Disclaimer

This presentation solely reflects the opinion of the SHRP 2 contractor and does not necessarily represent the opinion of the National Academies, the National Research Council, or the sponsors of the research.
Value of Reliability (VOR)

Synthesis of Existing Practices and Insights from SHRP2 C04 Project “Improving Our Understanding of How Highway Congestion & Pricing Affect Travel Demand”
VOR Quantification

- Choice context / travel dimensions:
  - Route choice (highway users only)
  - Mode choice (all travelers)
  - Time-of-day choice (depends)

- Assumed generalized cost function:
  - \( U = \alpha \times \text{Time} + \beta \times \text{Cost} + \gamma \times \text{Reliability} \)
  - \( U = \alpha \times f(\text{Time}) + \beta \times g(\text{Cost}) + \gamma \times \text{Reliability} \)

- Reliability measure:
  - Time spent in congested conditions (proxy)
  - STD or Variance (symmetric absolute)
  - Buffer time (asymmetric absolute)
  - Expected delay & early arrival vs. PAT (asymmetric absolute)
  - STD per unit distance (symmetric relative)
Still Problem with Data

- Time in congested conditions as proxy for Reliability:
  - SP and RP (a bit more elaborate skims)
- Time variability (STD, buffer time)
  - Majority is based on SP
  - Very few RP settings (ML vs. GPL)
  - SHRP 2 C04 used special method
- Schedule delay/lateness:
  - SP only since PAT is normally unknown in RP
Reliability Ratio ($\rho$)

- $U = \alpha \times \text{Time} + \beta \times \text{Cost} + \gamma \times \text{Reliability}$
  - $VOT = \alpha / \beta$
  - $VOR = \gamma / \beta$
  - $\rho = \gamma / \alpha = VOR / VOT$

It is more complicated with non-linear models:
- $VOT$, $VOR$, and $\rho$ becomes functions of time, cost, or distance
- These variables must be fixed at certain values to calculate $VOT$, $VOR$, and $\rho$
## Summary of Defaults for $\rho$

<table>
<thead>
<tr>
<th>Population segment</th>
<th>Travel segment</th>
<th>Perceived congested time vs. free-flow</th>
<th>STD vs. mean time</th>
<th>Buffer 90th-50th vs. median time</th>
<th>Lateness against PAT vs. mean time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To work</td>
<td>2.0</td>
<td>0.8</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>From work</td>
<td>1.5</td>
<td>0.6</td>
<td>0.6</td>
<td>2.0</td>
</tr>
<tr>
<td>High income (60K+)</td>
<td>Non-work</td>
<td>1.2</td>
<td>0.4</td>
<td>0.5</td>
<td>1.8</td>
</tr>
<tr>
<td>Low income (U60K)</td>
<td>To work</td>
<td>2.5</td>
<td>1.0</td>
<td>1.2</td>
<td>6.0</td>
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<tr>
<td></td>
<td>From work</td>
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<td>0.3</td>
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<td>1.7</td>
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<tr>
<td></td>
<td>Non-work</td>
<td>1.1</td>
<td>0.2</td>
<td>0.2</td>
<td>1.5</td>
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</table>

TRB, January 2011
SHRP 2 C04 Findings: Improved Generalized Cost Function

- **Deterministic version:**
  \[ U_s = \Delta_s + (a_{1s} + a_{2s} \times \text{Dist} + a_{3s} \times \text{Dist}^2) \times \text{Time} + \beta_s \times \frac{\text{Cost}}{(\text{Inc}_e \times \text{Occ}_f)} + \gamma_s \times \text{STD}/\text{Dist} \]
  - Applicable with any model that generates STD reliability measure
  - If STD reliability measure cannot be produced perceived highway time can be used as a proxy

- **Probabilistic version:**
  \[ U_s = \int [\Delta_s + (a_{1s} + a_{2s} \times \text{Dist} + a_{3s} \times \text{Dist}^2) \times \text{Time} + \beta_s \times \frac{\text{Cost}}{(\text{Inc}_e \times \text{Occ}_f)} + \gamma_s \times \text{STD}/\text{Dist}] \times g(a_{1s}) \, da_{1s} \]
  - Applicable only with advanced microsimulation model
Incorporation of Reliability

- \( U = \alpha \times \text{Time} + \beta \times \text{Cost} + \gamma \times \text{STD}/\text{Dist} \)
- \( \text{VOR} = \left( \gamma / \beta \right) / \text{Dist} \)
- \( \text{VOR/VOT} = \left( \gamma / \alpha \right) / \text{Dist} \)
- \( \text{VOR} \& \rho \) range:

<table>
<thead>
<tr>
<th>Trip purpose</th>
<th>Distance</th>
<th>VOR</th>
<th>( \rho )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work</td>
<td>5 miles</td>
<td>$54.9/hour</td>
<td>1.88</td>
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<td>10 miles</td>
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<td>20 miles</td>
<td>$13.8/hour</td>
<td>0.47</td>
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<tr>
<td>Non-work</td>
<td>5 miles</td>
<td>$40.8/hour</td>
<td>2.02</td>
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<tr>
<td></td>
<td>10 miles</td>
<td>$20.4/hour</td>
<td>1.02</td>
</tr>
<tr>
<td></td>
<td>20 miles</td>
<td>$10.2/hour</td>
<td>0.51</td>
</tr>
</tbody>
</table>