MOVES Onroad Vehicle Population and Activity Update

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FACA MOVES Review Workgroup
December 7, 2016

Agenda

- Introduction
- MOVES2014 data sources and methodology
- Proposed updates for next MOVES release
- Request for feedback

Introduction

- MOVES links vehicle population and activity information to emission processes and rates
- The primary data are national default:
  - VMT
  - Vehicle Populations
  - Age Distributions
- These are then distributed among the following to link the activity to an emission rate:
  - Calendar Year
  - Source Type
  - Regulatory Class
  - Fuel Type
  - Age
- This information is primarily used at National Scale

MOVES
Motor Vehicle Emission Simulator

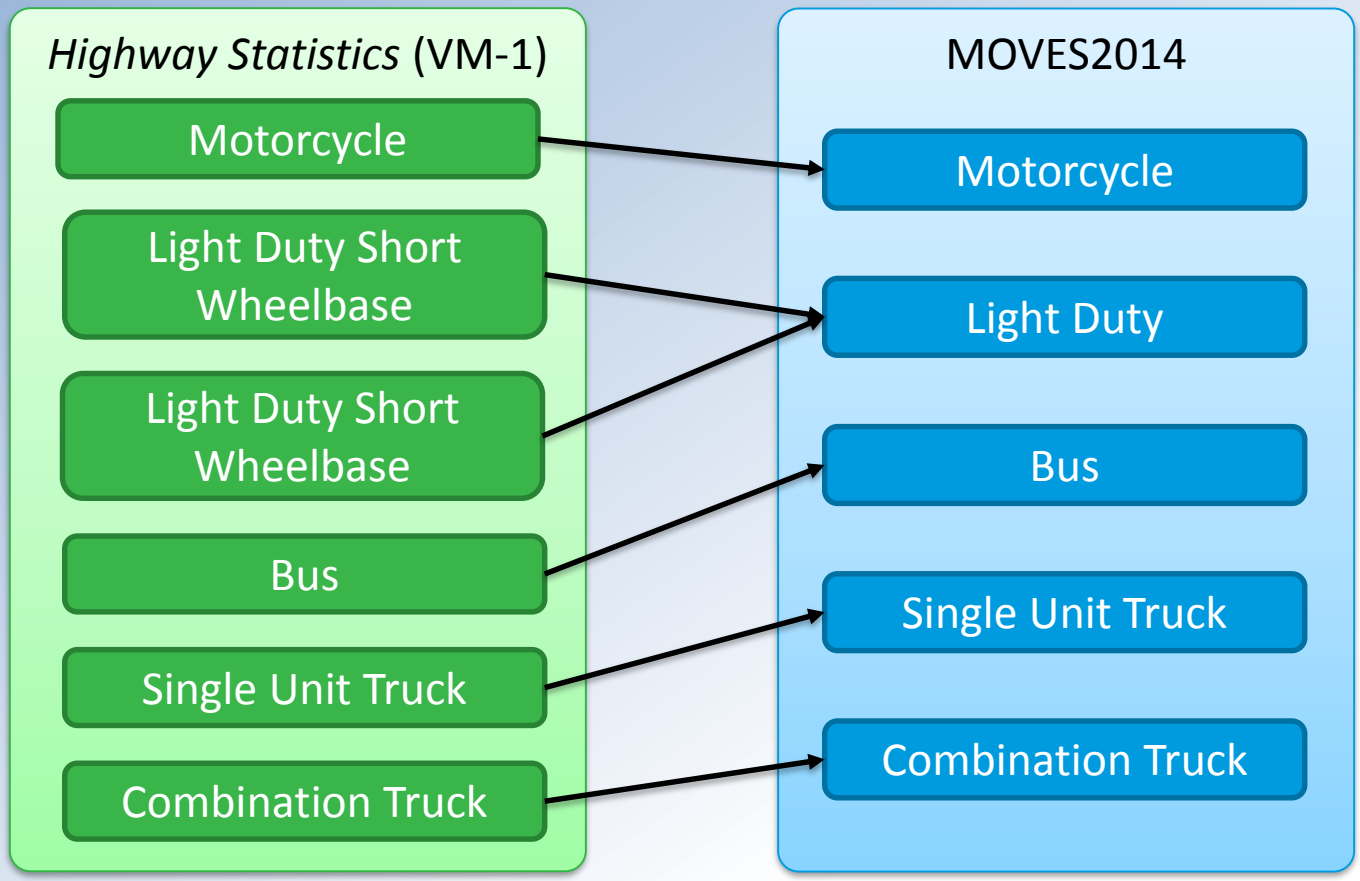
Vehicle Miles Travelled (VMT)

Historic VMT in MOVES2014

- Calendar years 1990 and 1999-2011
- All data come from FHWA's *Highway Statistics*[1]
- National default VMT are input by HPMS class*
  - VMT is allocated to source type, reg class, fuel type, and model year during model run time through Relative Mileage Accumulation Rates (from VIUS) and the Sample Vehicle Population
  - LD categories are combined because MOVES does not differentiate by wheelbase

*HPMS classes are groupings used by the Dept. of Trans. Highway Performance Monitoring System.

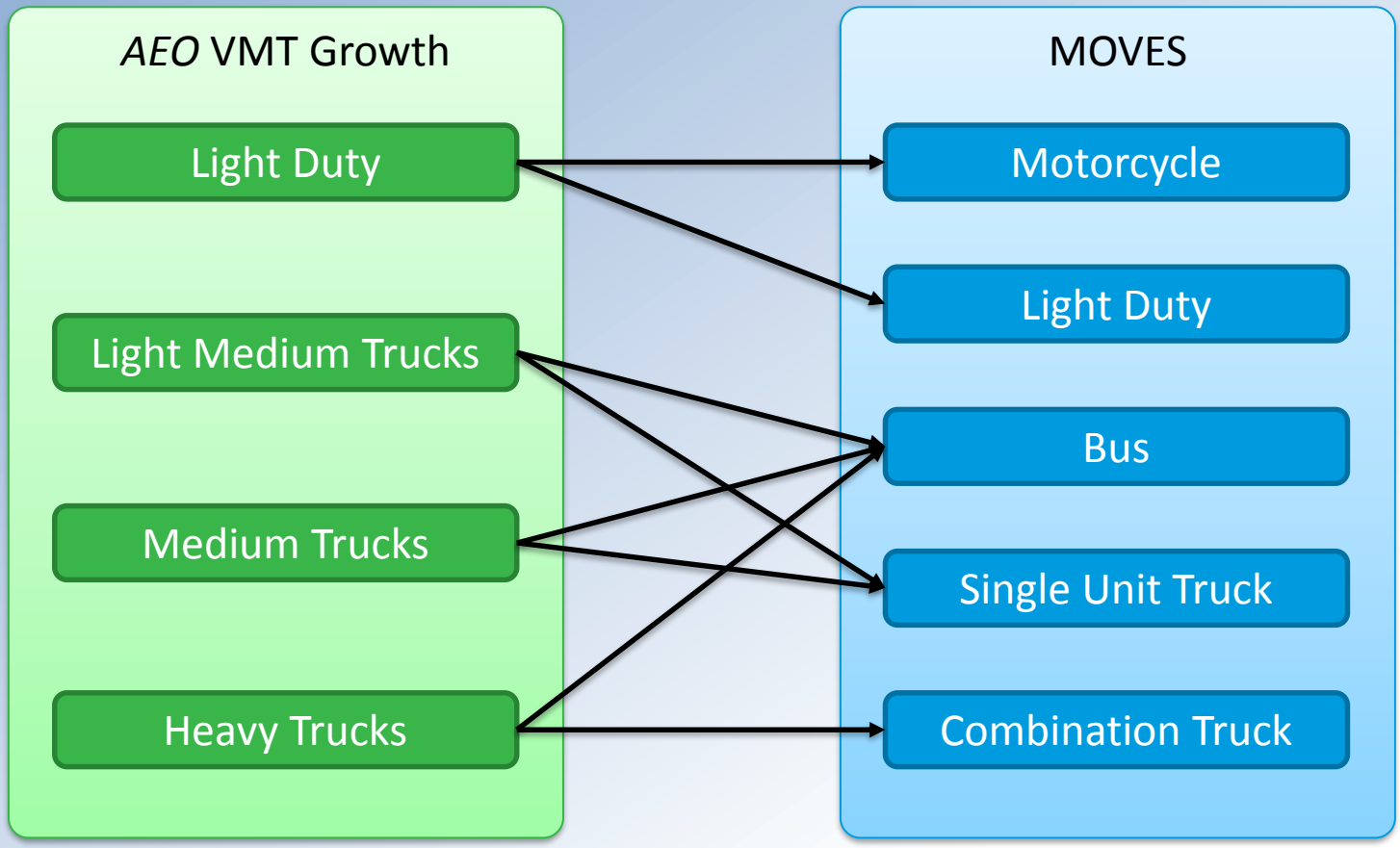
Historic VMT in MOVES2014



Projected VMT in MOVES2014

- VMT projections from Dept. of Energy's Annual Energy Outlook[2] (AEO) 2014
  - Year-over-year growth rates in VMT were calculated by AEO vehicle classifications
    - Light duty
    - Freight: Light Medium, Medium, and Heavy heavy duty
  - Growth rates applied to last historic year (2011) VMT through a mapping between AEO classes and HPMS classes
  - Average VMT growth rate for 2031-2040 used for 2041-2050

Projected VMT in MOVES2014



Proposed VMT Changes for Next Version of MOVES

- Historic VMT
  - Include data up to 2015 from *Highway Statistics* if available, otherwise use 2014
    - Highway Statistics 2015 scheduled to be released Dec 2016
- Projected VMT
  - Calculate from AEO2017 if available, otherwise use AEO2016
    - AEO2017 scheduled to be released Jan 2017
  - Project beyond final year of AEO using the final year growth as a surrogate
    - AEO2016 projects out to 2040
    - AEO2017 will project out to 2050
    - The next version of MOVES will project out to 2060

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Vehicle Populations

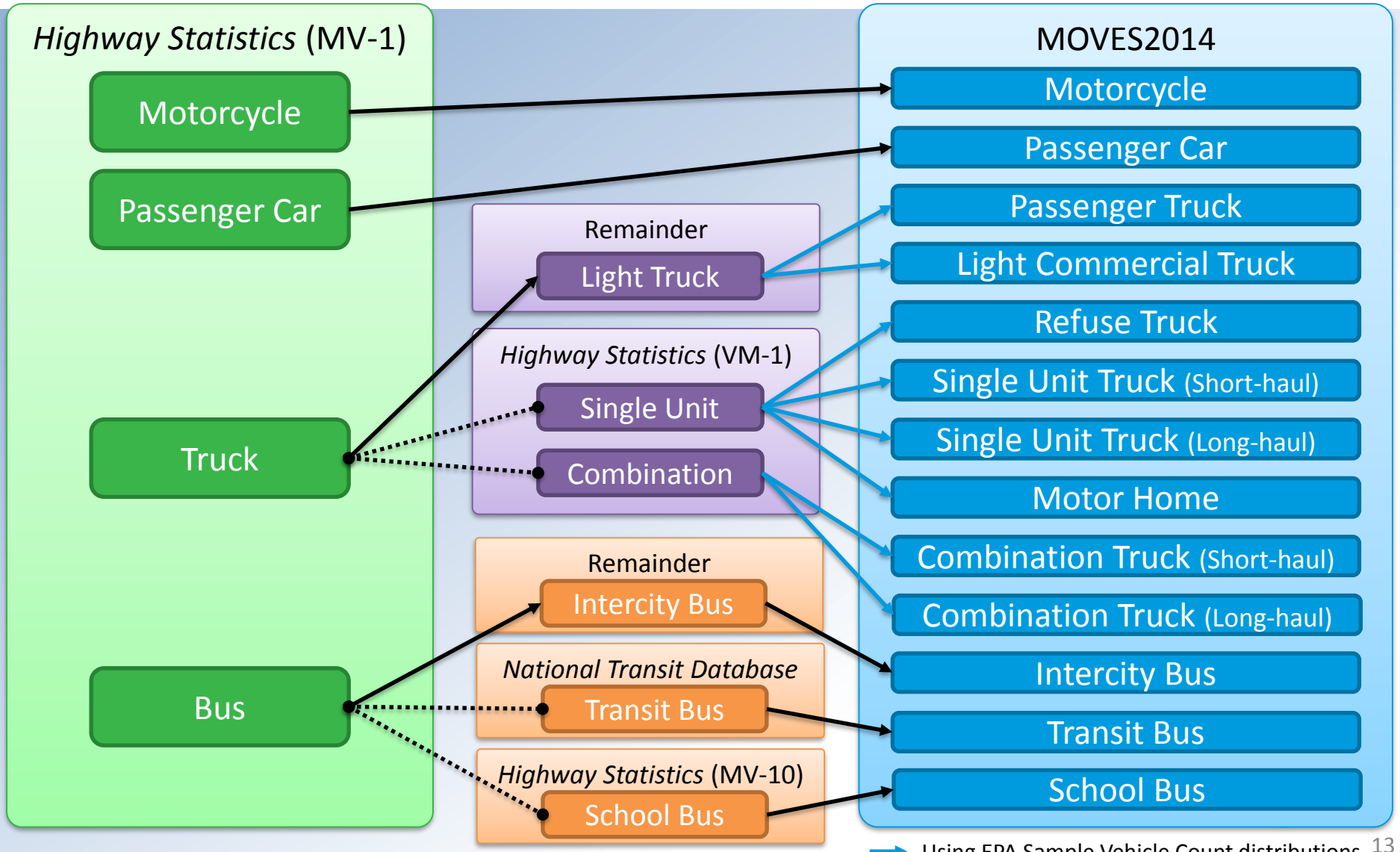
Sample Vehicle Population

- Based on EPA Sample Vehicle Counts
  - Contains representative vehicle counts by source type, fuel type, model year, and regulatory class
  - Distributions calculated from the vehicle counts are used in MOVES
    - To allocate default activity to fuel types and regulatory classes
    - With Alternative Vehicle and Fuel Technologies (AVFT) importer to allocate user input activity
  - Combines 2011 registration data from IHS Automotive with 2002 Vehicle Inventory and Use Survey (VIUS) for most source types
    - Bus distributions come from unpublished FHWA data and published National Transit Database[3] data. Motor home distributions come from same FHWA data

Historic Populations in MOVES2014

- Calendar years 1990 and 1999-2011
- Principal data source is FHWA's *Highway Statistics*
- Bus populations also use National Transit Database

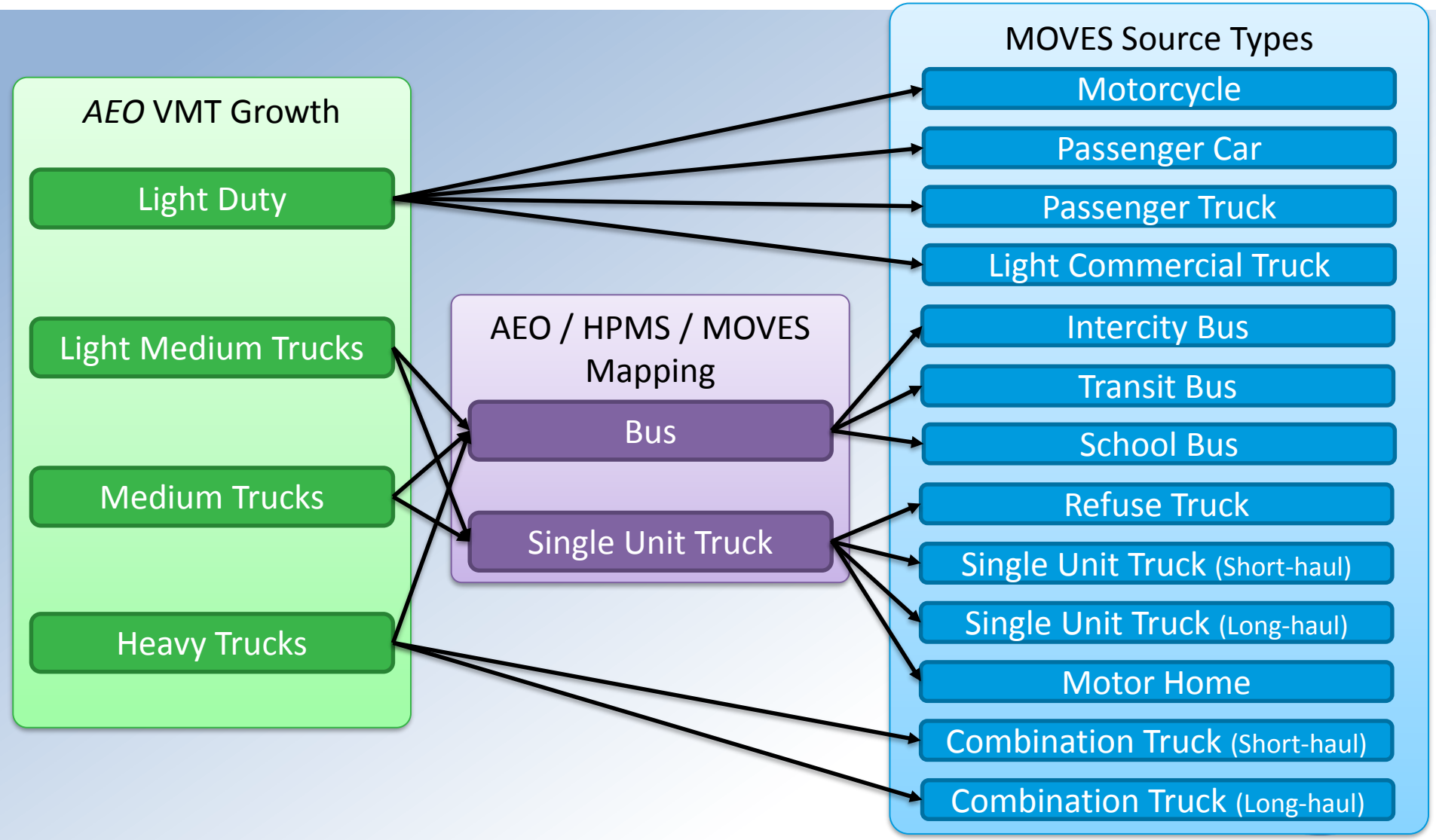
Historic Populations in MOVES2014



Projected Vehicle Populations in MOVES2014

- Used VMT projections from AEO 2014
  - VMT per vehicle by HPMS class was relatively constant from 1999-2011
  - Year-over-year growth rates in VMT were calculated by AEO vehicle classifications
    - Light duty
    - Freight: Light Medium, Medium, and Heavy heavy duty
  - Growth rates applied to last historic year (2011) populations through a mapping between AEO classes, HPMS classes, and MOVES source types

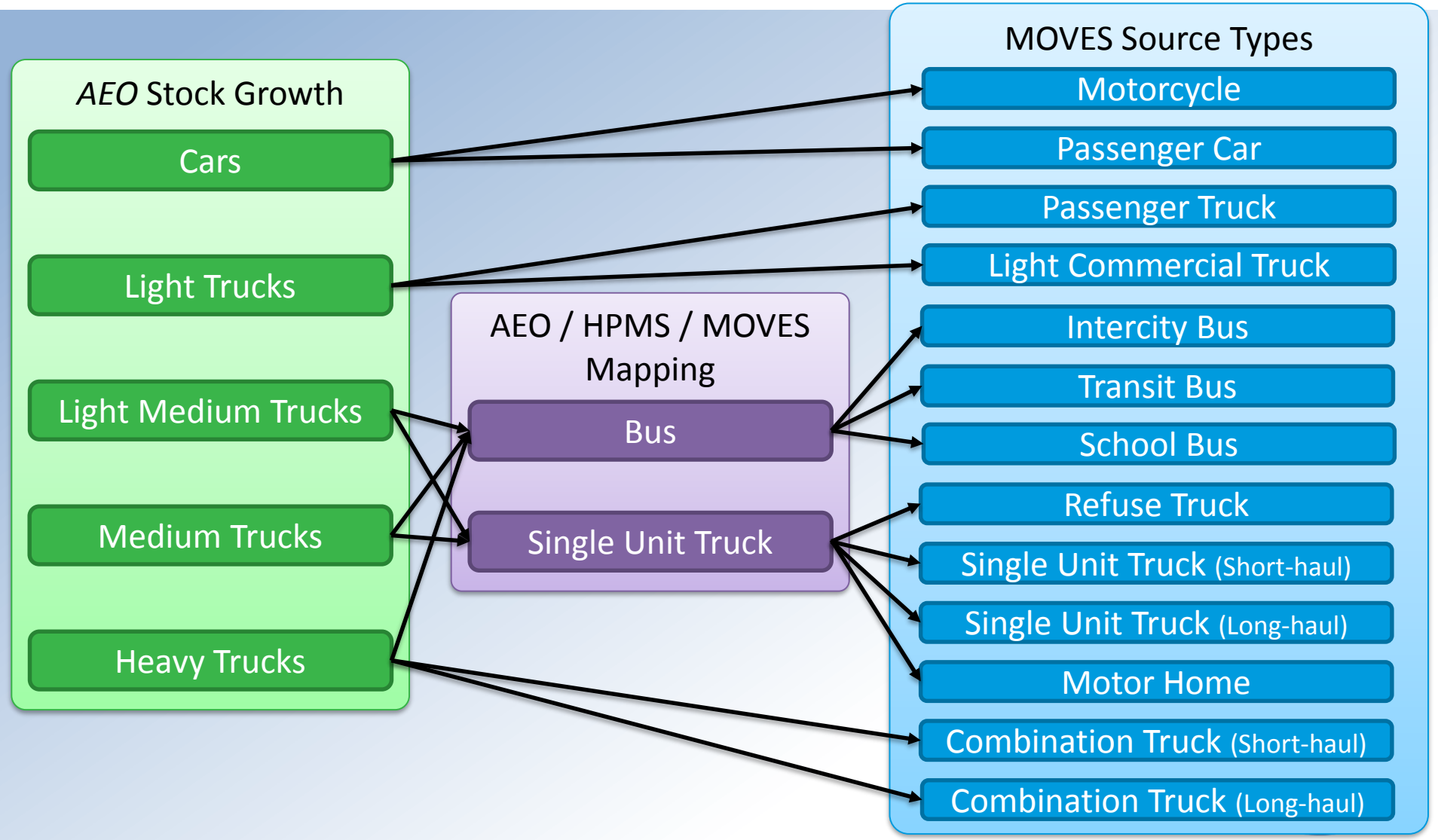
Projected Vehicle Populations in MOVES2014



Proposed Vehicle Population Changes for Next Version of MOVES

- For both Historic and Projected Populations
  - Correct an error in EPA Sample Vehicle Counts, which impacts fuel and regulatory class distributions for class 2a/2b trucks
- Historic Populations
  - Include data up to 2015 from *Highway Statistics* and *National Transit Database* if available, otherwise use 2014
- Projected Populations
  - Calculate from AEO2017 if available, otherwise use AEO2016
  - Use vehicle stock instead of VMT projections

Proposed Vehicle Population Changes for Next Version of MOVES



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Age Distributions

Historic Age Distributions in MOVES2014

- Calendar years 1990 and 1999-2011
- Vary by source type
- 2011 age distributions from EPA Sample Vehicle Count (IHS + VIUS)
- Algorithm to backcast from 2011 to 1999:

$$P_{y-1} = P_y - N_y + R_{y-1}$$

  - P is population in year y or y-1
  - N is new vehicle sales in year y
  - R is the removed (scrapped) vehicles in year y-1

Historic Age Distributions in MOVES2014

- Source type populations known
- Historic sales data sources:
  - Motorcycle Industry Council[4]: motorcycles
  - *Transportation Energy Data Book*[5] (TEDB): light duty, single unit trucks, combination trucks
  - *School Bus Fleet Fact Book*[6]: school buses
  - EPA Certification Data: transit buses
  - No known source for intercity bus sales, so these are estimated based on the other two bus categories

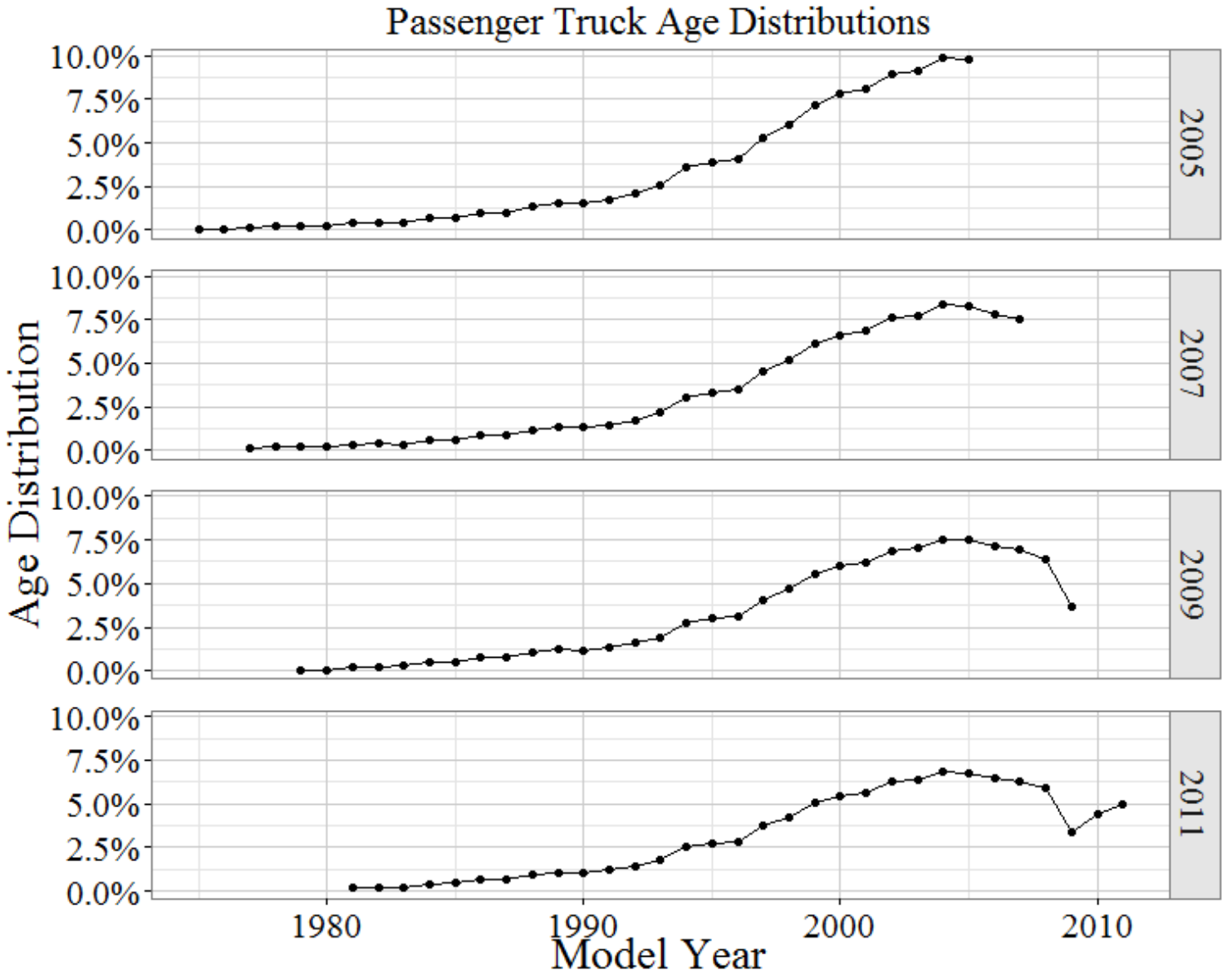
Historic Age Distributions in MOVES2014

- No known source for annual scrappage, so we calculate it from:

$$P_{y-1} = P_y - N_y + \boldsymbol{R_{y-1}}$$

- Distribute scrapped vehicles by age:
  - Start with a base scrappage profile
    - Light duty scrappage from 2002 National Highway Traffic Safety Administration (NHTSA) study
    - Heavy duty scrappage from TEDB
  - Scale scrappage profile so the sum total of scrapped vehicles satisfies the above equation
  - Calculated at HPMS level, and applied to each source type within HPMS class

Historic Age Distributions in MOVES2014



Projected Age Distributions in MOVES2014

- Calculated for calendar years 2012-2050
- Vary by source type
- Based on 2011 age distributions from EPA Sample Vehicle Count (IHS + VIUS)
- Algorithm to forecast from 2011 to 2050:

$$P_{y+1} = P_y + N_{y+1} - R_y$$

  - P is population in year y or $y+1$
  - N is new vehicle sales in year $y+1$
  - R is the removed (scrapped) vehicles in year y

Projected Age Distributions in MOVES2014

- Source type populations known
- Sales fractions calculated from AEO using sales and stock numbers for each of the AEO categories
  - E.g.: $\text{LD sales fraction} = \frac{\text{Car Sales} + \text{Truck Sales}}{\text{Car Stock} + \text{Truck Stock}}$
- Projected sales by HPMS class calculated from sales fractions and populations, using AEO to HPMS mapping
  - E.g.: $\text{LD sales} = \text{LD sales fraction} * \text{LD population}$

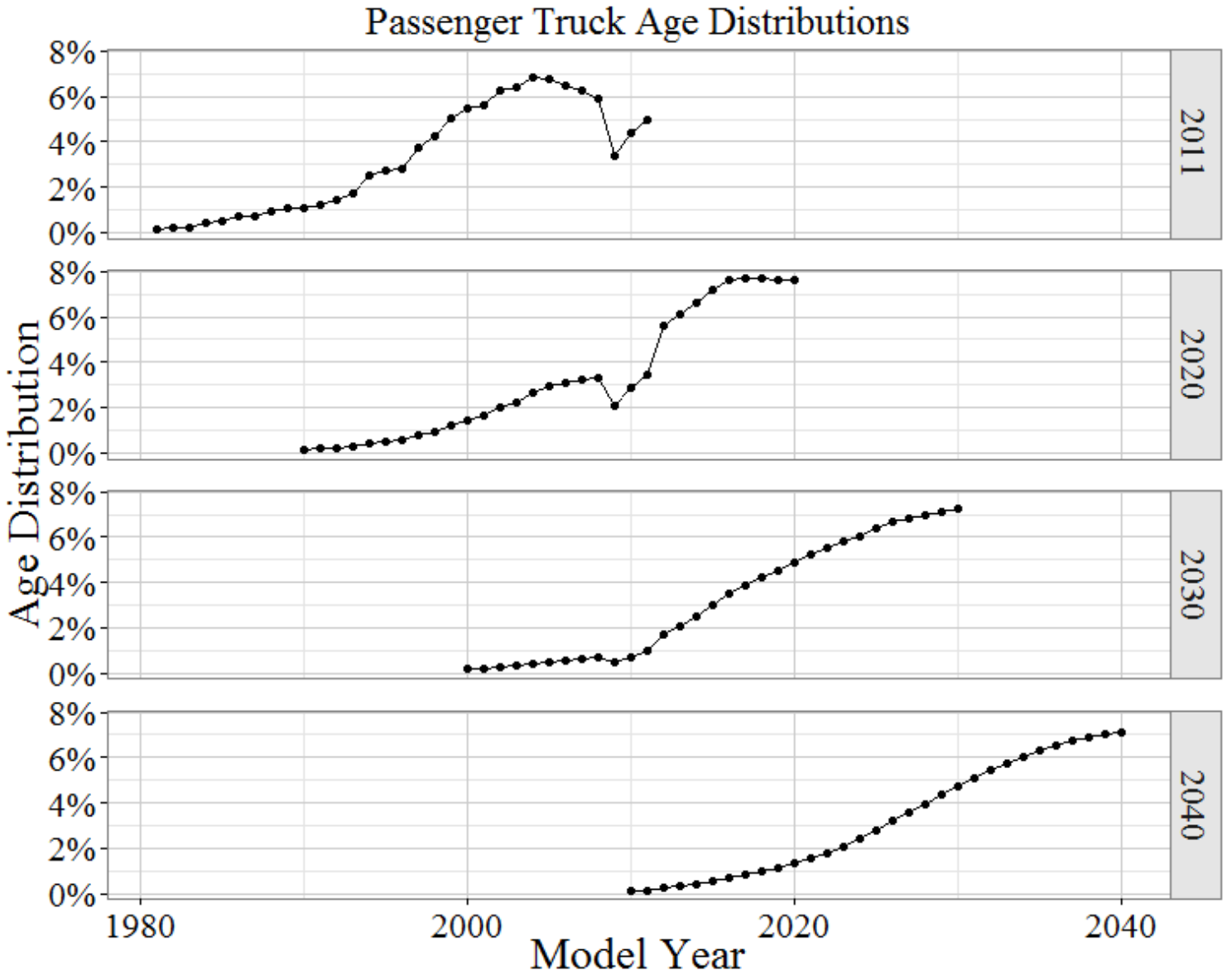
Projected Age Distributions in MOVES2014

- No known source for projected scrappage, so we calculate it from:

$$P_{y+1} = P_y + N_{y+1} - \boldsymbol{R_y}$$

- Distribute scrapped vehicles by age using same technique as historical age distributions
  - Start with a base scrappage profile
  - Scale scrappage profile so the sum total of scrapped vehicles satisfies the above equation
  - Calculated at HPMS level, and applied to each source type within HPMS class

Projected Age Distributions in MOVES2014



Proposed Age Distribution Changes for Next Version of MOVES

- Historic Age Distributions
  - Recalculate historic age distributions using updated historic populations
  - Use calendar year 2014 for base year age distributions from a new IHS data purchase
  - Use latest sales data from Motorcycle Industry Council, TEDB, and *School Bus Fleet Fact Book*
  - Use latest data from *National Transit Database* for transit buses
  - Update algorithm:
    - In $P_{y-1} = P_y - N_y + R_{y-1}$, the distribution of scrapped vehicles depends on the age distribution for P_{y-1} which is the output of the algorithm. Use an iterative approach to calculate the scrappage distribution

Proposed Age Distribution Changes for Next Version of MOVES

- Projected Age Distributions
  - Calculate from AEO2017 if available, otherwise use AEO2016
  - Perform calculations at the source type level, instead of HPMS class
    - Use same AEO / HPMS / Source Type mapping

Other Potential Changes

- If timing and resources allow:
  - Update base scrappage profiles using IHS registration data from 2011 and 2014
  - Update EPA Sample Vehicle Counts dataset and the Sample Vehicle Population table for model years 2012+ using 2014 IHS registration data
  - Include default age distributions by county
    - Use national sales estimates for projecting and backcasting from 2014
    - Adjust scrappage for counties with a younger or older average age in 2014 to maintain that delta

Requested Feedback

- Are we missing any data sources for national scale vehicle population or activity?
- Feedback on our proposed changes

Citations

1. *Highway Statistics Series.* Federal Highway Administration. https://www.fhwa.dot.gov/policyinformation/statistics.cfm
2. *Annual Energy Outlook.* Energy Information Administration. https://www.eia.gov/forecasts/aeo/
3. *National Transit Database.* Federal Transit Administration. https://www.transit.dot.gov/ntd
4. *Statistical Annual.* Motorcycle Industry Council. https://mic.org/StatAnnual.aspx
5. *Transportation Energy Data Book.* Oak Ridge National Laboratory. http://cta.ornl.gov/data/index.shtml
6. *School Bus Fleet Fact Book.* School Bus Fleet. http://digital.schoolbusfleet.com/
7. *Population and Activity of On-road Vehicles in MOVES2014.* U.S. EPA. http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100O7VJ.pdf