What I’ll Cover

- Definition of travel time reliability (TTR) and why it’s important
- Forecasting reliability
  - SHRP 2 products
  - Example applications: Florida MPOs, Maryland SHA, and Knoxville TPO
TRAVEL TIME RELIABILITY DEFINED
A Model of Congestion and Its Sources

Physical Capacity \( \rightarrow \) …interacts with… \( \rightarrow \) Demand Volume

Base Delay ("Recurring" or "Bottleneck")

\( n \) = Source of Congestion
A Model of Congestion and Its Sources

- **Source of Congestion**: n

### Diagram:

- **Physical Capacity**
  - ...interacts with...
  - **Demand Volume**
  - ...determine...

- **Daily/Seasonal Variation**
  - Planned

- **Special Events**
  - Emergencies

- **Base Delay**
  - (“Recurring” or “Bottleneck”)

- **Daily/Seasonal Variation**
  - 2

- **Special Events**
  - 3

**Note:** The diagram illustrates the relationships between the different factors contributing to congestion and their potential sources.
A Model of Congestion and Its Sources

- Traffic Control Devices
- Daily/Seasonal Variation
- Special Events

- Physical Capacity
- Demand Volume

- Base Delay ("Recurring" or "Bottleneck")

- Planned
- Emergencies

- Roadway Events
  - Weather
  - Incidents
  - Work Zones

= Source of Congestion
A Model of Congestion and Its Sources

- **Traffic Control Devices**
- **Daily/Seasonal Variation**
- **Special Events**

1. Traffic Control Devices
2. Daily/Seasonal Variation
3. Special Events

**Base Delay** ("Recurring" or "Bottleneck")

**Physical Capacity**

**Demand Volume**

**Event-Related Delay**

**Total Congestion & TTR**

**Roadway Events**

- **Weather**
- **Incidents**
- **Work Zones**

**Planned Emergencies**

...determine...

...lowers capacity and changes demand...

...can cause...

\(n\) = Source of Congestion
Travel Time Reliability

- Measured by how travel time of a trip varies over time (from day-to-day) for a specific time period (e.g., peak period)

- 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 should have the ability to predict travel time for a trip and to arrive at destination within an “on-time window”
Why Is Reliability Important?

- Planning for unreliable travel has costs for users
  - In the past we assumed only the average travel time for a trip was valued, ...but..
  - Studies have shown that variability/unpredictability has cost too
    - VOR ~ 80% of VOT, higher for trucks

- Can be treated cost-effectively by addressing roadway “events” through operations strategies
  - But any capacity increase or demand reduction will also improve reliability

- Considering reliability is basically analysis of the “full year” rather than the “perfect day” – it’s how facilities actually operate and what users actually experience
MEASURING RELIABILITY
Reliability in Concept

Each cell is one analysis period of an analysis segment.
Effects of Incidents and Weather

Weekday Travel Times
5:00-6:00 P.M., on State Route 520 Eastbound, Seattle, WA

Travel Time (in Minutes)

Jan 3  Feb 2  Mar 4  Apr 3

2003

Number of Incidents
Travel Time Distribution is the Basis for Reliability Performance Measures

Number of Trips (in Thousands)

Free Flow  Mean  95th Percentile  99th Percentile

Travel Time (in Minutes)

Misery Time

Buffer Time

Planning Time

Standard Deviation
PREDICTING RELIABILITY
Reliability Prediction: SHRP2 Tools

<table>
<thead>
<tr>
<th>SHRP2 Project</th>
<th>Analysis Scale (in order of increasing complexity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C11</td>
<td>Sketch planning; system or project level</td>
</tr>
<tr>
<td>L07</td>
<td>Detailed sketch planning; mainly project level</td>
</tr>
<tr>
<td>L08</td>
<td>Facility analysis using HCM scale of analysis</td>
</tr>
<tr>
<td>C10</td>
<td>Regional planning using linked travel demand and mesoscopic simulation analysis</td>
</tr>
<tr>
<td>L04</td>
<td>Corridor planning using linked travel demand and mesoscopic or microscopic simulation analysis</td>
</tr>
</tbody>
</table>
C11 Sketch Planning Tool

- **Original Product**
  - Designed for project level analysis (one project at a time)
  - Used national defaults for reliability prediction curves
  - Standalone spreadsheet
  - Recurring (bottleneck) and incident delay only

- To be more useful, why not link to travel demand model so that the reliability of system-wide projects can be developed?
  - Can be used to produce not only the common reliability measures but the MAP-21 measures and other travel time-based measures
C11 Post-Processor: Enhancements

- **Functionality**
  - Post-Processor to TDF models; uses loaded network file

- **Analytics**
  - Custom reliability relationships, including arterials
  - Library of operations improvements and their impact factors

- **Maryland SHA**
  - Statewide model
  - Allows capacity and operations projects to be considered

- **Florida MPOs**
  - Safety prediction

- **Knoxville TPO**
  - Delay due to weather (NOAA data for TYS) and traffic variability (Knoxville ITS data)
C11 Post-Processor: How It Works

- Traffic data gathered from loaded network file
  - Volumes and capacities are critical; model values may need adjusting

- Users define:
  - Corridors for tabulating results
  - Assign improvements to corridors

- Recurring congestion uses a VDF (modified Davidson)

- Incident delay uses IDAS equations

- Improvements affect capacity, delay, or incident characteristics

- Reliability predicted from average conditions
NPMRDS-Based Relationships for TN
NPMRDS-Based Relationships for TN (cont.)
## Knox County 2040 Results

<table>
<thead>
<tr>
<th>Route</th>
<th>Mean TTI</th>
<th>80&lt;sup&gt;th&lt;/sup&gt; %ile TTI</th>
<th>95&lt;sup&gt;th&lt;/sup&gt; %ile TTI</th>
<th>MAP-21 % Reliable (PM)</th>
<th>Total Excessive Delay (PM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcoa Highway</td>
<td>1.108</td>
<td>1.138</td>
<td>1.416</td>
<td>97.1%</td>
<td>549</td>
</tr>
<tr>
<td>I-140</td>
<td>1.214</td>
<td>1.300</td>
<td>1.706</td>
<td>93.8%</td>
<td>771</td>
</tr>
<tr>
<td>I-275</td>
<td>1.072</td>
<td>1.077</td>
<td>1.232</td>
<td>100.0%</td>
<td>235</td>
</tr>
<tr>
<td>I-40/75</td>
<td>1.507</td>
<td>1.645</td>
<td>2.749</td>
<td>51.0%</td>
<td>2,558</td>
</tr>
<tr>
<td>I-640/75</td>
<td>1.134</td>
<td>1.147</td>
<td>1.436</td>
<td>100.0%</td>
<td>270</td>
</tr>
<tr>
<td>Chapman Hwy</td>
<td>1.264</td>
<td>1.354</td>
<td>2.029</td>
<td>93.6%</td>
<td>554</td>
</tr>
<tr>
<td>Kingston Pike</td>
<td>1.400</td>
<td>1.595</td>
<td>2.465</td>
<td>86.8%</td>
<td>1,173</td>
</tr>
</tbody>
</table>
C11 Post-Processor: Next Steps

- Currently “not ready for prime time software” – can be run for an MPO as a service
- Ideally, “user grade” software should be created
- Calibration to NPMRDS speeds
  - Adjust capacity (as per the HCM) to match observed speeds
  - TDF models not usually calibrated this way – will it change interpretation?
- Can help with MAP-21 target setting
  - Planning Rule states that projects in LRTP and TIP need to “show progress toward targets
  - Time periods for MAP-21 measures do not coincide with TDF model periods very well
Questions?

- Rich Margiotta
- Rmargiotta@camsys.com
MAP-21/FAST ACT MOBILITY PERFORMANCE MEASURES
Known by many names but Rule refers to them as “System Performance Measures”
  » MAP-21, FAST ACT, PM3 are other names you hear

Final rule is slightly different from the proposed rule, but is still a mix of measures and targets for the measures

Measures now based on both based on travel time vs. other forms of data

Implementation of the Final Rule was delayed twice as new administration reviewed it

Measures to be based on empirical data: the NPMRDS or approved “equivalent”
### Proposed vs. Final Rule

<table>
<thead>
<tr>
<th>Proposed Rule</th>
<th>Final Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Reliability</td>
<td>System Reliability</td>
</tr>
<tr>
<td>Peak Hour Travel Time Ratio</td>
<td>(dropped)</td>
</tr>
<tr>
<td>Truck Travel Time Reliability</td>
<td><strong>Truck Travel Time Reliability</strong></td>
</tr>
<tr>
<td>Average Truck Speed</td>
<td>(dropped)</td>
</tr>
<tr>
<td>Excessive Delay</td>
<td><strong>Peak Hour Excessive Delay</strong></td>
</tr>
<tr>
<td>CMAQ On-Road Emissions</td>
<td>Percent Non-SOV Travel</td>
</tr>
<tr>
<td></td>
<td>Percent Change in Tailpipe CO2 Emissions (now in administrative limbo)</td>
</tr>
</tbody>
</table>

*Bold indicates travel time-based measures*
National Performance Management Research Data Set (NPMRDS)

- FHWA just switched contractors from HERE to a UMD/INRIX /TTI team
- First new data expected in July
- NPMRDS #1 went through February but is now unavailable
  » Old data MAY become available through new contract
- New features
  » Conflated to HPMS
  » “Probe Data Indicators” – TBD
  » Data based on a mix of spot speeds and path processing
    – Should help signalized highway estimates
  » More TMCs included (links)
    – Break out small links that are internal to intersections and interchanges; these were previously aggregated onto adjacent links
Opportunities for Modeling

- NPMRDS speeds being used to calibrate simulation models – can be used for TDF models and sketch planning tools as well

- Ability to predict the System Performance measures
  - Planning Rule states that projects in TIP, STIP, and LRTP should, “to the extent possible”, indicate how projects contribute to progress toward the target
  - Standalone (e.g.) HCM vs. integration with travel demand and simulation models
  - **Perhaps part of a larger Model Applications Guide**

- Challenges
  - Multiple time periods considered by the new measures – beyond what users typically consider
Where the Modeling Can Help

- Forecasting activities for performance management
  - Target setting
  - Statistical controls in before/after studies
  - Evaluating proposed projects, especially how they make progress toward targets

- New HCM Reliability procedures “hit the sweet spot”
  - More rigorous than sketch planning, less data and resource intensive than simulation