Myriad Urban & Rural Uses of Bluetooth-Derived Travel Times

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Market for Travel Time Systems

• For metropolitan/urban environments, there is inadequate coverage and data for accurate travel times.

• Vehicle travel times are an excellent and direct measure of traffic flow.

• **Travel Time = Measure of Effectiveness**

Source: Skyline Products
Arterial T/T Estimation Issues

- Traffic signals
- Mounting or housing locations
- Smaller sample sizes
- Vehicles diverting out of study zone
- Vehicles making brief detours or stops
Current Travel Time Collection Methods

• Floating car runs
  – Temporary studies
  – Typically used for verification of other technologies

• Vehicle probe data
  – Real-time data, highly reliable on freeways
  – Limited coverage on arterials (getting better)

• Toll tags
  – Higher material and maintenance cost
  – Reliable for tollways, limited on arterials

• Radar
  – Spot speeds only, estimates travel time
  – Good traffic volume counter

• Loops
  – Excellent traffic volume counter
  – Higher maintenance cost
  – Long-time use and experience by agencies

• Magnetometer
  – Newer technology
  – Requires in-ground sensors = higher maintenance, limited life
MAC Address Matching Technology

- **Agencies want a cost-effective travel time system that delivers accurate real-time data**

- Bluetooth (or Wi-Fi) MAC address matching travel time systems provide that by being:
  - Low cost
  - Reliable
  - Accurate
  - Low maintenance
  - Low risk
  - Proven - *Many studies done around the world verifying data sets, accuracy, and value*
Cost Comparison

Reference: Texas Transportation Institute

<table>
<thead>
<tr>
<th>Technology</th>
<th>Estimated Cost (Per Mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toll Tags</td>
<td>$25,000</td>
</tr>
<tr>
<td>Dual Loops</td>
<td>$10,000</td>
</tr>
<tr>
<td>Magnetometer</td>
<td>$5,000</td>
</tr>
<tr>
<td>Private Sector</td>
<td>$0</td>
</tr>
<tr>
<td>Radar</td>
<td>$5,000</td>
</tr>
<tr>
<td>Bluetooth/Wi-Fi</td>
<td>$0</td>
</tr>
</tbody>
</table>
Bluetooth/Wi-Fi Technology

![Diagram of Bluetooth/Wi-Fi Technology](image_url)

- **Roadside Detection System A**
  - CPU Processor
  - Bluetooth radio adapter
  - Bluetooth antenna
  - Field software component

- **Roadside Detection System B**
  - CPU Processor
  - Bluetooth radio adapter
  - Bluetooth antenna
  - Field software component

- **Bluetooth Enabled Phone**

- **MAC Address Matching Software**
  - Data collection server
  - Travel time algorithm
  - Data archival

- **MAC Address**
  - MAC Address
  - Detector ID
  - Timestamp

- **A to B**
  - Travel Time: 1 Minute
  - Speed: 60 MPH
Deployment Options

- Existing Cabinets
- POE
- Portable
- AC Powered
- Solar Powered

Source: TTI
Source: Iteris
Source: Iteris
Source: DigiWest
Source: TrafficCast
Source: TTI
Host Software Considerations

• Host SW uses sophisticated algorithms and filtering methods of the MAC IDs to process matches and calculate speeds and travel times

• Hosted Model
  – Outside hosting performed by vendor
  – Recurring licensing fees
  – Data is outside control of agency
  – Additional monthly or annual fees

• Agency-owned Model
  – Software resides within agency network
  – All data is owned by agency
  – Control over algorithms/filtering choices
  – No recurring fees
## Typical Equipment Costing

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Equipment Cost</th>
<th>Maintenance Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Unit</td>
<td>$5k - $7k</td>
<td>High</td>
</tr>
<tr>
<td>AC/POE Standalone Unit</td>
<td>$4k - $5k</td>
<td>Some</td>
</tr>
<tr>
<td>Rental Unit</td>
<td>$700 - $1000 per week per field unit</td>
<td>High</td>
</tr>
<tr>
<td>In-Cabinet Unit</td>
<td>$3.5k - $4k</td>
<td>None</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Equipment</th>
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<th>Maintenance Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hosted Software Initial Integration Fees</td>
<td>$100 - $700 per month per field unit</td>
<td></td>
</tr>
<tr>
<td>Agency Owned Software</td>
<td>None if agency supplies server</td>
<td>None</td>
</tr>
</tbody>
</table>

*Note: not including any cell phone service if required – est. $60/month/unit*
Bluetooth or Wi-Fi?

• **Bluetooth**
  – Continually *scans* for devices in proximity
  – Fast “grab” of MAC address, useful at all speeds
  – Very high **re-identification** rate – 90% and up

• **Wi-Fi**
  – Continually *listens* for devices in proximity
  – Field units act as a hotspot
  – Slower “grab” of MAC address
  – Results have shown that the **re-identification** rate of Wi-Fi devices is much lower than BT (~1/10TH)
# Bluetooth or Wi-Fi?

## Bluetooth
- 3-20% of volume includes Bluetooth-enabled devices
  - Mostly in-vehicle systems
- Bluetooth is a proven data set
- Bluetooth and Wi-Fi provide virtually identical travel time patterns in free flow conditions

## Wi-Fi
- Could be as much as 10X more reads at a given field unit
  - Mostly cell phones
- More reads can provide more robust O/D data
- Only useful when the traffic has the opportunity to slow or stop
What are we going to do with all this data?

1. Congestion Mapping & 511
2. Smart Work Zones
3. Origin-Destination Information
4. Populating Dynamic Message Signs
5. Rural Applications
6. ATMS Integration
7. Performance Measurement/Operations
Congestion Mapping

- Situational awareness
VDOT IS USING BLUETOOTH DATA TO FILL IN THE GAPS THAT INRIX DATA IS NOT AVAILABLE FOR
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Smart Work Zones

• Utilizing technology to inform drivers about upcoming work zone information
• Portable CMS
• Variable Speed Limit Signs
• Phone Apps
Smart Work Zones

- IH-35 Mobility Program
  - Run by TTI
- Bluetooth Sensors
- Real-time Website Data
- Portable CMS
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Origin-Destination

- Much lower cost than ALPR
- Useful for planners and transportation engineers
- Determine traffic patterns
- O/D Matrix Generation
- Analyze preferred routes through a network

Source: Stantec
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Freeway Dynamic Message Signs (DMS)

Source: Iteris

Source: Skyline Products

Source: Iteris

Source: TransCore

Source: Google Images
Arterial DMS

Source: Skyline Products

Source: Google Images

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Innovation for better mobility
Virginia DOT Example

Innovation for better mobility
Arlington County, VA Example

Source: Iteris
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Rural Applications for Bluetooth

- Very cost effective solution for rural highways
  - Low maintenance
  - Solar powered
- Excellent capture rate, even at high speeds
- 5-10 miles spacing recommended
  - Greater spacing can be used

Source: TTI
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Innovation for better mobility

**ATMS Integration**

- Typically utilize an XML output that external programs can extract data sets from
City of Lakewood, CO Example

- Data integrated into TransSuite
  - Output of travel times on congestion map
  - Incorporate into corridor travel times for distribution
  - Mobile apps for travel time and congestion data display
  - Overlaying data on time-space diagram
Innovation for better mobility

Time-space diagram

Solid line is design speed  Dash line is actual speed from Bluetooth data
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Performance Measures

- MAP-21
- Travel Time Reliability
- Aging of timing plans
- Trigger for Adaptive signal parameter review
- Validation of re-timing efforts

Reviewing historical data for trends to perform before/after studies
Other Applications

- Intersection Delay Calculations
  - Duration Data or Passage Time
  - Analyze time that devices are moving through a particular intersection to estimate delay
  - Evaluate delay for different turning movements
Summary

• Many Operational Use Applications
• Non-Intrusive Deployments
• Low Maintenance
• High Accuracy
• Proven Technology
• Lower Cost
Questions?

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