PostgreSQL Administration, Migration, Java Application Modernization & Server Management

Duration: 12 days

Day 1 – PostgreSQL Community Architecture & Installation

Topics

- Introduction to PostgreSQL Community Edition
- Open-source PostgreSQL ecosystem
- PostgreSQL architecture
    - Process model
    - Memory model
- PostgreSQL cluster concept
- PostgreSQL installation on Linux
- initdb and data directory structure
- Starting and stopping PostgreSQL using pg_ctl
- Working with psql

Hands-On

- Install PostgreSQL 16 Community Edition
- Initialize a PostgreSQL cluster manually
- Explore the PostgreSQL data directory
- Start and stop PostgreSQL services
- Connect using psql
- Create the first database

Outcome

Participants can install PostgreSQL Community Edition and understand its fundamental server architecture and cluster structure.

Day 2 – Server Configuration & Authentication

Topics

- postgresql.conf deep dive
- Important server configuration parameters
- Memory configuration
    - shared_buffers
    - work_mem
    - maintenance_work_mem
- Connection configuration
- pg_hba.conf
- Authentication methods

    - Trust
    - MD5
    - SCRAM-SHA-256
- PostgreSQL logging
- WAL fundamentals
- Autovacuum fundamentals

Hands-On

- Enable and configure PostgreSQL logging
- Configure remote PostgreSQL connections
- Modify memory parameters
- Configure pg_hba.conf
- Test multiple authentication mechanisms
- Review PostgreSQL server logs

Outcome

Participants can configure PostgreSQL servers, authentication, connectivity, memory, and logging.

Day 3 – Database Objects & Storage

Topics

- PostgreSQL object hierarchy
- Databases versus schemas
- Tablespaces
- PostgreSQL storage concepts
- System catalogs
- pg_catalog
- Database statistics views
- Disk-space monitoring
- Identifying large tables
- Database system identifiers

Hands-On

- Create databases and schemas
- Move objects between schemas
- Create and configure tablespaces
- Check database and table sizes
- Explore pg_class
- Explore PostgreSQL statistics views
- Identify database system information

Outcome

Participants understand PostgreSQL logical and physical storage structures and can administer common database objects.

Day 4 – Transactions & Concurrency

Topics

- ACID properties in PostgreSQL
- MVCC architecture
- Transaction processing
- Isolation levels
- Locks
- Blocking sessions
- Deadlock detection
- Backend processes
- Materialized views

Hands-On

- Simulate concurrent transactions
- Test different isolation levels
- Monitor pg_locks
- Identify blocking sessions
- Terminate backend processes
- Simulate locking scenarios
- Create and refresh materialized views

Outcome

Participants can troubleshoot locking and concurrency issues and understand PostgreSQL transaction behavior.

Day 5 – Security & Extensions

Topics

- PostgreSQL role-based security
- Users and roles
- Privileges and grants
- Object ownership
- Password security
- Row-Level Security
- PostgreSQL extensions
- postgres_fdw
- dblink
- hstore
- citext

Hands-On

- Create administrative and application roles
- Configure restricted database access
- Grant and revoke privileges

- Configure Row-Level Security
- Install PostgreSQL extensions
- Configure postgres_fdw
- Execute cross-database queries

Outcome

Participants can implement PostgreSQL security controls and use commonly required Community Edition extensions.

Day 6 – Monitoring & Performance Tuning

Topics

- PostgreSQL monitoring architecture
- pg_stat views
- pg_stat_activity
- pg_stat_user_tables
- Identifying slow-running queries
- EXPLAIN
- EXPLAIN ANALYZE
- Query execution plans
- Indexing strategies
- Detecting missing indexes
- Detecting unused indexes
- Memory tuning considerations

Hands-On

- Find active and long-running sessions
- Analyze slow queries
- Generate execution plans
- Create and evaluate indexes
- Compare execution plans before and after optimization
- Tune work_mem
- Improve query performance without modifying application SQL

Outcome

Participants can monitor PostgreSQL workloads, interpret query plans, and perform fundamental performance tuning.

Day 7 – Vacuum, Bloat & Database Maintenance

Topics

- Autovacuum internals
- Dead tuples
- Table bloat

- Index bloat
- VACUUM
- VACUUM FULL
- ANALYZE
- Reindexing
- PostgreSQL statistics
- Routine DBA maintenance
- Maintenance planning

Hands-On

- Generate table bloat
- Monitor dead tuples
- Tune autovacuum parameters
- Run manual vacuum operations
- Analyze tables
- Reindex tables and indexes
- Monitor table statistics
- Prepare a DBA maintenance checklist

Outcome

Participants can implement routine maintenance and troubleshoot database bloat and statistics-related issues.

Day 8 – Backup, Recovery & Replication

Topics

- **Logical Backup**
- pg_dump
- pg_dumpall
- Restore methods
- **Physical Backup**
- pg_basebackup
- **Recovery**
- WAL archiving
- Continuous archiving
- Point-In-Time Recovery

Replication

- Streaming replication
- Primary and standby architecture
- Replication slots
- Hot standby
- Manual failover
- Introduction to repmgr

Hands-On

- Perform logical database backup
- Restore PostgreSQL databases
- Create a physical backup
- Configure WAL archiving
- Configure primary and replica PostgreSQL servers
- Create replication slots
- Simulate primary failure
- Perform manual failover
- Execute PITR recovery

Outcome

Participants can implement PostgreSQL backup, recovery, replication, and basic high-availability operations.

Day 9 – Oracle 19c to PostgreSQL Migration – Assessment & Schema Conversion

Topics

- Oracle-to-PostgreSQL migration lifecycle
- Migration planning
- Migration assessment
- Oracle versus PostgreSQL architecture
- Object compatibility assessment
- Data type mapping
- Oracle sequences versus PostgreSQL sequences/identity
- Constraints migration
- Index migration
- Oracle PL/SQL versus PostgreSQL PL/pgSQL
- Introduction to Ora2PG
- Ora2PG installation and configuration
- Migration assessment reports
- Schema conversion strategy

Hands-On

- Install and configure Ora2PG
- Connect Ora2PG with Oracle
- Generate migration assessment reports
- Analyze incompatible database objects
- Convert Oracle schema
- Generate PostgreSQL DDL
- Review and modify generated PostgreSQL objects

Outcome

Participants can assess an Oracle database and prepare its schema for PostgreSQL migration.

Day 10 – Oracle 19c to PostgreSQL Migration – Data Migration & Validation

Topics

- Data migration strategy
- Full versus incremental migration considerations
- Data migration using Ora2PG
- Handling unsupported Oracle constructs
- Sequence migration
- Constraint migration
- Index migration
- Migration validation
- Row-count validation
- Data reconciliation
- Constraint validation
- Post-migration verification
- Migration cutover considerations

Hands-On

- Export Oracle data
- Import data into PostgreSQL
- Migrate sequences
- Migrate constraints and indexes
- Resolve migration errors
- Compare Oracle and PostgreSQL row counts
- Validate constraints
- Perform migration reconciliation
- Execute post-migration database verification

Outcome

Participants can migrate and validate Oracle database structures and data in PostgreSQL Community Edition.

Day 11 – Java Application Migration: Oracle to PostgreSQL Hands-On

Topics

Java Database Connectivity Migration

- Understanding the existing Java-to-Oracle integration
- Identifying Oracle dependencies in Java source code
- Oracle JDBC driver versus PostgreSQL JDBC driver
- PostgreSQL JDBC driver configuration
- JDBC URL differences
- Driver configuration
- Connection properties

- Updating Maven dependencies
- Updating Gradle dependencies
- Database credentials and configuration files
- Environment-specific connection configuration

SQL Migration in Java Applications

- Identifying embedded Oracle SQL
- Oracle SQL versus PostgreSQL SQL
- Data type differences affecting Java applications
- VARCHAR2 versus VARCHAR
- NUMBER mapping considerations
- DATE and TIMESTAMP differences
- Boolean handling
- Sequences and auto-generated IDs
- Oracle NEXTVAL migration
- SYSDATE and date/time function migration
- NVL versus COALESCE
- DECODE alternatives
- String function differences
- Pagination differences
- Oracle-specific joins and SQL syntax
- Handling stored procedure/function calls

Java Data Access Layer Changes

- JDBC PreparedStatement
- CallableStatement
- Result-set handling
- Transaction management
- Generated key retrieval
- Exception handling
- PostgreSQL SQLState and database exceptions
- Connection pooling considerations

Hands-On

Lab 1 – JDBC Connectivity Migration

- Review a sample Java application connected to Oracle
- Remove Oracle JDBC dependency
- Add PostgreSQL JDBC dependency
- Modify JDBC connection URL
- Update connection properties
- Test PostgreSQL connectivity

Lab 2 – Oracle SQL Refactoring

- Identify Oracle-specific SQL in Java source code
- Replace Oracle functions with PostgreSQL equivalents

- Modify sequence handling
- Modify date/time operations
- Update pagination queries
- Validate migrated queries in PostgreSQL

Lab 3 – Java CRUD Migration

- Execute INSERT operations from Java
- Execute SELECT operations
- Execute UPDATE operations
- Execute DELETE operations
- Validate transactions
- Handle database errors

Outcome

Java developers can modify their existing application source code, JDBC connectivity, and SQL implementation to migrate applications from Oracle to PostgreSQL.

Day 12 – PostgreSQL Server Configuration, Administration & Integrated Migration Lab

Part 1 – Server Administration

Linux & PostgreSQL Server Management

- PostgreSQL server prerequisites
- Linux directory structure relevant to PostgreSQL
- PostgreSQL service management
- Using systemctl
- Service startup and shutdown
- Enabling PostgreSQL during system boot
- PostgreSQL OS user and permissions
- Directory and file ownership
- Data directory permissions
- PostgreSQL configuration file locations

Server Configuration

- Server hostname and network configuration considerations
- PostgreSQL listening addresses
- Port configuration
- Firewall considerations
- Remote connectivity
- Authentication configuration
- Basic resource configuration
- Memory considerations
- Disk-space monitoring
- Log management

Routine Administration

- Checking PostgreSQL server status
- Process monitoring
- CPU and memory monitoring
- Disk utilization
- PostgreSQL log monitoring
- Database connection monitoring
- Starting and stopping PostgreSQL safely
- Restart versus reload
- Configuration reload
- Basic troubleshooting
- Managing database server services

Hands-On

Lab 1 – PostgreSQL Server Setup

- Prepare a Linux PostgreSQL host
- Install PostgreSQL Community Edition
- Configure directories and permissions
- Configure PostgreSQL service
- Verify server startup

Lab 2 – Connectivity Configuration

- Configure listen_addresses
- Configure PostgreSQL port
- Configure pg_hba.conf
- Configure firewall/network access
- Connect from a remote Java/client machine

Lab 3 – Server Administration

- Start/stop/restart PostgreSQL
- Reload configuration without restart
- Monitor PostgreSQL processes
- Check CPU, memory, and disk usage
- Review PostgreSQL logs
- Troubleshoot a failed connection
