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

AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

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

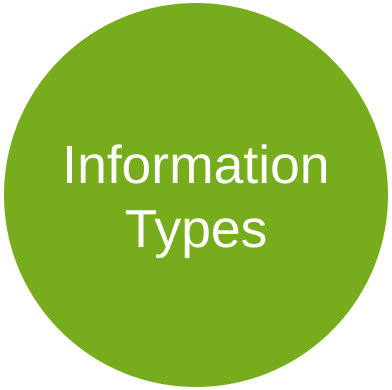
Extensive experience in Transit Technology

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



Train Locations

Arrival/Departure Predictions

Service Alerts

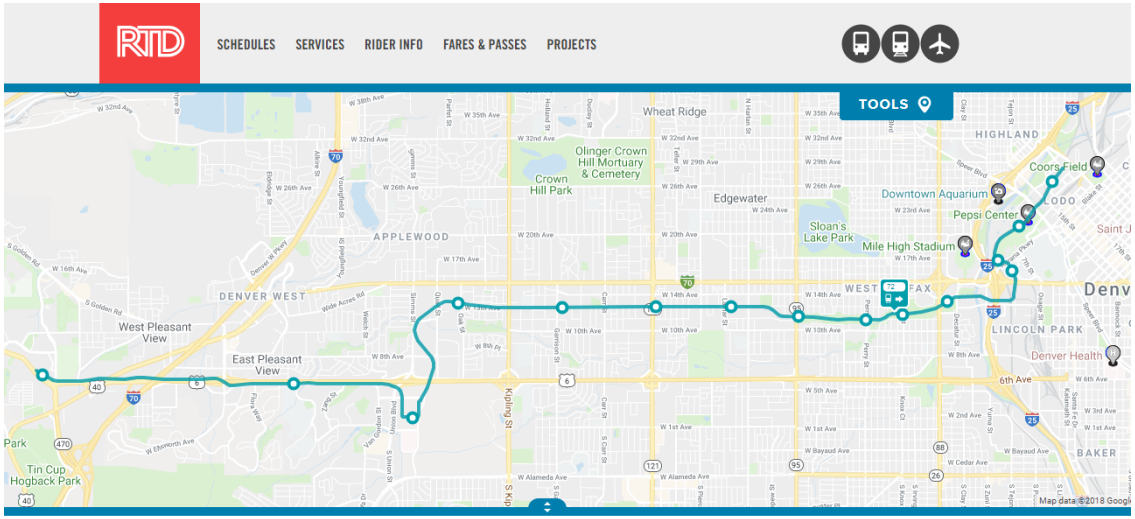
Information Types

Train Locations

Arrival/Departure Predictions

Service Alerts

Agency Website



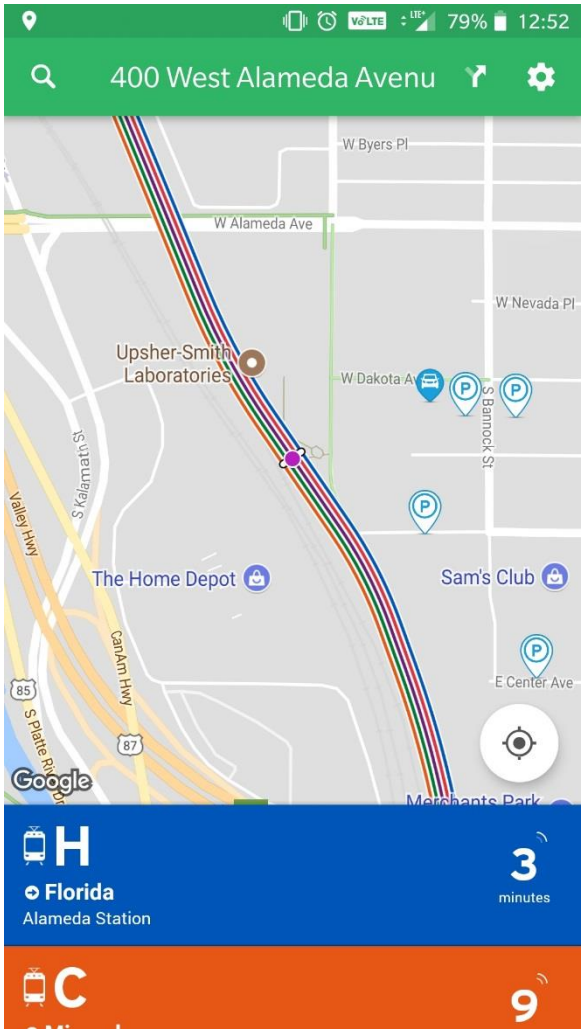
VEHICLE 72

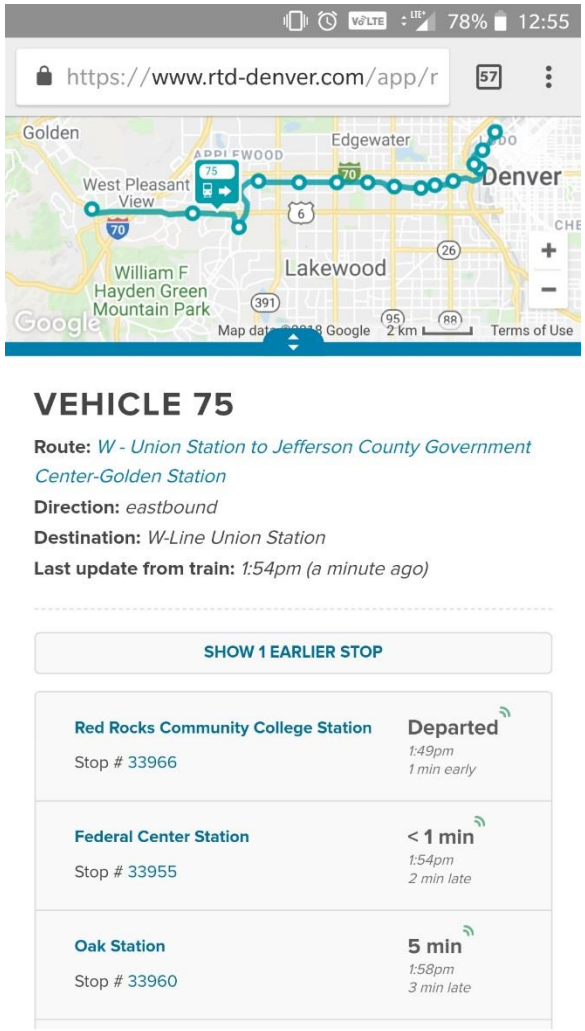
Route: *W - Union Station to Jefferson County Government Center-Golden Station*
Direction: *eastbound*
Destination: *W-Line Union Station*
Last update from train: *11:25am (a minute ago)*

SHOW 9 EARLIER STOPS

Knox Station	Stop # 33941	0 min *11:27am - 1 min early*

Apps


79% 12:52
400 West Alameda Avenu
W Byers Pl
W Alameda Ave
W Nevada Pl
Upsher-Smith Laboratories
W Dakota Ave
S Bannock St
S Kalamath St
Valley Hwy
The Home Depot
Sam's Club
E Center Ave
CanAm Hwy
S Platte River
Google
Merchants Park
H
Florida
Alameda Station
3
minutes
C
9


78% 12:55
https://www.rtd-denver.com/app/r
Golden
Edgewater
Denver
West Pleasant View
Lakewood
William F Hayden Green Mountain Park
Google
Map data ©2018 Google
2 km
Terms of Use
VEHICLE 75
Route: W - Union Station to Jefferson County Government Center-Golden Station
Direction: eastbound
Destination: W-Line Union Station
Last update from train: 1:54pm (a minute ago)
SHOW 1 EARLIER STOP
Red Rocks Community College Station
Stop # 33966
Departed
1:49pm
1 min early
Federal Center Station
Stop # 33955
< 1 min
1:54pm
2 min late
Oak Station
Stop # 33960
5 min
1:58pm
3 min late

Overview

Passengers expect RTPI

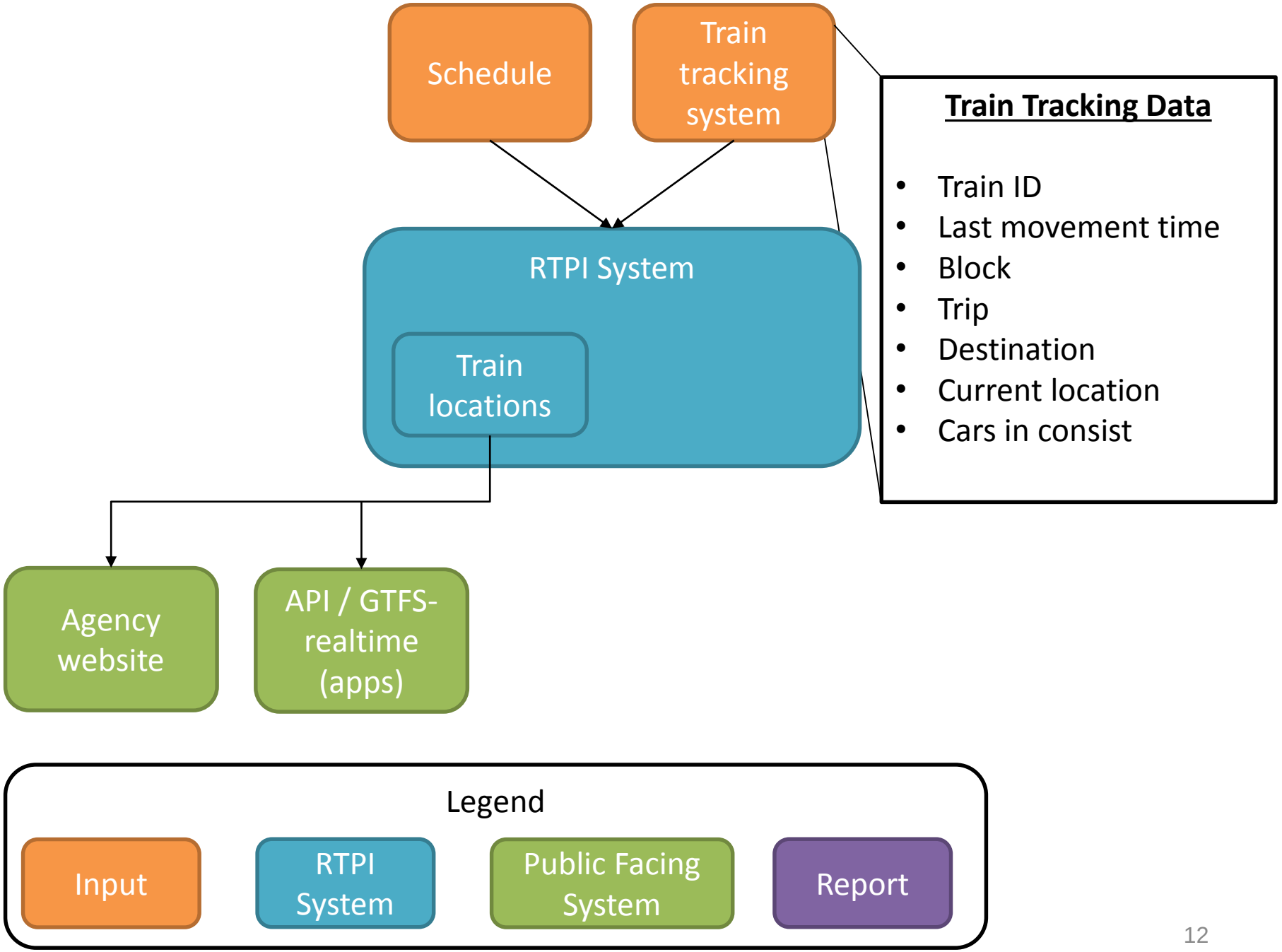
RTPI for bus is fairly standardized

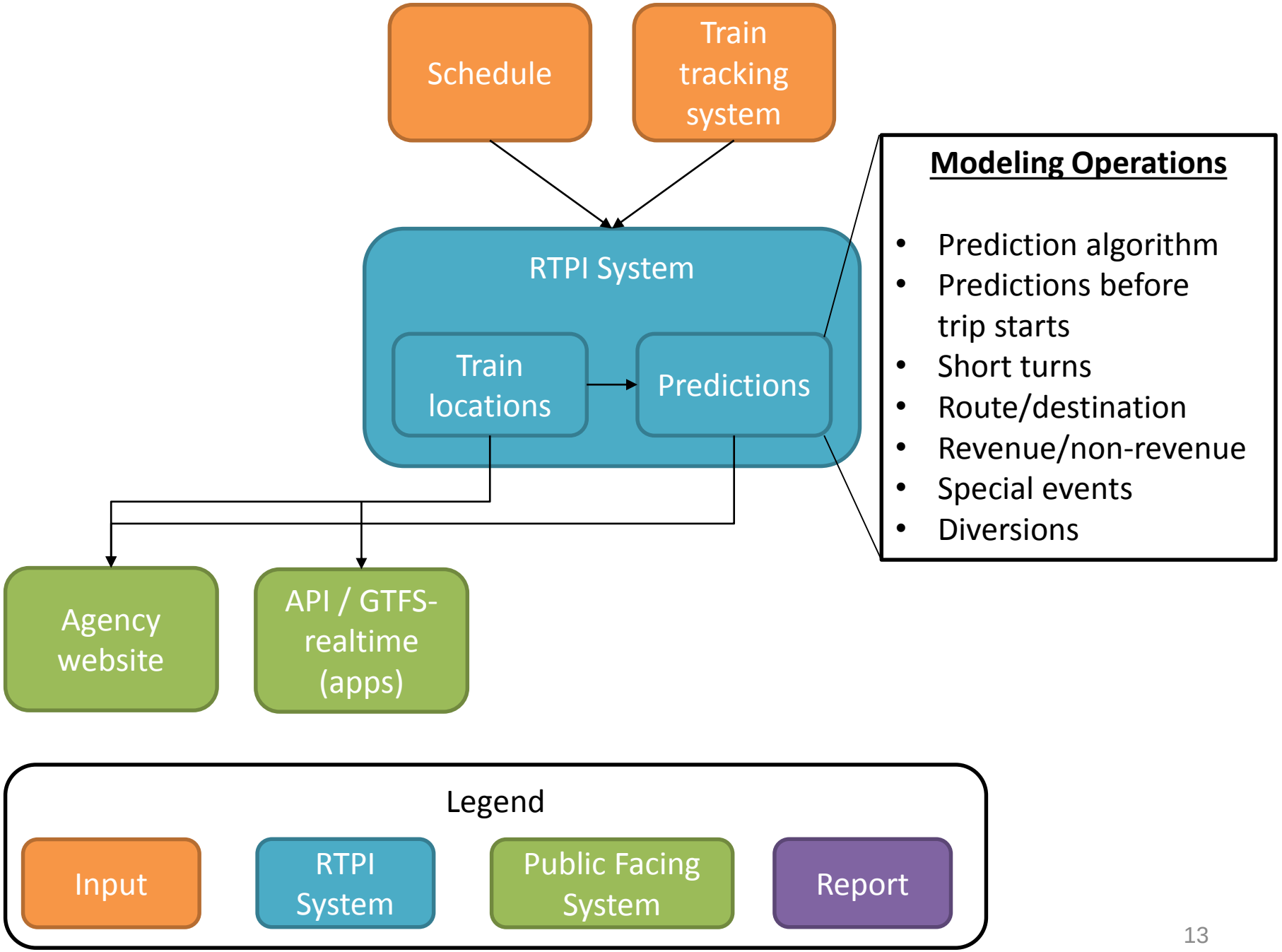
Every rail system is unique

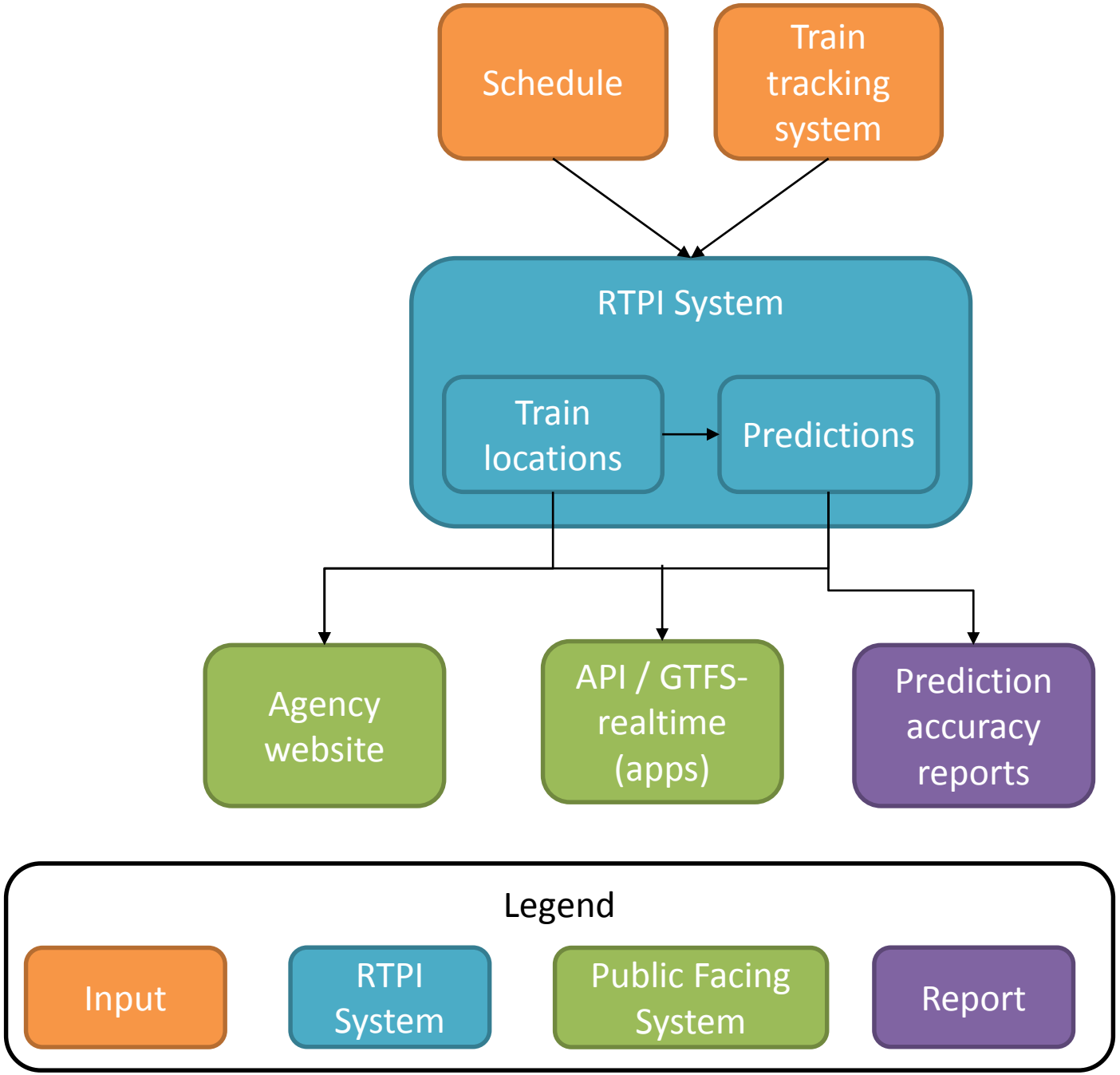
Good rail operations doesn’t equal good RTPI

RTPI for rail challenges and opportunities

RTPI for Rail System Components

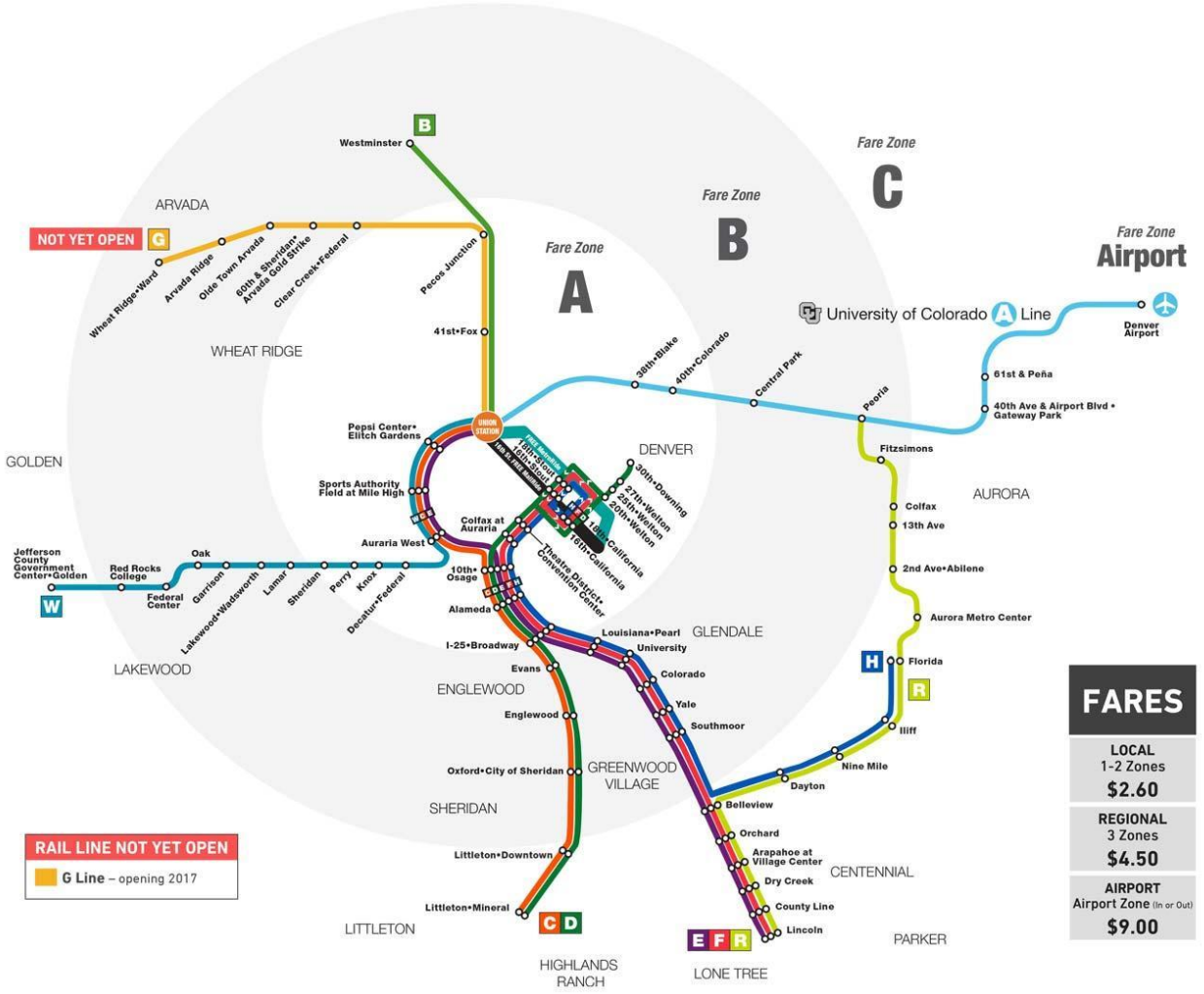

Schedule
Train tracking system
Train Tracking Data
Train ID
Last movement time
Block
Trip
Destination
Current location
Cars in consist
RTPI System
Train locations
Agency website
API / GTFS-realtime (apps)
Legend
Input
RTPI System
Public Facing System
Report


Schedule
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
Agency website
API / GTFS-realtime (apps)
Legend
Input
RTPI System
Public Facing System
Report


Schedule
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

Case Study – RTD Denver

RTD's Light Rail Network



Unique Attributes of RTD Light Rail

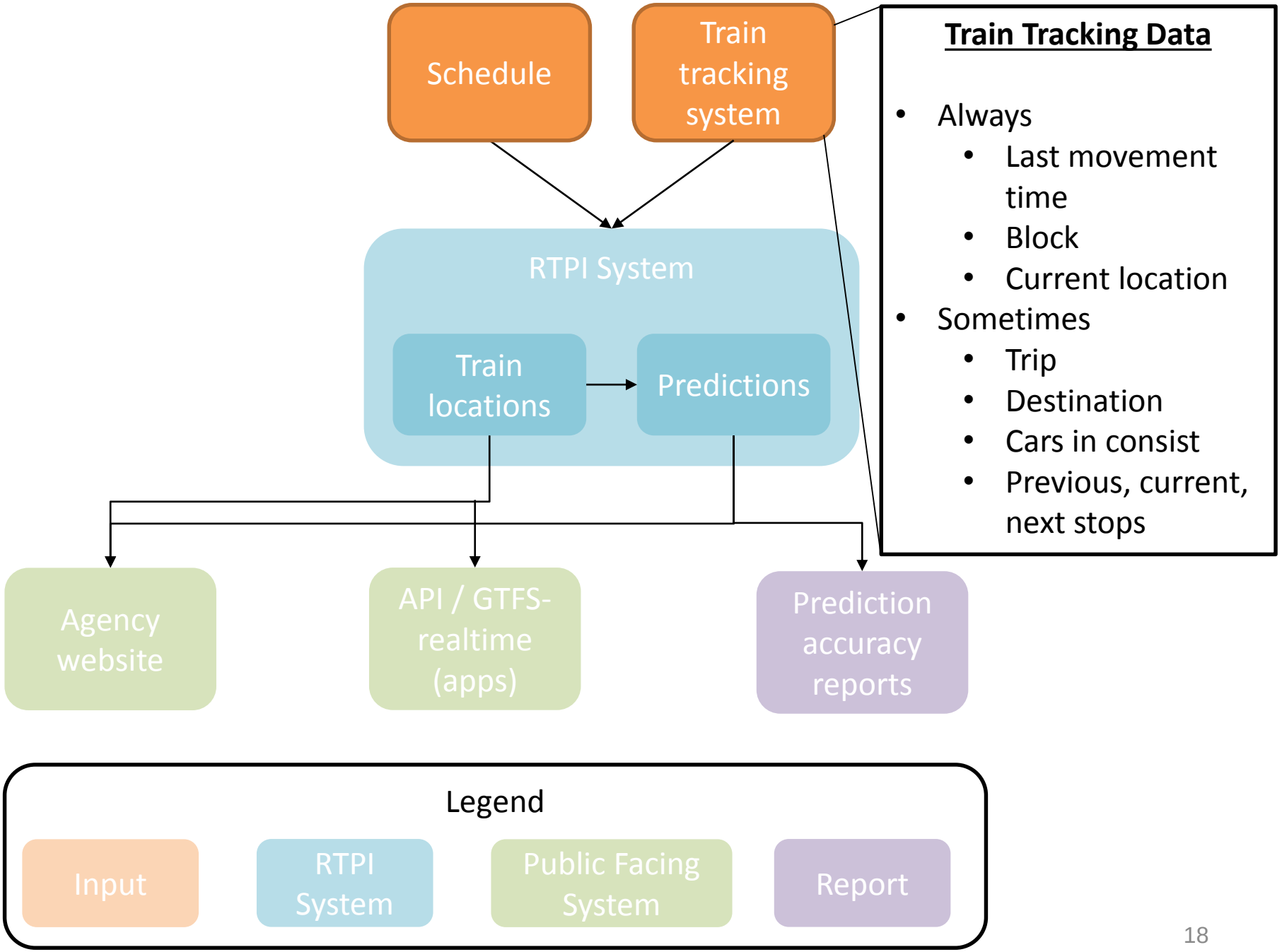
RTD Light Rail has unique attributes including:

- Shared Corridors
- On-Street Operations

Understanding operations is critical

Challenges for RTPI

System was designed in response

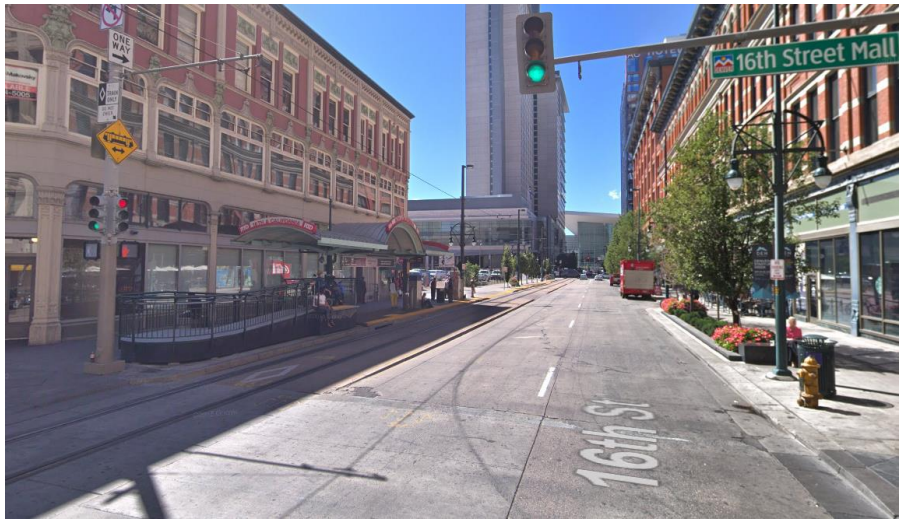

Schedule
Train tracking system
Train Tracking Data
Always
Last movement time
Block
Current location
Sometimes
Trip
Destination
Cars in consist
Previous, current, next stops
RTPI System
Train locations
Predictions
Agency website
API / GTFS-realtime (apps)
Prediction accuracy reports
Legend
Input
RTPI System
Public Facing System
Report

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

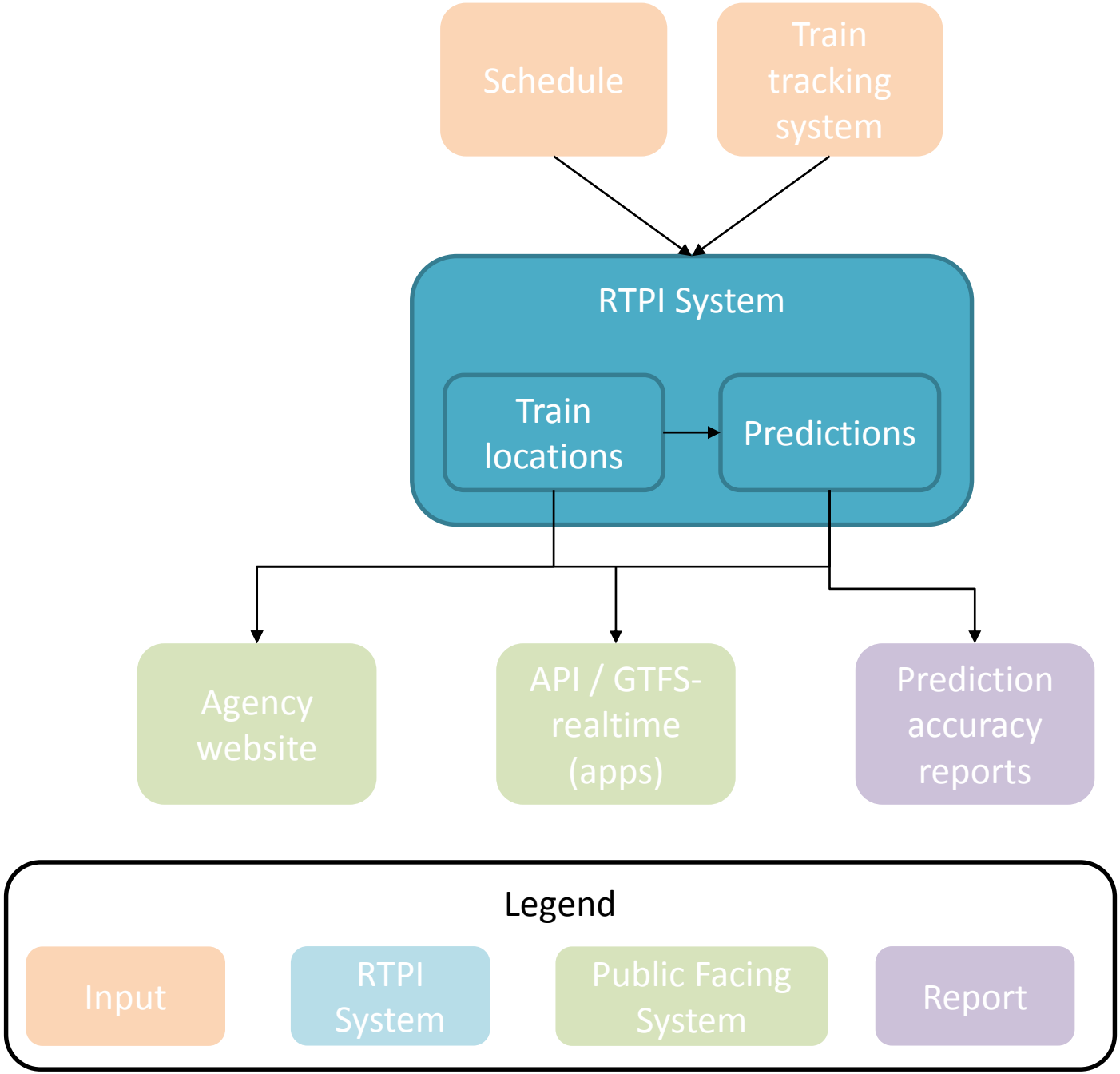


Potential Issues – Predictions

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


Schedule
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RTPI System
Train locations
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Reference Data

For each route and direction:

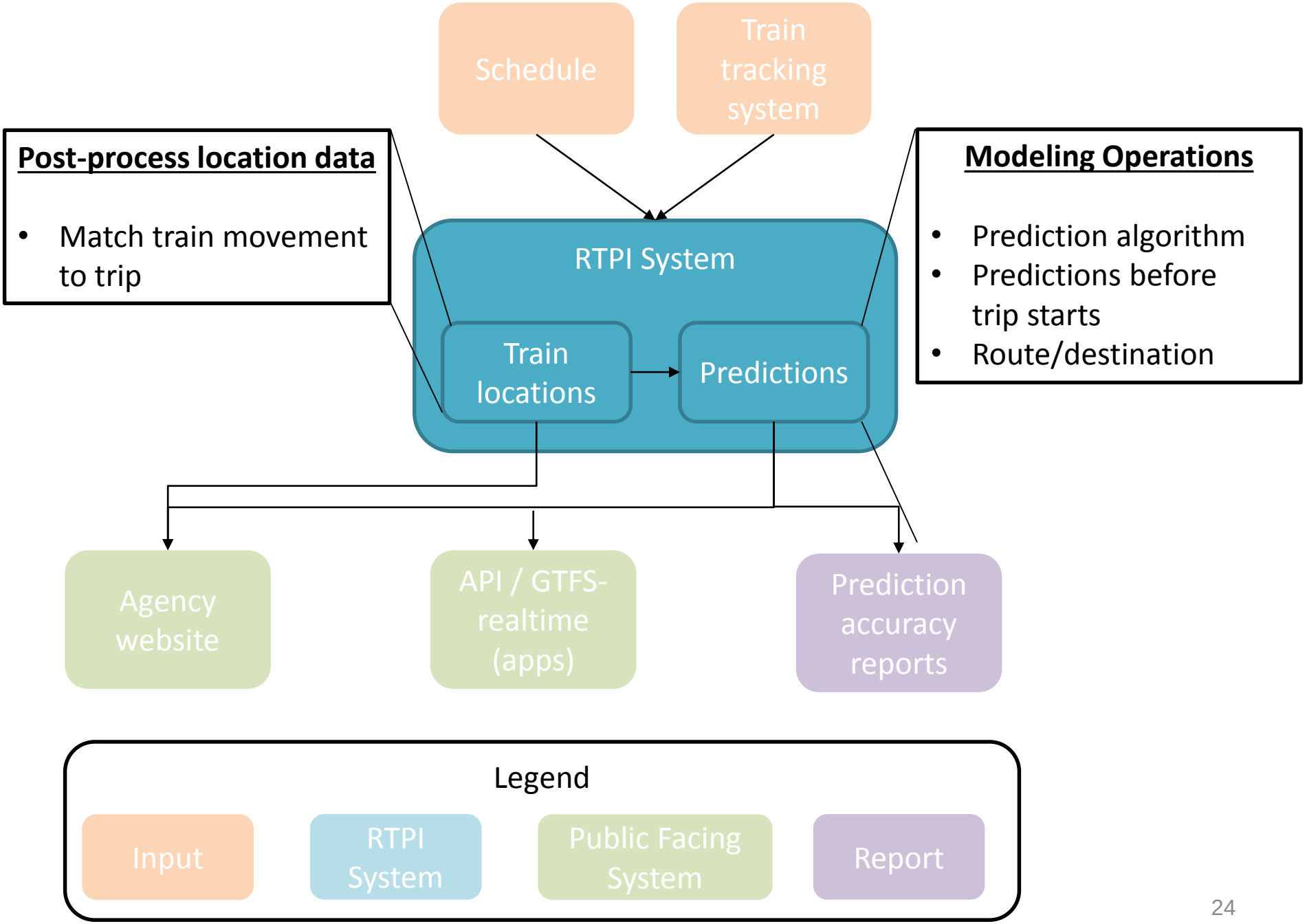
- Sequence of stops and intermediate positions
- Expected travel time between positions based on historical data

Approach

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

Match SCADA feed to reference data

Quality measurement and iterative improvement

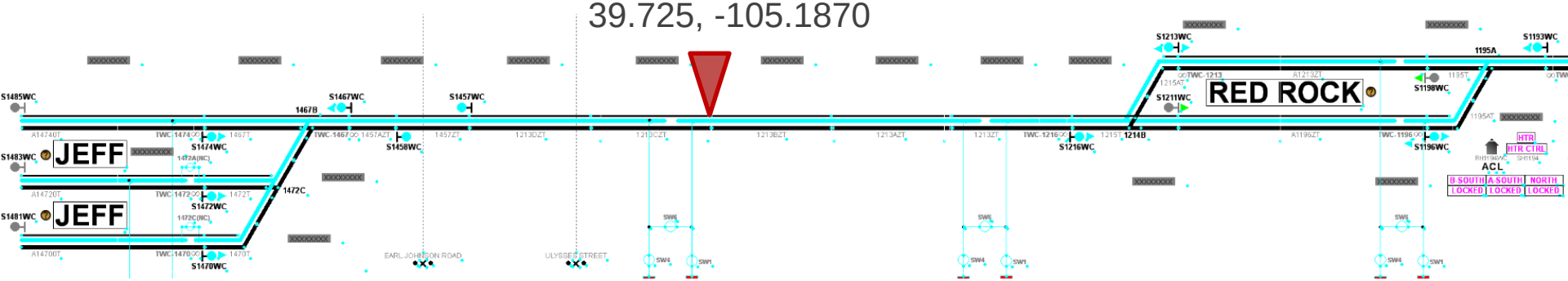

Schedule
Train tracking system
Post-process location data
• Match train movement to trip
RTPI System
Train locations
Predictions
Modeling Operations
• Prediction algorithm
• Predictions before trip starts
• Route/destination
Agency website
API / GTFS-realtime (apps)
Prediction accuracy reports
Legend
Input
RTPI System
Public Facing System
Report

Locations

Match train to a trip based on:

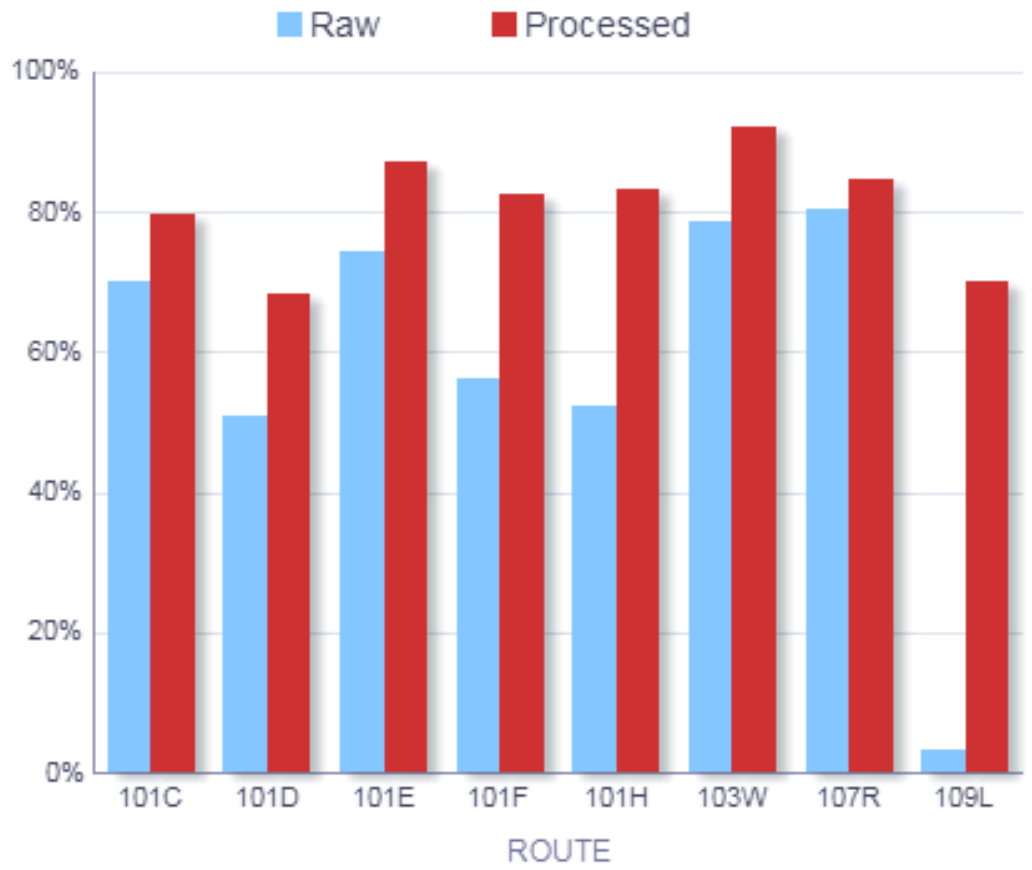
- Block Number
- Position
- Time of Movement

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



Location Quality:

Raw and Processed Locations



Phase 1:
Make predictions for trips that have begun

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

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

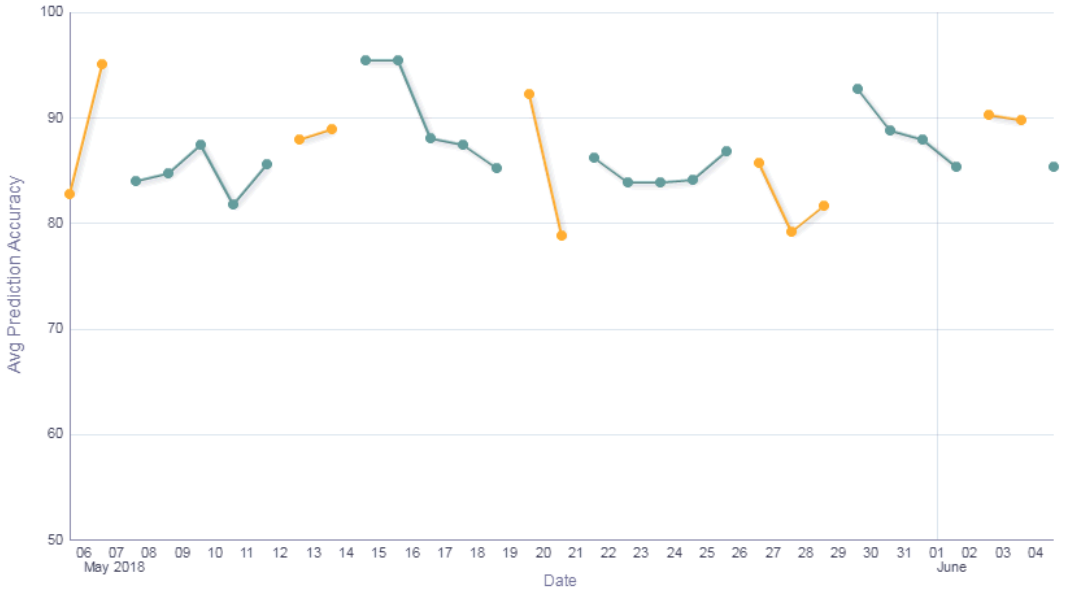
For the next trip:
Determine whether train will likely start next trip on time or late

Use that as baseline for that trip's predictions

Prediction Quality:

RTPI Quality Monitoring

Route	# of Trips	Prediction Accuracy				Average
		0-3	3-6	6-12	12-30	
101C	32	93.15%	99.04%	99.67%	99.43%	97.82%
101D	25	76.89%	71.06%	77.42%	97.52%	80.72%
101E	35	94.42%	96.91%	97.29%	99.38%	97.00%
101F	12	80.93%	82.23%	89.44%	98.90%	87.87%
101H	28	83.73%	84.17%	84.48%	93.97%	86.59%
103W	48	98.94%	99.61%	99.60%	99.89%	99.51%
107R	86	92.80%	95.41%	96.37%	98.00%	95.65%
109L	123	62.76%	77.16%	62.19%	39.72%	60.46%



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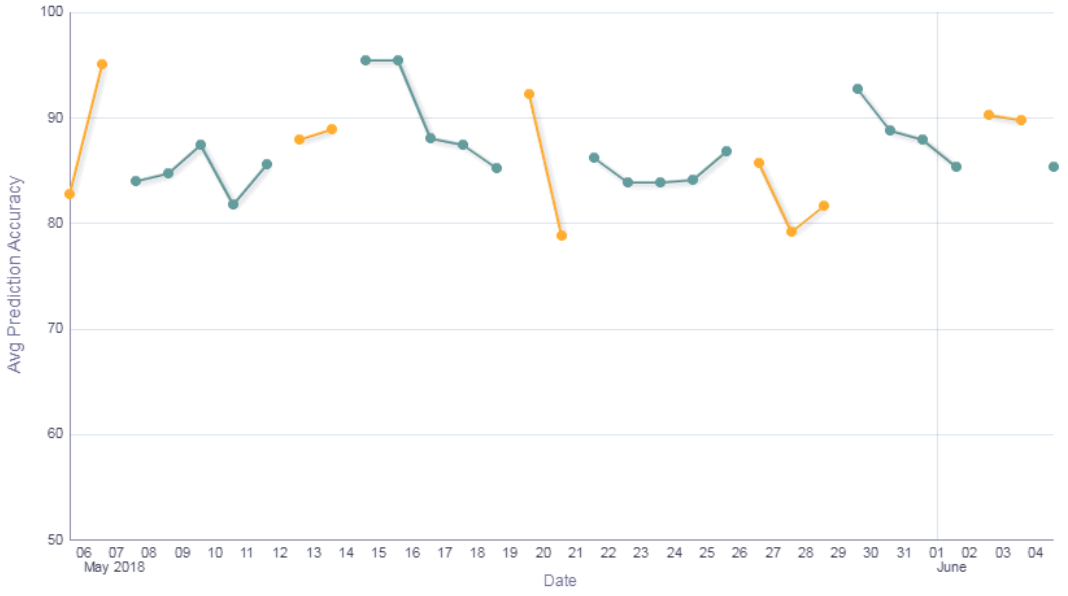

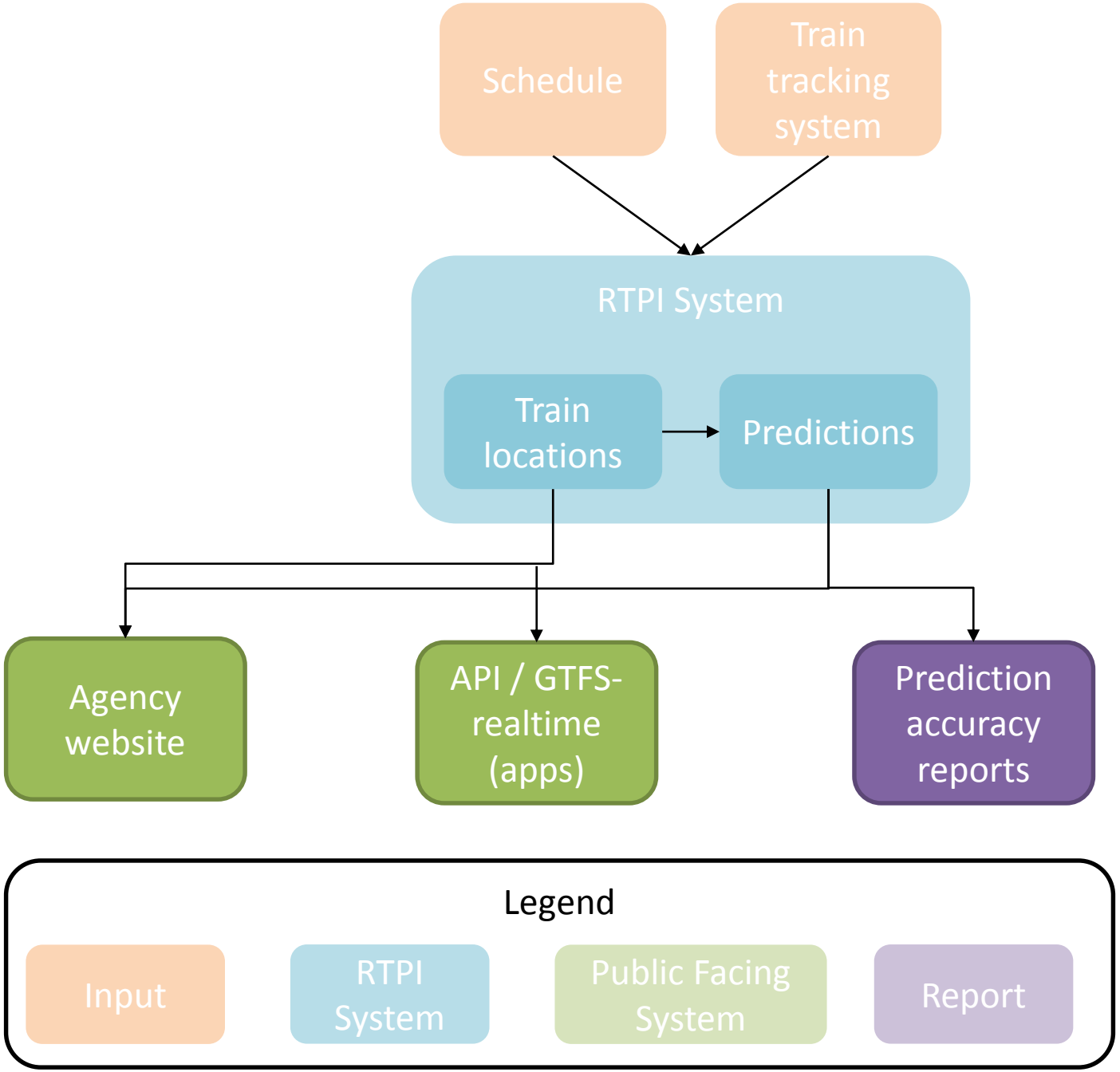
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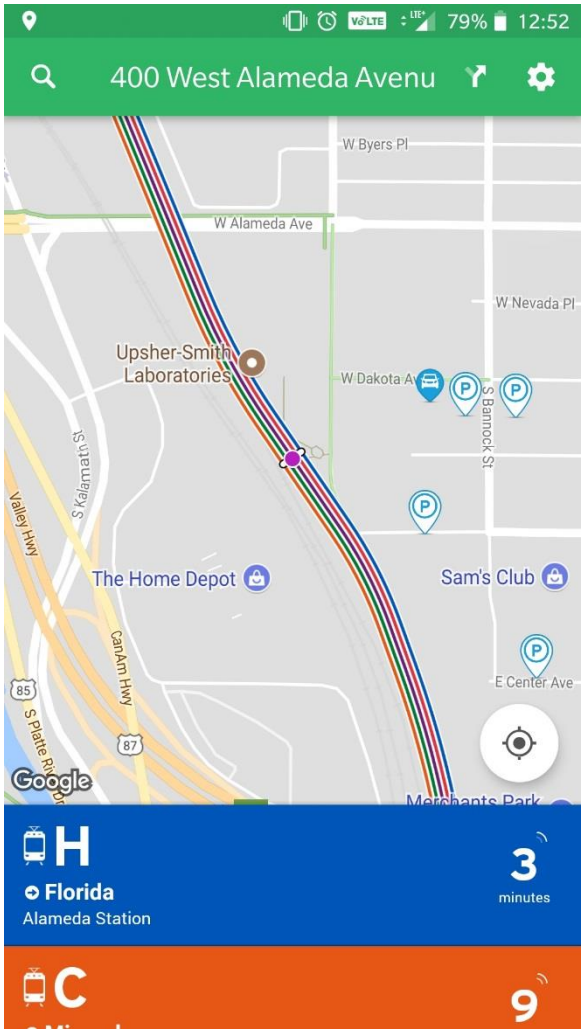
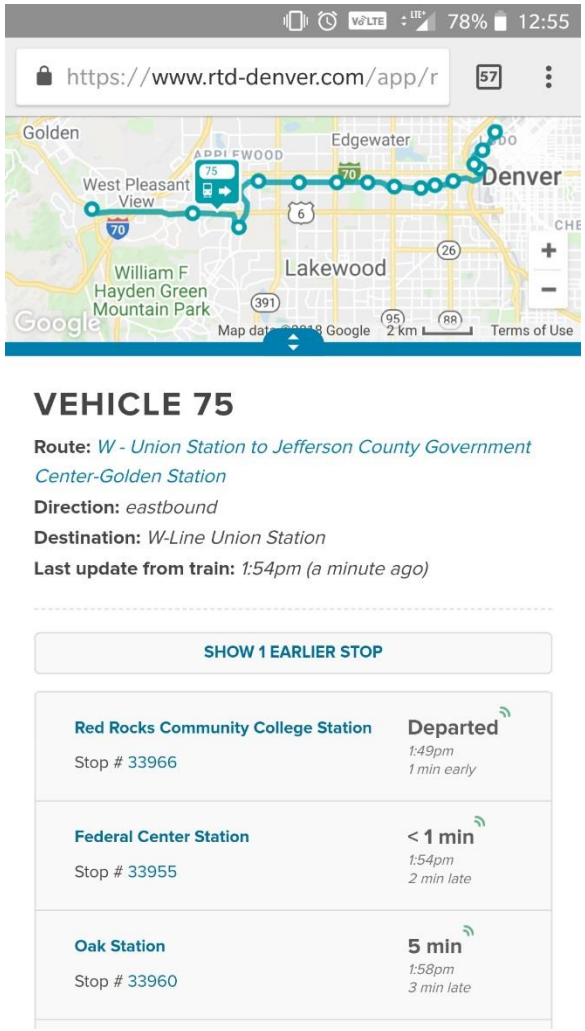
Example Outputs





Next Steps

Redesign prediction algorithm to consume location and trip data from multiple sources

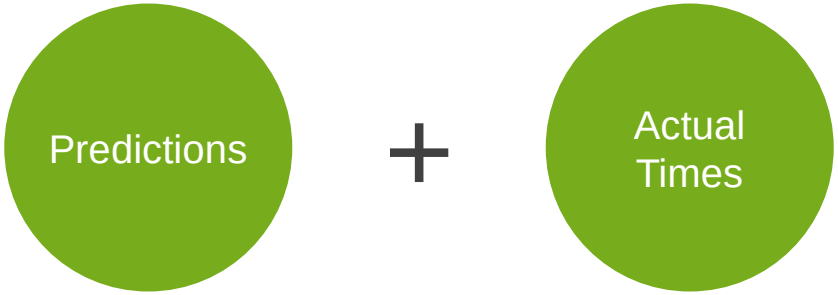
Goals:
Increase granularity and accuracy of train locations and predictions

Reduce dependence on manually configured reference data

Thank You

Questions?

daniel.bernstein@ibigroup.com

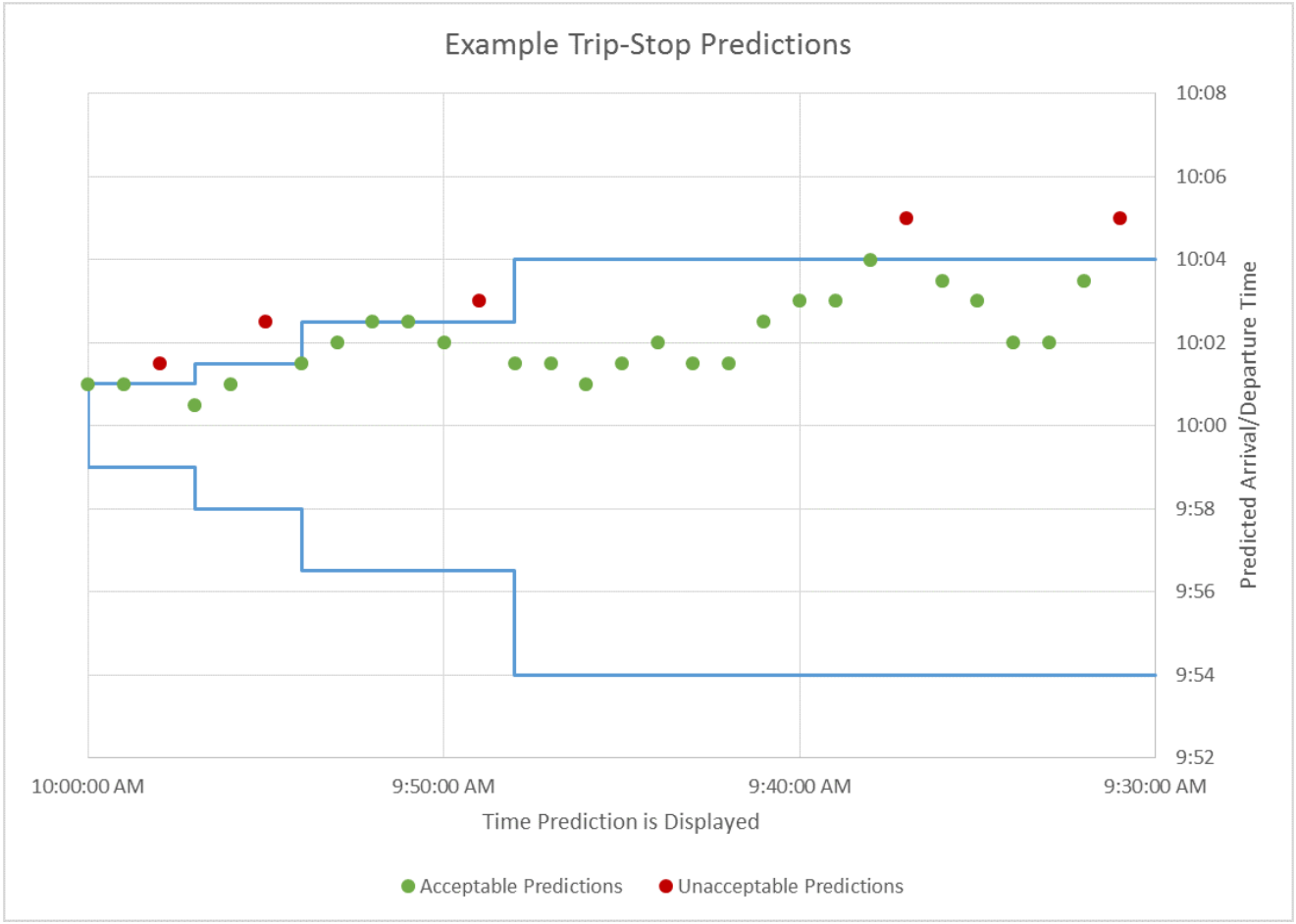


Time from Actual = Actual Arrival/Departure Time – Prediction Display Time

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

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

Time from Actual Bin	Prediction Error Thresholds
0 – 3 mins	-1 to +1 mins
3 – 6 mins	-1.5 to +2 mins
6 – 12 mins	-2.5 to +3.5 mins
12 – 30 mins	-4 to + 6 mins


Example Trip-Stop Predictions
10:08
10:06
10:04
10:02
10:00
9:58
9:56
9:54
9:52
Predicted Arrival/Departure Time
10:00:00 AM
9:50:00 AM
9:40:00 AM
9:30:00 AM
Time Prediction is Displayed
Acceptable Predictions
Unacceptable Predictions