2ndQuadrant® PostgreSQL

Postgres-BDR: Advanced HA Clustering & Scaling

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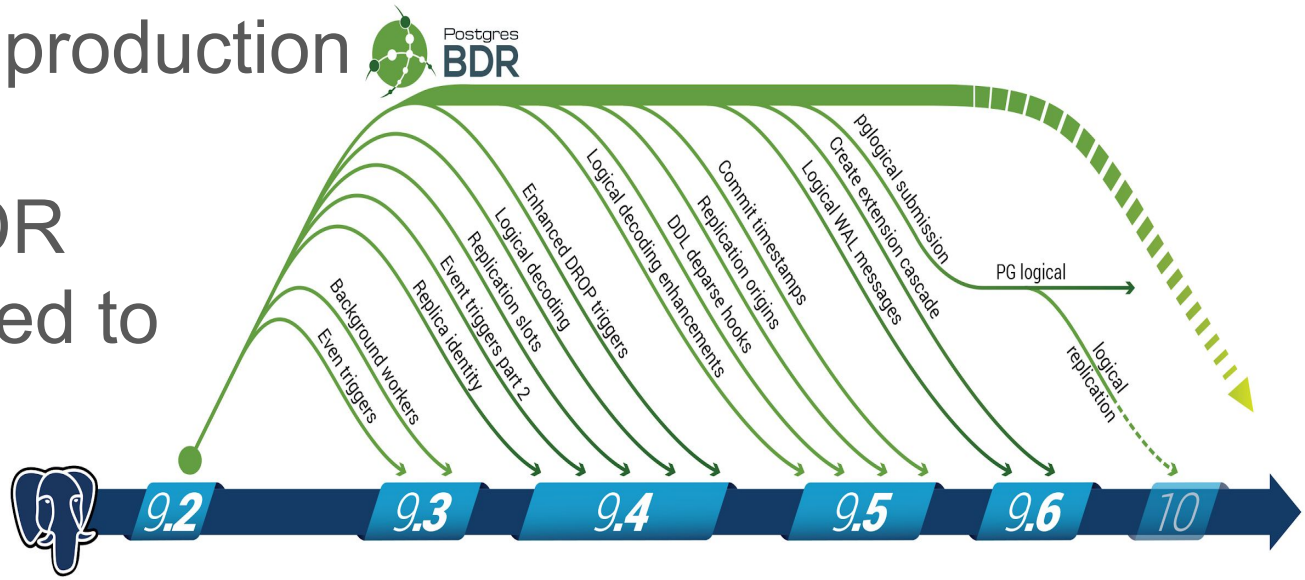
BDR History

Largest single contribution project to PostgreSQL

- 2009 Logical replication design
- 2012 BDR prototype
- 2014 BDR1 in production

- 2012+ Many BDR features contributed to PostgreSQL



BDR Editions and Versions

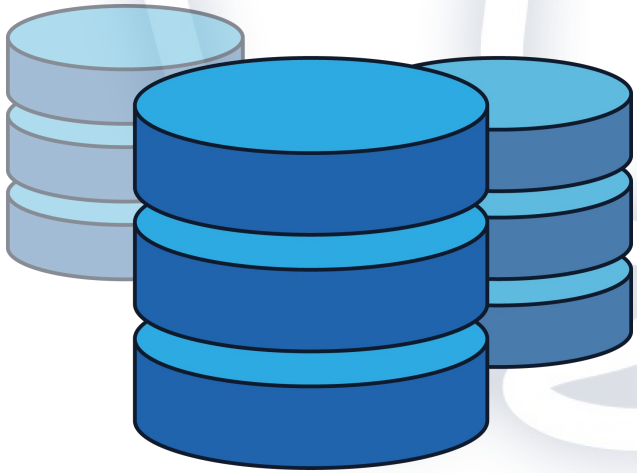
PostgreSQL11, with Advanced Features

- BDR 3.6.9 current version
  - BDR-SE Standard Edition
    - All features in Extension
  - BDR-EE Enterprise Edition
    - Various advanced features
- BDR 3.7 available October 2019

BDR3 Fundamentals

MultiMaster Database for PostgreSQL

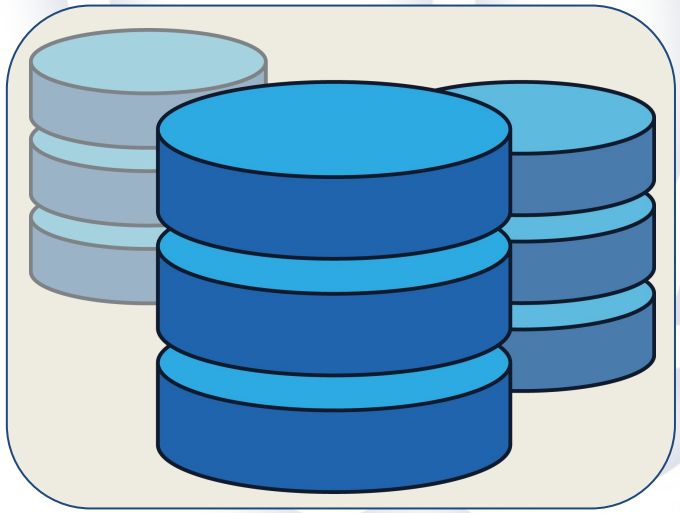
- Multiple Master nodes
- Fully automatic **DML** replication
- Fully automatic **DDL** replication
- Replication options
  - Efficient (Async)
  - Eager Replication



BDR "Group"

Building Blocks for Advanced Clusters

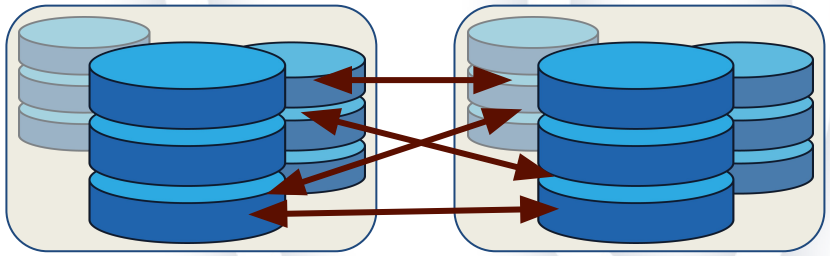
- A small cluster of 2-3 nodes is called a **Group** (or Group), multiple groups form the building block for advanced clusters
  - Integrated backup
  - Integrated routing for fast switchover to alternate nodes
  - Repair lost nodes



BDR AlwaysOn

Very High Availability Clustering

- Active-Active
  - One Group on each Site
  - 2-3 DB nodes per Group



  - One main node, switching to other nodes should node, site or network failures occur

BDR Worldwide

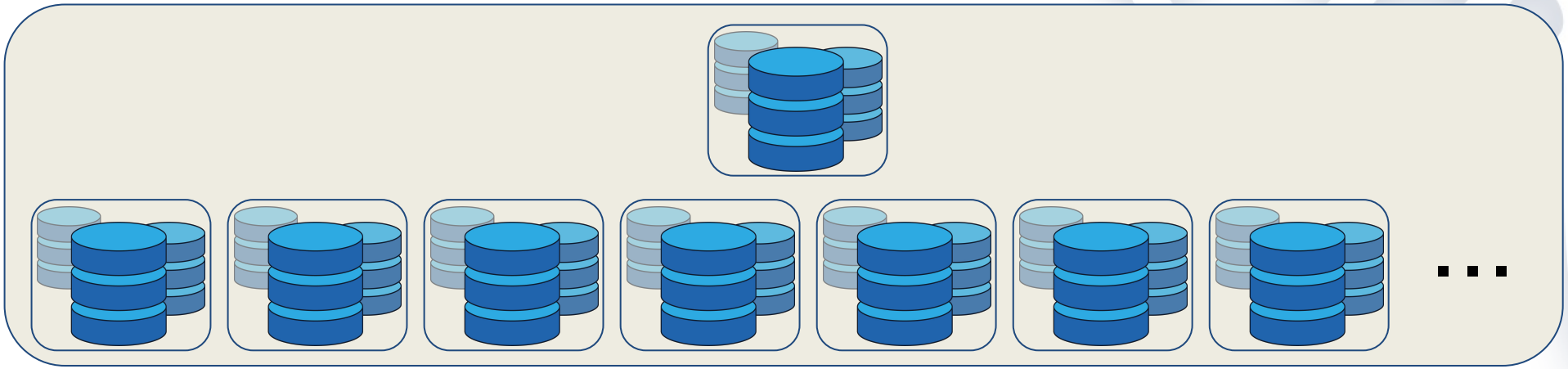
- Multiple Sites
  - Up to 32 Sites
  - No distance Limitation

  - Option to store data only on local site
  - Suitable for IoT, Monitoring and TimeSeries

BDR AutoScale

Massively Parallel Database & Elastic Scaling

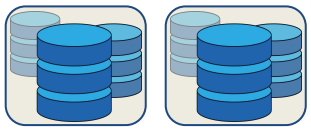
- **AutoScale offers Sharding solution**
  - Elastically scalable cluster of 2+ Groups
  - Optional Read/Write Coordinator Groups(s)
  - Optional Disaster Recovery site



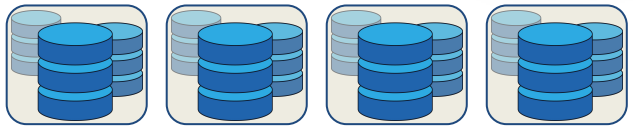
BDR Use Cases

Advanced Clustering & Scaling

- BDR Worldwide
  - Geographically Remote Databases
- BDR AlwaysOn (3.6+)

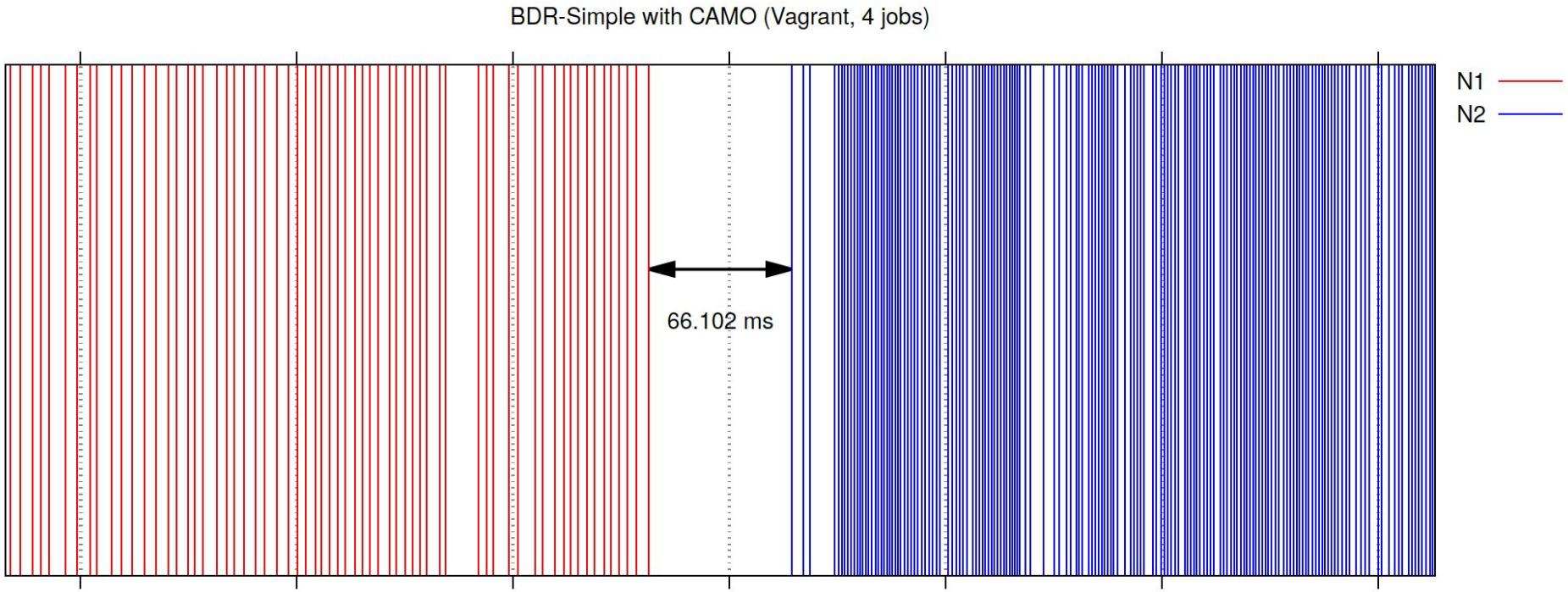


  - Very High Availability PostgreSQL
- BDR AutoScale (3.7+)



  - PostgreSQL MPP databases using BDR sharding

BDR Fast Switchover



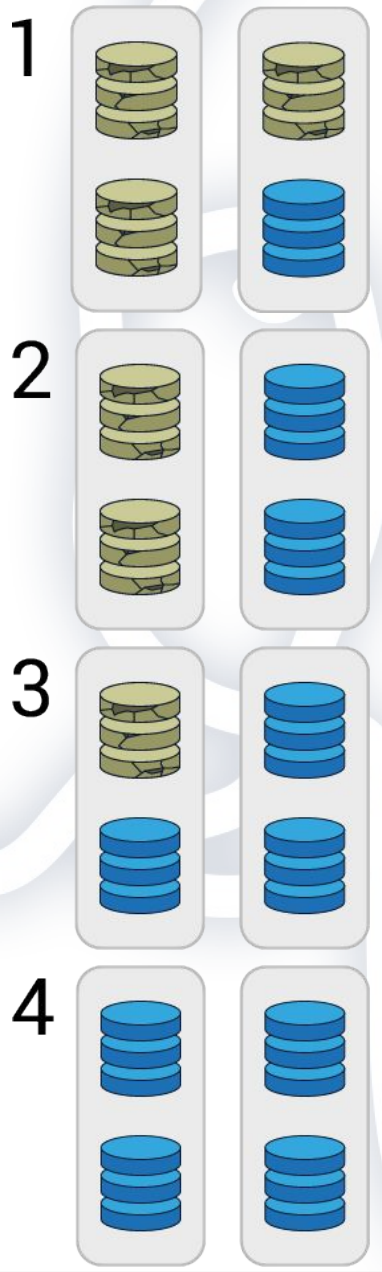
- Execute on node1 until failure, fast failover node2
- Compare 30-90s for single master failover
  Against <100ms for AlwaysOn failover

BDR Data Loss Protection

- Commit At Most Once ensures that any in-flight transactions with unknown state are fully resolved
  - **No transactions are duplicated or skipped**
  - Works for Session and Transaction mode pooling
- Data in other sites for Disaster Recovery protection can be read and used for reporting/additional uses, since they are active they can use temp tables etc..

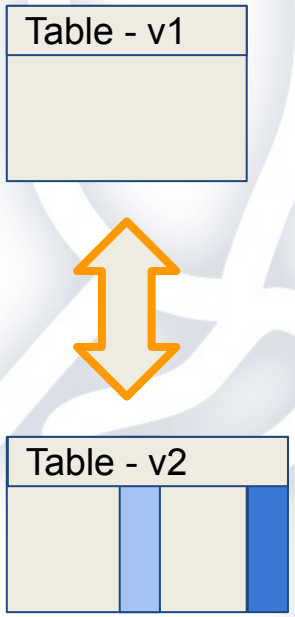
Rolling System Upgrades

- Rolling upgrades start with least used node and roll across all nodes slowly
- System Upgrades can upgrade BDR and/or main PostgreSQL releases
  - e.g. PG10 to PG11
    E.g. BDR3.5.5 to BDR3.6.2
  - Nodes re-negotiate their protocols to ensure compatibility



Rolling Database Schema Upgrades

- Rolling upgrades start with least used node and roll across all nodes slowly, managed under DevOps control
- Update application's database schema
  - BDR tolerates mismatched schemas such as additional/missing columns, different datatypes, differing indexes
  - Application stays online during upgrade
  - Bad situations can be backed out



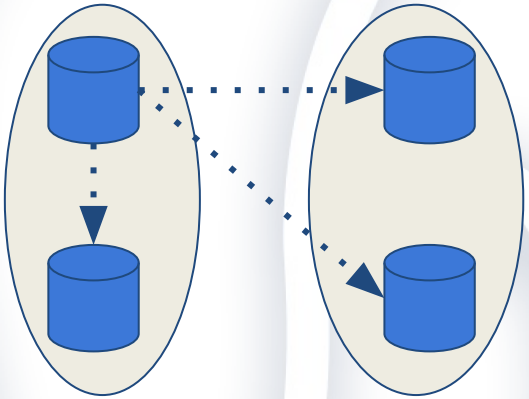
BDR Performance

Real-World Production Performance

- Massive partitioning performance gains
- Efficient logical replication
- Streaming of large transactions
- Efficient distributed sequences
- Choice of options for selecting appropriate robustness and performance trade-offs
- Replication performance analysis, Lock wait times and I/O timing

Writing to Postgres-BDR

Distributed database options

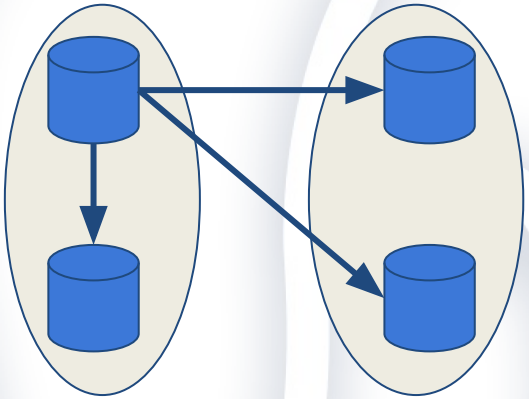


- **Post**-Commit Synchronization
  Resolve issues *after* COMMIT
  - Row-level Conflict Handling by default
  - Column-level Conflict Handling option
  - Conflict-Free Custom Datatypes (CRDTs)
  - Logging and resolution of issues, Conflict Triggers

- Eventual Consistency
  - Fast: Low latency, suitable for wide distribution

Writing to Postgres-BDR

Distributed database options



- **Pre**-Commit Synchronization
  Eager Replication *avoids* conflicts
  - All Nodes
  - (Majority nodes: roadmap feature)

- Avoids issues at COMMIT
  - Additional latency not desirable in many cases
  - Some transaction aborts in conflict cases
  - Suitable for high value data/hi latency tolerance

BDR Application Requirements

Advisory, not Mandatory

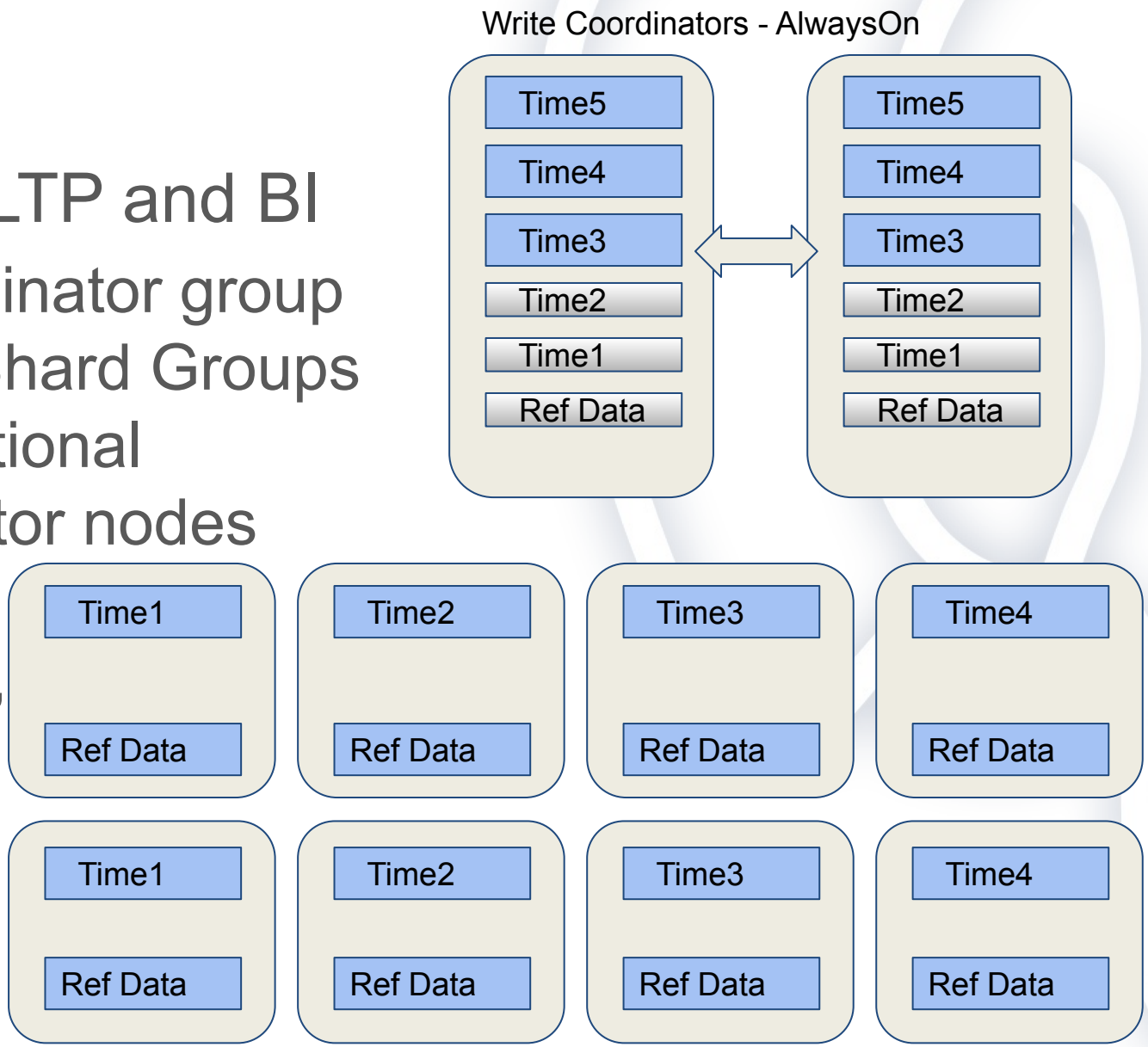
- Unique identifiers for rows (INSERTs, UPDATEs)
- Don't change identifiers (UPDATEs)
- Don't reuse identifiers (quickly) (DELETEs)

- If you don't follow these you may get conflicts/issues
- BDR Assessment offers tools to identify these
- BDR LiveCompare offers data verification/correction to assure production systems

AutoScale

Shard data for OLTP and BI

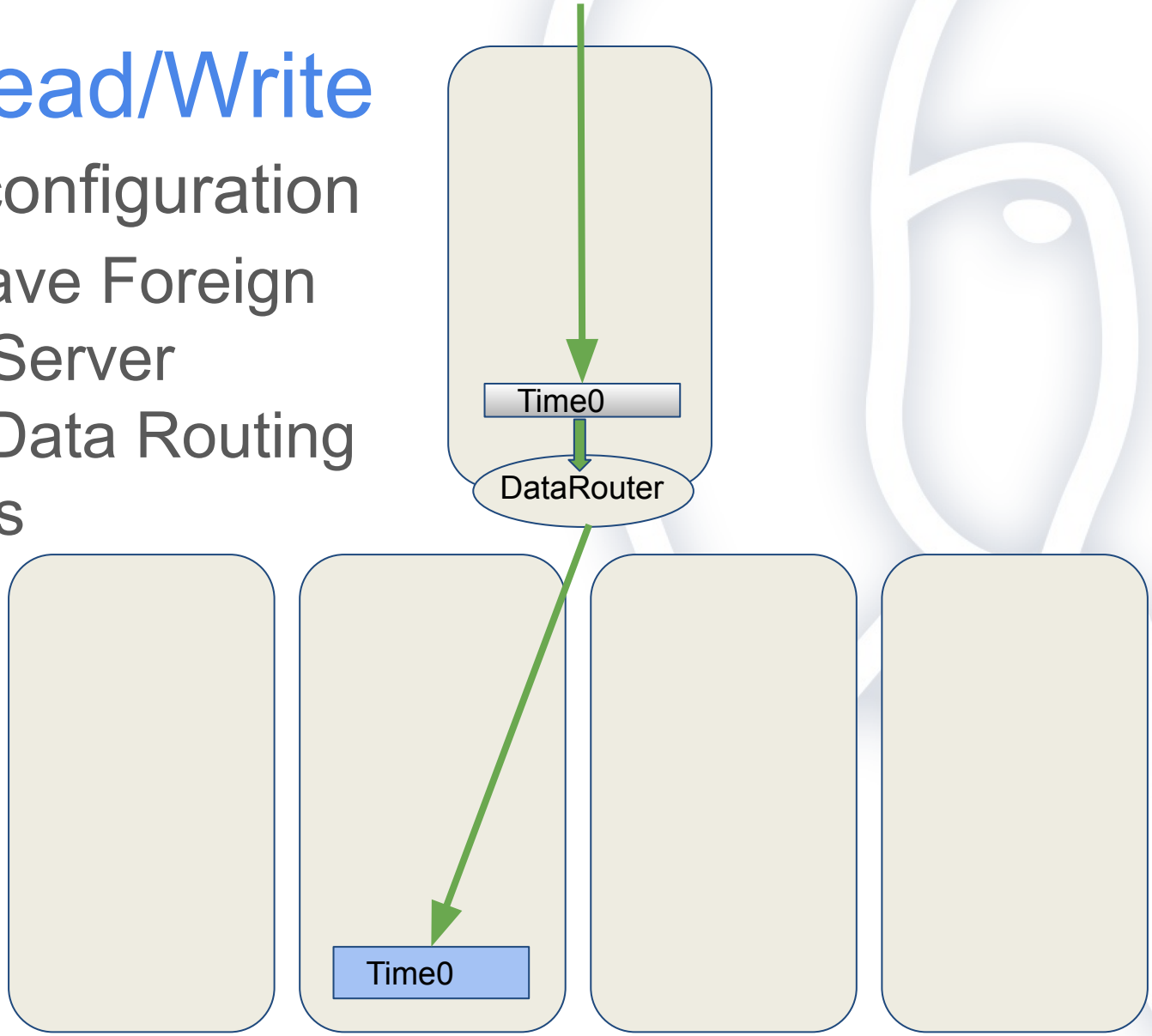
- OLTP on Coordinator group
- BI on array of Shard Groups
- We can add optional Read Coordinator nodes
- Easily upgrade array of groups, without moving existing data



AutoScale Read/Write

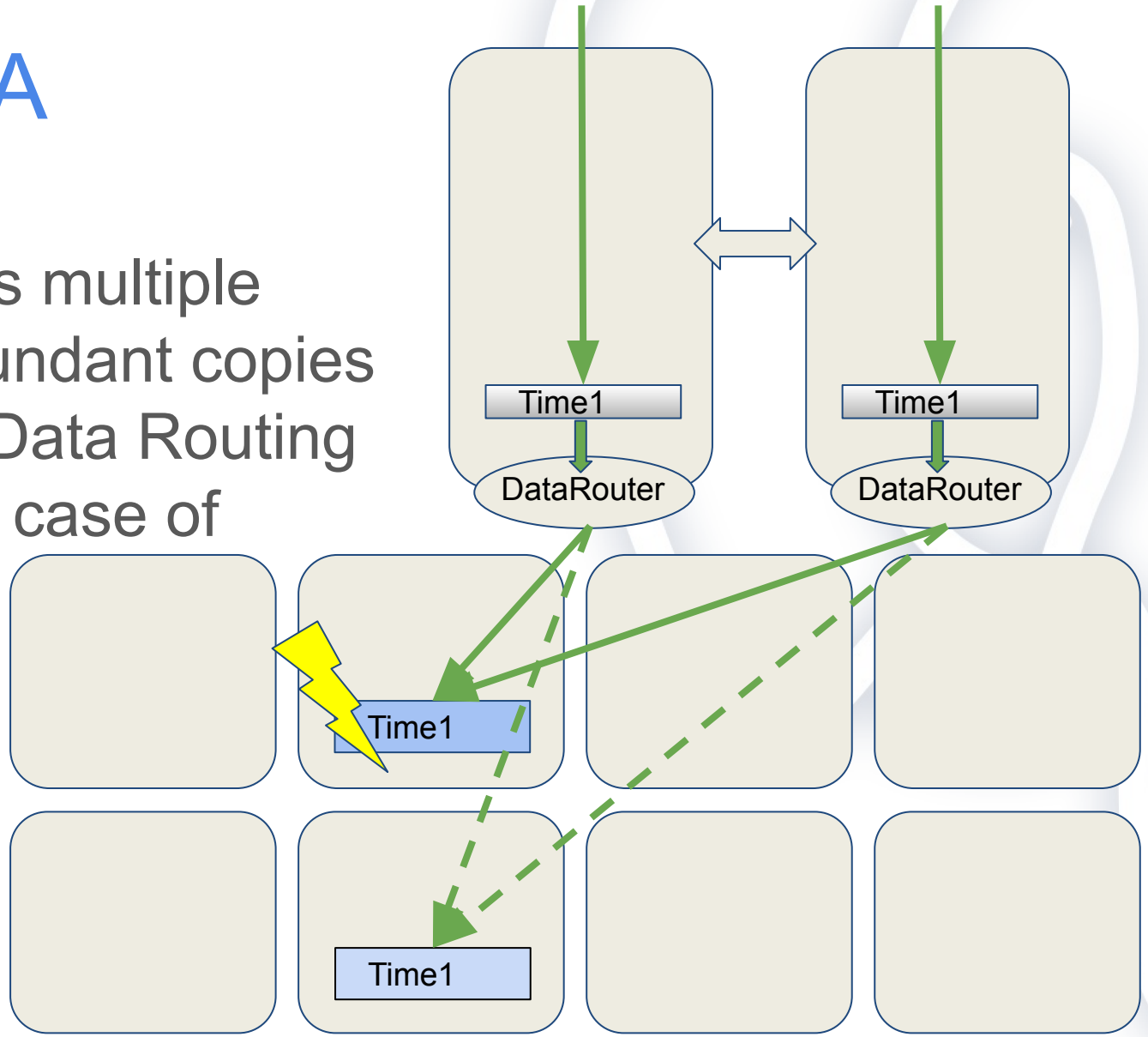
Data Node only configuration

- Coordinators have Foreign Tables to BDR Server
- BDR performs Data Routing
- All query access happens via Postgres FDW mechanisms



AutoScale HA

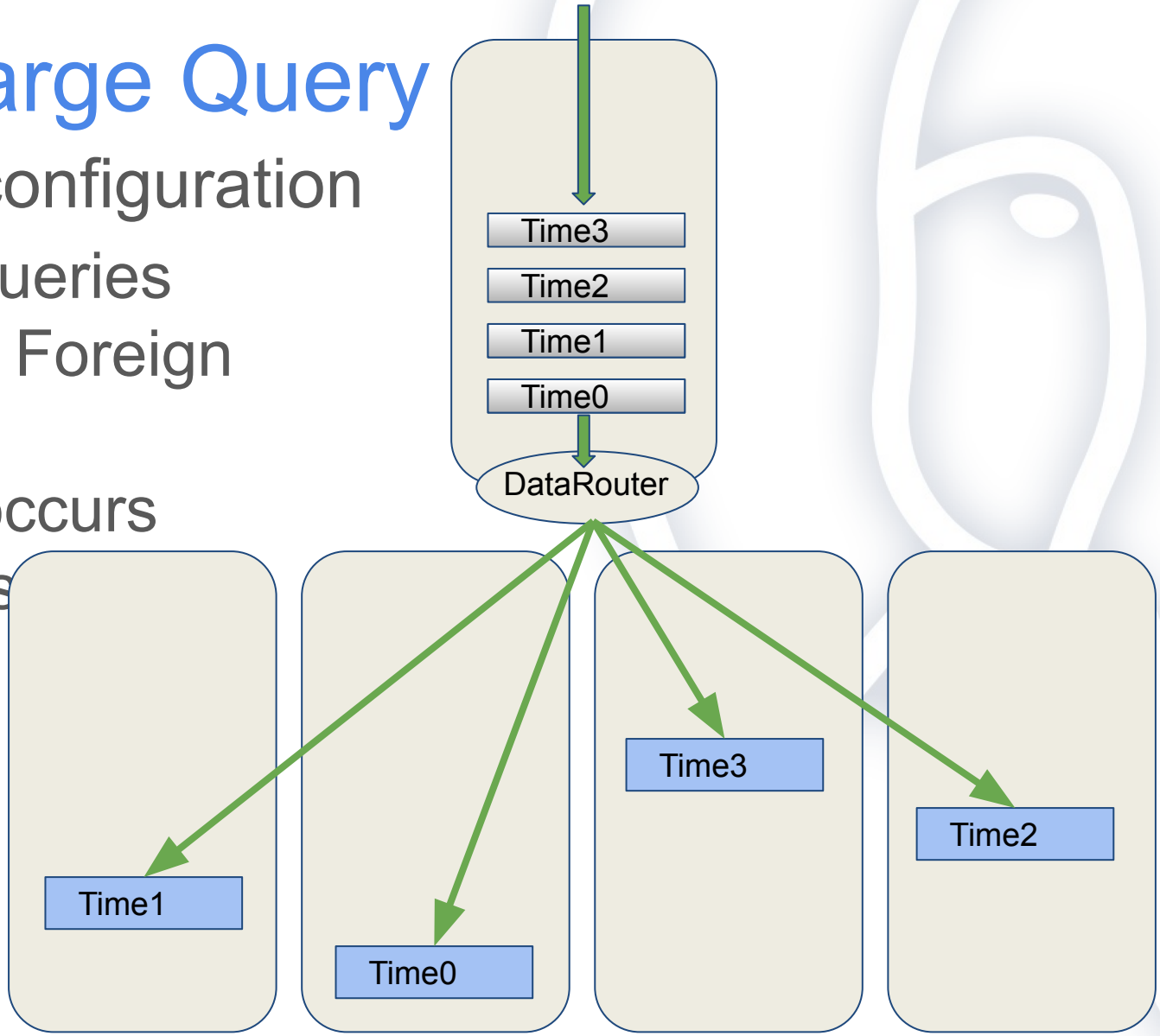
- Each Group has multiple nodes with redundant copies
- BDR performs Data Routing **dynamically** in case of down nodes
- Built-In HA



AutoScale Large Query

Data Node only configuration

- Multi-partition queries access multiple Foreign Tables
- Parallel query occurs because access spread across multiple nodes



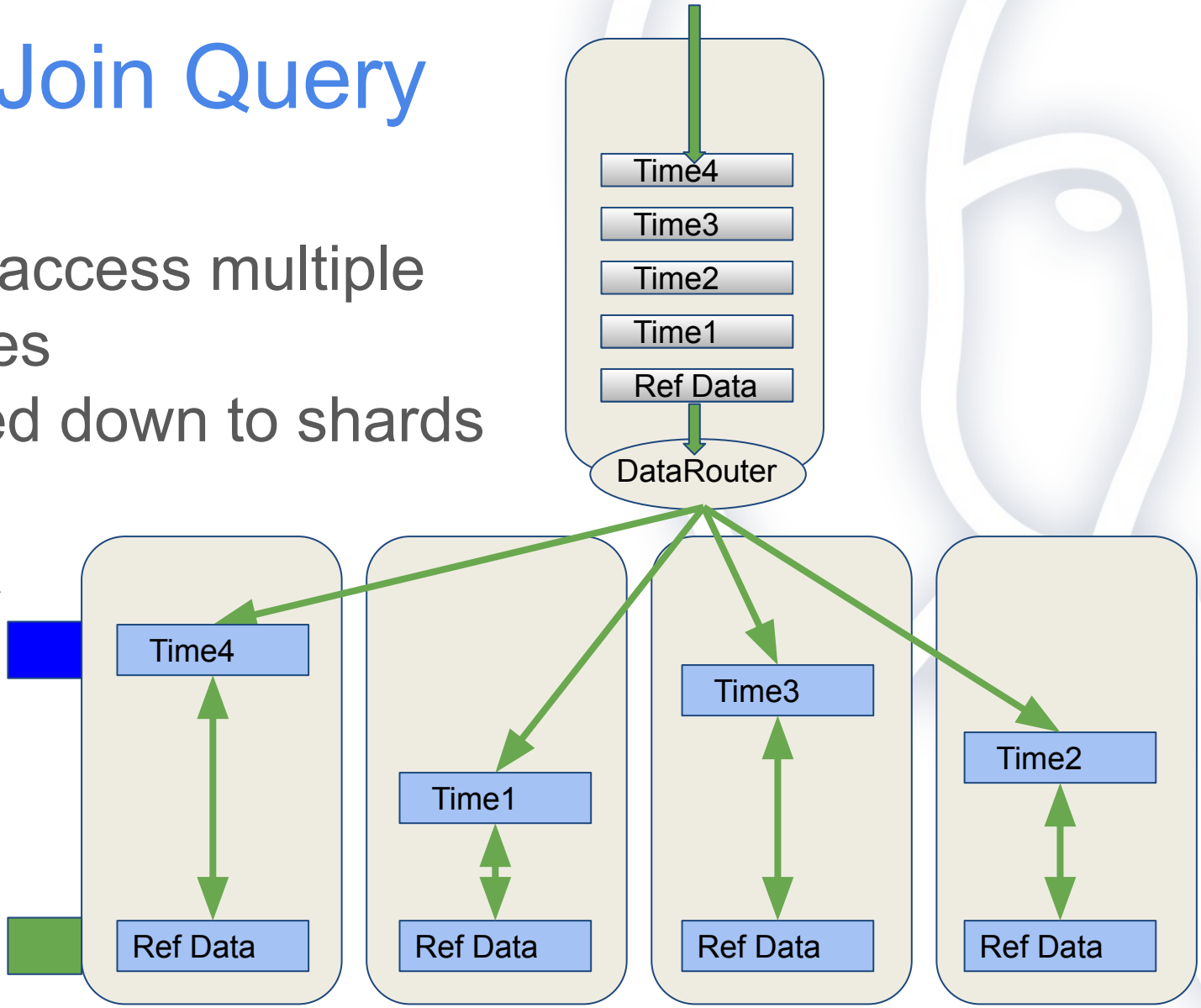
Example Query - SSB Q3.2

```
SELECT c_city, s_city, d_year, sum(lo_revenue) as revenue
FROM    lineorder
    JOIN customer ON lo_custkey = c_custkey
    JOIN supplier ON lo_suppkey = s_suppkey
    JOIN date ON lo_orderdate = d_datekey
WHERE c_nation = 'UNITED STATES'
and s_nation = 'UNITED STATES'
and d_year >= 1992 and d_year <= 1997
GROUP BY c_city, s_city, d_year
ORDER BY d_year asc, revenue desc;
```

AutoScale Join Query

- Join queries access multiple Foreign Tables
- Join is pushed down to shards

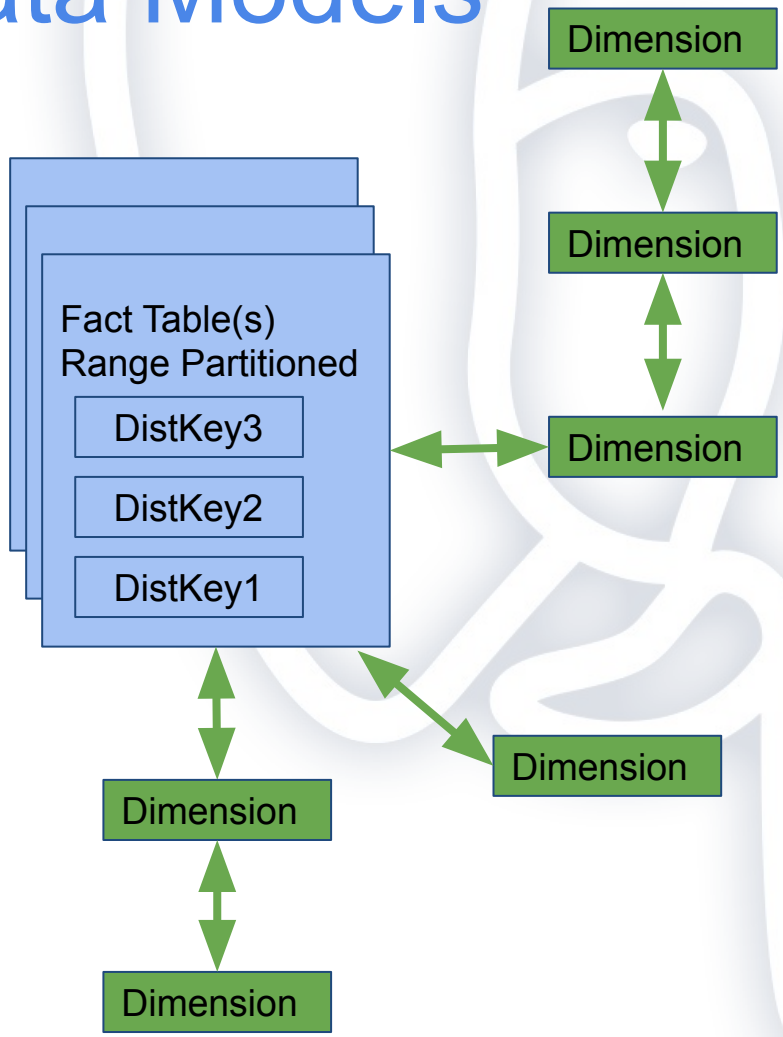
- Star Schema joins only, covers most performant case



AutoScale Supported Data Models

Snowflake Schema

- Multiple Fact Tables
  - Range Partitioned only using matching partitions
  - 1 to Many Relationships between Fact tables
  - Spliced across shard groups
- Multiple Dimension tables
  - Copies on all groups
  - Normalized



BDR Multi-node Query

Consistency and Performance

- Timestamp-based consistency (ClockSI)
- Allow consistent queries **across** nodes even with real-time replication of data
- Data verification between nodes

- Multi-node parallel query (MPP) across
  - Local clusters with remote DR nodes
  - Geo-distributed clusters

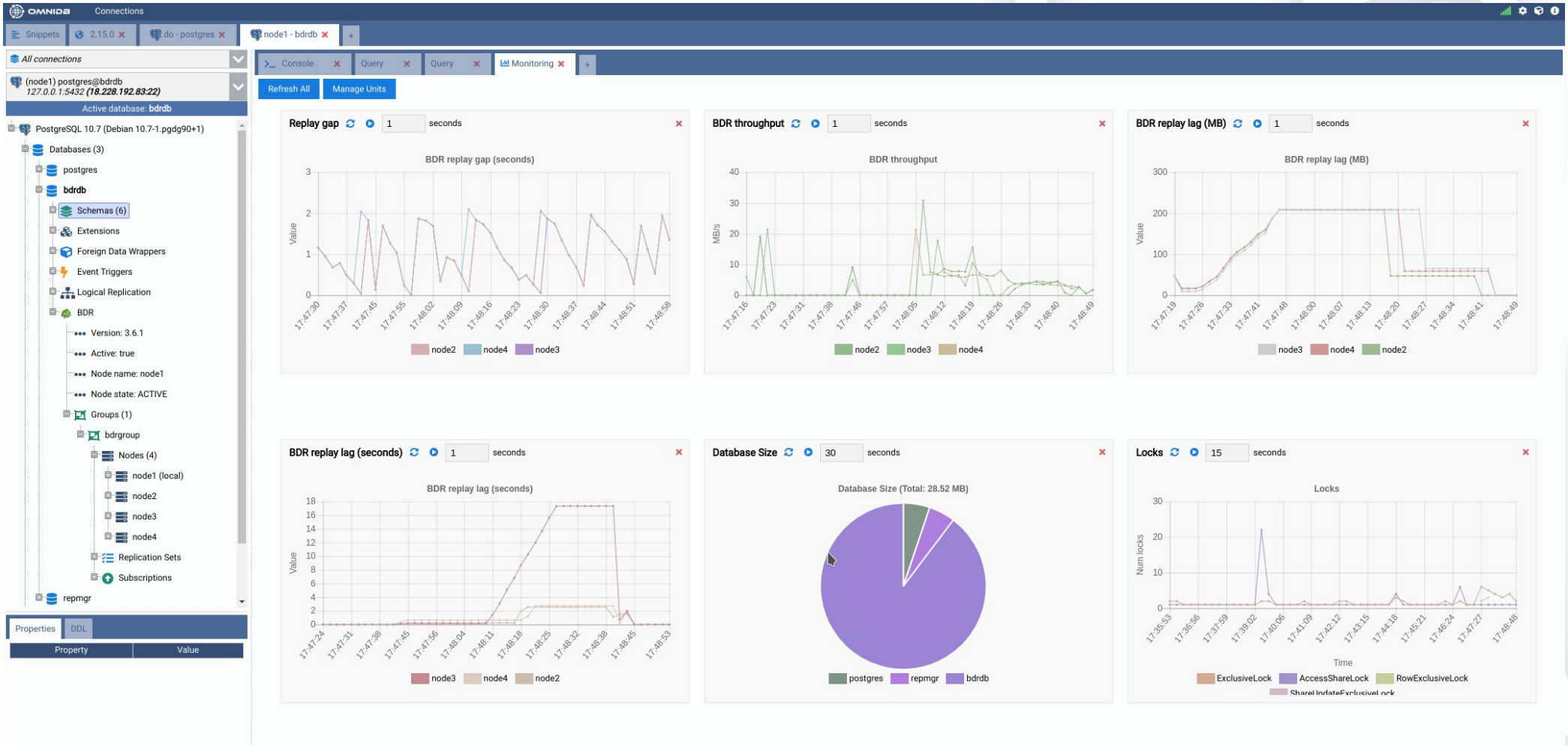
BDR3 Enterprise Edition (BDR-EE)

PostgreSQL, with Advanced Features

- Very High Availability
- Maximum Data Protection
- Rolling System Upgrades
- Rolling Application Upgrades
- AutoPartition
- AutoScale
- Performance & Security
- Robustness from Production Experience

Postgres-BDR Plugin for OmniDB

Visual Administration



Cloud Native Integration

Working together in the Cloud

- 2ndQuadrant is a Silver Member of the CNCF
- Kubernetes operators for BDR and PostgreSQL
- OpenTracing built into BDR3.7 for end-end observability
- Prometheus storage plugin for BDR AutoScale
- Fluentd integration via syslog input

- TPAexec Cloud/On-Premise Orchestration
- Postgres Cloud Manager for Pure/Hybrid Own-Management

2ndQuadrant PostgreSQL Solutions

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