UPDATE ON THE MAP-21 SYSTEM PERFORMANCE NPRM

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Freight Subcommittee
July 14, 2016

Federally Prescribed National Goals

	GOAL AREAS	NATIONAL GOALS
1	SAFETY	Achieve significant reduction in traffic fatalities and serious injuries on all public roads
2	INFRASTRUCTURE CONDITION	Maintain highway system in a state of good repair
3	CONGESTION REDUCTION	Achieve significant reduction in congestion on the National Highway System
4	SYSTEM RELIABILITY	Improve efficiency of surface transportation system
5	FREIGHT MOVEMENT AND ECONOMIC VITALITY	Improve Freight Network; Support regional economic development; Rural communities access to national and international markets
6	ENVIRONMENTAL SUSTAINABILITY	Enhanced transportation system performance while protecting and enhancing natural environment
7	REDUCED PROJECT DELIVERY DELAYS	Elimination of delays on project development and delivery

USDOT Rulemaking Schedule

	Planning Rules *USDOT Significant Rulemaking Report, as of June 2016*	Proposed Rulemaking	Final Rulemaking
Planning	• Statewide and Metropolitan and Non-metropolitan Planning	June 2014	May 27, 2016
Highway Safety	• Safety Performance Measure Rule • Highway Safety Improvement Program (HSIP)	March 2014	March 2016
Highway Conditions	• Pavement and Bridges Performance Measurement • Asset Management Plan	January/February 2015	*December 1, 2016*
Congestion / System performance	• System Performance Measures Rule (NHS, Freight and CMAQ)	April 22, 2016	*January 2017*
Transit	• Transit Asset Management • National Public Transportation Safety Plan • Public Transportation Agency Safety Plan	September 2015 (Transit Asset) February 2016 (Transit Safety)	*July 15, 2016* (Transit Asset) *October 2016* (Transit Safety)

The System Performance NPRM

- On April 22, 2016, the FHWA published a Notice of Proposed Rulemaking (NPRM) to propose National Performance Management Measures to assess
  - Performance of the National Highway System,
  - **Freight Movement on the Interstate System**, and
  - the Congestion Mitigation and Air Quality Improvement Program
- Commenting period closes August 20, 2016

System Performance Measures: NHS, Freight and CMAQ (Proposed)

	Performance Measure	Data
Performance of the NHS	(1/2) Percent of the Interstate System / non-Interstate NHS providing for Reliable Travel Times	Level of Travel Time Reliability (LOTTR)
	(3/4) Percent of the Interstate System / non-Interstate NHS where Peak Hour Travel Times meet expectations	Peak Hour Travel Time Ratio (PHTTR)
Freight Movement	(5) Percent of the Interstate System Mileage providing for Reliable Truck Travel Times	Truck Travel Time Reliability (TTTR)
	(6) Percent of the Interstate System Mileage Uncongested	Average Truck Speed
CMAQ Traffic Congestion	(7) Annual Hours of Excessive Delay Per Capita	Total Excessive Delay
CMAQ On-Road Mobile Source Emissions	(8) 2- and 4-year Total Emission Reductions for each applicable criteria pollutant and precursor	Annual Tons of Emission Reductions by project for each applicable criteria pollutant and precursor

Freight Movement on Interstates

Areas	Measures	Metrics	Equations	Thresholds	Time Periods (in Calendar Year)	Applicable Network	Target Scope
Freight movement on the Interstate System	Percent of the Interstate System Mileage providing for Reliable Truck Travel Time	Truck Travel Time Reliability	95th Truck TT / 50th Truck TT	Reliable: Annual Average Truck Travel Time Reliability < 1.50	24/7/365	Interstate	Statewide target; MPO-wide target
	Percent of the Interstate System Mileage Uncongested	Average Truck Speed	Arithmetic mean of Truck Speeds ***(leading to inconsistency between average speed and average travel time)***	Uncongested: Truck Speed > 50 mph	24/7/365	Interstate	Statewide target; MPO-wide target

Takeaways

- Well-designed performance measures: basic calculations and determinations are conducted at the road segment level, then summation takes place at the system level (no averaging)
  - Pro: Straightforward answer (Yes/No) according to a threshold
  - Con: the magnitude of departure from the threshold is buried
- Prescriptive rulemaking has simple calculations, but also poses challenges in:
  - Data preparation (such as hourly traffic volume, desired peak period travel time, posted speed limit)
  - Target setting (Statewide vs. MPO-wide vs. single Urbanized Area)

Data Needed

- By reporting segment:
  - Travel time: by all vehicles and trucks (NPMRDS or equivalent)
  - Desired peak period travel time for AM and PM peaks (agency determined)
  - Posted speed limit (to impute missing travel time data)
  - Traffic volume (Used for the Excessive Delay measure; Hourly volumes or AADT)
  - Highway type designation (Interstate and non-Interstate NHS)
- Area-wide
  - Urbanized area population and boundary (Census or FHWA-approved boundary)
  - MPO boundary

Travel Time Data Set: NPMRDS or Equivalent?

- The NPRM requires National Performance Management Research Data Set (NPMRDS), or Equivalent Data Sources(s)
- State DOT shall establish, in coordination with MPOs, a single travel time data set
- A State DOT and MPO(s) must use the same travel time data set for each reporting segment
- The same data source shall be used for each year in a performance period

Requirements of Equivalent Data Source(s)

	Requirements of Equivalent Data Source(s)	VPP (INRIX*)
Coverage	Contiguous segments that cover the full NHS	Not all NHS is covered, but very close to full coverage
Time granularity	5-minute	5-minute (full compliance)
Missing data handling	Be populated with actual measured vehicle travel times and shall not be populated with travel times derived from imputed methods	Critical challenge. Although "Score = 30" can be used a filter, data still generated by "INRIX Fusion Engine" (black box)
All traffic and freight vehicle	Include, for each segment at 5 minute intervals throughout a full day (24 hours) for each day of the year, the average travel time, recorded to the nearest second, representative of at least one of the following: (A) All traffic on each segment of the NHS (B) Freight vehicle traffic on each segment of the Interstate System	VPP does not have a freight category specified in the contact, but vendors MAY have the capability to provide (NPMRDS uses truck data from ATRI, not sure if vendors could match the truck sample size)

Preliminary Conclusion: New procurement is required for equivalent data source(s)

*DC, MD and VA are all using INRIX data, so it is used here as an example.

Desired Peak Period Travel Time

- The State DOT, in coordination with MPOs, shall assign a "Desired Peak Period Travel Time," based on their operational policies for their NHS roadways, for each segment…
- Separate AM and PM peak desired travel times (could be the same)
- Discussion: what would be the Desired Peak Period Travel Time?
  - Some references in the NPRM:
    - In Freight, the NPRM uses 50 mph as the threshold
    - In Traffic Congestion, the NPRM uses 35 mph for freeways and 15 mph for non-freeways
  - Posted Speed Limit, or a percentage of it?
  - Historical average speed, or a percentage of it? A percentile of all speeds in a year?
    - If so, the Desired Peak Period Travel Time needs periodical updates

Posted Speed Limit

- Do we have the data, where is it?
- Inventory building, updating
- Change of speed limit will likely result in different performance, but the magnitude of impact is expected to be marginal?

Traffic Volume

- State DOTs shall develop hourly traffic volume data for each reporting segment
- If continuous count stations exist, hourly counts can be applied to multiple reporting segments
- If no hourly volume counts exist, use AADT to estimate hourly, directional traffic volume
  - Reference: Texas A&M Transportation Institute's method
  - State DOTs' existing methods, if any?
- Manual or automated process?
- Factors should be considered (courtesy of Rich Margiotta):
  - Functional class (freeway, non-freeway)
  - Day of week (weekday, weekend/holiday)
  - General congestion level for weekdays (low, moderate, severe)
  - Directionality of peaking for weekdays (AM or PM)
- Methodology has to be reported to FHWA

Average Truck Speed: Arithmetic vs Harmonic Mean

$$Average\ Truck\ Speed\ (s) = \frac{\left[\sum_{b=1}^{T} \frac{Segment\ Length\ (s)}{Truck\ Travel\ Time_b}\right]}{T} \times 60 \times 60$$

b = a 5-minute time interval of a travel time reporting segment "s;"
s = a travel time reporting segment;
T = total number of time intervals in everyday in a full calendar year;

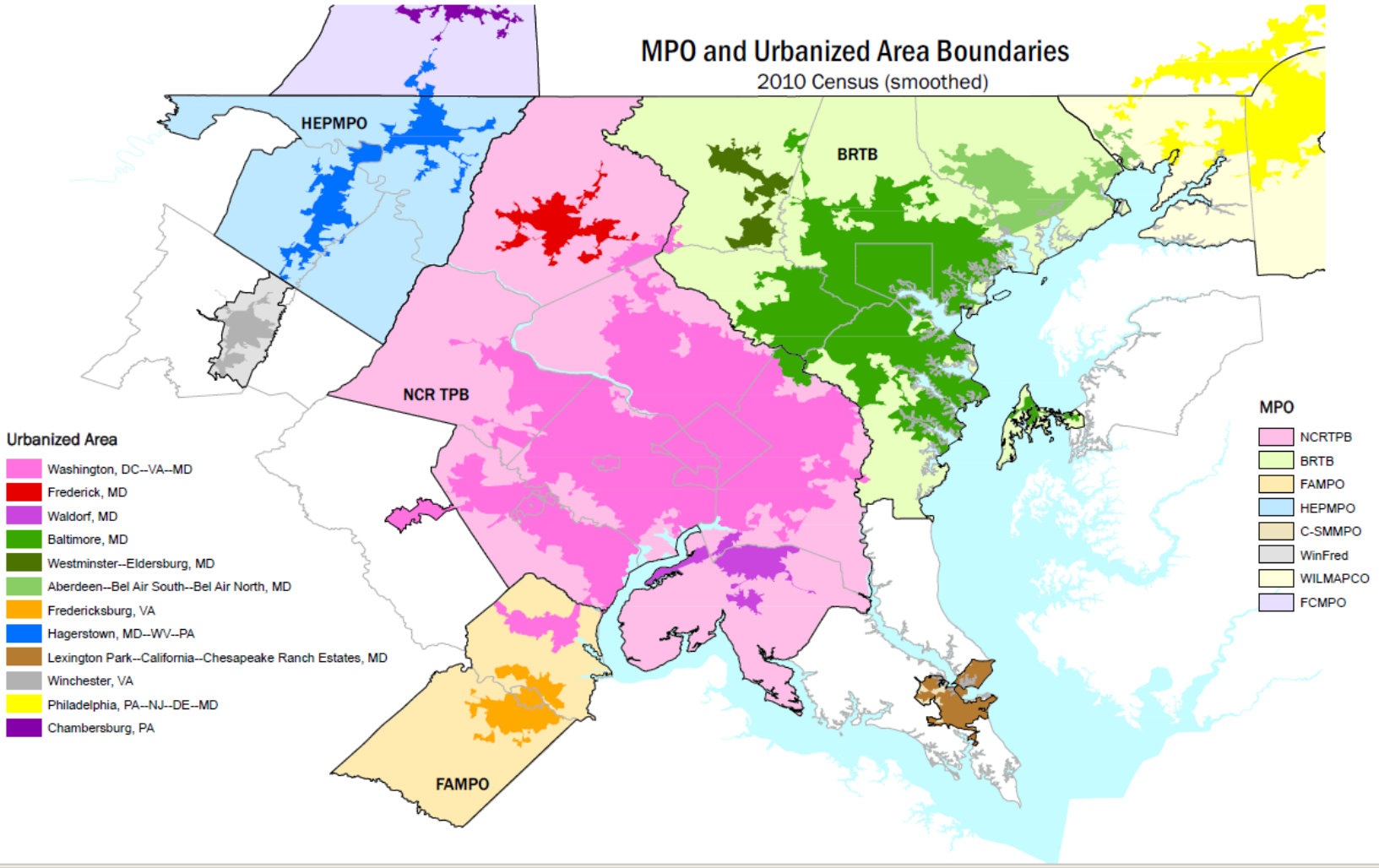
TABLE 1 Difference in Travel Time and Speed If Arithmetic Mean Speed Is Used to Aggregate 1-min Data into 1-h Data

Magnitude	Number of Records	% of All Records	Magnitude	Number of Records	% of All Records
Absolute Difference in Travel Time			Percentage Difference in Travel Time		
≥1 min	3,444	0.5671	≥30%	27,692	4.5597
≥5 min	152	0.0250	≥100%	3,571	0.5880
≥10 min	33	0.0054	≥200%	2,488	0.4097
Absolute Difference in Speed			Percentage Difference in Speed		
≥5 mph	52,800	8.6940	≥30%	25,437	4.1884
≥10 mph	21,660	3.5665	≥100%	5,968	0.9827
≥20 mph	8,487	1.3975	≥200%	2,420	0.3985

NOTE: There are 607,315 valid records in the aggregated 1-h data.

Source: Pu. W. (2013), Transportation Research Record No. 2338, pp.44-57

MPO vs Urbanized Area Boundaries



TPB Staff Activities - Completed

- Regional discussions
  - May 13, 2016 on Management, Operations and Intelligent Transportation Systems (MOITS) – Vehicle Probe Data User Group (VPDUG) joint meeting
  - June 24, 2016 Conference Call with state DOTs
- Draft Comments

Comments on the NPRM (to submit by 8/20/16)

- Metropolitan Planning Area (MPA) vs. Urbanized Area
  - Use of MPA boundary is recommend as opposed to the use of Urbanized Area as specified in the NPRM (*in conjunction with June 27 NPRM*)
- Subpart F: § 490.611 (c) (2): Method to calculate Average Truck Speed
  - Harmonic Mean is recommended as opposed to Arithmetic Mean used in the NPRM
- Subpart F: § 490.613 (c): Threshold to determine (un)congested freight movement on Interstates
  - A percentage of posted speed limit is recommended as opposed to a fixed number – 50 mph as specified in the NPRM
- Subpart G: § 490.711 (c): Threshold to determine if excess delay occurs
  - A percentage of posted speed limit is recommended as opposed to fixed numbers – NPRM has 35 mph for freeways and 15 mph for non-freeways

TPB Staff Activities – Ongoing & Future

	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17
Planning	Discuss MOU and coordination rule with DOTs	Review obligation report. Comments due Coordination NPRM by 8/26.	Brief TPB on Planning rule	Develop MOU on performance measures. Discuss with DOTs, TAs, MPOs	Begin developing new TIP format for PBPP. Discuss with DOTs, TAs, others		
Congestion / System performance	Discuss comments w State DOTs. Identify info needed from DOTs.	Comments due by 8/20. Review DOT CMAQ inputs.	Work w DOTs to develop needed data (speed limits, desired peak hour travel time)	Conduct sensitivity tests with proposed metrics for the planning/urbanized area.			Final rule might be published.
Highway Safety	Work w DOTs to get non-motorized data.	Get 2015 data for all measures. Prepare updated performance for MPA					
Highway Conditions	Complete 2015 Bridge analysis.	Conduct Bridge condition analysis by Jurisdiction		2015 Pavement data available for analysis. Review MD section data for use in previous years analysis	Final rule anticipated.		
Transit Safety and Assets	Transit Asset Management final rule anticipated.	Work with WMATA, PRTC, and other transit agencies as required.	Transit Safety final rules anticipated.	Transit Agencies approve asset targets.	Compile Transit Agency asset submittals. Prepare MPO transit asset report	Compile and analyze Transit Agency safety data.	

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Additional Slides

Draft Comments (1/3)

Subpart F: § 490.611 (c) (2): The method to calculate Average Truck Speed

The Average Truck Speed shall be calculated for each reporting segment as follows:

$$Average\ Truck\ Speed\ (s) = \frac{\left[\sum_{b=1}^{T} \frac{Segment\ Length\ (s)}{Truck\ Travel\ Time_b}\right]}{T} \times 60 \times 60$$

where,

b = a 5-minute time interval of a travel time reporting segment "s;"

s = a travel time reporting segment;

T = total number of time intervals in everyday in a full calendar year;

Segment Length (s) = length of reporting segment "s," to the nearest one thousandth of a mile;

Truck Travel Time b = travel time of trucks, for time interval "b" in the Travel Time Data Set or TTL@PSL for the reporting segment s described in paragraph (1), to the nearest second;

Average Truck Speed (s) = average annual speed of trucks travelling through the reporting segment "s," to the nearest hundredth mile per hour.

Draft Comments (2/3)

Comments:

Section 490.611 (c) (2) uses the Arithmetic Mean to calculate the Average Truck Speed of a reporting segment in a calendar year. Studies and practice have shown that the Arithmetic Mean could lead to 1) inconsistent Average Speed and Average Travel Time of the same segment in the same analysis period, and 2) higher-than-ground truth Average Speed. Harmonic Mean is recommended to calculate the Average Truck Speed, and the calculation formula is:

$$Average\ Truck\ Speed\ (s) = \frac{T}{\left[\sum_{b=1}^{T} \frac{Truck\ Travel\ Time_b}{Segment\ Length\ (s)}\right]} \times 60 \times 60$$

From a traffic engineering perspective, segment-based probe speed is Space Mean Speed, and location-fixed spot speed is Time Mean Speed. Harmonic Mean should be used to average Space Mean Speed and Arithmetic Mean should be used to average Time Mean Speed. The Highway Capacity Manual recommends Space Mean Speed for analysis. The following uses an example to demonstrate the difference between the two speeds.

Assume Segment Length (s) = 1 mile, in one 5-minute time interval, Truck Travel Time = 120 seconds, in another 5-minute interval, Truck Travel Time = 60 seconds.

The Average Truck Speed calculated by the NPRM (Arithmetic Mean) is:

$$Average\ Truck\ Speed\ (s) = \frac{\frac{1}{120} + \frac{1}{60}}{2} \times 60 \times 60 = 45\ mph$$

However, the Average Travel Time of the two interval is (120+60)/2 = 90 seconds, which corresponds to Average Truck Speed = (1 mile / 90 seconds) x 60 x 60 = 40 mph.

Obviously, 45 mph > 40 mph.

By using Harmonic Mean as recommended, the above inconsistency disappears:

$$Average\ Truck\ Speed\ (s) = \frac{2}{\frac{120}{1} + \frac{60}{1}} \times 60 \times 60 = 40\ mph$$

The difference between the Arithmetic Mean and the Harmonic Mean of the same samples could be significant. Mathematically, Arithmetic Mean >= Harmonic Mean is always true.

For more information, please refer to Pu, W. (2013), Standardized Data Processing: When Is It Needed in the Mining of Private-Sector Probe-Based Traffic Data to Measure Highway Performance? *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2338, pp.44-57.

Draft Comments (3/3)

Subpart F: § 490.613 (c): Threshold to determine (un)congested freight movement on Interstates

An uncongested reporting segment is where calculated Average Truck Speed for the reporting segment, in § 490.611(c) (2), is greater than 50.00 mph.

Comments:

In the District of Columbia, a portion of the Interstates has speed limit = 45 mph.

A percentage of posted speed limit is recommended as the threshold.

Subpart G: § 490.711 (c): Threshold to determine if excess delay occurs

The threshold speed is 35 mph for Interstates/freeways/expressways, and 15 mph for principal arterials and all other NHS roads.

Comments:

The two thresholds are not flexible enough to reflect different operating characteristics of different segments of the NHS.

A percentage of posted speed limit is recommended as the threshold.

System Performance

Areas	Measures	Metrics	Equations	Thresholds	Time Periods (in Calendar Year)	Applicable Network	Target Scope
Performance of the Interstate	Percent of the Interstate System providing for Reliable Travel	Level of Travel Time Reliability (LOTTR)	80th TT / 50th TT	Reliable: LOTTR < 1.50	6:00 am-10:00 am, M-F 10:00 am-4:00 pm, M-F 4:00 pm-8:00 pm, M-F 6:00 am-8:00 pm, S-S	Interstate	Statewide target; MPO-wide target
	Percent of the Interstate System where peak hour travel times meet expectations	Peak Hour Travel Time Ratio (PHTTR)	Longest PHTT / Desired PHTT in that hour the longest PHTT occurred	Meet expectation: PHTTR < 1.50	Could be any one of the 6 peak hours: 6:00 am-9:00 am, 4:00 pm-7:00pm in non-Federal holiday weekdays	Interstate in urbanized area with population over 1 million	A single urbanized area target
Performance of the Non-Interstate NHS	Percent of the non-Interstate NHS providing for Reliable Travel	Level of Travel Time Reliability (LOTTR)	80th TT / 50th TT	Reliable: LOTTR < 1.50	6:00 am-10:00 am, M-F 10:00 am-4:00 pm, M-F 4:00 pm-8:00 pm, M-F 6:00 am-8:00 pm, S-S	Non-Interstate NHS	Statewide target; MPO-wide target
	Percent of the non-Interstate NHS where peak hour travel times meet expectations	Peak Hour Travel Time Ratio (PHTTR)	Longest PHTT / Desired PHTT in that hour the longest PHTT occurred	Meet expectation: PHTTR < 1.50	Could be any one of the 6 peak hours: 6:00 am-9:00 am, 4:00 pm-7:00pm in non-Federal holiday weekdays	Non-Interstate NHS in urbanized area with population over 1 million	A single urbanized area target

Traffic Congestion

Areas	Measures	Metrics	Equations	Thresholds	Time Periods (in Calendar Year)	Applicable Network	Target Scope
Traffic Congestion	Annual Hours of Excessive Delay per Capita	Vehicle-hours of delay per capita	Delay * volume	Delay occurs if speed < 35 mph on Interstate (FC1), freeways and expressways (FC2); and < 15 mph on principal arterials (FC3) and all other NHS	24/7/365	NHS in nonattainment or maintenance urbanized area with population over 1 million	A single urbanized area target

Additional Information

- CATT Lab: www.cattlab.umd.edu/MAP-21
  - MAP-21 PM3 NPRM Performance Measure Calculations Webinar Presentation available at VPDUG Website (item 3) http://www.mwcog.org/committee/committee/documents.asp?COMMITTEE_ID=283
- White paper: MAP-21 Proposed Measures for Congestion, Reliability, and Freight, Step-by-Step Calculation Procedures:
  - Docket: https://www.regulations.gov/#!documentDetail;D=FHWA-2013-0054-1658
  - VPDUG Website (Item 3):
- Calculating The MAP-21 Performance Measures for Congestion and Reliability,
  - A presentation to the NPMRDS Quarterly Webinar on May 10, 2016 by Richard Margiotta, Cambridge Systematics, Shawn Turner, Texas Transportation Institute, and Pete Koeneman, Texas Transportation Institute
  - VPDUG Website (Item 3):
  - NPMRDS Quarterly Webinar recording: http://www.ops.fhwa.dot.gov/perf_measurement/