TDOT's Transition to MOVES

Current Activities and Future Plans

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TDOT's MOTIVATION

Why are we here?

MOTIVATION

- **MOVES will impose new demands on TDOT, TDEC and MPO resources**
  - Input Data
  - Staff
  - Conformity Process

- **Some relaxation to the time pressures**
  - Grace period has been extended (3/2/2013)
  - Announcement of a new ozone standard has been postponed
  - But time pressures remain

- **This is an opportunity to formalize how TDOT can support the transition to MOVES**
  - Technical Resources
  - Financial Resources

TDOT's Response

■ **Strategic Planning for the Transition to MOVES**

- Retained AECOM
- Inventory of Current Status and Practices
- Recommendations for Actions
- Schedule for the Transition

■ **TDOT's Commitment**

- Support the Cost of Model Updates
- Provide Centralized Support Services

THE STRATEGIC PLAN

OBJECTIVES OF THE STRATEGIC PLAN

■ **Help TDOT, TDEC, MPOs, TPOs to prepare for and incorporate MOVES into their technical procedures**

■ **Address:**

- Affected parties
- Data requirements
- Travel modeling practices
- Processing methods
- Hardware and software resources
- Staff training

■ **Outline needed technical development and support**

ELEMENTS OF THE STRATEGIC PLAN

- **Interviews**
  - MPOs and TPOs, TDEC, TDOT
  - Current / anticipated practices and capabilities
  - Model status and approaches
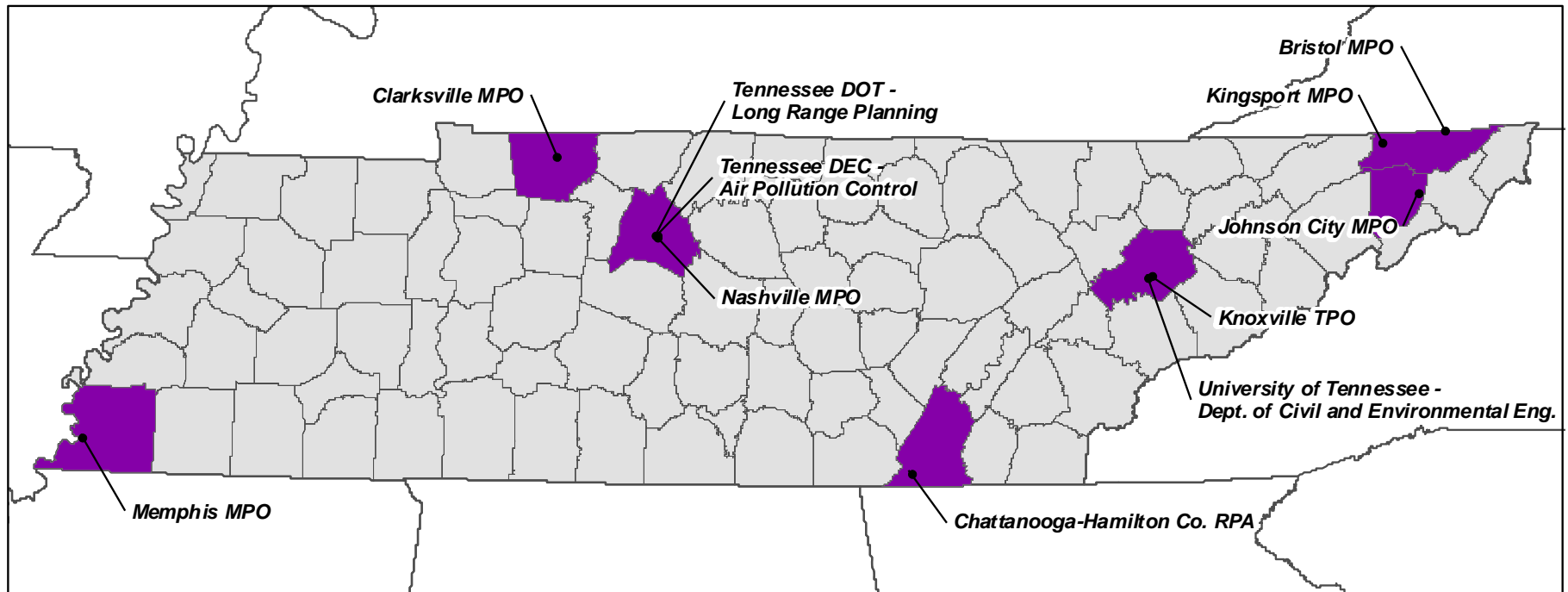 - MOVES-specific activities, resources, needs

- **Assessment**
  - What is needed?

- **Recommendations**
  - Travel demand and post processor modeling approach
  - Data Acquisition
  - Process Management
  - Schedule

CONFORMITY BUDGET TEST STATUS

	NOX Status With MOVES		PM-2.5 Status With MOVES	
Bristol	N?	?	N	
Chattanooga	N?	?	R	+
Clarksville	R	?	N	
Johnson City	N?	?	N	
Kingsport	N?	?	N	
Knoxville	R	+	R	X
Memphis	R	+	N	
Nashville	N?	?	N	

R	Test required	**?**	Not known
N	Test not required	**+**	Not known, margins available
N?	Test not required but may be (new standards)	**X**	No margin available

TRAVEL MODELS: GENERAL OBSERVATIONS

- **Fidelity and complexity varies from area to area**
  - Knoxville, Nashville, Memphis are more robust

- **Key features to support emissions analysis**
  - Multiple time periods vs. single daily
  - Separate auto / truck estimates
  - Mode choice sub-models (less important for emissions)

- **Emissions post processing**
  - 5 of 8 have a MOBILE6 post-processor
  - Only Chattanooga has begun a MOVES post-processor

GUIDING PRINCIPLES

- **Objective should be to be as accurate and complete as possible, within available resources**
  - MOVES provides default data and distributions
  - HOWEVER: USEPA recommends use of local data and disaggregated distributions

- **Disaggregated and locally-based analyses are more sensitive to project effects**

MOVES DATA NEEDS

■ **Activity Data**

1.   VMT by Vehicle Type

2.   Hour Fractions

3,4. Day/Month Fractions

5.   Average Speed Distribution by Vehicle Type

6.   Road Type Fractions

7.   Ramp Fractions

8.   Source Type Population

■ **Non-Activity Data**

9.   Vehicle Age Distribution

10.   Inspection / Maintenance Programs

11,12. Fuel Formulation and Fuel Supply

13.   Meteorology

MOVES INPUT DATA #1: VMT by Vehicle Type

- ■ **MOVES Inputs should include locally-derived Vehicle Type fractions**

- ■ **Sources:**
  - Travel model auto & truck assigned volumes
  - Vehicle type patterns derived from classification counts
  - Motor fuel sales (from gas tax receipts)
  - MOVES defaults where no data is available

CURRENT VEHICLE TYPE CAPABILITY OF MODELS

	Model Vehicle Types	Post Processor (MOBILE6) Vehicle Types
Bristol	Autos, Trucks	Total
Chattanooga	Autos, 3 Trucks	Total
Clarksville	Total	Total
Johnson City	Total	
Kingsport	Autos, 2 Trucks	
Knoxville	Autos, 2 Trucks	3 -> 16 Types
Memphis	Autos, 2 Trucks	3- > 16 Types
Nashville	Autos, 3 Trucks	HPMS 16 Types

SUGGESTED VEHICLE TYPE CAPABILITY

	Model Vehicle Types	Post Processor (MOBILE6) Vehicle Types	Suggested Enhancement
Bristol	Autos, Trucks	Total	Disaggregate model types to MOVES types
Chattanooga	Autos, 3 Trucks	Total	Disaggregate model types to MOVES types
Clarksville	Total	Total	Enhance model, disaggregate to MOVES types
Johnson City	Total		Enhance model, disaggregate to MOVES types
Kingsport	Autos, 2 Trucks		Disaggregate model types to MOVES types
Knoxville	Autos, 2 Trucks	3 -> 16 Types	Disaggregate model types to MOVES types
Memphis	Autos, 2 Trucks	3- > 16 Types	Disaggregate model types to MOVES types
Nashville	Autos, 3 Trucks	HPMS 16 Types	Disaggregate model types to MOVES types

SUGGESTED ACTIONS: VMT by Vehicle Type

- **Models with Vehicle Type Capability**
  - Calibrate / validate as needed
  - Post process to disaggregate model vehicle type VMT (2-4 types) to MOVES vehicle type VMT (13 types)

- **Models without Vehicle Type Capability**
  - Migrate toward adding vehicle-type capability to travel model
  - Post process to disaggregate model vehicle type VMT (2-4 types) to MOVES vehicle type VMT (13 types)

- **Support Data**
  - Vehicle type distributions by TDOT and UT
  - Additional data collection (class counts) to improve sample by county / functional class to underlie pattern files

MOVES INPUT DATA #2: HOUR FRACTIONS

■ **MOVES inputs should include locally-derived temporal fractions**

■ **Sources:**

- Travel model time period assigned volumes
- Hourly volume patterns derived from traffic counts
- Preferable to compute fractions on the fly

17

TEMPORAL CAPABILITY OF MODELS

	Model Time Periods	Post Processor (MOBILE6) Time periods
Bristol	Daily	Daily
Chattanooga	Daily	Daily
Clarksville	Daily	
Johnson City	Daily	
Kingsport	Daily	
Knoxville	3 periods	3 periods
Memphis	4 periods	4 periods
Nashville	3 periods	Daily

TEMPORAL CAPABILITY OF MODELS

	Model Time Periods	Post Processor (MOBILE6) Time periods	Suggested Enhancement
Bristol	Daily	Daily	Model by time period and post process to hourly
Chattanooga	Daily	Daily	Model by time period and post process to hourly
Clarksville	Daily		Model by time period and post process to hourly
Johnson City	Daily		Model by time period and post process to hourly
Kingsport	Daily		Model by time period and post process to hourly
Knoxville	3 periods	3 periods	Post process to hourly
Memphis	4 periods	4 periods	Post process to hourly
Nashville	3 periods	Daily	Post process to hourly

SUGGESTED ACTIONS: HOUR FRACTIONS

- **Models with Temporal Capability**
  - Calibrate / validate as needed
  - Post process to disaggregate period VMT to hourly VMT, compute hour fractions

- **Models without Temporal Capability**
  - Migrate toward adding temporal capability to travel model
  - Post process to disaggregate period VMT to hourly VMT, compute hour fractions

- **Support Data**
  - Hourly distributions by TDOT and UT
  - Additional data collection to improve sample by county / functional class (to underlie pattern files)

MOVES INPUT DATA #3,4: DAY/MONTH FRACTIONS

- **MOVES Inputs should include locally-derived temporal fractions**
  - Model Typical Day -> Annual -> MOVES Analysis Day

- **Sources:**
  - Patterns derived from TDOT's daily/seasonal factors and permanent count stations (TDOT, UT)

- **Suggested Actions:**
  - TDOT / UT data development is underway

MOVES INPUT DATA #5:
AVERAGE SPEED DISTRIBUTIONS

- **Speed inputs to MOVES are a key indicator of transportation improvement impacts**

- **Sources:**
  - Travel models
  - Speed surveys (spot vs. space, coverage issues)
  - Travel model / emissions post processors

MOVES INPUT DATA #5:
AVERAGE SPEED DISTRIBUTIONS

- **Model-calculated speeds are insufficient for MOVES analysis**
  - Hourly distribution of speeds typically not available (period at best)
  - Less opportunity for VMT adjustments
    - Daily/seasonal variation
    - HPMS VMT reconciliation
    - Off-model projects
  - Model validation issues
  - Traffic Operations Analysis: Over-saturated conditions not handled well

- **Crucial variable in MOVES' calculation of emissions**

- **Some form of Post Processing is necessary:**
  - Simpler method:
    - Link-level aggregate analysis
  - More robust method (PPSUITE)
    - Link and Intersection based
    - Tools for conformity-specific network analysis

WHY ARE HOURLY SPEEDS IMPORTANT

Single Daily Volume
and Average Daily Speed

Hourly Volumes
and Speeds

AM
(Inbound)

PM
(Outbound)

WHY ARE HOURLY SPEEDS IMPORTANT

Single Daily Volume
and Average Daily Speed

Hourly Volumes
and Speeds

UNDERSTATES
PEAK VOLUMES

OVERSTATES
PEAK SPEEDS

AM
(Inbound)

PM
(Outbound)

Volume

Hour

Volume

Hour

Volume

Hour

Volume

Hour

Single Daily Volume
and Average Daily Speed

Hourly Volumes
and Speeds

AM
(Inbound)

PM
(Outbound)

OVERSTATES
PEAK VOLUMES
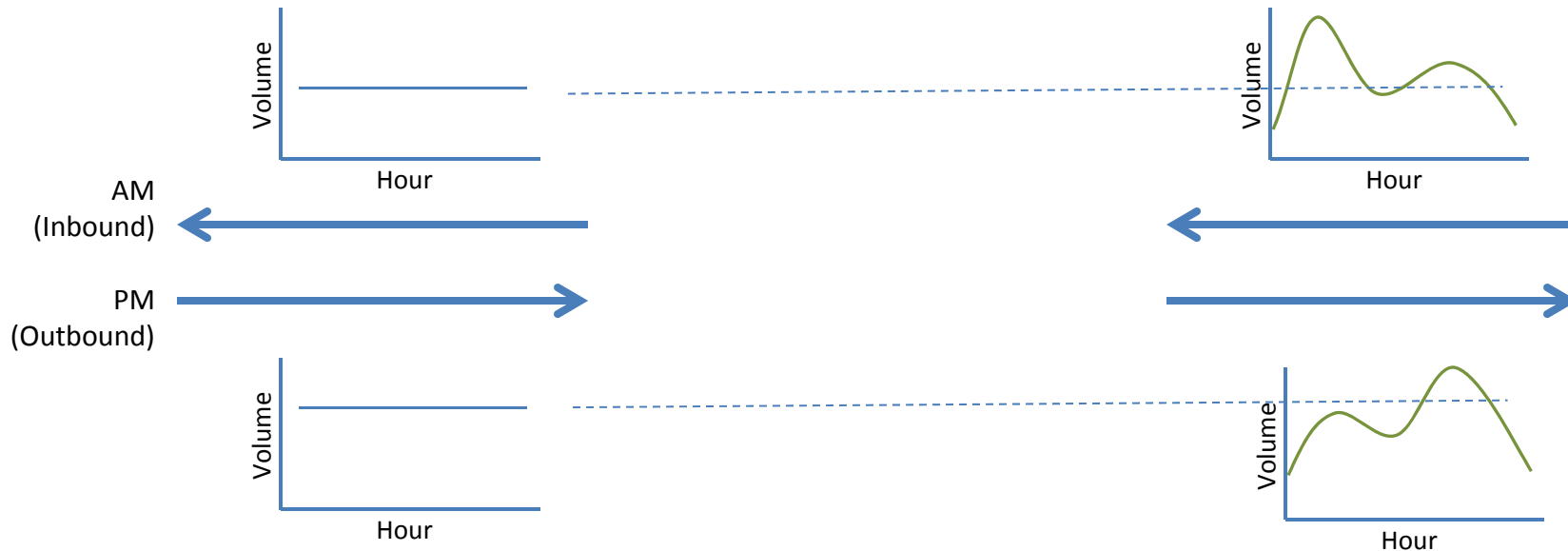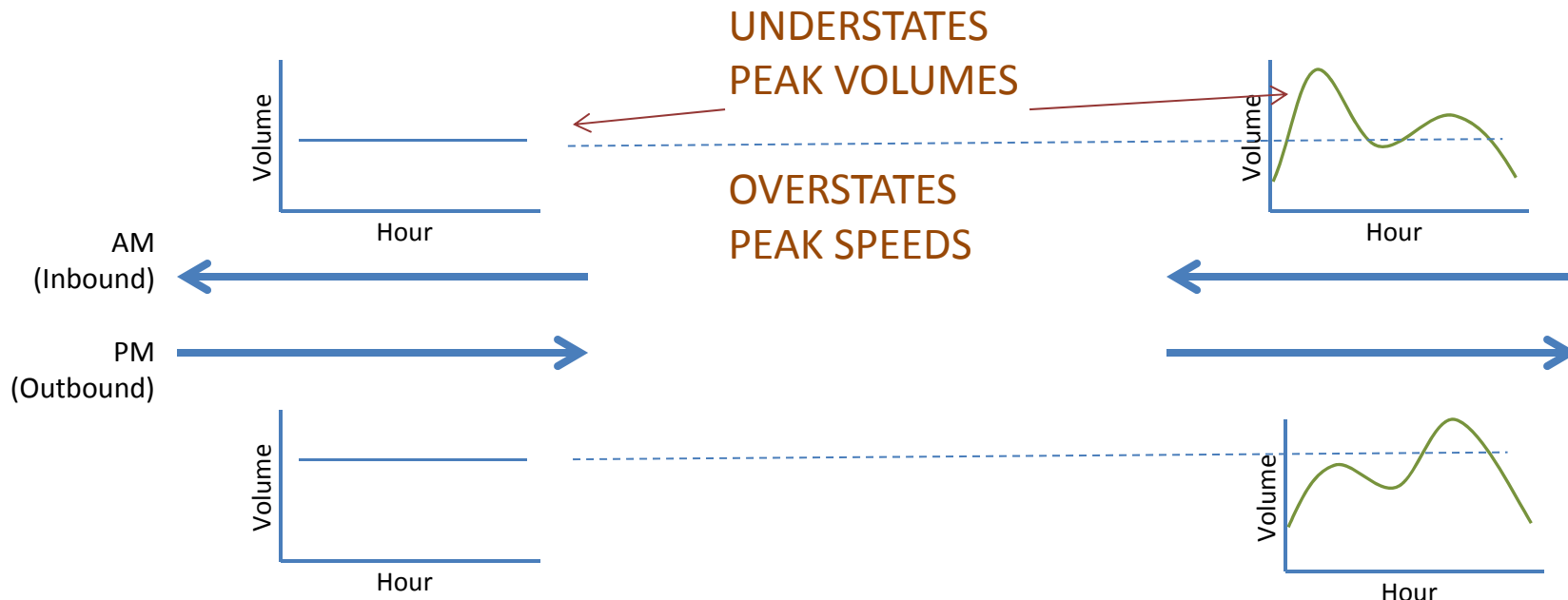
UNDERSTATES
PEAK SPEEDS
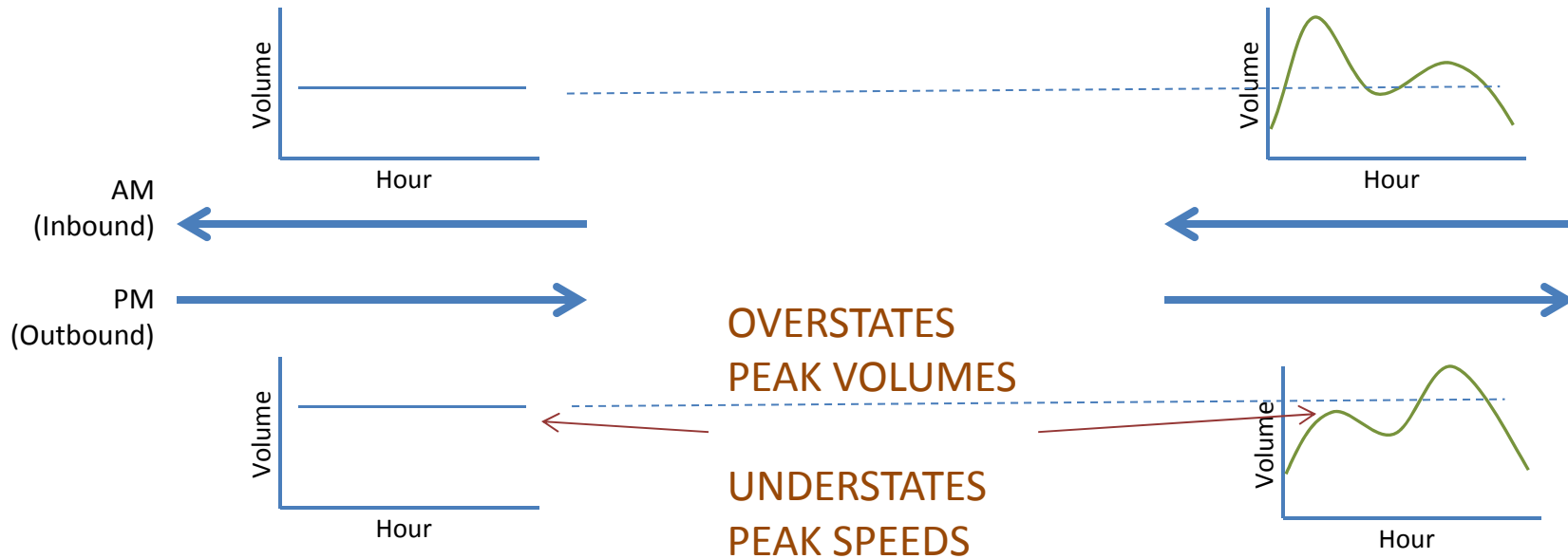
SUGGESTED ACTIONS: AVERAGE SPEED DISTRIBUTIONS

- **Models with Speed Post Processing Capability**
  - Enhance to support MOVES standards
  - Calibrate, validate as needed for hourly analysis
  - Post process to disaggregate period / daily speeds to hourly speeds, aggregate to 16 speed bins

- **Models without Speed Post Processing Capability**
  - Migrate toward adding speed post processing capability to travel model
  - Calibrate, validate as needed for hourly analysis
  - Post process to disaggregate period / daily speeds to hourly speeds, aggregate to 16 speed bins

- **Support Data**
  - Speed surveys, other calibration data

MOVES INPUT DATA #6: ROAD TYPE FRACTIONS

- **MOVES Inputs must be categorized according to four road types**
  - Urban / Rural
  - Restricted / Unrestricted
- **Sources:**
  - Analysis of network topology (one-time)
  - Travel model network (one-time or on-the-fly)

- **Fraction of VMT on each MOVES Road Type, by Source Type ID**

- **Mapping Scheme Required**
  - Model Facility Type
  - Model Area Type
  - To Road Type
  - ROAD TYPE DISTRIBUTION fractions are computed on the fly, based on % of:
    - Calculated VMT on links
    - By facility and area type

- **Grapple with Off-Network VMT**

Model Facility Type (typical)
1) Freeway
2) Expressway
3) Principal Arterial Divided
4) Principal Arterial Undivided
5) Arterial Divided
6) Arterial Undivided
7) Minor Arterial
8) Collectors / Local
9) High-Speed Ramp
10) Medium-Speed Ramp
11) Low-Speed Ramp
12) Centroid Connector

Model Area Type
1) CBD
2) Urban
3) Urban Fringe
4) Suburban
5) Exurban

MOVES Road Type	
2) Urban Restricted	
3) Urban Unrestricted	
4) Rural Restricted	
5) Rural Unrestricted	

SUGGESTED ACTIONS: ROAD TYPE FRACTIONS

- **Implement Within Post Processor**
  - Functional Class / Facility Type / Road Type mapping scheme
  - Sensitivity to scenarios by on-the-fly calculation

- **Support Data**
  - HPMS VMT by Functional Class: VMT Reconciliation Process

MOVES INPUT DATA #7: RAMP FRACTIONS

- **MOVES Inputs should include locally-derived ramp fractions**
  - MOVES default (8%) overstates ramp share of VHT
  - What is a ramp?

- **Sources:**
  - Off-model: Analysis of network topology (one-time)
  - On-model: Travel model network assigned volumes (one-time or on-the-fly)

- **Suggested Actions:**
  - Implement post-processor support
  - Calculate at run time for sensitivity to scenarios

MOVES INPUT DATA #8: SOURCE TYPE POPULATION

- **SOURCE TYPE POPULATION drives off-road emissions:**
  - Starts / soaks / evaporatives
  - Can be a dominant portion of total emissions in comparison to running emissions:

- **Source Type Population represents the number of vehicles present and emitting during the analysis day**

- **Currently, the number of registered vehicles (with adjustments) in the domain is taken as a surrogate for Source Type Population**

SOURCE TYPE POPULATION

- **One Typical Method**
  - Autos   Registration data

  - Motorcycles   Registration data

  - Buses   Registration data and agency-provided data
    (Transit bus garages, number of school buses)

  - Other 2-axle,   Registration data
  4-tire vehicles

  - Trucks   External (through) vs. internal travel problematic
    Long haul vs. short haul estimate problematic
    Use local truck VMT with MOVES default
     VMT:Population ratios

- **Suggested Actions:**
  - TDOT / UT data development is underway

MOVES INPUT DATA #9: VEHICLE AGE DISTRIBUTION

- **MOVES Inputs must be derived from local motor vehicle registration data**

- **Sources:**
  - TN Dept of Revenue tabulation

- **Suggested Actions:**
  - Dept of Revenue data has been received
  - TDOT / UT data development is underway

- **MOVES Inputs must describe the local program**
  - I/M in 7 counties

- **Sources:**
  - TDEC / Local Air Agency conversion of MOBILE6 specifications

- **Suggested Actions:**
  - TDEC data development is underway

MOVES INPUT DATA #11,12: FUELS

- ■ **MOVES Inputs must describe local fuel characteristics**
  - ● Fuel Formulation: Attributes of specific fuels
  - ● Fuel Supply: Market share by county

- ■ **Sources:**
  - ● Assembled from sampling data by TDEC

- ■ **Suggested Actions:**
  - ● TDEC data development is underway

MOVES INPUT DATA #13: METEOROLOGY

- **MOVES Inputs must describe the local meteorologic conditions**

- **Sources:**
  - Assembled from weather station data by TDEC
  - 2000 – 2009 data prepared, ongoing effort

- **Suggested Actions:**
  - TDEC data development is underway

MOVES METHOD: RATES vs. INVENTORY

	Inventory	Rate Lookup
Simplicity of Application	🟢	🔴
Advance Runs and Setups Required	🟢	🟠
Run Execution Times (Conformity)	🟠	🟢
Run Times (Statewide)	🔴	🟢
Audit Trail	🟢	🔴
Hardware Resources	🔴	🟢

MOVES METHOD: RATES vs. INVENTORY

- **Method yet to be determined with input from MPOs/TPOs, TDOT, TDEC**
  - PPSUITE post processor switch-hits painlessly
  - Results can be identical, if internal adjustments are properly applied to account for MOVES "anomalies"

- **Suggested actions**
  - Further testing and consultation
  - Prototype application

RECOMMENDATIONS

RECOMMENDATIONS

- **Travel model enhancements to estimate travel by time of day and by vehicle types**

MPO/TPO	Travel Model Time-of-Day Capability	Time-of-Day Sub-model Needed?	Vehicle Type (Trucks) Capability	Truck Sub-model Needed?
Bristol MPO	24-hour only	Yes	Autos, trucks	Yes
Chattanooga MPO	24-hour only	Yes	Autos, (3 truck types; but not validated)	Yes
Clarksville MPO	24-hour only	Yes	Total traffic	Yes
Johnson City TPO	24-hour only	Yes	"All vehicles" only	Yes
Kingsport MPO	24-hour only	Yes	Autos, 2 truck types	No
Knoxville TPO	3 time periods	No	2 truck types	No
Memphis MPO	4 time periods	No	2 truck types	No
Nashville MPO	3 time periods; aggregated to daily prior to AQ model input	No	3 truck types, not input to emissions model	No

■ Consistent post-processing platform

- Enables enhanced analysis of travel model outputs
- MOVES-ready
- Facilitates centralized technical support
- Consistent with non-modeled counties (TDOT) and TDEC technical activities (e.g. SIP budgets)
- Prototype PPSUITE application (with a TN region) will be installed
  - Platform for reviewing / testing data
  - Opportunity to evaluate processing methods

RECOMMENDATIONS (cont'd)

- **Data Acquisition**
  - Adopt / adapt data being prepared by UT
    - Month, day, hour fractions
    - Source Type Population
    - Vehicle Age distributions
  - Adopt / adapt non-activity data being prepared by TDEC
    - Inspection / Maintenance
    - Fuel Formulation and Supply
    - Meteorology
  - Additional data collection for county-level vehicle type distributions, speed data for validation and non-modeled counties
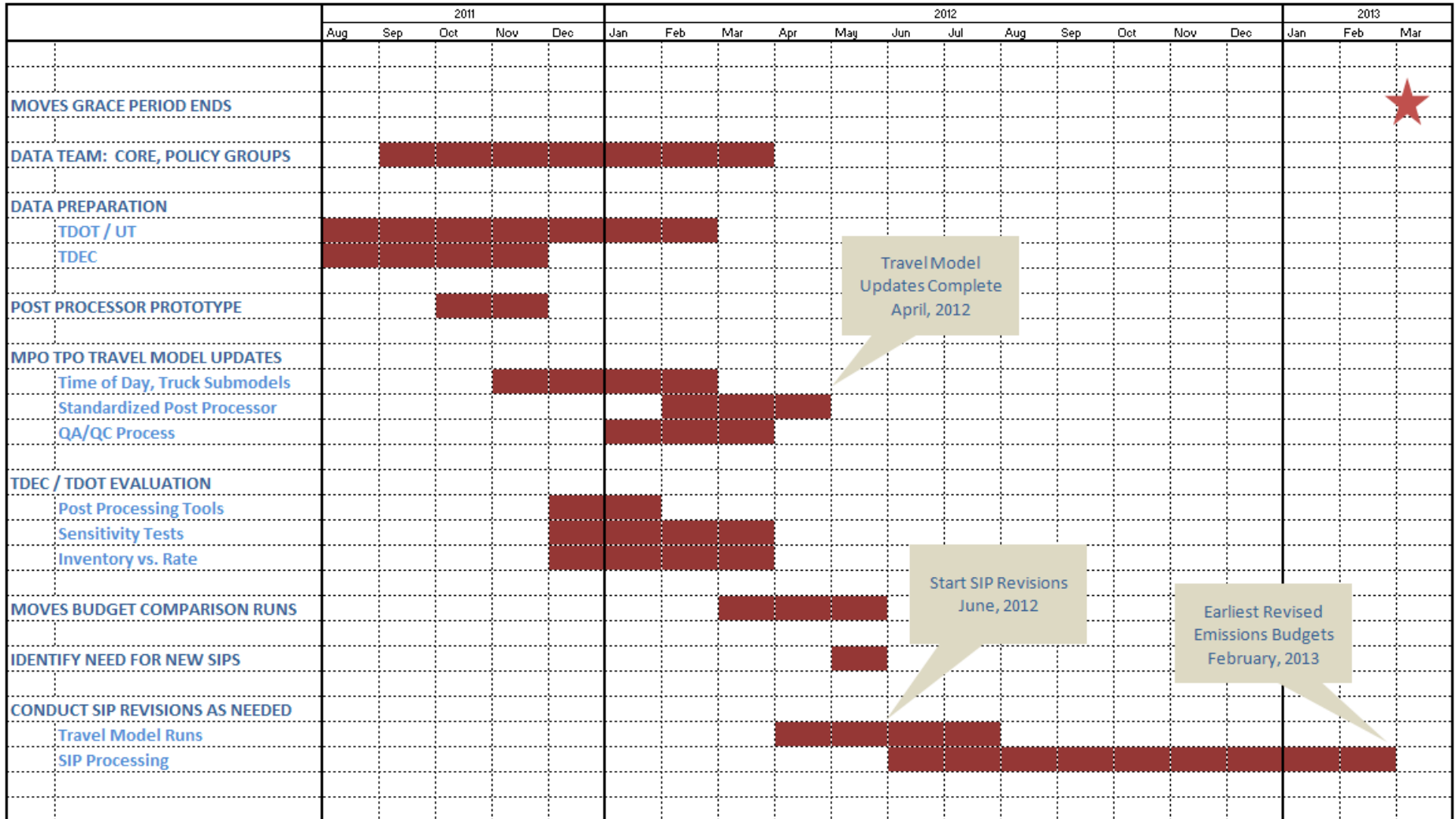
Process Management

- Data Review Team:
  - Core Group: Technical review
  - Policy Group: Agency coordination
- TNMUG or similar User Group
  - Forum for discussion and technical coordination
  - Workshops and telephone / web conferencing
- Overall QA/QC process
- Assessment of County Inventory vs. Rate Lookup methods
  - TDOT leadership with TDEC

SCHEDULE

MOVES IMPLEMENTATION SCHEDULE

Updated November 3, 2011

NEXT STEPS

NEXT STEPS

- **Management Webinar (Nov. 21, 2011)**
  - TDOT's Proposal to Offer:
    - Model Enhancements and Updates
    - Pilot Post Processor
    - Technical Support and Assistance
  - Data development
  - Rate vs. Inventory Method Issues

- **Prototype Installation to Demonstrate / Evaluate:**
  - Data Issues
  - Processing

- **Policy and Core Group Meetings**

- **Travel Model Improvements**