✅ **Default File Format: Parquet**

Parquet is the default file format because of its efficiency and compatibility:

🔷 **Key Features of Parquet:**

1. **Columnar Storage**
    - Optimized for analytics and read-heavy workloads.
    - Reads only the required columns, reducing I/O.
2. **Efficient Compression**
    - Better compression due to columnar format (e.g., Snappy, GZIP).
    - Reduces storage cost.
3. **Schema Evolution Support**
    - Can add new columns or modify schema with some flexibility.
4. **Splittable & Scalable**
    - Easy to parallelize across distributed systems like Spark.
5. **Open Source & Interoperable**
    - Compatible with Spark, Hive, Presto, Athena, BigQuery, etc.

Delta Lake is an **open-source storage layer** that brings **ACID transactions**, **scalable metadata handling**, and **unified batch & streaming** processing to **data lakes**. It builds on top of **Apache Parquet** files and enhances them with **transactional features**, making your **data lake into a lakehouse**.

✅ **Key Features of Delta Lake Format**

Feature	Description
ACID Transactions	Guarantees **atomicity**, **consistency**, **isolation**, and **durability** for all writes
Schema Enforcement	Ensures incoming data follows a defined schema; avoids bad/missing columns
Schema Evolution	Supports automatic schema updates when new fields are added (with control)
Time Travel	Allows users to query previous versions of the data using VERSION AS OF or TIMESTAMP AS OF

Feature	Description
Data Lineage	Tracks every version of a table for audit and debugging
Streaming + Batch	Unified support for both **real-time streaming** and **batch processing**
Scalable Metadata	Metadata is stored in Apache Spark's distributed parquet/log system instead of Hive metastore
Data Compaction (Optimize)	Compacts small files into larger ones to improve performance (OPTIMIZE command)
Data Cleanup (Vacuum)	Deletes old, unneeded data files to manage storage and keep tables clean

🚀 Performance Enhancements

- **OPTIMIZE**: Merges small files → faster reads.
- **ZORDER**: Reorders data on columns to improve filtering performance.
- **VACUUM**: Cleans up old files after retention period.

🧪 Time Travel Example in Spark SQL

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```sql
-- View the table as it existed 5 versions ago
SELECT * FROM my_delta_table VERSION AS OF 5;

-- Or using a timestamp
SELECT * FROM my_delta_table TIMESTAMP AS OF '2024-06-01T12:00:00';
```

🗂️ Delta Lake Table Structure

Delta tables are stored in a **directory-based structure**:

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```
/delta-table/
├── _delta_log/            <- Transaction log files (JSON + CHECKPOINT.parquet)
├── part-00001.snappy.parquet
├── part-00002.snappy.parquet
└── ...
```

- **_delta_log**: Contains logs for every transaction (`.json` for write actions and `.checkpoint.parquet` for faster loading).
- **Parquet files**: Contain the actual data.