Vertica and Spark: Connecting Computation and Data

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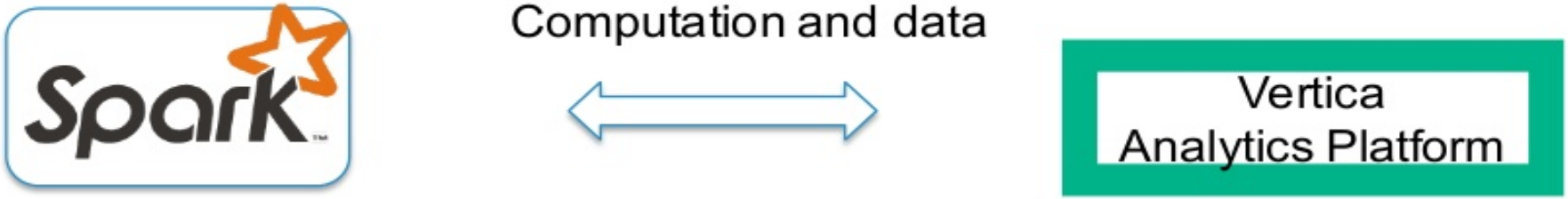
Overview

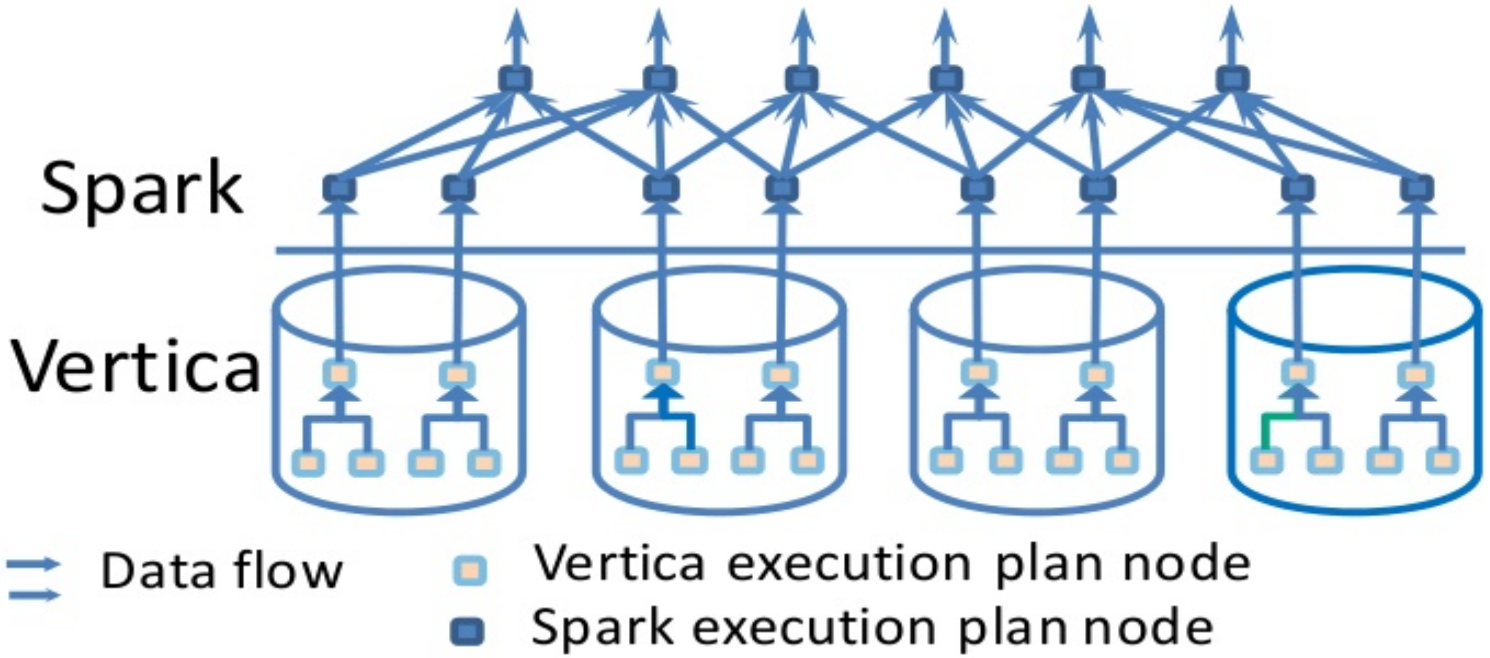


- The Vertica-Spark connector connects both data and computation between Vertica and Spark
  - VerticaRDD and Vertica Data Source APIs
  - Data-locality optimization
  - Computation pushdown
  - Save data from Spark to Vertica

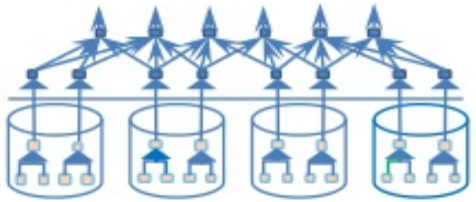
HPE Vertica

- An advanced SQL analytics platform
- Shared-nothing MPP architecture
- Column-oriented storage organization
- Standard SQL interface with many analytics capabilities built-in
- Extensible via User-Defined Functions

Connected pipeline



Connected pipeline

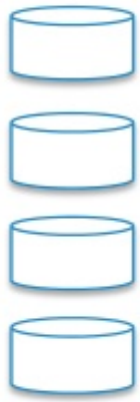


- Connects the computation pipelines of Spark and Vertica in an optimized way
- Utilizes parallel channels (parallel queries) for data movement
- Leverages data-locality optimization on Vertica
- Ensures computation push-down into Vertica as appropriate (filters and projections)

Vertica data segmentation on hash ring

CREATE TABLE t …
SEGMENTED BY HASH(id) …

Id	Name	Age	email	…

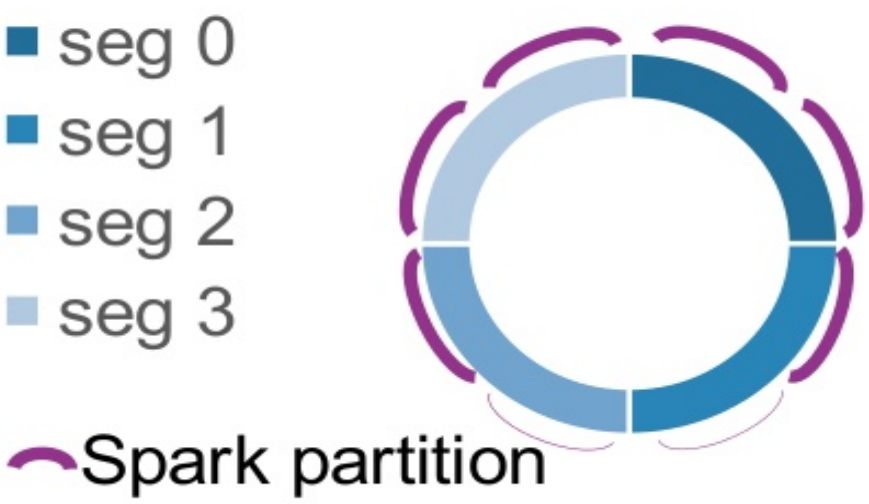


Spark locality-aware partitions

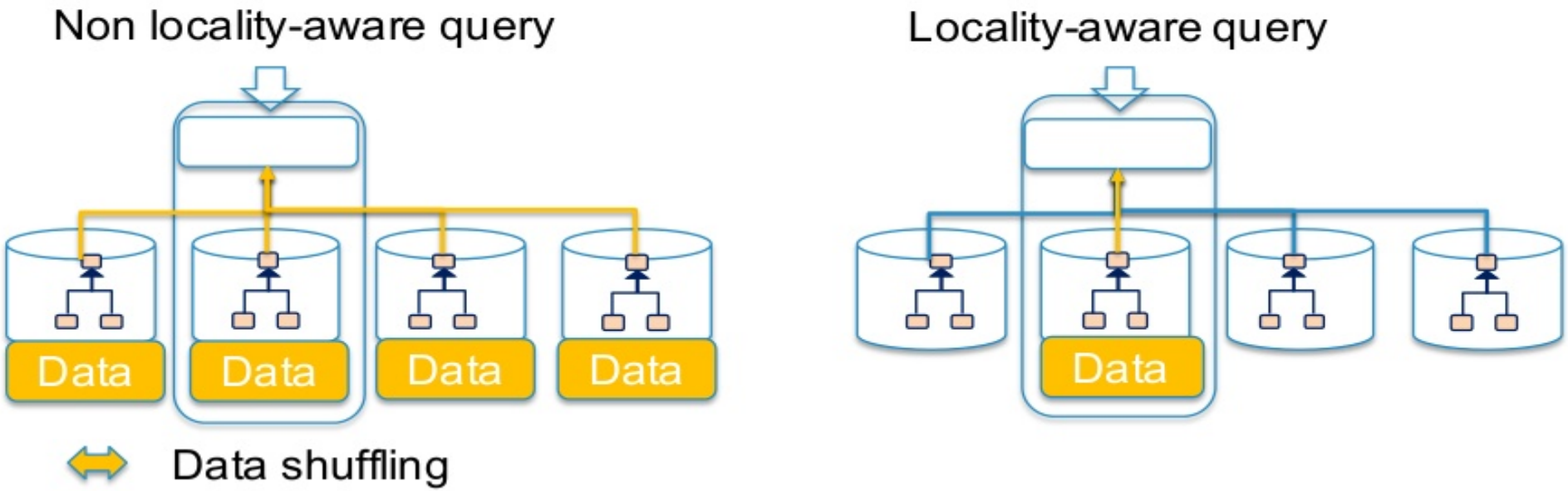
Locality-aware partition:

- Uses Vertica data-distribution information
- Generates locality-aware queries

```
SELECT id, name  FROM T
where
   0 < 0xffffffff & hash(id)
AND
   0xffffffff & hash(id) < 278985;
```

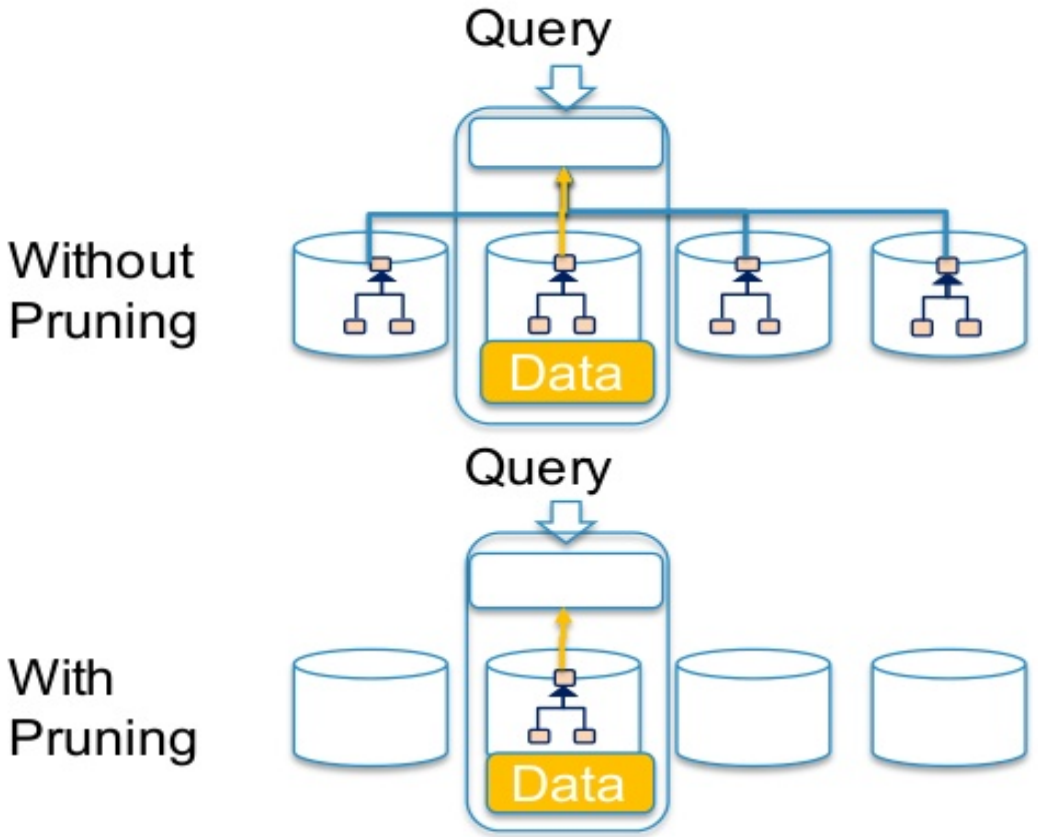


Locality-aware query



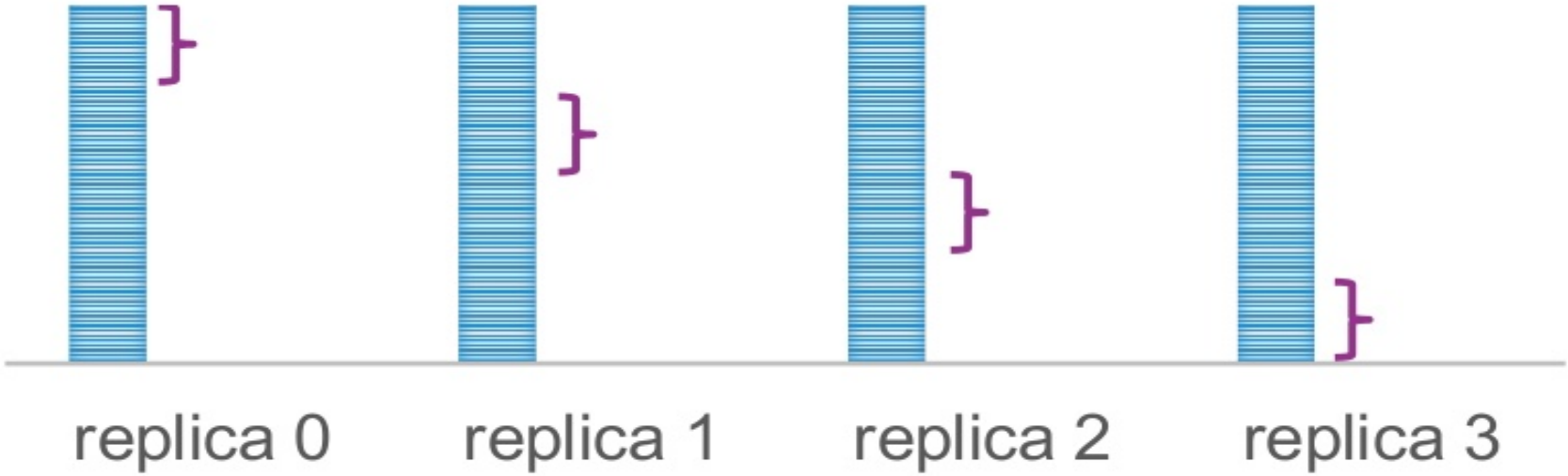
Vertica query pruning

- For a locality-aware query, the execution can be pruned
- Query only executes on nodes that contain the data

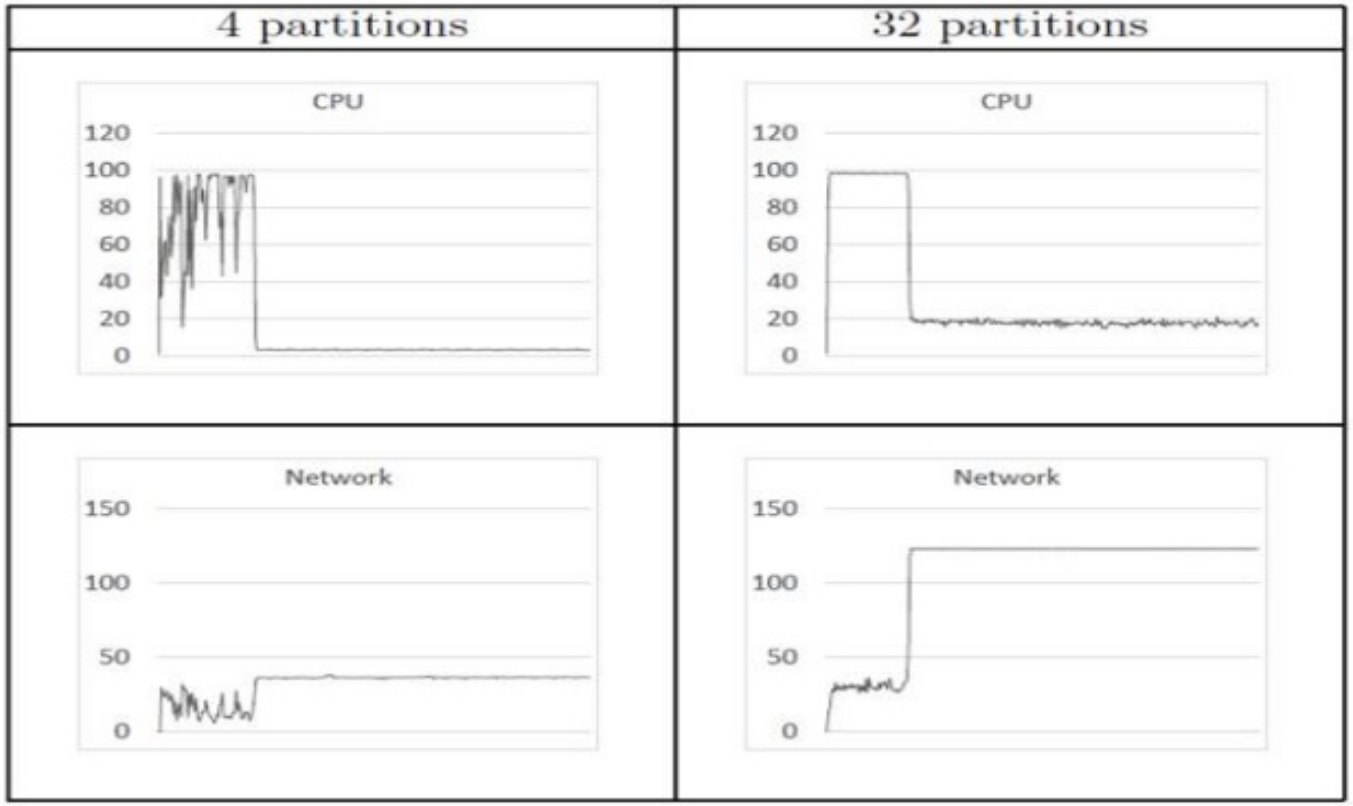


Arbitrary number of partitions

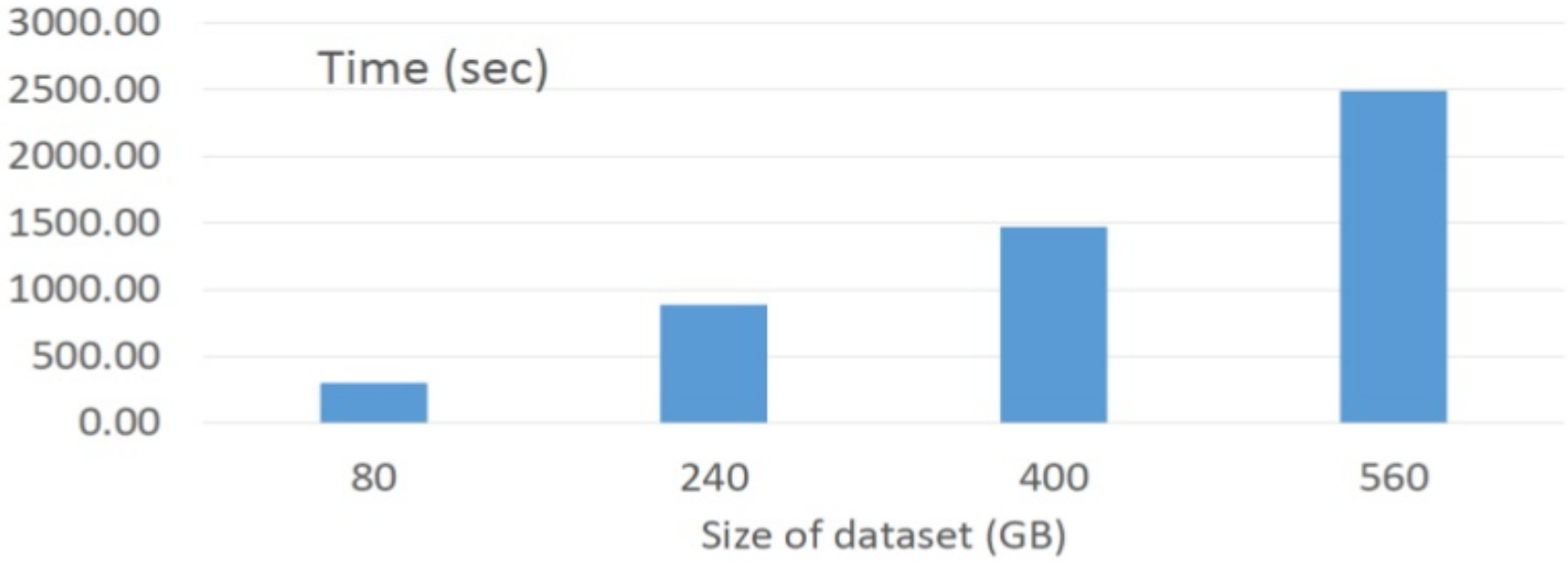
Spark partitions over unsegmented table replicas



Performance characteristics

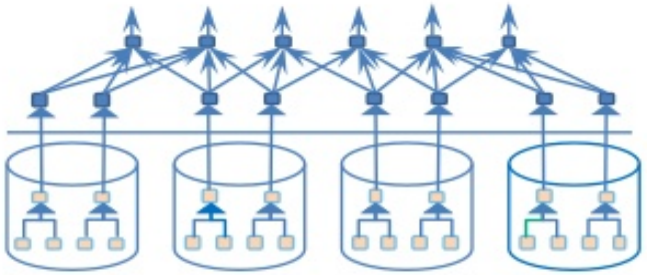


Scalability of throughput



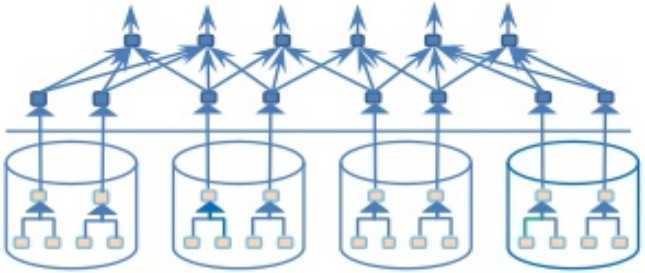
Computation push-down

- Implemented:
  - Filters
  - Projections
  - Count(*)
- Works in progress:
  - Joins
  - Aggregations
- Future work:
  - User-Defined Functions



Computation push-down schemes

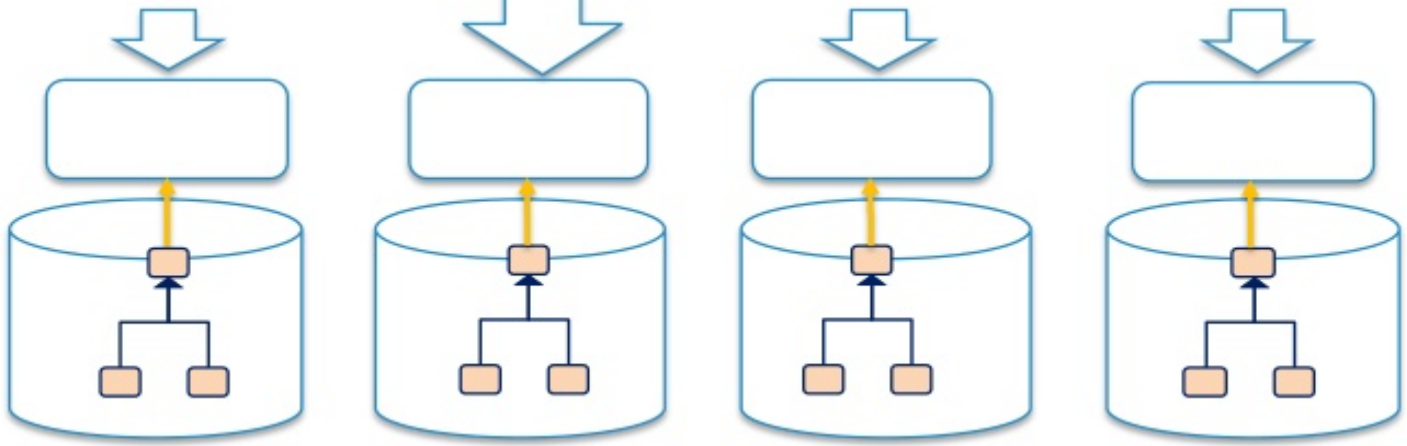
- Per-tuple computation (filtering, projection)
  - Always pushed down
- Joins & aggregations
  - Locality-aware: when join and aggregation keys are co-segmented in Vertica
  - Single query: run single query with join/aggregation inside Vertica



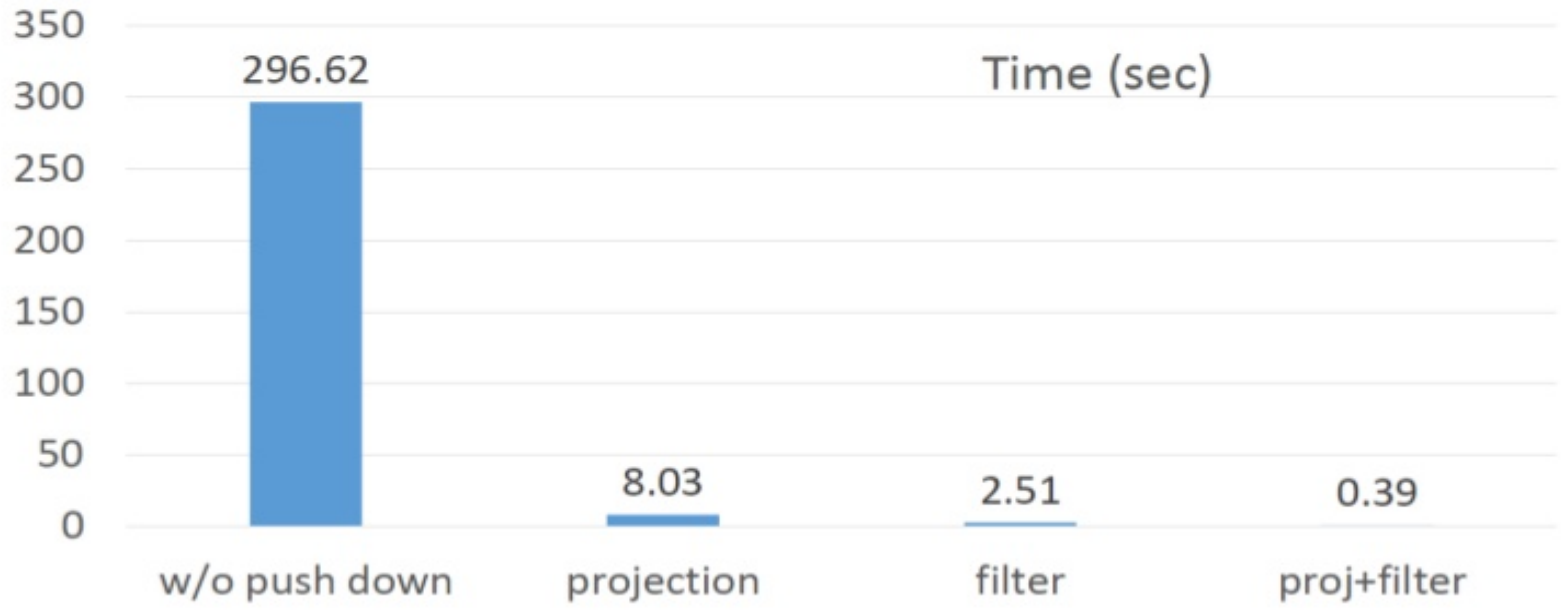
Original Query: select c,d,f from A JOIN B on A.foo = B.foo

Locality-aware push-down query:

```
select c,d,f from
A JOIN B on A.foo = B.foo
where
0 < 0xffffffff & hash(foo) AND
0xffffffff & hash(foo) < 278985 …
```



Performance Impact of Pushdowns



Vertica Analytics

- Geospatial analytics
- Sentiment analysis
- Sessionization of event streams
- Time series pattern matching
- ... (Many more)

The Other Direction

Spark as an ETL Engine for Vertica

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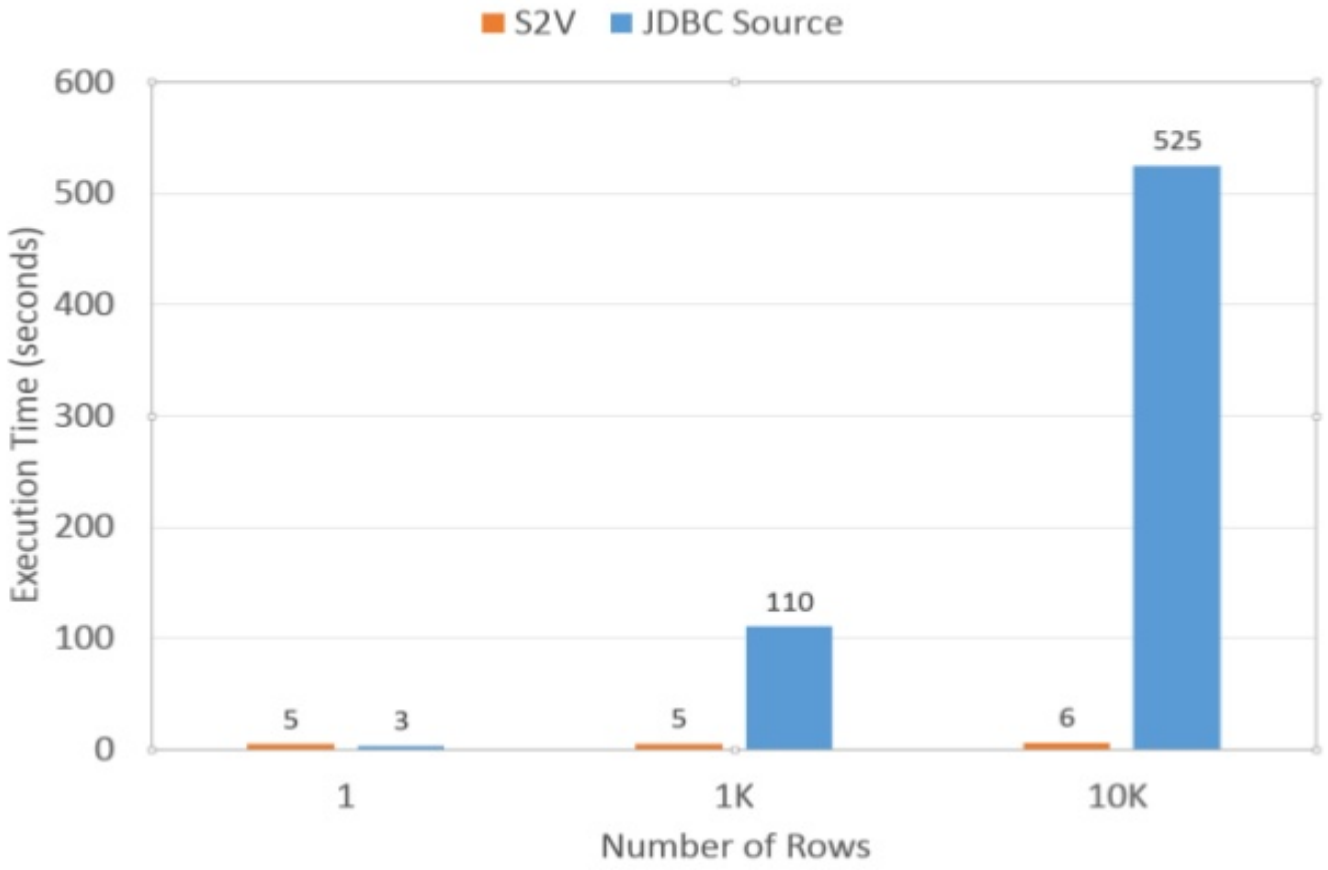
Objective: Want reliable and fast bulk loading

Two Possible Approaches

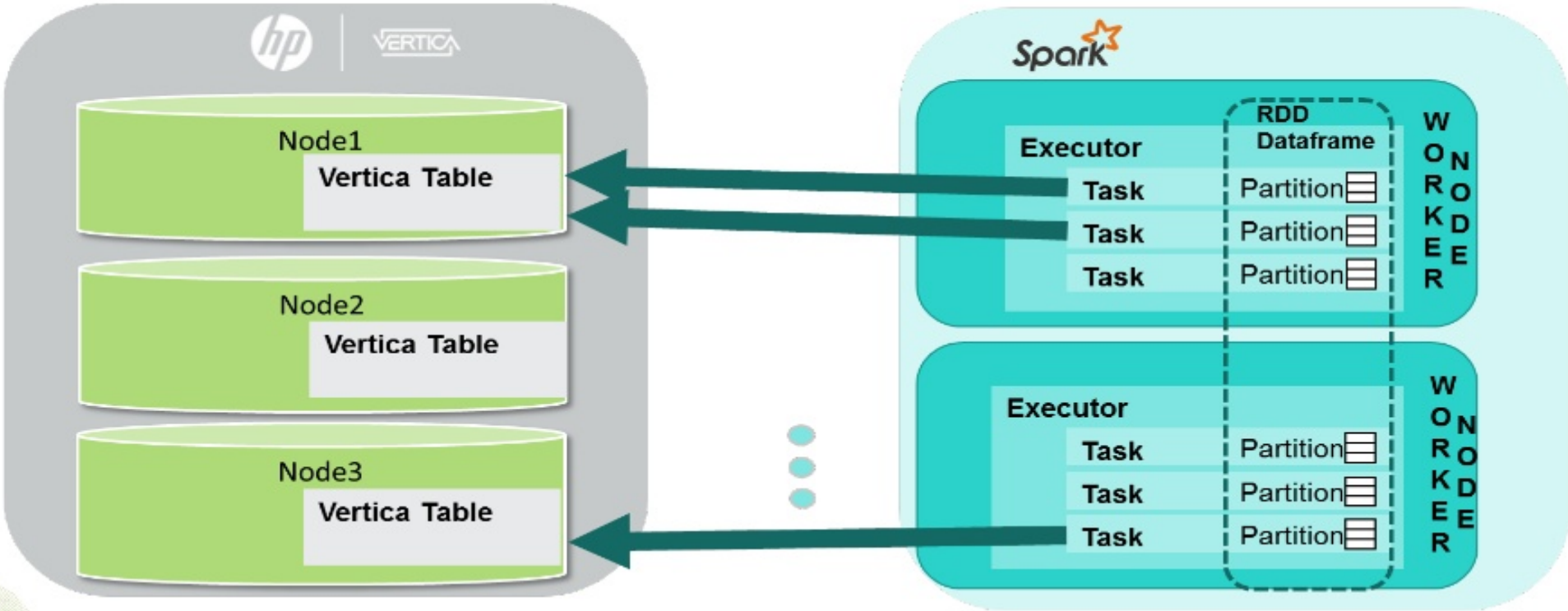
Direct

Indirect (Two-Stage)

Comparison to JDBC Source



What could happen?



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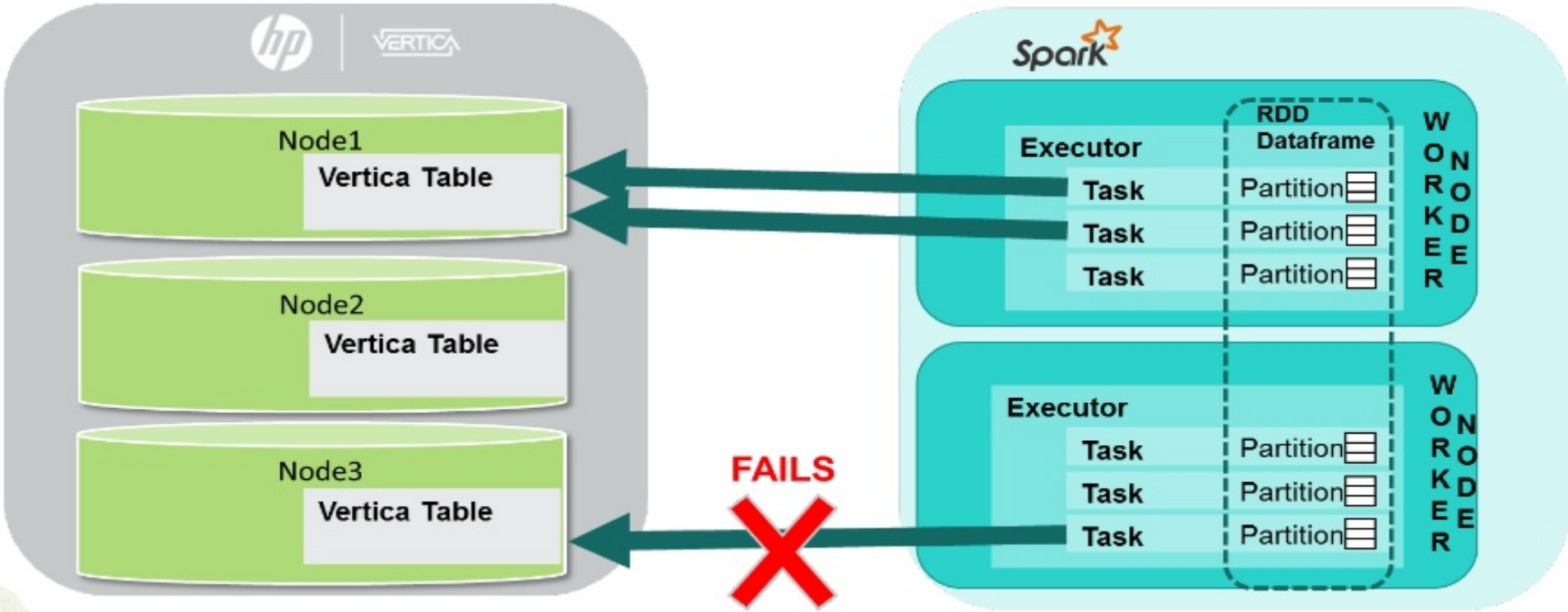

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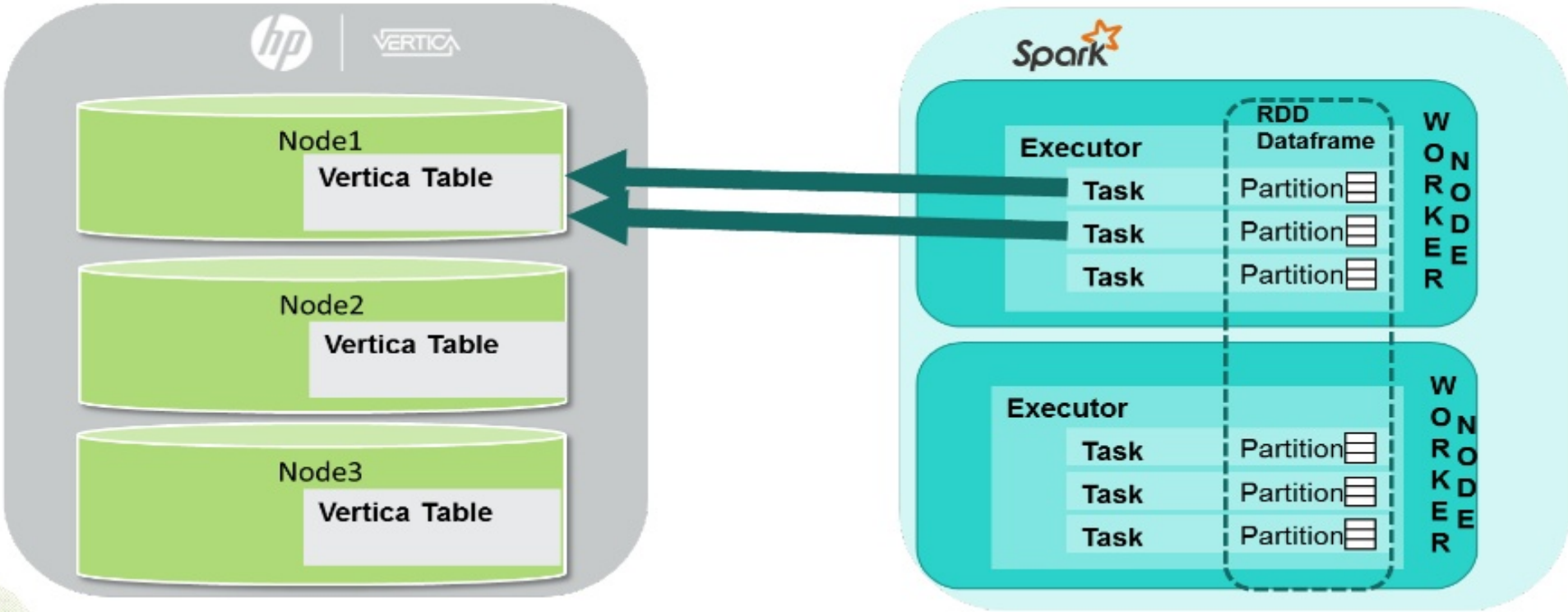

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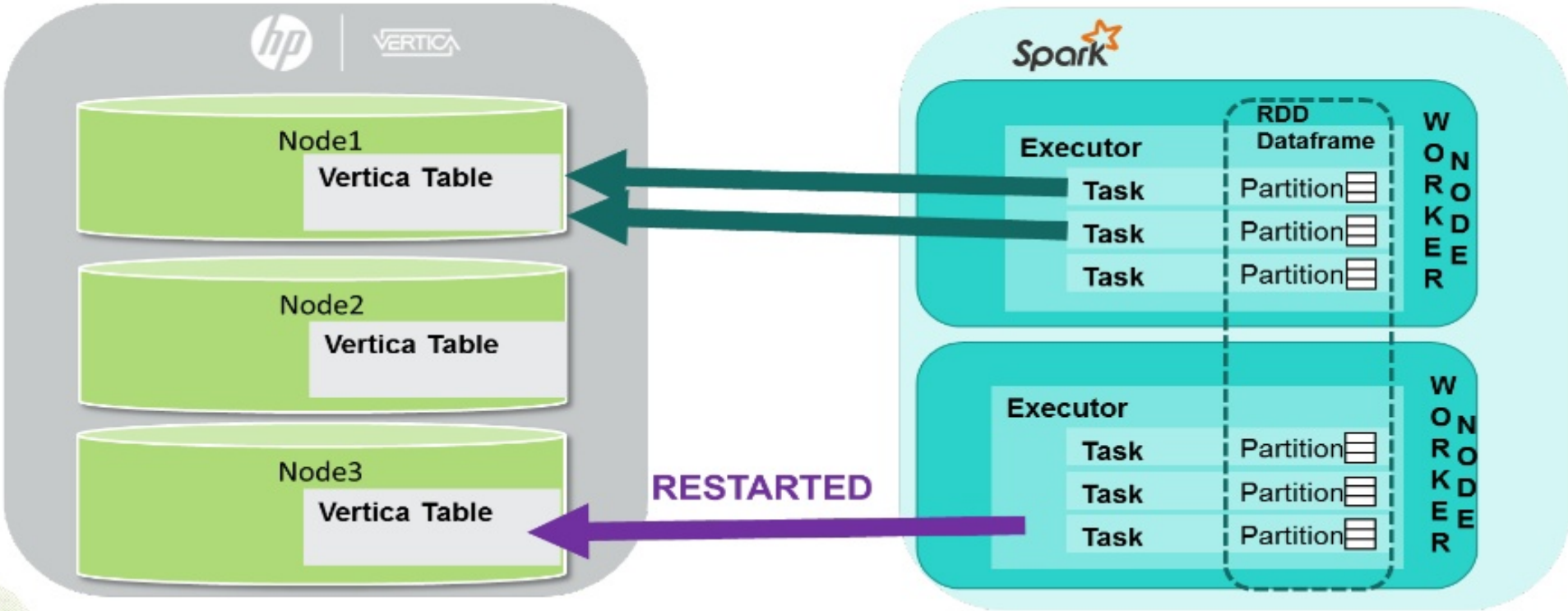

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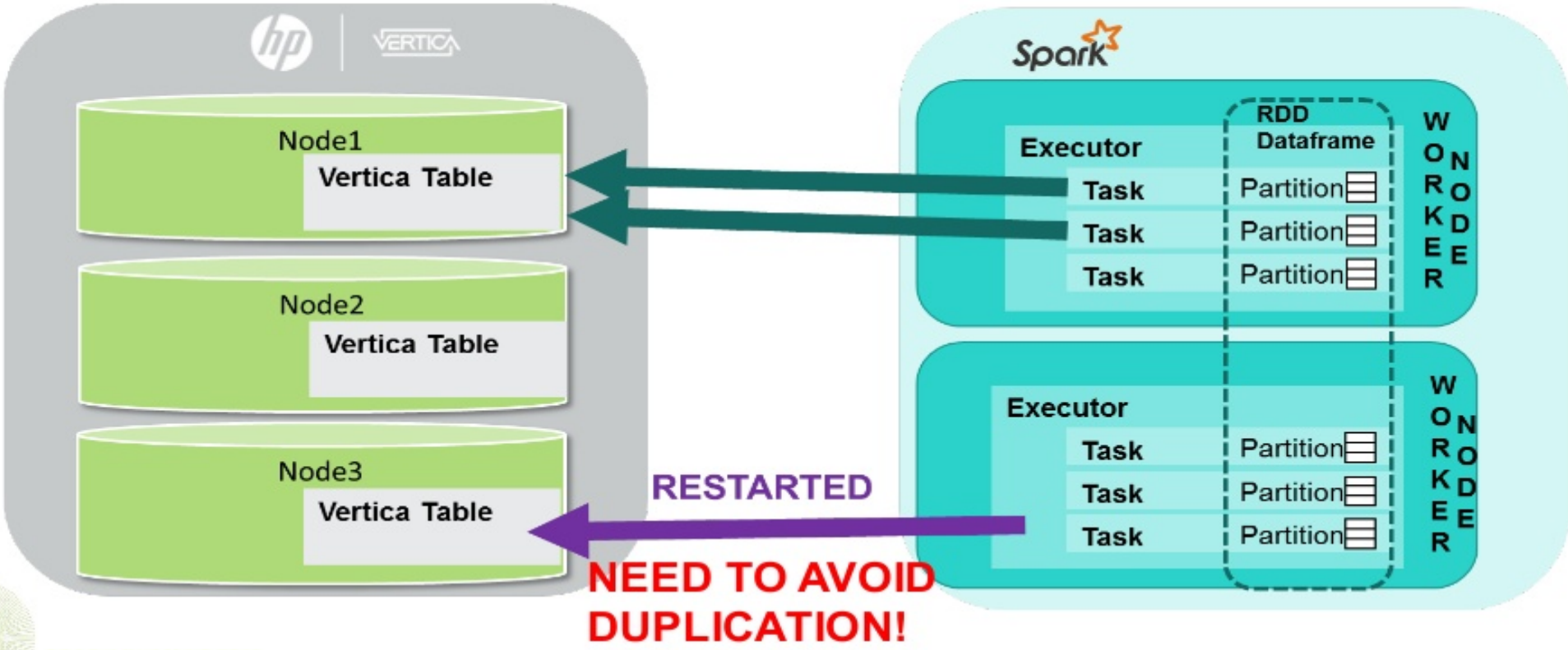
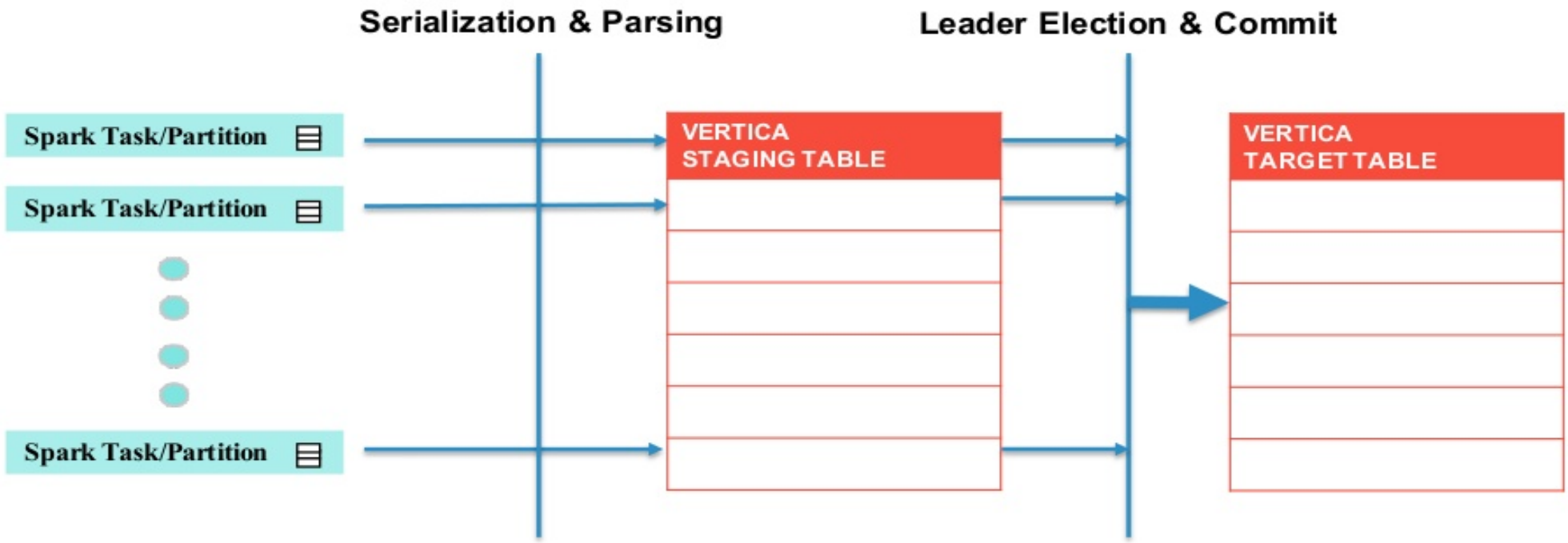
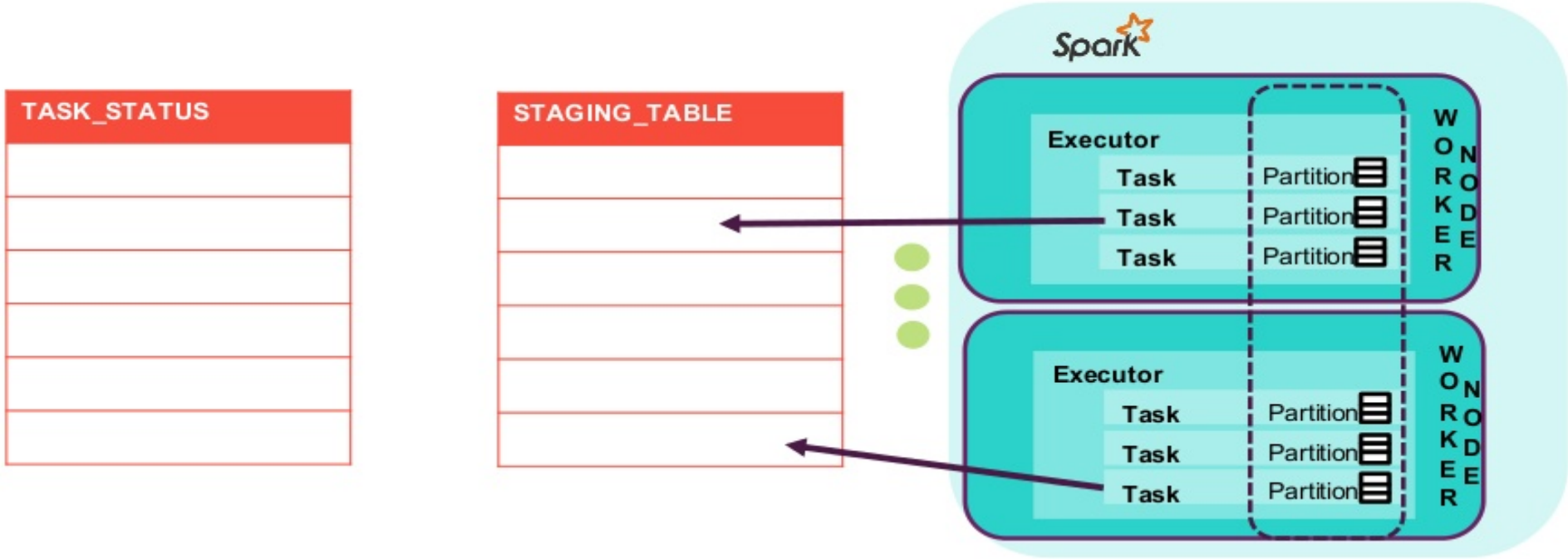


Big-Picture (Direct)



Exactly-once Semantics

Never results in partial or duplicate table loads



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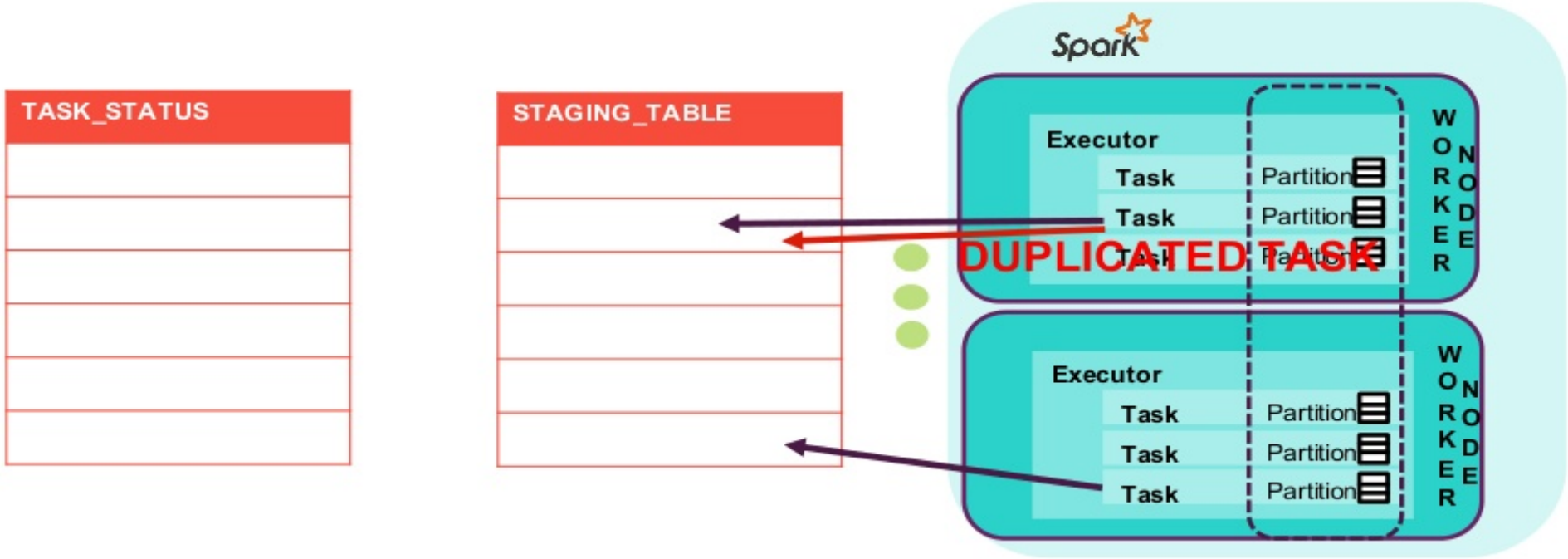

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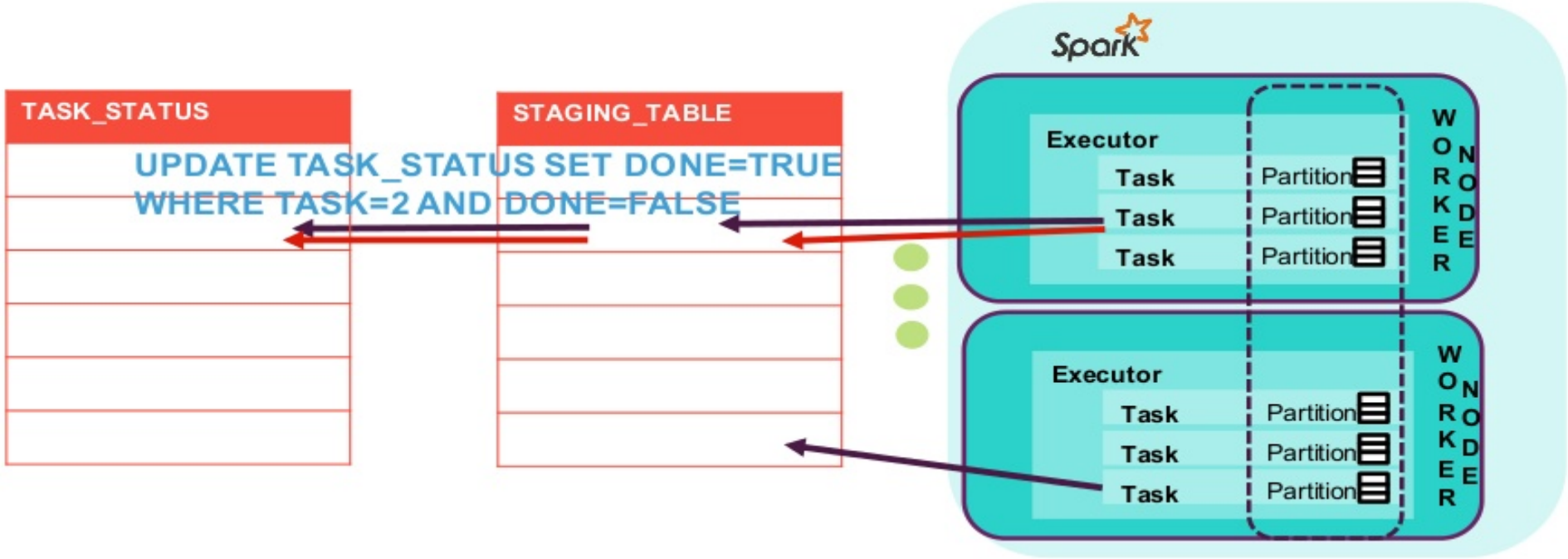

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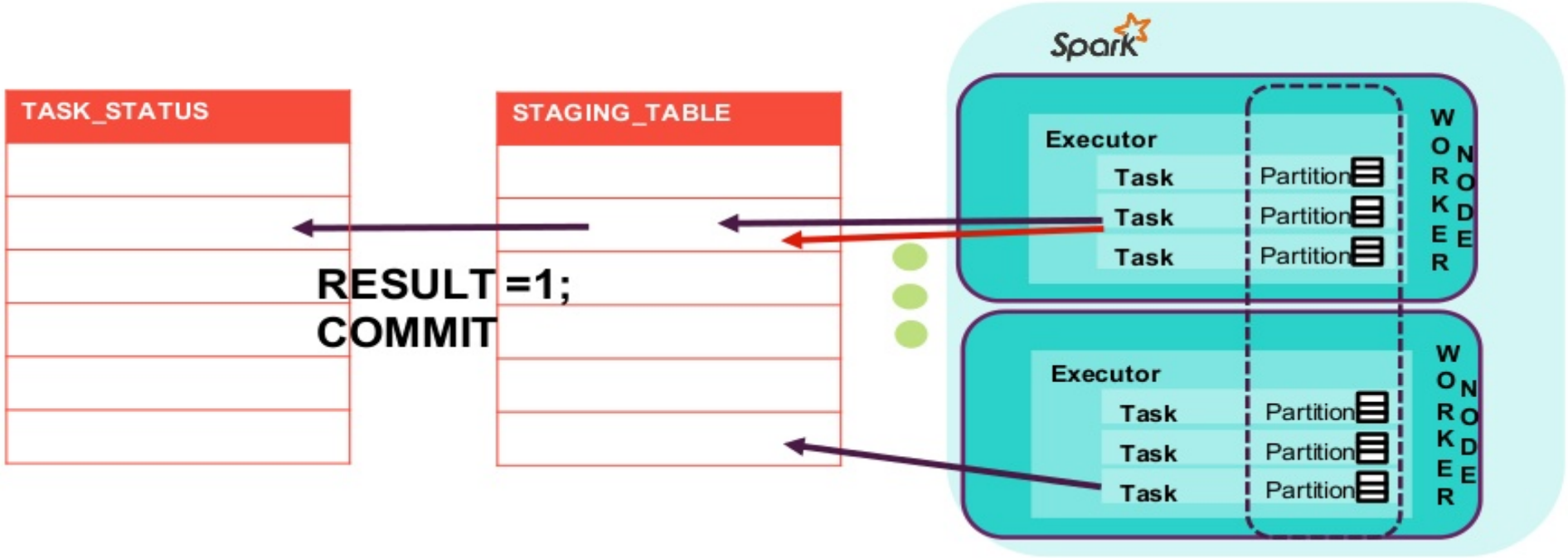

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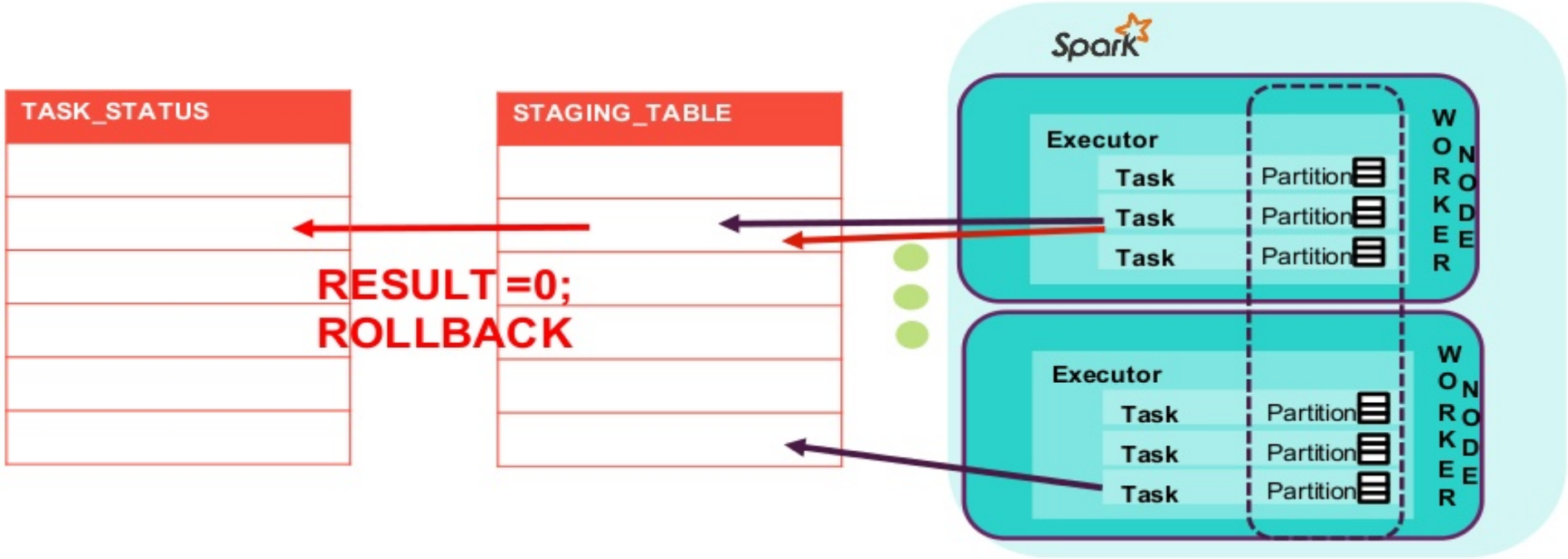
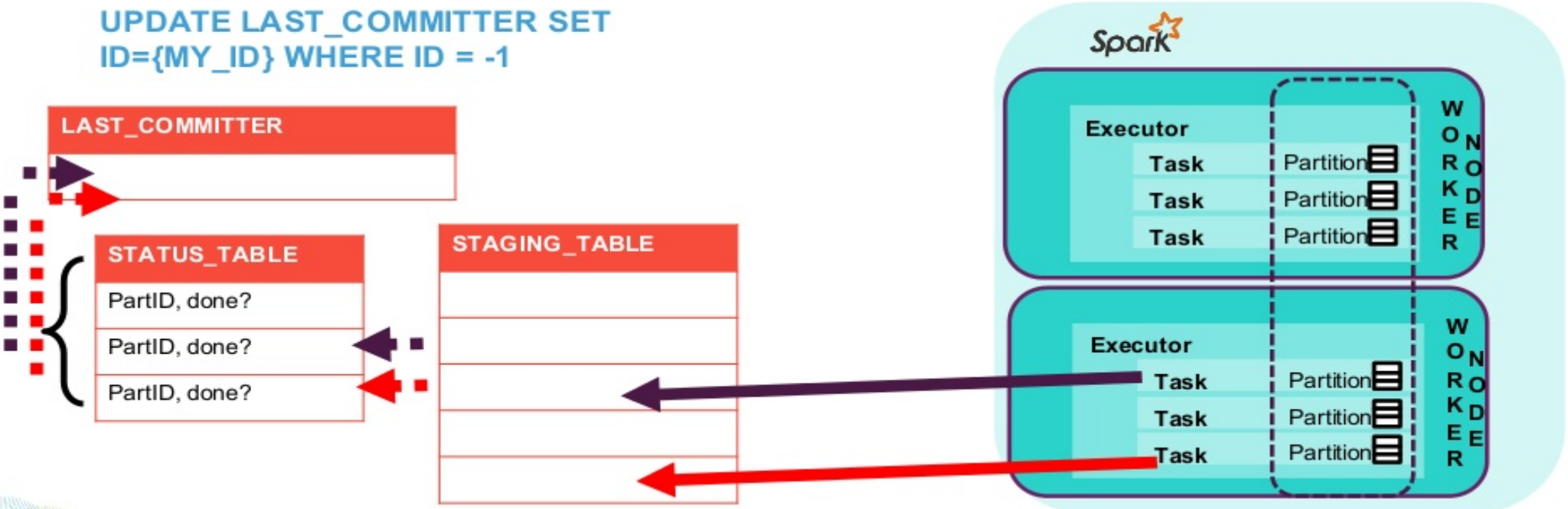


Leader Election

Find Out Which Task Won The Race



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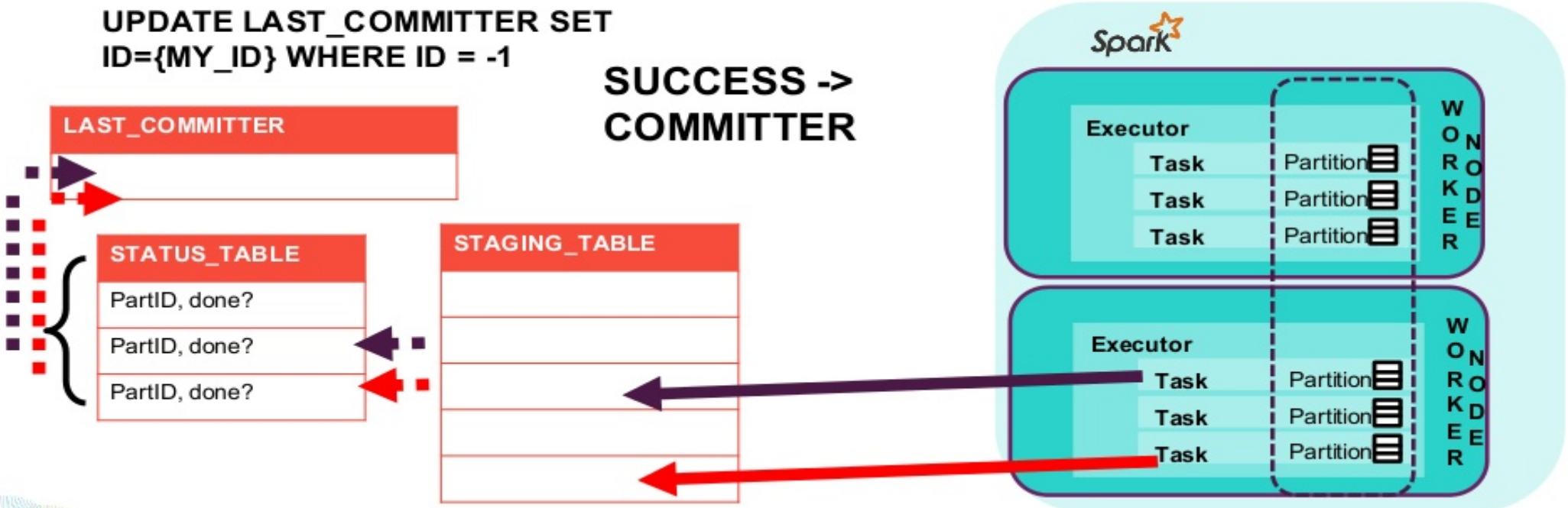

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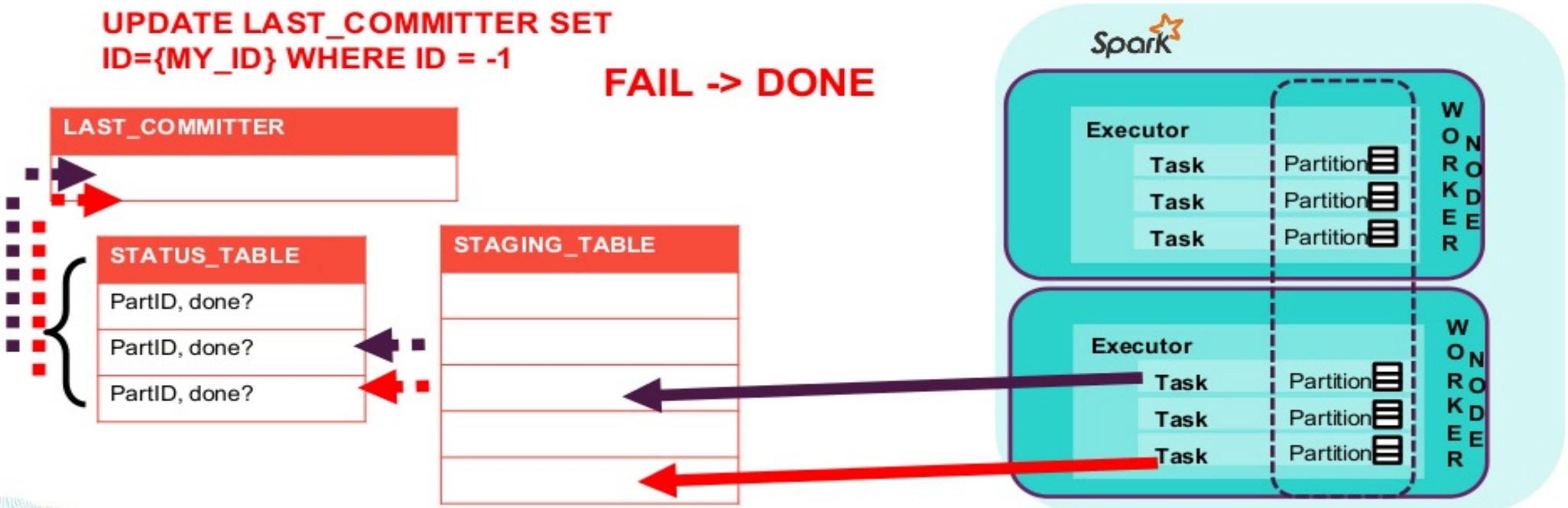
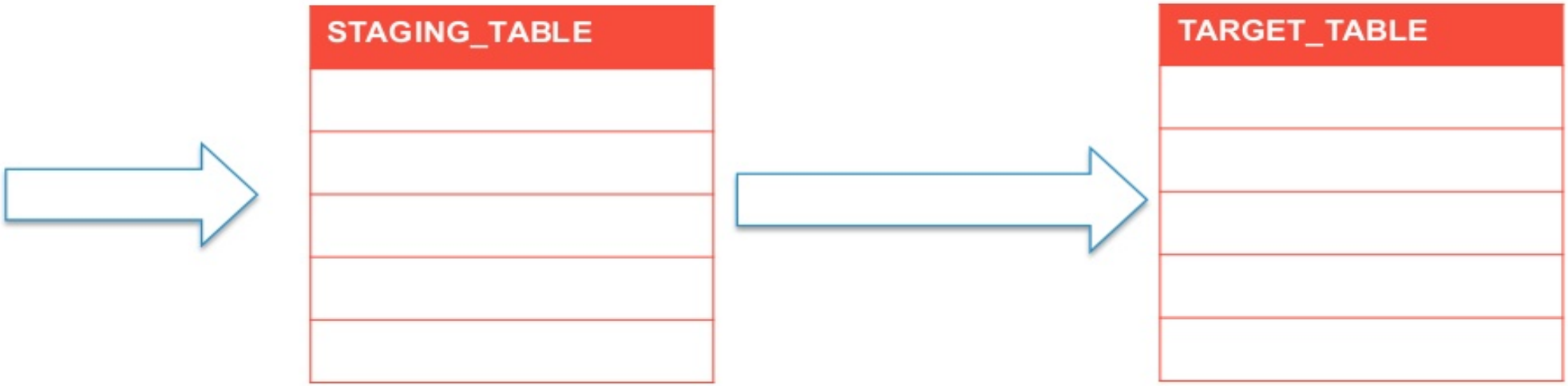


Move to Target Table



Direct: Pros & Cons

+ Requires no external system beyond Vertica and Spark

+ Less I/O: Does not involve an additional write stage

- Exactly-once semantics are non-trivial to ensure

Big-Picture (Two-Stage)

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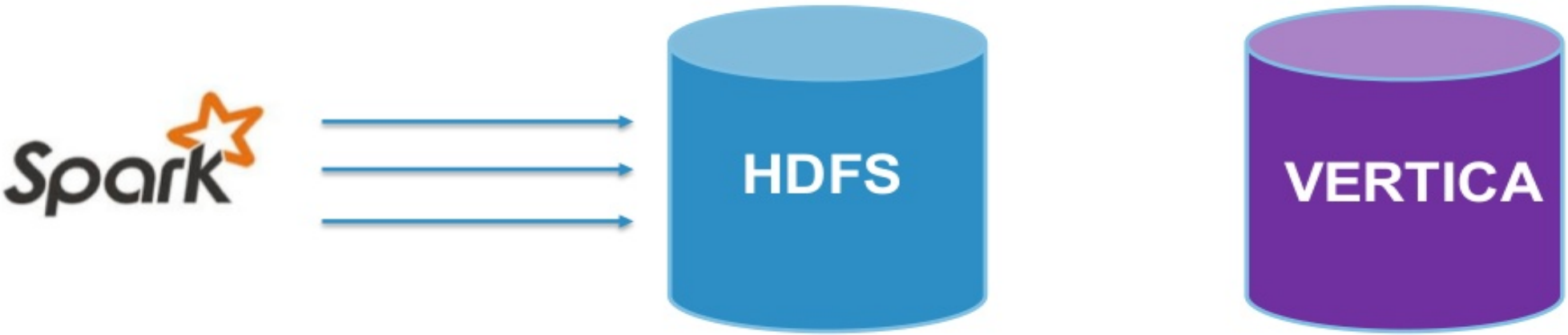

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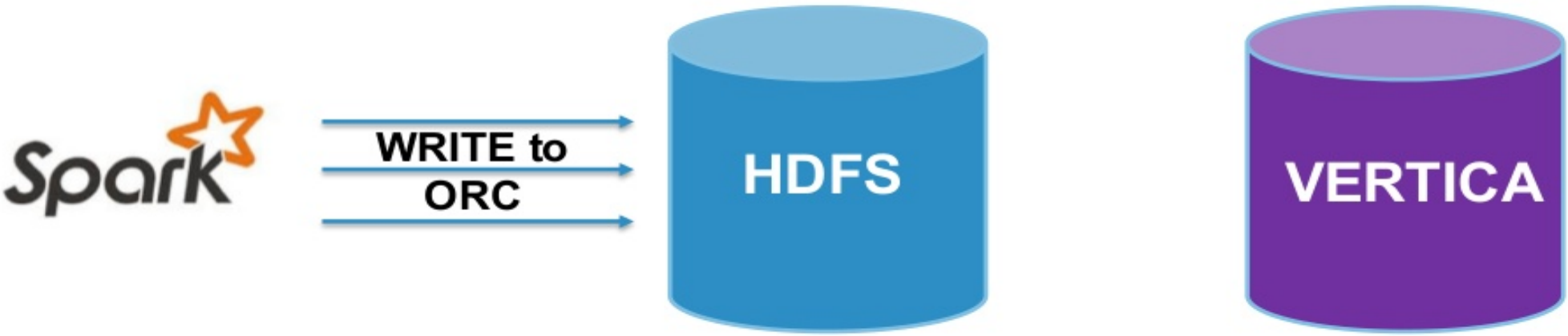

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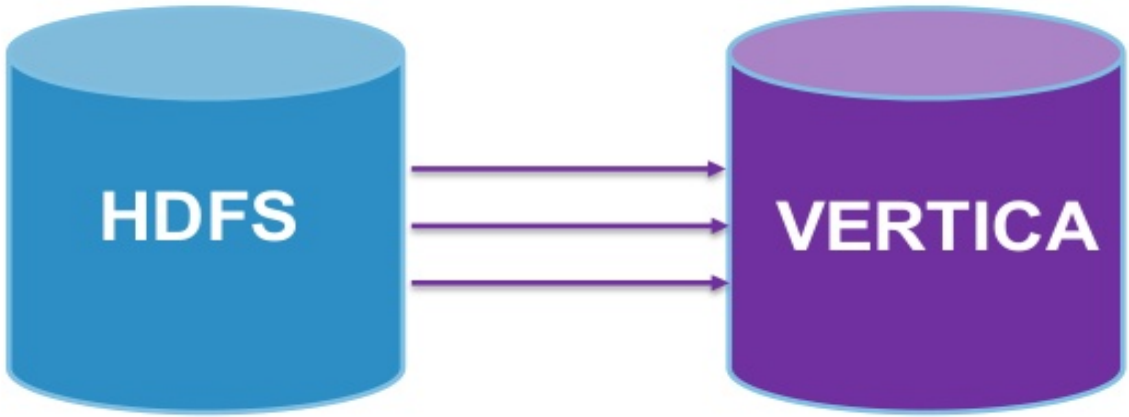
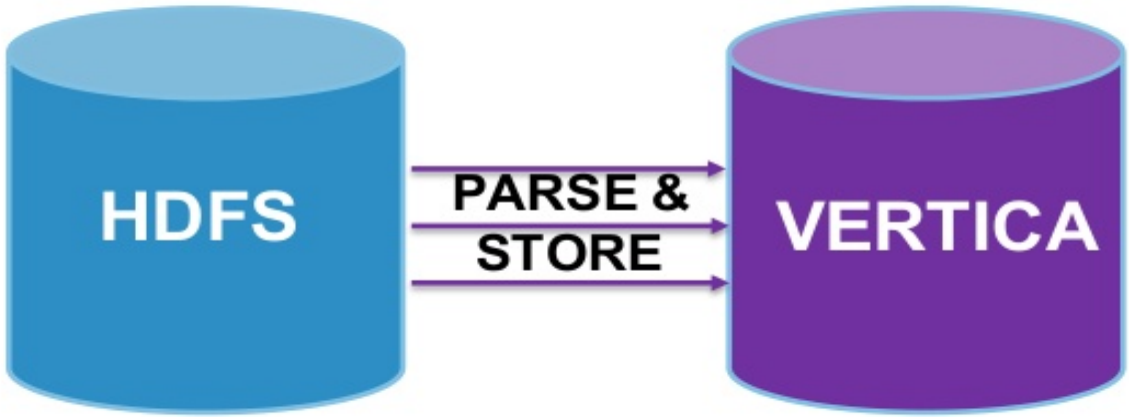


COPY target_table FROM 'hdfs://…' ON ANY NODE ORC;

Big-Picture (Two-Stage)



COPY target_table FROM 'hdfs://…' ON ANY NODE ORC;

Two-Stage: Pros & Cons

+ Utilizes Vertica's built-in parallel COPY command for bulk loads, and may allow for better scalability

+ Uses the optimized ORC reader for parsing (developed in collaboration with Hortonworks).

+ Simpler code logic, since only one query is involved

- More I/O: Requires an additional writing stage.

- Requires an additional dependency on intermediate storage system.

Conclusions

- **Vertica-to-Spark**
  - Utilizes hash-range queries to minimize intra-Vertica data movement
  - Node-pruning eliminates unneeded distributed query processing in Vertica
  - Query pushdown to reduce data transfer and to take advantage of Vertica native analytics.

- **Spark-to-Vertica**
  - Direct connector approach efficiently and reliably coordinates transfer with parallel Spark tasks
  - A two-stage approach with an intermediary staging storage (HDFS) utilizes a single Vertica query to load and may be more efficient on resource consumption on Vertica side

Learn More About – and Try! - HPE Vertica

- Community Edition
  - Free Download 1TB, 3 nodes
  - my.vertica.com/

- Spark Connector – Beta Program
  - https://saas.hpe.com/marketplace/big-data/hpe-vertica-connector-apache-spark

THANK YOU.

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