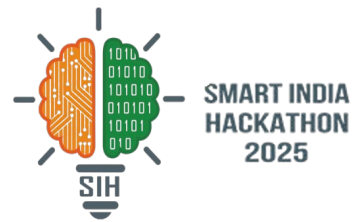# SMART INDIA HACKATHON 2025

PROBLEM STATEMENT ID: 25013

PROBLEM STATEMENT TITLE: Real-Time Public Transport Tracking for Small Cities

THEME: Transportation & Logistics

PS CATEGORY: Software

TEAM ID:

TEAM NAME: CogniCore

PROPOSED SOLUTION (IDEA)

What we are building

A mobile-first platform for commuters, drivers, and authorities enabling real-time bus tracking + predictive ETAs in Tier-2 cities.

Innovation / what's uniquely ours

- **AI-powered delay prediction** (stop-level accuracy).
- **Crowd-verified live status** → increases reliability.
- **Gamified adoption**: commuters earn points for consistent app use/reporting.
- **AR stop locator**: camera overlay to find nearest bus stop.
- **LLM-powered summaries**: route health reports for city officials.

Key Features

- **Driver App (Flutter)**: captures GPS from driver's phone, sends updates every 5–10s.
- **Commuter App**: live map, ETAs, AR stop-finder, multilingual voice interface.
- **Predictive ETAs** using ML models trained on historical delays.
- **Community layer**: commuters can flag overcrowding, skipped stops, or diversions.
- **Authority dashboard**: fleet view, route analytics, punctuality KPIs.

TECHNICAL APPROACH

Architecture

- **Driver App (Flutter)** → captures GPS, sends location pings to server.
- **Ingest Layer (Node.js + MQTT/HTTP)** → authenticates, processes incoming data.
- **Stream Processor (Python/FastAPI workers)** → smoothing, map-matching, stop detection.
- **Location Store** → Redis (hot cache) + Postgres/PostGIS (historical).
- **ETA Service (Python)** → GBDT/LSTM-based predictions with fallbacks.
- **Commuter App (Flutter)** → real-time map, AR stop finder, multilingual support.
- **Authority Dashboard (React)** → fleet view, KPIs, OTP, bunching analytics.
- **Notification Service** → FCM push, WhatsApp, IVR alerts.

Technology Stack

- **Frontend:** Flutter (Commuter + Driver Apps), React (Dashboard)
- **Backend:** Node.js APIs, FastAPI ML services
- **Database:** Redis, Postgres + PostGIS
- **Data Standards:** GTFS / GTFS-Realtime, OpenStreetMap
- **AI/ML:** ETA predictions, anomaly detection, crowd input sentiment

FEASIBILITY & VIABILITY
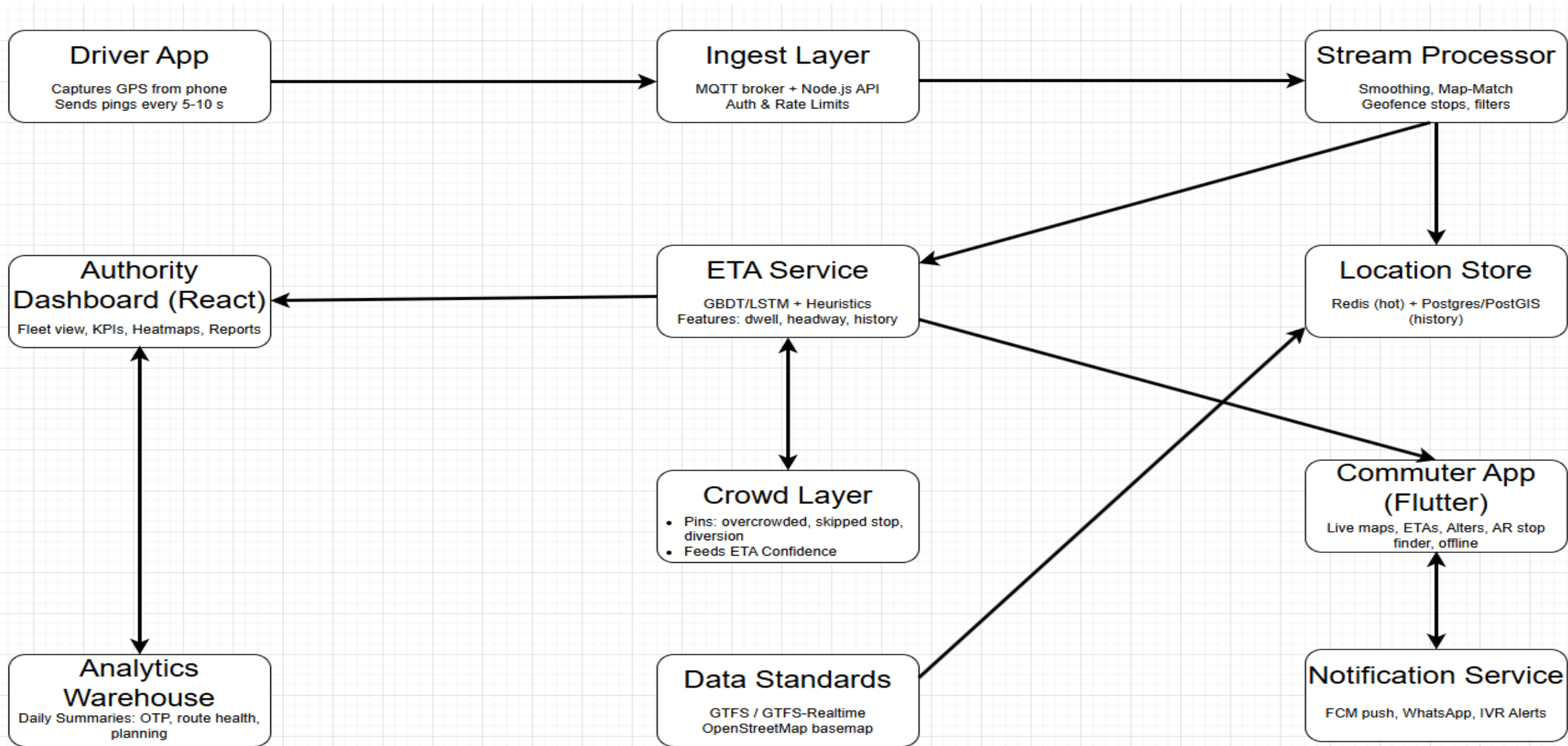
Feasibility

- Works on **drivers' own smartphones** (no external hardware required).
- Lightweight apps designed for **low-end Android devices (₹6k–₹8k phones)**.
- Offline-capable with store-and-forward GPS sync.
- Modular backend → scalable across multiple cities.

Potential Challenges

Driver adoption — Some may hesitate to use app.
Mitigation: 10-min training, one-tap duty mode, incentives.
Weak connectivity — Network issues in rural routes.
Mitigation: GPS caching, compressed payloads, fallback ETAs.
Crowd input misuse — False reports.
Mitigation: Reputation scoring, upvote/downvote system.

Why Viable?

- **Zero hardware dependency** = faster rollout, lower cost.
- **Cloud-light stack** = minimal infra cost, highly scalable.
- **Multi-tenant architecture** = new cities onboarded in days.

IMPACT AND BENEFITS

For Commuters

- 25–40% **reduction in wait times**.
- Real-time reliability → **higher trust in buses**.
- Local-language & IVR/WhatsApp access → inclusivity.

For the City & Environment

- Boost in **public transport usage** → reduction in private vehicle traffic.
- Lower **emissions & congestion**.
- Economic benefit: optimized fuel & better fleet utilization.

For Authorities

- On-Time Performance (OTP) monitoring.
- Heatmaps for overcrowding & demand analysis.
- Route redesign & targeted driver coaching.

Scalability

- Multi-city deployment possible using GTFS data standards.
- Cloud-ready, lightweight architecture = scales with demand.

RESEARCH & REFERENCES

- **Urban Mobility India Report 2024 (MoHUA)** → highlights inefficiencies in Tier-2 transit.
- **Case studies**: Kochi Metro Open Mobility, Indore iBus, BMTC live bus tracking.
- **Data Standards:** GTFS & GTFS-Realtime → ensures interoperability.
- **Technologies:**
  - OpenStreetMap for maps
  - MapLibre/Mapbox SDK
  - MQTT for lightweight streaming
  - Redis + Postgres/PostGIS for data
- **AI/ML:** Kalman smoothing, GBDT/LSTM for ETAs, heuristic fallback models.