SHRP2
STRATEGIC HIGHWAY RESEARCH PROGRAM

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Reliability and Cost-Benefit in the ITS Deployment Analysis System

presented to

International Meeting on Value of Travel Time Reliability and Cost-Benefit Analysis

presented by
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October 15, 2009

Transportation leadership you can trust.

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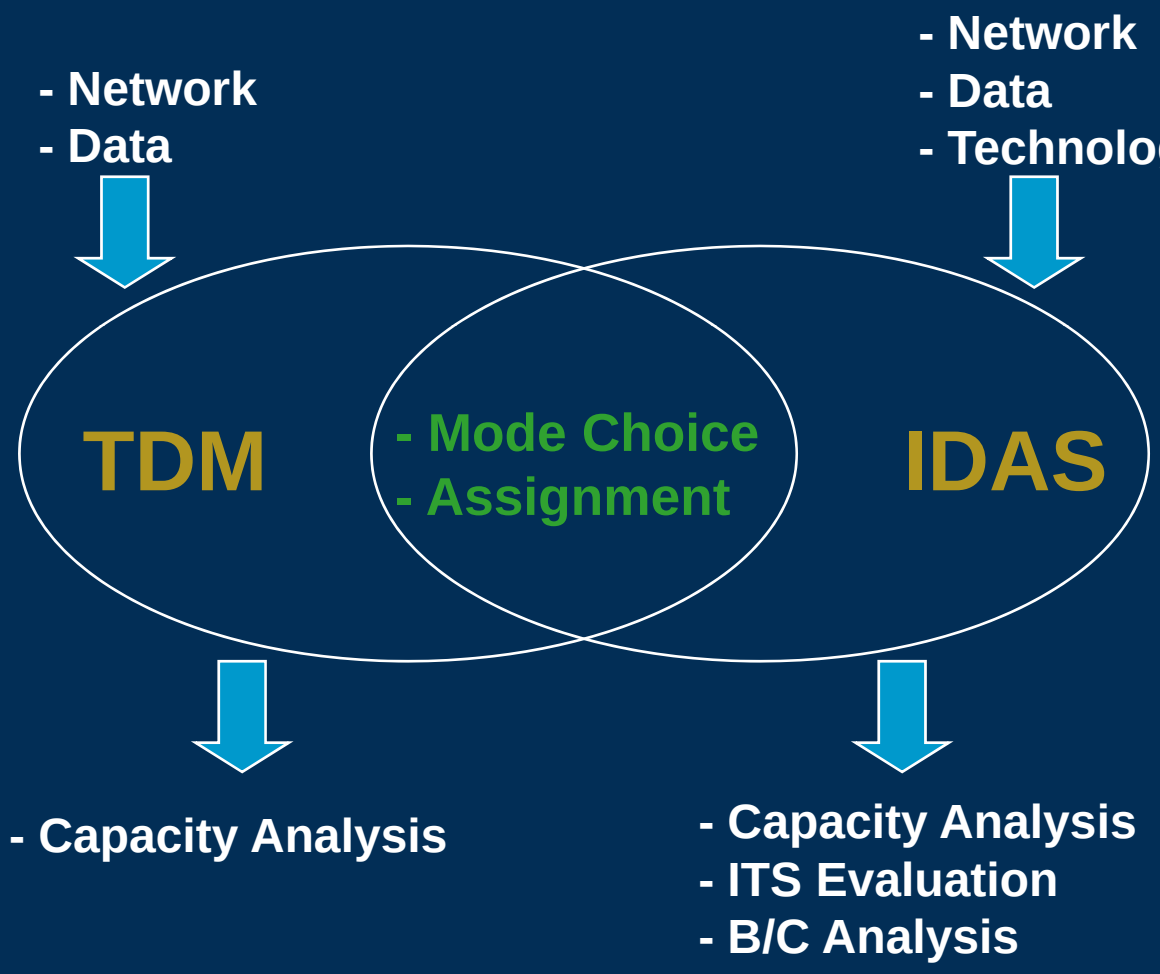
IDAS is a Postprocessor and Extender to the Travel Demand Model (TDM)



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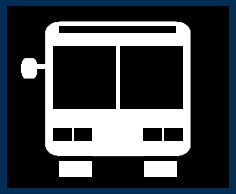
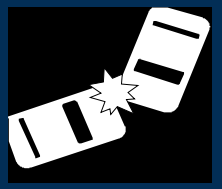
Types of ITS Components in IDAS

Regional Multimodal Traveler Information

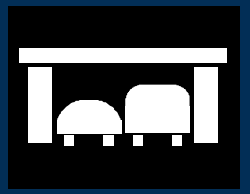


Advanced Public Transportation Systems



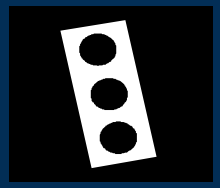
Incident Management

Freeway Management



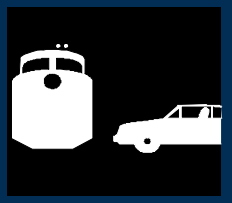
Electronic Toll Collection

Emergency Management



Arterial Management

Electronic Fare Payment



Railroad Grade Crossings

Commercial Vehicle Operations

Advanced Vehicle Control and Safety Systems

Supporting and Generic Deployments

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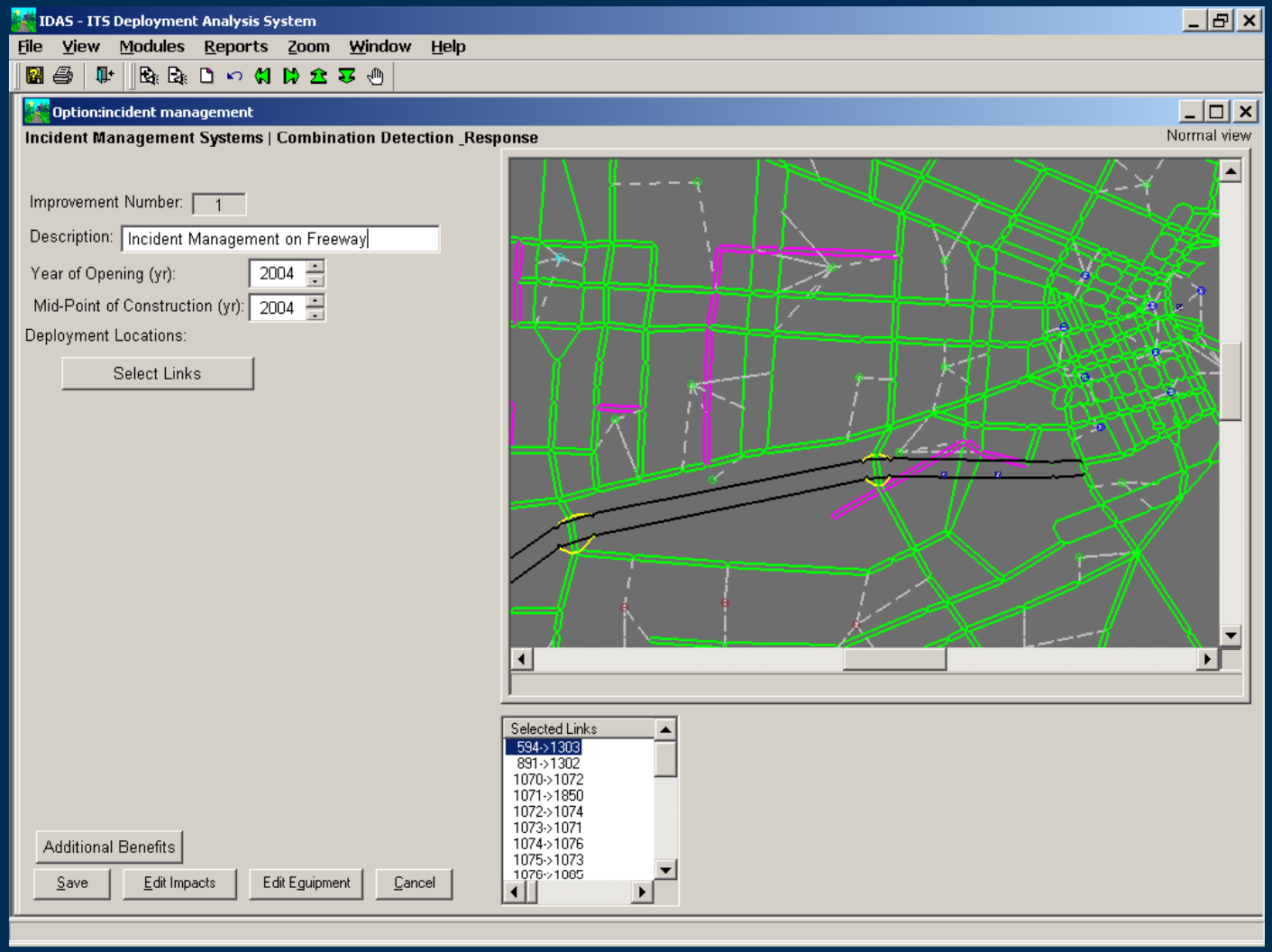
Example ITS Deployment Screen



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IDAS Performance Measure Outputs

- Systemwide performance measures including
  - Mobility
  - Travel time
  - Travel time reliability
  - Accidents (fatality, injury, property damage)
  - Emissions (HC, CO, NOx, PM10)
  - Fuel use
  - Agency efficiency
  - Costs (capital and operating & maintenance)
  - Benefit/cost
- Viewed by
  - Market sector (mode)
  - Facility type
  - District (user defined)

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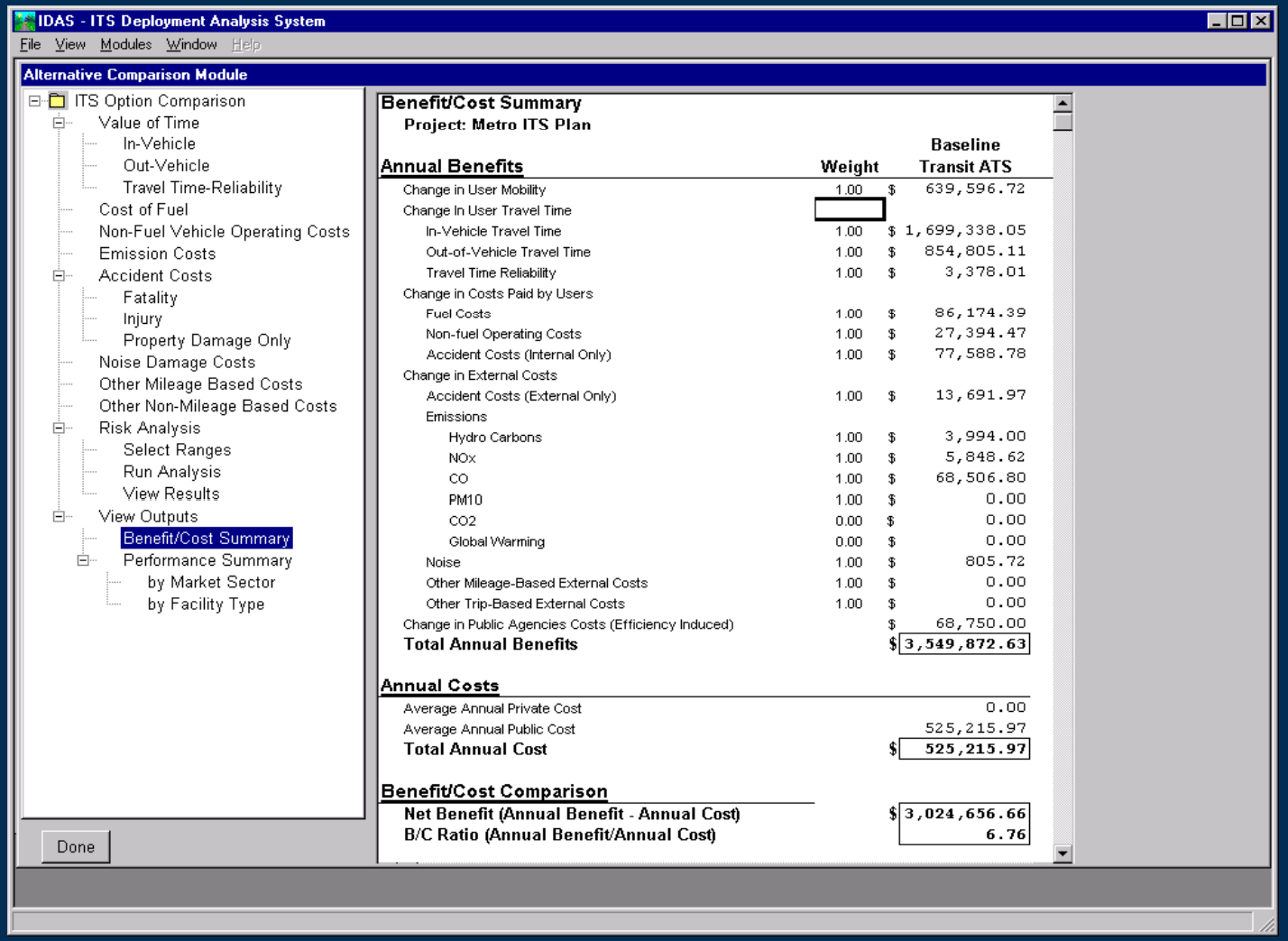
Benefit/Cost Summary



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IDAS Limitations (General)

- Does not directly analyze rural ITS or non-ITS type operational improvements (RWIS, HOV lanes, toll lanes)
- Initial set-up – data transfer from model can be problematic
- Requires availability of travel demand model, not directly compatible with GIS
- Travel demand model limitations
  - Static travel demand assignment
  - Constrained to time period, modes, network… of local model
  - Volumes, speeds not necessarily current
- Can not modify network within IDAS, must be done prior
- Traveler information analysis methodology too simplistic (i.e., does not capture traveler responses)
- Transit analysis capabilities limited (no transit network)
- Emissions based on Mobile 5a
- Limited graphical output, no animation
- Does not meet the needs of every analysis – too sketch versus too complex

Reliability in IDAS

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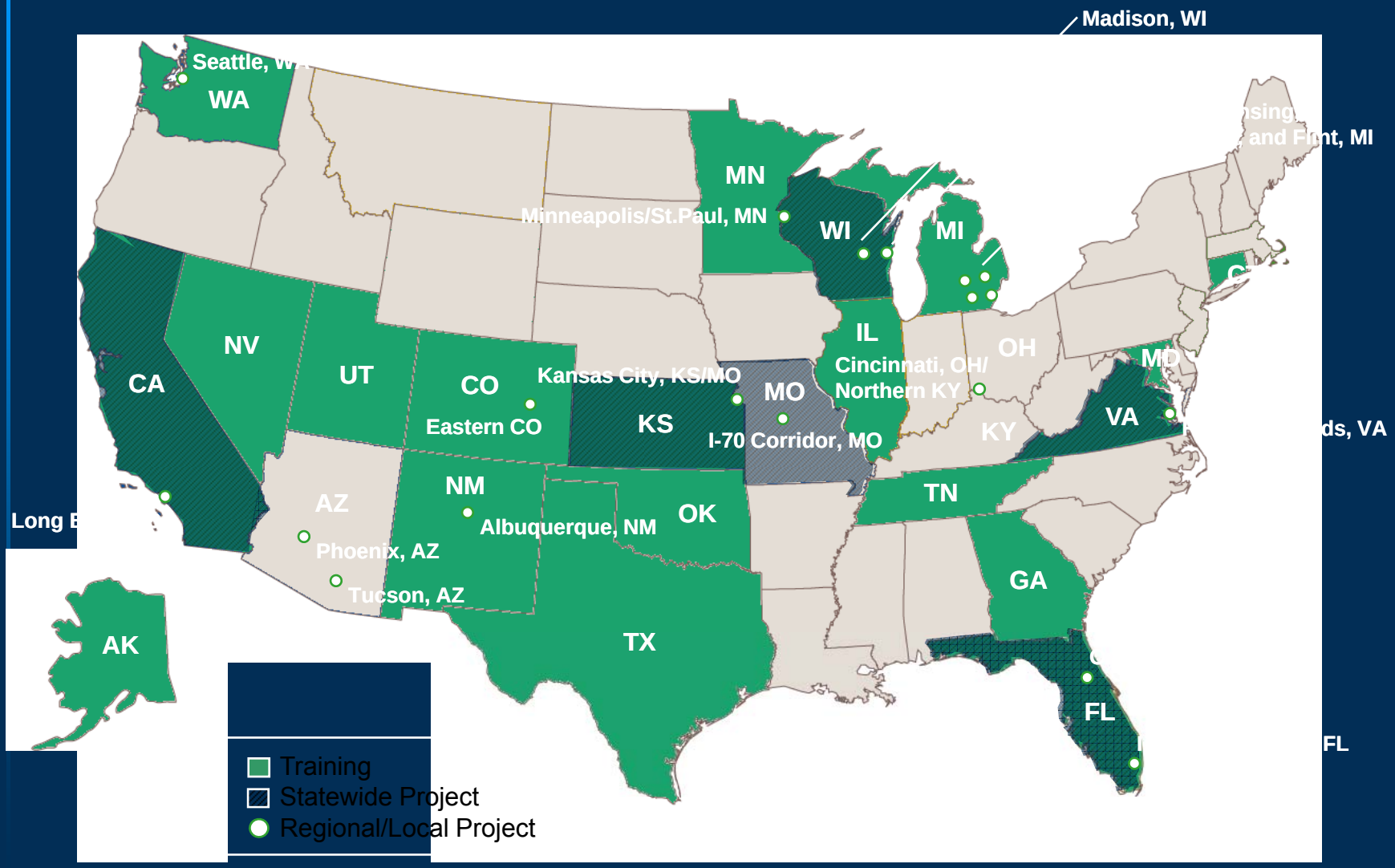
Travel Time/Delay Estimation in IDAS

- **Recurring delay**
  - **Based on modified BPR formulations (v/c ratio)**
- **Incident delay**
  - **Based on equations derived from stochastic modeling of incidents**
    - **v/c ratio**
    - **Number of lanes**
    - **Incident rate**
    - **Incident duration**
- **Incident delay is assumed to be the reliability component**

Travel Time/Delay Valuation in IDAS

- Review of literature (ca. 1999) revealed that the value of *unexpected* delay ranged from 1x – 6x that of average delay
  - Literature based primarily on commuters habits and preferences (stated preference)
- IDAS default value for incident delay value is 3x average delay (can be overridden)

Where IDAS Has Been Used



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Beyond IDAS:

Some Thoughts on Improving Reliability Estimation and Valuation in Models

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Travel Time Reliability: Definition

- Measured by how travel time varies from one time period to another
  - Can be for a link, section, trip, or network
- In other words, reliability is measured as the variability of travel times
  - "How long will my trip take today compared to the same trip at the same time on any average day?"

… this implies …

  - Travelers seek the ability to predict travel time and to arrive at destination within an "on-time window"

Travel Time Reliability: Definition

… Which leads us to a general definition of reliability:

A consistency or dependability in travel times, as measured from day to day and/or within different times of day

Travel Time Reliability: Definition

- User perspective: How predictable/consistent is travel?
- Operator perspective:
  - How does the system perform over time against a predefined standard?
  - Alternately, how susceptible is the system to breakdown or other level of service?
- Reliability "happens" over a long period of time
  - Need a history of travel times that capture all the things that make them variable (e.g., incidents, weather, work zones)

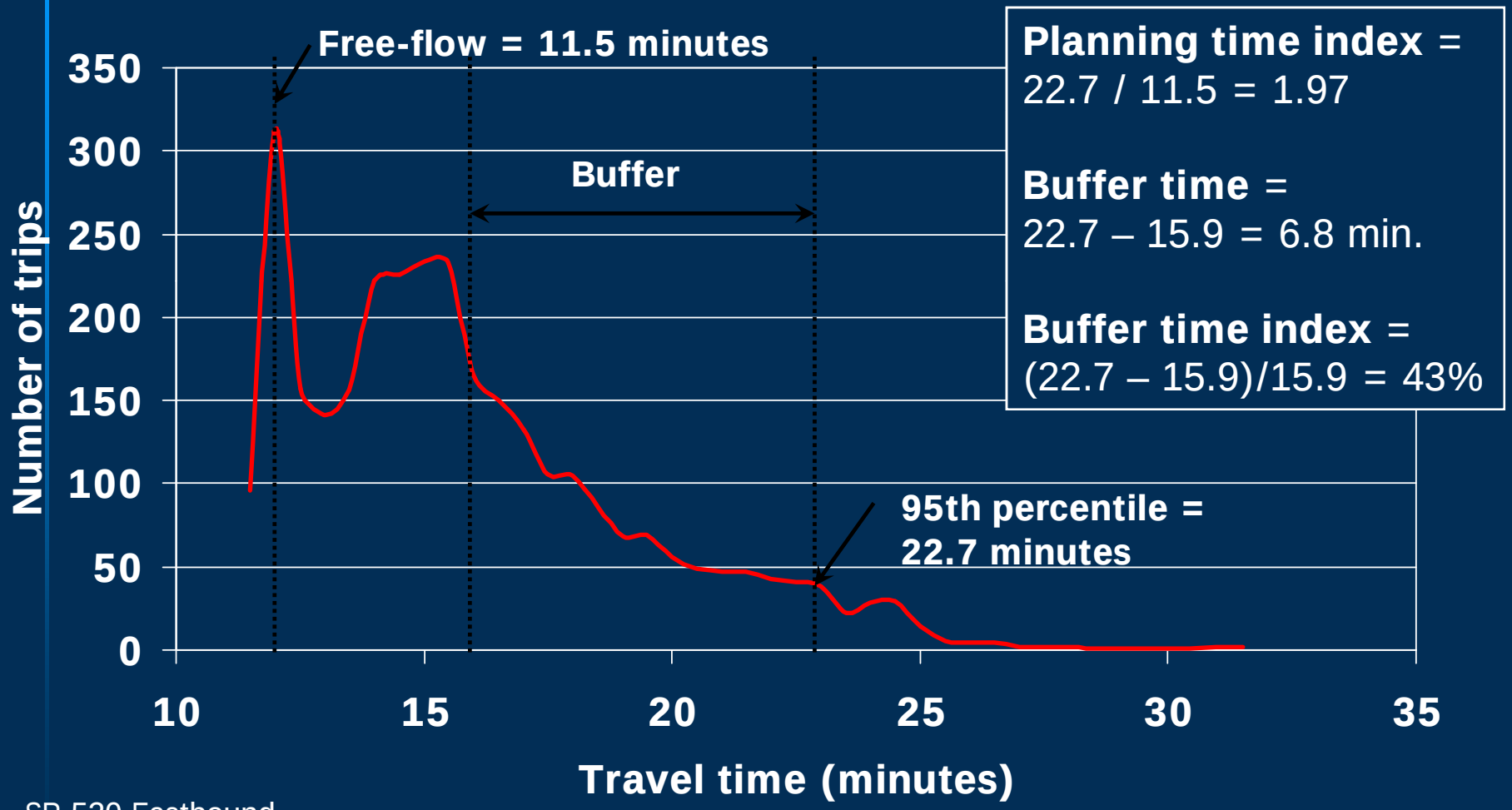
Recurring vs. Incident Delay Is Too Simplistic

- Even in the absence of incidents, there will be variation in travel times due to:
  - Weather
  - Volume fluctuations
    - Normal daily/seasonal changes in demand
    - Special events
    - Emergencies
  - Driver behavior
    - Traffic flow at the tipping point of capacity susceptible to very small changes

Recurring vs. Incident Delay Is Too Simplistic (cont.)

- Capacity expansion projects will also improve reliability (not just better incident management), and operations improves the average/typical condition
- SHRP 2 L03 Before/After Studies
  - FSP expansion
    - 15% reduction in unreliability
    - 20% reduction in average travel time
  - Lane addition
    - 38% reduction in unreliability
    - 35% reduction in average travel time
- Perhaps it's time for a more holistic approach

The Complete Travel Time Distribution and the "Buffer" (Urban Freeway Section)



Planning time index = 22.7 / 11.5 = 1.97

Buffer time = 22.7 – 15.9 = 6.8 min.

Buffer time index = (22.7 – 15.9)/15.9 = 43%

SR 520 Eastbound
Seattle, 4-7pm weekdays

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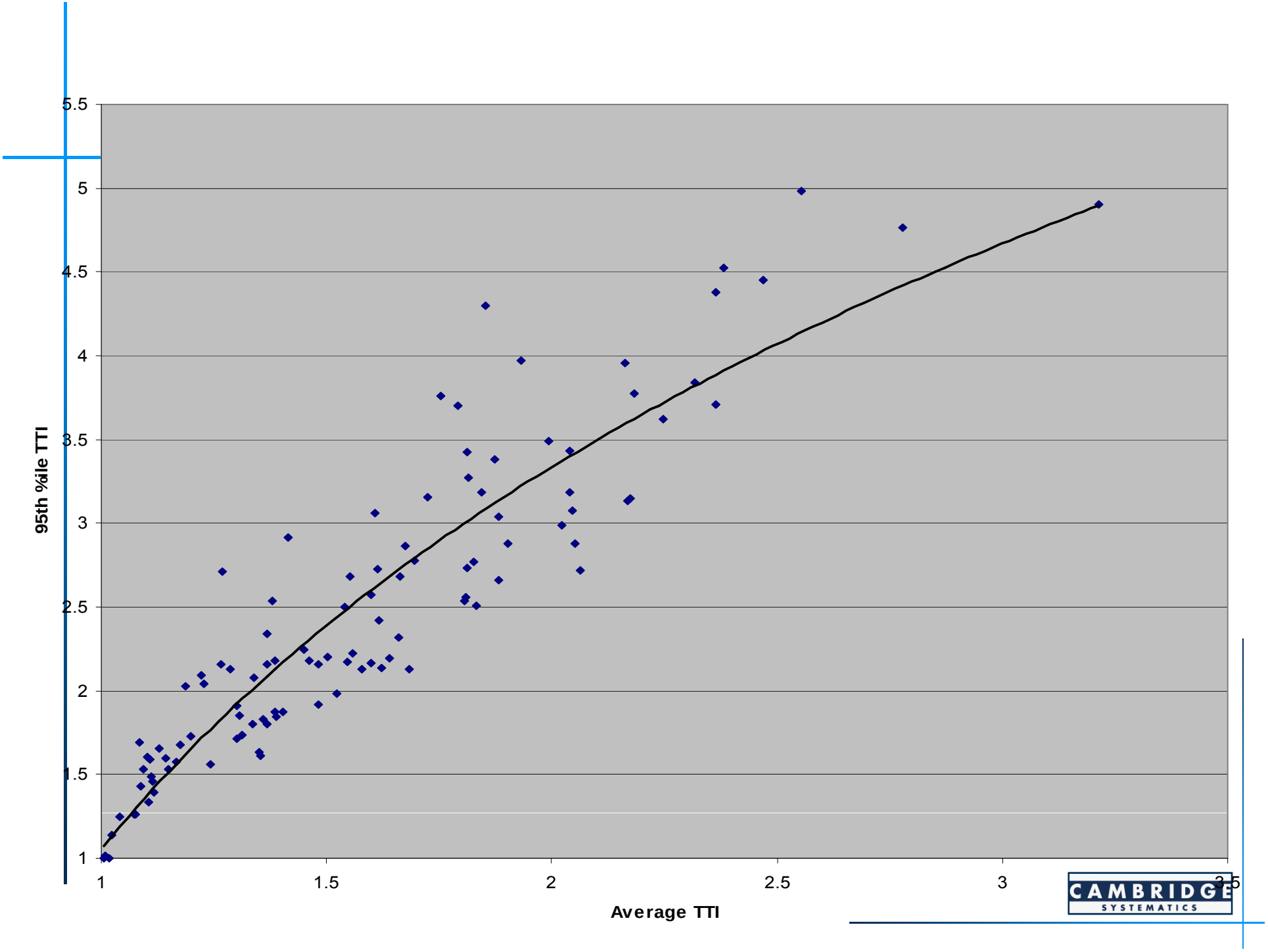
Using the Concept of a Buffer in Valuing Reliability

- Convenient way of getting at the expected vs. unexpected delay issue directly
- Different travelers and trip types will have different buffers
  - Routine commuters pad their schedules based on past experience
  - Travelers making infrequent trips on unfamiliar routes may not build in much of a buffer
- Trips made within the buffer valued at one rate (it's "planned"), but "unplanned lateness" will be valued at a premium (probably)


95th %ile TTI
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
1
1.5
2
2.5
3
3.5
Average TTI
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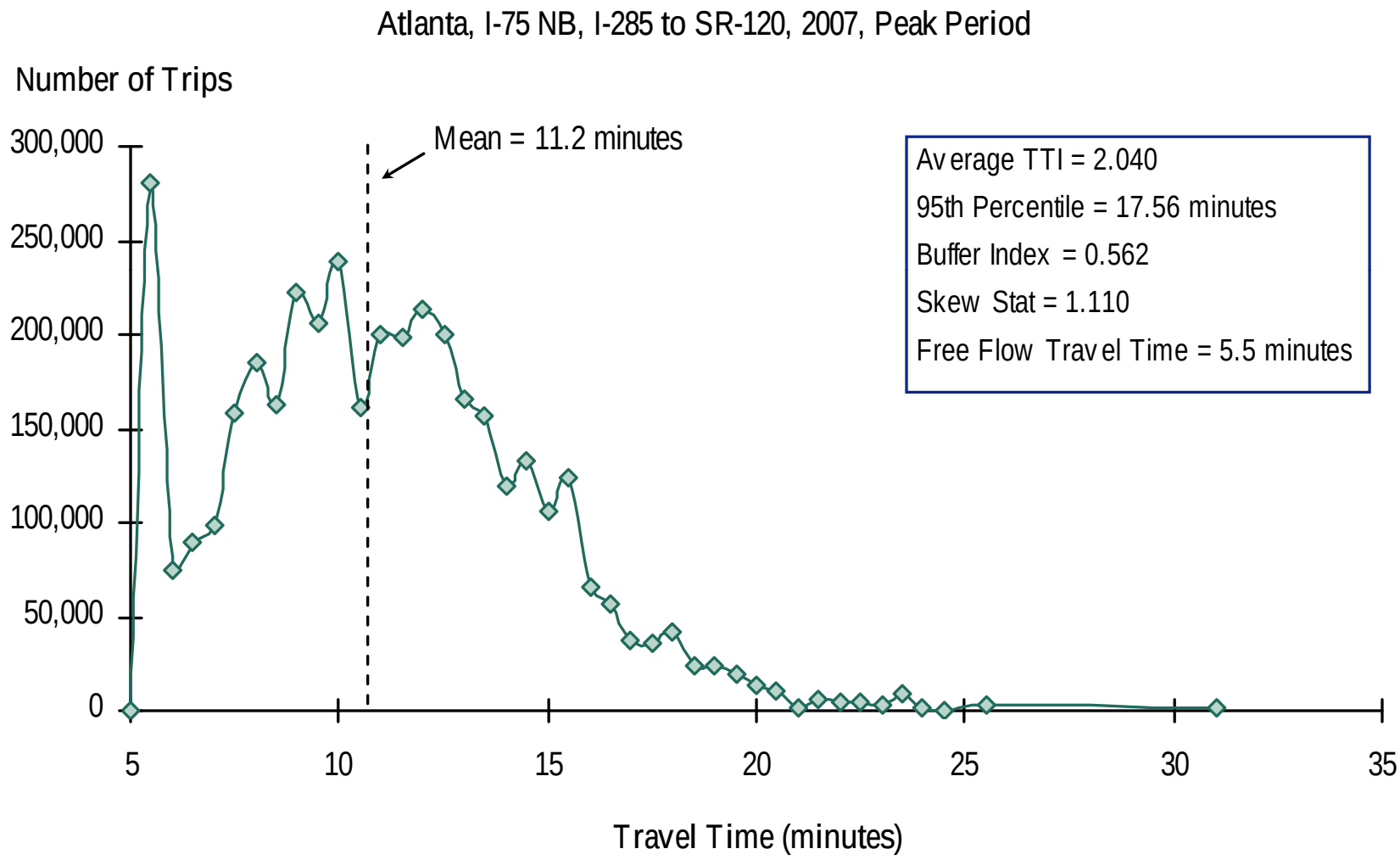
SHRP 2 Project L03: Statistical Modeling

- Results show that all reliability measures defined in the study can be predicted as a function of average Travel Time Index
- Urban Freeways: mean, 80th, and 95th%ile Travel Time Index can be predicted as a function of:
  - "Critical" demand-to-capacity ratio
  - Lane-hours lost due to incidents + work zones
  - Hours where rainfall >= 0.05"
- Results applicable to extended highway sections, but these will be only a part of a complete trip
  - Can we apply valuation at the section level or do we need to value entire trips?

Travel Time Distribution for an Urban Freeway "Section"



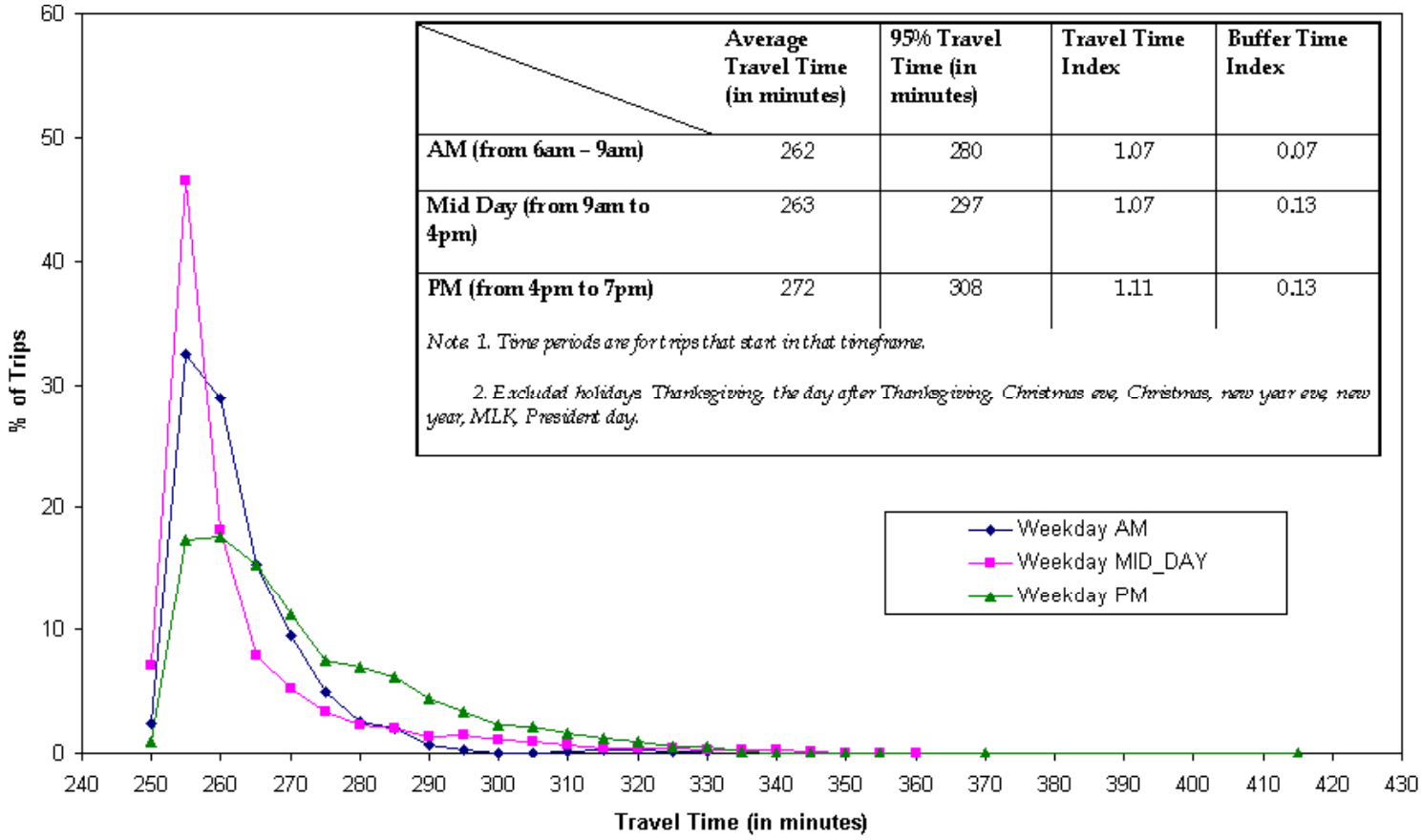
Travel Time History for a Long Intercity Trip: D.C. to GW Bridge

Non-Holiday Weekday Travel Time Distributions
I95 DC to GW Bridge, NB, 247 miles, Nov 2008 and March 2009

	Average Travel Time (in minutes)	95% Travel Time (in minutes)	Travel Time Index	Buffer Time Index
AM (from 6am – 9am)	262	280	1.07	0.07
Mid Day (from 9am to 4pm)	263	297	1.07	0.13
PM (from 4pm to 7pm)	272	308	1.11	0.13

Note 1. Time periods are for trips that start in that timeframe.

2. Excludes holidays Thanksgiving, the day after Thanksgiving, Christmas eve, Christmas, new year eve, new year, MLK, President day.



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Summary

- Not accounting for reliability misses a substantial portion of the benefits of transportation improvements
- ALL types of highway improvements will improve reliability
  - Capacity and demand management make the system less vulnerable to disruptions by events
  - Operations directly targets the effects of events
- The concept of a “buffer” appears to be useful for segmenting the valuation of reliability
  - Research needed to determine how travelers actually do this
- Predicting the buffer (reliability) on highway sections is feasible with models
- But should we be concerned more with trip reliability

Thanks!

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