An Empirical Examination of Freeway Travel Reliability

Michael Mauch
UC Berkeley – ITS/PATH

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US-101 Study Corridor
San Francisco to San Jose

Southbound Bottlenecks

Northbound Bottlenecks
US-101 (Northbound + Southbound)
Average Weekday Average Daily Travel (ADT)
US-101 (Northbound + Southbound)
Average Weekday Vehicle Hours Delayed (VHD)
In heavily congested corridors, moderate changes in demand can bring about large impacts to travel delays & levels of congestion.
## Corridor Traffic Growth Trends (2014-16)

<table>
<thead>
<tr>
<th>Day(s) of Week</th>
<th>Corridor Performance Metric</th>
<th>US-101 Northbound</th>
<th>US-101 Southbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-holiday Weekday</td>
<td>VMT</td>
<td>3.2%</td>
<td>4.6%</td>
</tr>
<tr>
<td></td>
<td>VHD</td>
<td>12.4%</td>
<td>12.4%</td>
</tr>
<tr>
<td>Saturday</td>
<td>VMT</td>
<td>6.5%</td>
<td>8.0%</td>
</tr>
<tr>
<td></td>
<td>VHD</td>
<td>28.0%</td>
<td>29.5%</td>
</tr>
<tr>
<td>Sunday</td>
<td>VMT</td>
<td>5.4%</td>
<td>7.2%</td>
</tr>
<tr>
<td></td>
<td>VHD</td>
<td>32.2%</td>
<td>43.4%</td>
</tr>
</tbody>
</table>
US-101 Corridor - Weekday Average Travel-times

**US-101 (NB) Corridor Travel-times on an Average Weekday**

Calendar Year
- 2014
- 2015
- 2016
- Freeflow

**US-101 (SB) Corridor Travel-times on an Average Weekday**

Calendar Year
- 2014
- 2015
- 2016
- Freeflow
US-101 Corridor – Weekday Average Vehicle-Hours Delayed
Travel Time Reliability – Buffer Index

Buffer Index (BI) is a very commonly used travel-time reliability metric. The buffer index represents the extra time (or time cushion) that travelers must add to their average travel time when planning trips to ensure an on-time arrival.

\[
BI(\%) = 100\% \times \frac{95th\% - ile\ travel\ time\ (minutes) - average\ travel\ time\ (minutes)}{average\ travel\ time\ (minutes)}
\]

- The 95\(^{th}\) percentile travel time is a reasonable upper bound for expected travel time – on very heavily congested days.
- A BI of zero means that the 95\(^{th}\) percentile travel time and the average travel time are the same; there are no differences (or variability) in the travel times between an average day and a heavily congested day.
- A BI of 50 means that the travel times on heavily congested days are 1.50 times (or 50\%) greater than on average days.
US-101 Northbound
Average Weekday Buffer-Index & Speed Contours
US-101 Northbound
Average Weekday Buffer-Index & Speed Contours
INRIX data: Mean speeds & reliability

- Unreliable Speeds
- Moderate Reliability
- Stable Speeds
- Highly Congested
- Moderate Congestion
- Freely Flowing


- Speed(Mean, StDev) Data Point
- Empirical Means
- Mean - Std-Dev
- Mean + Std-Dev

Segment Standard Deviation in Speeds (mph) vs. Segment Mean Speeds (mph)
US-101 Southbound
Average Weekday Buffer-Index & Speed Contours


US-101 Southbound
Average Weekday Buffer-Index & Speed Contours


INRIX data: Mean speeds & reliability

- **Unreliable Speeds**
- **Moderate Reliability**
- **Stable Speeds**

**Highly Congested**

**Moderate Congestion**

**Freely Flowing**

**Freeway travel-time reliability**

**Reliability = Consistency**

Travel times tend to be reliable or consistent on freeway segments (and time-of-day) when traffic is always freely flowing – no congestion.

Travel times tend to be fairly reliable on heavily congested stretches – segments and times that are congested every day – not just occasionally congested.

Travel times tend to be the most unreliable on freeway segments that are congested on some days and not congested on other days – some good days & some bad days \( \rightarrow \) not consistent.

Reliability gets worse as corridors transition from uncongested to moderately congested.

Reliability gets better as corridors transition from moderate to severe congestion.
Freeway travel-time reliability

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Thank You
Questions & Comments