
aws

AWS Redshift

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One of the fastest growing and most popular cloud services from AWS is Amazon Redshift. If you have ever googled Redshift you have probably read the following: it is a fully managed,relational database management service based on the PostgreSQL engine. It can handle petabyte-scale data while offering lightning-fast querying performance. The query handling efficiency is achieved through the combination of:

- **Highly parallel processing (shared-nothing system)**: the service uses a number of processors to perform coordinated computations in parallel,
- **A columnar database design**: it delivers column-orientated technology on an as-a-service basis, making it affordable, easy, and fast to get up and running with,
- **Data compression of columns**: owing to columnar data storage, Redshift automatically can use adaptive compression encoding, depending on the column data type,
- **A query optimizer**: it uses analyzed information about tables to generate efficient query plans for execution,
- **Compiled query code**: the query execution engine compiles the query into machine code and distributes it to the cluster nodes. The compiled code executes faster because it eliminates the overhead of using an interpreter.

AWS Redshift - Query LifeCycle

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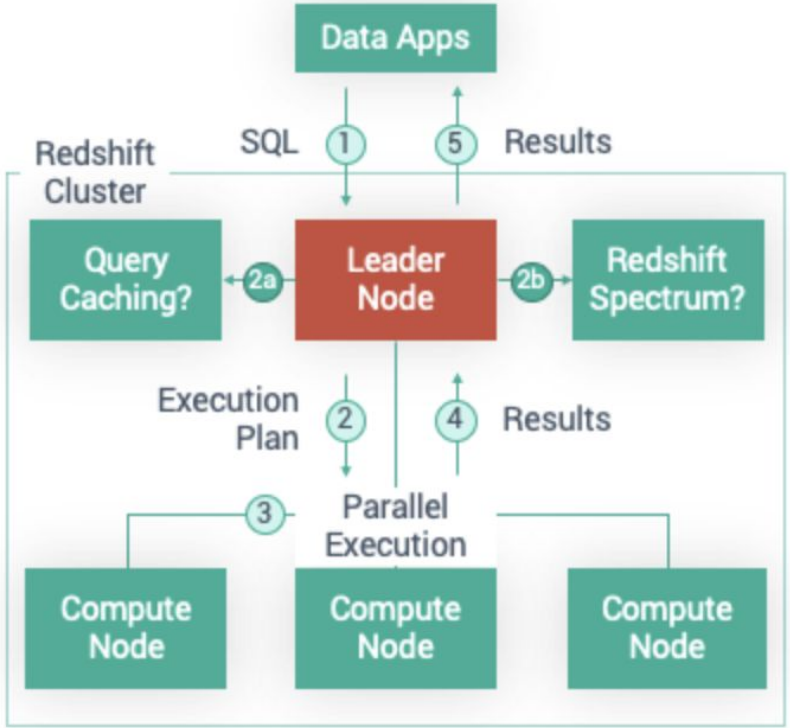
Amazon Redshift Architecture: Query Caching & Redshift Spectrum

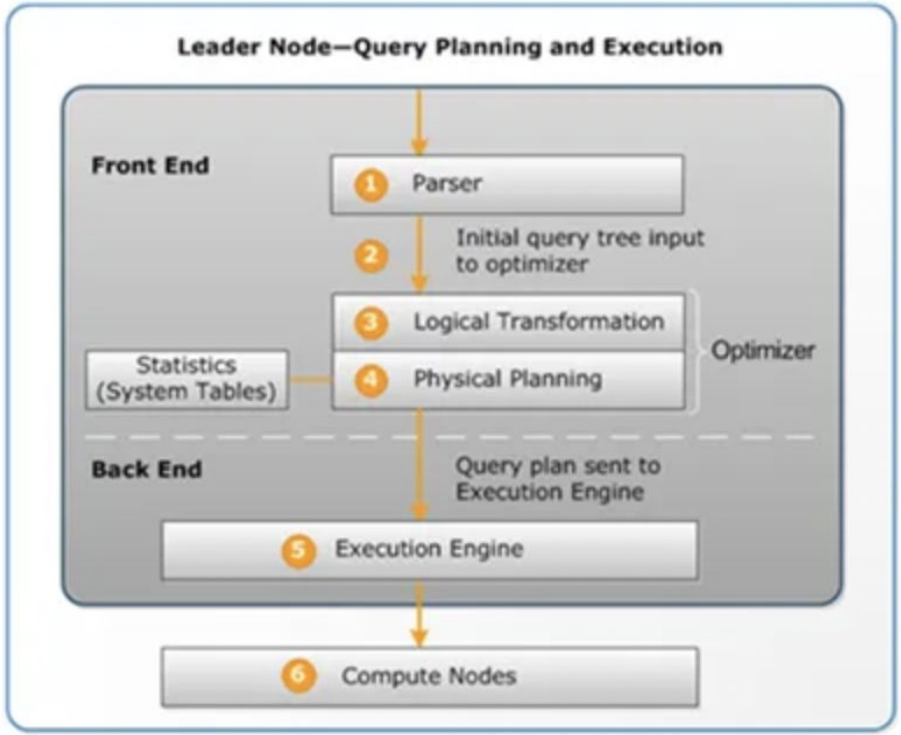


1. The cluster receives a query coming from a data app and parses the SQL in the leader node.
2. The leader node creates an execution plan that breaks a query down into a discrete sequence of steps.
   - 2a Determines if cached result is available
   - 2b Determines if query goes to Redshift Spectrum
3. The leader node distributes the work of executing the steps in parallel across the compute nodes.
4. The compute nodes send the results back to the leader node to merge data into a single result.
5. The leader node addresses any final sorting or aggregation and returns the results to the data app.

Leader node

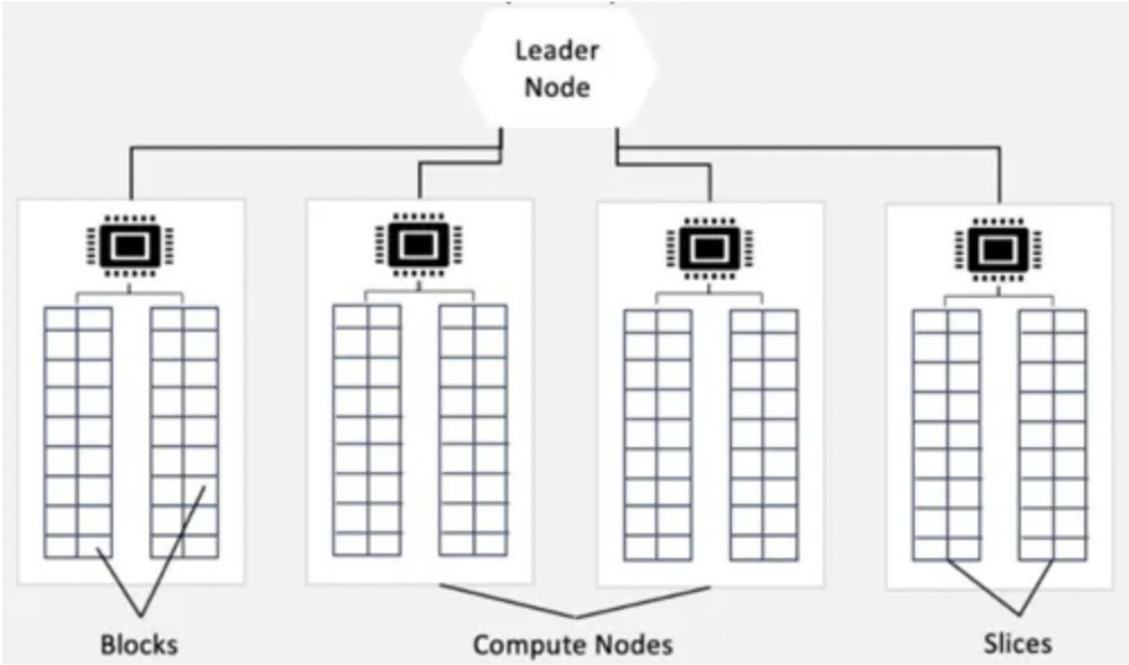
The leader node manages all external and internal communications with data applications and all communication with compute nodes. It is responsible for:

- Parsing and query rewriting,
- Planning of query processing,
- Query compiling to C++ and further distribution to compute nodes,
- Task scheduler and WLM,
- Executing queries (limited functionality).



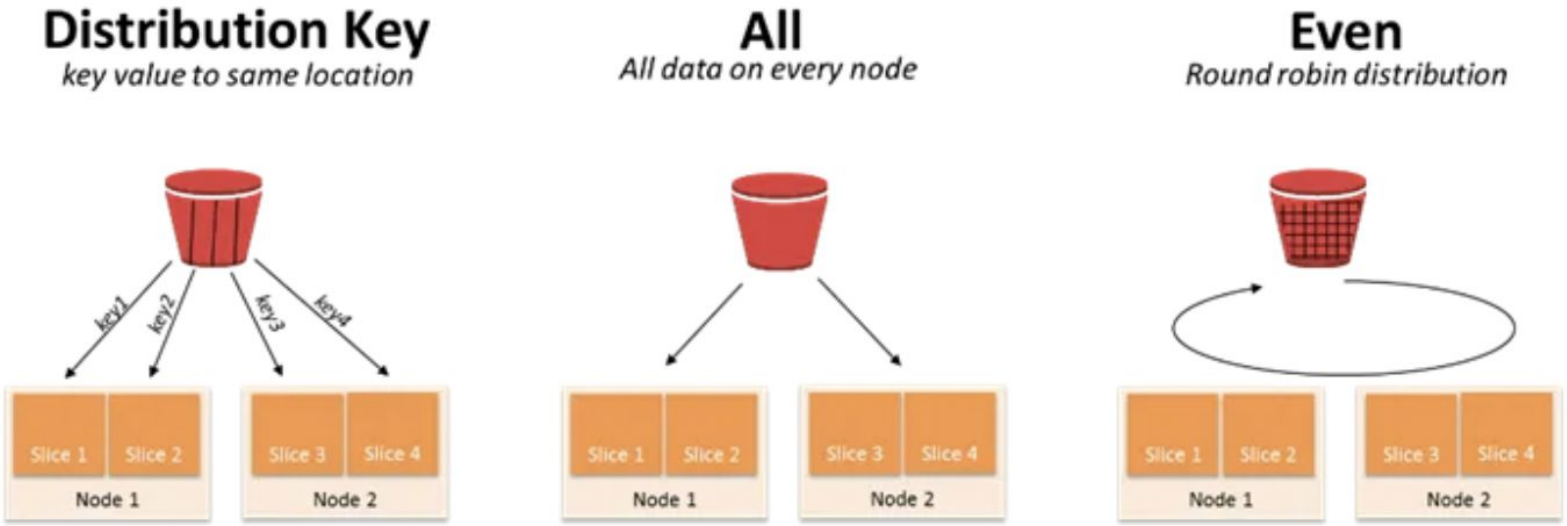
Compute node

The compute nodes handle all query processing, and they do so in parallel execution (“massively parallel processing”, or “MPP”), and they also run backup and restore processes. They are located on a separate, isolated network that client applications never access directly.



Slices

Each computational node is composed of two or more slices, which allow parallel access and processing across slices on each node. The objective of this concept is to distribute the workload of queries evenly across all nodes in order to leverage the parallel processing and to increase efficiency. The three distribution styles supported by Redshift are EVEN, KEY, and ALL (also AUTO, but it is not considered to be a separate style).



Slices

· **KEY distribution**: rows are distributed according to the values in one column. The leader node places matching values on the same node slice. It is usually done with high cardinality columns [CJ1] to improve performance between two tables while joining them or aggregating values.

· **ALL distribution**: a copy of the entire table is distributed to every node. ALL distribution multiplies the storage required by the number of nodes in the cluster, and so it takes much longer to load, update, or insert data into multiple tables. ALL distribution is appropriate only for relatively slow-moving tables.

· **EVEN distribution**: the leader node distributes the rows across the slices in a round-robin fashion, regardless of the values in any particular column. EVEN distribution is appropriate when a table doesn’t participate in joins. It is also appropriate when there is not a clear choice between KEY distribution and ALL distribution.

What is Redshift Spectrum?

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Amazon Redshift Spectrum is a feature of Amazon Redshift, a fully managed data warehouse service in AWS. Redshift Spectrum allows users to run complex SQL queries directly against vast amounts of data in Amazon S3, **without needing to load or ETL** (Extract, Transform, Load) the data into Redshift itself. Here are some of its key characteristics and features:

- **Extensive Data Querying:** Redshift Spectrum lets you query data that resides in Amazon S3, as if they were regular Redshift tables. This makes it seamless to analyze data in its raw, stored format.
- **No ETL Required:** Since you can query data directly in Amazon S3, there's no need for an ETL process to load data into the Redshift warehouse, which can be a time-saving advantage for ad-hoc or one-off analyses.
- **Scalability**: Redshift Spectrum scales out query processing by dynamically allocating thousands of parallel query processors as required. This ensures quick results even on large datasets.
- **Cost-Effective**: With Redshift Spectrum, you pay only for the queries you run against the data stored in S3. This makes it a flexible solution, especially if you don't need to analyze your entire dataset in Redshift itself.
- **Integrated with AWS Glue**: AWS Glue's Data Catalog is used as the native metadata repository for Redshift Spectrum, making it easy to discover and manage the metadata of datasets.
- **Support for Various Data Formats:** Redshift Spectrum supports popular data formats like Parquet, ORC, JSON, Avro, and more.

What is Redshift Spectrum?

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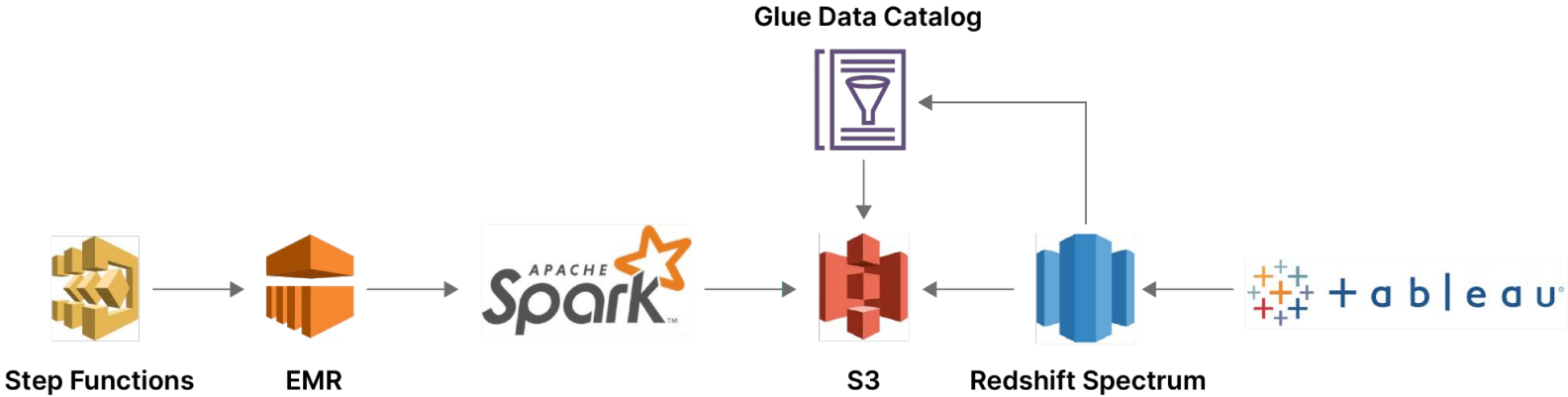
- **Security**: Redshift Spectrum offers multiple layers of security, including options to encrypt data at rest and in transit. It also integrates with AWS Identity and Access Management (IAM) for access controls.
- **Unified Data Analysis**: Users can run SQL queries that span their data warehouse and data lake, allowing for complex analyses that blend structured data in Redshift with semi-structured or unstructured data in Amazon S3.
- **Performance Optimization**: The system uses sophisticated query optimization and columnar storage on S3, reducing the amount of data that needs to be read from disk, which speeds up queries.



Redshift Commands

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- **Create Table (Internal Table)**

```
CREATE TABLE sales (
    id INT ENCODE lzo,
    date DATE ENCODE bytedict,
    product VARCHAR(255) ENCODE lzo,
    quantity INT ENCODE delta,
    revenue DECIMAL(10,2) ENCODE delta
)
DISTSTYLE KEY
DISTKEY (date)
SORTKEY (date, product);
```

- **Load data from S3 table**

```
COPY sales
FROM 's3://your-bucket/path/to/data/sales-data.csv'
IAM_ROLE 'arn:aws:iam::your-account-id:role/YourRedshiftRole'
DELIMITER ','
IGNOREHEADER 1
REGION 'us-west-2';
```

Redshift Commands

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- **Unload Query Results into S3 (Multi Parts)**

```
UNLOAD ('SELECT * FROM sales WHERE date = "2023-08-01"')
TO 's3://your-bucket/path/to/export/sales-data-'
IAM_ROLE 'arn:aws:iam::your-account-id:role/YourRedshiftRole'
DELIMITER ','
ADDQUOTES
ALLOWOVERWRITE
REGION 'us-west-2';
```

- **Unload Query Results into S3 (Single File)**

```
UNLOAD ('SELECT * FROM sales WHERE date = "2023-08-01"')
TO 's3://your-bucket/path/to/export/sales-data.csv'
IAM_ROLE 'arn:aws:iam::your-account-id:role/YourRedshiftRole'
DELIMITER ','
ADDQUOTES
ALLOWOVERWRITE
REGION 'us-west-2'
PARALLEL OFF;
```

Redshift Commands

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- **Unload Query Results into S3 with Manifest File**

```
UNLOAD ('SELECT * FROM sales')
TO 's3://your-bucket/path/to/export/sales-data-'
IAM_ROLE 'arn:aws:iam::your-account-id:role/YourRedshiftRole'
DELIMITER ','
ADDQUOTES
ALLOWOVERWRITE
MANIFEST;
```

Redshift Commands

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- **Load into S3 with Manifest File**

```
COPY sales
FROM 's3://your-bucket/path/to/import/sales-data.manifest'
IAM_ROLE 'arn:aws:iam::your-account-id:role/YourRedshiftRole'
DELIMITER ','
MANIFEST;
```

The usefulness of a manifest file when loading data into Redshift includes:

- **Explicitness:** By using a manifest file, you're being explicit about which files to load. This can be useful in scenarios where there may be other unrelated files in the same S3 location.

- **Error Handling:** If a COPY operation fails for some files but succeeds for others, you can adjust the manifest file to only retry the files that failed, rather than retrying the entire dataset.

- **Parallelism:** Redshift can load multiple files in parallel. If your data is split across many files (which is often the case when unloading data from Redshift or using distributed data processing frameworks), using a manifest file ensures that all files are loaded concurrently, utilizing Redshift's MPP (massively parallel processing) capabilities.

- **Flexibility**: Manifest files give you flexibility in data loading. For example, you can have files from different S3 locations or even from different S3 buckets in a single manifest.

- **Ensuring Completeness**: Especially in environments where new data files might be continuously added to an S3 location, using a manifest ensures that you know exactly which files were loaded into Redshift.

Redshift Commands

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- **Create External Schema**

```
CREATE EXTERNAL SCHEMA your_external_schema
FROM DATA CATALOG
DATABASE 'your_external_database'
IAM_ROLE 'arn:aws:iam::your-account-id:role/YourRedshiftRole'
CREATE EXTERNAL DATABASE IF NOT EXISTS;
```

- **Create Table - Redshift Spectrum (External)**

```
CREATE EXTERNAL TABLE spectrum_schema.sales (
    id INT,
    date DATE,
    product VARCHAR(255),
    quantity INT,
    revenue DECIMAL(10,2)
)
ROW FORMAT DELIMITED
FIELDS TERMINATED BY ','
STORED AS TEXTFILE
LOCATION 's3://your-bucket/path/to/data/'
TABLE PROPERTIES ('skip.header.line.count'='1');
```

Materialized view in Redshift

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A materialized view in Amazon Redshift is a database object that contains the results of a query. Unlike a regular view which is just a saved SQL query that runs against the base tables every time it's queried, a materialized view stores the actual query results in the Redshift cluster.

Here are some reasons why you would want to use materialized views in Redshift:

- **Performance**: Since materialized views store the query results, accessing a materialized view can be much faster than running the underlying query, especially if the query is complex and involves multiple joins, aggregations, and filtering.
- **Minimize Redundant Computation**: If you find yourself running the same heavy query frequently, it's wasteful to compute the results from scratch every single time. Materialized views allow you to compute once and reuse the results.
- **Automated Refresh**: You can set materialized views to be refreshed automatically at regular intervals or manually as needed, ensuring that the data remains relatively up-to-date without constant manual intervention.
- **Simplified Querying**: Materialized views can simplify complex business logic into a single table-like structure. This can make it easier for analysts and other end-users to fetch data without having to understand the intricacies of the base tables and joins.
- **Optimization**: Redshift can further optimize how the data in a materialized view is stored, making reads even faster. For instance, using sort keys and data distribution strategies.
- **Cost-effective**: For heavy queries that would otherwise be run multiple times, using a materialized view can save computational resources, translating to cost savings.

Redshift Commands

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- **Create Materialized Views**

  ```
  CREATE MATERIALIZED VIEW sales_summary AS
  SELECT product, SUM(quantity) AS total_quantity, SUM(revenue) AS total_revenue
  FROM sales
  GROUP BY product;
  ```

- **Refresh Materialized Views**

  ```
  REFRESH MATERIALIZED VIEW sales_summary;
  ```