PeraVerse Exhibition 2025
RFID Ticketing System
High-Level Architecture Description

Overview

This document outlines the high-level architectural design of the RFID Ticketing System developed for the PeraVerse Exhibition 2025. The system enables smart visitor tracking, zone monitoring, real-time alerts, and personalized feedback using RFID technologies integrated with modern web and mobile applications.

Technology Stack

- Backend Framework: Django (Python)
- Frontend Web: Bootstrap (integrated into Django templates)
- Mobile App: React Native
- Database: PostgreSQL with the following extensions:
  - ✓ JSONB for flexible metadata storage
  - ✓ PostGIS for geospatial tracking and zone breach detection
  - ✓ Full-text search for visitor logs and analytics
  - ✓ pgcrypto for encryption and security
- Notifications:
- ✓ Firebase Cloud Messaging (mobile push)
- ✓ SMS (via Twilio or similar)
- Communication:
  - ✓ Wi-Fi connectivity between UHF RFID Readers and Scan Receiver
  - ✓ Django Channels based microservice for real-time WebSocket alerts

Explanation of the High-Level Architecture

The architecture is structured into three layers, consistent with the SRS and the provided code set, with modifications to align with the SRS requirements:

1. Client Devices (Top Layer)
- Web Browser: Accesses the Visitor Registration UI (React-based, Section 2.1) and Staff Dashboard for registration and monitoring (FR-T3, FR-T9).
- Mobile App: Integrates with the parent system's Flutter app for staff access and alert notifications (Section 3.1, FR-T5, FR-T7, FR-T10).
- UHF RFID Readers: 10–20 readers (IP65-rated, 10m range) send scan data to the RFID Scan Receiver via Wi-Fi or Ethernet (Section 3.2, FR-T1).
- Kiosk Terminals: Used for on-site registration and QR code generation (Section 1.4, FR-T3).

2. Application Layer (Middle Layer)
RFID Hardware & Tag Lifecycle (FR-T1, FR-T2, FR-T8, FR-T10):

- ✓ RFID Scan Receiver: Processes 100 scans/min with ≤1% error rate (FR-T1).
- ✓ RFID Tag Assignment Engine: Manages 12,000 wristbands (FR-T8).
- ✓ Offline Sync Queue: Queues offline scans for post-event sync (FR-T1).
- ✓ Fraud Detection Module: Detects duplicate RFID IDs (FR-T2).
- ✓ Zone Breach Detection Module: Monitors visitor scan locations against geofenced zones, detects unauthorized entries, and triggers real-time alerts (FR-T10).
- ✓ Zone Breach & Proximity Alert Engine: Triggers alerts for proximity violations (FR-T5, FR-T7) and zone breaches (FR-T10).

Registration & Batch Management (FR-T3, FR-T5–T7):

- ✓ Visitor Registration UI: React-based, multilingual (Sinhala, Tamil, English), WCAG 2.1 compliant (Section 3.1).
- ✓ Batch Creation Module: Supports batches (100 students, 15 friends, 25 family members, FR-T5–T7).
- ✓ RFID Tag-Linking API: Links tags to visitors (FR-T3, FR-T8).
- ✓ QR Backup Generator: Generates QR codes for backup (Section 1.4).
- ✓ Payment Gateway Interface: Processes payments in ≤3 seconds (FR-T3).
- ✓ Group Categorization Module: Categorizes visitors (e.g., School Student, FR-T3).
- ✓ Proximity Tracking Module: Tracks proximity every 5 seconds within 10m (FR-T5, FR-T7).

Organizer Dashboard & Analytics (FR-T9, FR-T10):

- ✓ Staff Dashboard: Displays active visitors, batch alerts, and analytics (FR-T9).
- ✓ Analytics Engine: Logs entry/exit times and booth visits (FR-T9).
- ✓ Heatmap Data Publisher: Updates maps every 5 seconds (FR-T6, FR-T7).
- ✓ Alert Panel: Displays proximity and zone breach alerts (FR-T10).
- ✓ Feedback QR Generator: Generates post-exit feedback QR codes (Section 6.2).
- ✓ Deployment & Monitoring: Ensures ≥99% uptime, manages CI/CD and system logs (Section 6.2).

3. Data & Infrastructure Layer (Bottom Layer)

- ✓ MySQL Database: Supports 10,000 concurrent queries with ≤5-second latency, AES-256 encryption, ACID transactions (FR-T4).
- ✓ Local Application Server: Hosts Node.js backend for processing (Section 2.1).
- ✓ Wi-Fi Network: 100 Mbps with WPA3 encryption (Section 2.4).
- ✓ 4G Backup Network: 20 Mbps fallback for low Wi-Fi areas (Section 2.4).
- ✓ Payment Gateway: TLS-encrypted, handles ticket purchases (Section 3.3).
- ✓ SMS/Email Alert Service: Delivers alerts in ≤10 seconds (FR-T5, FR-T7, FR-T10).
- ✓ Cloud Monitoring & CI-CD: Supports deployment 1 week before the event (Section 6.2).

4. Security & Compliance

- ✓ TLS 1.3 for data in transit
- ✓ AES-256 for data at rest
- ✓ Role-Based Access Control (RBAC)
- ✓ 30+ days audit log retention
- ✓ Multilingual support
- ✓ WCAG 2.1 accessibility compliance

Interconnections Summary (Key Data Flows)

- ✓ RFID Readers -> Scan Receiver (via Wi-Fi)
- ✓ Scan Receiver -> RFID Tag Assignment Engine -> PostgreSQL
- ✓ Scan Receiver & Tag Engine -> Zone Breach Detection Module
- ✓ Zone Detection Module -> Alert Engine -> Push/SMS/Alert Panel
- ✓ Analytics Engine <-> PostgreSQL
- ✓ Analytics Engine -> Heatmap Publisher -> Dashboard
- ✓ Feedback QR Generator -> Dashboard & Analytics Engine

Attachments

High level Architecture Diagram

System Source Code

SECURITY & COMPLIANCE

- TLS 1.3 (Data in Transit)
- AES-256 (Data at Rest)
- Role-Based Access (Staff/Admin)
- Sinhala/Tamil /English
- 30+ Days Logs (Encrypted)
- PDPA 2022 (Anonymized Analytics)
- Accessibility

CLIENT DEVICES

- UHF RFID Readers (10-20, IP65, 10m range)
- Mobile App (Flutter)
- Web Browser
- Kiosk Terminals (On-Site Registration)

RFID HARDWARE & TAG LIFECYCLE (FR-T1, FR-T2, FR-T8, FR-T10)

- Scan Receiver (≤1% error, 100 scans/min)
- Fraud Detection (FR-T2, ≤1% false positives)
- Offline Sync (Post-Event Sync)
- Zone/Proximity Alerts (FR-T5, FR-T7, FR-T10)
- Tag Assignment (12,000 wristbands)
- Zone Breach Detection (FR-T10)
- detect duplicates (FR-T2)
- queue offline scans (FR-T1)
- trigger alerts (FR-T10)
- assign tags (FR-T8)
- tag deactivation/visitor mapping
- real-time scan data
- visitor tag mappings
- delayed scan data

ORGANIZER DASHBOARD & ANALYTICS (FR-T6, FR-T10)

- Dashboard (Role-Based Active Visitors)
- Analytics (Entry/Exit, Booth Visits)
- Heatmap Publisher (5s refresh)
- CI/CD & Monitoring (≥99% uptime)
- Feedback QR (Post-Exit)
- Alert Panel (Proximity/Zone Breach)
- Feedback QR (Post-Exit Section 6.2)
- show analytics (FR-T6)
- publish movement data (FR-T6, FR-T7)
- QR event for analysis
- incident log (optional)
- display feedback QR (Section 6.2)
- show alerts (FR-T9)
- send alerts (FR-T10)
- offline scans (FR-T1)
- offline data
- scan data

DATA & INFRASTRUCTURE

- Wi-Fi Network (100 Mbps, WPA3)
- Cloud Monitoring/CI-CD (Deployment 1 week prior)
- 4G Backup (20 Mbps)
- SMS/Email Alerts (≤10s delivery)
- App Server (Django, Microservices – Django Apps/Modules)
- PostgreSQL DB (AES-256, ACID, 10,000 queries)
- Payment Gateway (TLS)
- primary connectivity
- heatmap data (FR-T6, FR-T7)
- deployment & monitoring
- analytics data
- backup connectivity
- send notifications (≤10s, FR-T5, FR-T7, FR-T10)
- read/write (≤5s latency)
- alert data (FR-T10)
- deployment logs
- feedback QR codes
- process payments (≤3s, FR-T3)
- payment processing

REGISTRATION & BATCH MANAGEMENT (FR-T3, FR-T5, FR-T6, FR-T7)

- Proximity Tracking (5s checks, 10m radius)
- Tag-Linking API (FR-T3, FR-T8)
- Batch Module (School: 100, Friends: 15, Family: 25)
- Payment Gateway Int. (TLS, ≤3s validation)
- Registration UI (React, Sinhala/Tamil /English, WCAG 2.1)
- Group Categorization (School, Student, Teacher, etc.)
- QR Backup (Visitor IDs)
- proximity data (FR-T5, FR-T7)
- link tags (FR-T3, FR-T8)
- tag links (FR-T3, FR-T8)
- batch registration (FR-T5, FR-T6, FR-T7)
- batch data (FR-T5, FR-T6, FR-T7)
- categorize visitors (FR-T3)
- on-site registration (FR-T3)
- register/operate (≤5s)
- generate QR codes
- group data

Connection labels:
- send scans (≤3s)
- fraud logs (FR-T2)
- scan logs (FR-T1, FR-T2)
- dashboard data (FR-T9)
- analytics data (FR-T9)
- heatmap data (FR-T6, FR-T7)
- scan data (FR-T1)
- organizer access (Flutter)
- receive alerts (≤10s)
- location sharing (FR-T6, FR-T7)
- staff access (RBAC)
- scan data (exit detection)
- store QR event/visitor ID
- feedback QR data (Section 6.2)
- display feedback QR
- breach alert
- alert triggers
- alert logs (FR-T10)
- tag lifecycle
- tag data (FR-T8)
- zone definitions (PostGIS)
- registration data
- tag assignments
- proximity data
- batch data
- group data
- proximity data (FR-T5, FR-T7)
- QR codes
- payment records (FR-T3)
- group data (FR-T3)
- visitor data (FR-T3)
- QR codes (FR-T3)

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