Transit Hub

Smart Decision Support System for Public Transportation

Fangzhou Sun, Shashank Shekhar, Himanshu Neema, Aniruddha Gokhale, Sandeep Neema, Jules White, Abhishek Dubey

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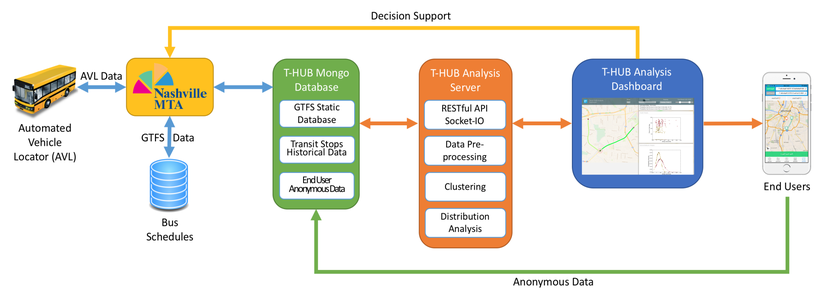
Context-aware individualized travel planning and notification service.
Focuses on increasing engagement with the public transit system.

PROBLEM

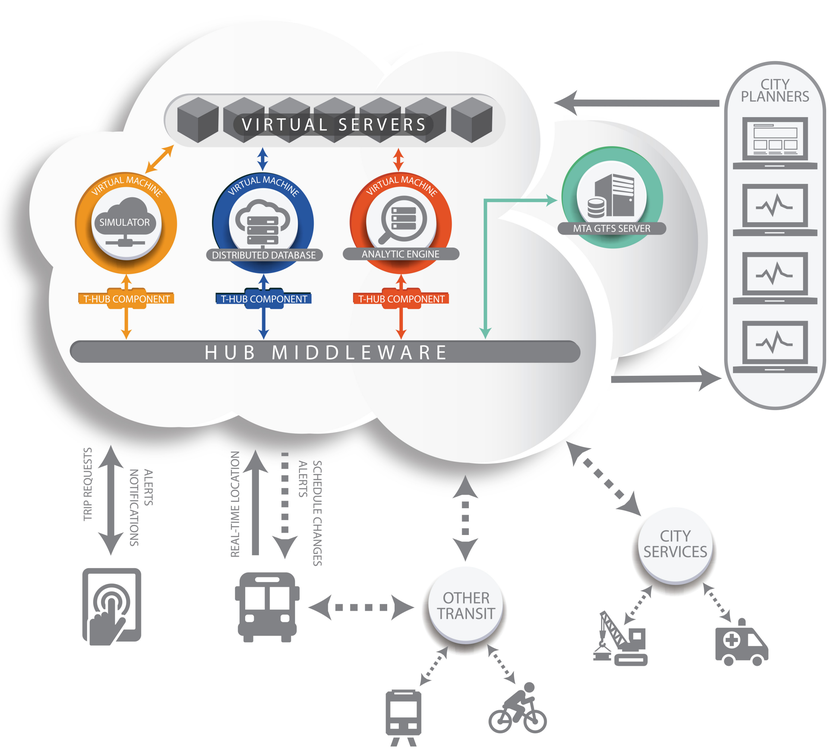
Traffic congestion in the rapidly growing metropolis of Nashville has nearly doubled in the past decade. The 10-county metro region could hit 3 million residents by 2040. It is further challenged by multiple limitations in deploying the types of public mass transportation networks as seen in larger cities.

Making transit services easier to use and providing incentives that make the experience competitive and, at times, even better than personal automobiles are key to attracting riders.

INFORMATION FLOW

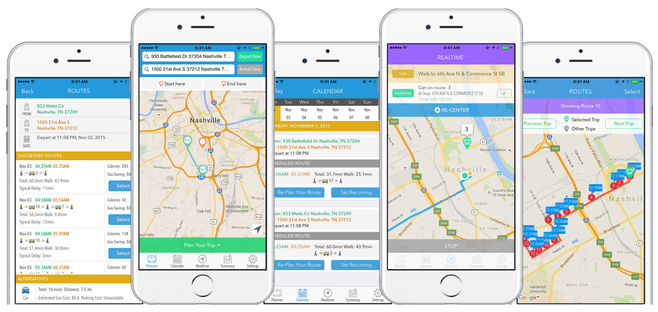


SOLUTION



DECISION SUPPORT SYSTEM

- *Data-driven and Model-driven analytics as a service for the city*
- *Available as a service in the cloud*
- *Service for city planners: Study the impact of events such as games, concerts, snow, accidents on city traffic*
- *Service for customers: Evaluate multiple trip options simultaneously based on preconfigured criteria and usesr inputs*
- *Integrated with the Transit Hub application used on handheld devices and on city hubs.*



TRIP PLANNING

- *Choose the time they need to leave and time that they must arrive*
- *Supports recurring trips*
- *Estimated trip time considering the predicted traffic congestion, planned city events and service alerts*
- *Compare different trip options*
- *Fuel savings*
- *Carbon credits*
- *Calories burned*
- *Latest trip for the day is automatically activated in real-time*

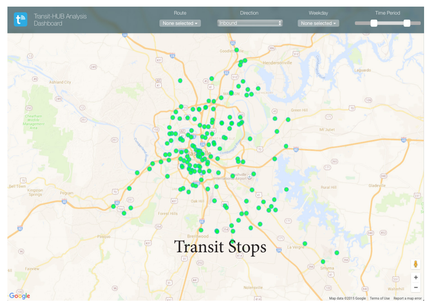
REAL-TIME TRACKING

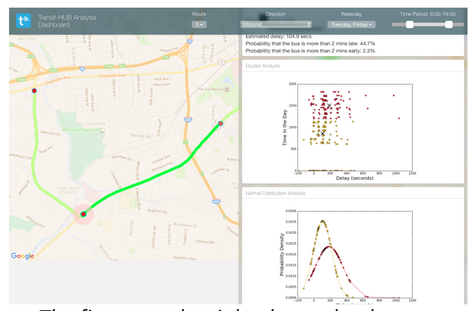
- *Active assistance for the next planned trip*
- *Tracks the location of the next bus to take in real-time*
- *Configurable real-time notification for better coordination*
- *Detects when the customer is on the bus and the view is updated to track the next bus for the planned route.*
- *MTA can push service alerts which results in re-planning of the affected trip*
- *Can be extended to support crowd-sourced real-time tracking of the transit vehicles that do not have Automated Vehicle Locators (AVL)*

INCENTIVE CAMPAIGNS

- *Smart and effective incentives are important for engaging commuters*
- *Transit hub platform enables the city to customize and run incentive campaign*
- *By default, the system collects and reports the following information: Fuel saved, calculated based on reported miles per gallon for the private vehicle owned by the commuter and transit points*
- *Enable social sharing of usage summary*

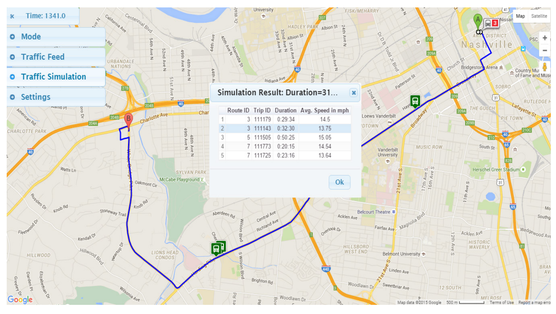
DATA-DRIVEN ANALYSIS





- *The dashboard helps the MTA identify consistent patterns leading to lost time and refine their transit schedules.*
- *The source of data includes the Automated Vehicle Locator information from the buses and the static transit schedule from Nashville MTA.*
- *Data is grouped into clusters using silhouette analysis and K-Means algorithm, based on the delay and time of the day*
- *Heat map visualization is employed to depict the intensity of delay data at transit stops and segments between them*
- *Historical data is used to create aggregate models for anomalous operation identification and future prediction.*
- *The figure on the right shows the departure delay of each transit stop and the travel delay of segments between any two adjacent transit stops on Route 3, Inbound Direction between 6 AM and 9 PM in the day*
- *It also shows the results of clustering analysis and Gaussian Distribution analysis on a selected stop*
- *These charts exhibit that the delay distribution patterns differ between morning and afternoon on the chosen weekdays*
- *It also provides improved predicted delay information to the end users when they are planning their trips*
- *Future capabilities include crowdsourced data and monte carlo simulation for analyzing data aggregates across routes.*

MODEL-DRIVEN ANALYSIS



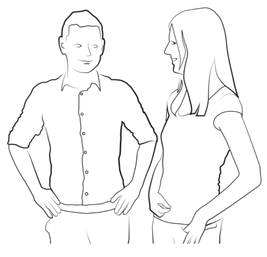
- *Real-time GTFS feeds about the bus locations and trips periodically get collected from Nashville MTA servers*
- *Nokia's HERE API is used to collect real-time traffic data*
- *Simulation of Urban Mobility (SUMO) microscopic simulator is used for simulating city traffic. OpenStreetMap (OSM) maps are transformed into SUMO maps for Nashville city*
- *Static routes for buses are mapped to SUMO format to perform simulations*
- *Simulator is configured with the current location of the vehicle and the lane speeds are adjusted according to the real-time traffic*
- *Bus movement and stoppage time are also accounted for using vehicle following models supported by the simulator*

FUTURE WORK

- *Combining data driven analysis and model-driven analysis.*
- *The simulation will include passenger behavior models to account for delays at the bus stops where passengers board and alight*
- *The traffic signal timing models will be based on actual timings*
- *Traffic incidents such as accidents and rerouting will be taken into account*
- *Account for events such as game day, bad weather etc.*

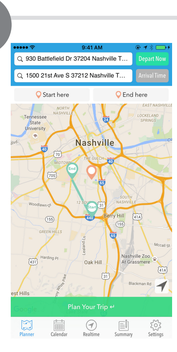
USE CASE

1



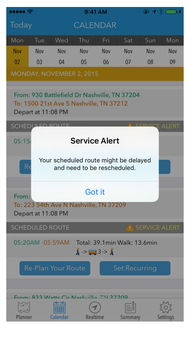
Lisa and Joe are visiting downtown Nashville from a different city.

2



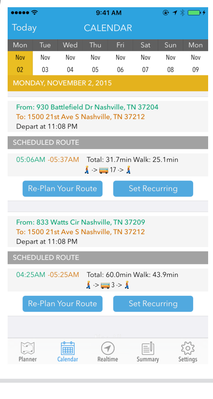
They use the T-HUB mobile application to plan a trip to their destination.

3



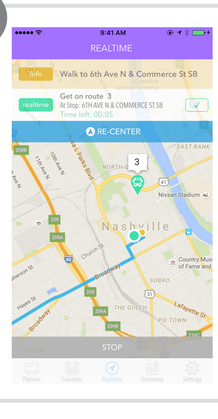
The app keeps track of their schedule. It notifies them when there is a service alert that might affect their scheduled trip.

4



They use the app's trip planner to re-plan their trip to the destination, and add the new schedule to Calendar.

5



The app notifies them when it's time to depart. They use the app to track the real-time locations of the buses and follow the step by step navigation to their destination.

PUBLICATIONS

- Shashank Shekhar, Fangzhou Sun, Abhishek Dubey, Aniruddha Gokhale, Himanshu Neema, Martin Lehofer, and Dan Freudberg. *Transit hub: A smart decision support system for public transit operations.* A handbook on Smart City Case studies, 2016. to appear.
- Shashank Shekhar, Subhav Pradhan, Fangzhou Sun, Annirudha Gokhale , and Abhishek Dubey. *Empowering the next generation city-scale smart systems.* In Workshops on Dynamic Data Driven Applications Systems(DDDAS) In conjunction with 22nd International Conference on High Performance Computing (HiPC), 2015, to appear.
- Abhishek Dubey, Monika Sturm, Martin Lehofer and Janos Sztipanovits (2015). *Smart City Hubs: Opportunities for Integrating and Studying Human CPS at Scale.* Workshop on Big Data Analytics in CPS: Enabling the Move from IoT to Real-Time Control.

PARTNERS

Nashville MTA

SIEMENS