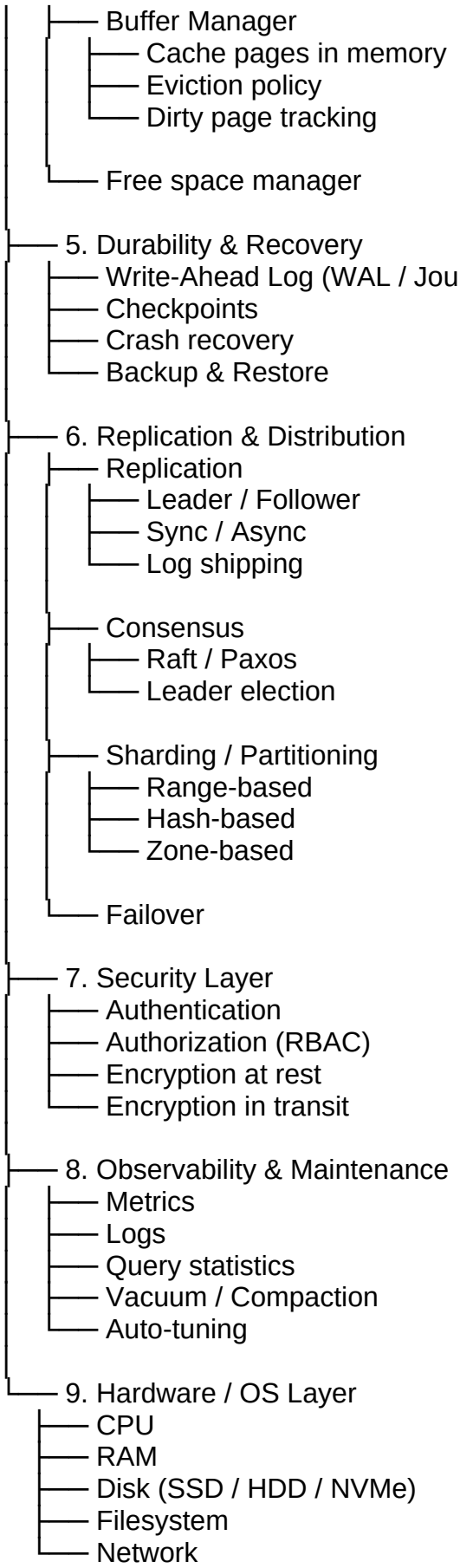
BASE DE DATOS (DBMS)

- 1. Client Interface
  - Drivers (JDBC, ODBC, Mongo Driver, etc)
  - Protocolos (TCP, TLS)
  - Autenticación inicial
- 2. Query Layer
  - Parser
    - Lexical analysis
    - Syntax tree (AST)
  - Validator
    - Schema validation
    - Permissions
    - Type checking
  - Query Optimizer
    - Cost-based optimizer
    - Statistics
    - Index selection
    - Execution plan
  - Execution Engine
    - Operators (scan, join, filter)
    - Pipeline execution
    - Result materialization
- 3. Transaction Manager
  - Transaction lifecycle
    - BEGIN
    - COMMIT
    - ROLLBACK
  - Isolation control
    - MVCC
    - Locks
    - Snapshots
  - Concurrency control
    - Deadlock detection
    - Conflict resolution
- 4. Storage Engine
  - Data organization
    - Pages / Blocks
    - Segments
    - Tablespaces / Collections
  - Index Manager
    - B-Tree
    - Hash indexes
    - LSM Trees
    - Compound / Partial indexes


Buffer Manager
Cache pages in memory
Eviction policy
Dirty page tracking
Free space manager
5. Durability & Recovery
Write-Ahead Log (WAL / Journal)
Checkpoints
Crash recovery
Backup & Restore
6. Replication & Distribution
Replication
Leader / Follower
Sync / Async
Log shipping
Consensus
Raft / Paxos
Leader election
Sharding / Partitioning
Range-based
Hash-based
Zone-based
Failover
7. Security Layer
Authentication
Authorization (RBAC)
Encryption at rest
Encryption in transit
8. Observability & Maintenance
Metrics
Logs
Query statistics
Vacuum / Compaction
Auto-tuning
9. Hardware / OS Layer
CPU
RAM
Disk (SSD / HDD / NVMe)
Filesystem
Network