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L02 – Establishing Monitoring Programs for Travel Time Reliability

Current Status

For the:
Transportation Research Board Annual Meeting
Session 136

Washington, DC      January 23, 2011
Purpose and Deliverables

• **Purpose**
  - Guidebook and methodology for monitoring travel time reliability

• **Deliverables**
  - Guidebook
  - Methodology
  - Efficacy assessment
    - How well the guidebook and methodology work
    - Real-world network and data
Guidebook

• Part I: Introduction
• Part II: Use Cases
• Part III: Analytical Techniques
• Part IV: System Functional Specifications
• Part V: Case Studies

Part IV

• Chapter 8: Introduction
• Chapter 9: Data Collection
• Chapter 10: Data Management
• Chapter 11: Computational Engine
• Chapter 12: Management of a Monitoring System
Phases I and II - Completed

**Phase I - System Design Needs:**

*Define user and functional requirements*

- *Task 1*: Inventory and Assess Existing Traffic Monitoring Systems
- *Task 2*: Identify User Needs
- *Task 3*: Characterize User Needs
- *Task 4*: Define Functional Requirements
- *Task 5*: Phase I Interim Report

**Phase II - System Design Completion and Guidebook Preparation**

*Prepare the draft guidebook*

- *Task 6*: Develop Sampling and Data Acquisition Plans
- *Task 7*: Design a Monitoring System (Draft Guidebook)
- *Task 8*: Assess the Design Trade-offs for Real-time versus Archived Travel Time Data Collection Systems
- *Task 9*: Phase II Report
Phase III – Underway

• Field Testing
  • Five sites
  • Validate methodology
  • Analyze results
  • Summarize results
• Update the guidebook
• Prepare the final report
Reliability, Consistency, and Disutility
Organizing the Reliability Data

- Travel time is the fundamental metric
- TT-PDFs tell the story
- Regimes – codify the TT-PDFs – modes of operation

- Monuments – mid-link locations
- Segments – monument to monument (virtual) links
- Routes – sequences of segments
- Route bundles – collections of routes (M2M or A2A)
- Temporal buckets – periods of time (e.g., 5 min, AM peak)
- User groups – travelers (packages) of a similar type
- Market – (user group, temporal bucket, route bundle)
Data Processing for Use Cases

50 Use Cases (e.g.,)
• When do I have to leave?
• What is the system status?
• What are the causal factors?
Data Analyses

• Real-Time
  • Identify operative regimes by segment (TT-PDFs)
  • Predict future regimes based on emerging trends
  • Estimate trip TT-PDFs

• Off-line
  • Update regimes – Bayesian methodology
  • Check regime sets (add new?)

• Ex-post-facto
  • Causal factor analysis
  • Check TT-PDF trends
  • Analyze correlation behavior
Analysis Challenges

• Obtaining travel time inputs
• Relating PDFs for travel times by *individuals* to PDFs for *mean* travel times (speeds) observed by system sensors
• Relating segment TT-PDFs to trip TT-PDFs
• Identifying regimes
• Identifying causal factors
Developing the TT-PDFs

Processing Steps

- **State-of-the-Practice**
  - Count-to-Speed Converter
  - DT 3b Count-to-Speed
  - Segment Speeds Converter
- **State-of-the-Art**
  - Inference Engine
  - Est. OD TT-PDFs

Data Types

- **Volumes/Occupancies**
  - DT 4 Volumes/Occupancies
- **Measured Speeds**
  - DT 3a Measured Speeds
- **Segment Travel Times**
  - DT 2a Measured Segment Travel Times
- **OD Travel Times**
  - DT 1b Measured OD Travel Times

Traffic Data Sources

- **Infrastructure-based**
  - Single Loop
  - Dual Loops
- **Vehicle-based**
  - AVL
  - AVI
  - Some AVI
Individual Arterial Travel Times

Arterial Trip Time Trends - One Reader Pair
Week of 8-1-2007
Individual Travel Time Percentiles

![Graph showing travel time percentiles for Tuesday (2-5) and Thursday (6-3)]
Arterial Regimes
Impacts of Weather

CDF for 6-3 on 12-13

Number of Observations vs. Travel Time (sec)

- Blue line: 11:16-11:55
- Green line: 11:48-12:25
- Red line: 12:15-12:56
- Cyan line: 12:53-13:26

CDF for 6-3 on 12-13

Number of Observations vs. Travel Time (sec)

- Green line: 13:32-14:28
- Red line: 13:34-15:08
- Cyan line: 13:35-21:23
Individual TTs and Mean TT-PDFs

**Individual Trip Times on an Arterial**

- **Travel Time (seconds)**
- **Time During the Week (Days)**

**Mean Arterial Travel Time Distribution**

- **Number of Observations**
- **Mean Travel Time (seconds)**
Trip TT-PDFs and Segment TT-PDFs

Segment Travel Time Distribution

PDFs for Three Conditions

P(T(A+B) = x
x = T(A+B), minutes

PDFs for Three Conditions

Pos
Neg
Uncor
Freeway Regimes

Travel Time (min)
Freeway Trip Mean TT-PDFs
Freeway Causal Factors

No Event

Incident

Weather

Special Event

I-8 WB, weekdays 4:00 PM-8:00 PM, Nov 1, 2008-Feb 28, 2009
Congestion Impacts
Congestion Impacts (2)
Site 1 – San Diego

- **Instrumentation**
  - Loop detectors and RTMS on freeways
  - Wireless sensors on 18 arterial links and 10 intersections
  - 80% of the buses have AVL and 50% have automated passenger counters

- **Data**
  - Freeways – 5 minute granularity
  - Arterials – Re-ID travel times
  - Signals - Control delay and effective green time.
  - Transit – “Service Pattern” travel times

- **Analyses**
  - Auto trips
  - Transit trips
  - Truck (freight) trips
Site 2 – Northern Virginia

- **Instrumentation**
  - Multiple Types of Sensors on Freeways
  - Primarily I-395 and I-66

- **Data**
  - Speed and Volume data available for approximately 100 mi. of instrumented roadways
  - Includes instrumented HOV lanes
  - High quality metadata available for all sensor stations

- **Analyses**
  - Travel times on freeways
Site 3 – Sacramento to Lake Tahoe

- **Instrumentation**
  - Tag readers
  - I-80: 2 miles apart – 75 miles
  - US-50: at Lake Tahoe

- **Data**
  - AVI data by segment and overall

- **Analyses**
  - Individual traveler TT-PDFs versus system TT-PDFs
  - Travel time correlations
  - Trip TT-PDFs from segments.
Site 4 - Northern New Jersey

• Instrumentation
  ➢ TRANSMIT tags and readers
  ➢ ALK Co-Pilot Live probe data

• Data
  ➢ Aggregated tag-based travel times
  ➢ AVL data (from probes)

• Analyses
  ➢ System-level trends from aggregated tag data
  ➢ Traveler versus system comparisons based on probe data
Site 5 – Atlanta

- Instrumentation
  - NaviGAtor cameras
  - About 1,645 video stations
  - Every 1/3 mile along interstates
- Data
  - Continuous speed and volume data to the TMC
  - New data feed
  - Deployed as part of NaviGAtor 2
    TMC software scheduled to be online before end of 2010
- Analyses
  - How to use video data
  - Segment travel time correlations?
  - Space-mean speeds?
Summary

- Perspective and methodology have been developed
- Draft guidebook has been prepared
- Field-based testing is getting underway
Questions / Thank you