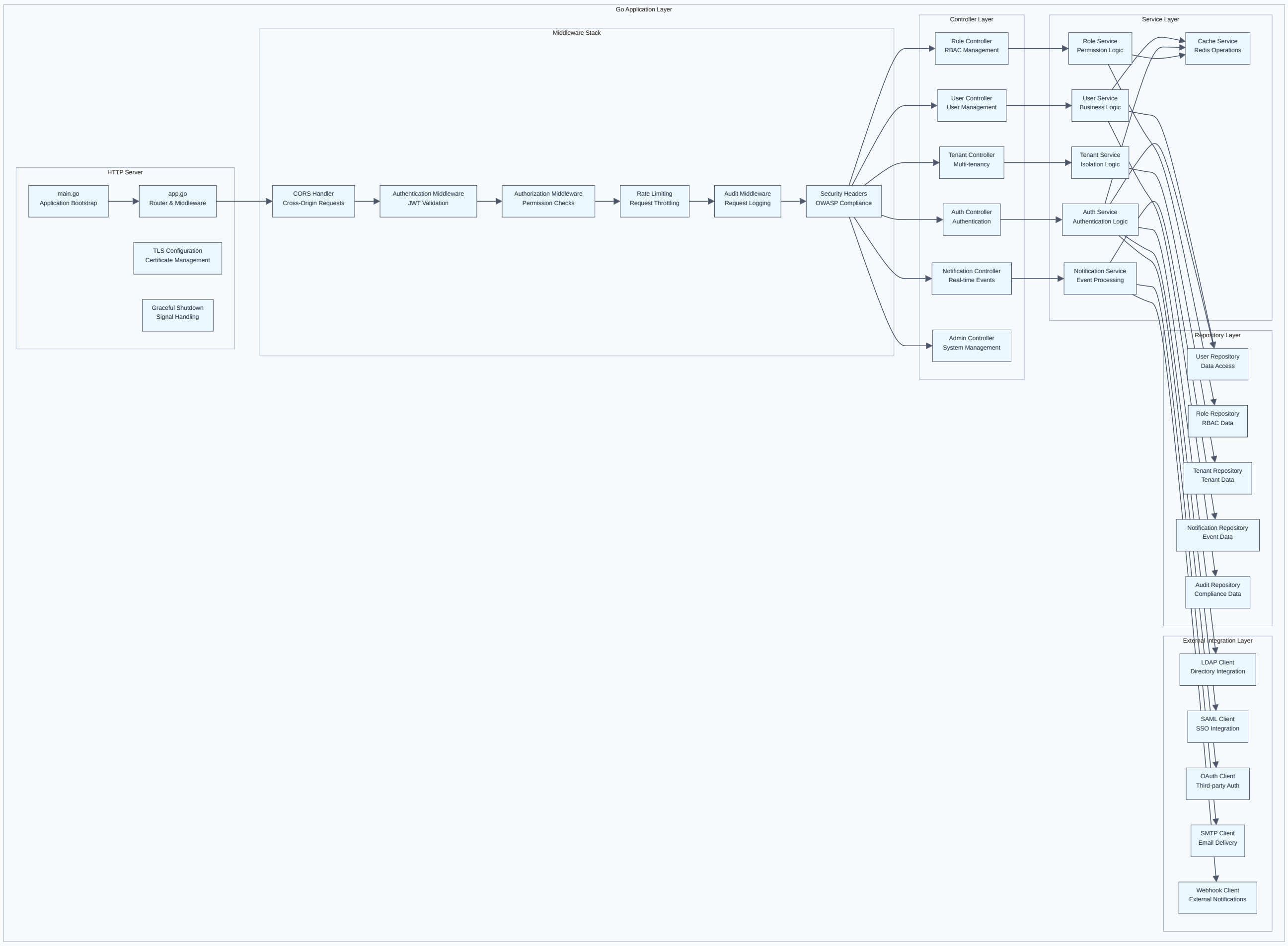
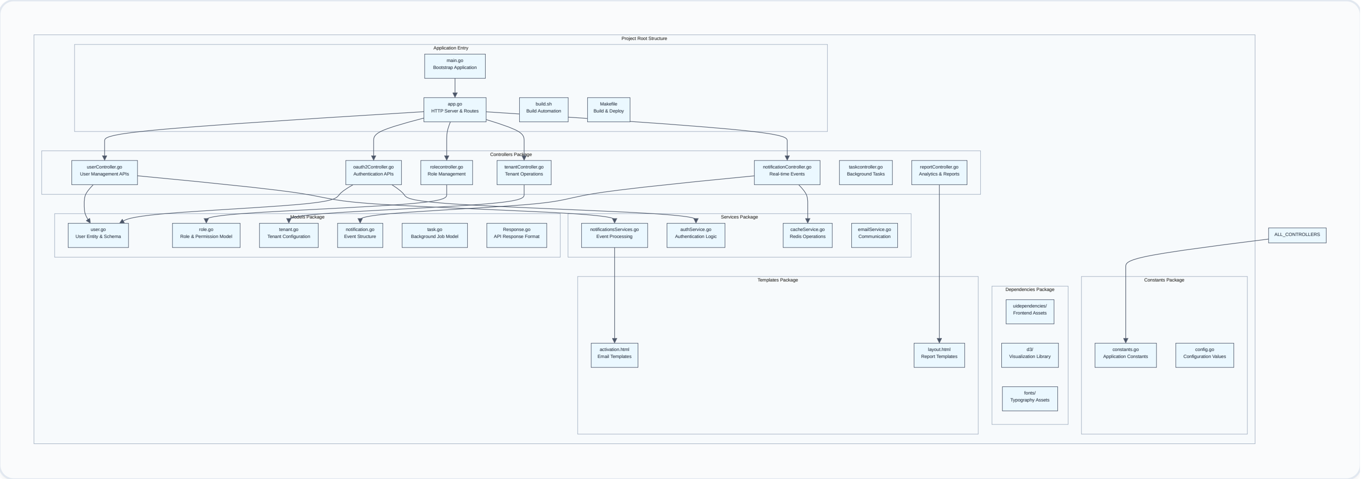
Securaa User Service - Low Level Design¶

🔧 TECHNICAL ARCHITECTURE OVERVIEW¶

Service Implementation Architecture¶

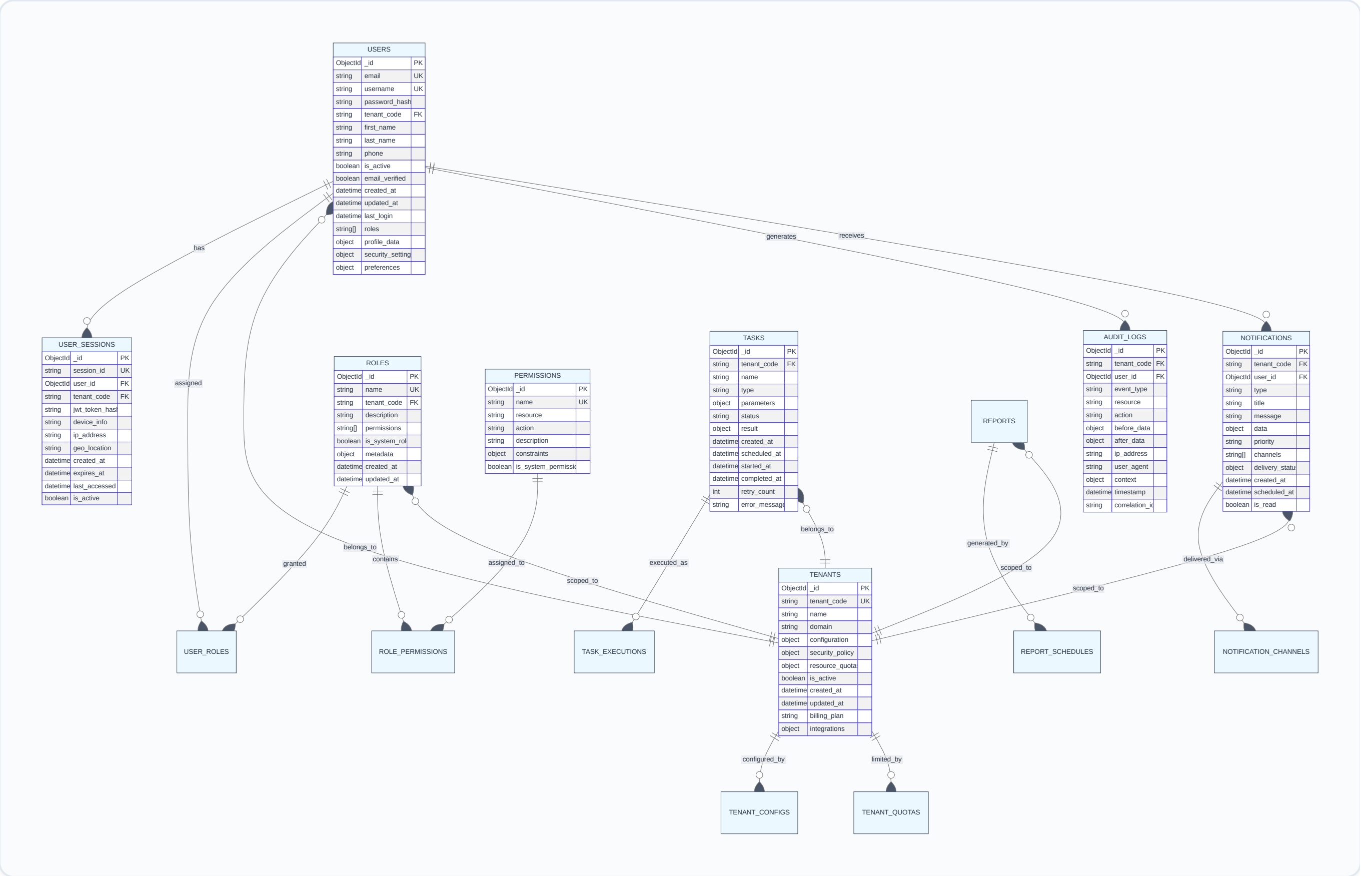


Code Structure & Package Organization¶

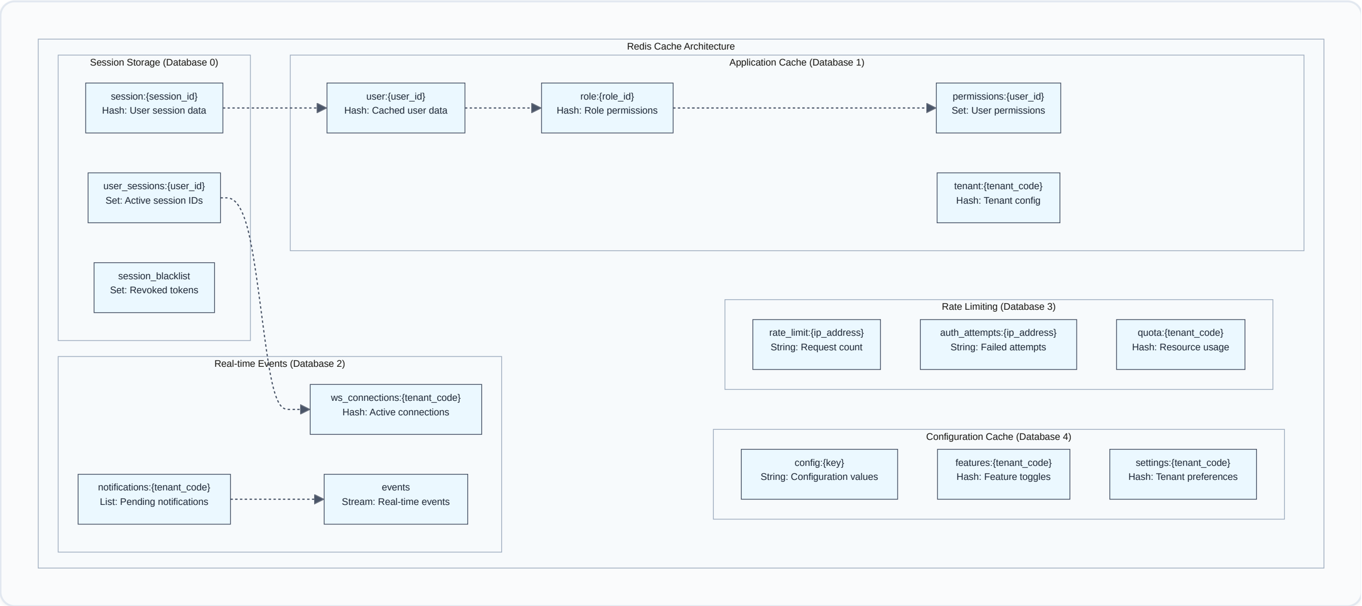


🏗️ DATABASE DESIGN & DATA MODELS¶

MongoDB Collection Schema Architecture¶

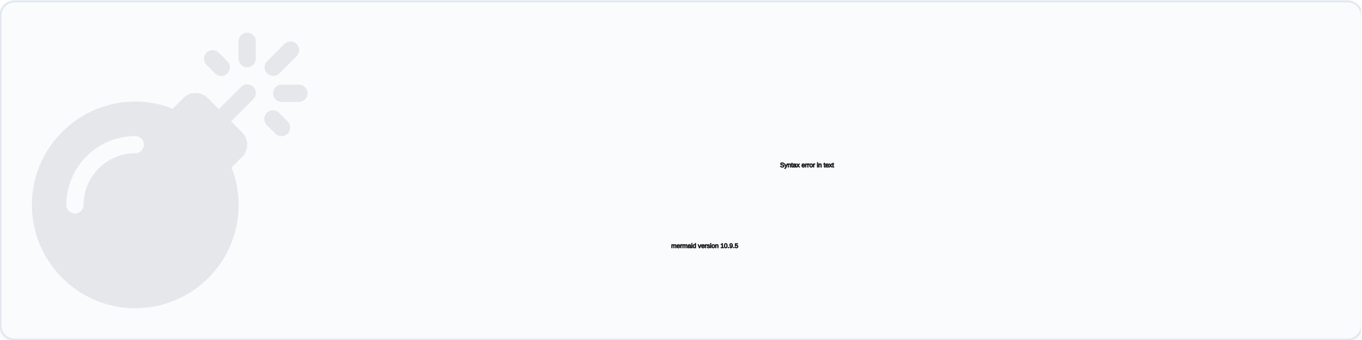


Redis Cache Schema Design¶



🔗 API DESIGN & ENDPOINT SPECIFICATIONS¶

RESTful API Architecture¶



Syntax error in text

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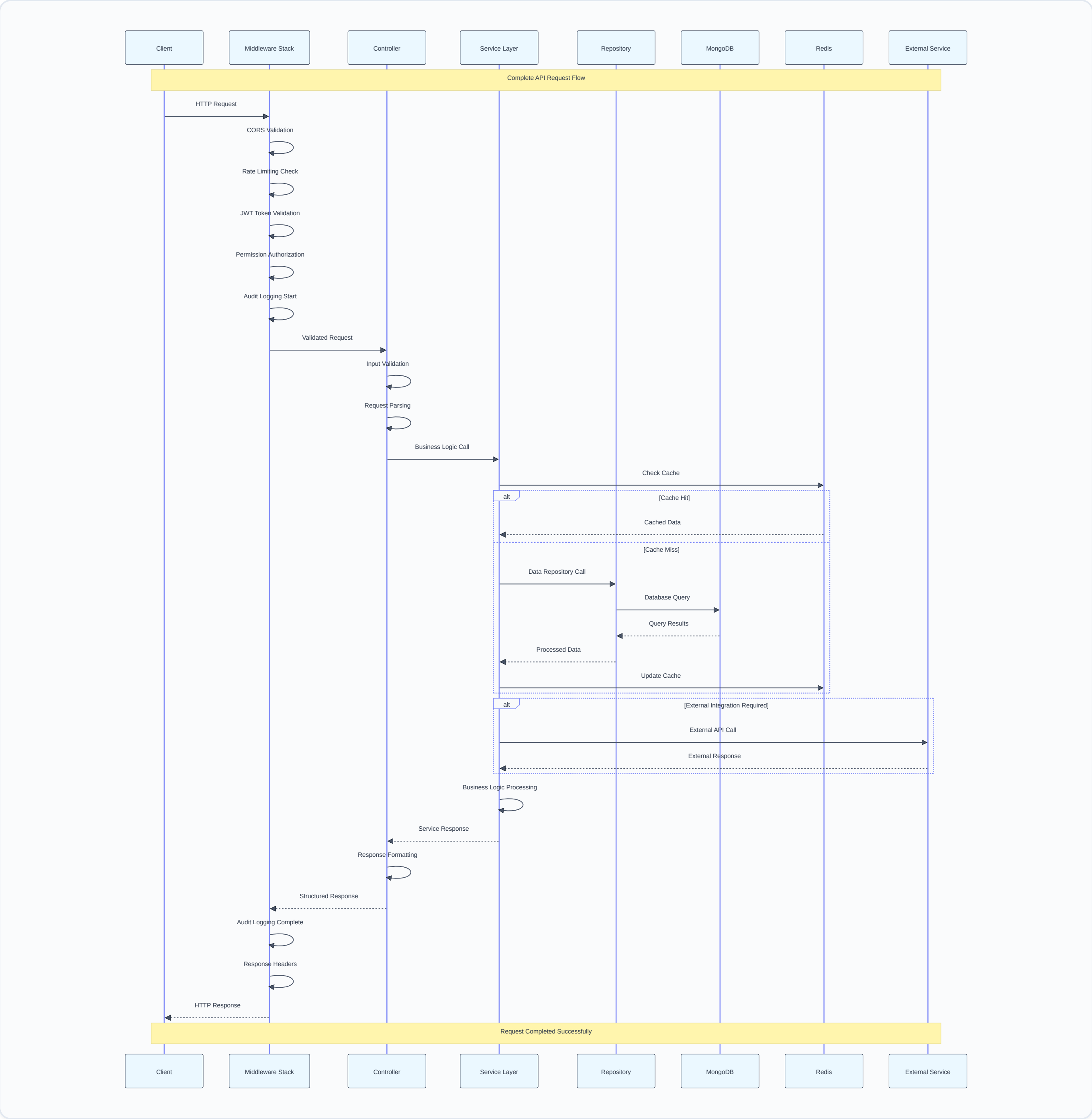
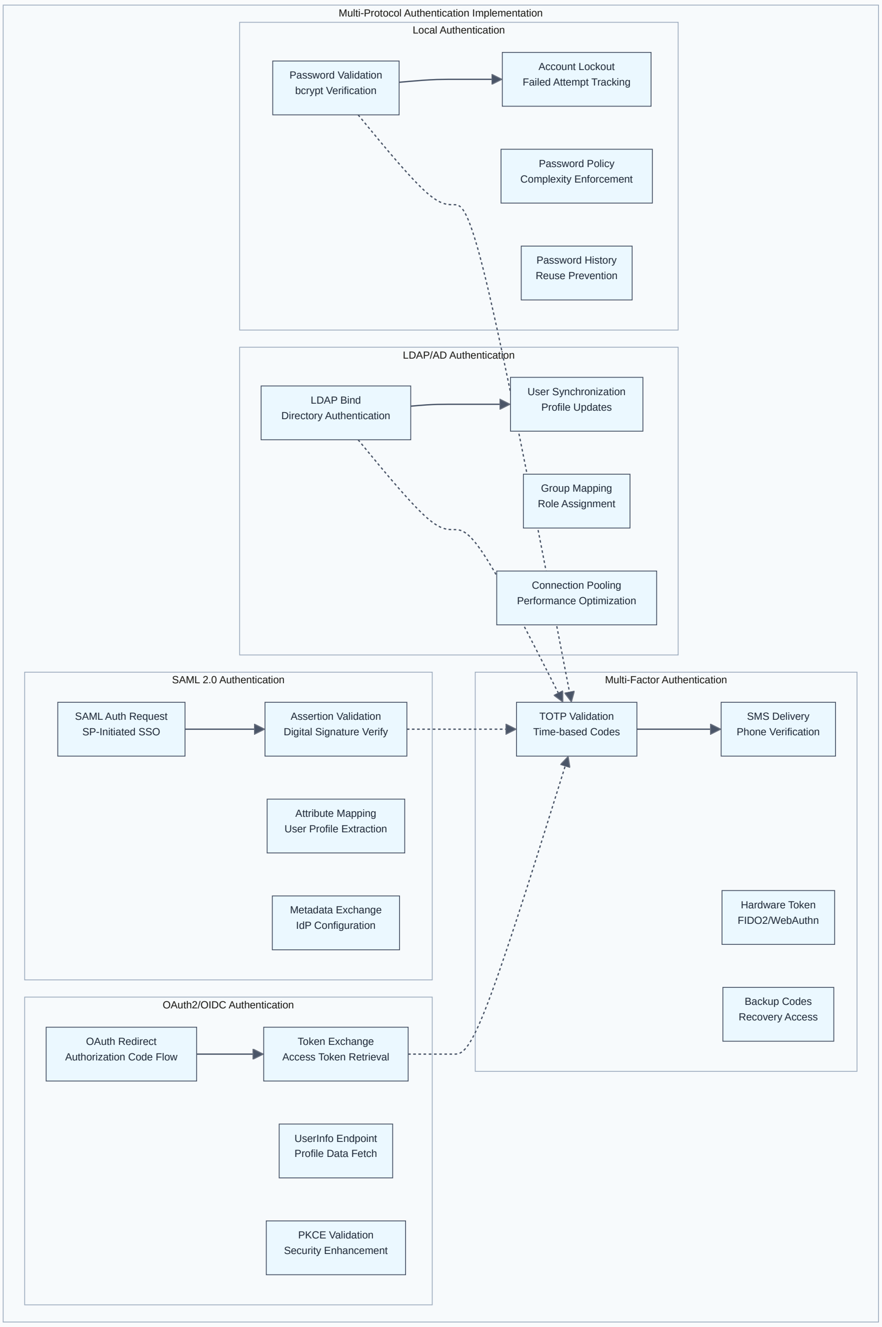
API Request/Response Flow Diagram¶

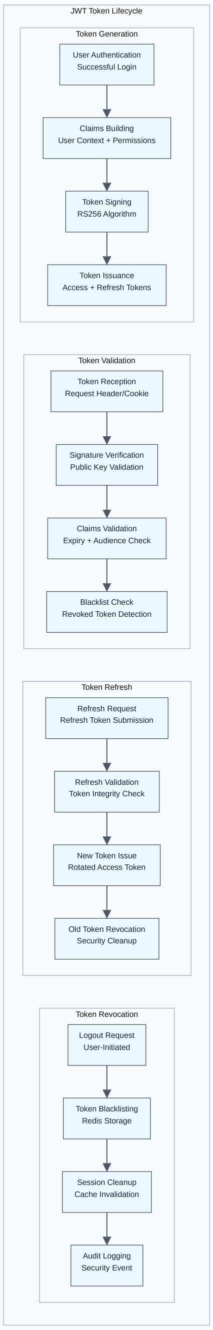


🔒 SECURITY IMPLEMENTATION DETAILS¶

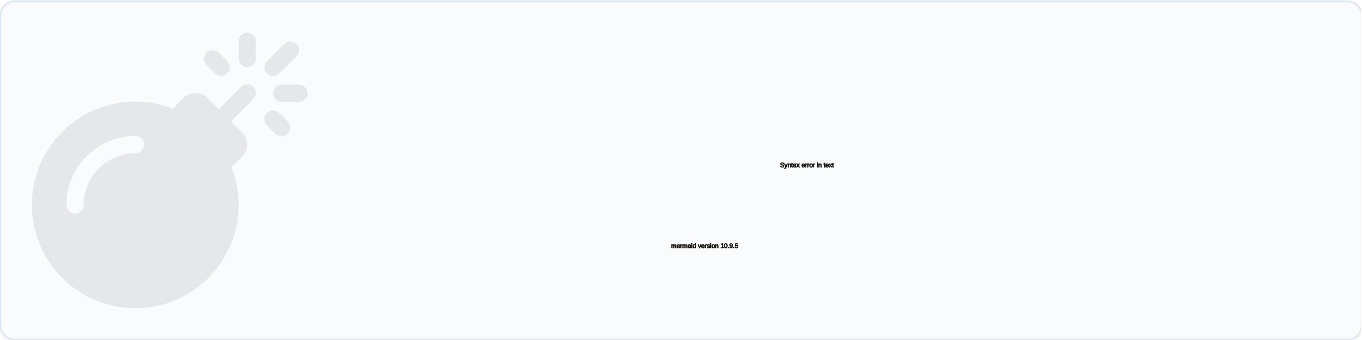
Authentication & Authorization Flow¶



JWT Token Management Implementation¶


JWT Token Lifecycle
Token Generation
User Authentication Successful Login
Claims Building User Context + Permissions
Token Signing RS256 Algorithm
Token Issuance Access + Refresh Tokens
Token Validation
Token Reception Request Header/Cookie
Signature Verification Public Key Validation
Claims Validation Expiry + Audience Check
Blacklist Check Revoked Token Detection
Token Refresh
Refresh Request Refresh Token Submission
Refresh Validation Token Integrity Check
New Token Issue Rotated Access Token
Old Token Revocation Security Cleanup
Token Revocation
Logout Request User-Initiated
Token Blacklisting Redis Storage
Session Cleanup Cache Invalidation
Audit Logging Security Event

Role-Based Access Control (RBAC) Implementation¶



🚀 DEPLOYMENT & INFRASTRUCTURE IMPLEMENTATION¶

Traditional Server Deployment Architecture¶

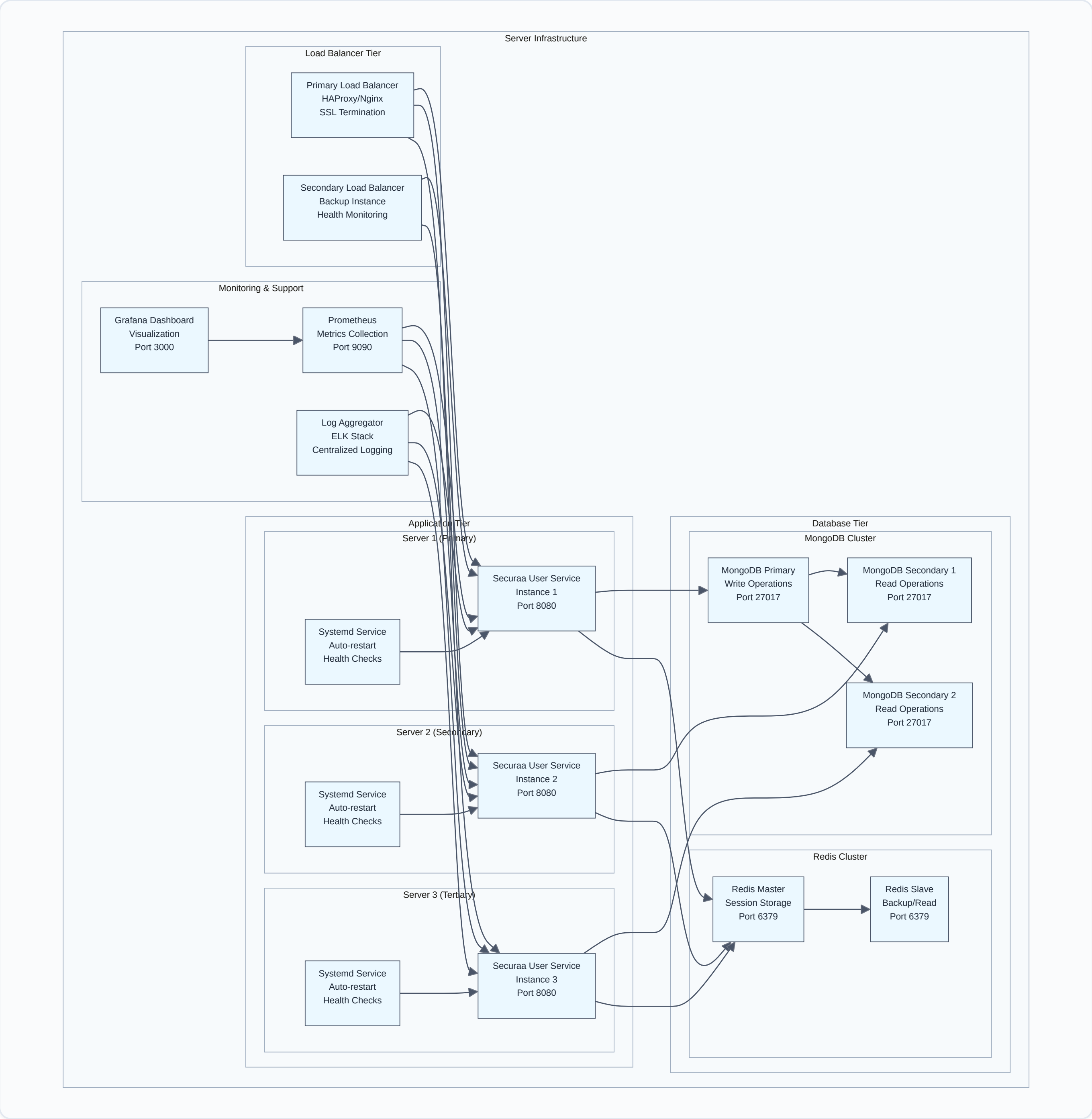
The Securaa User Service is deployed using traditional server architecture with load balancing and service clustering for high availability and scalability.

Server Deployment Strategy:

Load Balancer Configuration:
- **Primary Load Balancer**: HAProxy or Nginx for traffic distribution and SSL termination
- **Health Check Integration**: Application-level health endpoints for intelligent routing
- **Session Management**: Sticky sessions support for WebSocket connections
- **SSL/TLS Termination**: Certificate management and encryption handling at the edge

Service Instance Management:
- **Multiple Instances**: 3+ service instances for high availability
- **Process Management**: Systemd service files for automatic restart and lifecycle management
- **Configuration Management**: Environment-specific configuration files and secrets
- **Log Management**: Structured logging with centralized log aggregation

Database Deployment:
- **MongoDB Replica Set**: Primary and secondary instances for read scaling and failover
- **Redis Cluster**: Master-slave configuration for caching and session storage
- **Connection Pooling**: Optimized database connections with configurable pool sizes
- **Backup Strategy**: Automated backup schedules with point-in-time recovery



Deployment Process:

Service Installation:

1. **Binary Deployment**: Go binary compilation and distribution to target servers
2. **Configuration Setup**: Environment-specific configuration files and secrets deployment
3. **Service Registration**: Systemd service file installation and enablement
4. **Health Verification**: Automated health checks during deployment process

Database Setup:

1. **MongoDB Replica Set**: Primary and secondary node configuration with authentication
2. **Redis Configuration**: Master-slave setup with persistence and clustering
3. **Index Creation**: Database index optimization for query performance
4. **Data Migration**: Automated migration scripts for schema updates

Load Balancer Configuration:

1. **SSL Certificate Installation**: TLS certificate deployment and renewal automation
2. **Health Check Configuration**: Application-level health endpoint configuration
3. **Traffic Routing Rules**: Request routing based on URL patterns and headers
4. **Failover Configuration**: Automatic failover to healthy instances

Monitoring Setup:

1. **Metrics Collection**: Prometheus metrics endpoint configuration
2. **Dashboard Deployment**: Grafana dashboard installation and configuration
3. **Alerting Rules**: Alert configuration for critical system events
4. **Log Aggregation**: Centralized logging setup with retention policies

Production Deployment Configuration¶

Systemd Service Configuration:

```
# /etc/systemd/system/securaa-user-service.service
[Unit]
Description=Securaa User Service
Documentation=https://docs.securaa.com/securaa-user
After=network.target mongodb.service redis.service
Wants=mongodb.service redis.service

[Service]
Type=exec
User=securaa-user
Group=securaa-user
WorkingDirectory=/opt/securaa-user
ExecStart=/opt/securaa-user/bin/securaa-user-service
ExecReload=/bin/kill -HUP $MAINPID
Restart=always
RestartSec=10
StandardOutput=journal
StandardError=journal
SyslogIdentifier=securaa-user-service

# Security Settings
NoNewPrivileges=true
PrivateTmp=true
ProtectSystem=strict
ProtectHome=true
ReadWritePaths=/opt/securaa-user/logs /opt/securaa-user/data

# Environment Variables
Environment=ENVIRONMENT=production
Environment=LOG_LEVEL=info
Environment=HTTP_PORT=8080
Environment=METRICS_PORT=9090
Environment=HEALTH_CHECK_PORT=8081

# Resource Limits
LimitNOFILE=65536
LimitNPROC=4096

[Install]
WantedBy=multi-user.target
```

Environment Configuration:

```
# /opt/securaa-user/config/production.env
# Database Configuration
MONGO_URI=mongodb://securaa-user:${MONGO_PASSWORD}@mongo-primary:27017,mongo-secondary1:27017,mongo-secondary2:27017/zona_user?replicaSet=rs0&authSource=admin
REDIS_URI=redis://:${REDIS_PASSWORD}@redis-master:6379/0

# Security Configuration
JWT_SECRET_KEY=${JWT_SECRET_KEY}
ENCRYPTION_KEY=${ENCRYPTION_KEY}
SAML_CERT_PATH=/opt/securaa-user/certs/saml.crt
SAML_KEY_PATH=/opt/securaa-user/certs/saml.key

# Integration Configuration
EMAIL_SMTP_HOST=smtp.securaa.com
EMAIL_SMTP_PORT=587
EMAIL_FROM=noreply@securaa.com

# Performance Configuration
MAX_CONNECTIONS=1000
CONNECTION_TIMEOUT=30s
IDLE_TIMEOUT=60s
READ_TIMEOUT=30s
WRITE_TIMEOUT=30s

# Monitoring Configuration
METRICS_ENABLED=true
PROMETHEUS_ENDPOINT=/metrics
HEALTH_CHECK_ENDPOINT=/health
LOG_FORMAT=json
LOG_OUTPUT=file
LOG_FILE_PATH=/opt/securaa-user/logs/securaa-user.log
```

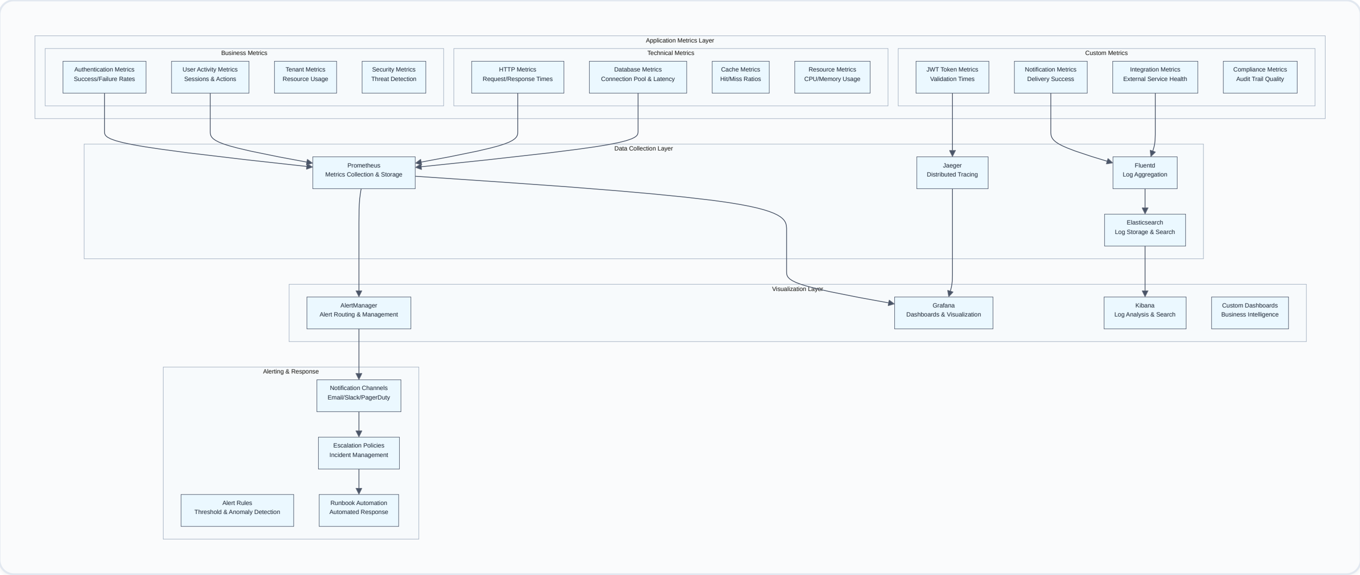
Deployment Script:

```bash
#!/bin/bash
# /opt/securaa-user/scripts/deploy.sh

set -euo pipefail

DEPLOY_DIR="/opt/securaa-user"
SERVICE_NAME="securaa-user-service"
BACKUP_DIR="/opt/securaa-user/backups"
LOG_DIR="/opt/securaa-user/logs"

# Pre-deployment checks
echo "Starting deployment of Securaa User Service..."
echo "Checking system requirements..."

# Verify dependencies
systemctl is-active --quiet mongodb || { echo "MongoDB not running"; exit 1; }
systemctl is-active --quiet redis || { echo "Redis not running"; exit 1; }

# Create backup of current version
if systemctl is-active --quiet $SERVICE_NAME; then
    echo "Creating backup of current deployment..."
    mkdir -p $BACKUP_DIR/$(date +%Y%m%d_%H%M%S)
    cp -r $DEPLOY_DIR/bin $BACKUP_DIR/$(date +%Y%m%d_%H%M%S)/
    cp -r $DEPLOY_DIR/config $BACKUP_DIR/$(date +%Y%m%d_%H%M%S)/
fi

# Deploy new binary
echo "Deploying new binary..."
cp ./securaa-user-service $DEPLOY_DIR/bin/
chmod +x $DEPLOY_DIR/bin/securaa-user-service
chown securaa-user:securaa-user $DEPLOY_DIR/bin/securaa-user-service

# Update configuration
echo "Updating configuration..."
cp ./config/* $DEPLOY_DIR/config/
chown -R securaa-user:securaa-user $DEPLOY_DIR/config/

# Restart service
echo "Restarting service..."
systemctl restart $SERVICE_NAME

# Health check
echo "Performing health check..."
sleep 10

for i in {1..30}; do
    if curl -f http://localhost:8081/health > /dev/null 2>&1; then
        echo "Health check passed!"
        break
    fi
    if [ $i -eq 30 ]; then
        echo "Health check failed! Rolling back..."
        systemctl stop $SERVICE_NAME
        # Restore from backup
        LATEST_BACKUP=$(ls -t $BACKUP_DIR | head -1)
        cp -r $BACKUP_DIR/$LATEST_BACKUP/* $DEPLOY_DIR/
        systemctl start $SERVICE_NAME
        exit 1
    fi
    echo "Waiting for service to start... ($i/30)"
    sleep 2
done

echo "Deployment completed successfully!"
```

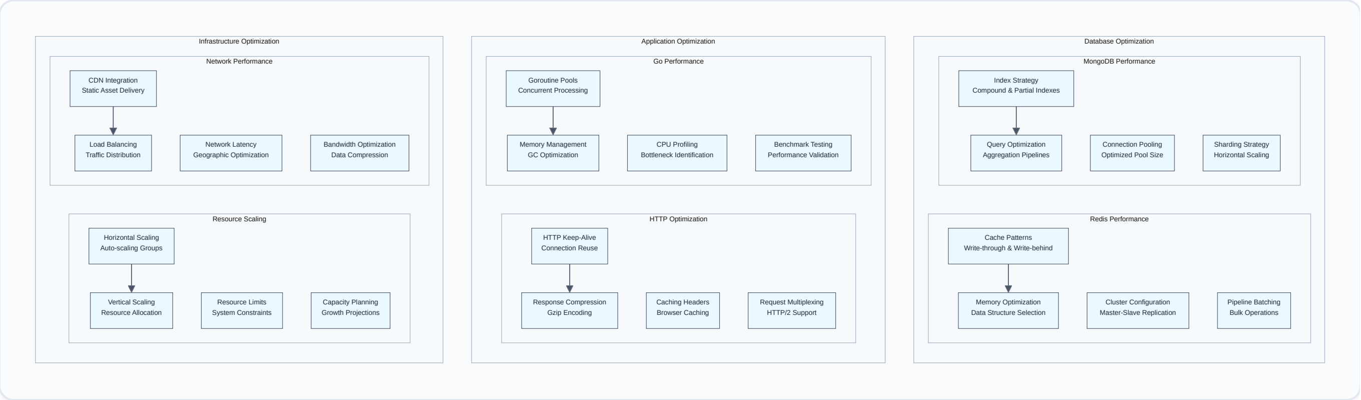
```
      - name: JWT_SECRET
        valueFrom:
          secretKeyRef:
            name: auth-secrets
            key: jwt-secret
      resources:
        requests:
          memory: "512Mi"
          cpu: "500m"
        limits:
          memory: "2Gi"
          cpu: "2000m"
      securityContext:
        allowPrivilegeEscalation: false
        readOnlyRootFilesystem: true
        capabilities:
          drop:
          - ALL
      livenessProbe:
        httpGet:
          path: /health/live
          port: 8000
          scheme: HTTPS
        initialDelaySeconds: 60
        periodSeconds: 30
        timeoutSeconds: 10
        failureThreshold: 3
      readinessProbe:
        httpGet:
          path: /health/ready
          port: 8000
          scheme: HTTPS
        initialDelaySeconds: 30
        periodSeconds: 10
        timeoutSeconds: 5
        failureThreshold: 3
      volumeMounts:
      - name: tls-certificates
        mountPath: /etc/ssl/certs
        readOnly: true
      - name: temp-storage
        mountPath: /tmp
      - name: config-volume
        mountPath: /app/config
        readOnly: true
    volumes:
    - name: tls-certificates
      secret:
        secretName: securaa-user-tls
    - name: temp-storage
      emptyDir: {}
    - name: config-volume
      configMap:
        name: securaa-user-config
```

📊 MONITORING & OBSERVABILITY IMPLEMENTATION¶

Comprehensive Monitoring Architecture¶

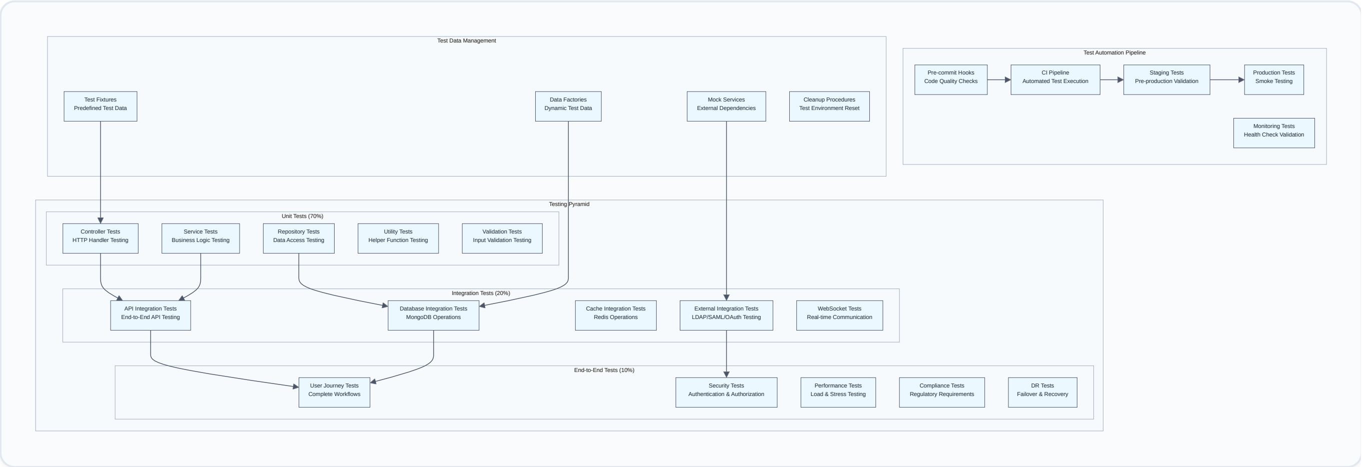

Application Metrics Layer
Business Metrics
Authentication Metrics Success/Failure Rates
User Activity Metrics Sessions & Actions
Tenant Metrics Resource Usage
Security Metrics Threat Detection
Technical Metrics
HTTP Metrics Request/Response Times
Database Metrics Connection Pool & Latency
Cache Metrics Hit/Miss Ratios
Resource Metrics CPU/Memory Usage
Custom Metrics
JWT Token Metrics Validation Times
Notification Metrics Delivery Success
Integration Metrics External Service Health
Compliance Metrics Audit Trail Quality
Data Collection Layer
Prometheus Metrics Collection & Storage
Jaeger Distributed Tracing
Fluentd Log Aggregation
Elasticsearch Log Storage & Search
Visualization Layer
AlertManager Alert Routing & Management
Grafana Dashboards & Visualization
Kibana Log Analysis & Search
Custom Dashboards Business Intelligence
Alerting & Response
Notification Channels Email/Slack/PagerDuty
Escalation Policies Incident Management
Alert Rules Threshold & Anomaly Detection
Runbook Automation Automated Response

Performance Optimization Strategies¶

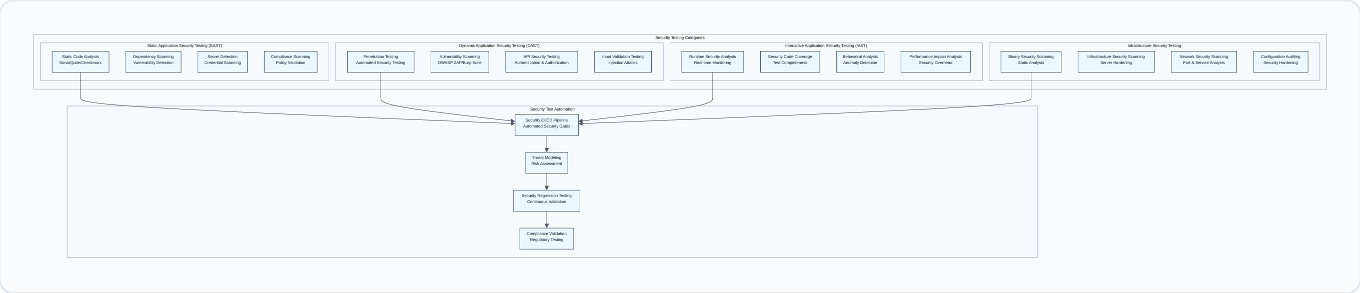


🧪 TESTING STRATEGY & IMPLEMENTATION¶

Comprehensive Testing Pyramid¶



Security Testing Implementation¶


Security Testing Categories
Static Application Security Testing (SAST)
Static Code Analysis
SonarQube/Checkmarx
Dependency Scanning
Vulnerability Detection
Secret Detection
Credential Scanning
Compliance Scanning
Policy Validation
Dynamic Application Security Testing (DAST)
Penetration Testing
Automated Security Testing
Vulnerability Scanning
OWASP ZAP/Burp Suite
API Security Testing
Authentication & Authorization
Input Validation Testing
Injection Attacks
Interactive Application Security Testing (IAST)
Runtime Security Analysis
Real-time Monitoring
Security Code Coverage
Test Completeness
Behavioral Analysis
Anomaly Detection
Performance Impact Analysis
Security Overhead
Infrastructure Security Testing
Binary Security Scanning
Static Analysis
Infrastructure Security Scanning
Server Hardening
Network Security Scanning
Port & Service Analysis
Configuration Auditing
Security Hardening
Security Test Automation
Security CI/CD Pipeline
Automated Security Gates
Threat Modeling
Risk Assessment
Security Regression Testing
Continuous Validation
Compliance Validation
Regulatory Testing

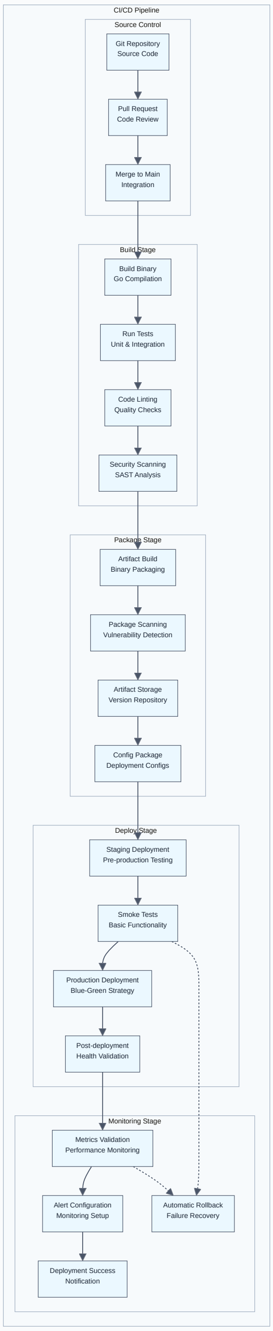
🔧 CONFIGURATION MANAGEMENT¶

Environment Configuration Strategy¶

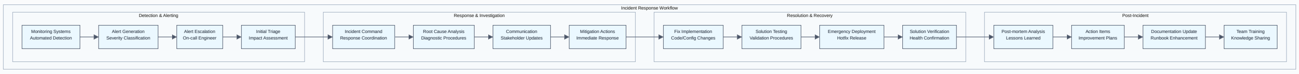
```
# Production Configuration Template
production:
  server:
    port: 8000
    tls:
      enabled: true
      cert_file: "/etc/ssl/certs/server.crt"
      key_file: "/etc/ssl/private/server.key"
      min_version: "1.2"
      max_version: "1.3"
      cipher_suites:
        - "TLS_AES_256_GCM_SHA384"
        - "TLS_CHACHA20_POLY1305_SHA256"
        - "TLS_AES_128_GCM_SHA256"

  database:
    mongodb:
      uri: "${MONGO_URI}"
      database: "securaa_production"
      max_pool_size: 200
      min_pool_size: 50
      connect_timeout_ms: 30000
      server_selection_timeout_ms: 30000
      socket_timeout_ms: 60000
      max_idle_time_ms: 300000

  cache:
    redis:
      cluster_endpoints:
        - "${REDIS_CLUSTER_1}"
        - "${REDIS_CLUSTER_2}"
        - "${REDIS_CLUSTER_3}"
      password: "${REDIS_PASSWORD}"
      max_retries: 3
      retry_delay_ms: 1000
      dial_timeout_ms: 5000
      read_timeout_ms: 3000
      write_timeout_ms: 3000
      pool_size: 100
      min_idle_connections: 20

  security:
    jwt:
      secret: "${JWT_SECRET}"
      issuer: "securaa-user-service"
      audience: "securaa-platform"
      access_token_ttl: "15m"
      refresh_token_ttl: "7d"
      signing_method: "RS256"

    encryption:
      key: "${ENCRYPTION_KEY}"
      algorithm: "AES-256-GCM"

    session:
      timeout: "4h"
      max_concurrent_sessions: 3
      secure_cookies: true
      same_site: "strict"

    password_policy:
      min_length: 12
      require_uppercase: true
      require_lowercase: true
      require_numbers: true
      require_special_chars: true
      prevent_reuse_count: 12
      max_age_days: 90

  integrations:
    ldap:
      servers:
        - "${LDAP_SERVER_1}"
        - "${LDAP_SERVER_2}"
      base_dn: "${LDAP_BASE_DN}"
      bind_dn: "${LDAP_BIND_DN}"
      bind_password: "${LDAP_BIND_PASSWORD}"
      user_search_filter: "(uid=%s)"
      group_search_filter: "(memberUid=%s)"
      tls_enabled: true
      skip_cert_verify: false

    saml:
      entity_id: "securaa-user-service"
      assertion_consumer_service_url: "https://api.securaa.com/auth/saml/acs"
      single_logout_service_url: "https://api.securaa.com/auth/saml/sls"
      metadata_url: "${SAML_METADATA_URL}"
      certificate_file: "/etc/ssl/certs/saml.crt"
      private_key_file: "/etc/ssl/private/saml.key"

    oauth2:
      providers:
        google:
          client_id: "${GOOGLE_CLIENT_ID}"
          client_secret: "${GOOGLE_CLIENT_SECRET}"
          redirect_url: "https://api.securaa.com/auth/oauth/google/callback"
          scopes: ["openid", "profile", "email"]
        microsoft:
          client_id: "${MICROSOFT_CLIENT_ID}"
          client_secret: "${MICROSOFT_CLIENT_SECRET}"
          redirect_url: "https://api.securaa.com/auth/oauth/microsoft/callback"
          scopes: ["openid", "profile", "email"]

    smtp:
      host: "${SMTP_HOST}"
      port: 587
      username: "${SMTP_USERNAME}"
      password: "${SMTP_PASSWORD}"
      from_address: "noreply@securaa.com"
      use_tls: true
      connection_pool_size: 10

    sms:
      provider: "twilio"
      account_sid: "${TWILIO_ACCOUNT_SID}"
      auth_token: "${TWILIO_AUTH_TOKEN}"
      from_number: "${TWILIO_FROM_NUMBER}"

  monitoring:
    metrics:
      enabled: true
      port: 9090
      path: "/metrics"

    logging:
      level: "info"
      format: "json"
      output: "stdout"

    tracing:
      enabled: true
      jaeger:
        endpoint: "${JAEGER_ENDPOINT}"
        sampler_type: "probabilistic"
        sampler_param: 0.1

    health_checks:
      enabled: true
      endpoints:
        - path: "/health"
          method: "GET"
        - path: "/health/ready"
          method: "GET"
        - path: "/health/live"
          method: "GET"

  compliance:
    audit_logging:
      enabled: true
      retention_days: 2555  # 7 years
      encryption_enabled: true
      remote_storage: true

    data_protection:
      gdpr_enabled: true
      data_retention_days: 1825  # 5 years
      anonymization_enabled: true
      right_to_be_forgotten: true

    regulatory:
      soc2_mode: true
      hipaa_mode: true
      pci_dss_mode: true
      iso27001_mode: true
```

📋 OPERATIONAL PROCEDURES¶

Deployment Automation Pipeline¶



Incident Response Procedures¶

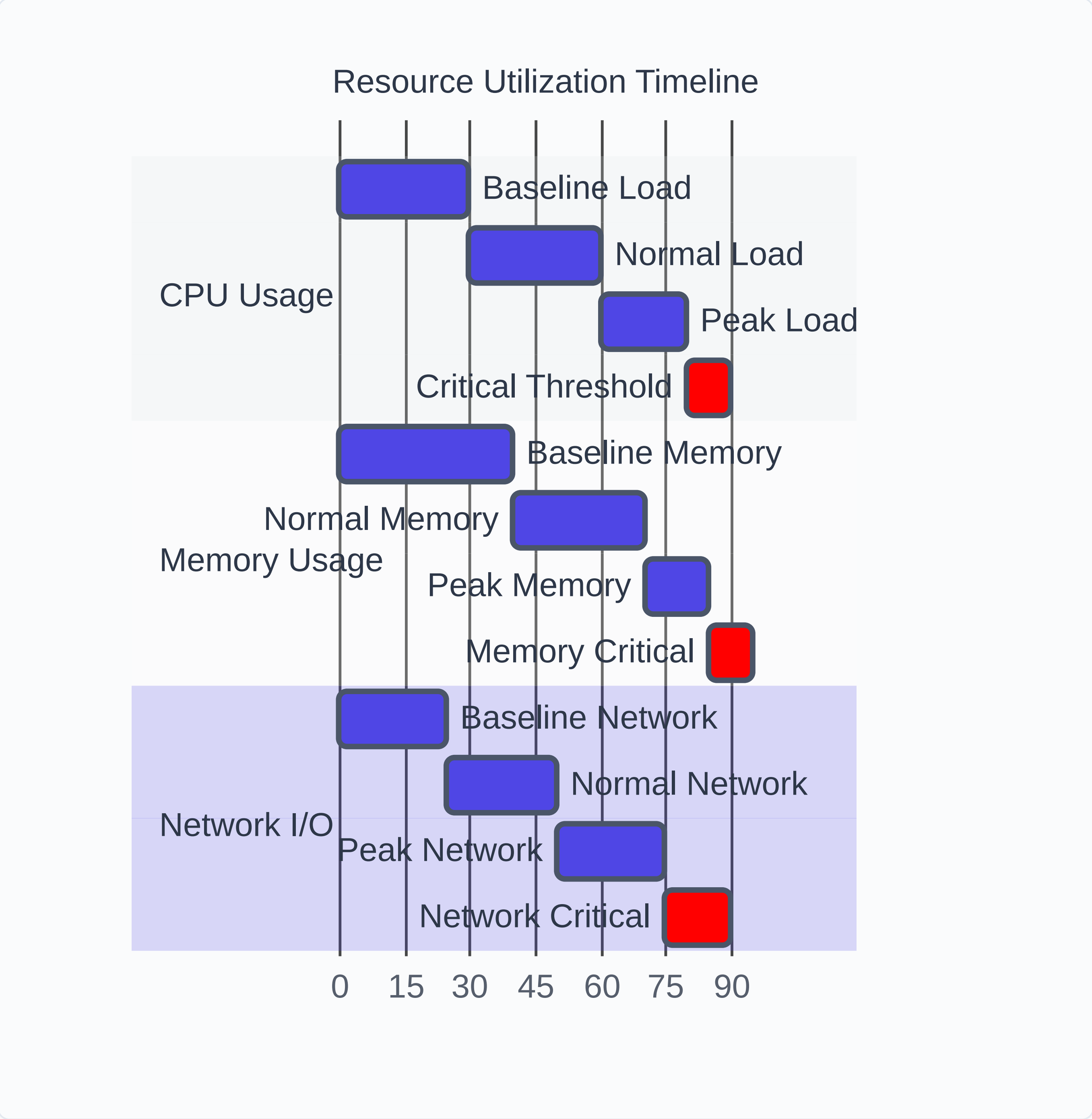


🎯 PERFORMANCE BENCHMARKS & TARGETS¶

Service Level Objectives (SLOs)¶

METRIC CATEGORY	OBJECTIVE	TARGET	MEASUREMENT
Availability	Service Uptime	99.99%	Monthly rolling window
Performance	Authentication Response	< 100ms (p95)	Request duration
Performance	API Response Time	< 200ms (p99)	End-to-end latency
Scalability	Concurrent Users	10,000+	Peak load capacity
Reliability	Error Rate	< 0.1%	Request success ratio
Security	Auth Success Rate	> 99.5%	Authentication attempts
Recovery	RTO (Recovery Time)	< 15 minutes	Incident response
Recovery	RPO (Recovery Point)	< 5 minutes	Data loss window

Resource Utilization Targets¶



🔒 SECURITY IMPLEMENTATION CHECKLIST¶

Security Controls Implementation Status¶

SECURITY CONTROL	IMPLEMENTATION STATUS	VALIDATION METHOD
Multi-Factor Authentication	✅ Implemented	Automated testing + Manual verification
JWT Token Security	✅ Implemented	Security scanning + Penetration testing
Role-Based Access Control	✅ Implemented	Permission matrix testing
Tenant Data Isolation	✅ Implemented	Cross-tenant access testing
Encryption at Rest	✅ Implemented	Database encryption verification
Encryption in Transit	✅ Implemented	TLS configuration validation
Input Validation	✅ Implemented	Injection attack testing
Audit Logging	✅ Implemented	Log completeness verification
Session Management	✅ Implemented	Session security testing
Rate Limiting	✅ Implemented	Load testing + DoS simulation
CORS Protection	✅ Implemented	Cross-origin request testing
CSRF Protection	✅ Implemented	CSRF attack simulation
SQL/NoSQL Injection Prevention	✅ Implemented	Injection attack testing
XSS Protection	✅ Implemented	Script injection testing
Security Headers	✅ Implemented	Header configuration validation

This comprehensive Low Level Design document provides detailed technical specifications, implementation details, code structure, database schemas, API designs, security implementations, deployment configurations, and operational procedures for the Securaa User Service. The document includes extensive diagrams, code examples, and configuration templates to guide development and operations teams in implementing and maintaining this critical security service.