TPM Technical Implementation Workshop

Overview of Performance Measures: Freight Reliability

Jeff Purdy, Office of Freight Management and Operations
Eric Pihl, Resource Center Freight and TPM Team

Phoenix, AZ

September 14-15, 2017

U.S. Department of Transportation
Federal Highway Administration

Agenda

- Introduction of new 23 CFR Part 490
- National Performance Management Measures for Freight Movement on the Interstate
  - Data requirements
  - Calculating Truck Travel Time Reliability
- Establishment of performance targets
- Determination of significant progress toward achieving freight reliability targets
- Truck freight bottleneck reporting
  - Identifying truck freight bottlenecks
  - Addressing congestion at truck freight bottlenecks

New 23 CFR Part 490 Summary

National Performance Management Measures

Subpart A: General Information (Target Establishment, Reporting, and NHPP and NHFP Significant Progress Determination)

Subpart B: Measures for Highway Safety Improvement Program

Subpart C: Measures to Assess Pavement Condition

Subpart D: Measures to Assess Bridge Condition

Subpart E: Measures to Assess Performance of the NHS

Subpart F: Measure to Assess Freight Movement on the Interstate System

Subpart G: Measures to Assess CMAQ Program Traffic Congestion

Subpart H: Measure to Assess CMAQ Program On-Road Mobile Source Emissions

National Performance Management Measure for Freight Movement on the Interstate

U.S. Department of Transportation
Federal Highway Administration

TPM
HOW WE GET THERE

23 CFR Part 490 Subpart F Measure

- **Freight Reliability Measure**: Truck Travel Time Reliability (TTTR) Index
  - The sum of maximum TTTR for each reporting segment, divided by the total Interstate system miles

Definitions (23 CFR 490.101)

- **Measure:** an expression based on a metric that is used to establish targets and to assess progress toward achieving the established targets
- **Metric:** a quantifiable indicator of performance or condition
- **Target:** a quantifiable level of performance or condition, expressed as a value for the measure, to be achieved within a time period required by FHWA
- **Travel time reliability:** the consistency or dependability of travel times from day to day or across different times of the day
- **Travel time segment:** a contiguous stretch of the NHS for which average travel time data are summarized in the travel time data set

23 CFR 490.607 Freight Reliability Measure

	Criteria		Result
Each Reporting Segment	**METRIC** **Truck Travel Time Reliability (TTTR) for each time period and each segment on the Interstate System**	**THRESHOLD** **Not applicable to this measure**	**Maximum TTTR for each reporting segment**
Interstate System	**MEASURE** **TTTR Index:** **The sum of maximum TTTR for each segment, divided by total Interstate miles**	**TARGET** **TTTR Index for the Interstate System**	**State or MPO meets / does not meet target for statewide TTTR Index**

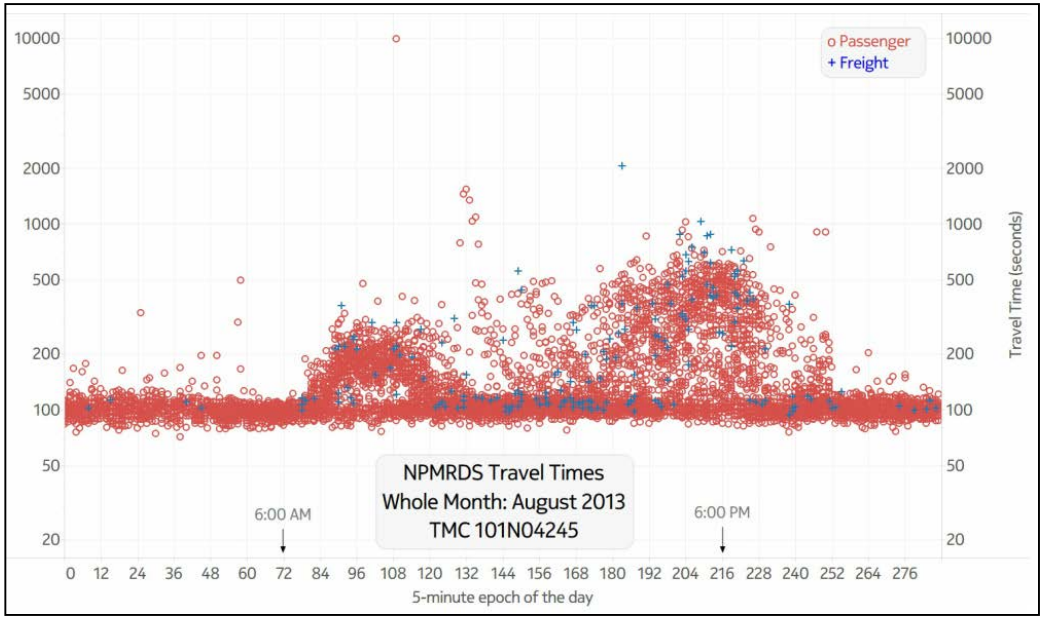
National Performance Management Research Data Set (NPMRDS)

Derived from vehicle/passenger probe data (sourced from Global Positioning Station [GPS], navigation units, cell phones)

- Covers the National Highway System (NHS)
- Includes average travel times representative of all traffic and average travel times for freight trucks on segments that are on the Interstate System.
- Individual records represent 15-minute time periods of every day (24 hours) for a travel time segment, measured continuously throughout the year

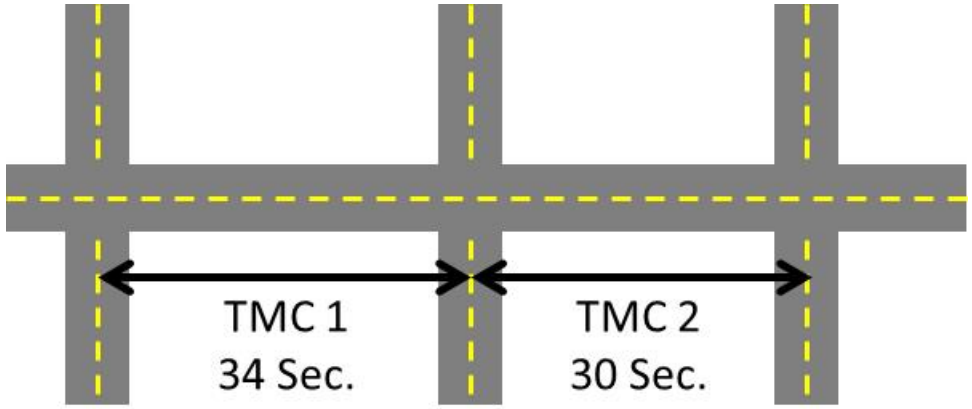
NPMRDS

- Travel times provided by road segments
- Pre-defined road segments are called TMC (traffic message channel) codes and based on the industry standard for traffic reporting
- Travel times provided for passenger, freight, combined values



NPMRDS

- **Map (Shapefile):** Contains precise road geometry of the NHS and attributes about the road segment
- **TMC Static File:** Contains descriptive information about the road segment (TMC code, names, admin info, segment lengths, latitude/longitude)
- **Monthly Travel Time Data File:** Contains the travel time data for each day for a 1-month timeframe

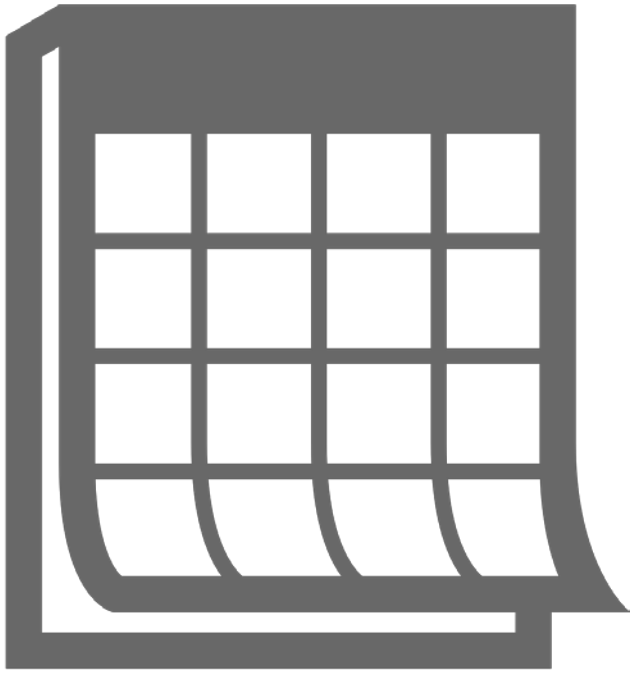


Required Data

- Travel time segment length (miles, to the nearest hundredth mile)
- Epoch (time interval, i.e., 15 minutes)
- Travel time: trucks (seconds)
  - Travel time all vehicles may be used where there are no data for trucks during a 15-minute epoch
- Highway type: Interstate
- Metropolitan Planning Area boundary designation (for MPO reporting)

23 CFR 490.609 Data Requirements: Applicable Time Periods

Full Year (Jan 1-Dec 31)



Weekdays (Mon – Fri)	Weekends
6 – 10 a.m.	**6 a.m. – 8 p.m.**
10 a.m. – 4 p.m.	
4 – 8 p.m.	

Overnight (all days)
8 p.m. – 6 a.m.

Truck Travel Time Reliability (TTTR) Metrics

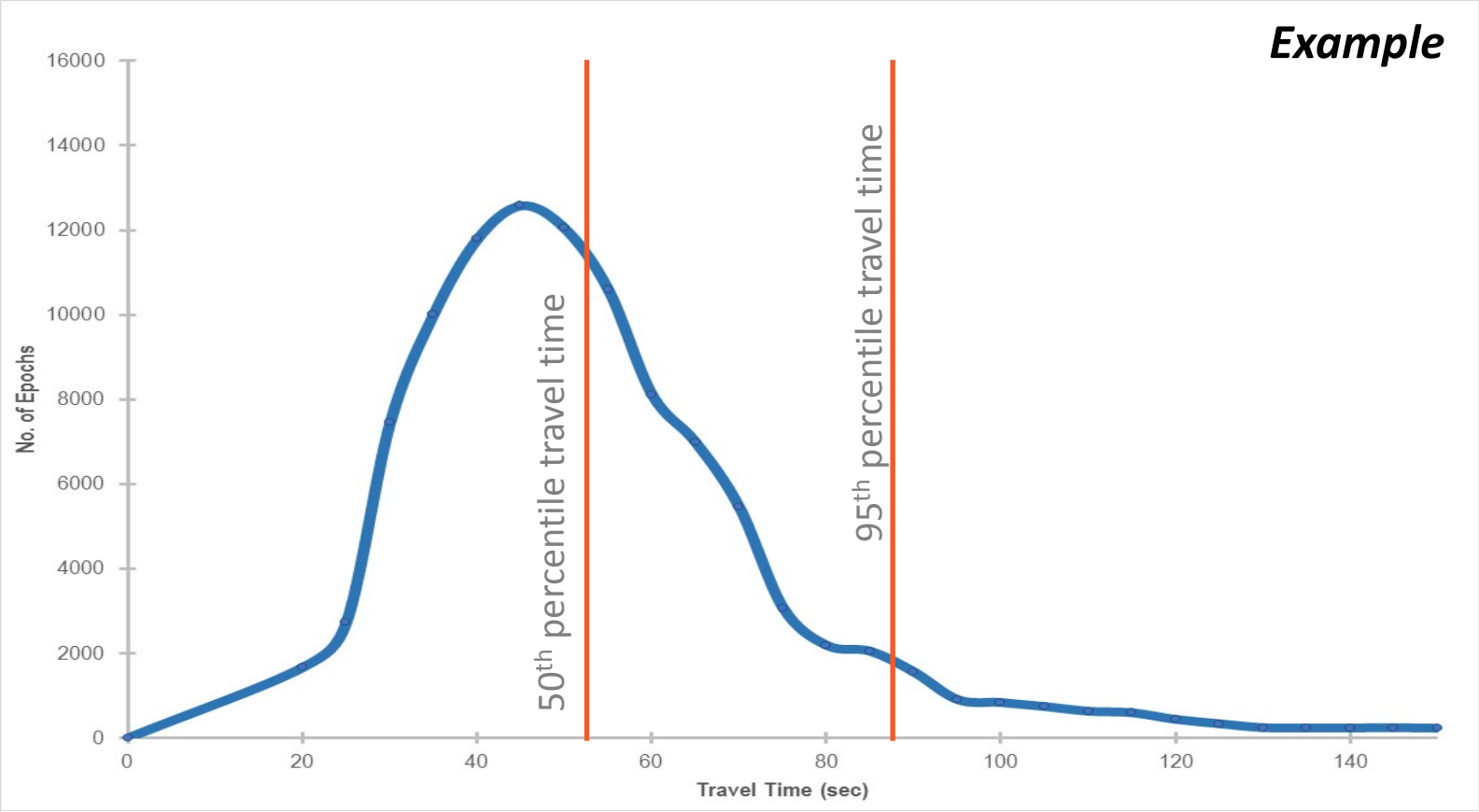
- Computed for each time period for the entire year ***for Interstate segments only***, rounded to nearest hundredth

$$TTTR_i = \frac{95th\ Percentile\ Travel\ Time_i}{50th\ Percentile\ Travel\ Time_i}$$

Where *i* is the time period:

1. 6 a.m. – 10 a.m. weekdays
2. 10 a.m. – 4 p.m. weekdays
3. 4 p.m. – 8 p.m. weekdays
4. 8 p.m. – 6 a.m. all days
5. 6 a.m. – 8 p.m. weekends

TTTR: Select the 95th and 50th percentile travel times from the complete distribution



23 CFR 490.611 Freight Reliability Metric

$$\frac{\text{Longer Truck Travel Time (95th)}}{\text{Normal Truck Travel Time (50th)}} = \frac{\text{\# seconds}}{\text{\# seconds}} = \text{TTTR Ratio}$$

TTTR: Single Segment, Interstate Highway System			*Example*
Monday – Friday	6 – 10 a.m.	$\text{TTTR} = \frac{63 \text{ sec}}{42 \text{ sec}} = 1.50$	
	10 a.m. – 4 p.m.	$\text{TTTR} = \frac{62 \text{ sec}}{45 \text{ sec}} = 1.38$	
	4 – 8 p.m.	$\text{TTTR} = \frac{85 \text{ sec}}{50 \text{ sec}} = \mathbf{1.70}$	
Weekends	6 a.m. – 8 p.m.	$\text{TTTR} = \frac{52 \text{ sec}}{40 \text{ sec}} = 1.30$	
Overnight	8 p.m. – 6 a.m.	$\text{TTTR} = \frac{46 \text{ sec}}{38 \text{ sec}} = 1.21$	
Maximum TTTR		**1.70**	

Freight Reliability Measure

$$Freight\ Reliability = \frac{\sum_{i=1}^{T}(SL_i \times maxTTTR_i)}{\sum_{i=1}^{T}(SL_i)}$$

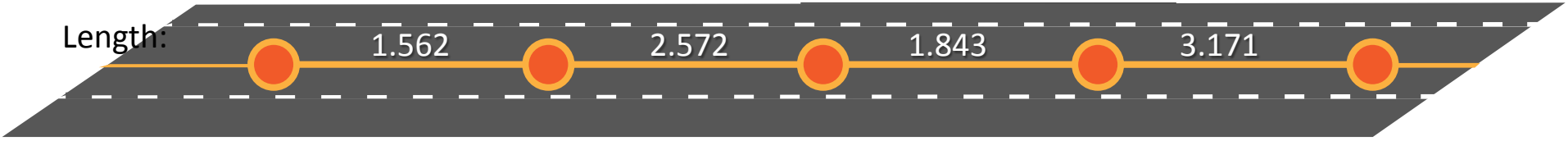
i = an Interstate reporting segment

$maxTTTR_i$ = the maximum TTTR of all five time periods for segment *i* (nearest hundredth)

SL_i = length of segment *i*

T = total number of Interstate segments

Freight Reliability Measure: Example



TTTR	1.50	2.10	1.45	1.56
	1.38	1.83	1.71	2.30
	1.70	1.79	1.62	2.12
	1.30	1.42	1.22	1.82
	1.21	1.03	1.01	1.27

$$\text{TTTR} = \frac{(1.70 \times 1.562) + (2.10 \times 2.572) + (1.71 \times 1.843) + (2.30 \times 3.171)}{(1.562 + 2.572 + 1.843 + 3.171)}$$

$$= \frac{2.655 + 5.401 + 3.152 + 7.293}{9.148}$$

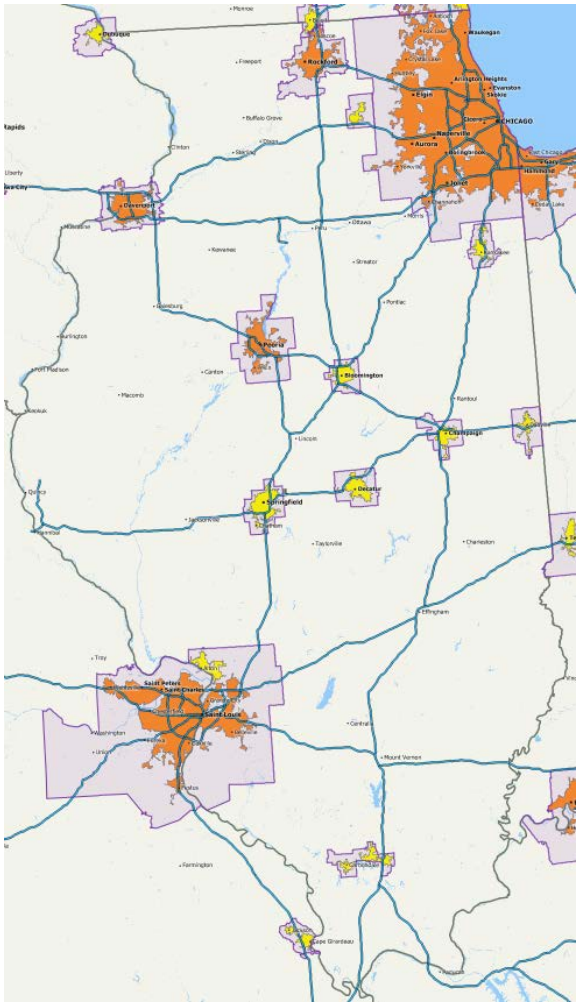
$$= 2.022$$

Target Establishment

U.S. Department of Transportation
Federal Highway Administration

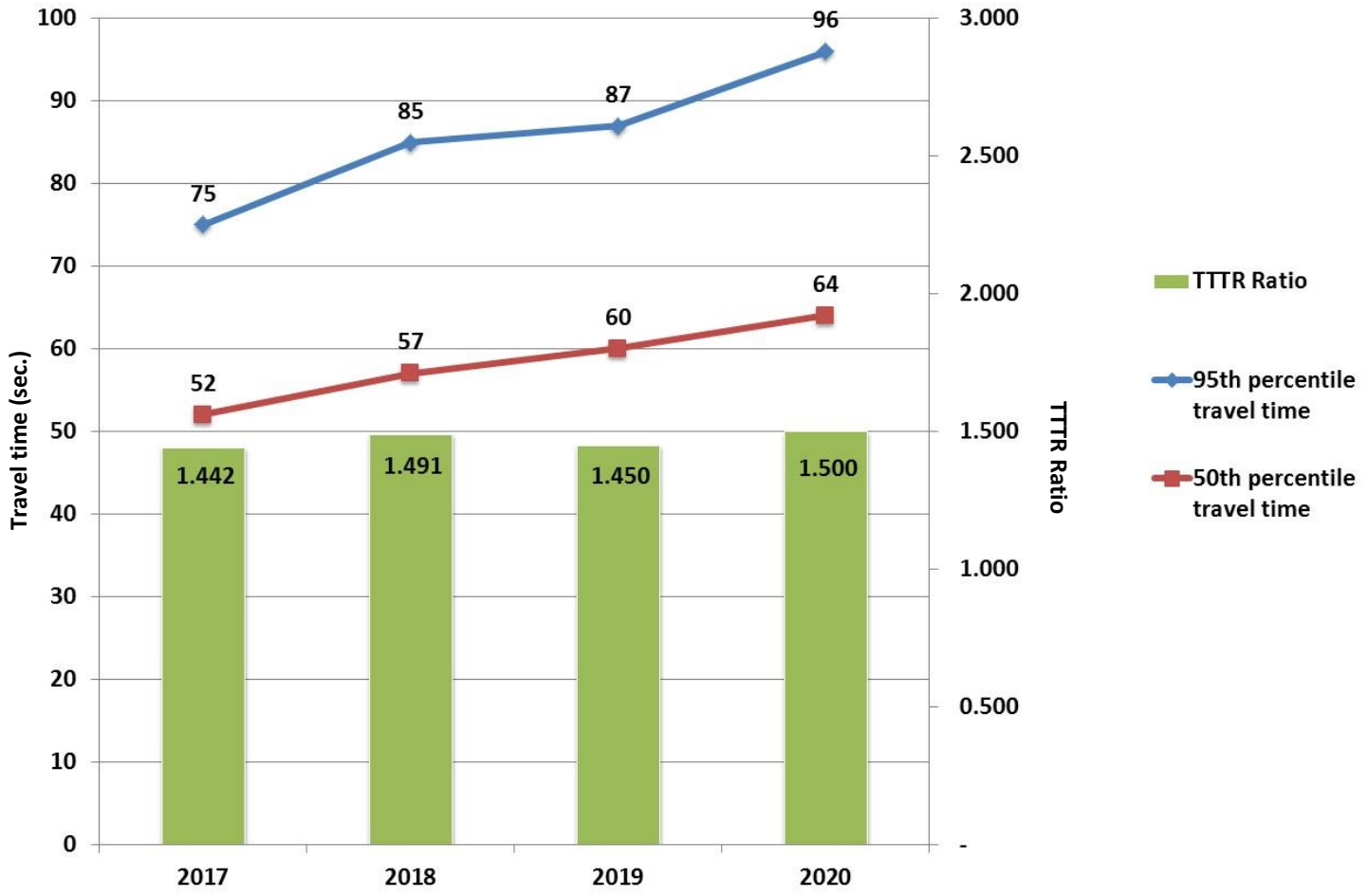
Freight Movement on the Interstate System Performance Measure Target

- Statewide TTTR Index
- MPO TTTR Index



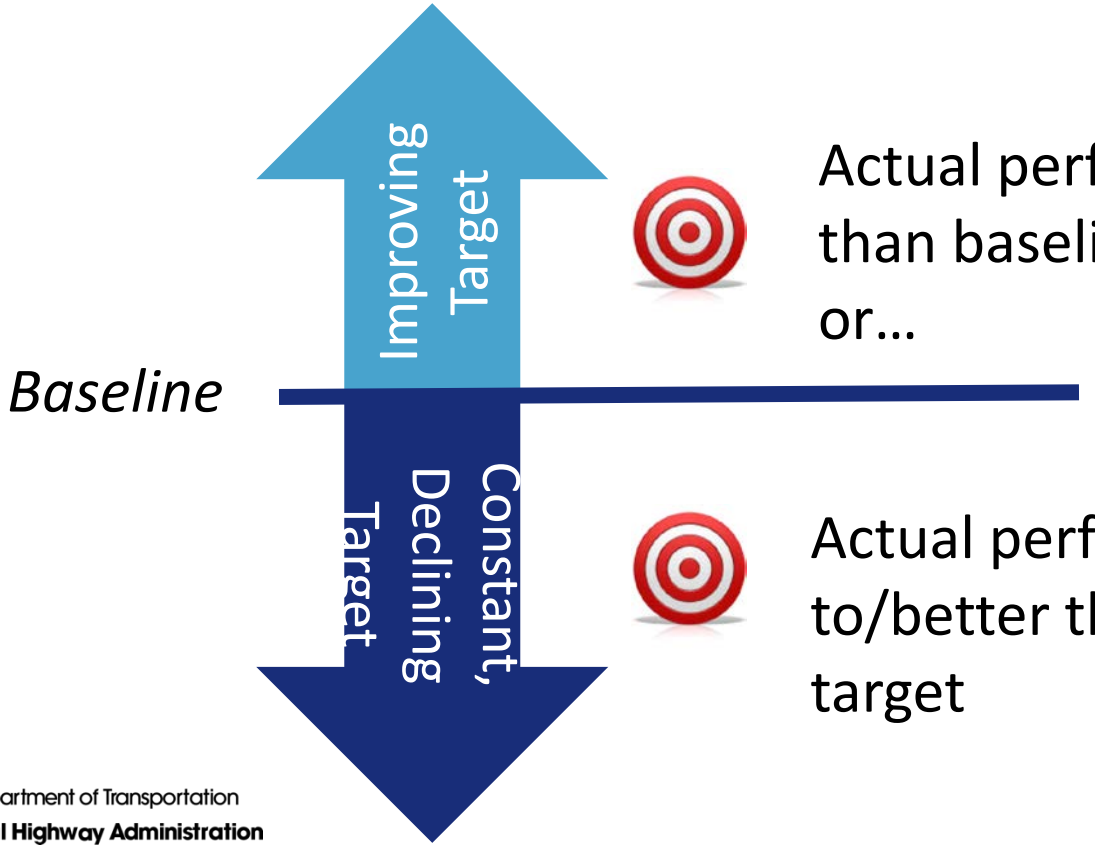
Source: FHWA HEPGIS

TTTR Target-Setting Considerations: Example



Assessing Significant Progress Toward Achieving TTTR Targets (23 CFR 490.109)

Targets can be improving, constant, or declining.
Significant progress is made when either…



Actual performance is better than baseline performance or…

Actual performance is equal to/better than established target

23 USC 150: Reporting on Performance Targets

States submit biennial performance report:

- NHS condition and performance
- Effectiveness of investment strategy in asset management plan
- Progress in achieving targets
- ***How the State is addressing congestion at freight bottlenecks, including those identified in the national freight strategic plan***

23 CFR 490.107: Baseline Performance Period Report

Documenting congestion at truck freight bottlenecks

- Location of truck freight bottlenecks, including those identified in the National Freight Strategic Plan
- If a State has prepared a State Freight Plan within the last 2 years, then Plan may serve as basis for identifying truck freight bottlenecks

Mid & Full Performance Period Progress Reports

Progress in addressing congestion at truck freight bottlenecks through improvement efforts in:

- State & MPO Freight Plans
- State Transportation Improvement Program (STIP) and MPO Transportation Improvement Program (TIP)
- Regional or corridor level efforts
- Other related planning efforts
- Operational and capital activities targeted to improve freight movement on the Interstate

Determination of Significant Progress Toward Achieving Freight Reliability Targets

U.S. Department of Transportation
Federal Highway Administration

TPM
HOW WE GET THERE

If State has not made significant progress toward Freight Reliability targets, then next State Biennial report shall include:

- Identification of significant freight system trends, needs, and issues;
- Description of freight policies & strategies that guide freight-related transportation investments; and
- Inventory of truck freight bottlenecks and description of ways in which the State is allocating funding to improve bottlenecks.
- See 23 CFR 490.109(f)(2).

Inventory of truck freight bottlenecks

If State has not made significant progress, then the inventory of truck freight bottlenecks shall include:

- Route and milepost location for each bottleneck,
- Roadway section inventory data reported in HPMS,
- AADT and AADTT,
- Travel-time data and measure of delay, such as travel time reliability, or average truck speeds, and
- Capacity feature causing the bottleneck or any other constraints applicable to trucks, such as geometric constraints, weight limits or steep grades.

Description of ways State DOT is allocating funding to improve bottlenecks

If State has not made significant progress, then the State shall provide for those facilities that are State-owned or operated:

- Description of ways in which State DOT is improving bottlenecks;
- Methods to address each bottleneck; and
- Improvement efforts planned or programed through State Freight Plan or MPO freight plans, STIP/TIP, regional or corridor level efforts, other related planning efforts, and operational/capital activities

Truck Freight Bottleneck Reporting

U.S. Department of Transportation
Federal Highway Administration

TPM
HOW WE GET THERE

23 CFR 490.101: Truck Freight Bottleneck Definition

- *Roadway segment with constraints* causing significant impact on freight mobility and reliability.
- *May include highway sections not meeting thresholds for freight **reliability** or other locations identified by the state.*
- *Causes may include recurring congestion causing **delays** in freight movement.*
- *Causes may include roadway features that **impact truck movements** such as:*
  - Steep grades,
  - Substandard vertical or horizontal clearances,
  - Weight restrictions,
  - Delays at border crossings or terminals, or
  - Truck operating restrictions

Truck Freight Bottleneck General Categories

1. **Travel Speed-Based Delay**
   Reduced speeds/delays due to recurring influence or nonrecurring event
2. **Truck-Based Delay**
   Reduced speeds/delays specific to truck freight movements

Source: FHWA

Travel Speed-Based Delay Bottlenecks

- Capacity-based bottlenecks
  - Location where traffic volumes exceed capacity
  - Traffic queue upstream of bottleneck with speeds below free-flow conditions
  - Free-flow traffic conditions downstream of bottleneck that have returned to nominal or design conditions
- Non-recurring bottlenecks frequently caused by:
  - Traffic incidents
  - Bad weather
  - Work zones

Sources: Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report, FHWA 2015; Recurring Traffic Bottlenecks: A Primer Focus on Low-Cost Operational Improvement, FHWA 2012.

Common Bottleneck Locations

- Lane drops
- Interchanges
- Freeway on and off ramps
- Weaving areas
- Changes in highway alignment
- Narrow lanes or lack of shoulders
- Traffic control devices

Sources: Freight Performance Measure Approaches for Bottlenecks, Arterials, and Linking Volumes to Congestion Report, FHWA 2015, Recurring Traffic Bottlenecks: A Primer Focus on Low-Cost Operational Improvement, FHWA 2012.

Truck-Based Delay

- Roadway geometrics
  - Tight curves
  - Narrow lanes
  - Low bridge heights
- Steep grades/terrain
- Frequent adverse weather
- Truck size/weight restrictions
- Hazardous materials restrictions
- Border crossings

Source: FHWA

Bottleneck Typology and Criteria: Example

Type	Example criteria threshold	Corridor weight or consideration	Freight implications
Travel speed	Average truck speeds below 80% of posted speed or free flow speed	Weighted based upon truck volumes	Travel time and cost increases
Reliability	Ratio of 95th percentile and 50th percentile (or other reference speed) more than 1.5	Weighted based upon truck volumes	Travel times are hard to estimate, resulting in poor on-time performance
Resiliency	Disruptions caused by severe weather or natural disasters, measured by frequency and duration of closures	Minimum AADTT for the roadway to be included	Facility failure causes economic impacts for shippers, goods receivers and carriers
Restricted access for legal loads	Facility has posted weight limit below an established gross vehicle weight	Critical freight connector	Trucks have to take detour route, adding additional miles to trip
Clearance restriction	Facility has posted height limit below 14 feet	Critical freight connector	Trucks have to take detour route, adding additional miles to trip

Quantifying Bottlenecks

Components:

1. Duration
2. Extent
3. Intensity
4. Reliability

Source: FHWA

Source: NCHRP Report 398 Volume 1: Quantifying Congestion

Identifying Truck Freight Bottlenecks: Recommended Methodology

- Identify bottlenecks based upon:
  - Average truck speed below an established threshold
  - Annualized hours of truck delay
  - Travel time freight reliability measures calculated (per 23 CFR §490.613)
  - Truck-based delay
  - Consider urban vs. rural thresholds
- Analyze duration, extent and intensity
- Verify though field observations & freight stakeholders
- Quantify top truck freight bottleneck locations
- Report locations for state-level and MPO-level truck freight bottlenecks

Recommended Approach to Quantify Annualized Hours of Truck Delay

- Average annual delay per truck
  - Use NPMRDS to estimate average travel times for trucks; compare with free flow travel times or other reference speed
- Length of segment
  - Multiply increased travel time by length of TMC segment
- Annualized average truck traffic delay
  - Multiple delay per truck by AADTT and annualize

Recommended Approach to Quantify Travel Speed-based Delay

Total Truck Delay = (Average TTT - Reference TTT) * AADTT

Where:

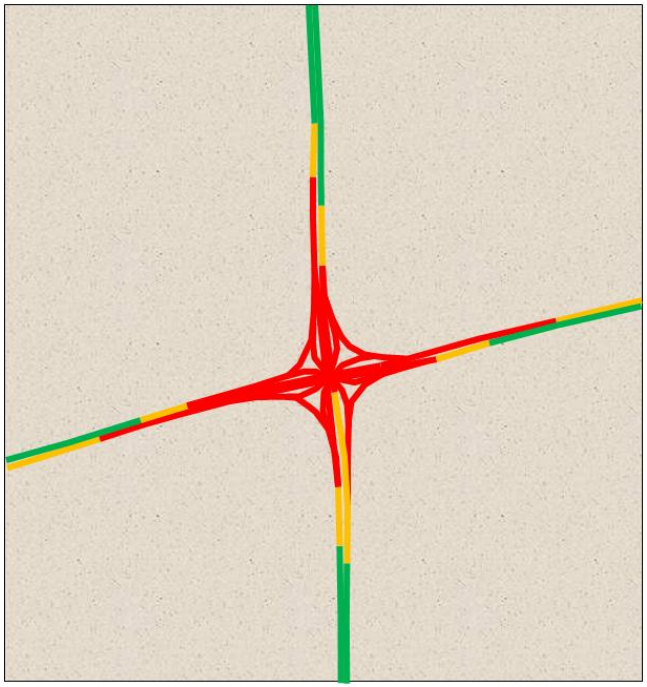
Average TTT = Average time for a truck to traverse the road segment

Reference TTT = Time for a truck to traverse the road segment traveling at reference speed based on posted speed, truck free flow speed or other target

AADTT = Annual Average Daily Truck Traffic; used to determine volume of trucks experiencing average travel time

Total Annual Truck Delay: Example

Identify sections with slow truck speeds



Source: FHWA

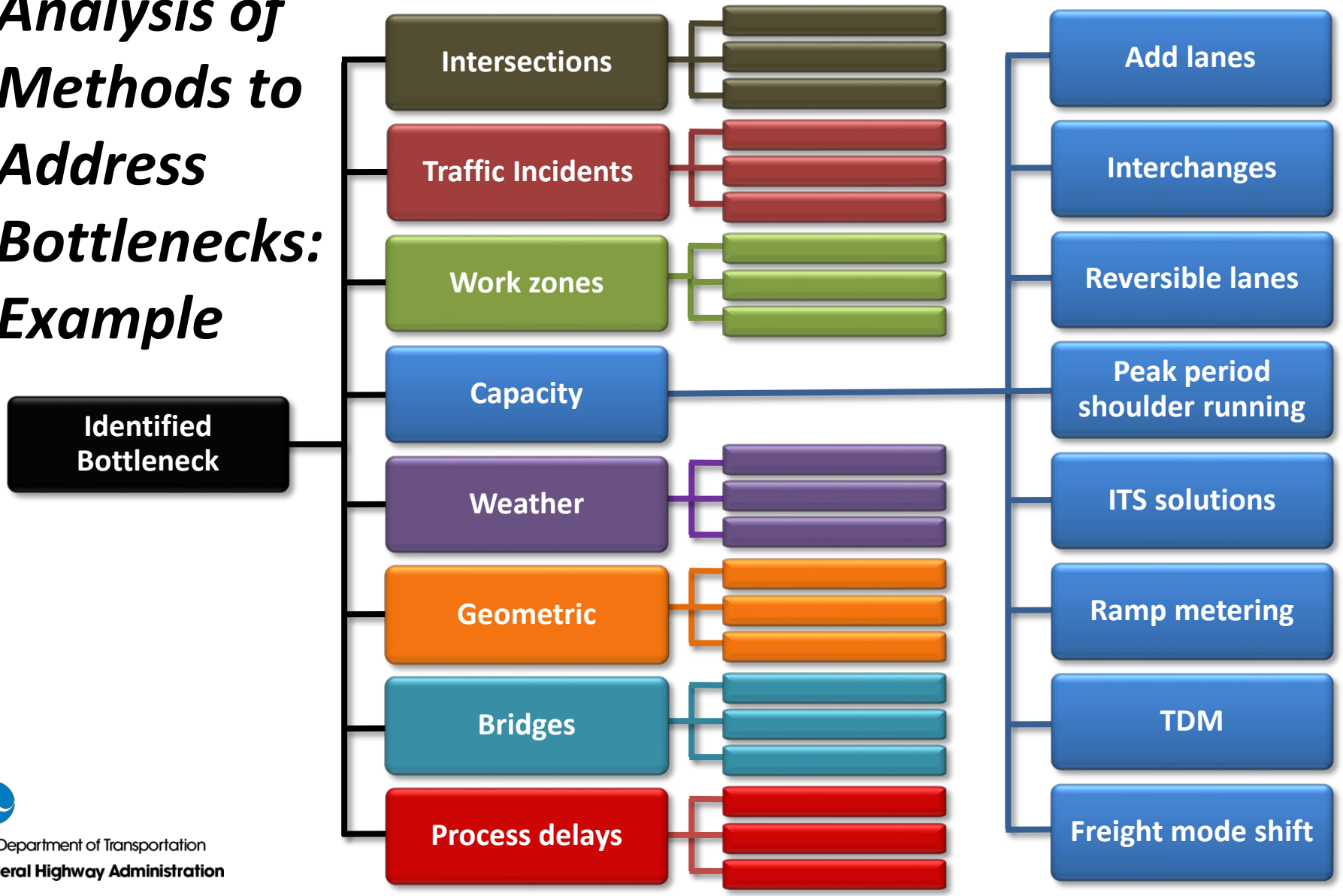
Use travel time data and AADTT to calculate annual hours of truck delay

	Average travel time (sec)	Reference travel time (sec)	Average delay/ truck (sec)	AADTT	Total truck delay/year (hr)
North	96	86	10	5,690	5,769
South	54	50	4	5,596	2,269
East	126	101	25	8,945	22,673
West	103	86	17	8,725	15,038
Total					45,750

Determining Bottleneck Root Cause

- Tools:
  - Persistent drop in speed between successive traffic detectors
  - Travel time runs and videos of program areas
  - Simulation tools to analysis of specific bottlenecks and determining impact of alternative solutions
  - Engineering judgment may be called into play when certain geometrics (e.g., grades, curves, sun angle, etc.) can't be analyzed by simulation tools
- "Hidden bottlenecks"; queue formed by dominant bottleneck can mask other problems upstream
- Field observations & freight stakeholders

Analysis of Methods to Address Bottlenecks: Example



Contacts

For questions or more information, please contact:

***Jeff Purdy**, Office of Freight Management and Operations,*
Jeffrey.Purdy@dot.gov, 202-366-6993

***Eric Pihl**, Resource Center Freight and TPM Team,*
Eric.Pihl@dot.gov, 303-594-3559

Questions?