# Assessing Segment- and Corridor-Based Travel-Time Reliability on Urban Freeways

tech transfer summary

September 2016

**RESEARCH PROJECT TITLE**

Assessing Segment- and Corridor-Based Travel-Time Reliability on Urban Freeways

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U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology (USDOT/OST-R)


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The Midwest Transportation Center (MTC) is a regional University Transportation Center (UTC). Iowa State University, through its Institute for Transportation (InTrans), is the MTC lead institution.

MTC's research focus area is State of Good Repair, a key program under the 2012 federal transportation bill, the Moving Ahead for Progress in the 21st Century Act (MAP-21). MTC research focuses on data-driven performance measures of transportation infrastructure, traffic safety, and project construction.





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**Precisely predicting travel time and travel-time reliability on increasingly congested urban freeways is critical for evaluating traffic conditions in real-time and developing traffic management systems.**


## Problem Statement

For travelers, travel time and travel-time reliability are more intuitive measures of highway service quality than the levels of service defined in the Transportation Research Board's 2010 *Highway Capacity Manual*. Highly variable travel times make personal travel difficult and interfere with just-in-time logistics services.

## Background

Travel time and travel-time reliability have been used as performance measures to evaluate traffic system conditions and develop advanced traveler information and traffic management systems.

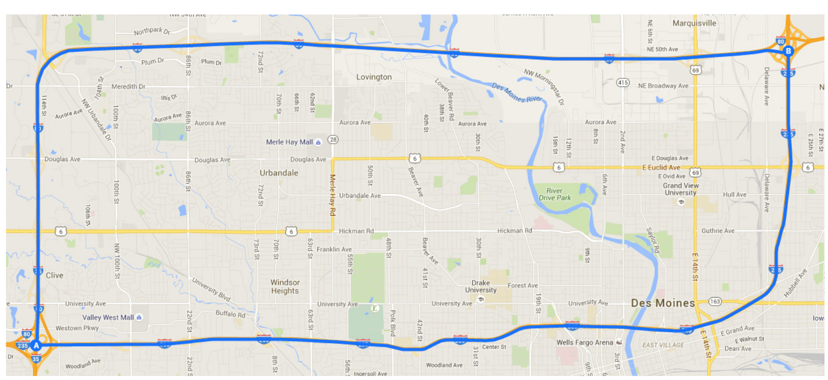
## Objectives

- Quantify segment- and corridor-based travel-time reliability measures on urban freeways using probe vehicle and radar sensor data gathered in the Des Moines, Iowa metropolitan area
- Predict corridor-level travel-time reliability on urban freeways by analyzing probe vehicle data and weather data to develop a corridor-level travel-time reliability prediction framework

## Research Methodology

### Data

To quantify travel time and travel-time reliability at the segment and corridor levels, two independent data sources were used: probe vehicle data and radar sensor data.




Map data ©2015 Google

*I-80/35 and I-235 freeway network used to develop method for predicting corridor-level travel-time reliability*

Probe vehicle travel-time data were used to verify the accuracy of estimated travel times and to develop the corridor-level travel-time reliability prediction framework. Real-time traffic data collected from in-vehicle transponders and cell phones were provided by INRIX. Time-stamped, segment-based data including speeds, travel times, and free-flow speeds were obtained at 1-minute aggregation intervals. Real-time travel-time data were used in this study.

Traffic speed and volume data collected by Wavetronix roadside radar sensors were used to estimate travel time and travel-time distribution. These sensors have been placed throughout the Des Moines metropolitan area by the Iowa Department of Transportation (DOT). The researchers aggregated data obtained through an online data portal into 1-minute data for consistency with the INRIX travel-time data.

The researchers also collected weather and road-surface condition data from the Des Moines metropolitan area to predict travel time and travel-time reliability.

### Methodology

The research team developed a travel-time estimation model that considers spatially correlated traffic conditions. They estimated segment- and corridor-level travel-time distributions using probe vehicle data and radar sensor data, and compared the estimates from each dataset. The researchers used maximum likelihood estimation to select the best fitting travel-time distribution, with lognormal found to be the best fit among the Weibull, gamma, normal, and lognormal distributions. The researchers then calculated corridor-level travel-time reliability measures from the travel-time distributions.

The research team developed this framework for predicting corridor-level travel-time reliability based on real-time traffic conditions:

- Travel-time observations are classified based on weather conditions using hierarchical cluster analysis
- Segment travel times are predicted using an autoregressive integrated moving average (ARIMA) model
- Travel-time distribution is estimated based on the predicted travel time to derive travel-time reliability measures, such as 95th percentile travel time, and a buffer index
- Segment travel-time distributions are synthesized to corridor travel-time distributions

The team tested the performance of the travel-time distribution estimation method, the method for synthesizing segment travel time to corridor travel time, and the travel-time reliability framework on a freeway network in Des Moines using probe vehicle data as the ground truth. Moreover, they ran a Vissim simulation using Iowa-based calibration factors to compare simulated corridor-level travel-time distribution to travel-time distribution based on INRIX data.

## Key Findings

- When compared to INRIX probe vehicle data, the proposed travel-time estimation model captures the patterns of travel time and travel-time distribution well
- The proposed synthesizing method for predicting corridor-level travel-time reliability is able to adequately predict the short-term corridor-level travel-time distributions
- Inconsistencies or gaps in the INRIX and radar sensor data can randomly cause the travel-time estimation model to overestimate or underestimate travel-time reliability
- Travel-time reliability measures that can indicate uncertainty in corridor travel time for corresponding time intervals can be derived from travel-time distributions
- The Vissim-simulated travel-time distribution was found to be similar to that of the INRIX probe data

## Recommendations for Future Research

The impacts of lane-changing behavior and the temporal correlation of this behavior to travel time should be incorporated into the model for estimating corridor-level travel time and travel-time distribution. The distinct car-following behaviors of passenger cars and heavy vehicles should also be considered in the model.

Additionally, the short-term travel-time reliability prediction framework can be further developed. First, the proposed travel-time distribution estimation method can be extended to estimate the arterial travel-time distribution. Second, the synthesizing method can be extended to other distributions, such as lognormal and gamma. Third, the proposed method for estimating travel-time distribution can be extended to estimate travel-time distribution from limited probe samples.

## Implementation Readiness and Benefits

The precise prediction of travel time and travel-time reliability as performance measures can help travelers and shippers balance mean travel time and travel-time reliability to decide individual departure times and route choices before a trip and navigate optimal routes during a trip.

The proposed travel-time reliability prediction framework provides a systematic way to estimate real-time and near-future corridor travel-time reliability by considering weather impact among the other factors. The predicted travel-time distributions are intended to help traffic management practice and the traveling public by providing valuable information about short-term traffic conditions and travel-time variability.