Monitoring Travel Times and Speeds

TM 6

Photo: Courtesy of Thomas Brennan, The College of New Jersey (formerly of Purdue University)

Description: Understanding travel times and speeds of vehicles can help to evaluate the level of service provided by a roadway and it can also detect if there are incidents. Information from monitoring travel times in real time can also feed as input into variable speed limit systems (see #TM2) or can be used to provide travel times on dynamic message signs (DMS) (see #TTI3). The information can also be used for hurricane evacuation routes. Bluetooth detection; toll tag readers; in-pavement magnetic detectors; automatic license plate readers; machine vision; connected vehicles (see #CC4); radar, microwave, and LIDAR; inductive loops; crowdsourcing (see #TTI2); and cell phone signal monitoring have all been employed to determine travel times. However, some of these technologies, like cell phone signal monitoring, may be less applicable to rural environments. Therefore, because cell phone coverage is often still sporadic or non-existent in rural areas, it will not be discussed further in this tool sheet.

Rural Transportation Critical Needs

- ☑ Crash Countermeasures
- ☐ Emergency Services
- ☑ Operations & Maintenance
- ☐ Rural Transit & Mobility
- ☑ Surface Transportation & Weather
- ☐ Tourism & Travel Information
- ☑ Traffic Management

Issues Addressed

- ☑ Congestion and Delays
- ☐ Inefficient Signal Operations
- ☐ Parking Challenges
- ☐ Vehicle Detection
- ☐ Road Closures
- ☑ Travel Time
- ☑ Speed
- ☑ Alternate Routes
- ☑ Dynamic Traffic Control/Operations
- ☑ Special Event Management
- ☑ Inefficient Use of Road Network

Strategies Achieved

- ☑ Road User
- ☐ Road
- ☑ Vehicle
- ☐ Safety Culture
- ☑ Engineering
- ☐ Emergency Response
- ☐ Enforcement
- ☐ Education

Applicability	Partnerships	Key Components
•Information about travel times and speeds can feed into variable speed limit systems and notify traffic operation/management centers about weather or crash events. This information can be used to notify the public, potentially reducing secondary crashes. Because there are options to collect data passively (e.g. Bluetooth), obtaining data can be done relatively inexpensively.	•Applications benefit from collaboration among numerous agencies, which may include: •Departments of transportation (local, state, federal) •Construction contractors •Federal land management agencies	•Device readers (i.e., Bluetooth readers, toll tag reader) •Dynamic message sign •Data processing tools (e.g. MS Access)

Examples of Implementation

- **Anonymous Wireless Address Matching; College Station, Texas**

Research is currently on-going to test the feasibility of using anonymous wireless address matching to determine travel times in this small city.

- **Real-Time Travel Times During Construction, Minnesota Department of Transportation (MnDOT)**

MnDOT made use of real-time travel times during construction on seventy miles of rural interstate I-35. Overall, public response to the system was positive and MnDOT observed that the system provided a high degree of accuracy during free-flow conditions, but that inaccuracies occurred during congested conditions. In future deployments, additional signs may be needed.

- **Sidefire Microwave Detectors in Wisconsin**

Wisconsin collects travel time data using sidefire microwave detectors on the I-90/I-94 split near Tomah, WI; the I-94 corridor between Madison and Milwaukee; and part of the US-41 corridor between Milwaukee and Green Bay.

- **Hurricane Evaluation Route, Texas Department of Transportation (TXDOT)**

I-45 from Houston to Dallas, Texas, spans 230 miles and has been deemed a hurricane evacuation route. TXDOT deployed Bluetooth technology (replacing toll tag readers) to gather data to determine if contraflow is needed based on traffic conditions.

- **State Route 520 in Orange County, Florida**

Travel time data was collected from toll tag transponders on State Route 520 in Orange County, Florida and displayed on a dynamic message system.

- **Snoqualmie Pass, Washington State Department of Transportation (WSDOT)**

During peak season, congestion and closures (due to avalanches and crashes) contribute to rapidly changing travel times on Snoqualmie Pass in Washington State. Therefore, WSDOT recently installed 30 radar detectors over 74 miles (replacing their third-party data provider).

- **Real Time Modification of Variable Speed Limits, Maine Department of Transportation**

The Maine DOT used real-time traveler information to modify variable speed limit signs. Seventy-five signs covering 260 miles from Portland, Maine to Houlton, Maine were deployed. The information was also fed into their integrated traveler information system.

- **Automatic License Plate Reader, Arizona Department of Transportation (AZDOT)**

The Arizona DOT deployed an automatic license plate reader system to determine if the construction project contractor maintained the desired travel time thresholds. The system achieved a sixty percent recognition rate (could detect the license plate) and an eleven percent matching rate.

Implementation Considerations (General)

- In rural areas, alternative routes may be a considerable distance away, impacting the configuration of a travel time monitoring system.
- Third party data are easily available.
- Providing oversight staff with training on current technologies can assist with developing more robust bid documents.
- A study found that two roadside detectors (one on each side of the roadway) were more effective than only one in a median[1].
- For an automatic license plate reader, consider whether your state requires front license plates.
- Bluetooth detectors
  - Recommended to be placed 0.5 to 1.0 miles apart to obtain a 5 to 10 percent match rate (necessary to estimate travel times).
  - Function better when elevated[1].
  - The inquiry window should be short enough so that the detection time is not the same as time capture (Note: Those capable of asynchronous input/output do not have this problem.)
  - Unintended detections should be minimized by using an algorithm.
- In-pavement magnetic detectors need five sensors per monitored lane, a communication link, and may need repeaters to extend the wireless range.

Implementation Considerations (Pro)

- Systems enable more data to be collected on travel time as compared to probe vehicles.
- Systems allow for data collection in any weather conditions
- Units can collect bi-directional data.
- Units can be installed in roadside cabinets or be battery powered
- Bluetooth detectors
  - Non-intrusive and allow drivers to remain anonymous.
  - Installation does not require lane closures.
- In-pavement magnetic detectors
  - Detection rate is 100% (although missed detections and double-detections are possible); due to the limited traffic that may exist in some rural areas, this may make this technology particularly appealing.
  - Reported to have little or no maintenance requirements.
  - One device can be installed in 15 minutes and does not require calibration.

Implementation Considerations (Con)

- The public has concerns with “big brother” surveillance.
- Rural roadways can serve as interurban thoroughfares or may have very low traffic volumes, which may prove challenging when designing rural travel time collection.
- Limited traffic volumes can mean limited data availability to generate travel times.
- Toll tag readers have reported high failure rates[3].
- Bluetooth detectors can result in the need to process and filter a lot of data.
- Radar, microwave, and LIDAR have limited capabilities for spot speed measurements.
- Inductive loops are not “ideally suited” to obtain travel time information, have invasive installation, and high maintenance costs.
- In-pavement magentic detectors are not recommended for pilot projects due to installation requirements, may not detect motorcycles unless they travel directly over it, and only have a 10-year battery life.
- Automatic license plate readers typically need visible or infrared illumination to collect data in low-light/night and have high data bandwidth requirements for video/camera images.
- Federal agencies have been sued for tracking individuals with automatic license plate readers when the agency does not have a warrant.

Opportunities for Future Expansion

- In the future, connected vehicles will provide a recommended route based on the destination and estimated travel time (could be based on spot speed measurements over time as compared with determining travel times based on time over which a known distance is covered).

Useful Tip

Real-time travel time information collected from Bluetooth data can be displayed on dynamic message signs.

Additional Resources

- *Rural Data Collection Technology,* found here: https://ops.fhwa.dot.gov/publications/fhwahop13029/fhwahop13029.pdf
- *Travel Time on Arterials and Rural Highways: State-of-the-Practice Synthesis on Rural Data Collection Technology*, found here: https://rosap.ntl.bts.gov/view/dot/26389
- *Application of Travel Time Information for Traffic Management*, found here: http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=2994&context=jtrp
- *Bluetooth Traffic Detectors for Use as Permanently Installed Travel Time instruments*, found here: http://roads.maryland.gov/OPR_Research/MD-12-SP909B4D-Bluetooth-Traffic-Detectors_Report.pdf
- *Using New Technologies for Travel Speed and O/D Data*, found here: https://www.fhwa.dot.gov/planning/tmip/community/webinars/summaries/20100701/index.cfm

Cost Range

(Cost/financial information, where noted, is based on 2016 dollars (unless otherwise specified). Cost/financial information is estimated, and will vary based on size and scope of project, number of units, etc. In general, capital costs include initial purchase costs of hardware, software, and other required equipment. Maintenance and operations costs include staff time to operate, monitor and maintain systems; data collection; system upgrades; evaluation; etc.)

Capital Costs: The total capital costs for this tool range from low (Less than $50,000) to higher (above $250,000). In-pavement magnetic detectors, inductive loops, crowdsourcing, and cell phone signal monitoring were identified as low cost alternatives[1]. Toll tag readers, automatic license plate readers, radar, microwave, and LIDAR were identified as having medium costs[1]. Machine vision and connected vehicle technology were identified as high cost technologies.[1] Bluetooth detection costs were reported to range from $1,030 to $8,420 per location[1]. In Arizona, it cost $96,000 to purchase seven Bluetooth detectors and integrate them iwith dynamic message signs. In Sarasota and Manatee Counties in Florida, Bluetooth detectors for travel time cost $962,111. Toll reader installation ranges from $15,500 to $129,000, depending on the number of lanes. In Arizona, automatic license plate readers cost about $24,700 per camera including installation and supporting hardware. In Texas, a four-lane installation (sensor in each lane) cost $25,800. Machine vision is reported to range in cost from $16,500 to $18,550 with an 8 to 10-year life span. Microwave sensors in North Carolina reportedly cost $50,070 per mile.

Operations Costs: The operations and maintenance costs for this tool are anticipated as low (Less than $50,000). Equipment maintenance was reported as a maintenance and operation cost for Bluetooth readers. Annual operating cost for toll readers was reported as $4,100 to $6,200[1].

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