Traffic Engineering
Research Centre

Estimate Freeway Travel Time Reliability

Mar. 8th 2018

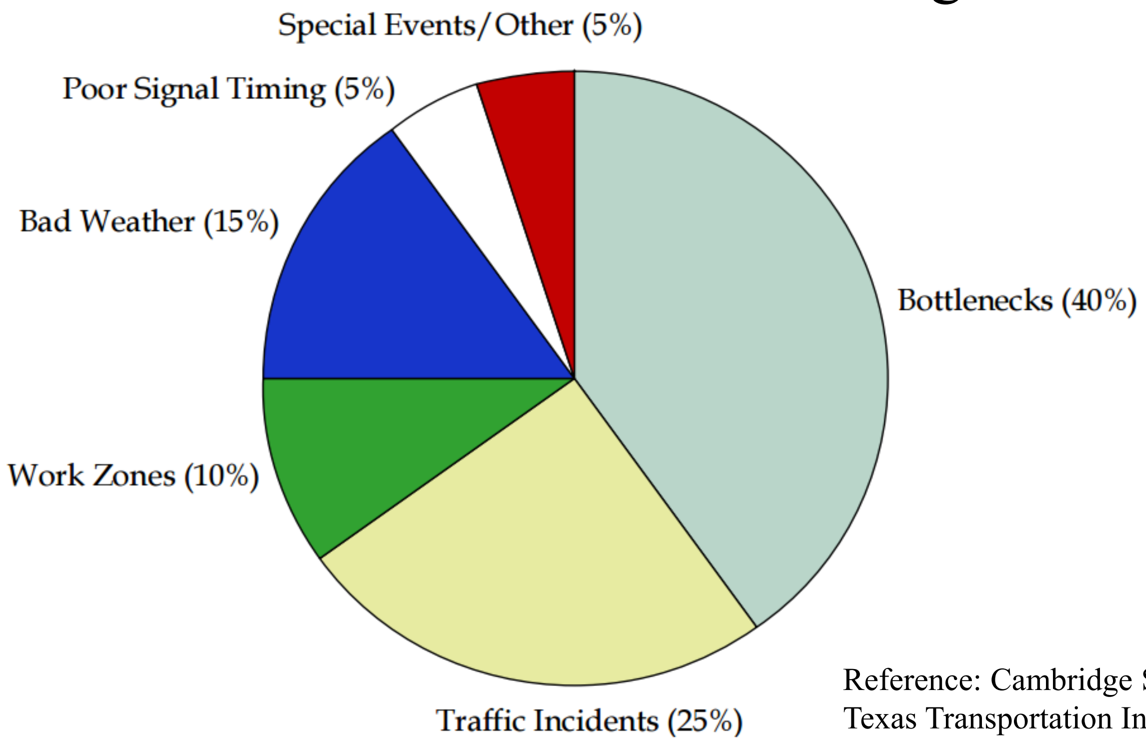
Chaoru Lu
Traffic Engineering Research Centre
Department of Civil and Transport Engineering, NTNU
E-mail: chaoru.lu@ntnu.no

OUTLINE

- Introduction
- Research Question 1
- Research Question 2
- Conclusions

INTRODUCTION

- Travel time and its reliability are intuitive system performance measures for freeway traffic operations.
- Travel times are the results of the traffic congestions.



Reference: Cambridge Systematics and Texas Transportation Institute, 2005

QUESTIONS

1. How to precisely estimate travel time and its reliability?

2. How to consider stochastic nature of driver behavior into the travel time reliability analysis?

Q1: ESTIMATING FREEWAY TRAVEL TIME AND ITS RELIABILITY

Introduction

- Probe vehicles and Automatic Vehicle Identification (AVI) are usually expensive or require high rate of public participation (Turner, 1996)

- Most of the metropolitan areas in United States have radar sensors/loop detectors installed on their freeway systems

Methodology

Travel Time Calculation:

1. Probe Vehicle Travel Time

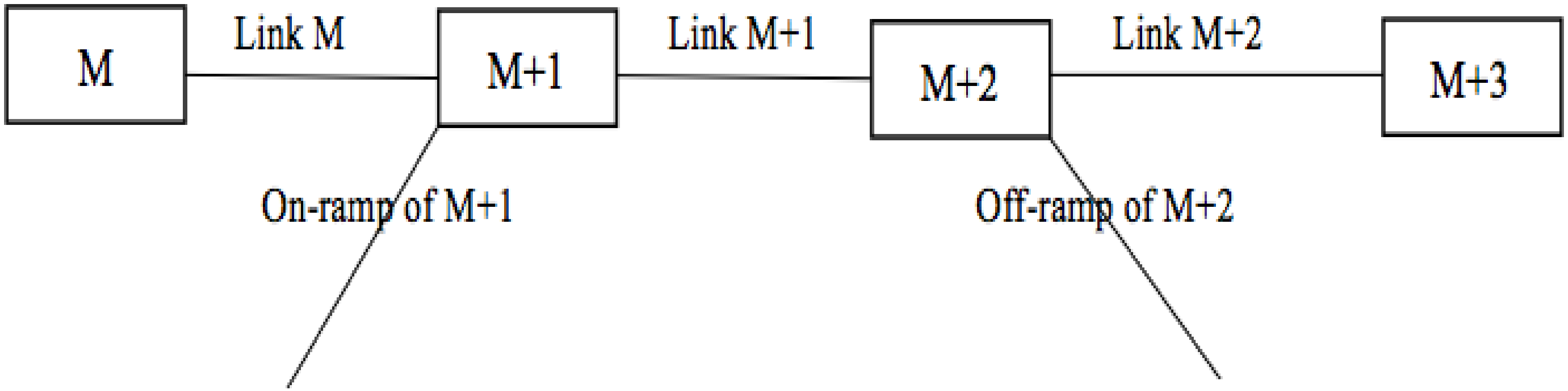
- Temporally stitched algorithm -------Simulate probe vehicles traveling along the corridor. (Chase et al., 2012)

2. Estimated Travel Time Based on Roadway Sensor Data

- Potential bottlenecks------ On-ramps and off-ramps
- Side-fired radar-based sensor
  1. speed
  2. ramp and mainline flow

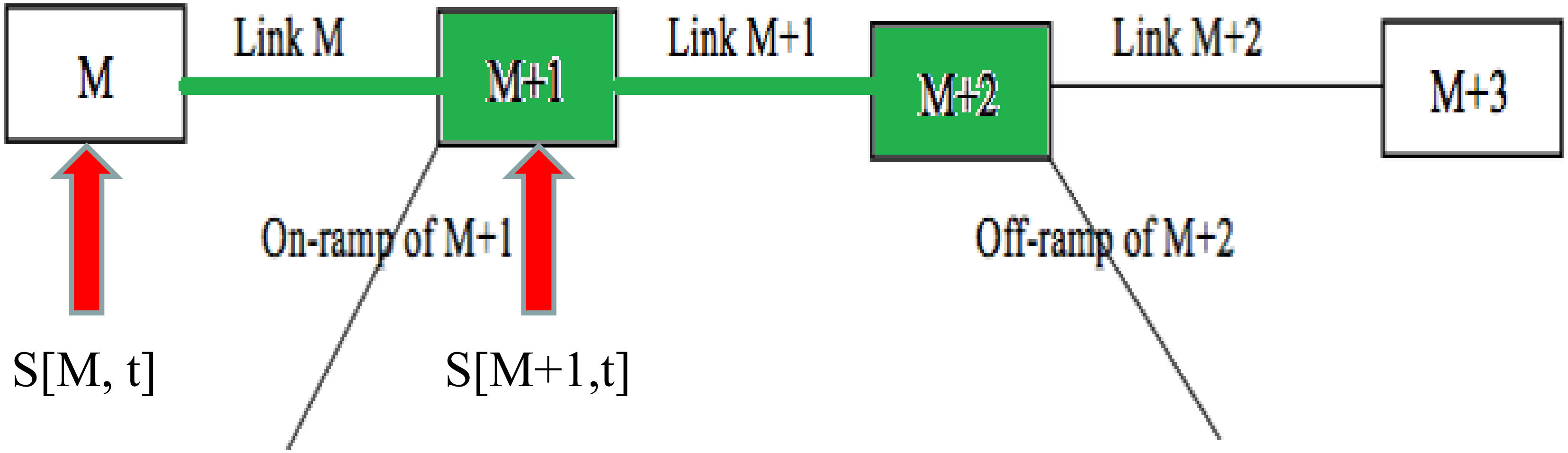
Methodology

- Consider a corridor with N potential bottlenecks.
- Each bottleneck (i.e., sensor location) is a node.
- Road segment between node M and node M+1 is denoted as link M.



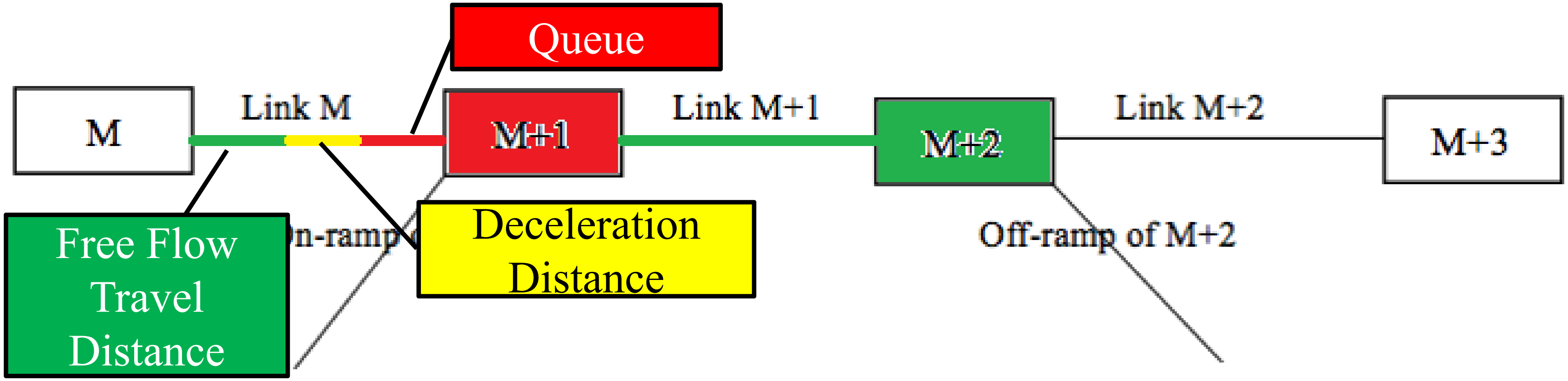
Methodology

<u>First Case</u>------No breakdown occurs on both link M and link M+1



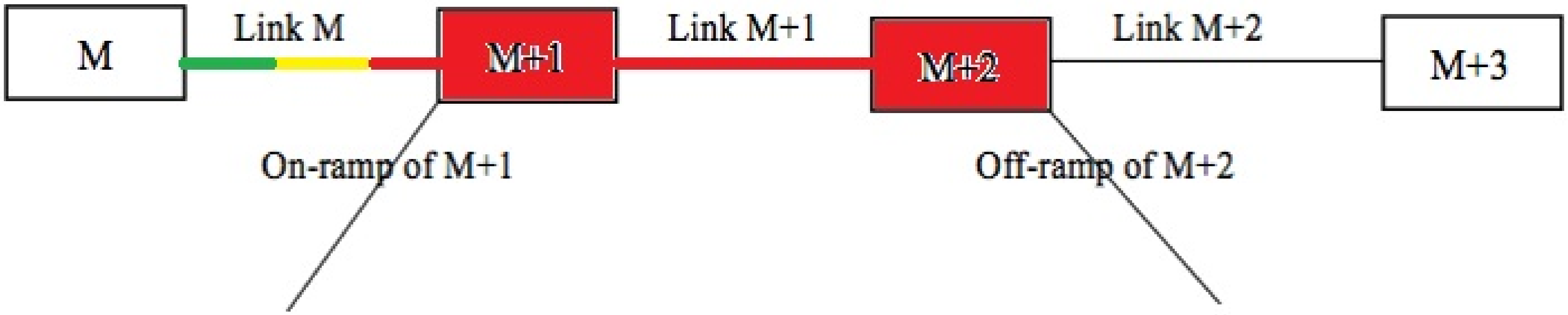
Methodology

<u>Second Case</u>------Breakdown occurs on link M



Methodology

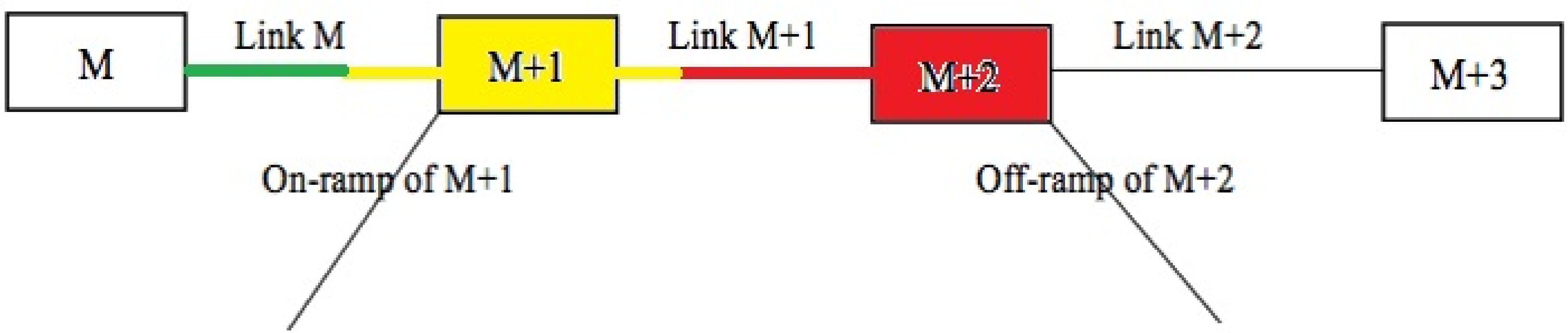
- **<u>Third Case</u>** ------the breakdown occurs on link M+1 at time t.
- If Queue length > length of link M+1



Methodology

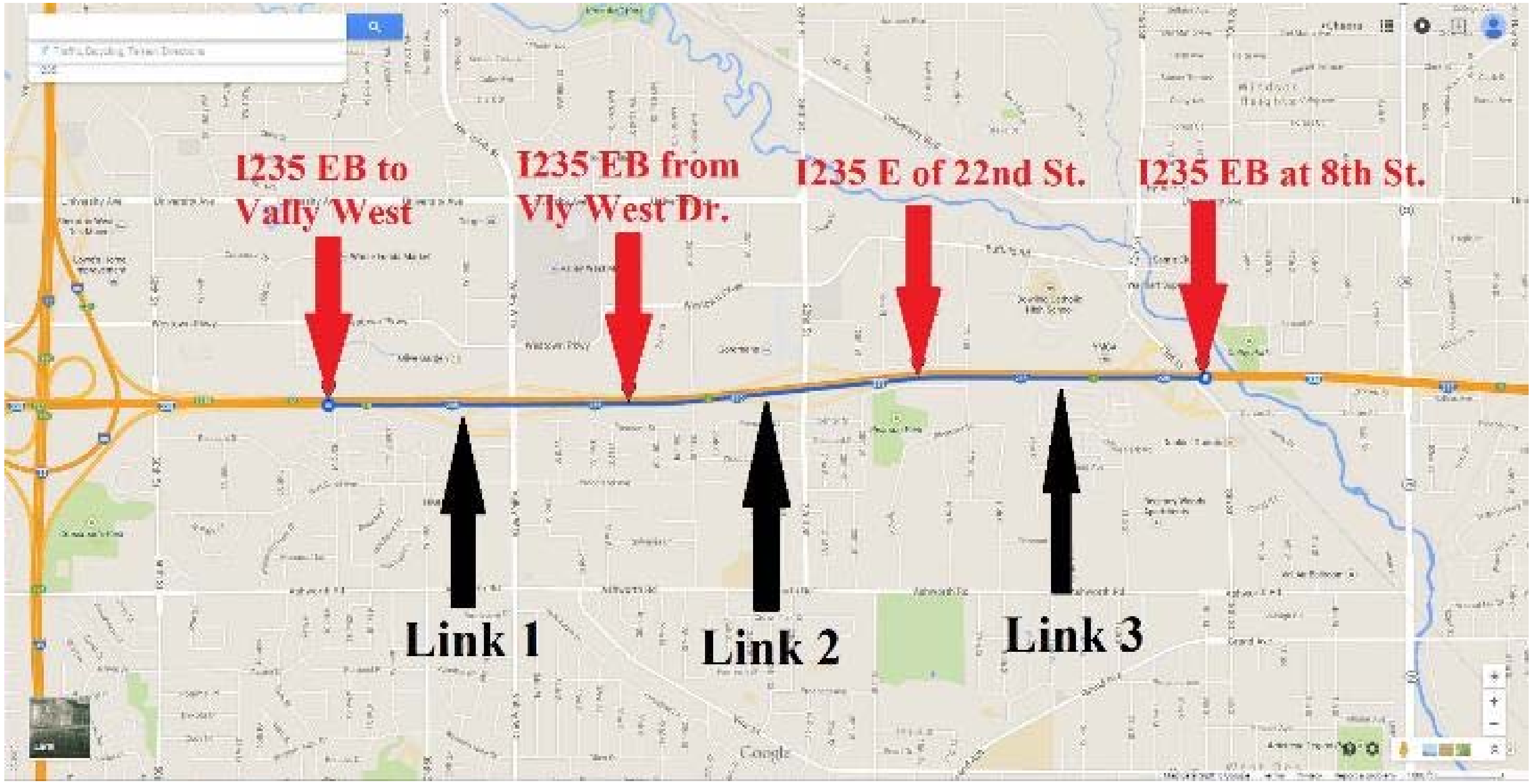
- If Queue length < distance of link M+1,

  But the queue length + deceleration distance > distance of link M+1

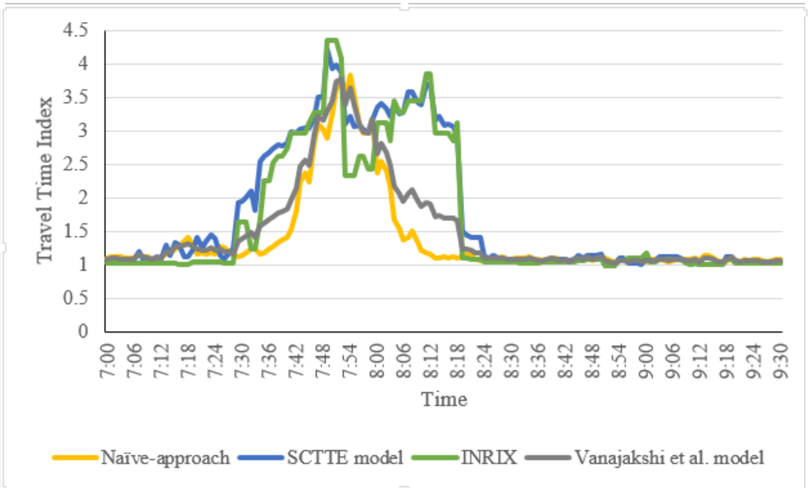


Otherwise, same as First Case.

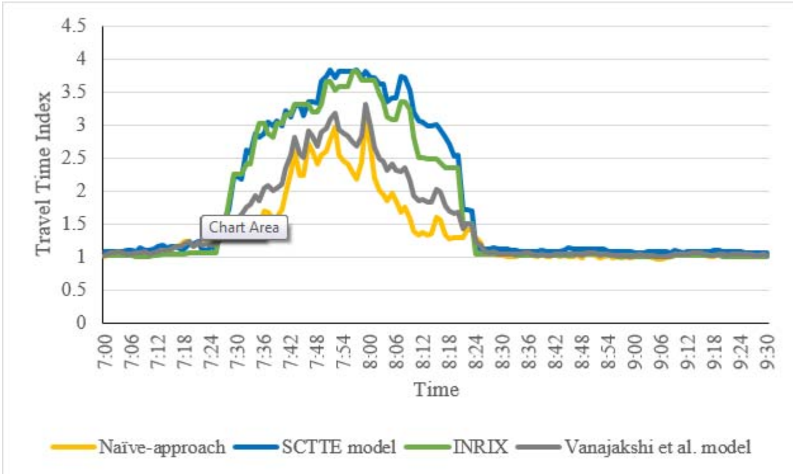
Application



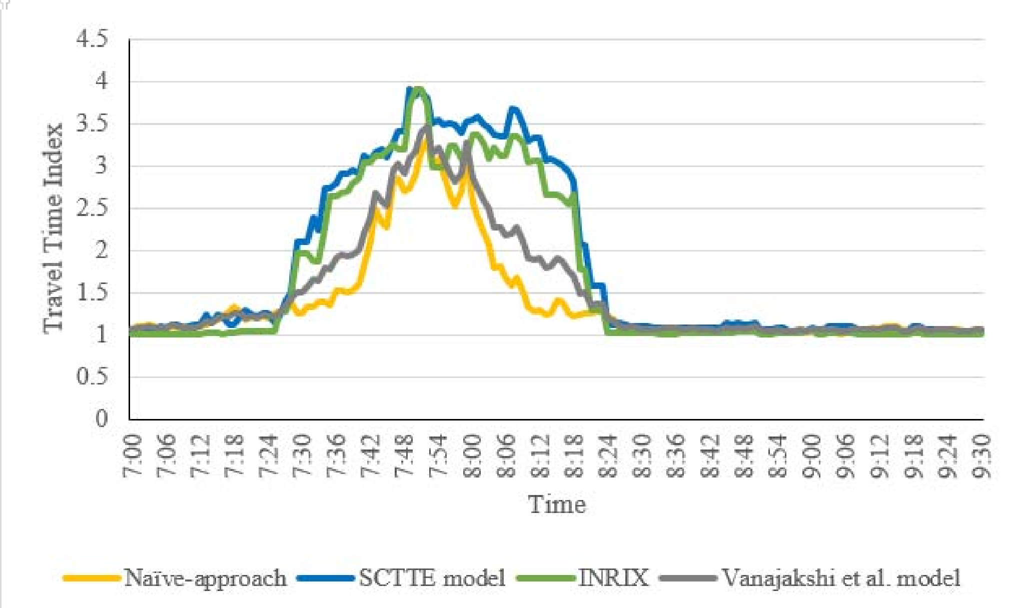
Results



(a) Link 1



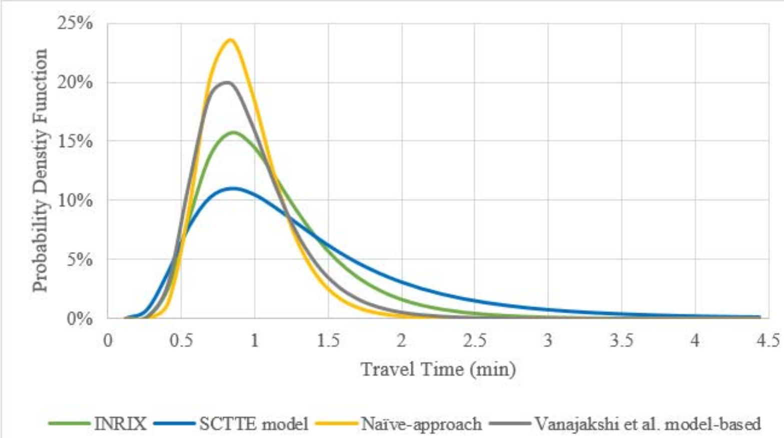
(b) Link 2



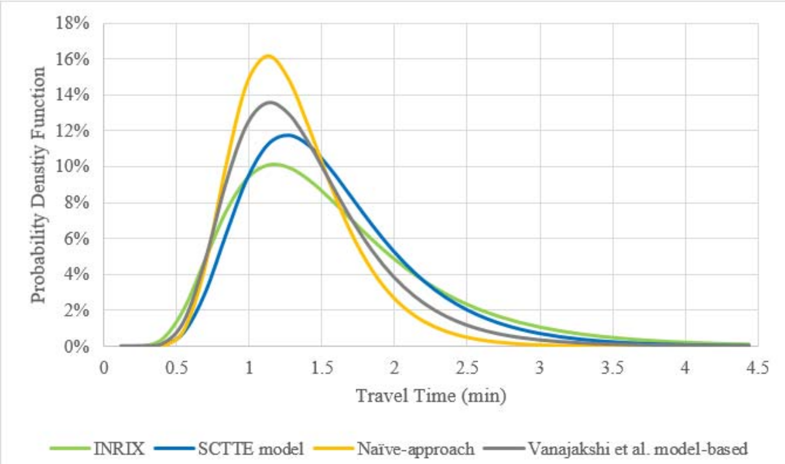
(c) Corridor

- The estimated travel time index well followed the pattern of the INRIX travel time index

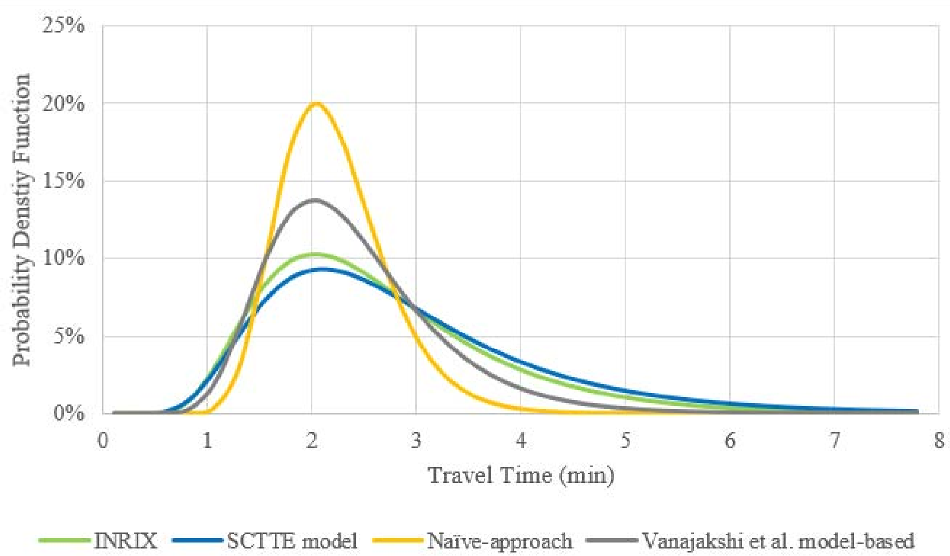
Results



(a) Lognormal Distribution of Link 1



(b) Lognormal Distribution of Link 2



(c) Lognormal Distribution of Corridor Travel Times

- The estimated travel time distribution well captured the tendency of the INRIX travel time distribution.

Summary

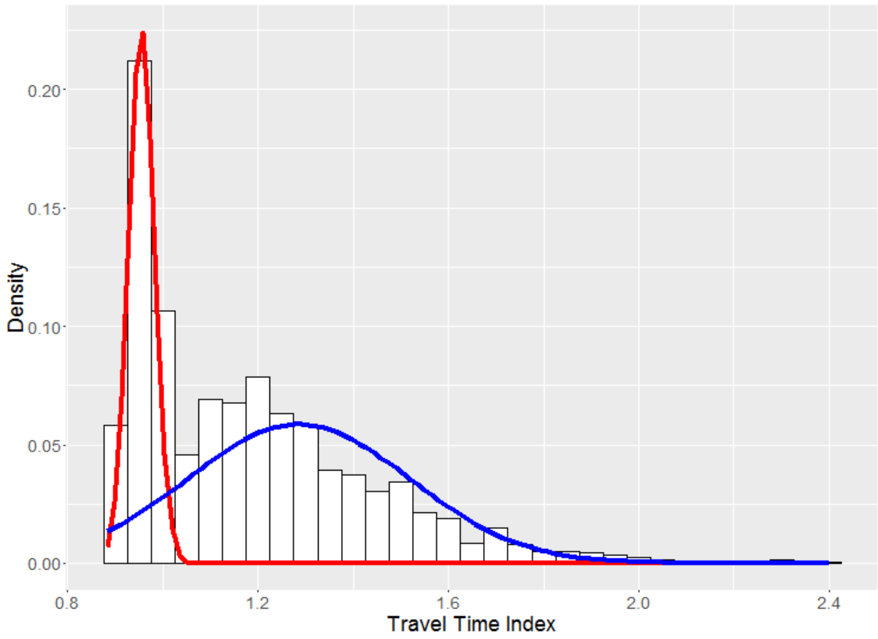
1. Considers the spatially correlated traffic conditions

2. Well captured the temporal patterns of travel time and its distribution

Introduction

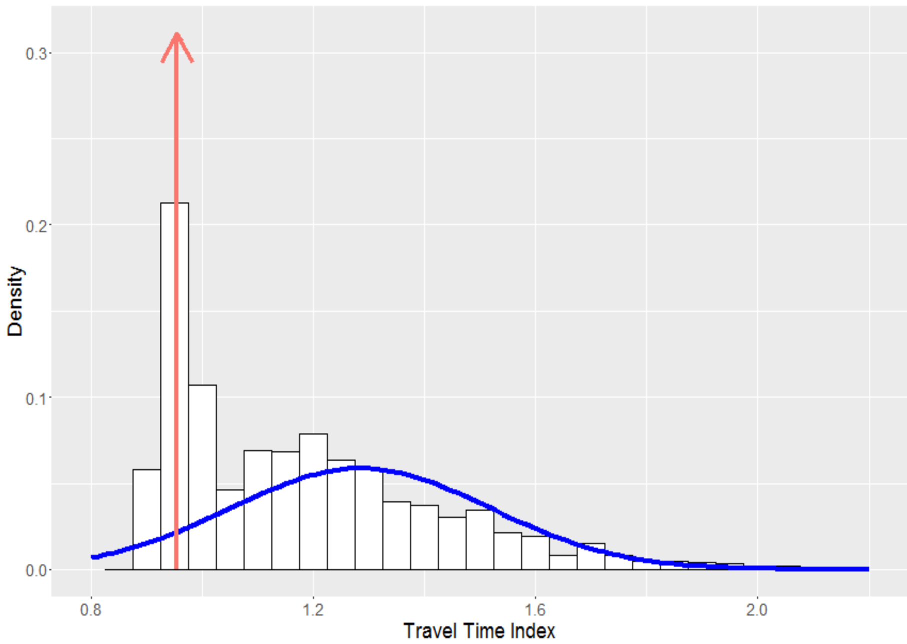
- Driver behavior plays an important role in determining the freeway capacity (Cambridge Systematics and Texas Transportation Institute, 2005)
- Freeway capacity is as an important parameter in delay-volume function to estimate travel time.
- Existing microsimulation software usually considers the driving behavior parameters as deterministic values.

Two-component travel time distribution

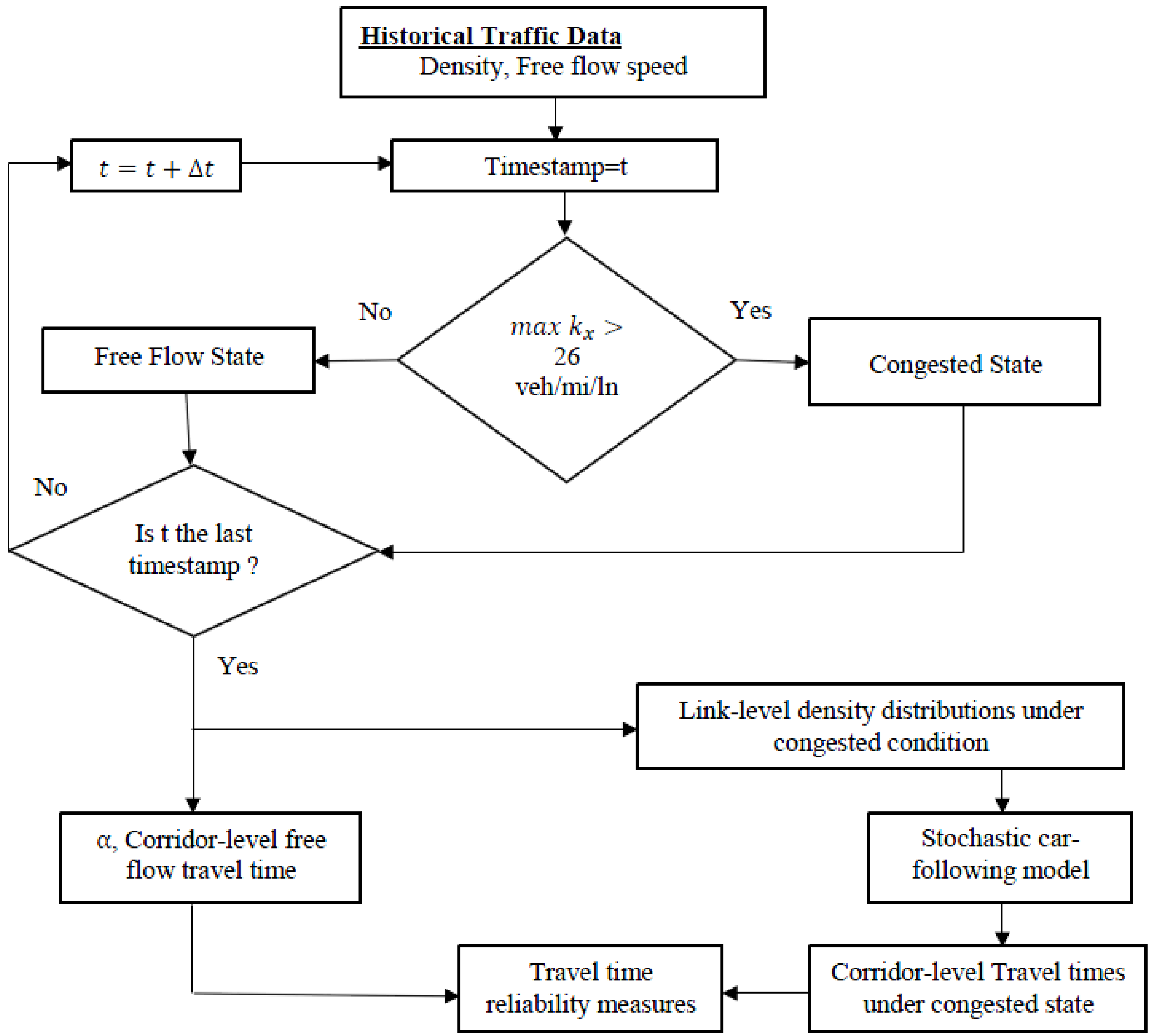


Guo et al. (2010) proposed a two-component travel time distribution model containing free-flow state and congested state

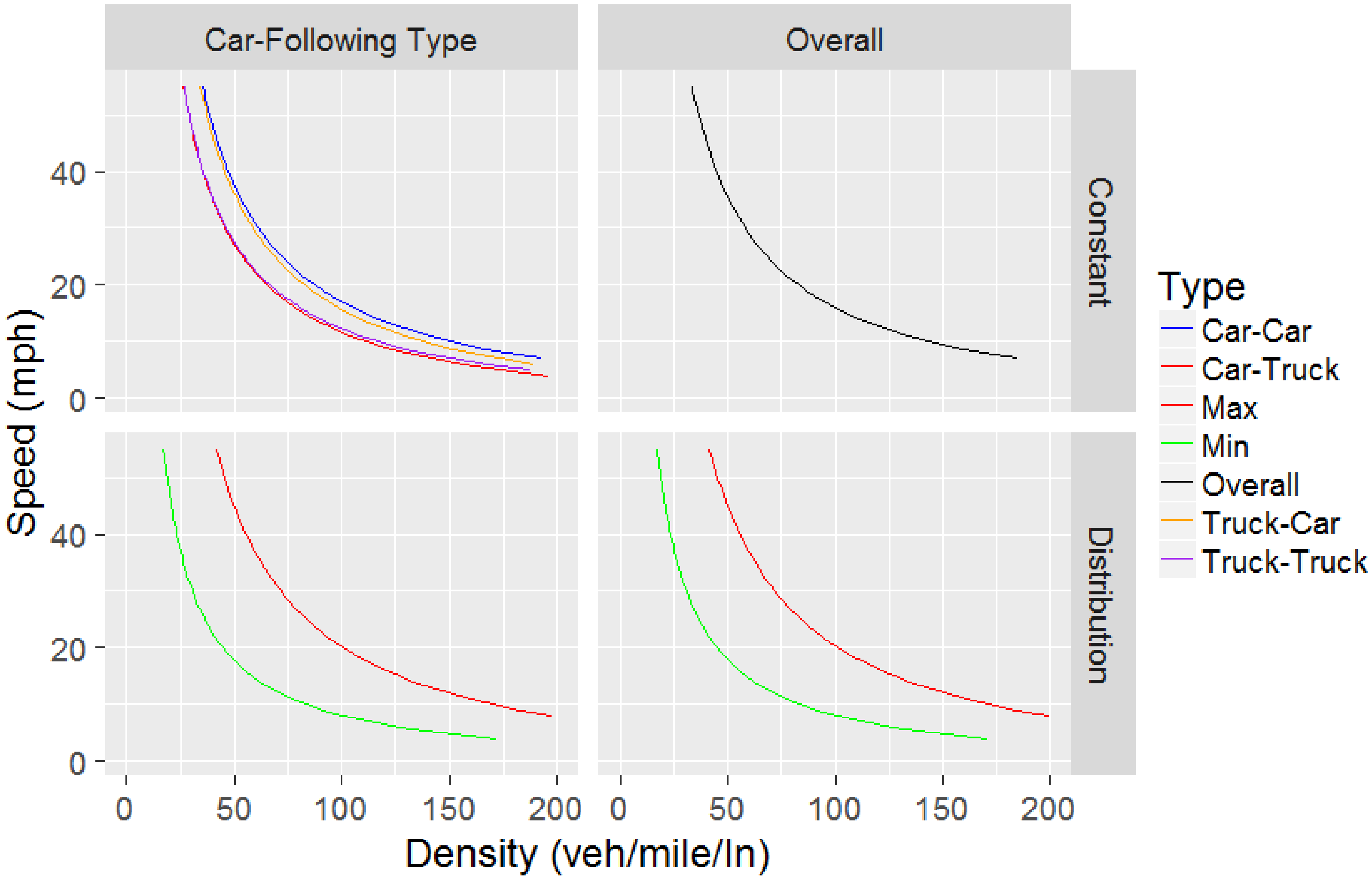
The standard deviations of free-flow travel times are generally small.



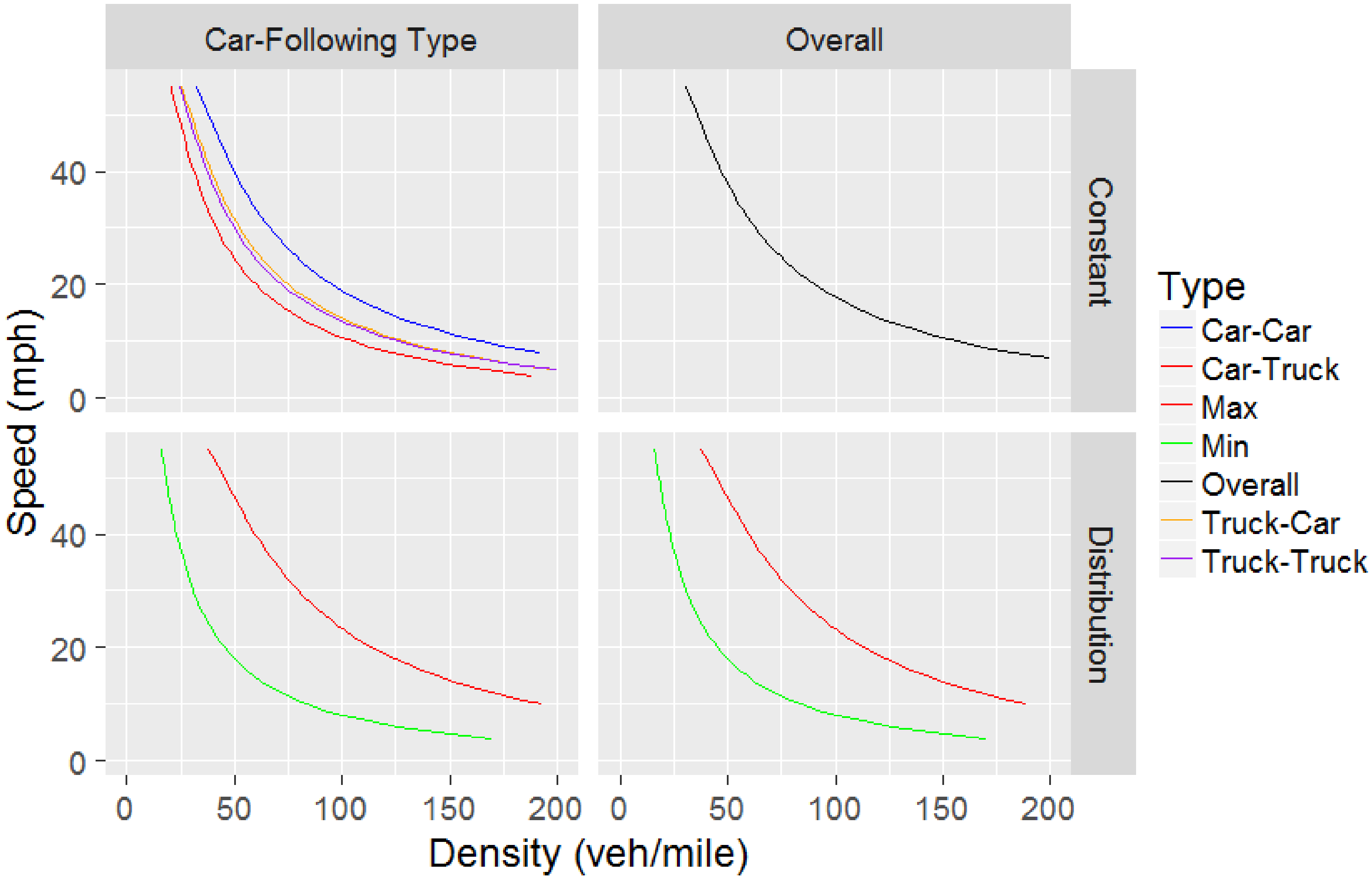
Travel time reliability estimation framework



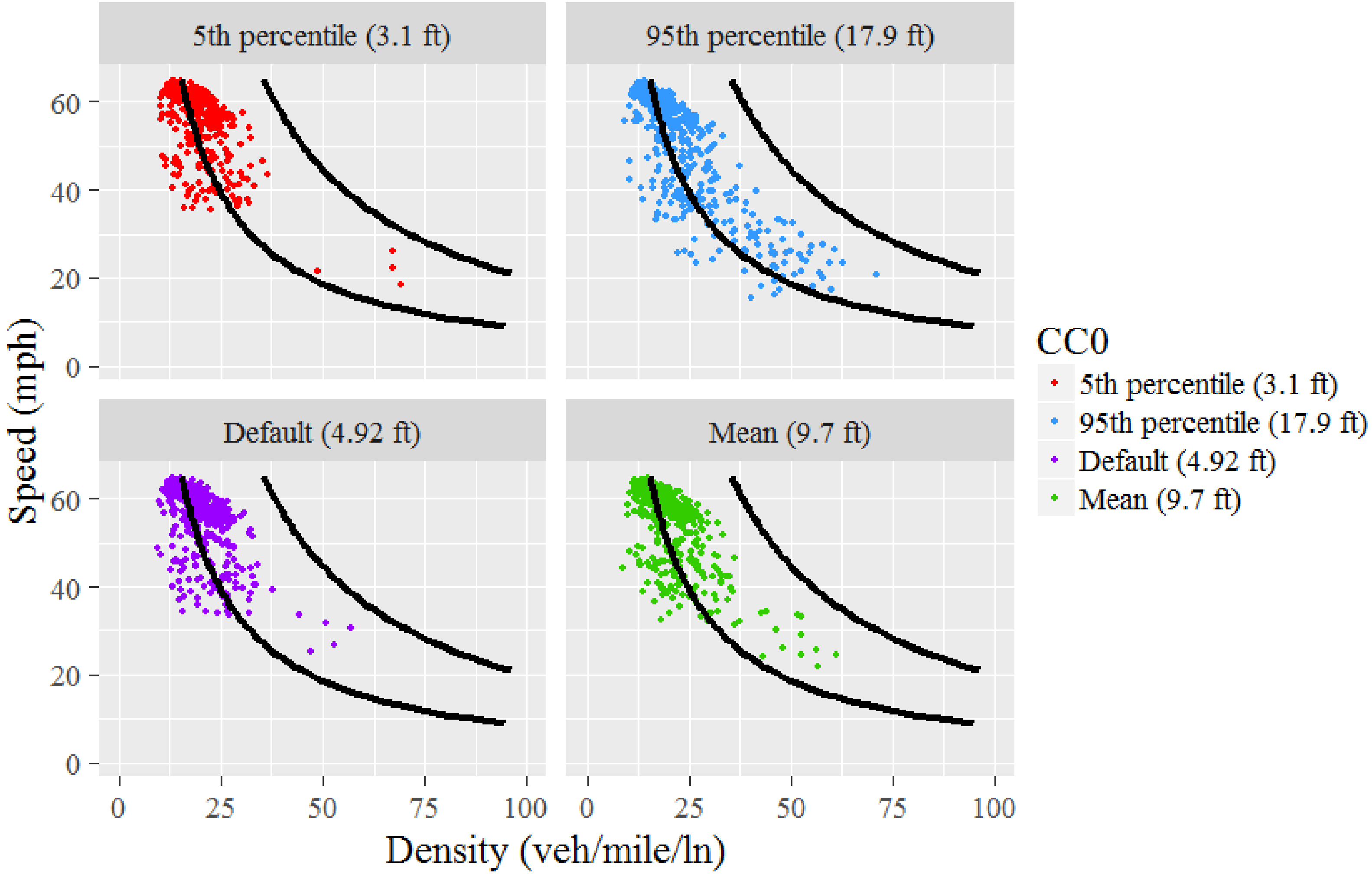
Results: Pipes car-following model



INTEGRATION Car-following model

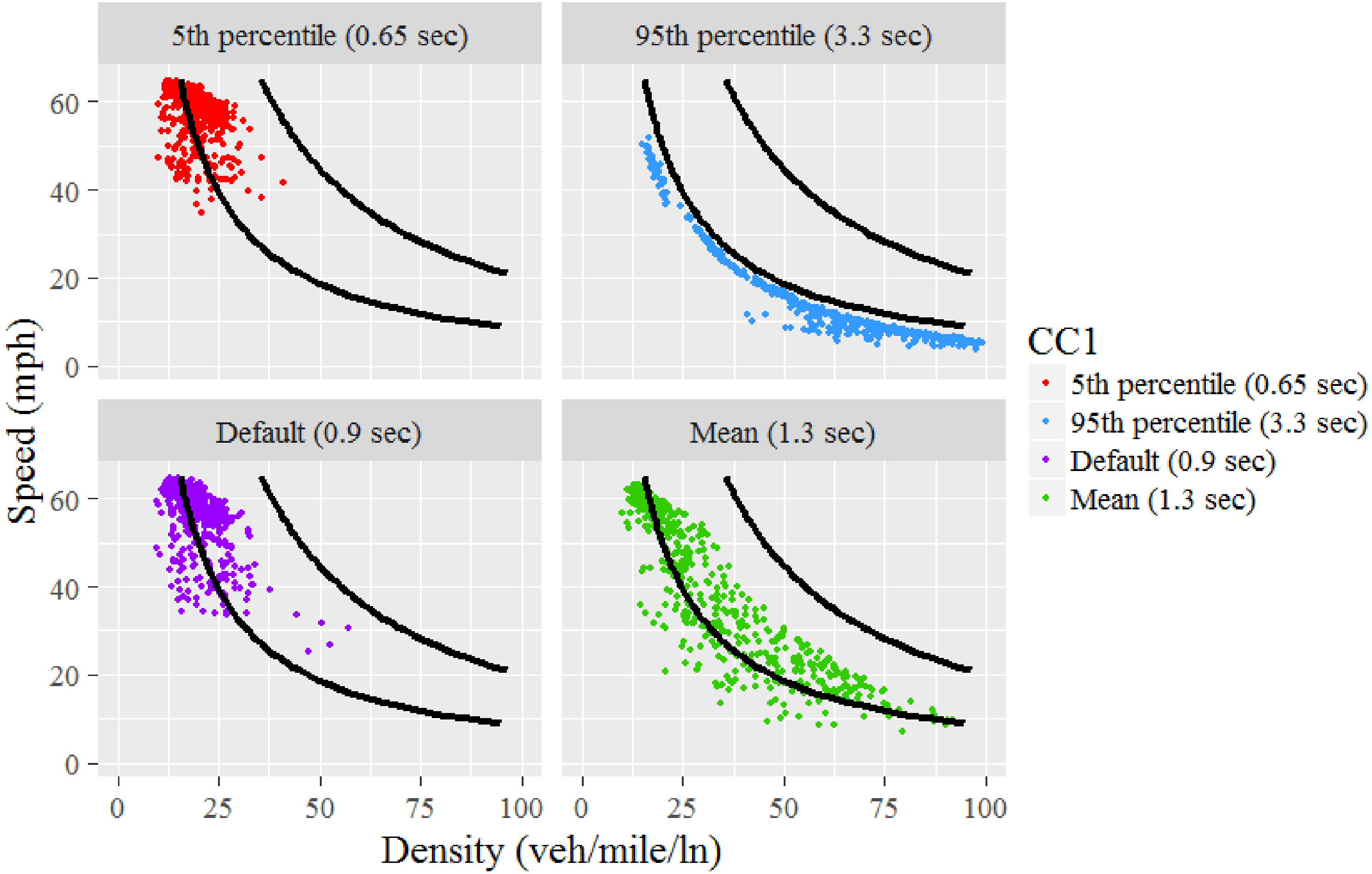


VISSIM Simulation: Varying CC0

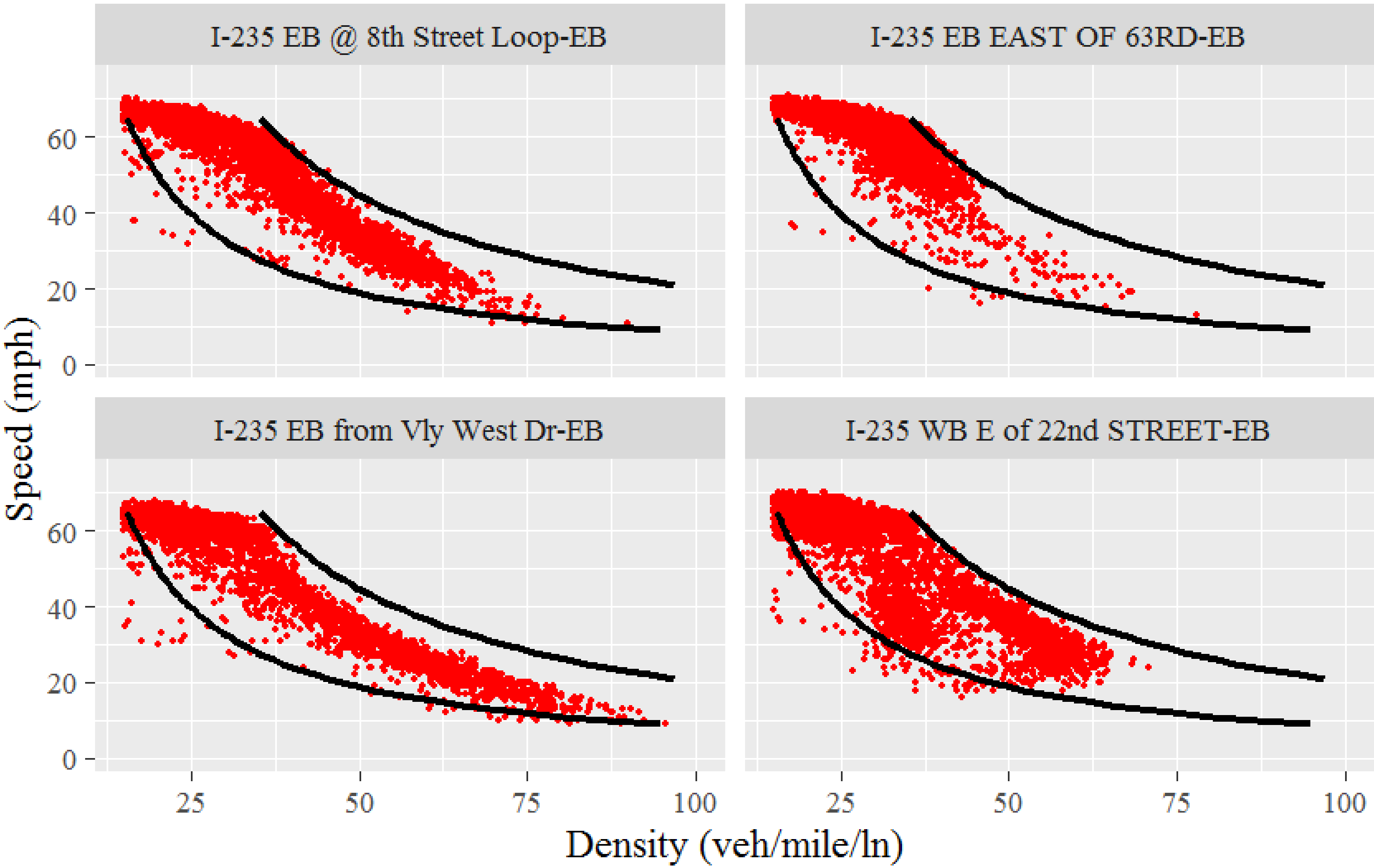


VISSIM Simulation: Varying CC1

$$CC1 = Time\ Headway - \frac{CC0 + Leader\ Vehicle\ Length}{Speed}$$

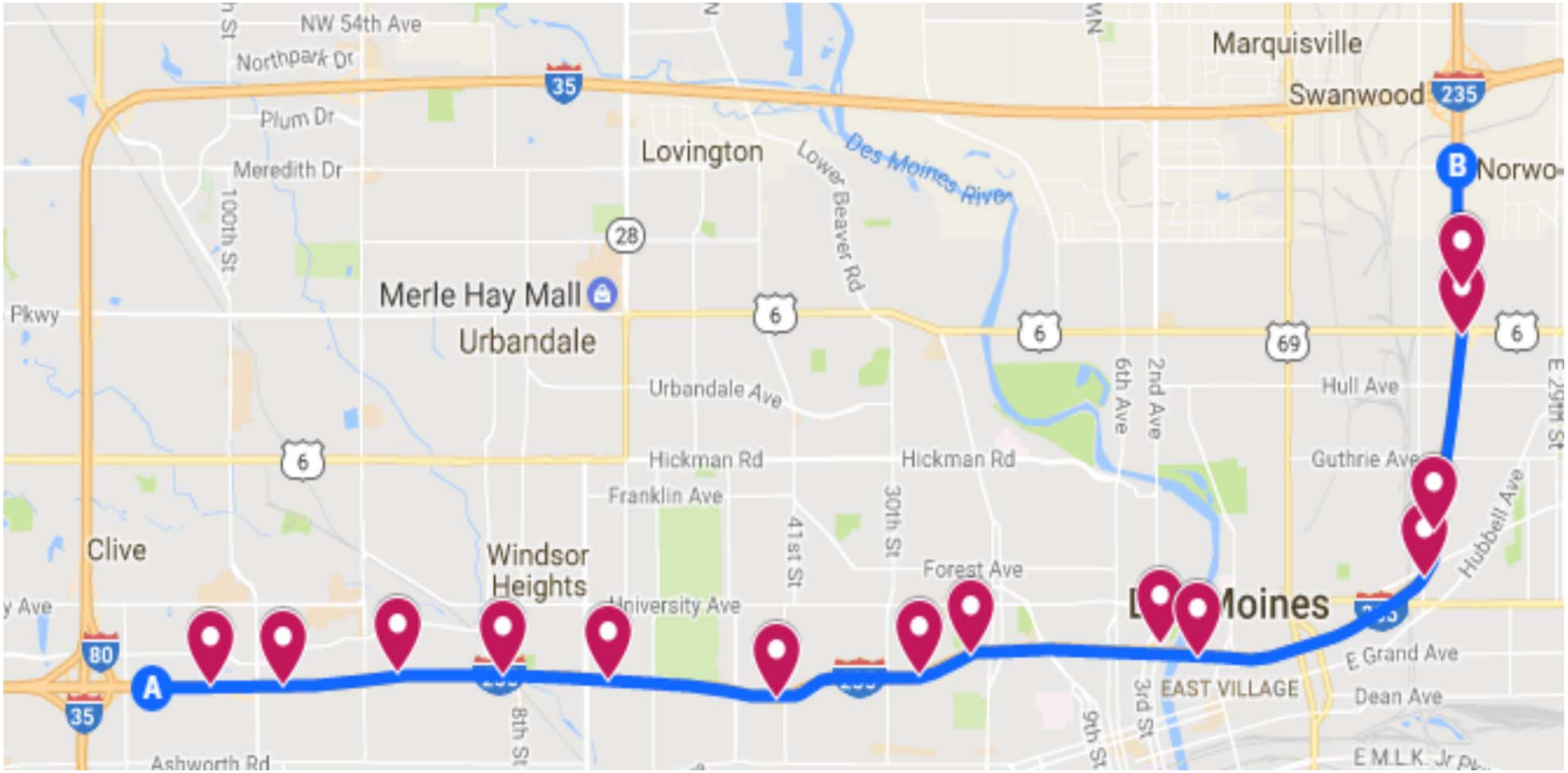


Field data



I-235 EB @ 8th Street Loop-EB
I-235 EB EAST OF 63RD-EB
I-235 EB from Vly West Dr-EB
I-235 WB E of 22nd STREET-EB
Speed (mph)
0
20
40
60
25
50
75
100
Density (veh/mile/ln)

Travel time reliability



Travel time reliability measures

- The proposed model generates more accurate reliability measures than VISSIM with less computational time.

	Mean	95th percentile travel time	Planning time index	Buffer time	Buffer time index	CPU Time (sec)
INRIX	17.26	24.69	1.90	7.43	0.43	—
Model-based	17.52	24.30	1.87	6.78	0.39	278
VISSIM	17.78	23.90	1.84	6.12	0.34	1198

Summary

1. Speed-density region derived from the Pipes model enclose most of the field data and outperforms VISSIM simulation output.

2. The proposed method provides better estimates with less computational time, compared to VISSIM simulation.


THANK YOU