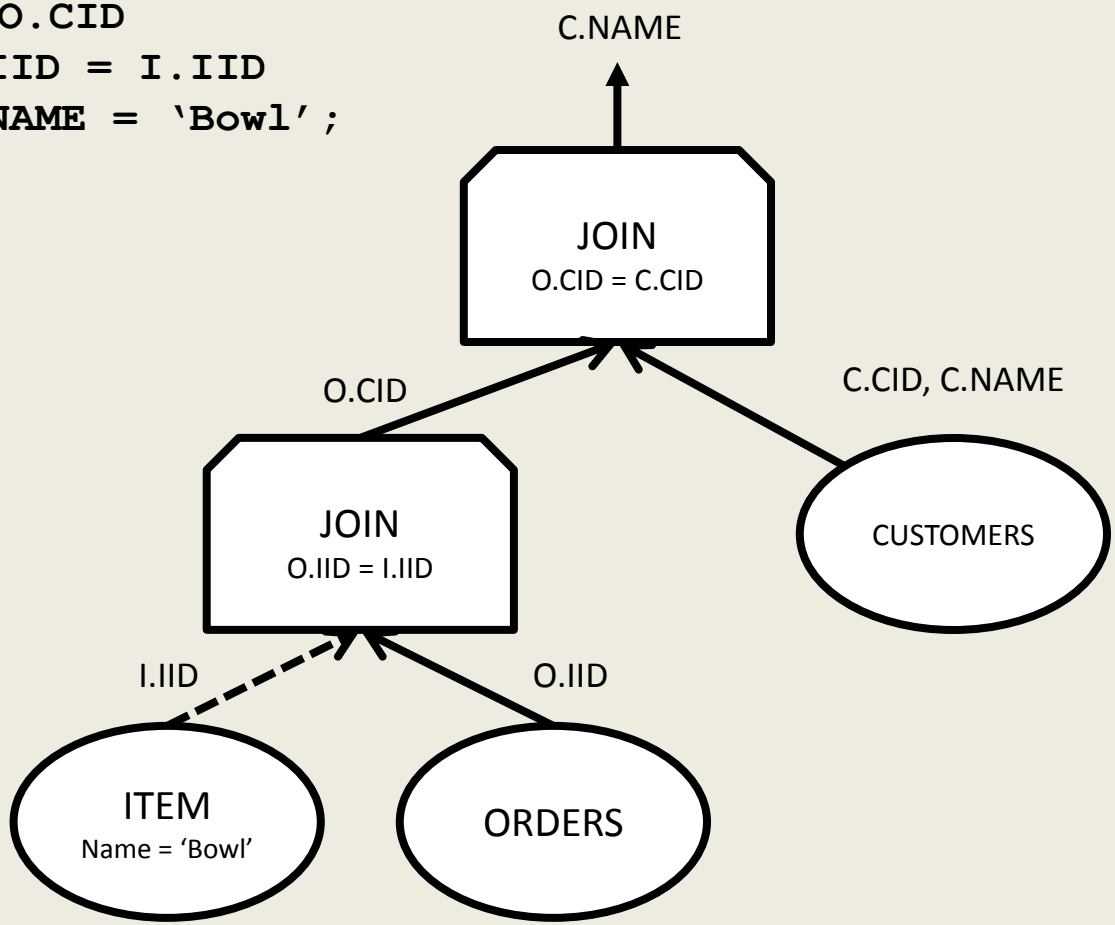

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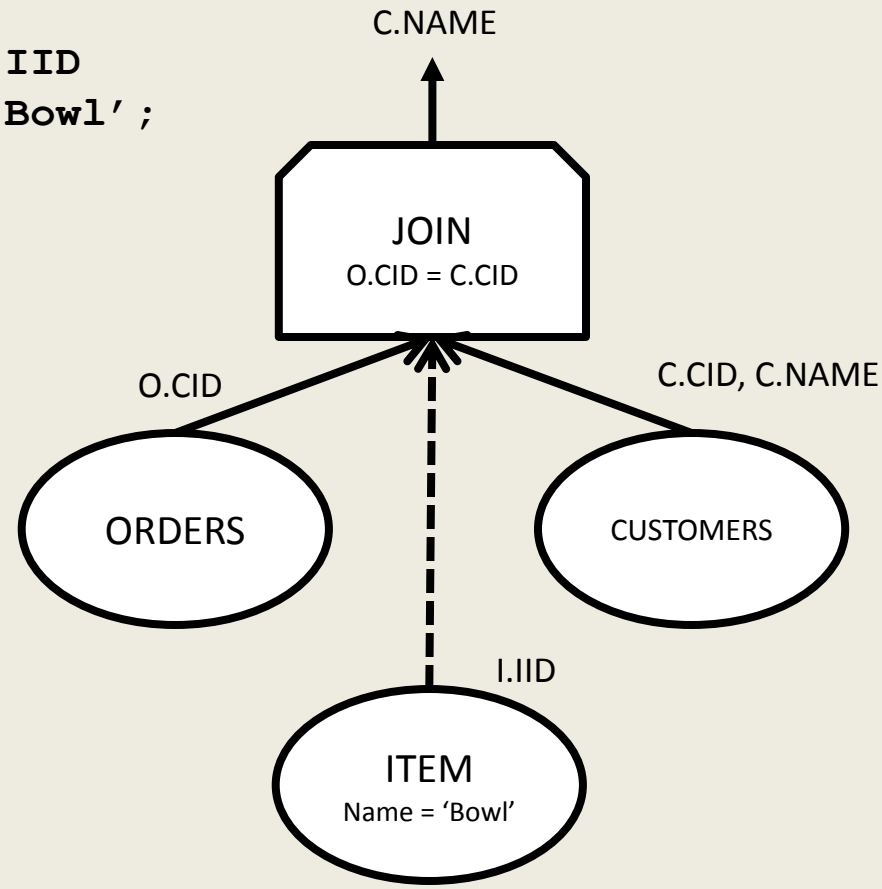

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The parallel (distributed) join

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SELECT C.NAME
FROM CUSTOMERS C, ORDERS O, ITEMS I
WHERE C.CID = O.CID
        AND O.IID = I.IID
        AND I.NAME = 'Bowl';
```
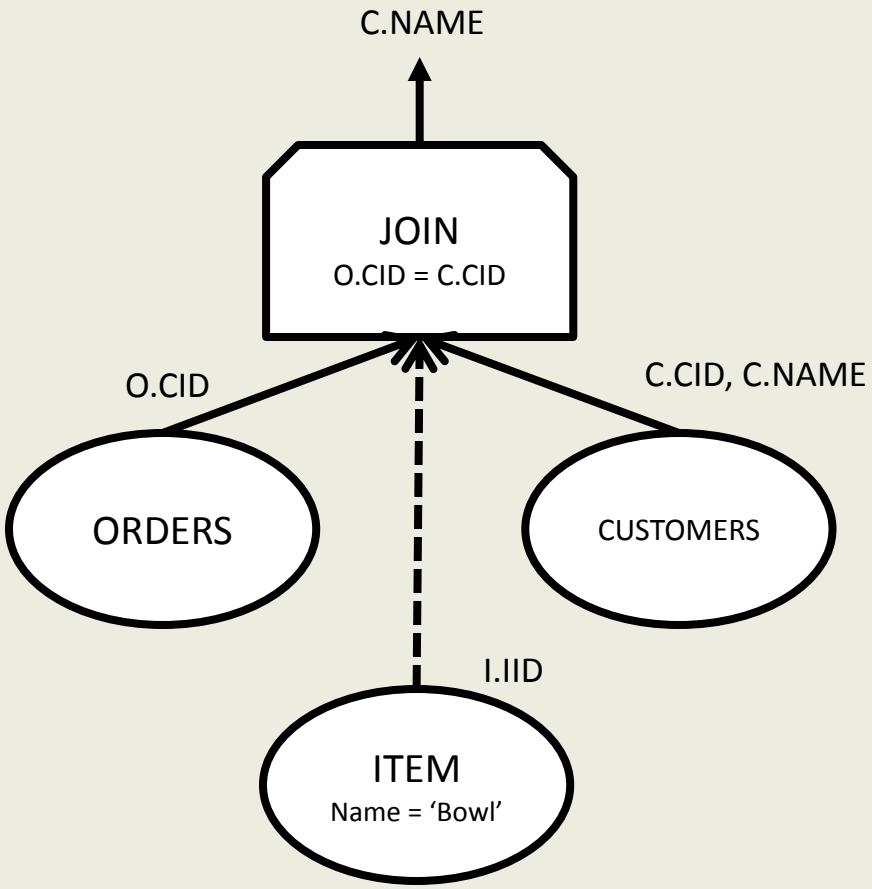

```
BROADCAST TO T1:
        SELECT IID FROM ITEMS
        WHERE NAME = 'Bowl';

RETURN:
        SELECT C.NAME
        FROM CUSTOMERS C,
        ORDERS O, T1
        WHERE C.CID = O.CID
        AND O.IID = T1.IID;
```



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Parallel Databases vs. Sharding

- Parallel Database
  - Database architecture
  - Application is data location agnostic
  - Application perceives a single database
  - Requires **no** application rewrites
- Application **is not** constrained by parallel database architecture
- A parallel database handles any schema

- Sharding
  - Application architecture
  - Application is data location aware
  - Application perceives a collection of databases
  - Requires application rewrites
- Application **is** constrained to the limitations of the sharding architecture
- Not all schemas are shard'able

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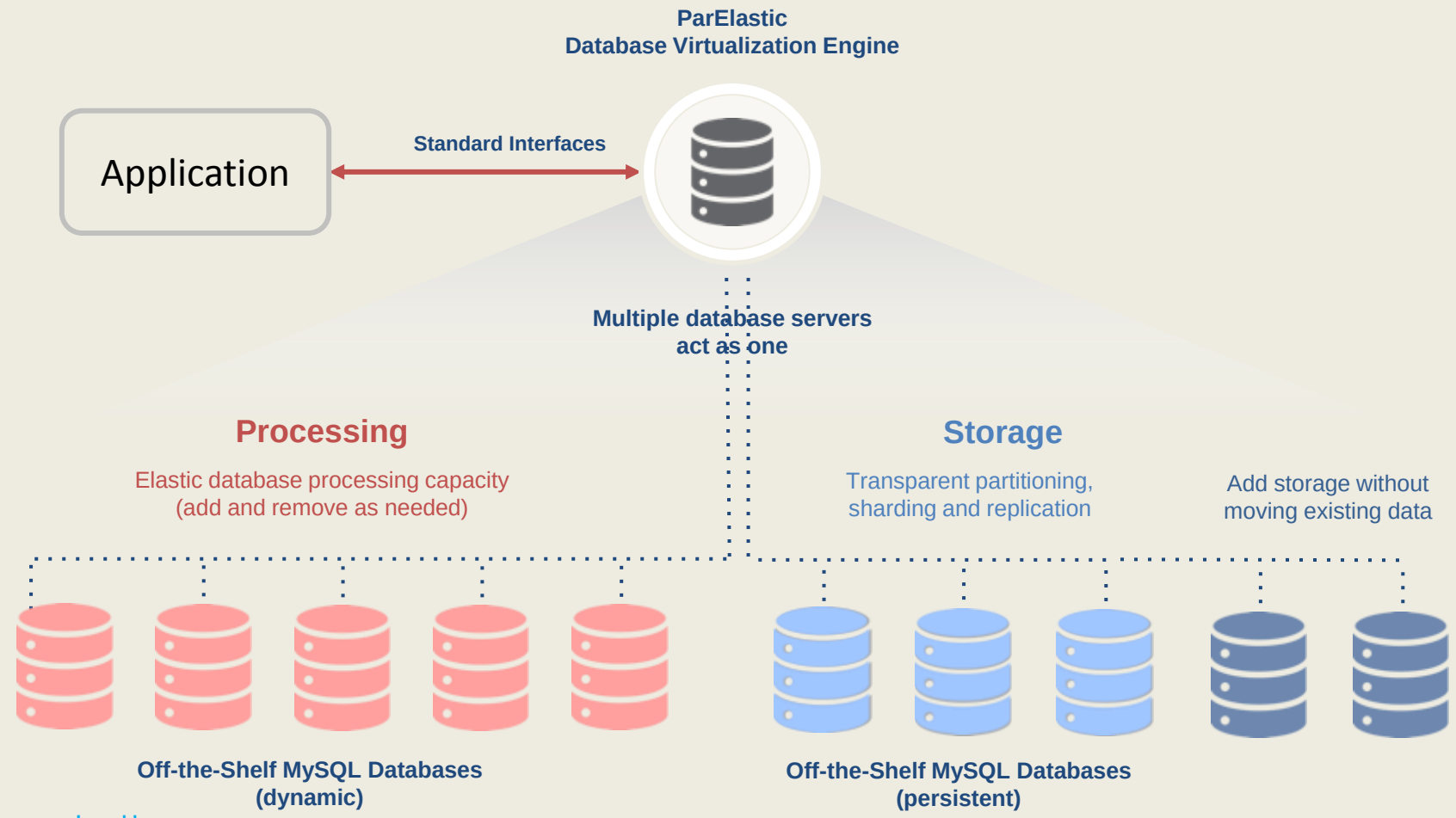
ParElastic Architecture



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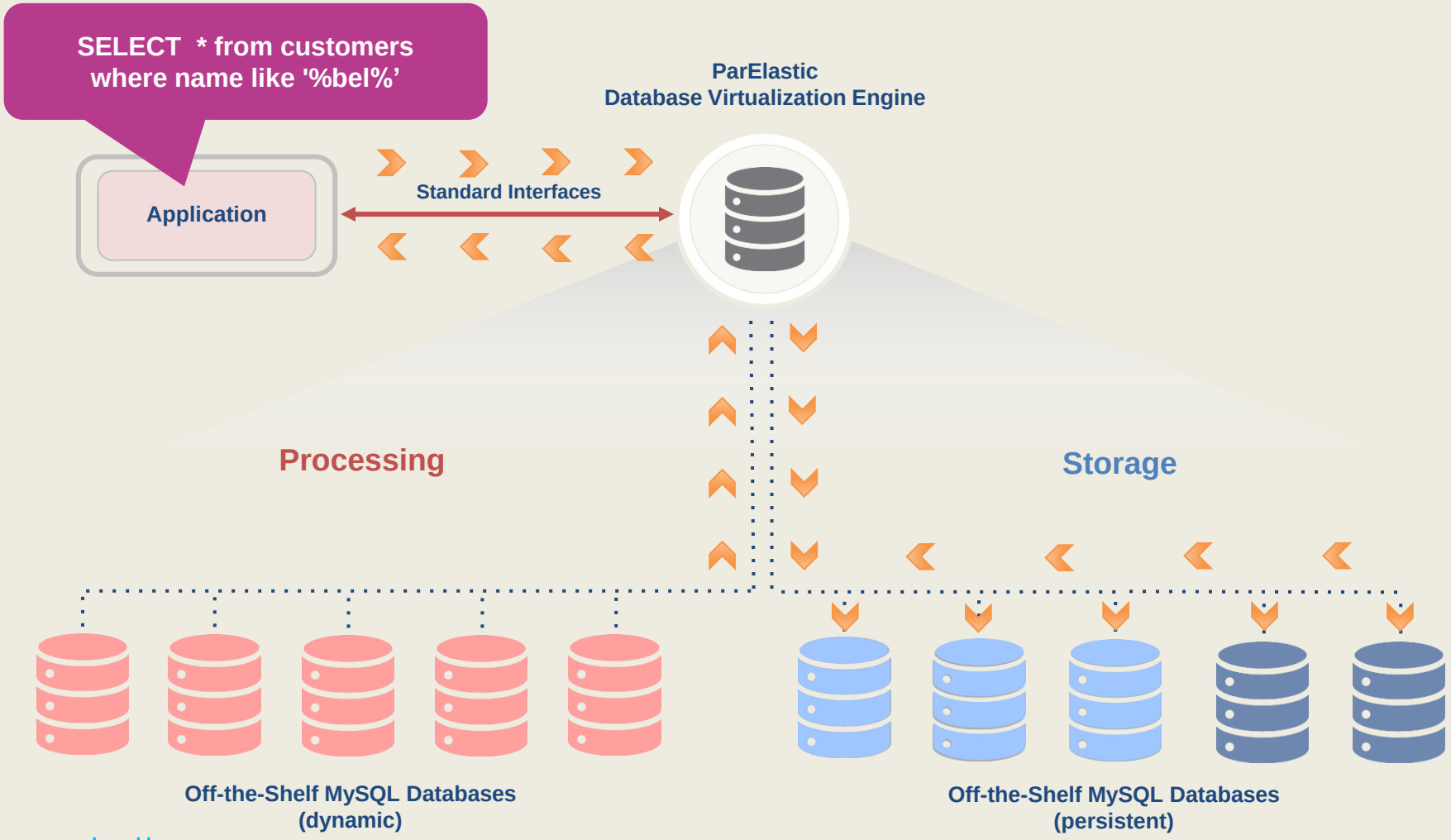
ParElastic data distribution

- Data distribution based on role in the schema
- Table data can be distributed
  - Randomly
  - Deterministically based on some attributes
  - Broadcast, XA for transaction consistency
- Other distribution methods for multi-tenancy
  - Later in this presentation

Simple Select



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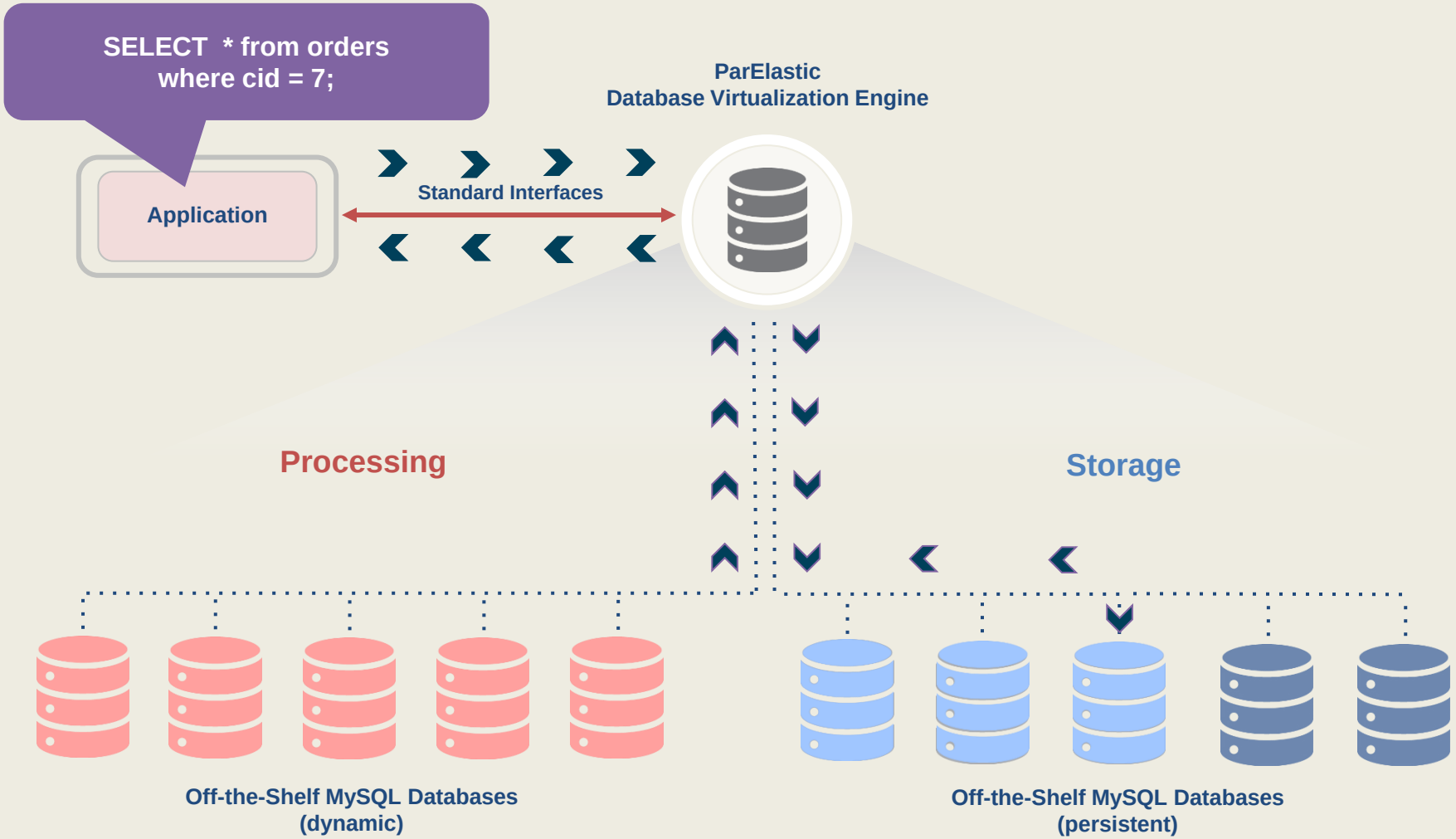
Query by Distribution Key



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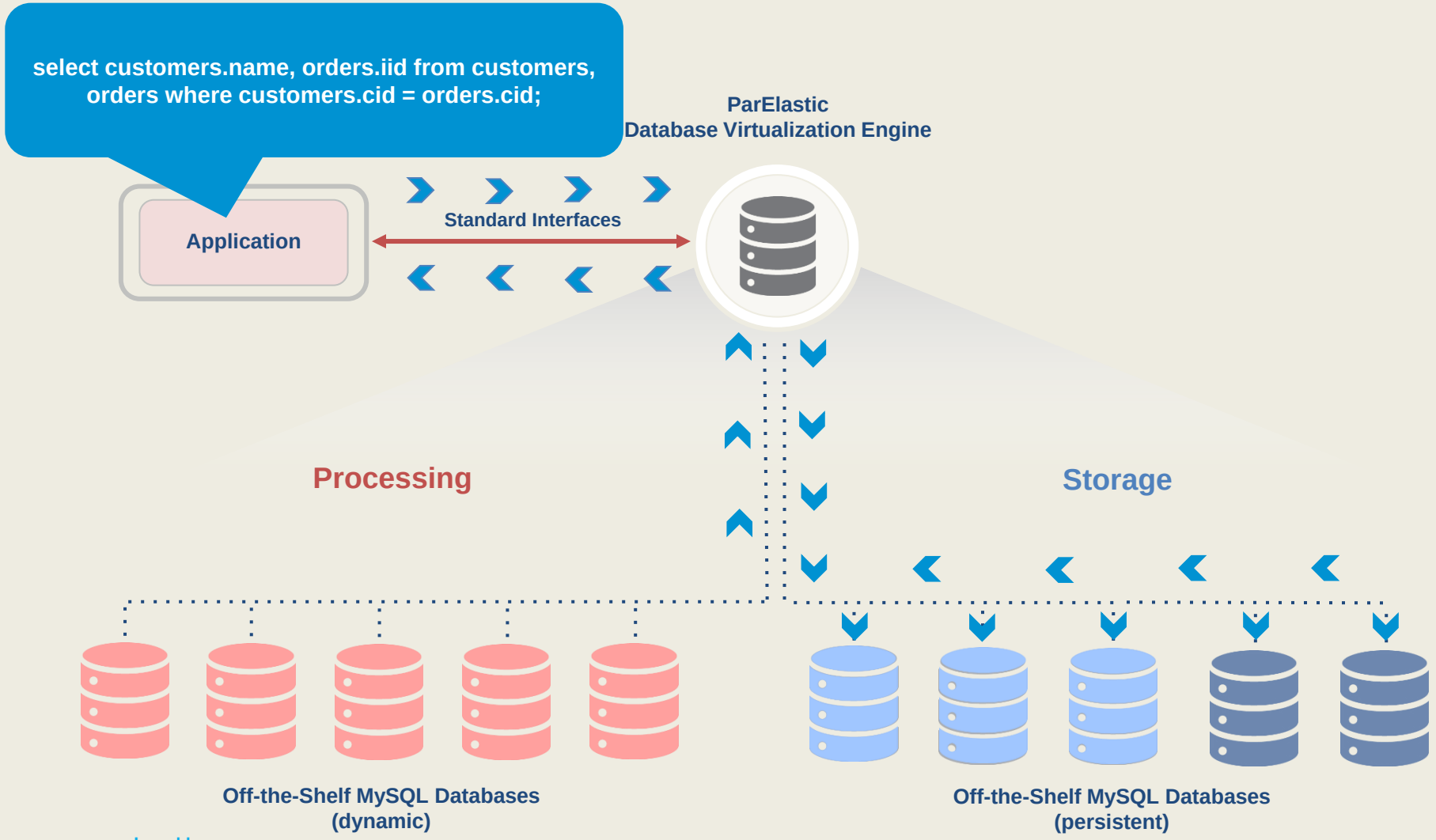
Local Join



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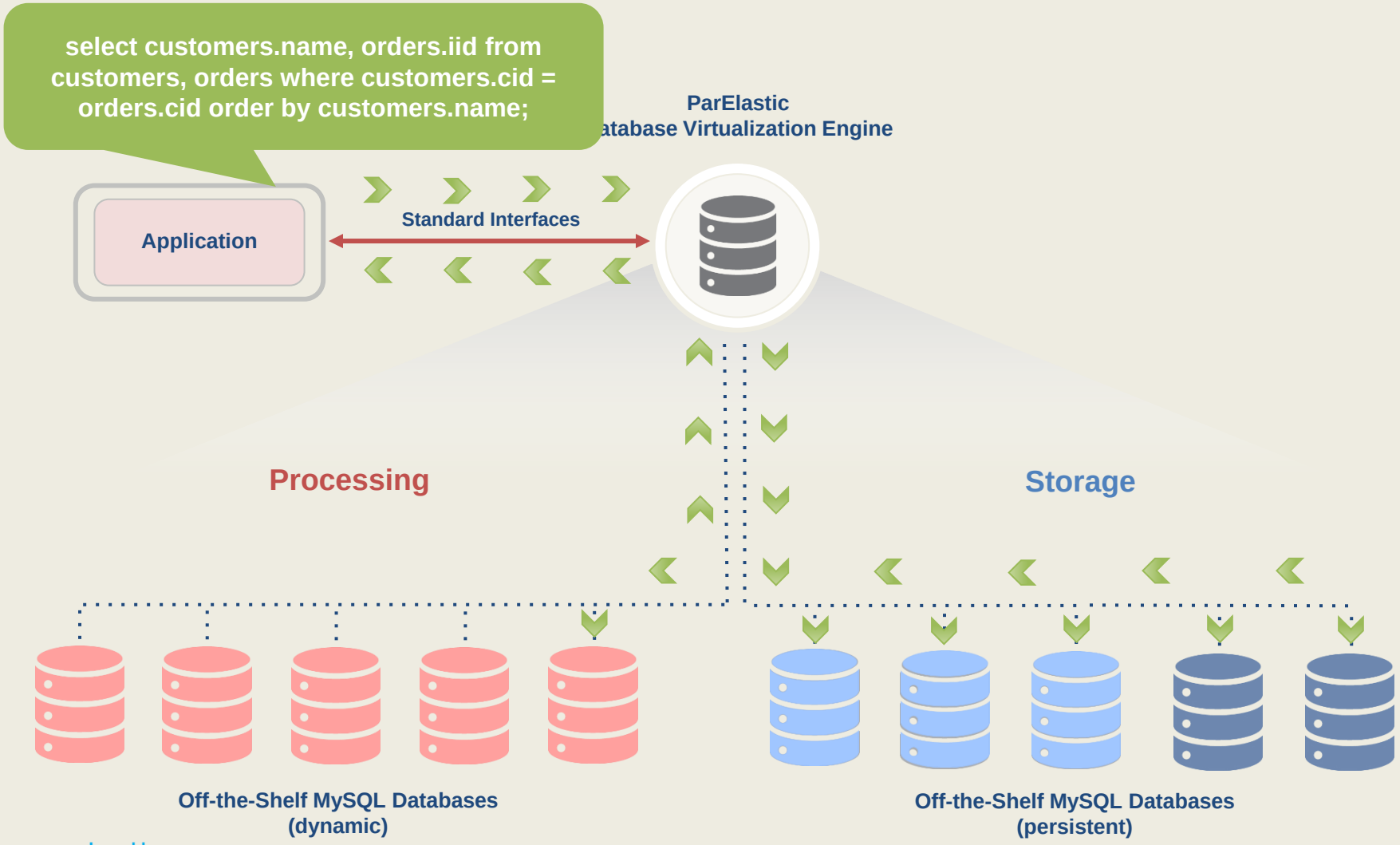
Ordered Result



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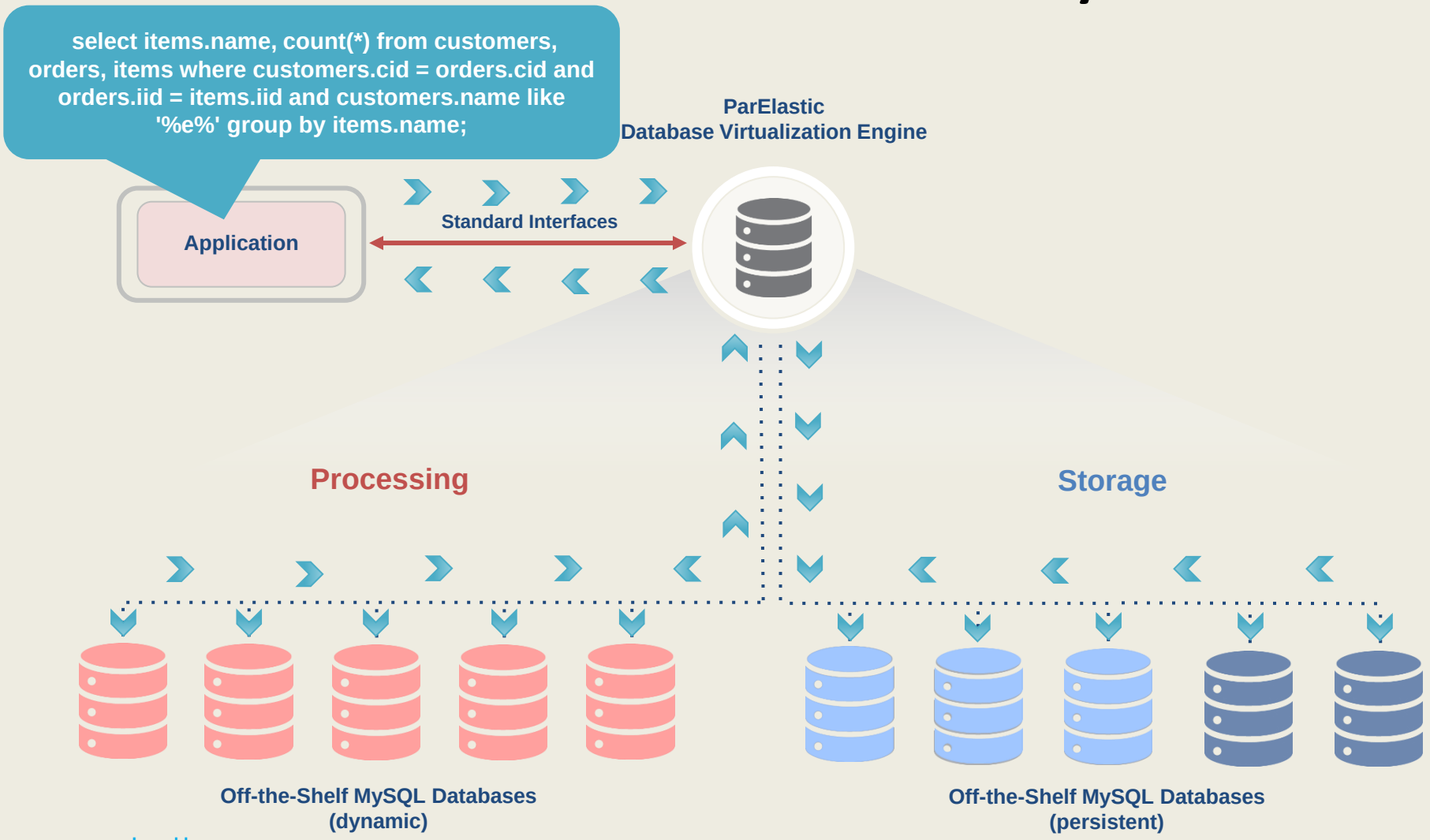
A Cross Node Query



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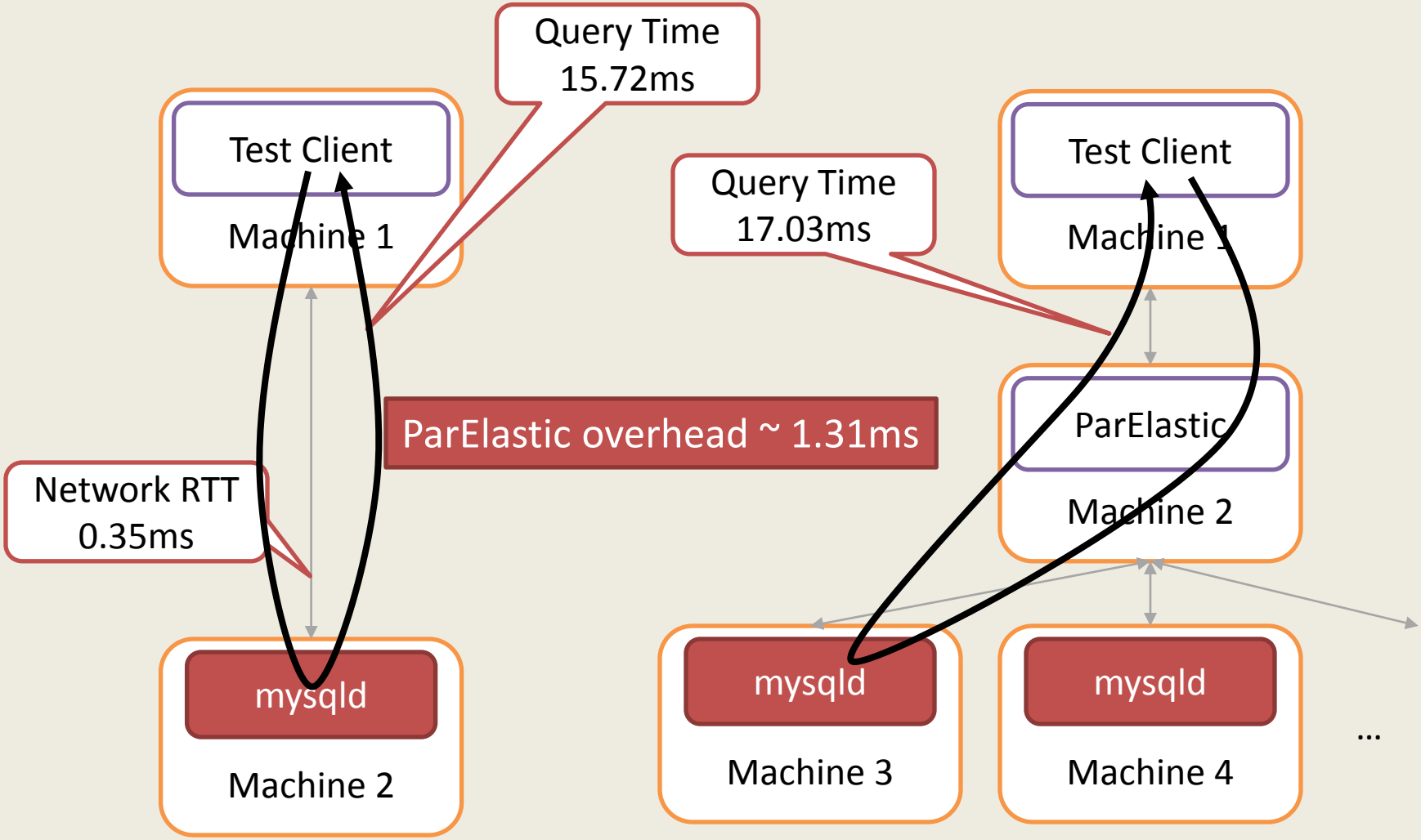
What's the overhead?



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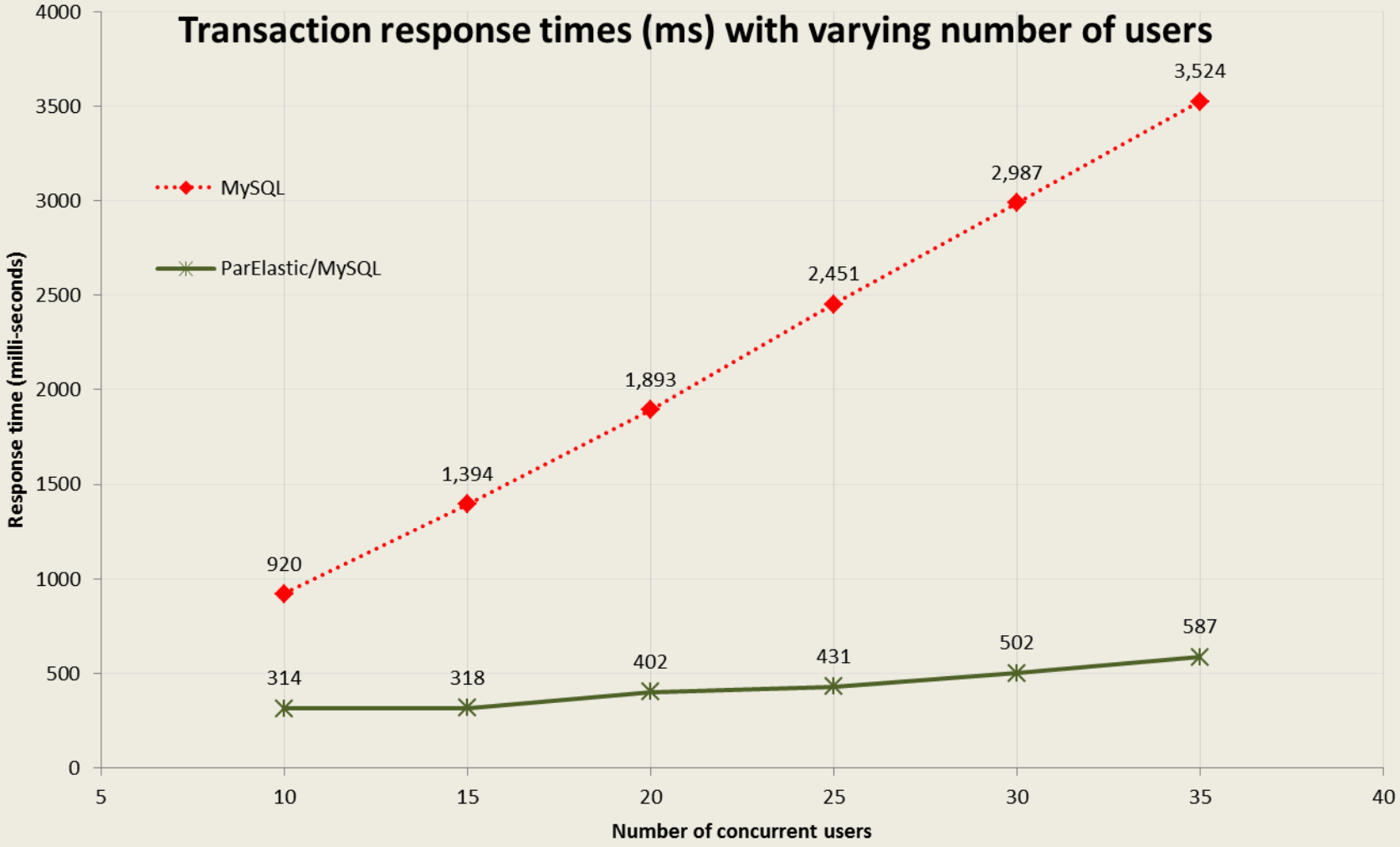
The power of parallelism



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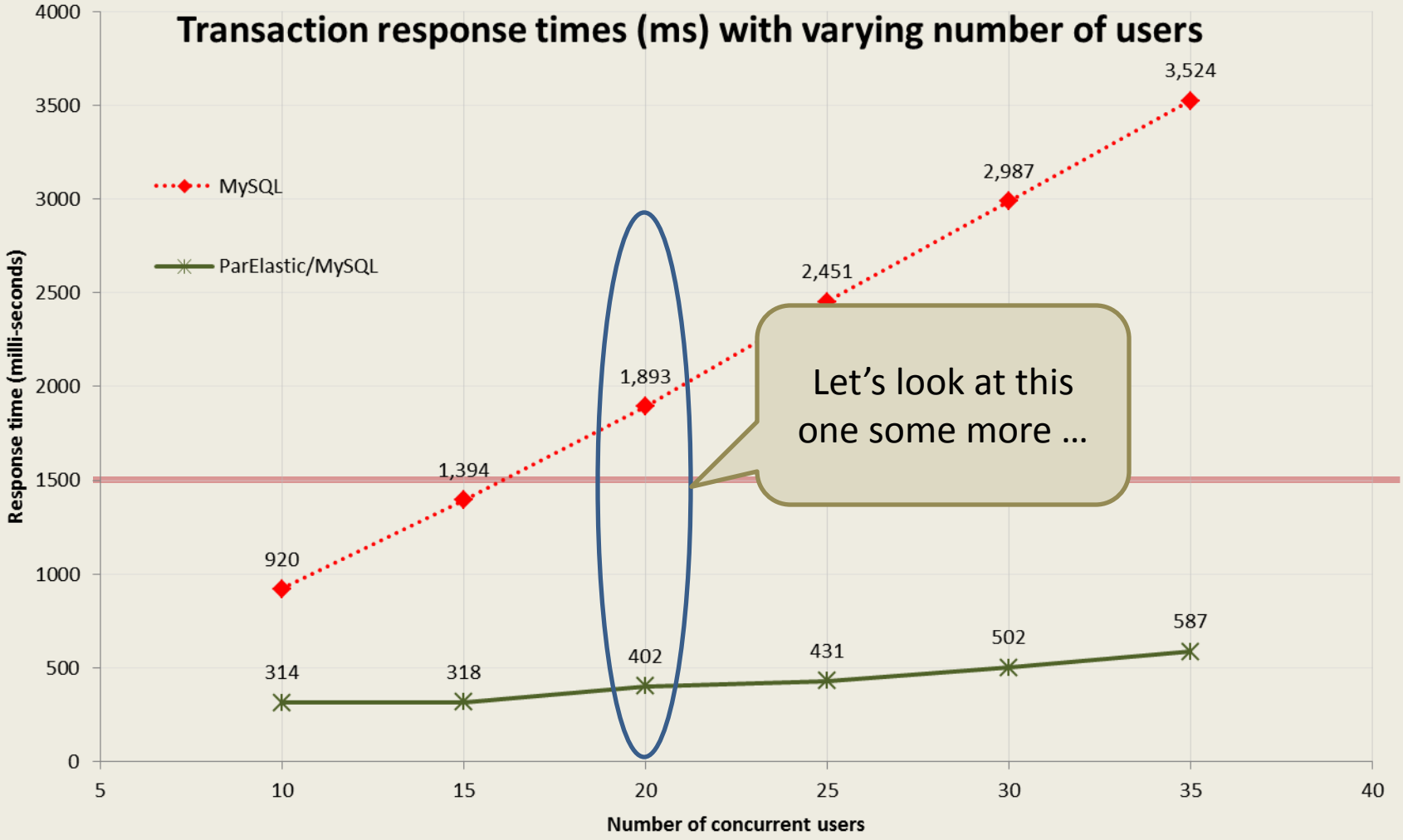
The power of parallelism



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SaaS Applications and Multi-tenancy

SaaS application multi-tenancy

	Simple MT	In application MT	ParElastic MT
	• Each tenant gets their own database & tables • Application switches to appropriate database	• Application code consolidates tenants into a single database	• Each tenant believes it has its own database and tables • ParElastic virtualizes and consolidates databases
PROS	• Simplicity • Isolation of data	• Improves utilization, reduces # databases	• Simplicity • Isolation of data • Rolling upgrades • Customizations supported
CONS	• Many databases causes performance issues • Bad neighbor effect	• Code complexity • Bad neighbor effect • Lock-Step Upgrades • Restricts customization	

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ParElastic Adaptive Multi-Tenancy

- Drupal: A SaaS Application
- Tens of thousands of Drupal sites
- Each site has its own database
  - With its own tables and data
  - Schema customizations / modules
  - Thousands of MySQL servers
- Thousands of Application Servers
  - Rolling software upgrades
  - Some with schema changes

Acquia™

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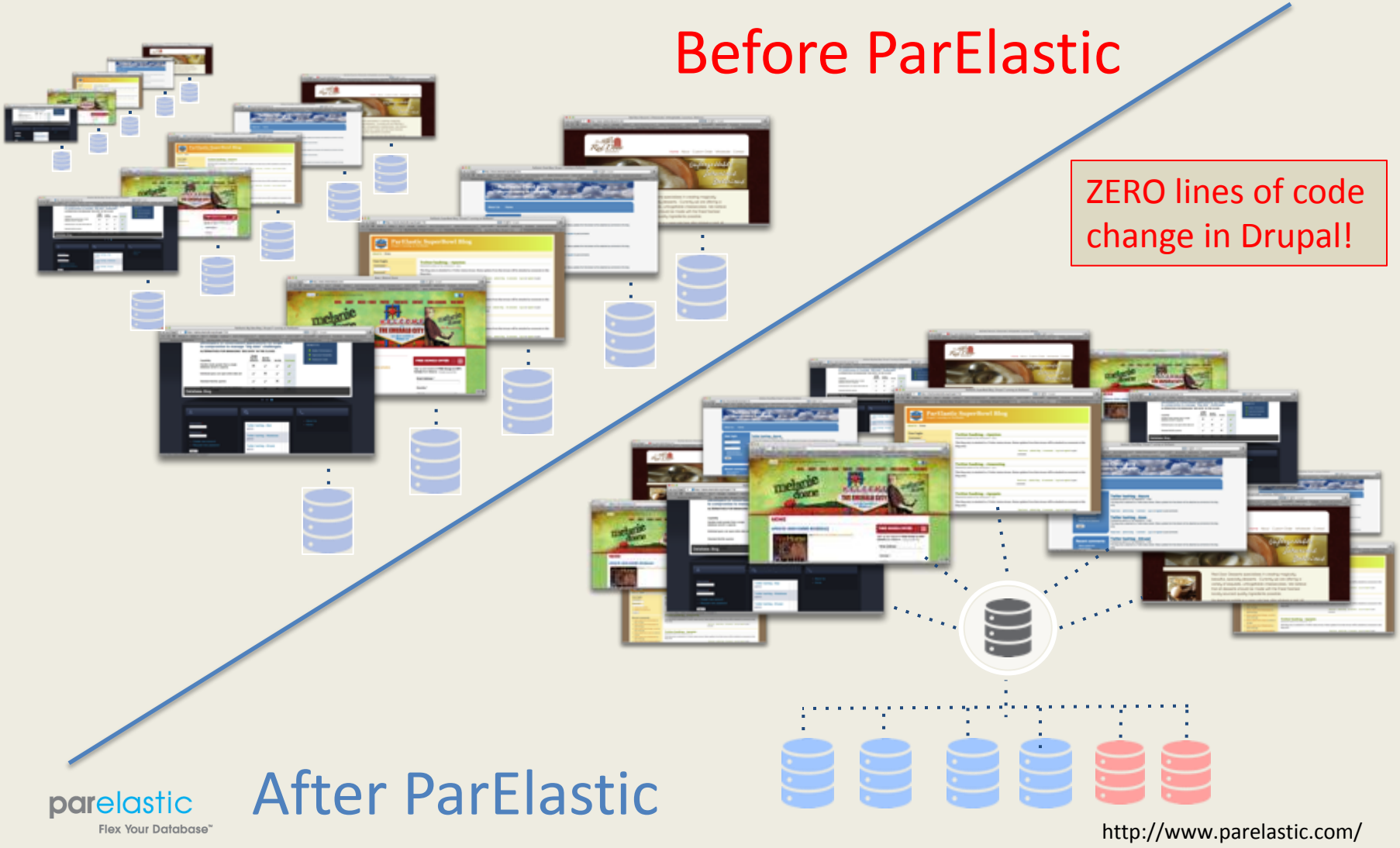
Database Scalability at Acquia



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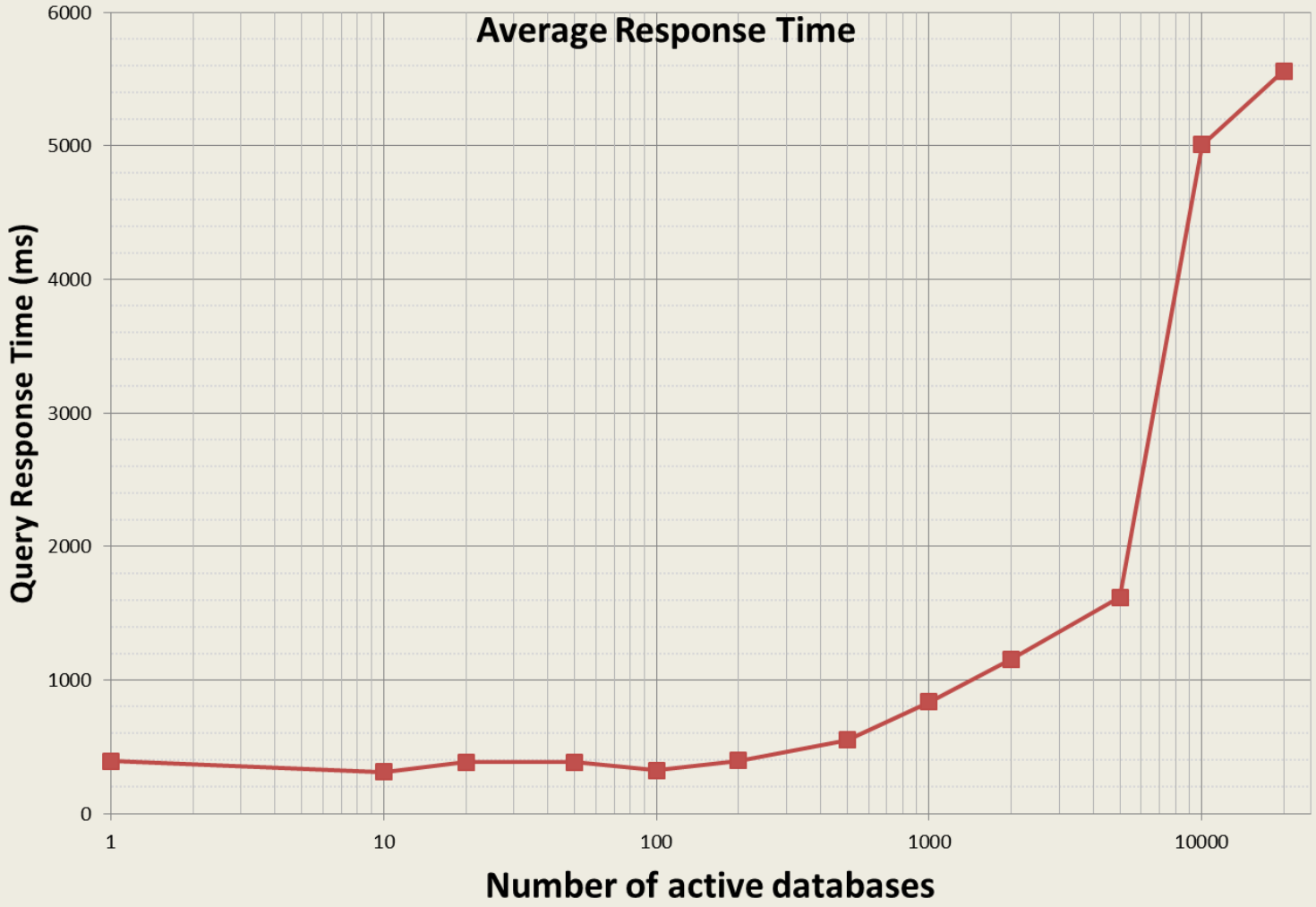
Impact of large database count



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ParElastic data distribution

- Data distribution based on role in the schema
- Table data can be distributed
  - Randomly
  - Deterministically based on some attributes
  - Broadcast, XA for transaction consistency
- Multi-tenant systems use all of the above plus
  - Tenant based distribution semantics

And now, a demonstration

The demonstration

- It's hard to demonstrate plumbing
  - Much easier to demonstrate a faucet!

- We demonstrate a Drupal site powered by ParElastic
- And to simulate traffic
  - We ingest data with specific #hashtags from Twitter
  - So go ahead and tweet with #mysql or #parelastic and you will generate traffic for the demo

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So what's ParElastic?

- A local start-up
  - Based in Waltham, R&D office in Toronto
  - We're hiring!
- ParElastic is Database Virtualization Software
  - Make groups of MySQL databases act as one
  - The cardinality of the group can change
    - Based on data size
    - Based on workload

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I want it, where can I get it?

- We're in closed beta
  - Working with some very exciting early adopters
  - Happy to work with you as well!

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