Travel Time Reliability Application for Planning-Level Transportation Project Evaluation

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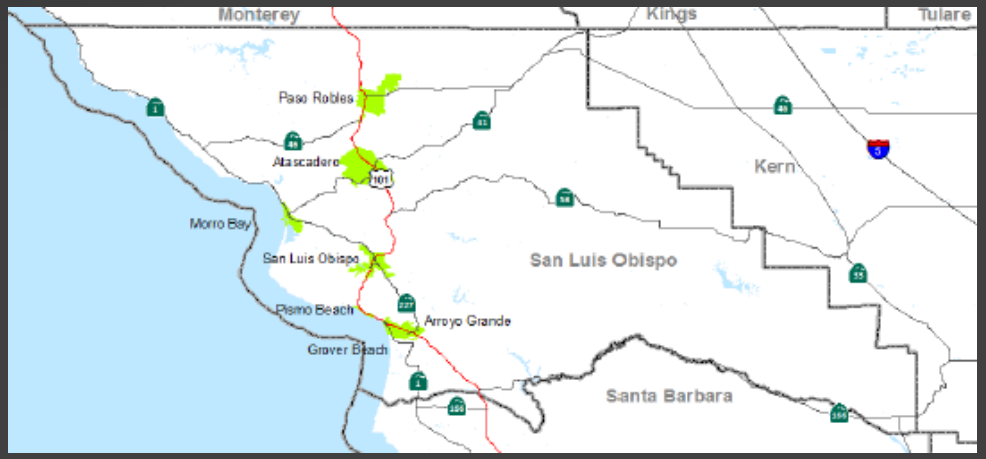
US 101 Corridor Mobility Master Plan & Travel Time Reliability

- Incorporated as part of the freeway operational analysis
- Travel Time Reliability – first application in District 5
- Travel Time Reliability represented by “Buffer Time”
- Buffer time reduction and delay reduction added to yield total monetary time saving benefits of US101 mainline improvement concepts
- Results? But first
  - what is travel time reliability?



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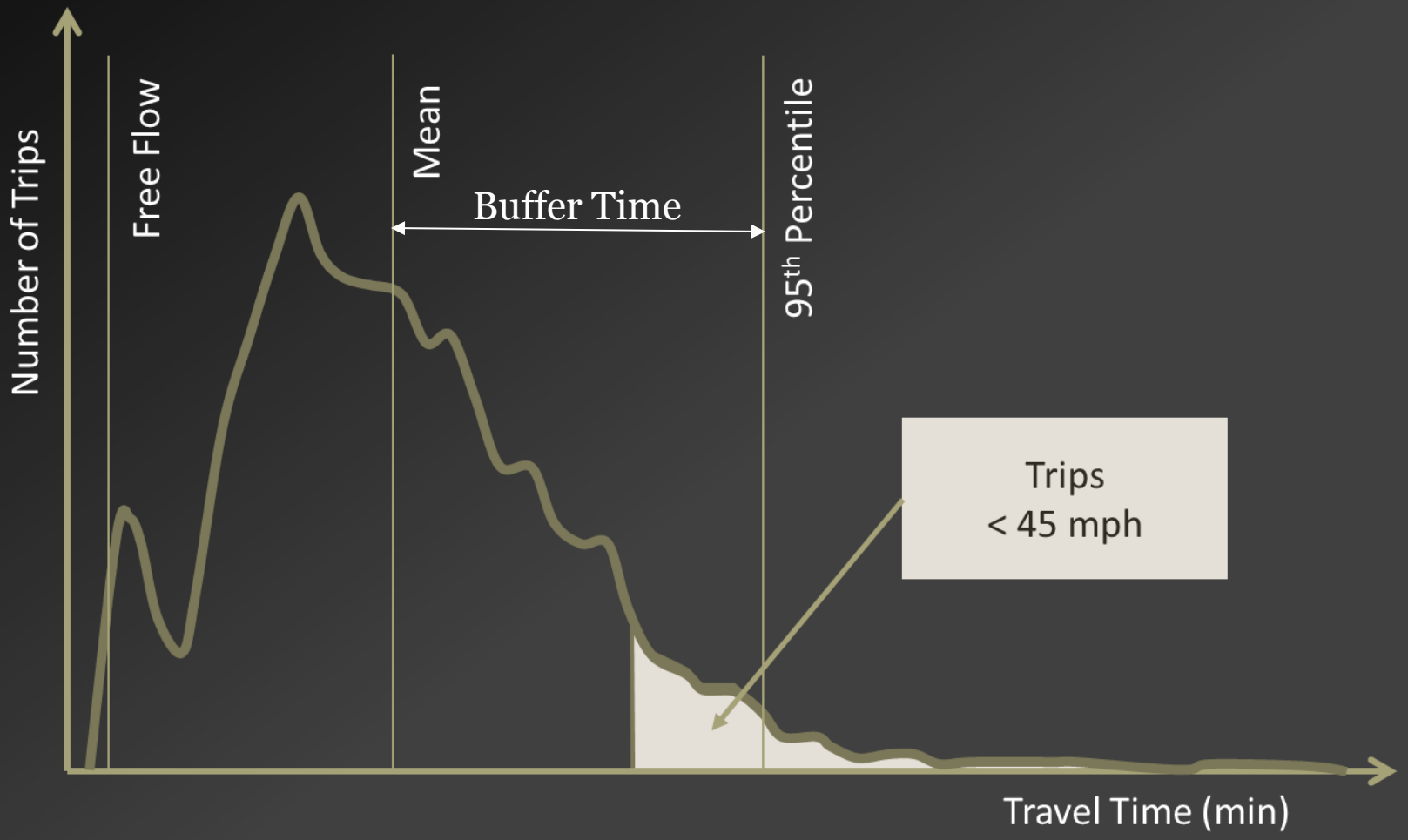
What is Travel Time Reliability?

- Travel time reliability is:
  - The distribution of travel times that a traveler should anticipate if starting a trip at a given point at a given time and day.
- Travel Time Reliability represented by “Buffer Time”
  - Buffer Time – added increment of time required to ensure you reach your destination at the desired time 95% of the time.
  - How much earlier do you need to leave your home to ensure arriving on time.
  - Time you could spend at home (effect is assumed to be similar to when you experience delay while driving your car i.e., travel time delay)

Buffer Time

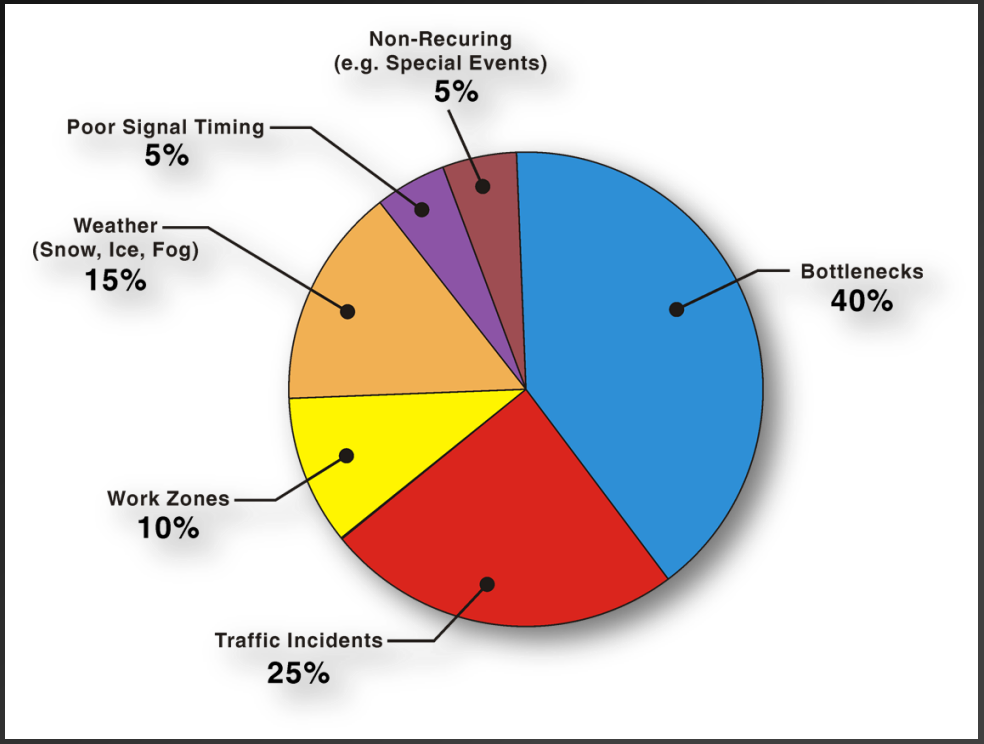

Number of Trips
Free Flow
Mean
Buffer Time
95th Percentile
Trips
< 45 mph
Travel Time (min)

Commonly Applied Reliability Measures

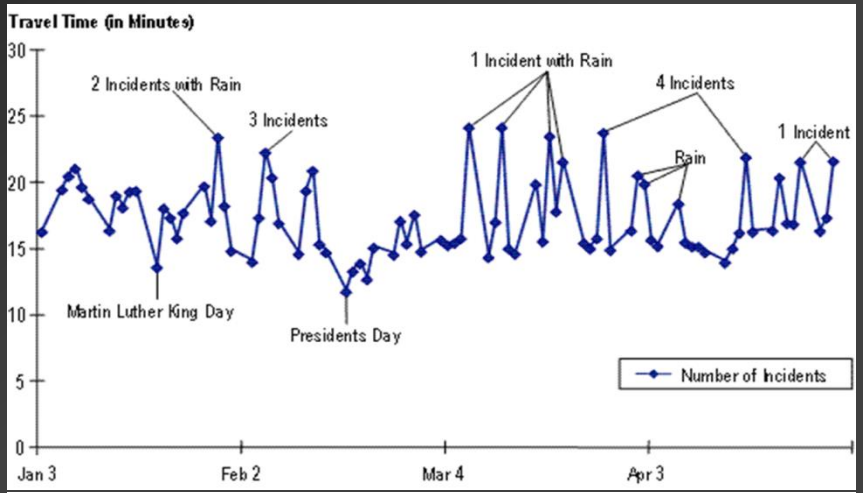
Measure	Definition	Description
Planning Time	95th percentile travel time	The total travel time required to arrive on-time 95% of the time
Planning Time Index	The ratio of the Planning Time to the Ideal or Free Flow Travel Time	How much larger the potential total travel time is than the ideal or free-flow travel time
Buffer Time	The difference between the 95th percentile travel time and the average travel time	The amount of buffer time required
Buffer Index	The 95th percentile travel time minus the average travel time divided by the average travel time	The size of the buffer as a percentage of the average
Travel Time Index*	Actual travel time divided by the free-flow travel time for a given observation period	Measure of average congestion

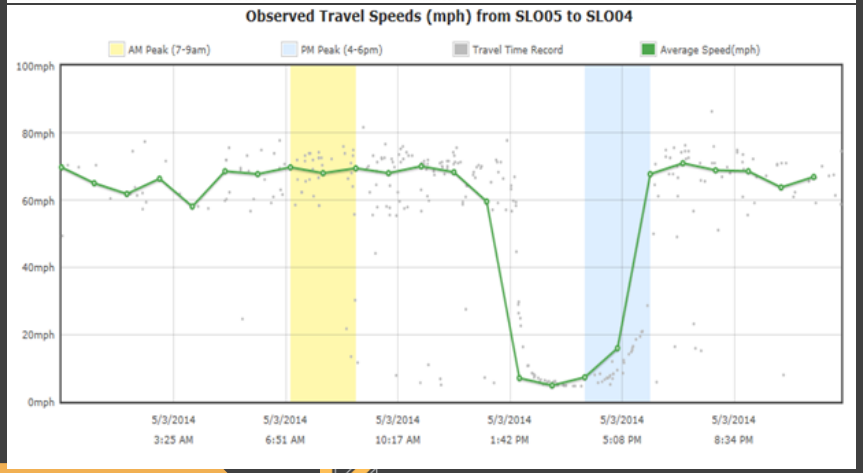
What are the Causes of Unreliability?

Causes of Unreliability



Day-to-Day Variations in Travel Time





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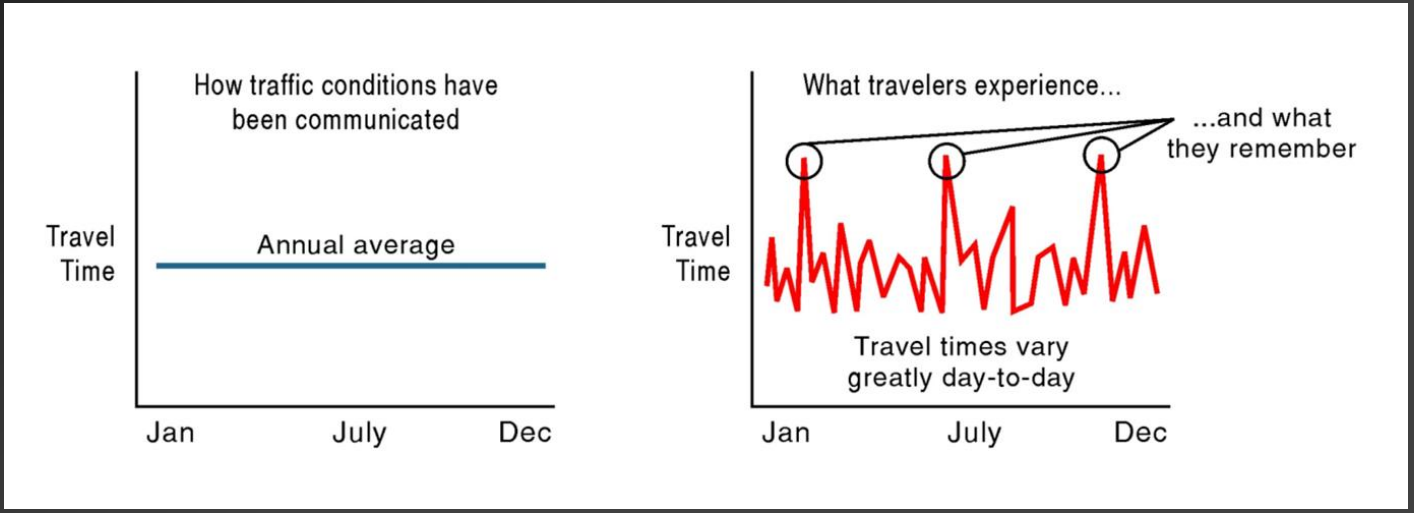
Why is Travel Time Reliability Important?

1) Our roadway networks are more frequently operating in a near or above capacity
2) Uncertainties in travel time adversely impact us in multiple ways
3) We don't have a way to measure the benefit of many of our strategies and investments



http://ops.fhwa.dot.gov/publications/tt_reliability/TTR_Report.htm

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Why is Travel Time Reliability Important?

- Old days (Capacity-oriented)
  - Network build-out and expansion → increase capacity
  - Secure funding environment
  - Traditional performance metrics
  - Reduce travel time
- New way (Reliability-oriented)
  - How best to manage the system we have → increase capacity utilization
  - Financial, environmental and public perception problems
  - Improvements that affect reliability more than capacity
  - MAP-21 (Federal), SB 375 (CA), SB 743 (CA)

Tools for Reliability

- Measuring Reliability
  - FHWA NPMRDS travel time monitoring data set for highways
  - Data Collection
- Predicting or Estimating Reliability
  - University of Florida/FDOT spreadsheet
  - SHRP2-C11 Method
  - HCM 2010 Update (under development)

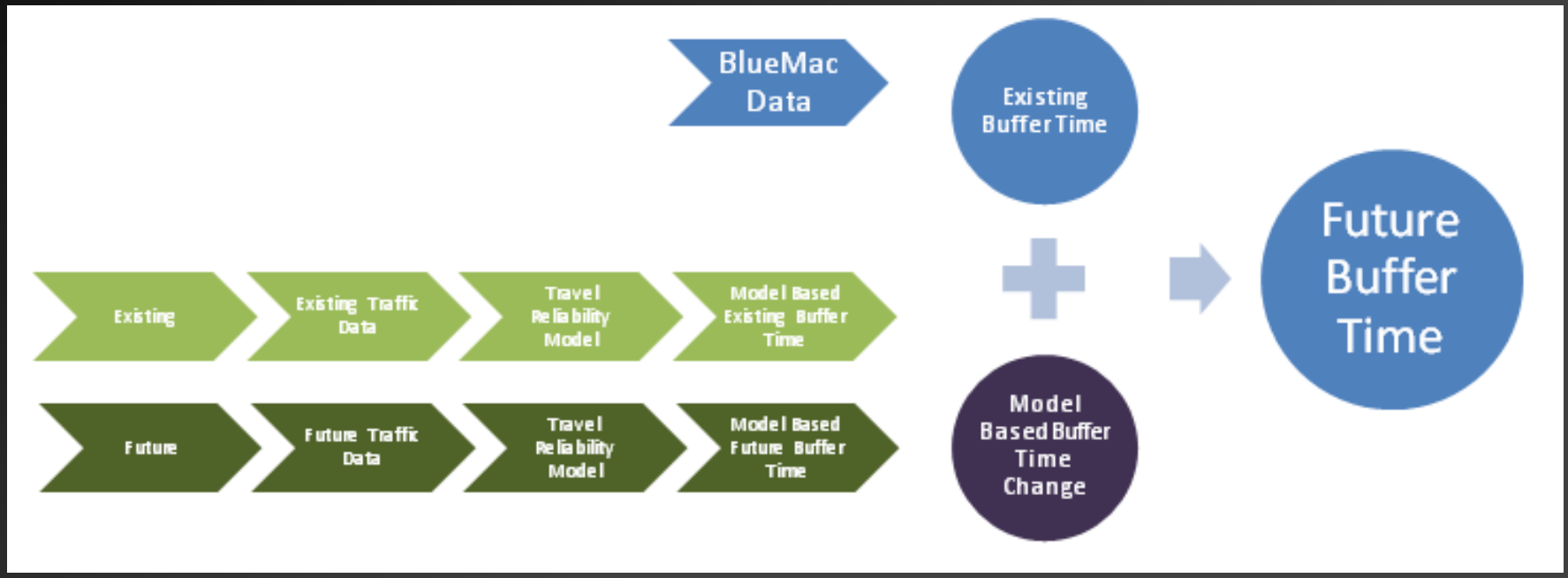
University of Florida/FDOT

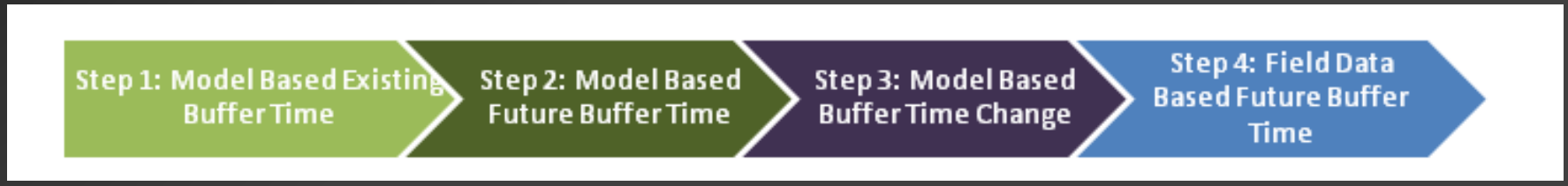
- The UF/FDOT Reliability Spreadsheets
  - Freeway
  - Arterials
- How it works
  - Allocate AADT to each hour of year
  - Compute recurring congestion using HCM capacities
  - For each hour of 24 hour day compute travel times for 24 possible scenarios combining weather, incidents, work zones
  - Assign probabilities to each scenario
  - Compute reliability statistics
- Lots and lots of assumptions built in
  - Seasonal traffic variation, incident frequencies, weather frequencies….

Case Study – SLOCOG 101 Mobility Master Plan

- Reliability measured using Bluetooth detection
- Reliability estimated University of Florida method
- Reliability was predicted by applying UF method growth applied to measured baseline

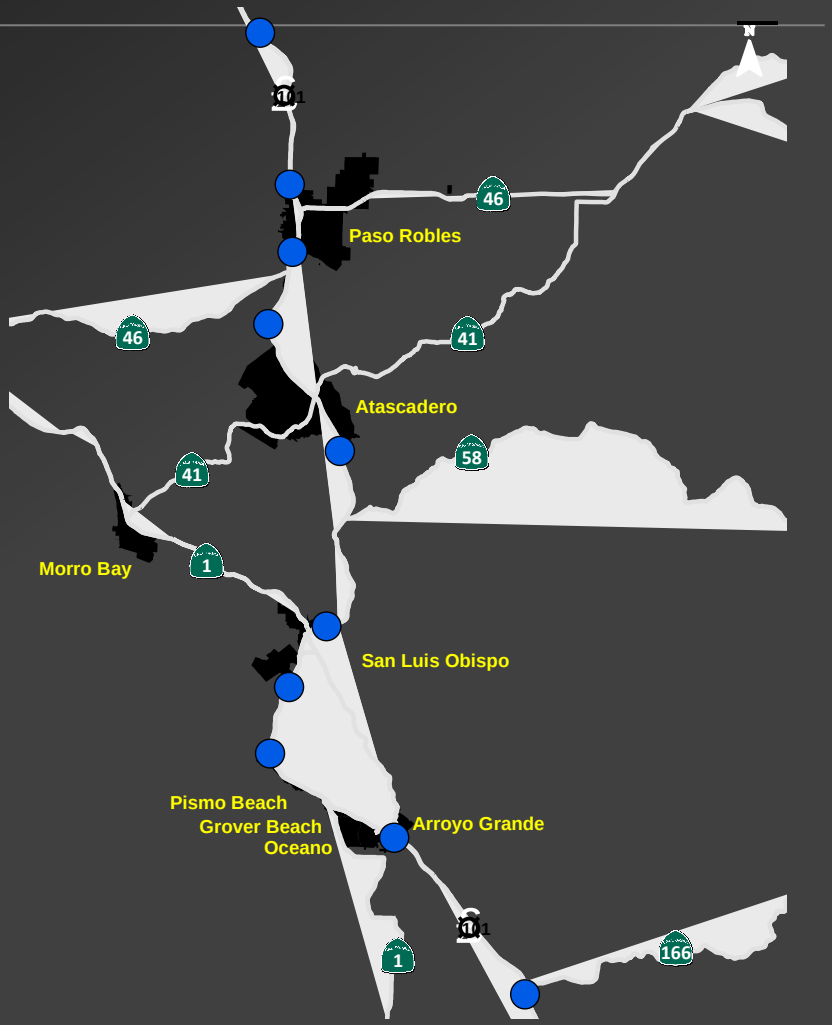
Travel Time Reliability Prediction





US 101 Reliability Measured

- 10 detectors deployed along US 101
- 9 individual segments
- Data was collected continuously for more than 4 months

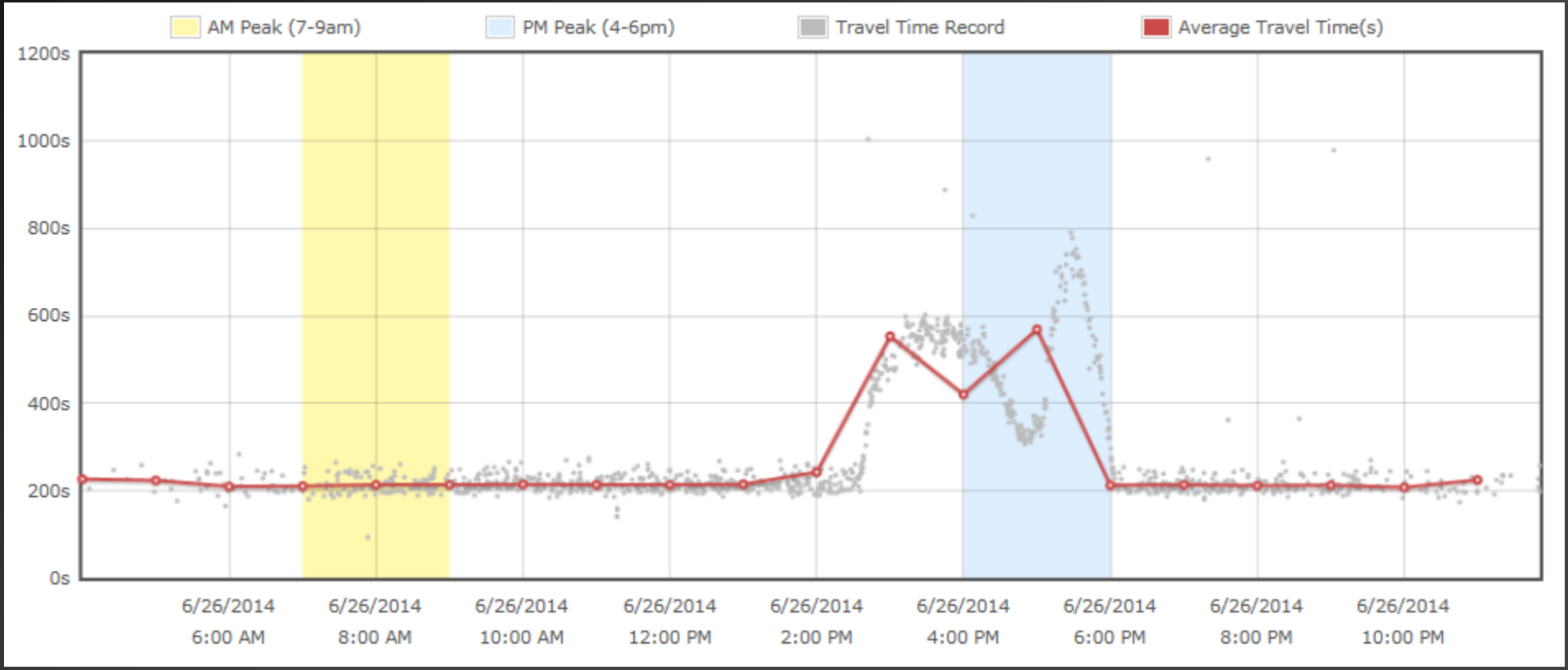


Data Needs for Reliability

- To Predict or Estimate Reliability
  - Demand Variability (Seasonality)
  - Weather frequencies
    - Light, medium, heavy Rain, snow
  - Incident and work zone frequencies
    - Number of lanes blocked
    - Duration
- To Measure Reliability
  - Hourly speeds and volumes 24/7 for 6 months to a year
  - FHWA NPMRDS

Example: Travel Time Reporting

- Southbound – Los Osos Valley Road to Avila Beach Road
  - Daily observed – June 26th, 2014



Example: Travel Characteristics
SB 101 Los Osos Valley to Avila Beach (4-6 PM)

• Trip Distance (miles)	4.03
• Expected Travel Time (sec. / min.)	202 / 3:22
• Number of Trips	1214
• Average Speed (mph)	48.5
• Average Travel Time (sec. / min.)	299 / 4:59
• Standard Deviation (sec.)	146.3
• 15th Percentile (sec. / min.)	200 / 3:20
• 85th Percentile (sec. / min.)	509 / 8:29
• 95th Percentile (sec. / min.)	583 / 9:43

Example: Travel Time Reliability
SB 101 Los Osos Valley to Avila Beach (4-6 PM)

	95th Percentile TT – Avg TT
• Sunday	237s – 215s = 22 sec.
• Monday	247s – 217s = 30 sec.
• Tuesday	250s – 221s = 29 sec.
• Wednesday	244s – 222s = 22 sec.
• Thursday	271s – 229s = 42 sec.
• Friday	320s – 260s = 60 sec.
• Saturday	251s – 219s = 32 sec.

US 101 Case Study in Reliability

- Objective
  - Incorporate Travel time reliability as a metric used in the B/C analysis
  - Buffer time (during typical weekday: Tuesday – Thursday)

- Approach: Existing Conditions
  - Vehicle Operating Conditions
    - Published Traffic Volumes and Counts
    - Bluetooth Data (4 months)
  - Incidents
    - Incident Inventory in PeMS (12 months)
    - CHP Reports (12 months)
  - Weather
    - Paso Robles Airport (12 months)
    - San Luis Obispo Airport (12 months)
  - Work zones
    - Caltrans Website
    - Caltrans PeMS (12 months)

US 101 Case Study in Reliability

- Approach: Future Conditions
  - Travel Demand
    - SLOCOG Travel Demand Model (NCHRP-255 Adjustments for Daily Volumes)
    - Caltrans K & D Factors for full 24-hour Distribution
    - UF Model
      - Expanded procedure for bi-directional results
      - Generate baseline TTR
  - Incidents (same as baseline – UF Model adjusted based on volume)
  - Weather (same as baseline – UF Model adjusted based on volume)
  - Work zones (same as baseline – UF Model adjust based on volume)
- UF Model Procedure (recap)
  - Compute recurring congestion using HCM capacities
  - For each hour of 24 hour day compute travel times for 24 possible scenarios combining weather, incidents, work zones
  - Assign probabilities to each scenario
  - Compute reliability statistics (buffer time, BTI, travel time, TTI etc.)
- Delta Method: Empirical Baseline + (UF Model Future – UF Model Baseline)

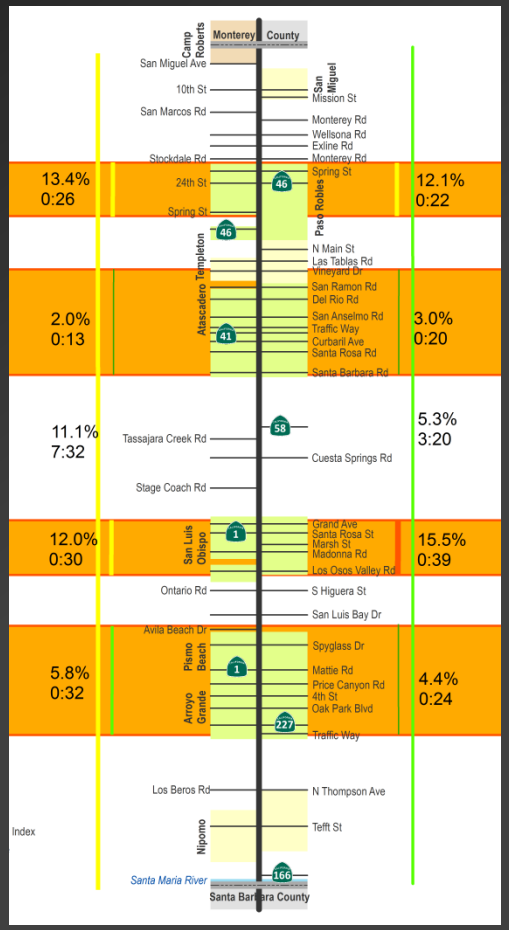
US 101 Case Study in Reliability

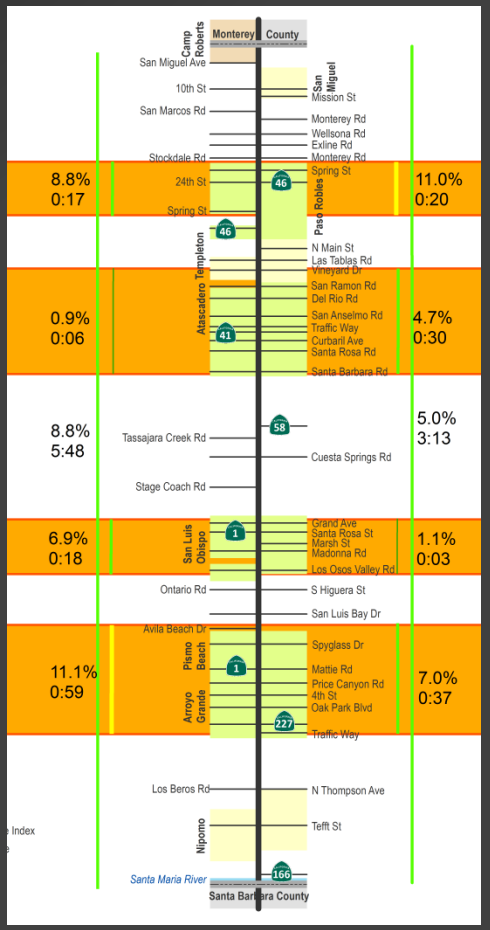
- Annualize 24-hour Distribution Effects on Capacity and Speeds
  - Weather
  - Incidents
  - Work zones
  - Recurring congestion

US 101 Case Study in Reliability

US 101 Case Study Corridor-wide Results

- Existing Condition Reliability on US 101
  - AM Southbound – ~7.5 minutes Buffer Time
  - AM Northbound – ~3.5 minutes Buffer Time
  - PM Southbound – ~6.0 minutes Buffer Time
  - PM Northbound – ~3.0 minutes Buffer Time





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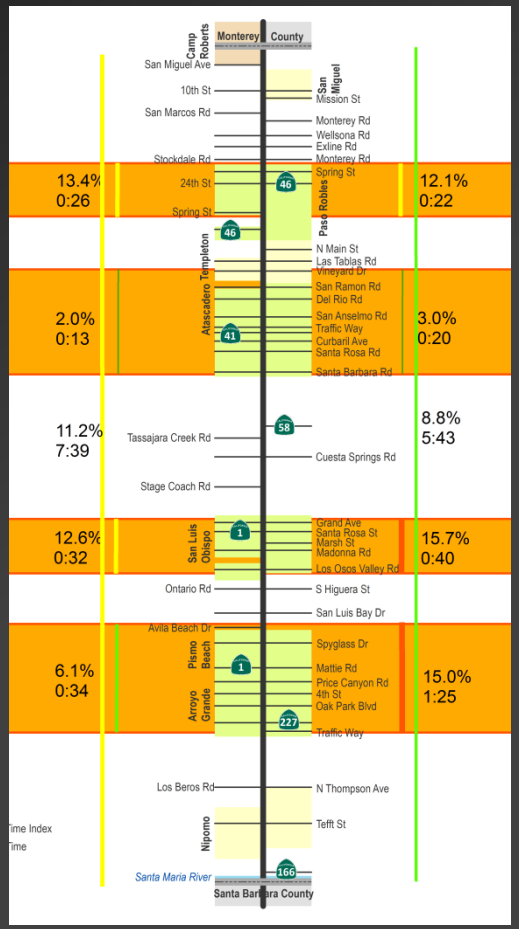
US 101 Case Study in Reliability

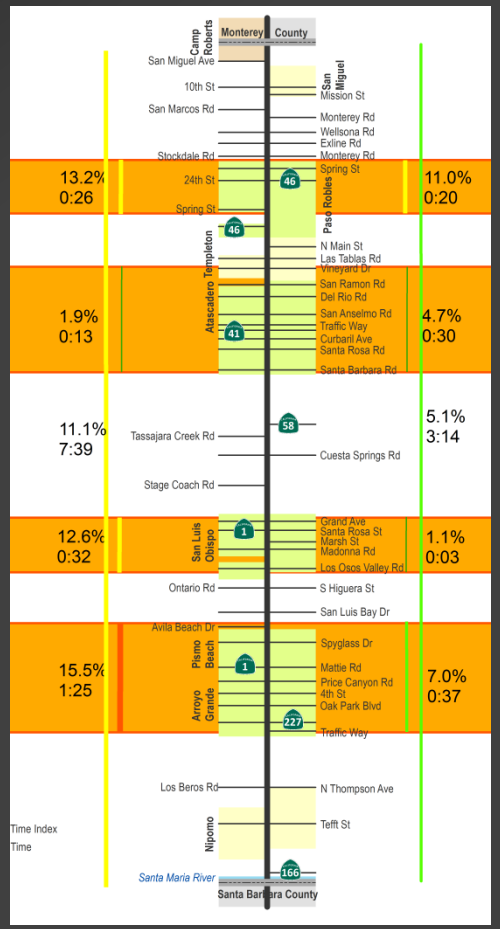
US 101 Case Study Corridor-wide Results

- Future Condition Reliability
  - AM Southbound – ~7.5 minutes Buffer Time
  - AM Northbound – ~6.0 minutes Buffer Time
  - PM Southbound – ~6.0 minutes Buffer Time
  - PM Northbound – ~3.0 minutes Buffer Time

US 101 Case Study Focus Area Results

- Future Condition Reliability (Change)
  - 5 City Area AM Northbound BTI (4.4% - 15%)
  - 5 City Area PM Southbound BTI (11.1% - 15.5%)
  - SLO Area PM Southbound BTI (6.9% - 12.6%)





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US 101 Case Study Findings

- Travel Time Reliability on US 101
  - Generally good reliability corridor-wide
    - < 8 minutes Southbound
    - < 4 minutes Northbound
  - Anticipated to not significantly change in the future
    - Weather not a significant factor
    - Work zones not a significant factor
    - Collision rates generally at or below statewide average for like facilities

US 101 Case Study Findings

- Travel Time Reliability on US 101
  - Where do reliability issues occur:
    - Five-City Area and City of San Luis Obispo
      - Southbound Direction
      - Northbound Direction (Five-City Area)
  - Correlates to where the greatest congestion is projected to occur
  - Supports US101 Mobility Master Plan
    - Buffer Time Reduction Increased B/C of HOV Improvement in Segment 1 by 8%
    - Buffer Time Reduction Increased B/C of HOV Improvement in Segment 2 by 4%

US 101 Case Study Findings

- Travel Time Reliability Metric
  - We did it
    - Wasn't too painful
    - Learned from our experience
      - More than 4-months of data (April – August)
      - Would have been nice to test other reliability tools
      - Expand analysis to weekend
    - Consistent with MAP-21 – provides greater support US101 Mobility Master Plan Recommendations
    - Supports SLOCOG for examining operational improvement on US 101

Questions?