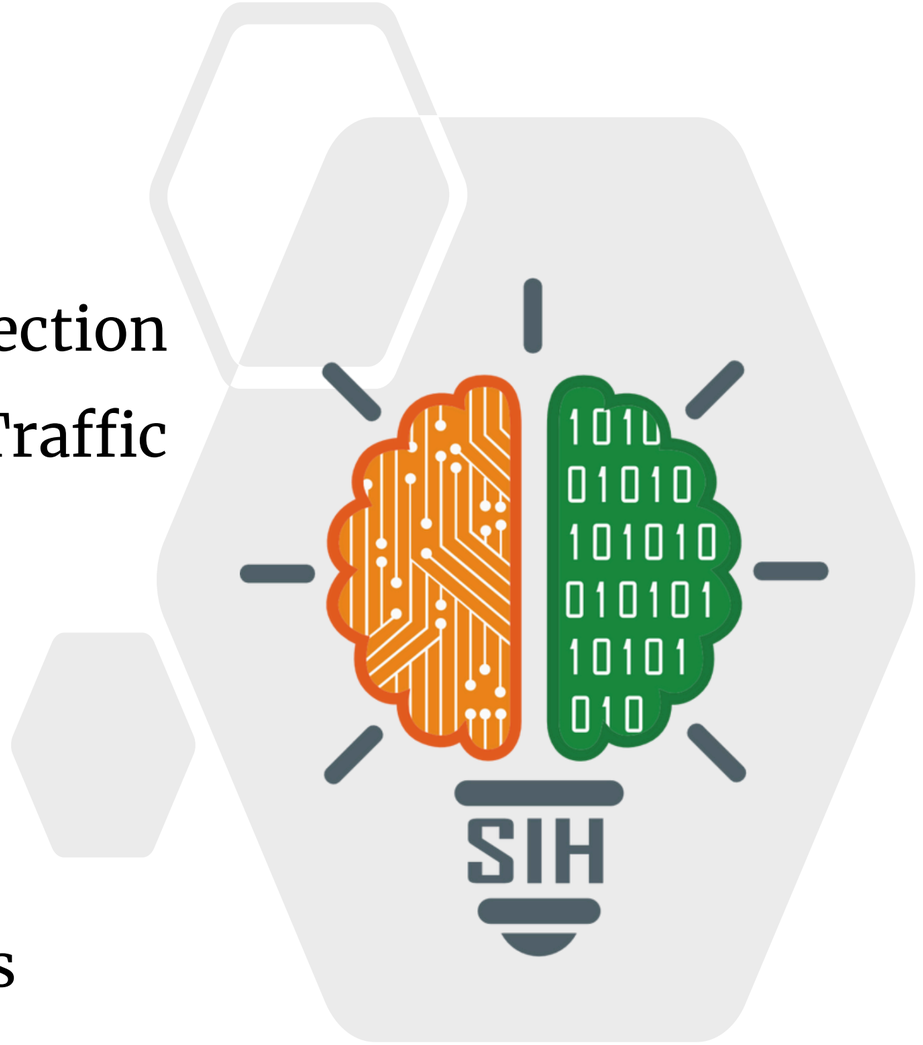
SMART INDIA HACKATHON 2025

TITLE PAGE

- **Problem Statement ID –** 25022
- **Problem Statement Title –** Maximizing Section Throughput Using Al-Powered Precise Train Traffic Control
- **Theme –** Transportation & Logistics
- **PS Category –** Software
- **Team ID –**
- **Team Name (Registered on portal) –** RailOptimus



IDEA TITLE

Idea/Solution

- An **AI-powered decision**- assists section controllers in **real-time train scheduling** and **precedence decisions.**
- Uses **operations research algorithms** to generate conflict-free, optimized schedules under **multiple constraints**

(track availability, train priorities, platform capacities, and safety rules.)

- Integrates a **predictive AI engine** (reinforcement learning) to forecast **train delays, ETAs, and dynamic speed guidance.**
- Provides **interactive scenario simulations**, allowing controllers to test **"what-if" situations.**
- **Dashboard-centric approach**: Visualizes live train states, performance KPIs, and route analytics through interactive maps, charts, and a user-friendly interface.
- **Offline-first design** ensures reliable operation in low-connectivity environments.
- **Modular architecture** allows seamless integration with existing railway control systems, making the solution production-ready while retaining flexibility for future scaling and additional ML-driven features.

Problem Resolution

- Replaces manual, intuition-based decisions with precise, data-driven recommendations.
- Resolves conflicts across multiple trains, priorities, and infrastructure constraints.
- Dynamic, conflict-free schedules reduce travel time improve throughput and punctuality.

Unique Value Preposition

- AI Predictor Card

  Delay/ETA insights directly on dashboard.

- Interactive Map & Simulation

  Visual exploration + rapid scenario testing.

- Offline Demo

  Bundled JSON/GeoJSON ensures smooth demo.

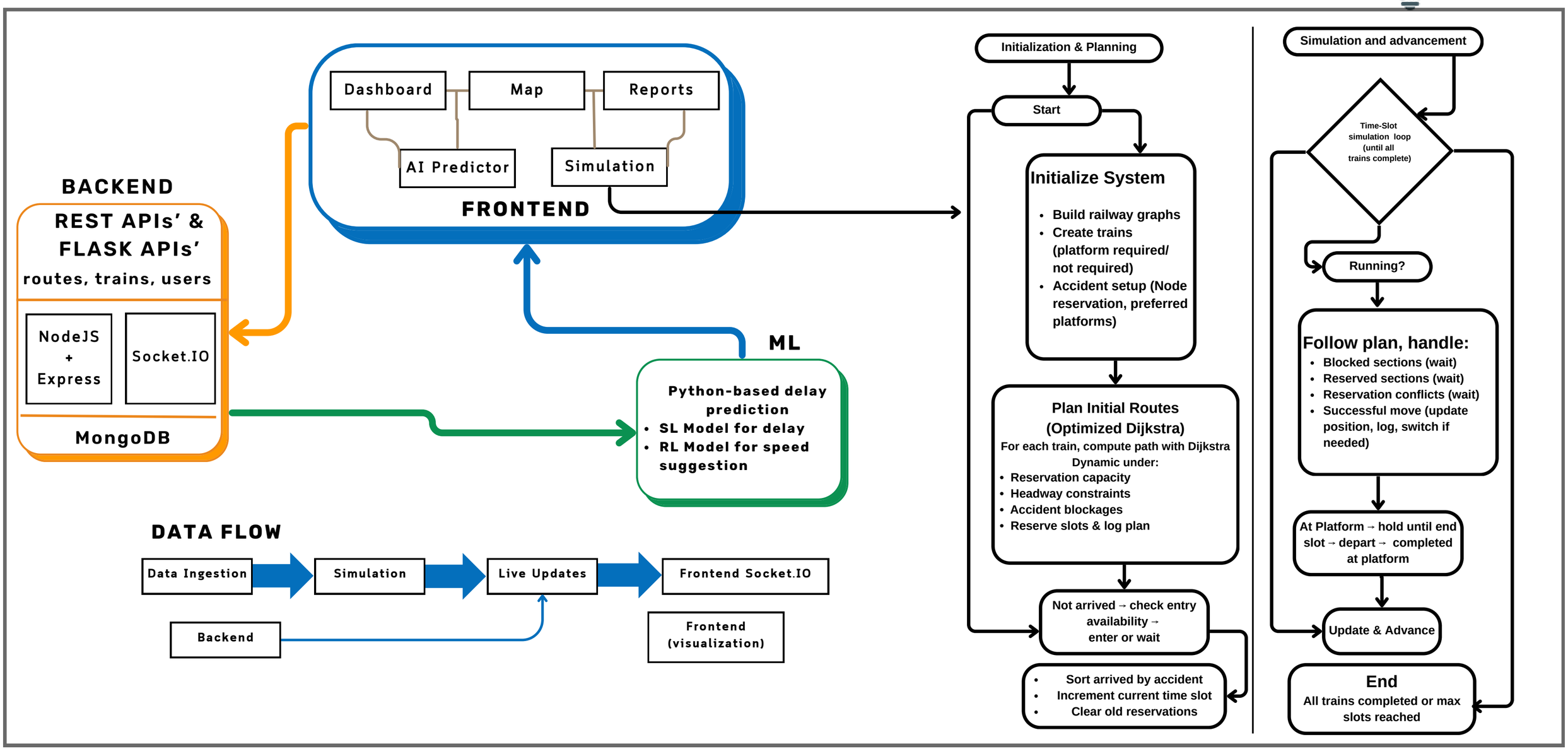
- Polished UX

  Responsive, intuitive, mobile-aware interface.

- Backend-Ready

  Easy integration with REST APIs without UI changes.

TECHNICAL APPROACH



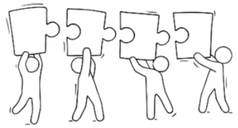
FEASIBILITY AND VIABILITY

Feasibility Analysis

Financial:
- Built entirely on open-source frameworks → zero licensing costs, long-term sustainability.
- Leverages existing Indian Railways IT ecosystem, minimizing upfront CAPEX and ensuring cost-efficient rollouts.

Technical:
- Enterprise-grade stack (React + TypeScript, Node.js + Express, MongoDB, Python ML)
- Real-time decision engine with Socket.IO for continuous optimization under live traffic.
- AI-powered delay forecasting & dynamic reallocation tackles the PS's combinatorial challenge directly.
- Resilient offline-first mode guarantees reliability even in low-connectivity zones.

Market / Operational:
- Direct integration into controller workflows with minimal training overhead.
- Maximizes throughput under congestion, especially with mixed-priority trains (freight, passenger, express).
- Scenario simulation & intuitive dashboards enable both day-to-day operations and policy-level decision-making.
- High adoption potential due to tangible efficiency gains and safety compliance.



Challenges

- **Technical**: Real-time conflict resolution under high traffic, integration with live railway systems.
- **Financial**: Deployment and maintenance costs at scale.
- **Operational / Market**: User training for controllers, adoption resistance, regulatory compliance.

Strategies

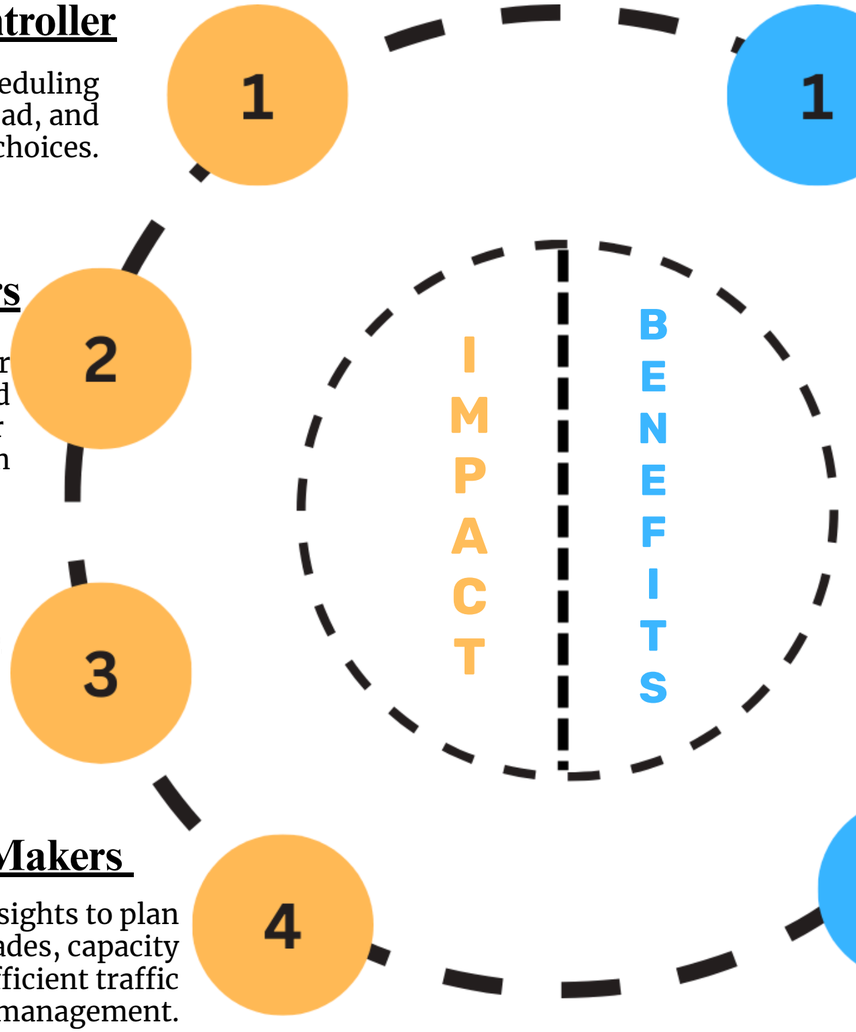
Operational: Intuitive UI, scenario simulations for training, secure APIs for seamless integration.

Algorithms: AI/ML for ETA prediction, OR-based optimization for schedules, conflict-aware simulation engine.

Financial: Cloud deployment for reduced infrastructure cost, gradual rollout.

Technical: Modular microservices, scalable WebSocket layer, offline-first fallback.

IMPACT AND BENEFITS



Section Controller

Automates complex scheduling decisions, reduces cognitive load, and empowers faster, safer choices.

Passengers

Fewer delays, smoother journeys, improved reliability, and higher satisfaction

Railway Operators

Maximizes network throughput, optimizes platform and track utilization, and reduces operational bottlenecks.

Policy Makers

Provides actionable insights to plan infrastructure upgrades, capacity expansion, and efficient traffic management.

Intuitive Decision Support

Interactive dashboards, maps, charts, and reports make insights immediately actionable

Operational Excellence

Real-time AI-driven train scheduling ensures punctuality and safety across high-density networks.

Predictive & Proactive

Forecasts delays, suggests rerouting, and enables rapid scenario simulations for disruptions.

Economic Efficiency:

Minimizes delays, reduces fuel and energy consumption, and lowers operational costs

RESEARCH AND REFERENCES

Research & References

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- https://openrailwaymap.org/
- https://www.ijraset.com/research-paper/optimized-implementation-of-dijkstras-algorithm-for-efficient-shortest-path-finding
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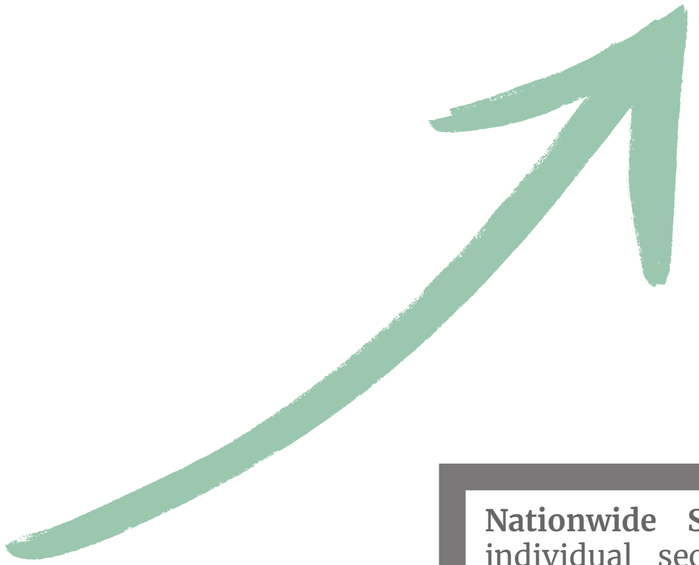

Multimodal Integration → Optimize not just rail, but also freight, metro, and intercity connections for a unified transport ecosystem.

Adaptive Learning Engine → ML models continuously improve from real-time and historical traffic data.

Nationwide Scalability → Extend from individual sections to cover all railway zones and corridors across India, including dense freight + passenger mixes.ud.

Cloud + Edge Hybrid Deployment → Scalable architecture ensures real-time performance at the edge while keeping nationwide coordination in the cloud.

AI-Powered Policy Simulation → Simulate "what-if" strategies (e.g., new express corridors, timetable shifts) before implementation.

Future Scope/ Scalability