Spark and Cassandra:
2 Fast, 2 Furious

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DataStax Inc.

SPARK SUMMIT 2016
DATA SCIENCE AND ENGINEERING AT SCALE
JUNE 6-8, 2016 SAN FRANCISCO

Russell, ostensibly a software engineer

- Did a Ph.D in bioinformatics at some point
- Written a great deal of automation and testing framework code
- Now develops for Datastax on the Analytics Team
- Focuses a lot on the **Datastax OSS Spark Cassandra Connector**

Datastax Spark Cassandra Connector

Let Spark Interact with your Cassandra Data!

Compatible with Spark 1.6 + Cassandra 3.0

- Bulk writing to Cassandra
- Distributed full table scans
- Optimized direct joins with Cassandra
- Secondary index pushdown
- Connection and prepared statement pools

http://spark-packages.org/package/datastax/spark-cassandra-connector

https://github.com/datastax/spark-cassandra-connector

http://spark-packages.org/package/TargetHolding/pyspark-cassandra

Cassandra is essentially a hybrid between a key-value and a column-oriented (or tabular) database management system. Its data model is a partitioned row store with tunable consistency*

Let's break that down

1. What is a C* Partition and Row
2. How does C* Place Partitions

*https://en.wikipedia.org/wiki/Apache_Cassandra

CQL looks a lot like SQL

```
CREATE TABLE tracker (
  vehicle_id  uuid,
  ts timestamp,
  x double,
  y double,
  PRIMARY KEY (vehicle_id, ts))
```

INSERTS look almost Identical

```
CREATE TABLE tracker (
  vehicle_id  uuid,
  ts timestamp,
  x double,
  y double,
  PRIMARY KEY (vehicle_id, ts))
```


```
INSERT INTO tracker (vehicle_id, ts, x, y) Values ( 1, 0, 0, 1)
```

Cassandra Data is stored in Partitions

```
CREATE TABLE tracker (
  vehicle_id  uuid,
  ts timestamp,
  x double,
  y double,
  PRIMARY KEY (vehicle_id, ts))
```

vehicle_id
1

ts: 0

x: 0 | y: 1

```
INSERT INTO tracker (vehicle_id, ts, x, y) Values ( 1, 0, 0, 1)
```

C* Partitions Store Many Rows

```
CREATE TABLE tracker (
  vehicle_id  uuid,
  ts timestamp,
  x double,
  y double,
  PRIMARY KEY (vehicle_id, ts))
```

vehicle_id
1

ts: 0		ts: 1		ts: 2		ts: 3	
x: 0	y: 1	x: -1	y:0	x: 0	y: -1	x: 1	y: 0

C* Partitions Store Many Rows

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```

vehicle_id
1

ts: 0	ts: 1	ts: 2	ts: 3
x: 0, y: 1	x: -1, y:0	x: 0, y: -1	x: 1, y: 0

Row

Within a partition there is ordering based on the Clustering Keys

```
CREATE TABLE tracker (
  vehicle_id  uuid,
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  x double,
  y double,
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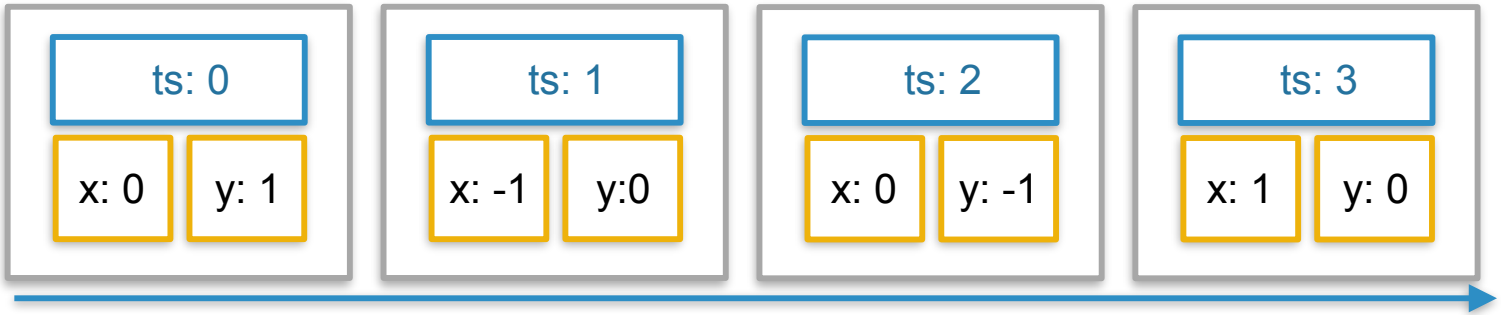
```

vehicle_id
1



Ordered by Clustering Key

Slices within a Partition are Very Easy

```
CREATE TABLE tracker (
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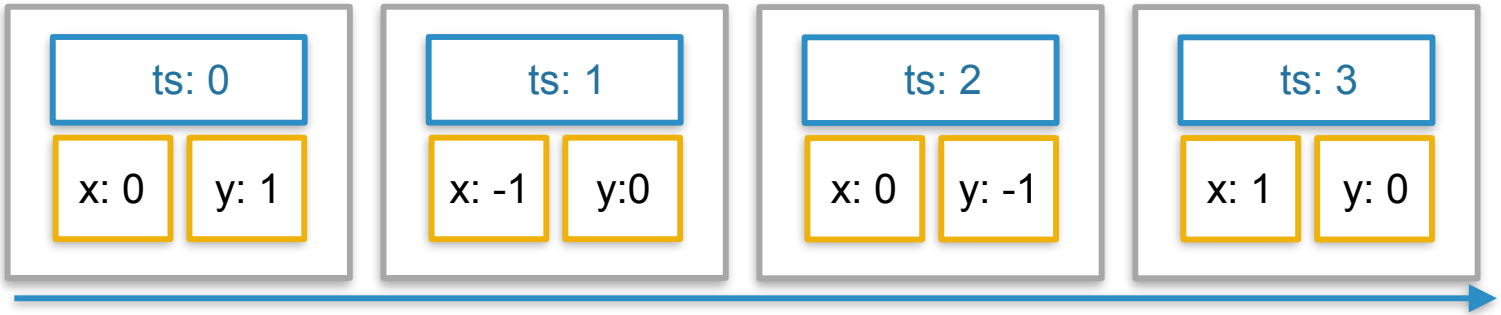
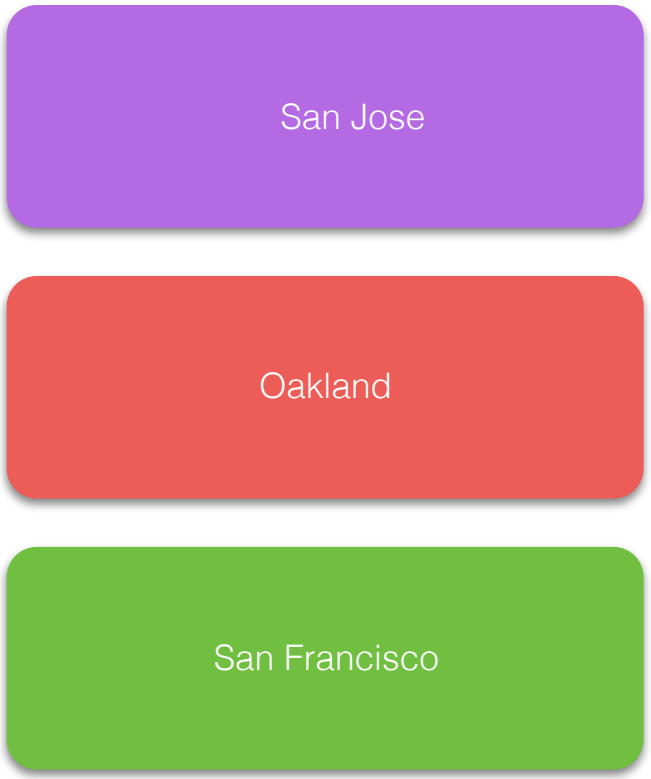
```

vehicle_id
1

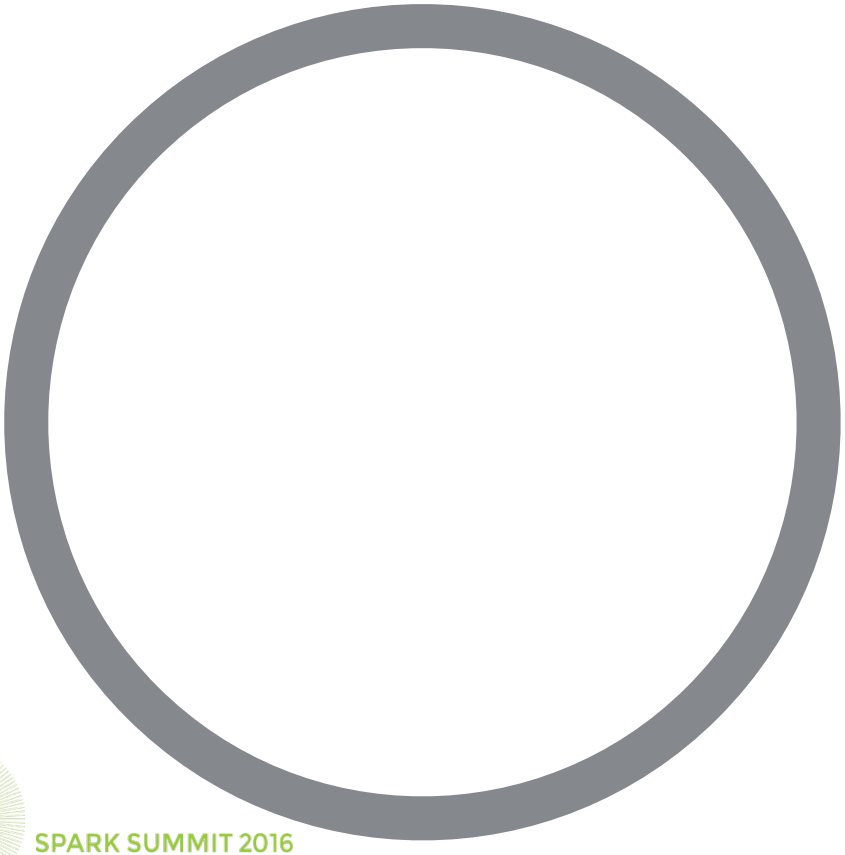


Ordered by Clustering Key

Cassandra is a Distributed Fault-Tolerant Database



Data is located on a Token Range



San Jose

Oakland

San Francisco

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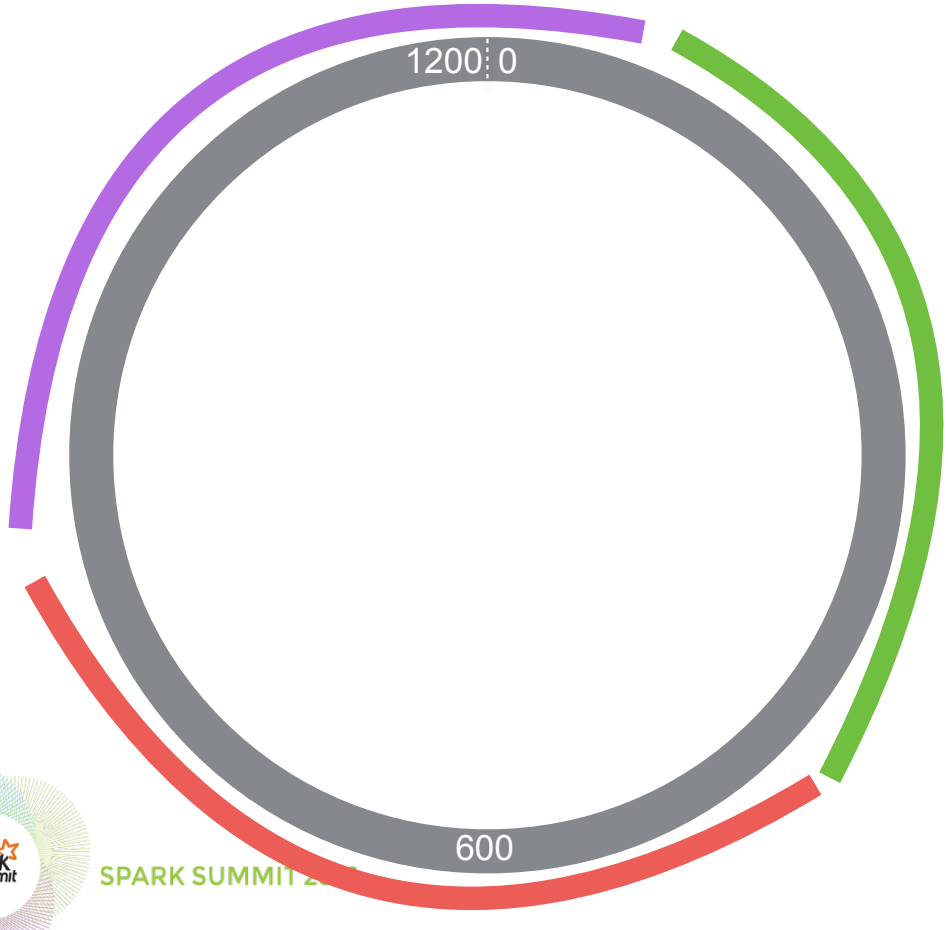

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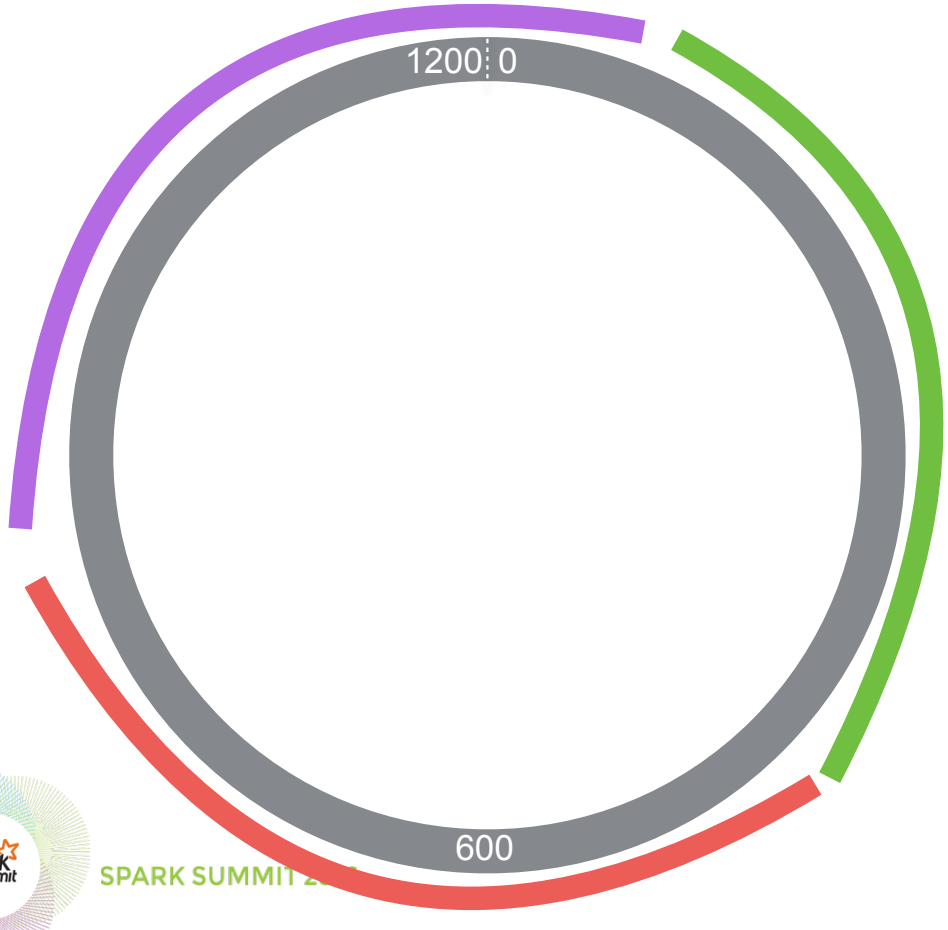
The Partition Key of a Row is Hashed to Determine it's Token



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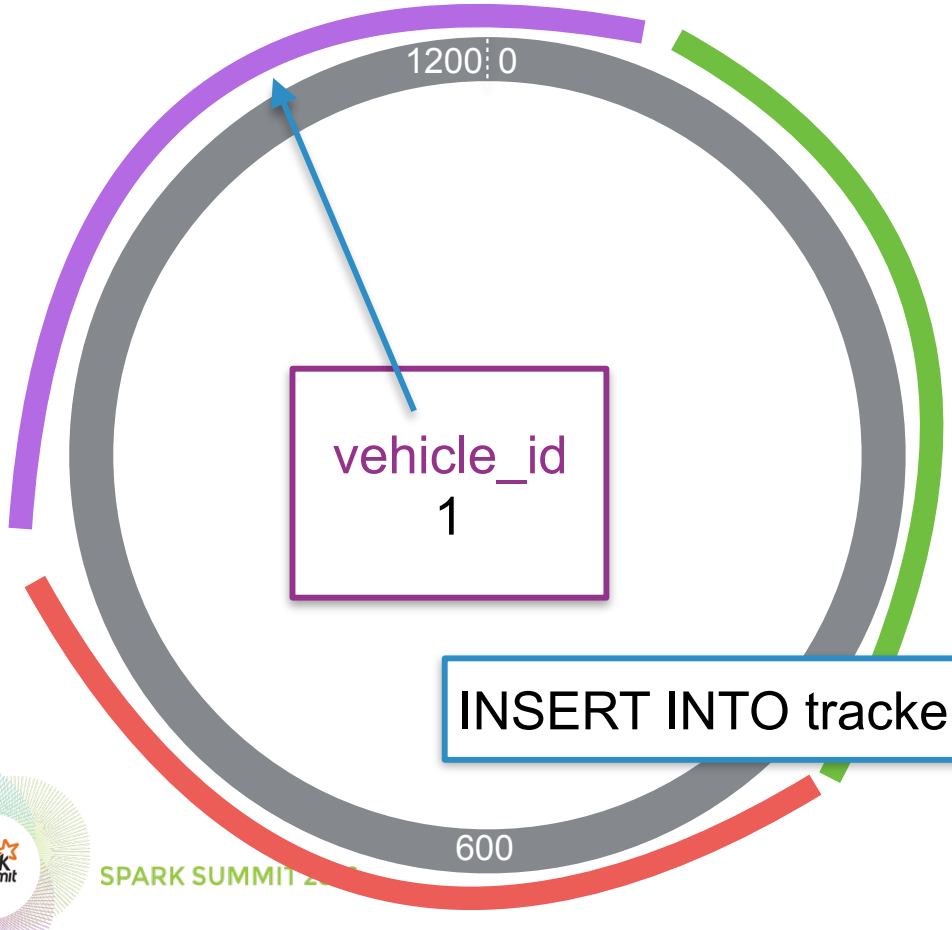

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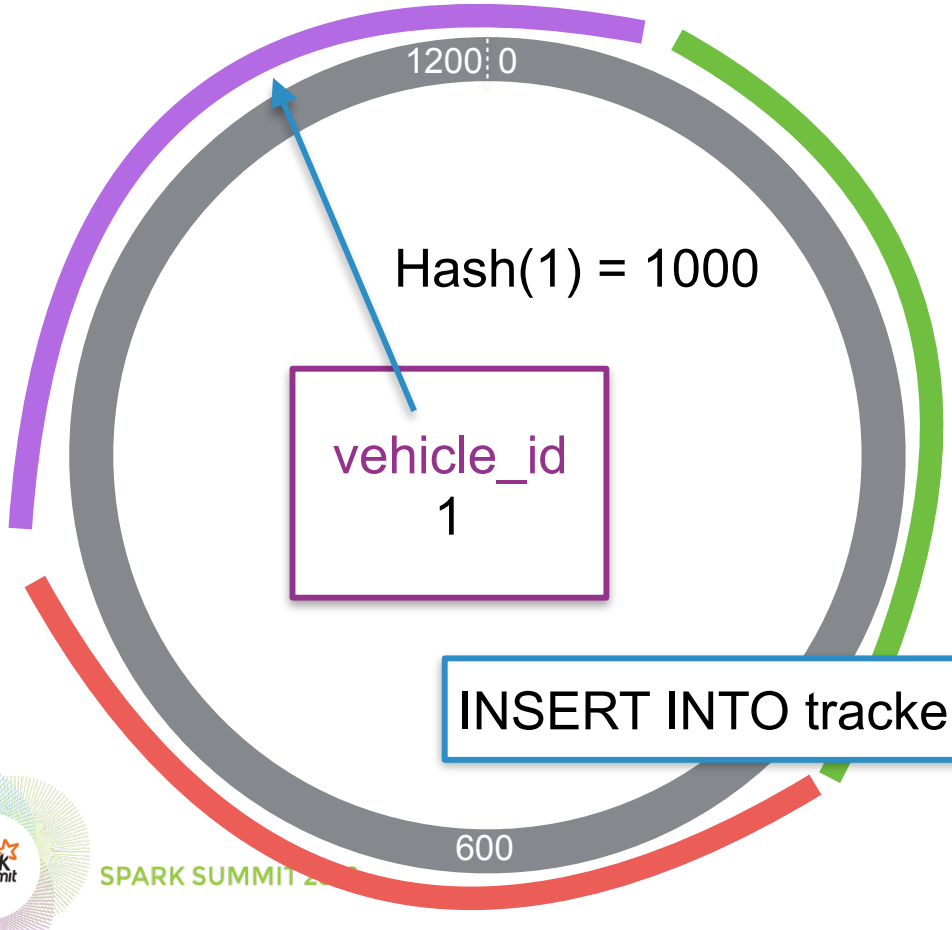

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How The Spark Cassandra Connector Reads

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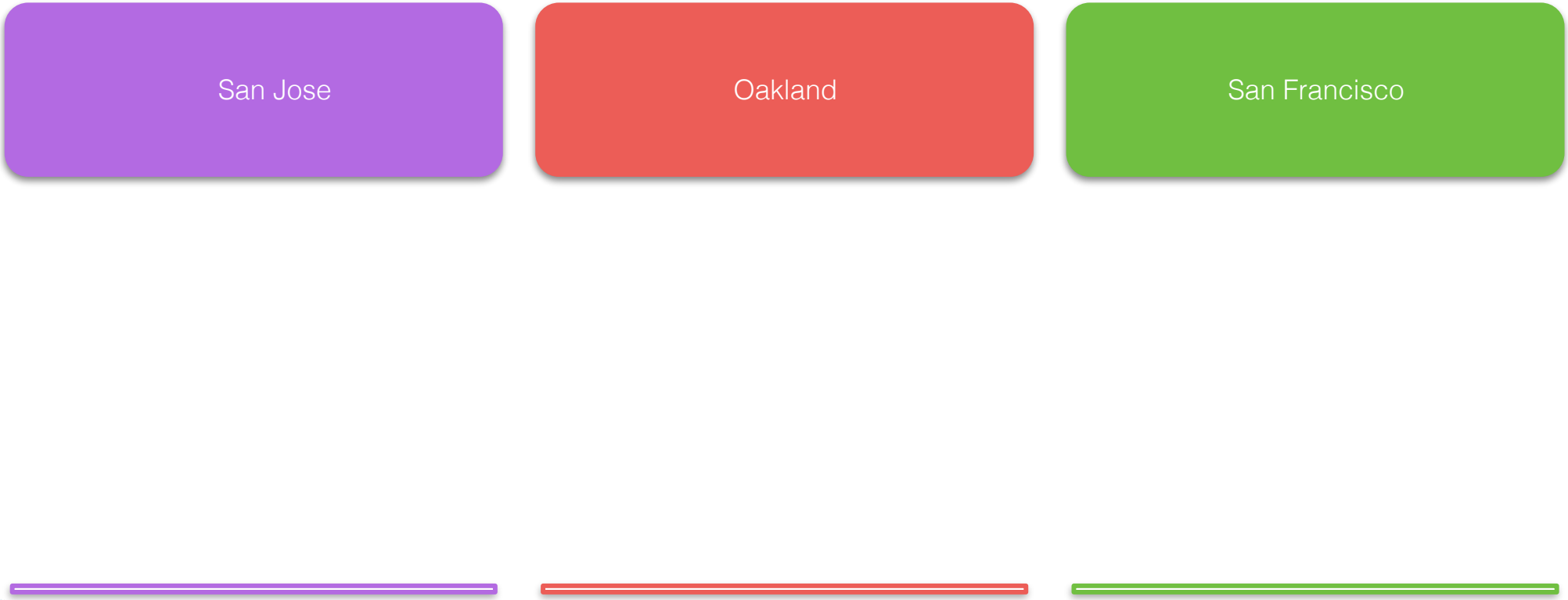
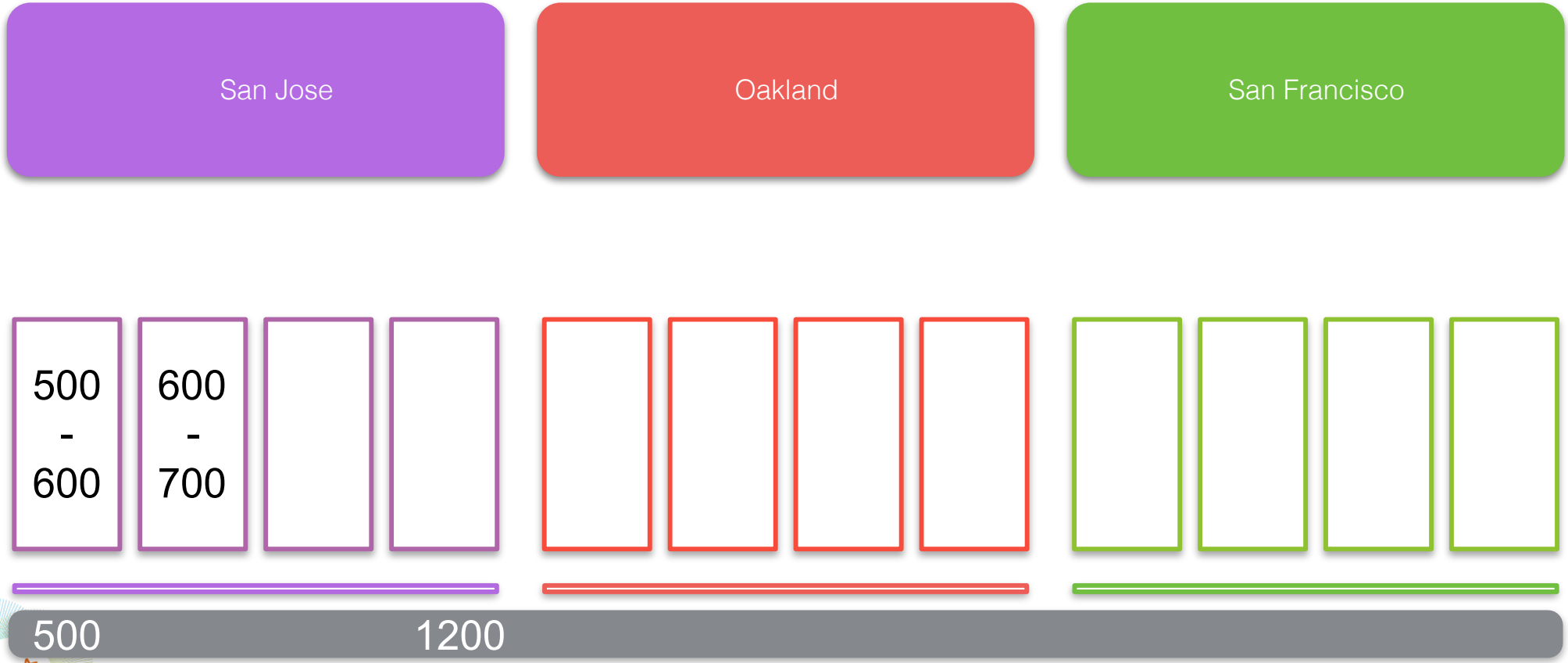
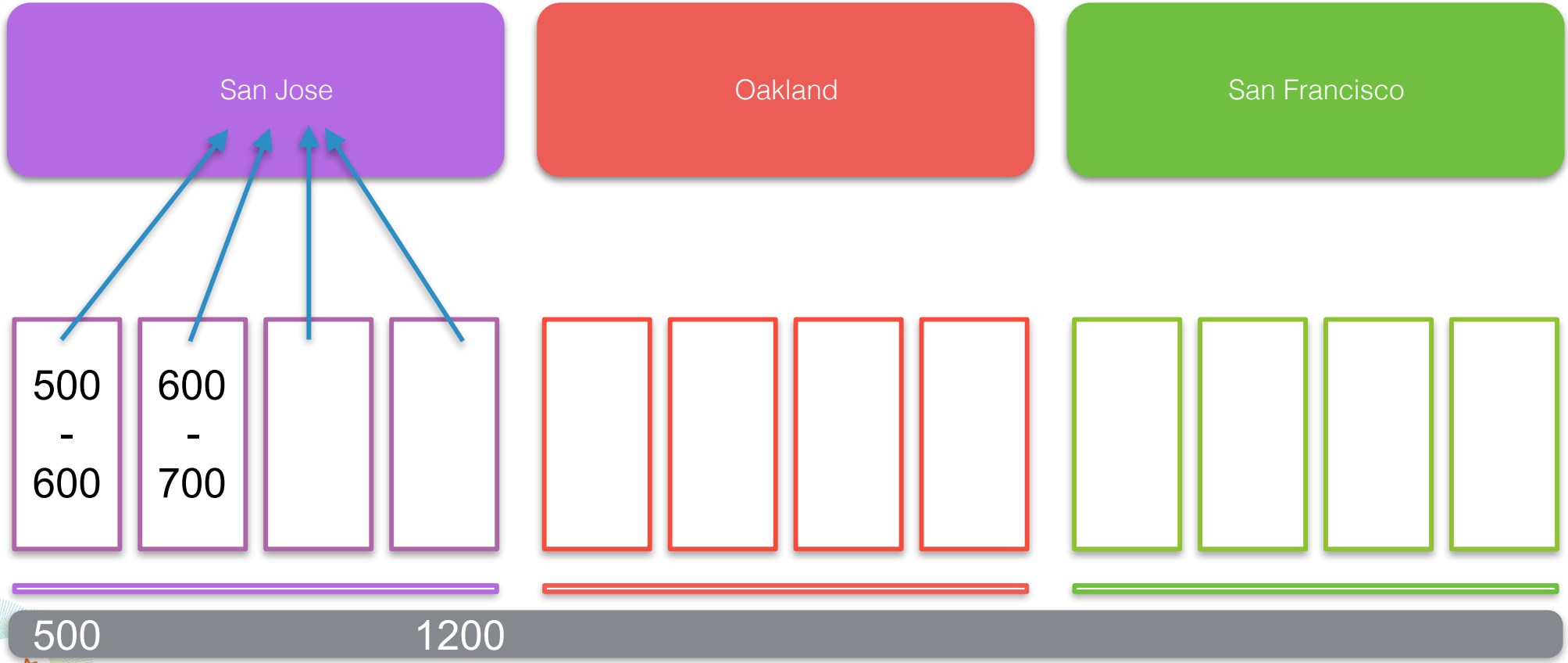


Spark Partitions are Built From the Token Range



Each Partition Can be Drawn Locally from at Least One Node



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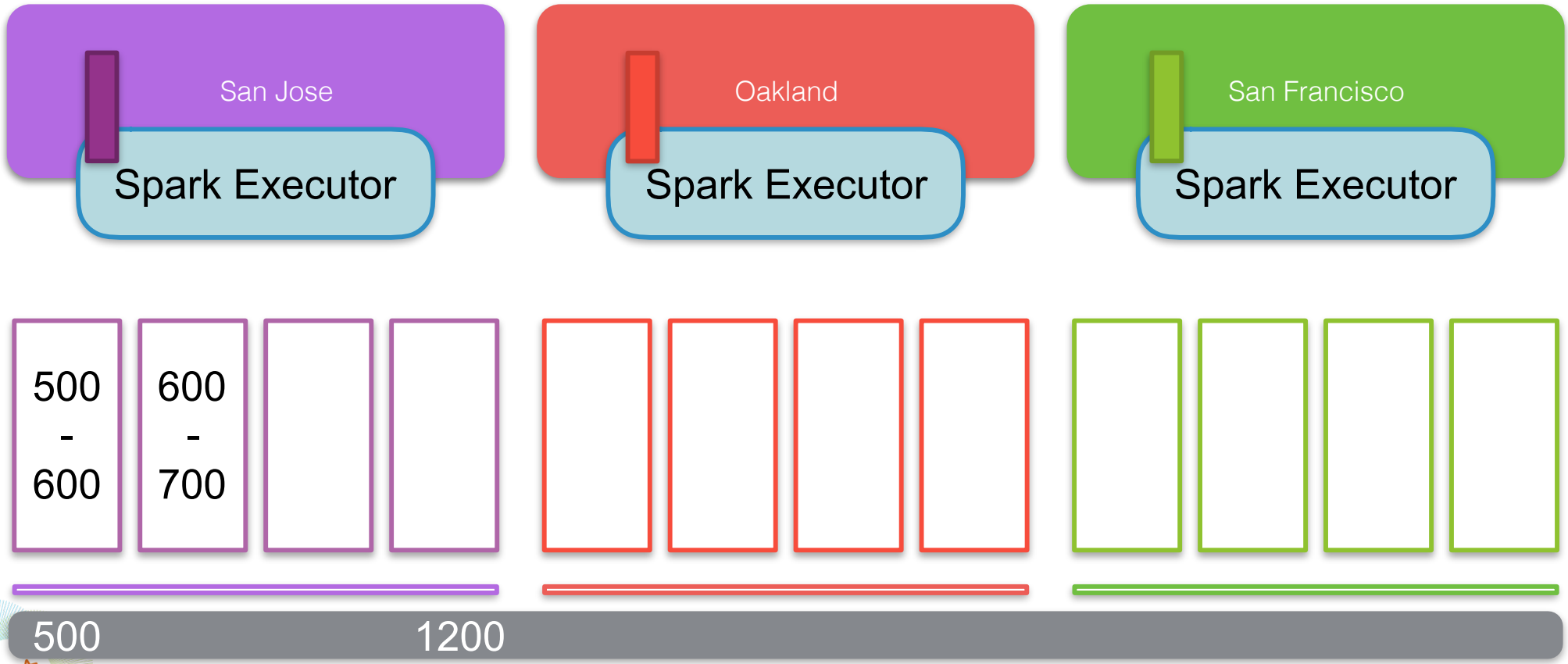


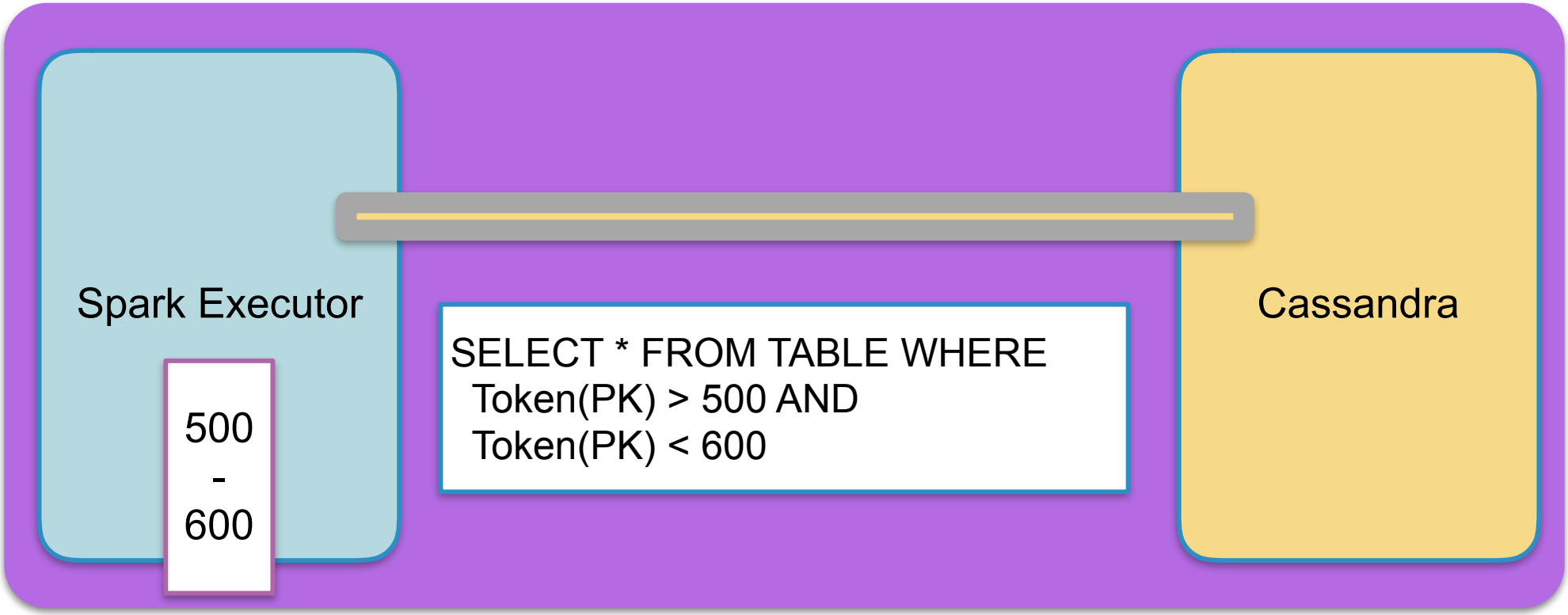
No Need to Leave the Node For Data!

Data is Retrieved using the Datastax Java Driver

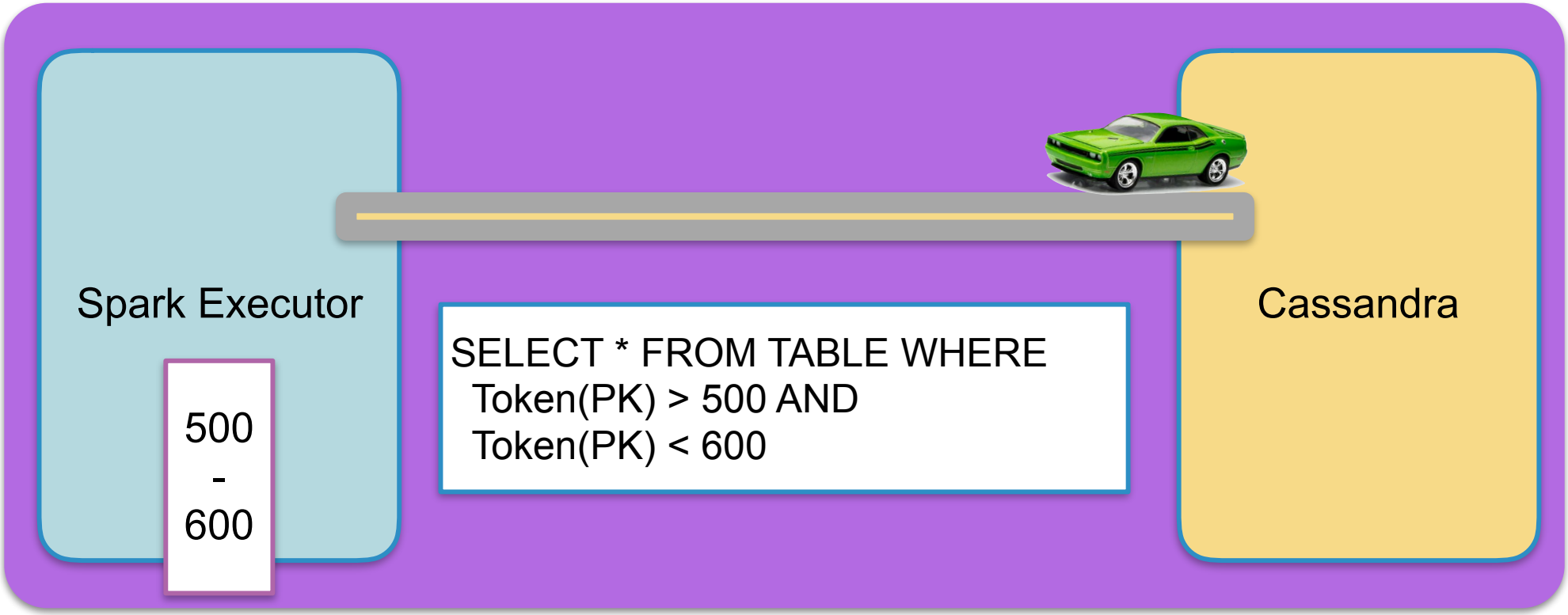
A Connection is Established

A Query is Prepared with Token Bounds

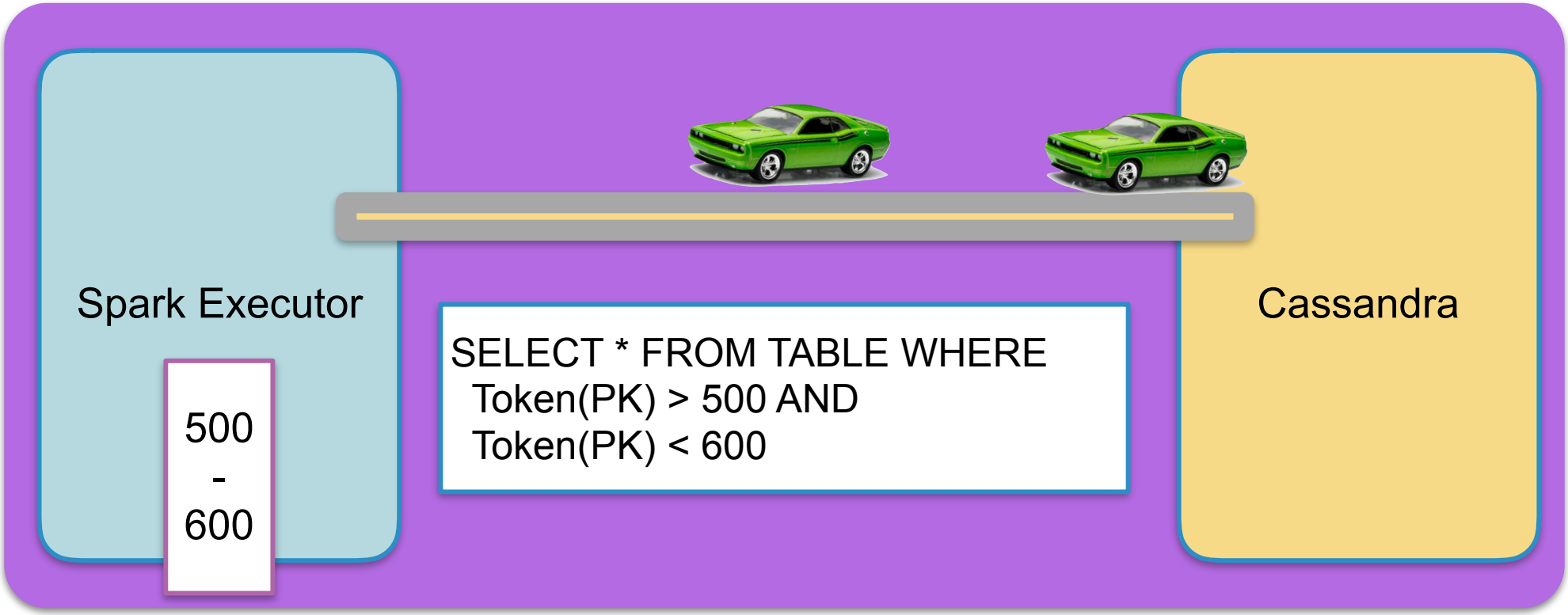
The Spark Partitions Bounds are Placed in the Query



Paged a number of rows at a Time



Data is Paged



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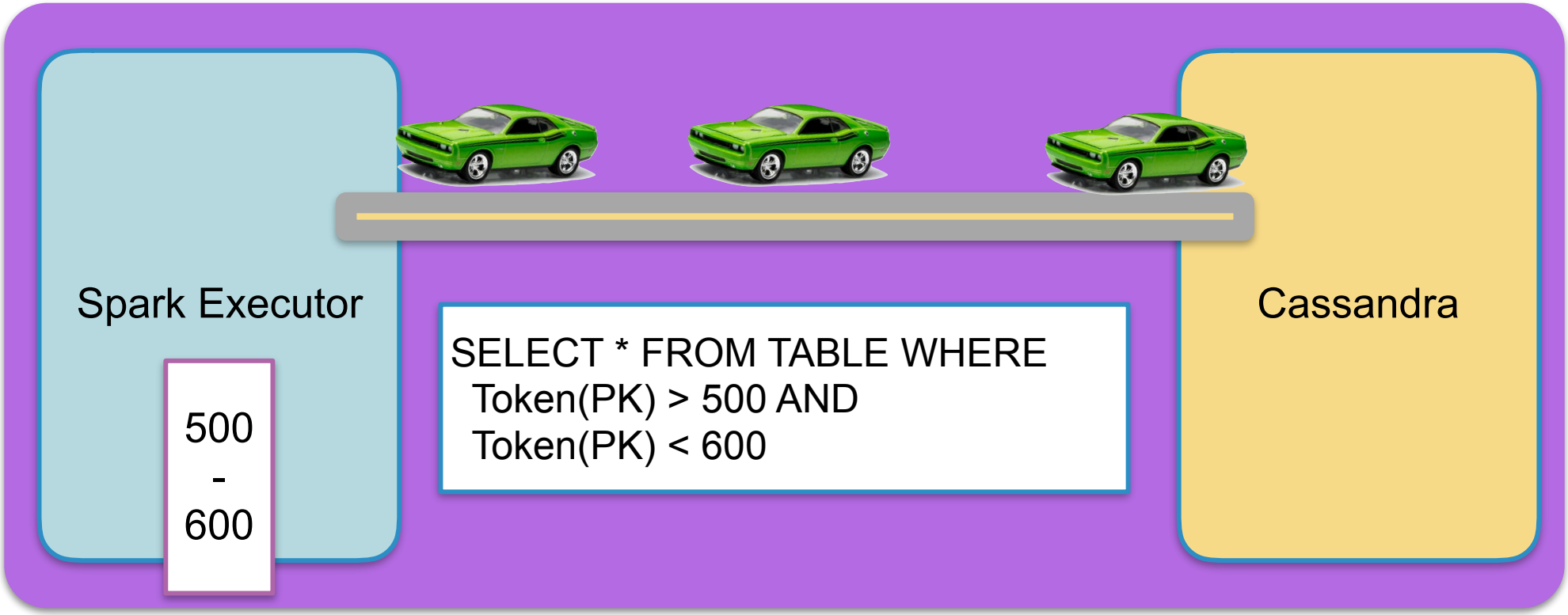

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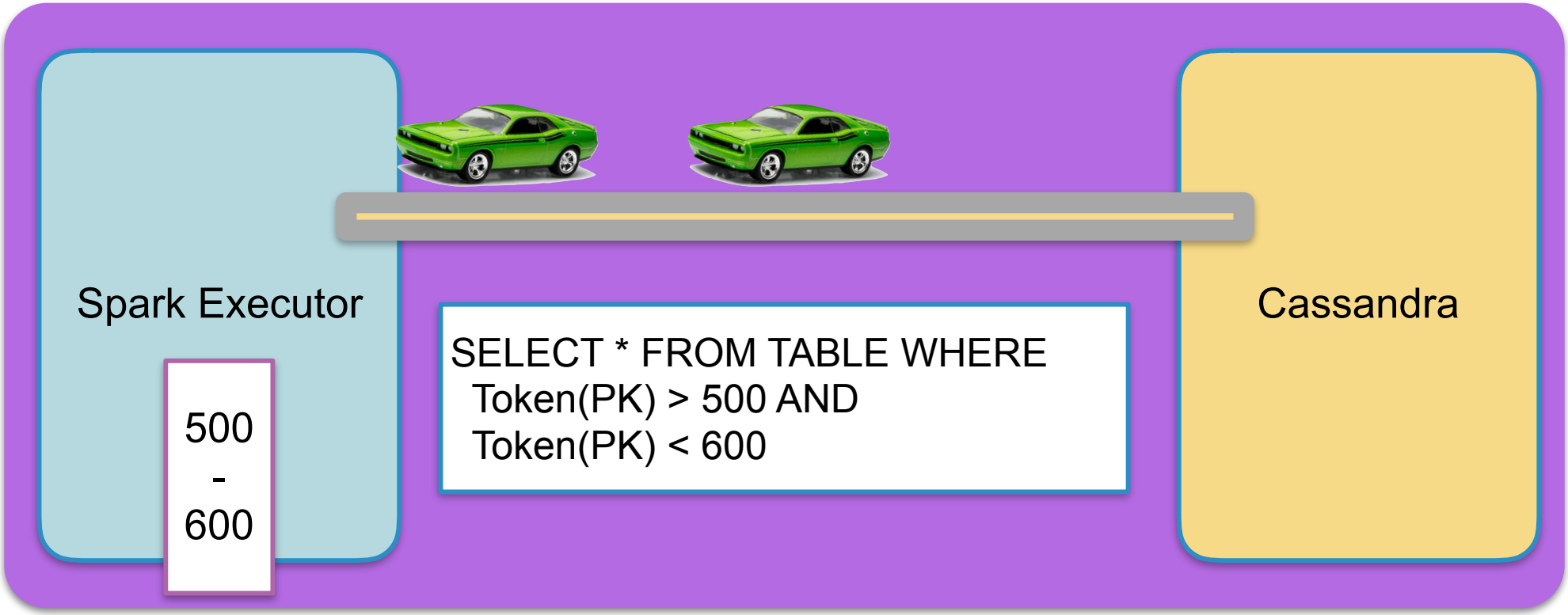

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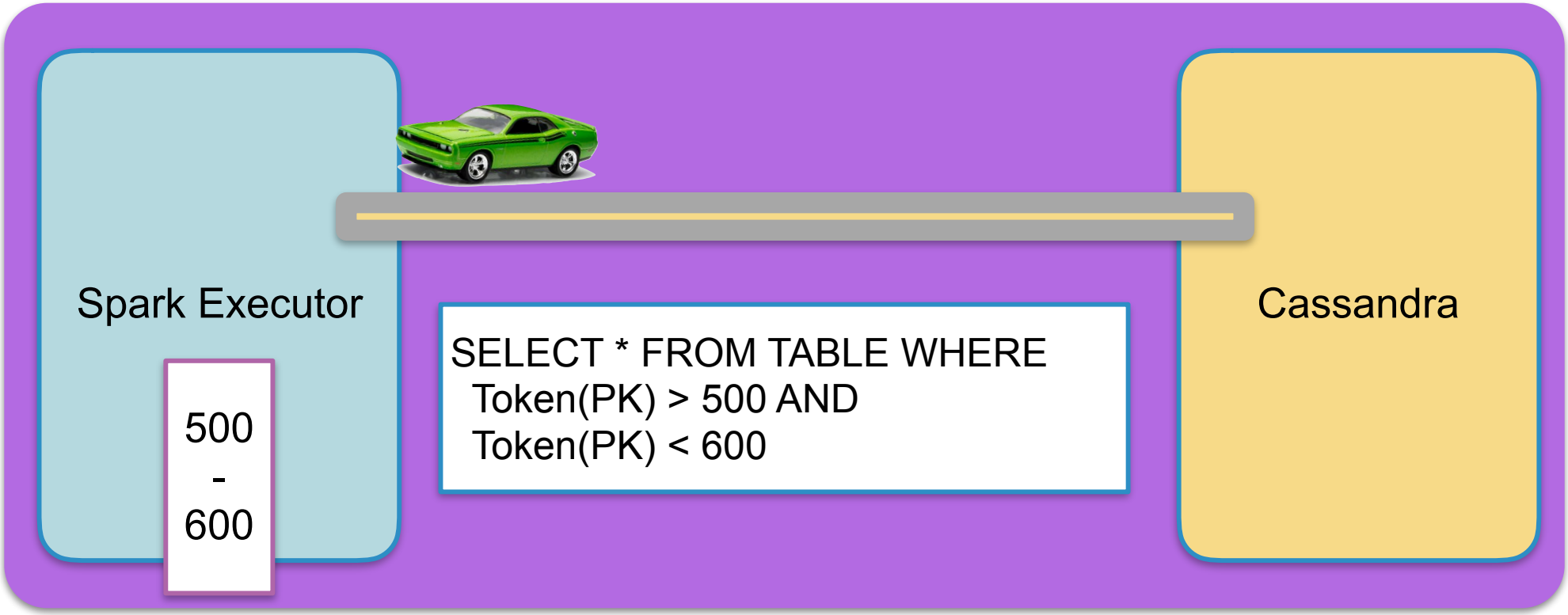


How we write to Cassandra

- Data is written via the Datastax Java Driver
- Data is grouped based on Partition Key (configurable)
- Batches are written

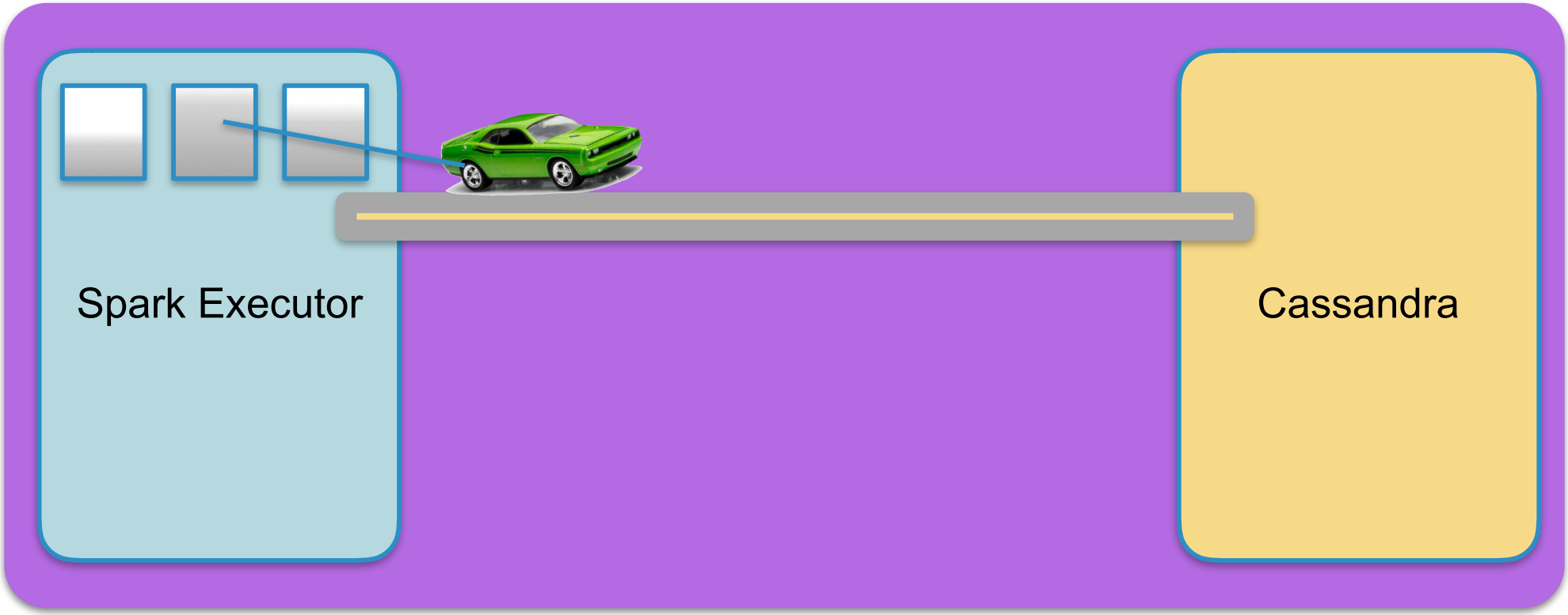
Data is Written using the Datastax Java Driver

A Connection is Established

Data is Grouped on Key

Data is Grouped on Key

Once a Batch is Full or There are Too Many Batches The Largest Batch is Executed



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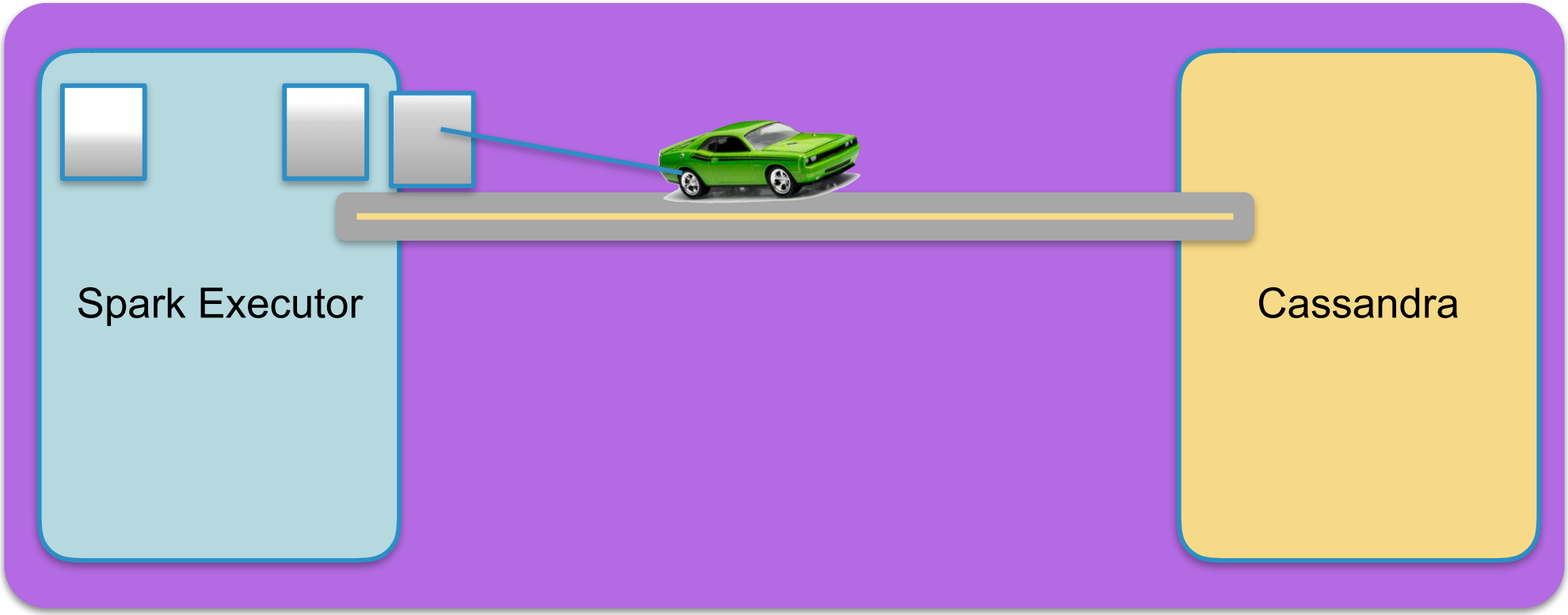

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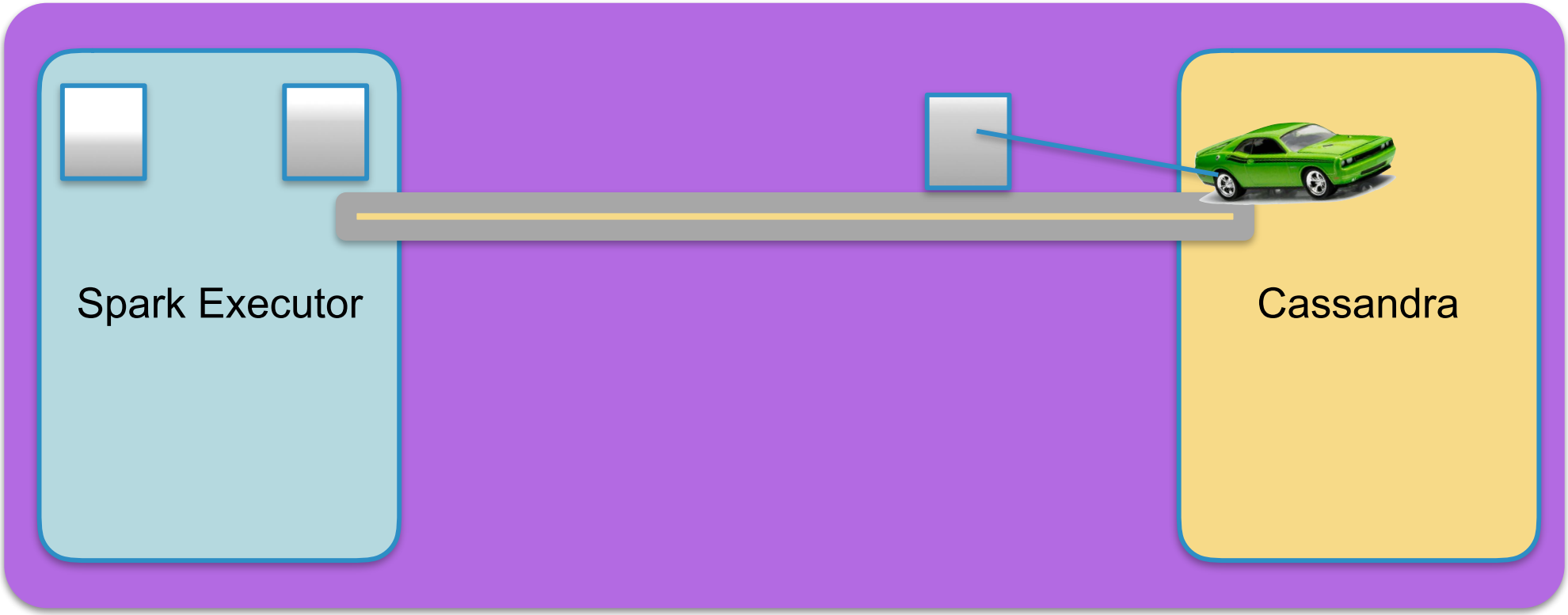


Once a Batch is Full or There are Too Many Batches The Largest Batch is Executed

Most Common Features

- RDD APIs
  - cassandraTable
  - saveToCassandra
  - repartitionByCassandraTable
  - joinWithCassandraTable
- DF API
  - Datasource

Full Table Scans, Making an RDD out of a Table

```
import com.datastax.spark.connector._

sc.cassandraTable(KeyspaceName, TableName)
```

```
import com.datastax.spark.connector._

sc.cassandraTable[MyClass](KeyspaceName, TableName)
```

Pushing Down CQL to Cassandra

```
import com.datastax.spark.connector._

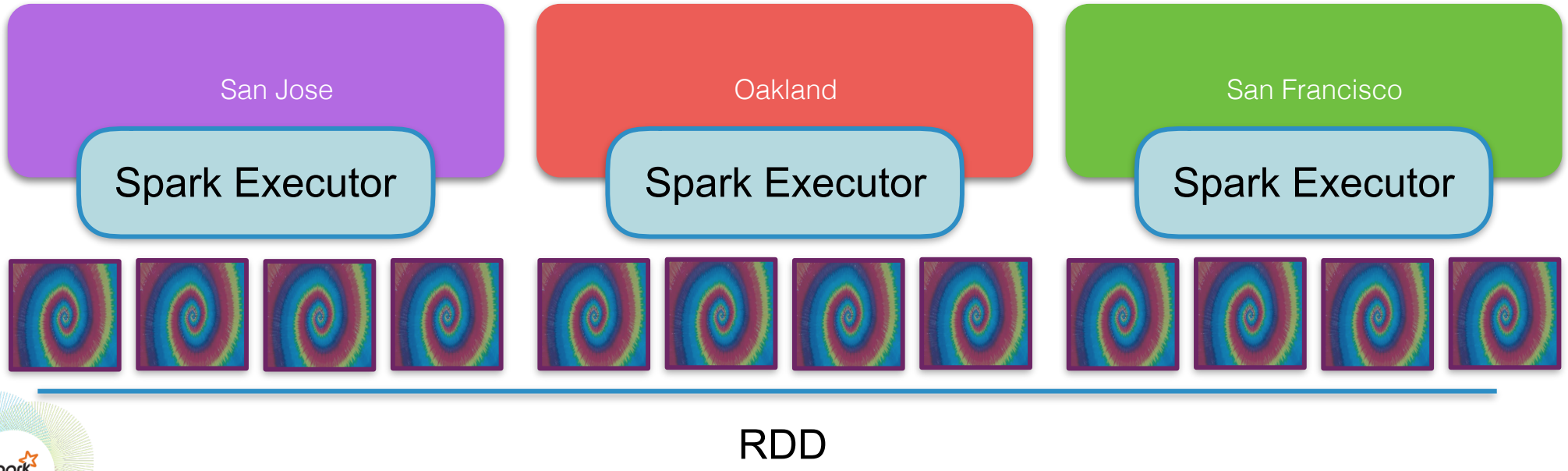
sc.cassandraTable[MyClass](KeyspaceName,
TableName).select("vehicle_id").where("ts > 10")
```

```
SELECT "vehicle_id" FROM TABLE
WHERE
  Token(PK) > 500 AND
  Token(PK) < 600 AND
   ts > 10
```

Distributed Key Retrieval

```
import com.datastax.spark.connector._

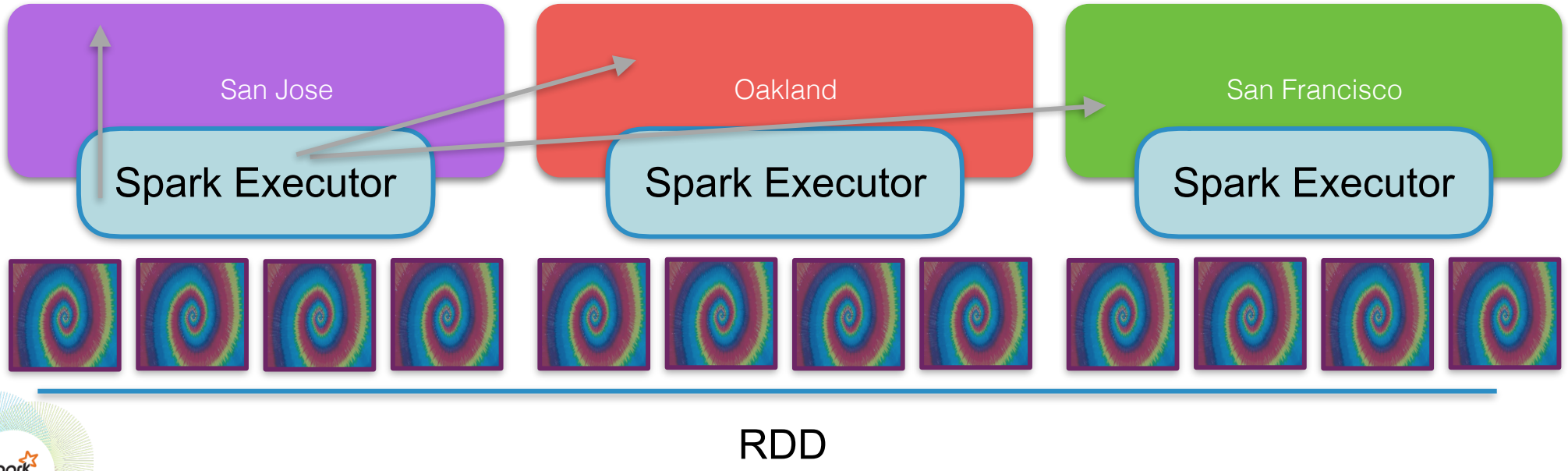
rdd.joinWithCassandraTable("keyspace", "table")
```



But our Data isn't Colocated

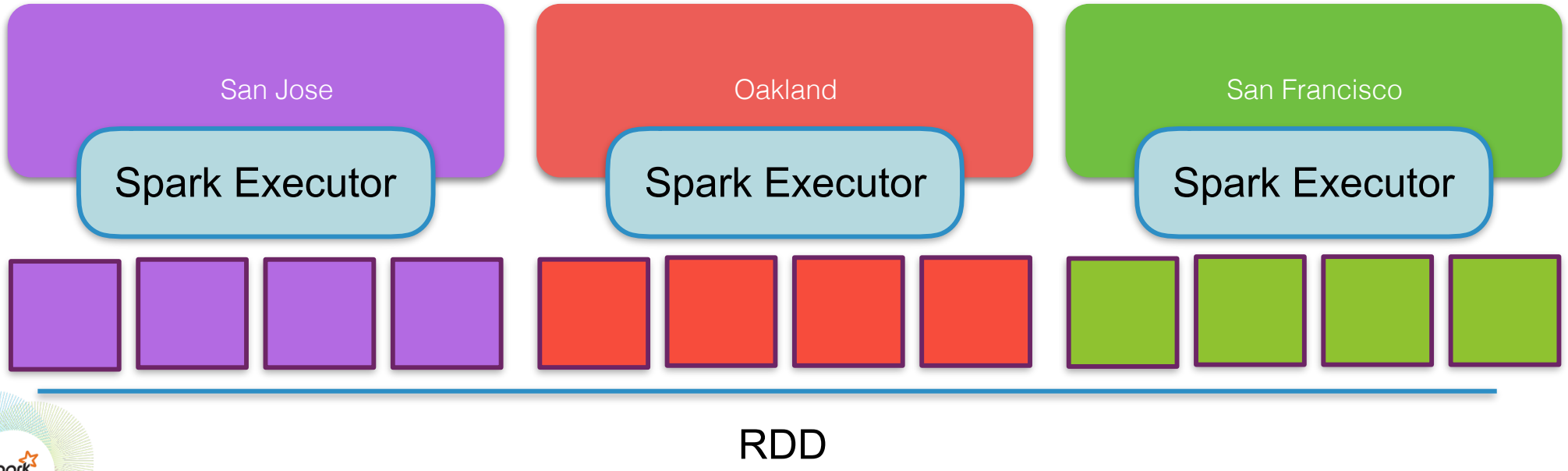
```
import com.datastax.spark.connector._

rdd.joinWithCassandraTable("keyspace", "table")
```



RBCR Moves bulk reshuffles our data so Data Will Be Local

```
rdd
 .repartitionByCassandraReplica("keyspace","table")
 .joinWithCassandraTable("keyspace", "table")
```



The Connector Provides a Distributed Pool for Prepared Statements and Sessions

```
CassandraConnector(sc.getConf)
```

```
rdd.mapPartitions{ it => {
  val ps = CassandraConnector(sc.getConf)
    .withSessionDo( s => s.prepare)
  it.map{ ps.bind(_).executeAsync()}
  }
```

Your Pool Ready to Be Deployed

The Connector Provides a Distributed Pool for Prepared Statements and Sessions

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CassandraConnector(sc.getConf)
```

```
rdd.mapPartitions{ it => {
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  }
```

Session Cache

Prepared Statement Cache

Your Pool Ready to Be Deployed

The Connector Supports the DataSources Api

```
sqlContext
  .read
  .format("org.apache.spark.sql.cassandra")
  .options(Map("keyspace" -> "read_test", "table" -> "simple_kv"))
  .load
```

```
import org.apache.spark.sql.cassandra._

sqlContext
  .read
  .cassandraFormat("read_test","table")
  .load
```

https://github.com/datastax/spark-cassandra-connector/blob/master/doc/14_data_frames.md

The Connector Works with Catalyst to Pushdown Predicates to Cassandra

```
import com.datastax.spark.connector._

df.select("vehicle_id").filter("ts > 10")
```

```
SELECT "vehicle_id" FROM TABLE
WHERE
  Token(PK) > 500 AND
  Token(PK) < 600 AND
   ts > 10
```

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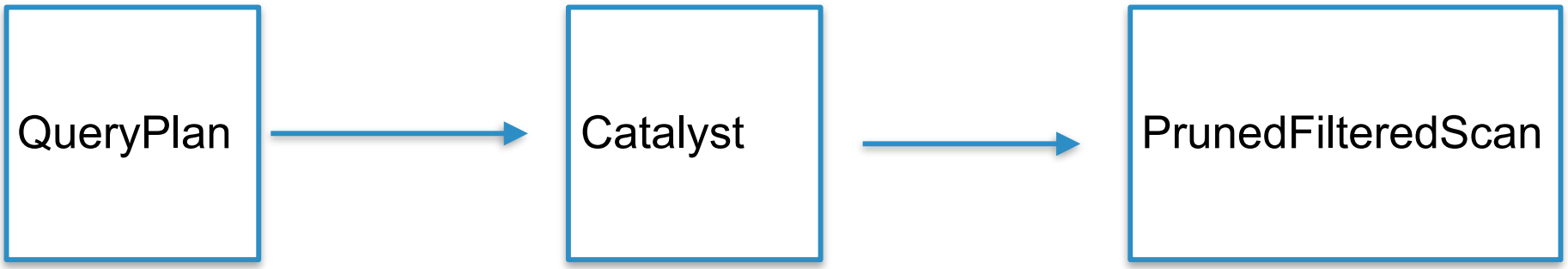


Only **Prunes** (projections) and **Filters** (predicates) are able to be pushed down.

Recent Features

- C* 3.0 Support
  - Materialized Views
  - SASL Indexes (for pushdown)
- Advanced Spark Partitioner Support
- Increased Performance on JWCT

Use C* Partitioning in Spark

Use C* Partitioning in Spark

- C* Data is Partitioned
- Spark has Partitions and partitioners
- Spark can use a known partitioner to speed up Cogroups (joins)
  - How Can we Leverage this?

Use C* Partitioning in Spark

Now if *keyBy* is used on a CassandraTableScanRDD and the PartitionKey is included in the key. The RDD will be given a C* Partitioner

```
val ks = "doc_example"
val rdd = { sc.cassandraTable[(String, Int)](ks, "users")
  .select("name" as "_1", "zipcode" as "_2", "userid")
  .keyBy[Tuple1[Int]]("userid")
}


rdd.partitioner
//res3: Option[org.apache.spark.Partitioner] =
Some(com.datastax.spark.connector.rdd.partitioner.CassandraPartitioner@94515d3e)
```

https://github.com/datastax/spark-cassandra-connector/blob/master/doc/16_partitioning.md

Use C* Partitioning in Spark

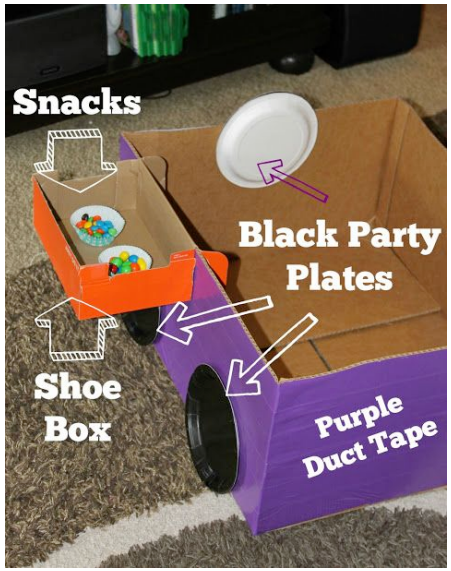
Share partitioners between Tables for joins on Partition Key

```
val ks = "doc_example"
val rdd1 = { sc.cassandraTable[(Int, Int, String)](ks, "purchases")
  .select("purchaseid" as "_1", "amount" as "_2", "objectid" as "_3", "userid")
  .keyBy[Tuple1[Int]]("userid")
}

val rdd2 = { sc.cassandraTable[(String, Int)](ks, "users")
  .select("name" as "_1", "zipcode" as "_2", "userid")
  .keyBy[Tuple1[Int]]("userid")
}.applyPartitionerFrom(rdd1) // Assigns the partitioner from the first rdd to this one

val joinRDD = rdd1.join(rdd2)
```

https://github.com/datastax/spark-cassandra-connector/blob/master/doc/16_partitioning.md

Use C* Partitioning in Spark

Many other uses for this, try it yourself!



- All self joins using the Partition key
- Groups within C* Partitions
- Anything formerly using SpanBy
- Joins with other RDDs
  And much more!

https://github.com/datastax/spark-cassandra-connector/blob/master/doc/16_partitioning.md

Enhanced Parallelism with JWCT

- joinWithCassandraTable now has increased concurrency and parallelism!
- 5X Speed increases in some cases
- https://datastax-oss.atlassian.net/browse/SPARKC-233
- Thanks Jaroslaw!

The Connector wants you!

- OSS Project that loves community involvement
- Bug Reports
- Feature Requests
- Doc Improvements
- Come join us!

Vin Diesel may or may not be a contributor

Tons of Videos at Datastax Academy

https://academy.datastax.com/

https://academy.datastax.com/courses/getting-started-apache-spark

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