Leveraging Existing Systems to Produce High-quality, Real-time Passenger Information for Rail Service

2018 Rail Conference

Daniel Bernstein, Transit Data Analyst, IBI Group
June 12, 2018
Agenda

Introduction
RTPI for Rail Overview
RTPI for Rail System Components
Case Study – RTD Denver
Multi-disciplinary professional services firm

2,500+ staff / 75+ offices including Seattle & Boston

Core expertise in transit / rail service planning and operations analysis

Extensive experience in Transit Technology

Increasing focus on Transit Data
IBI’s Transit Data practice focuses on helping transit agencies:

- Manage their data end-to-end
- Provide high-quality information to passengers
- Analyze and measure the quality of service provided to and experienced by customers
RTPI for Rail Overview
Information Types

Train Locations
Arrival/Departure Predictions
Service Alerts
Information Types

Train Locations

Arrival/Departure Predictions

Service Alerts
Apps
Passengers expect RTPI

RTPI for bus is fairly standardized

Every rail system is unique

Good rail operations doesn’t equal good RTPI

RTPI for rail challenges and opportunities
RTPI for Rail System Components
Train tracking system

RTPI System

Train locations

Train Tracking Data
- Train ID
- Last movement time
- Block
- Trip
- Destination
- Current location
- Cars in consist

Legend
- Input
- RTPI System
- Public Facing System
- Report

Agency website

API / GTFS-realtime (apps)
Train tracking system

RTPI System

Train locations → Predictions

Modeling Operations

- Prediction algorithm
- Predictions before trip starts
- Short turns
- Route/destination
- Revenue/non-revenue
- Special events
- Diversions

Legend

- Input
- RTPI System
- Public Facing System
- Report

Agency website
API / GTFS-realtime (apps)
Case Study – RTD Denver
RTD’s Light Rail Network
RTD Light Rail has unique attributes including:
Shared Corridors
On-Street Operations

Understanding operations is critical

Challenges for RTPI

System was designed in response
Train Tracking Data

- Always
  - Last movement time
  - Block
  - Current location
- Sometimes
  - Trip
  - Destination
  - Cars in consist
  - Previous, current, next stops

Legend

- Input
- RTPI System
- Public Facing System
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Potential Issues – Locations

Trains consistently track incorrectly in certain parts of the system

Gaps in train tracking due to operational environment

Trains move without an identifier assigned in the train tracking system
Potential Issues – Predictions

Operations control decisions not reflected in train tracking data feed

Latency between train movement and train tracking dissemination to downstream systems

Train tracking system clock times out of sync with reference clock
Train tracking system

RTPI System

Train locations ➔ Predictions

Agency website
API / GTFS-realtime (apps)
Prediction accuracy reports

Legend

Input
RTPI System
Public Facing System
Report
For each route and direction:
- Sequence of stops and intermediate positions
- Expected travel time between positions based on historical data
Approach

SCADA location feed + post-processing to account for data limitations & apply rules

Match SCADA feed to reference data

Quality measurement and iterative improvement
Train tracking system

RTPI System

Train locations → Predictions

Schedule

Modeling Operations

• Prediction algorithm
• Predictions before trip starts
• Route/destination

Post-process location data

• Match train movement to trip

Agency website

API / GTFS-realtime (apps)

Prediction accuracy reports

Legend

Input
RTPI System
Public Facing System
Report
Match train to a trip based on:
- Block Number
- Position
- Time of Movement

Block 72
8:52:34 A.M.
1213CZT Track
39.725, -105.1870
Raw and Processed Locations

Location Quality:

![Location Quality Chart](chart.png)
Phase 1:
Make predictions for trips that have begun

Phase 2:
Make predictions for a train’s upcoming trip
Predictions

For current trip:
Based on train’s current position, sum expected travel time segments to all successive stops on that trip

For the next trip:
Determine whether train will likely start next trip on time or late

Use that as baseline for that trip’s predictions
## Prediction Quality:

<table>
<thead>
<tr>
<th>Route</th>
<th># of Trips</th>
<th>0-3</th>
<th>3-6</th>
<th>6-12</th>
<th>12-30</th>
<th>Average</th>
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<tr>
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**Chart:**

- **Title:** Avg Prediction Accuracy
- **X-axis:** Date (06 May 2018 to 04 June)
- **Y-axis:** Avg Prediction Accuracy (50 to 100)
RTPI Quality Monitoring

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RTPI System

Train locations → Predictions

- Agency website
- API / GTFS-realtime (apps)
- Prediction accuracy reports

Legend:
- Input
- RTPI System
- Public Facing System
- Report
Redesign prediction algorithm to consume location and trip data from multiple sources

**Goals:**
- Increase granularity and accuracy of train locations and predictions
- Reduce dependence on manually configured reference data
Thank You

Questions?

daniel.bernstein@ibigroup.com
**Predictions** + **Actual Times**

**Time from Actual** = Actual Arrival/Departure Time – Prediction Display Time

**Prediction Error** = Actual Arrival/Departure Time – Predicted Arrival/Departure Time

**Prediction Accuracy** = Number of Acceptable Predictions / Number of Total Predictions

<table>
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<th>Time from Actual Bin</th>
<th>Prediction Error Thresholds</th>
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<tr>
<td>0 – 3 mins</td>
<td>-1 to +1 mins</td>
</tr>
<tr>
<td>3 – 6 mins</td>
<td>-1.5 to +2 mins</td>
</tr>
<tr>
<td>6 – 12 mins</td>
<td>-2.5 to +3.5 mins</td>
</tr>
<tr>
<td>12 – 30 mins</td>
<td>-4 to +6 mins</td>
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