Analyzing Public Transit Data

Eimar Boesjes
CEO, Moonshadow Mobile, Inc.
IoT: The Internet of Things
IoMT: The Internet of Moving Things

Examples:
- Buses
- Trains
- Light Rail
- Driver Mobile Apps
- Passenger Mobile Apps
How TriMet Collects Data: Real-Time and Daily

- **Sensors**
  - Time, Location, Delay
  - Acceleration, Speed
  - Breaking, Lane Changes
  - Passenger Counts
  - Engine Diagnostics

- **Gateway**
  - Some data is transmitted from the buses in real time via a radio or cellular connection

- **Computer**
  - Most of the data is stored on a computer located in the bus and uploaded once per day

Some data is transmitted from the buses in real time via a radio or cellular connection. Most of the data is stored on a computer located in the bus and uploaded once per day.
IoMT Isn’t Big Data, It’s Bigger Data

TriMet Example
- 700 buses
- 145 light rail
- 300,000 weekday trips
- 100 million trips/year
- 400,000 daily stops

One Month of Data
- 200 values per bus
- Measured every five seconds
- Stored in 30,000 daily log files
- Comprising 250 million records
- Containing 50 billion values
60 MPH = 1 mile/minute = 27 meters/second

For <1 meter movement resolution, you need 50 measurements/second

Now TriMet’s one-month bus movement database is 60 Billion Records

1 Month of TriMet Bus Data = 1TB in DB4IoT

That is for only 845 vehicles
The Solution: Make Big Data Small
## DB4IoT

### The Solution: Make Big Data Fast & Easy

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>High data ingestion rate</td>
<td>100k updates/second/server</td>
</tr>
<tr>
<td>Super efficient data storage</td>
<td>&lt;1 byte/value</td>
</tr>
<tr>
<td>High speed searches</td>
<td>200M records/cpu/second</td>
</tr>
<tr>
<td>Software as a Service</td>
<td>Requires no Hardware Purchases</td>
</tr>
<tr>
<td>Software as a Service</td>
<td>Requires no Technical Staff</td>
</tr>
<tr>
<td>Instant maps</td>
<td>Map 200M records 10x per second</td>
</tr>
<tr>
<td>Easy Integration</td>
<td>Does not replace existing systems</td>
</tr>
</tbody>
</table>

The Solution: Make Big Data Fast & Easy
Storing, Retrieving and Analyzing Data

DB₄IoT Mapped GUI

Real-Time Vehicle Data

ITS Fleet Daily Log Files

Modelling Data

Mobile App Data

Cellular & Radio

Wi-Fi

Internet

Cellular

DB₄IoT

API

DB₄IoT Mapped GUI

Dashboards

Customer Applications
Examples:

How Internet of Moving Things
Data Analytics and Visualization
Delivers Important Benefits
DB4IoT

Vehicle Speed Data: Every Dot is a Bus Recording

Data Source: TriMet
Conclusions from the Vehicle Speed Data

- Buses are slow when moving into the left lane before the bridge.
- Buses stop quickly and accelerate slowly. As a result, service stops show a "red tail".
- Traffic lights.
- Low AM peak traffic.
- Higher speed.
- Buses are slowed down when turning onto SE Grant to get into the right lane for the next service stop.

Data Source: TriMet
Comparing Time Periods

DB4IoT
Delays for One Month on Weekdays

The Graph shows delays over time.

The Map shows delays over space.

Data Source: TriMet
Comparing Speed and Delay over Time

Data Source: TriMet
Showing the service delay on a time graph and a distance graph gives detailed information about the service on a route.

TriMet Route 15 Eastbound

Data Source: TriMet
Passenger Count by Time of Day and Route Distance

TriMet Route 4
Eastbound Weekdays

Data Source: TriMet
TriMet
Route 4
Eastbound
Weekdays

Data Source: TriMet

DB4IoT

Speed by Time of Day and Route Distance
Bus Delay Versus Passenger Count

These images show how Delay increases as the Estimated Load (number of passengers) increases.

Data Source: TriMet

Routenumber 15 Eastbound by Estimated Load
DB4IoT

Passenger Boarding and Alighting

Data Source: TriMet

Routenumber 15 Eastbound Morning Peak
Cellular Connectivity over One Month

Data Source: TriMet
Cellular Connectivity: Bad Areas

Data Source: TriMet
Comparing Connectivity with Geography

Data Source: TriMet
IoMT Data is Bigger Data

Leveraging IoMT Data Provides Insights, Breakthroughs and Solutions for Building Livable Communities with Public Transit