Software Requirements Specification

for

Enhancement on pgAgent Features

(In collaboration with IITM Pravartak)

Version 2.0

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1. Introduction

1.1 Purpose

*This document outlines the functional and non-functional requirements for enhancing pgAgent with **Job Dependency and Audit Logging** features. The primary objectives are:*

- ***Job Dependency:** Enable the scheduling of jobs based on the completion status of other jobs.*
- ***Audit Logging:** Implement a logging mechanism to track job-related actions such as creation, modification, deletion, and execution.*

*These enhancements aim to improve job execution workflows, provide **transparent auditing for administrative and security purposes**, and optimize job scheduling efficiency in PostgreSQL environments.*

1.2 Project Scope

The system extends pgAgent functionalities by implementing:

- ***Job Dependency:** Supporting sequential, conditional, and parallel job dependencies.*
- ***Audit Logging:** Logging all job-related actions with timestamps, user details, and operation types to enable tracking and compliance monitoring.*

*This enhancement will facilitate **efficient database task automation, improve system observability, and ensure accountability in job execution workflows**.*

1.3 References

*1. **PostgreSQL Official Documentation***

- *Comprehensive resource for understanding PostgreSQL's features, including job management and logging mechanisms.*
- *Covers details on extensions like PgAgent and best practices for database auditing.*

*2. **PostgreSQL Logging & Auditing Best Practices***

- *Provides guidelines on structured logging, error handling, and compliance-driven audit logging in PostgreSQL.*
- *Discusses use cases for logging job-related operations and security events.*

*3. **SQL Server Agent Documentation***

- *SQL Server Agent supports job scheduling and dependency management via configurable steps and triggers.*
- *Includes logging mechanisms that provide insights into job execution history and failures.*

*4. **PostgreSQL pgAgent Documentation***

- *Documentation for pgAgent, the job scheduling agent for PostgreSQL.*
- *Details existing job management features and provides a foundation for enhancements.*

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2. System Overview

2.1 System Perspective

*The enhancement integrates with existing pgAgent functionalities, extending its capability to support **job dependencies** and **audit logging for job-related activities**.*

2.2 Core Functionalities

- ***Job Dependency:***
  - *Define dependencies between jobs.*
  - *Set conditions such as "execute only if the parent job succeeds."*
  - *Support parallel execution of dependent jobs.*
- ***Audit Logging:***
  - *Log job-related actions such as creation, modification, deletion, and execution.*
  - *Store timestamps, user details, and operation types for tracking changes.*
  - *Provide query mechanisms to filter logs based on job name, operation type, and timestamp.*

2.3 User Classes and Characteristics

- ***Database Administrators:** Define job dependencies and oversee audit logs for accountability.*
- ***Developers:** Implement job workflows based on dependency conditions and review logs for debugging.*
- ***Operators:** Monitor job execution, track modifications, and manage job failures using audit logs.*

2.4 Design and Implementation Constraints

- *Must adhere to **PostgreSQL security and logging guidelines**.*
- *Ensure minimal performance impact due to dependency checking and logging mechanisms.*
- *Provide backward compatibility with existing PgAgent deployments.*
- *Implement **secure and tamper-proof audit logging** to prevent unauthorized modifications.*

3. External Interface Requirements

3.1 Hardware Interfaces

- *Supports multi-core CPU environments for parallel job execution and logging processes.*
- *Requires sufficient memory for handling multiple dependent jobs and storing audit logs efficiently.*

3.2 Software Interfaces

- *The system will interact with the following components:*
- *PostgreSQL 14+ for job execution and storing audit logs.*
- *pgAdmin 4 for job monitoring and viewing audit logs.*
- *pgAgent for job scheduling.*
- *Logging and Monitoring Systems for storing and querying audit logs securely.*

3.3 Communication Interfaces

- ***Secure Network Protocols:*** *TLS 1.2+ for encrypted communication.*
- ***REST APIs:*** *For external system integration with job dependency management and audit log retrieval..*

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4. Functional Requirements

4.1 Job Dependency

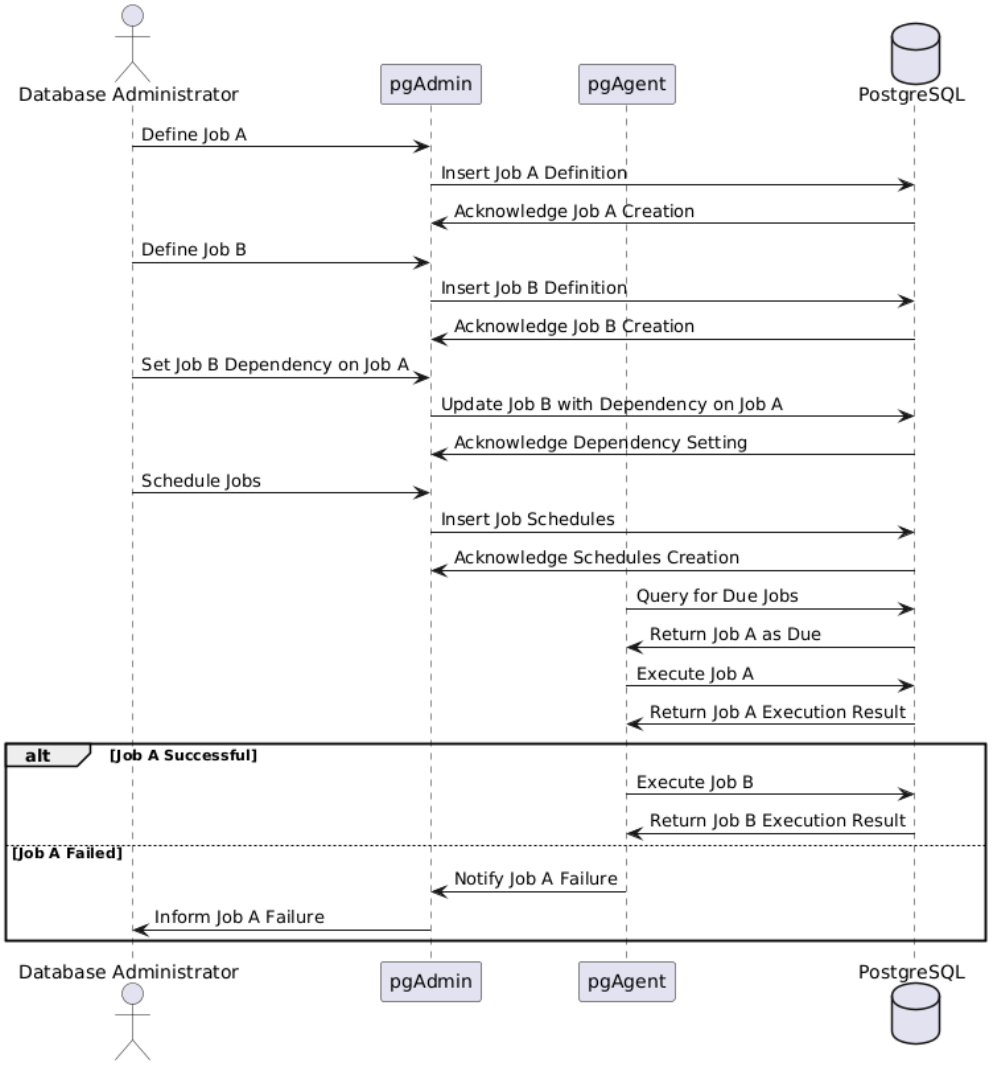
Description:
Allows users to configure job execution based on dependencies.

Priority: *High*

Functional Requirements:

- *FR-1: Support sequential and conditional job execution.*
- *FR-2: Allow parallel execution of dependent jobs.*
- *FR-3: Provide visual representation of job dependencies in pgAdmin*

Sequence Diagram:



4.2 Audit Logging

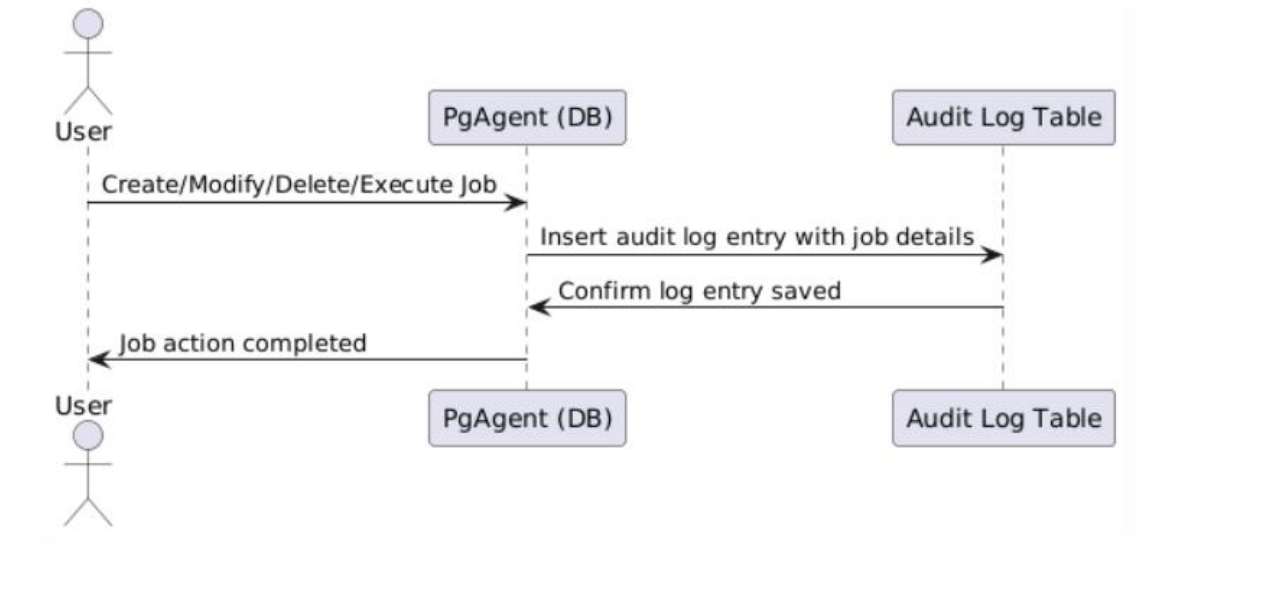
Description:
Implements audit logging for tracking job-related actions and ensuring accountability.

Priority: *Critical*

Functional Requirements:

- *FR-4: Log job-related actions, including creation, modification, deletion, and execution.*
- *FR-5: Ensure secure storage of audit logs with access restricted to authorized users.*
- *FR-6: Provide filtering and search capabilities for querying logs based on job name, operation type, and timestamp*

Sequence Diagram:



5. Nonfunctional Requirements

1.1 ***Performance***

- *Ensure minimal latency in checking job dependencies and* ***recording audit logs****.*
- *Optimize queries and indexing for efficient* ***log retrieval and job scheduling****.*
- *Benchmark system performance under high job execution loads.*

5.2 ***Scalability***

- *Support an increasing number of job dependencies without significant performance degradation.*
- *Ensure audit logging scales efficiently for enterprise-level deployments.*

5.3 ***Security***

- *Use AES-256 encryption for stored job details* ***and audit logs****.*
- ***Restrict log access*** *to authorized users to prevent unauthorized modifications.*
- *Implement* ***detailed auditing*** *of user activities, including job creation, modification, deletion, and execution.*

5.4 ***Availability***

- *Ensure a minimum uptime of* ***99.9%*** *for job execution, monitoring, and* ***audit logging services****.*

6. System Architecture and Design

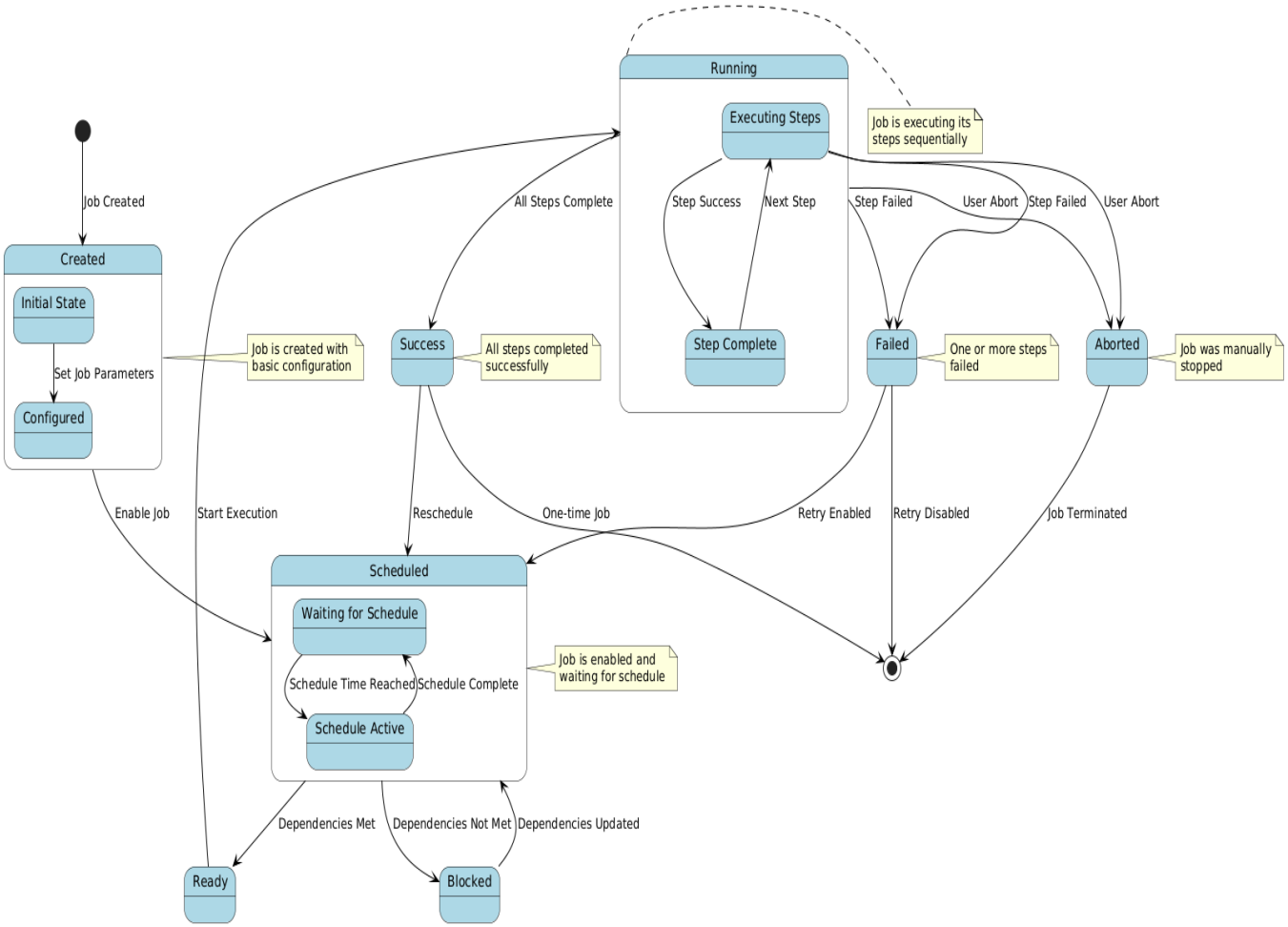
6.1 Architectural Overview

The system adopts a modular architecture that integrates seamlessly with PostgreSQL and pgAgent. The architectural components include:

- ***Job Dependency Manager****: Handles dependency rules and execution order.*
- ***Audit Logging Module****: Records job-related actions, including creation, modification, deletion, and execution.*
- ***Database Layer****: Stores job details, dependency information, and* ***audit logs****.*
- ***Interface Layer****: Provides APIs and pgAdmin UI integration for* ***audit log visualization and job dependency management****.*

6.2 System Flow

1. *Job Dependency:*
    - *Define job dependencies in pgAdmin.*
    - *Store dependency rules in the database.*
    - *Execute dependent jobs sequentially, conditionally, or in parallel.*
2. *Audit Logging:*
    - *Record user actions related to job creation, modification, deletion, and execution.*
    - *Store logs securely with timestamps and user details.*
    - *Provide filtering options to retrieve specific logs based on job name, operation type, or time period.*



7. Implementation Plan

7.1 Phases of Development

The project will be developed in the following phases:

Phase 1: Requirements Gathering and Analysis *(Duration: 2 weeks)*

Phase 2: Job-Dependency *(Duration: 3 weeks)*

Phase 3: Audit Logging *(Duration: 2 weeks)*

Phase 4: System Testing and Optimization *(Duration: 2 weeks)*

7.2 Implementation Steps

Step 1: Requirement Analysis
Analyze the scheduling and access control requirements by collaborating with stakeholders. Identify use cases for job dependencies and audit logging.

Step 2: System Design
Design the system architecture, database schema for job dependencies and roles, and workflows for job execution and audit tracking.

Step 3: Job Dependency Development
Implement functionalities to define job dependencies, set conditions, and allow parallel or sequential execution of jobs.

Step 4: Audit Logging Development
Implement the audit logging module, ensuring all job-related actions are recorded.Design log storage and retrieval mechanisms for efficient access.

Step 5: Integration
Integrate audit logging with pgAdmin for log visualization and job tracking.Ensure compatibility with external monitoring systems like Prometheus and Grafana.

Step 6: Testing
Perform functional testing for job dependency workflows and audit logging correctness.Conduct performance testing under high job loads and security testing for log integrity.

Step 7: Deployment
Deploy the solution in a production-like environment, conduct live testing, and ensure the system meets all functional and nonfunctional requirements.

8. Test Plan

8.1 Testing Objectives

- *Verify job dependency execution workflows.*
- *Validate audit logging for tracking job-related actions.*
- *Ensure system stability and performance under high job loads.*

8.2 Testing Strategy

- *Functional Testing: Ensure job dependencies (sequential, conditional, and parallel) and audit logging features work as intended..*
- *Performance Testing: Test the system's efficiency under heavy job scheduling and log generation.*
- *Security Testing: Validate access controls for log viewing and ensure log integrity.*
- *Usability Testing: Ensure the pgAdmin UI for audit log and job dependency visualization is user-friendly.*

8.3 Test Cases

- ***TC-1:** Create a job with a dependency on another job*
- ***TC-2:** Execute a job with a successful parent dependency*
- ***TC-3:** Execute a job with a failed parent dependency*
- ***TC-4:** Verify that audit logs capture job creation, modification, deletion, and execution actions*
- ***TC-5:** Delete a job with dependencies*
- ***TC-6:** Filter audit logs by date range and operation type*

9. Conclusion and Future Scope

9.1 Summary

*The proposed enhancements to pgAgent, specifically the implementation of **Job Dependency and Audit Logging**, aim to significantly improve the usability, efficiency, and security of PostgreSQL job scheduling.*

By introducing advanced dependency management, users can schedule jobs based on sequential, conditional, or parallel execution requirements, optimizing workflows for complex database tasks.

Audit Logging ensures that all job-related actions are recorded, providing transparency, accountability, and compliance tracking.

These features, combined with seamless integration into existing pgAgent systems, provide a robust solution for database administrators, developers, and operators to manage and monitor jobs effectively.

9.2 Future Enhancements

*While the current implementation addresses the core needs of **job monitoring and auditing**, several areas for future development could further enhance the system's functionality:*

1. ***Enhanced Visualization**: Incorporate advanced graphical representations for job dependencies and audit logs, such as **timeline-based log views**.*
2. ***Granular Log Retention Policies**: Implement **configurable log retention settings** to allow administrators to control storage usage.*
3. ***Real-Time Alerts**: Introduce **event-driven log monitoring** to trigger alerts for critical job failures or unauthorized modifications.*
4. ***Improved Scalability**: Optimize the system further to handle a large number of **concurrent jobs and logs efficiently** in enterprise environments.*