Reporting on Travel Times Provided by State Agencies versus NPMRDS

Outline

• GTIS background
• NPMRDS background
• Comparing travel times
  • Previous research
  • Reporting tools – maps and tables
  • Results
• Next steps
• Questions
GTIS Data
Gateway Traveler Information System
(http://www.travelmidwest.org/)

Expressways and some principal arterials in:
- Illinois
- Indiana
- Iowa
- Michigan
- Minnesota
- Missouri
- Ohio
- Wisconsin

Types of Public Data:
- Incidents
- Construction
- Message Signs
- Congestion
- Travel Times
- Cameras
- Weather
- Detectors
- Special Events
Reporting on Travel Times Provided by State Agencies versus NPMRDS

GTIS Travel Time Data

GTIS receives or calculates travel time data from various systems

- Illinois – Provided by IDOT’s ATMS and various local/regional systems (e.g., Lake County, Quad Cities, Tollway) as well as some Bluetooth data for arterials
- Indiana – Calculated using provided InDOT sensor data
- Wisconsin – Provided by 511 system (XML feed) and City of Madison
- Minnesota – MnDOT’s IRIS

**Raw Sources**
- Sensors (microwave/loop)
- Bluetooth
- Purchased probe data
NPMRDS

National Performance Management Research Data Set

• Originally released in 2013 – HERE data
• Version 2.0 released in 2017 – INRIX data
• Observed travel times from vehicle-based probes
• Average travel times every 5 minutes on the NHS
• Passenger, freight, and all traffic average travel times
• Free for state DOTs, MPOs, and contractors
Massive Data Downloader

Use the Massive Data Downloader to download raw probe data from our archive for offline analysis.

1. Select roads

   - TMC segments from: NPMRDS INRIX 2018

   - **States and counties:** 6 counties in Wisconsin
   - **Directions:** All
   - **Zip codes:** Example: 20742, 20904
   - **Road Classes:** All

   - Your selected roads: 6 counties in Wisconsin (3023 TMCs)

   - [Add region]

2. Select one or more date ranges

   - 03/31/2019 - through - 03/31/2019

   - [Add another date range]

3. Select days of week

   - Sun, Mon, Tue, Wed, Thu, Fri, Sat

4. Select one or more times of day

   - 12:00 AM to 11:59 PM

   - [Add another time of day]

5. Select data sources and measures

   - [More options]
Uses for NPMRDS Travel Times

• Replace traditional travel time detection on certain routes
• Quickly interpret impacts of construction, work zones, incidents, etc.
• FHWA’s Third performance rule (PM3) calculations
  • Level of travel time reliability
  • Truck travel time reliability
  • Total peak hour excessive delay
Previous Research

Evaluating Multiple Data Sources for WisDOT Travel Times

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Wisconsin Department of Transportation  
Bureau of Traffic Operations

ITS Wisconsin Forum  
November 8, 2017
T3E Project Objectives

• Compare arterial versus freeway travel times
• Compare long term versus short term travel times (cases such as alternative routes for construction projects)
• Compare costs of acquiring and maintaining data among competing technologies
• Compare difficulty of accessing and processing data sources
• Determine other uses of travel time data
• Integrate technologies into the transportation systems management and operations (TSM&O) decision process for detection
T3E Data Quality Comparisons

- Ease of Data Access
- Latency for Real-Time Application
- Reliability of Data Stream
- Ability to Archive Data
- Durability of Equipment
- Data Availability
- Travel Time Accuracy
Major finding
All travel time technologies are reasonably accurate for most routes and there is no definitive answer across the board on which technology should be used.

Recommendation 4: Study reported travel times as compared to travel times from the technologies in this study.
This study did not look at the aggregated and processed values for travel times as reported through the XML feed and via Wisconsin 511. A future study doing this comparison would help better compare travel time accuracy between detection types.
GTIS Travel Time Accuracy Report

• Compare travel times sent by agencies connected to GTIS against travel times computed using NPMRDS database and provide monthly "accuracy comparison reports".

• Report #1 to graphically show the percent difference between the NPMRDS data and the agency data by time of day and day of week category (M-Th,F,Sa,Su).

• Report #2 to show an overall accuracy score for each agency with percentage changes from last month.
Reporting on Travel Times Provided by State Agencies versus NPMRDS

GTIS v NPMRDS Report #1
https://transportal.cee.wisc.edu/gis/webmaps/gtis

peaks less pronounced
time Lag
GTIS v NPMRDS Report #1
https://transportal.cee.wisc.edu/gis/webmaps/gtis

less data = more random

poor data = obvious improvement
GTIS v NPMRDS Report #2

Overall accuracy score calculated using **seven** component scores

- **Similarity 1**
  - Based on Normalized Root Mean Square Error (NRMSE)
  - Shows how similar the values are / error in measurements
    \[
    100 - \frac{100 \cdot \sqrt{\sum_i (N_i - G_i)}}{\mu_N} \]

- **Similarity 2**
  - Based on Mean Absolute Percentage Error (MAPE)
  - Shows how similar the values are / error in measurements
  - Deviation between data points in terms of percentage,
    effected largely by overforcasts
    \[
    100 - \frac{100 \cdot \sqrt{\sum_i \frac{(N_i - G_i)}{N_i}}}{n} \]

- **Abnormality**
  - Based on data lying outside of three standard deviations from the mean versus what would normally be expected
  - Affected by GTIS and NPMRDS evenly
  \[ \mu \pm 3 \cdot \sigma \]

*Compare to expected (0.27%)*
GTIS v NPMRDS Report #2

Overall accuracy score calculated using **seven** component scores

- **Association**
  - Based on correlation coefficient between datasets
  - Can you predict one value based on the other

\[ \frac{n \cdot \sum (N_i \cdot G_i) - \sum N_i \cdot \sum G_i}{\sqrt{n \cdot \sum N_i^2 - (\sum N_i)^2} \cdot \sqrt{n \cdot \sum G_i^2 - (\sum G_i)^2}} + 1 \]

\[ \frac{100 \cdot \sqrt{\frac{1}{n} \sum (N_i - G_i)^2}}{\sqrt{\frac{1}{n} \sum (N_i)^2} + \sqrt{\frac{1}{n} \sum (G_i)^2}} \]

- **Inequality**
  - Based on Theil statistics for the data
  - Suite of four statistics commonly used to compare travel time data
  - Measuring covariance, variance, and bias

- **Bias**
  - Based on Theil bias statistic only

\[ U = \frac{\sqrt{\frac{1}{n} \sum (N_i - G_i)^2}}{\sqrt{\frac{1}{n} \sum (N_i)^2} + \sqrt{\frac{1}{n} \sum (G_i)^2}} \]

\[ U^M = \frac{n \cdot (\bar{N}_i - \bar{G}_i)^2}{\sum (N_i - G_i)^2} \]

\[ U^S = \frac{n \cdot (\sigma_N - \sigma_G)^2}{\sum (N_i - G_i)^2} \]

\[ U^C = \frac{2 \cdot n \cdot (1 - \rho) \cdot \sigma_A \cdot \sigma_B}{\sum (N_i - G_i)^2} \]
Reporting on Travel Times Provided by State Agencies versus NPMRDS

GTIS v NPMRDS Report #2

Overall accuracy score calculated using **seven** component scores

- **Omission**
  - Based on data availability
  - Large amounts of unavailable data results in lower score

- **Overall** - Weighted average of the seven intermediate statistics

- **Other Info provided**
  - Total length of road(s)
  - Travel time mean (GTIS)
  - Travel time mean (NPMRDS)
  - Change From Last Month
    - Percent change (positive or negative)
    - from last months overall score

\[
100 \cdot (n_{\text{expected}} - n_{\text{actual}})
\]
<table>
<thead>
<tr>
<th>Agency</th>
<th>Total Length (mi)</th>
<th>Total Travel Time, GTIS (min)</th>
<th>Total Travel Time, NPMRDS (min)</th>
<th>Similarity 1 (%)</th>
<th>Similarity 2 (%)</th>
<th>Abnormality (%)</th>
<th>Association (%)</th>
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<th>Change From Last Month (%)</th>
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</table>
Reporting on Travel Times Provided by State Agencies versus NPMRDS

GTIS v NPMRDS Report #2
https://files.topslab.wisc.edu/tsmo/gtis/

Agency Table with all Routes

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<th>Route</th>
<th>Total Length (mi)</th>
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<th>Total Travel Time, NPMRDS (min)</th>
<th>Similarity 1 (%)</th>
<th>Similarity 2 (%)</th>
<th>Abnormality (%)</th>
<th>Association (%)</th>
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Back to Agency Table
# GTIS v NPMRDS Report #2

https://files.topslab.wisc.edu/tsmo/gtis/

## Route Table with all Segments by Direction

<table>
<thead>
<tr>
<th>Direction</th>
<th>Segment Start</th>
<th>Segment End</th>
<th>Total Length (mi)</th>
<th>Total Travel Time, GTIS (min)</th>
<th>Total Travel Time, NPMRDS (min)</th>
<th>Similarity 1 (%)</th>
<th>Similarity 2 (%)</th>
<th>Abnormality (%)</th>
<th>Association (%)</th>
<th>Inequality (%)</th>
<th>Bias (%)</th>
<th>Omission (%)</th>
<th>Overall (%)</th>
<th>Change From Last Month(%)</th>
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GTIS v NPMRDS – Initial Findings

• Limitations
  • Study looked at raw data from both sources, with no distinction of data quality for each travel time
  • Study looked at aggregate values, not individual values
  • Study looked at relatively long segments
  • Score does not distinguish which travel time is more/less correct

• Findings
  • Volatility increases as number of probes decrease
  • Certain segments are a great match, many are not
  • Best way to compare segments is amongst themselves from month to month
  • Comparing states/agencies based on Overall Score discouraged
Next Steps

• Focused study
  • Use a few key segments and compare individual values
  • Travel times for specific incidents and construction periods
  • Determine which data sources are used by agency and compare directly to NPMRDS to determine which works best

• Expanded study
  • Work specifically with arterials
  • Expand to other states/agencies
  • Use full probe data packages (INRIX, HERE, TomTom, etc.)
Thank You

Special thanks to:
University of Illinois at Chicago
Illinois Department of Transportation

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Department of Civil and Environmental Engineering
Wisconsin TOPS Lab
Wisconsin Automated Vehicle Proving Grounds