Computational Alternatives for Traffic Assignment

Mr. David B. Roden, Senior Consulting Manager

AECOM

November 30, 2012

2013 Task Orders

- ## T.O. 7 – Meetings and General Support
  - LineSum support
- ## T.O. 8 – Traffic Assignment **
  - 8.1 – HOT-lane Modeling
  - 8.2 – HOV Modeling
  - 8.3 – Speed Validation
- ## T.O. 9 – Mode Choice and Transit Modeling
  - 9.1 – Network Preparation
  - 9.2 – Path Building

Traffic Management Concepts

- ## High Occupancy Vehicle (HOV) Lanes
  - Provide a travel time advantage for multi-occupancy vehicles that will encourage travelers to form carpools or take transit (i.e., change modes)

- ## Managed Lanes
  - Use demand-based pricing to ensure a reliable travel time for those travelers willing to pay (value of time)
  - Generate revenue to cover capital and operating costs and increase overall system capacity and performance

- ## High Occupancy Toll (HOT) Lanes
  - Combine both concepts – sell "excess" capacity

Current Mode Choice Structure
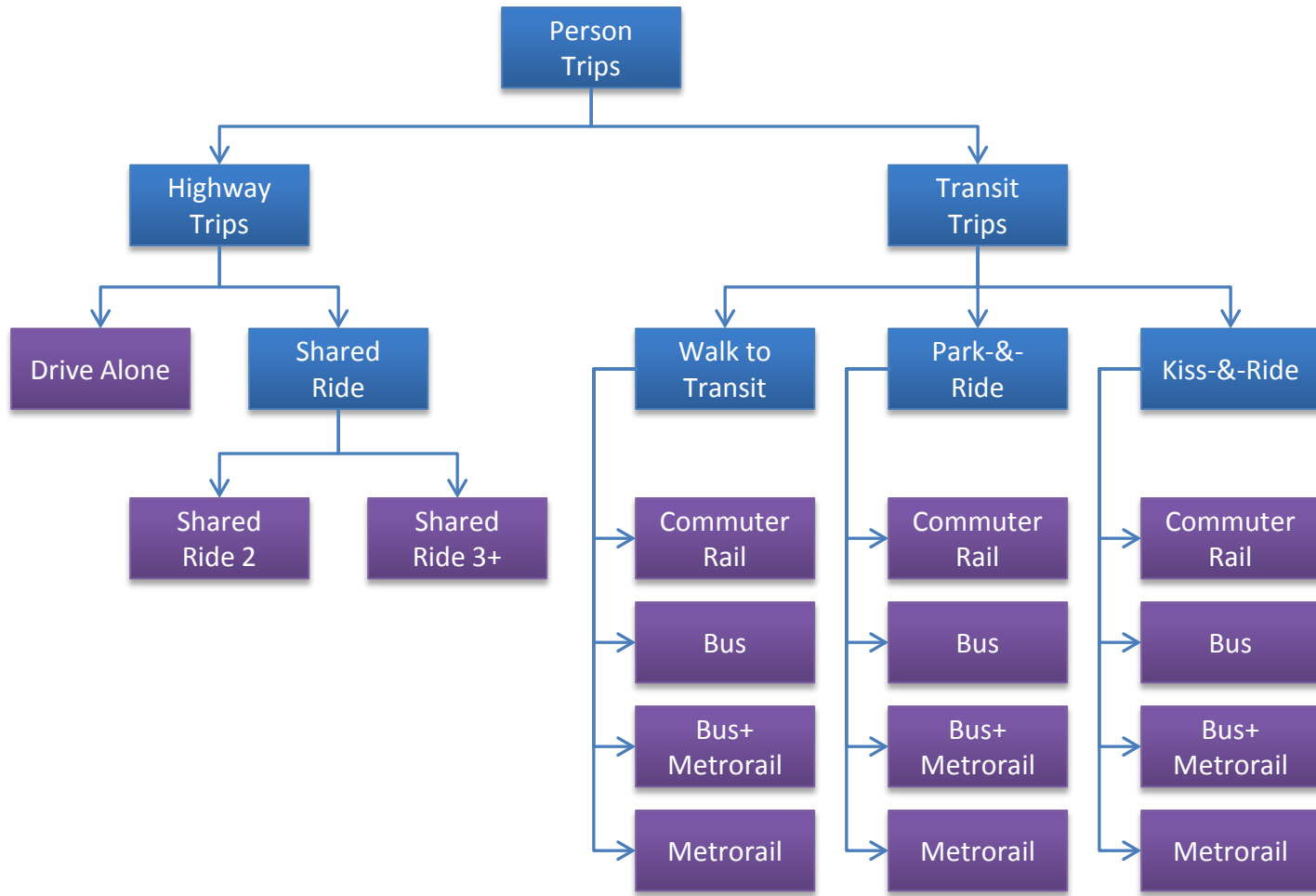
Current Assignment Process

- Bi-conjugate Frank-Wolfe
- Relative gap criteria: 0.001 or max 300 iterations
- Four time-periods
  - AM peak – 3 hours (6 am – 9 am)
  - Midday – 6 hours (9 am – 3 pm)
  - PM peak –   4 hours (3 pm – 7 pm)
  - Night – 11 hours (7 pm – 6 am)
- Six vehicle classes
  - SOV
  - HOV2
  - HOV3+
  - Commercial Vehicles
  - Medium/Heavy Trucks
  - Airport Auto Driver

Calculating Loaded Speed

- Volume-delay functions convert volume to speed
    - Computed using peak hour factors
        - AM: 41.7% ; PM: 29.4%
    - HOV facilities may have different peaking characteristics and hours of operation
- Iterate until the travel times on all used paths are equal (user equilibrium)
    - Model is validated against daily traffic counts
        - Loaded speed/travel time is a means to an end
        - Frequently results in unrealistic speeds
            - not unique to MWCOG

Speed Validation Task

- Compare INRIX data to model speeds
  - Classify the differences
- Speed modeling questions
  - Should MWCOG validate against observed speed data?
  - How are other agencies using operational speed data for validating planning-level models?
  - How can MWCOG best use the INRIX speed data to improve the regional modeling process?

Current HOV Assignment Method

- Midday and night time periods
  - Assign all six classes in a single multi-class assignment
- AM and PM peak periods
  - First assign non-HOV3+ trips to the LOV network
    - Calculate loaded speeds
    - HOV2+ links have speeds based on HOV2 trips
    - HOV3+ links have zero volume and free flow speeds
  - Then assign HOV3+ trips using loaded speeds
    - Encourages HOV3+ trips to use HOV facilities
- Overall assignment run time
  - ~2 hours per feedback loop (without parallel processing)
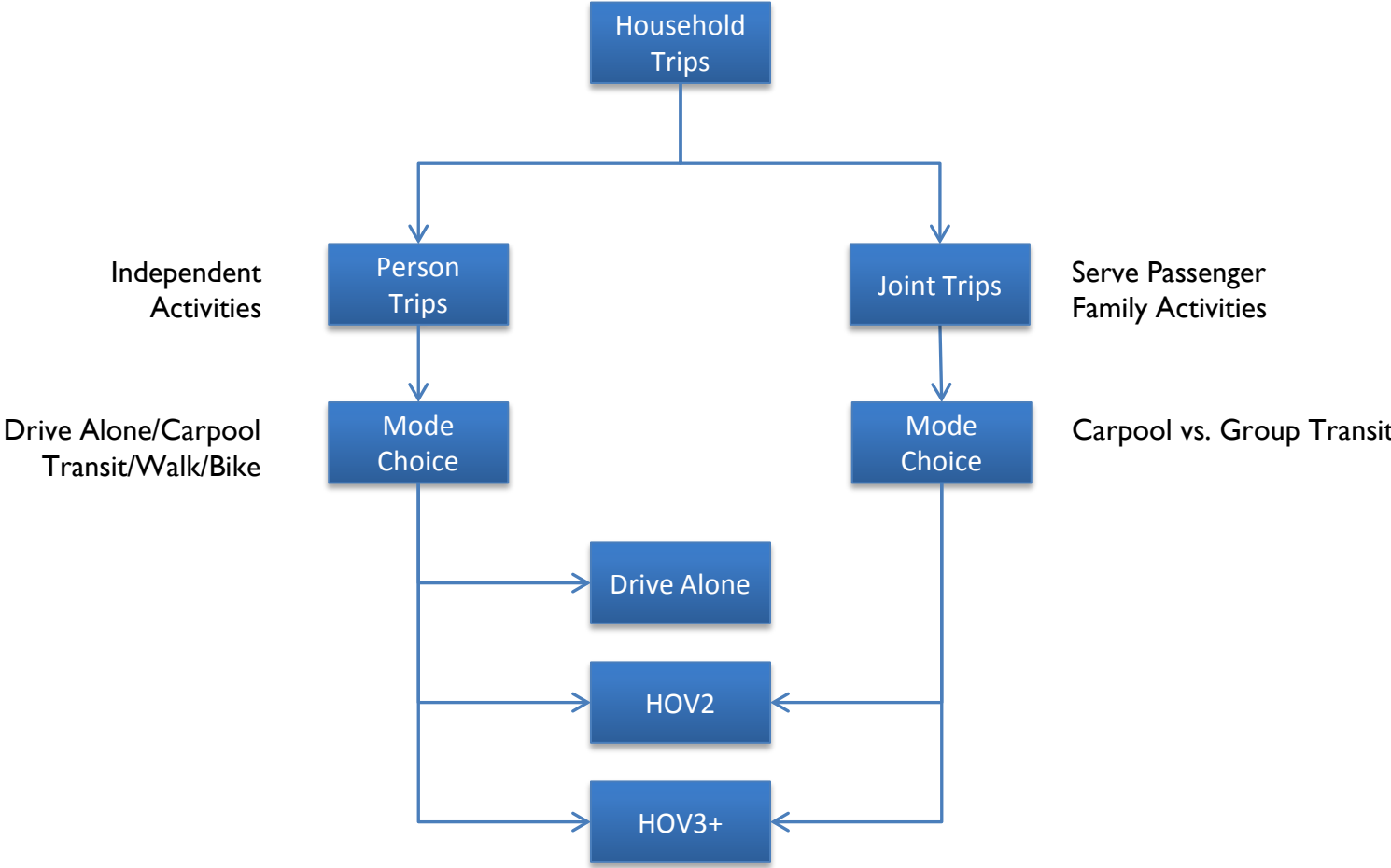
Concerns about the HOV Process

- Overall model run time
  - Traffic assignment is ~40% of total run time
- Current approach
  - Two step HOV3+ process adds time and complexity
  - Does not permit LOV trips to consider the impact of HOV3+ traffic (~20% of total trips) on travel speeds and path choice
  - HOV2 and HOV3+ facilities are not treated the same
- Multi-class assignment (i.e., AM/PM like MD/NT)
  - HOV3+ facility volumes are underestimated

AECOM

Potential HOV Improvements

- Separate HOV choice from shared household travel
  - Remove "red-bus/blue-bus" problems from the mode choice
- Split person trips into independent person trips and joint travel
  - Independent person trips
    - Full mode choice options, but limit the HOV choice to zone pairs with a travel time difference
  - Joint travel = multiple household members traveling together
    - Serve passenger and family activities
    - Group mode choice options and path attributes
      - Carpool times and costs vs. transit group times and costs
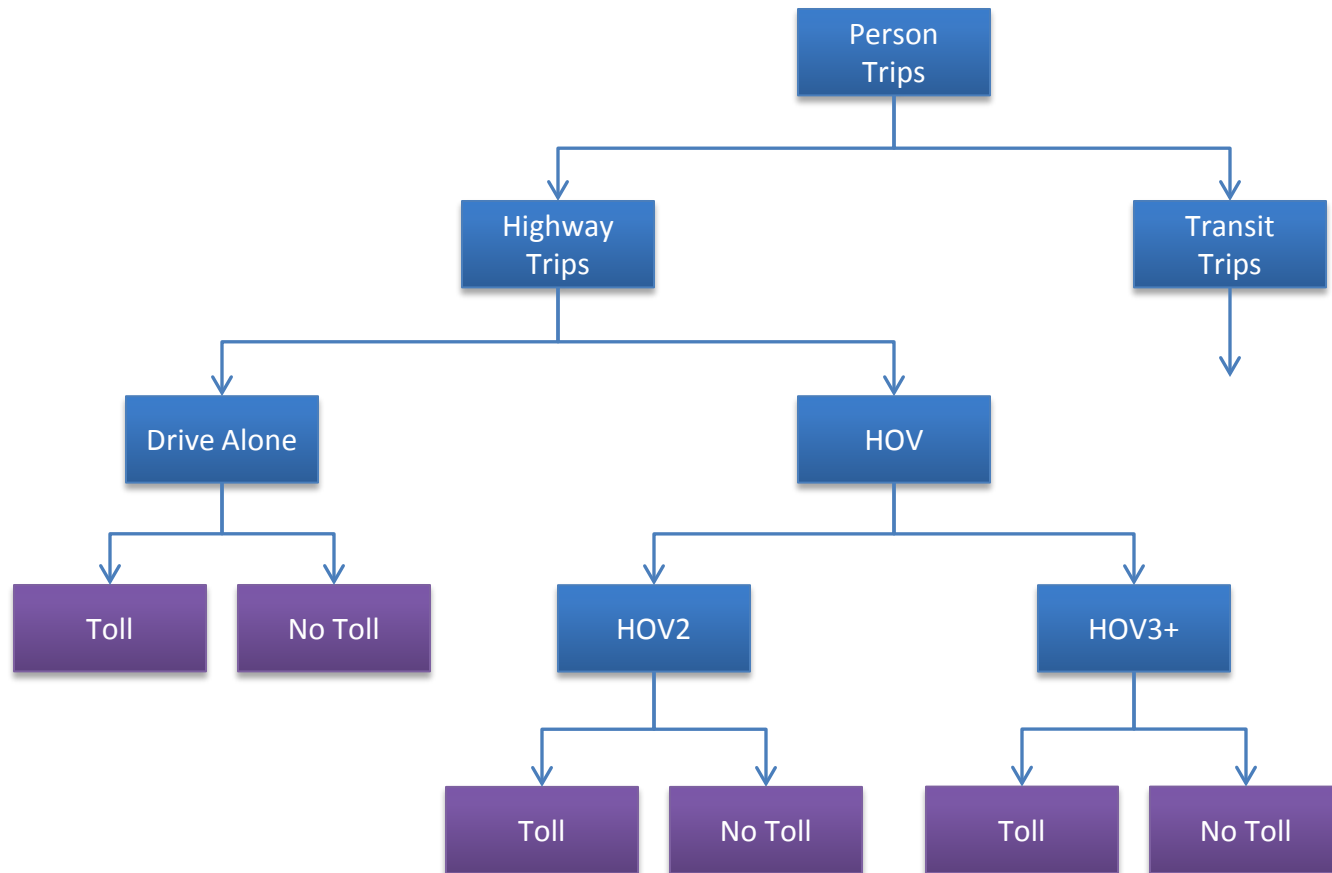
Improved Choice Structure

Independent Activities → **Person Trips**

Household Trips → **Joint Trips** ← Serve Passenger Family Activities

Drive Alone/Carpool Transit/Walk/Bike → **Mode Choice**

Mode Choice ← Carpool vs. Group Transit

Drive Alone

HOV2

HOV3+

AECOM

Current HOT-Lane Process

- Step 1: Toll Base
  - Change HOT lanes to HOV-Only and run the model
  - Use HOV skims in toll setting
- Step 2: Toll Pump Prime
  - Set HOT lanes to 20/15 cents per mile (peak/offpeak)
- Step 3: Toll Setting
  - Iteratively adjust toll based on V/C ratio
    - 10 to 50 cent adjustments based on V/C ratio
    - Stop when V/C ratio is between 0.95 and 1.01 (~50 mph)
    - Maximum of 100 iterations and $10 per mile
    - 30 hour run time for PM Peak
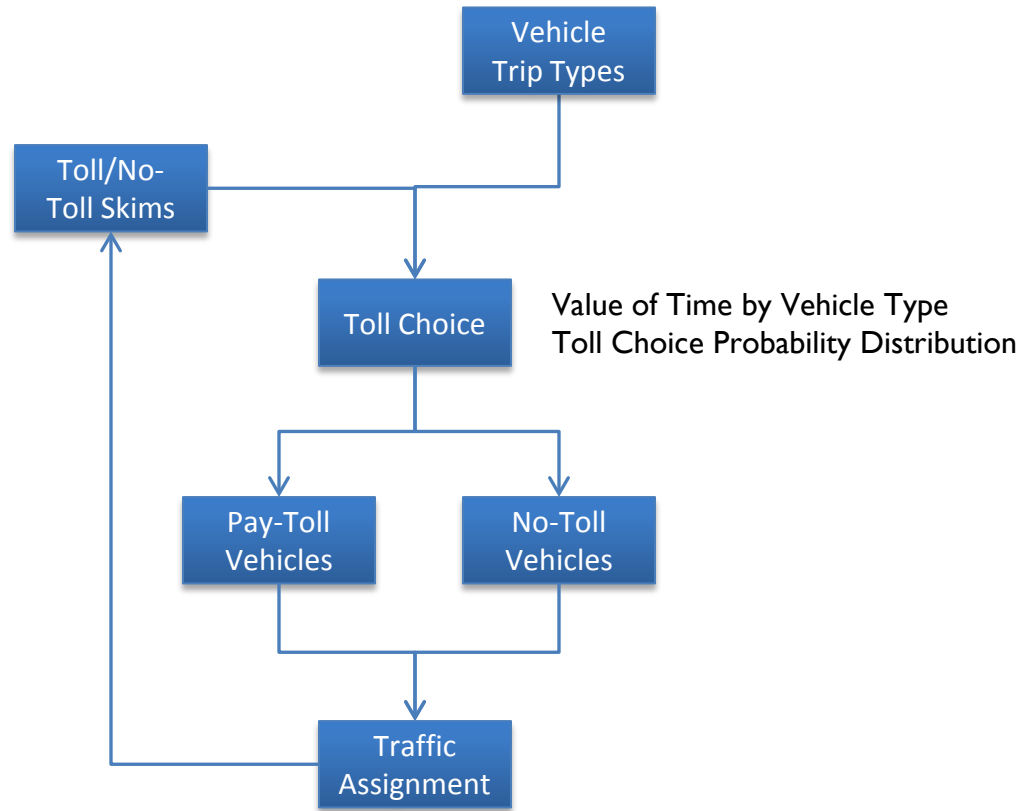- Step 4: Rerun the whole model with fixed tolls

Concerns about HOT Lane Process

- Overall model run time
  - HOT lane runs required two full model applications
- HOT lane toll rates are set outside of the standard modeling process
  - Alternatives that impact HOT lanes should update the toll rates
    - Adds ~30 hours to the run time
  - Link-based tolls using peak hour V/C ratios may not adequately replicate actual operations
    - Rates are trip-based and vary over the peak period
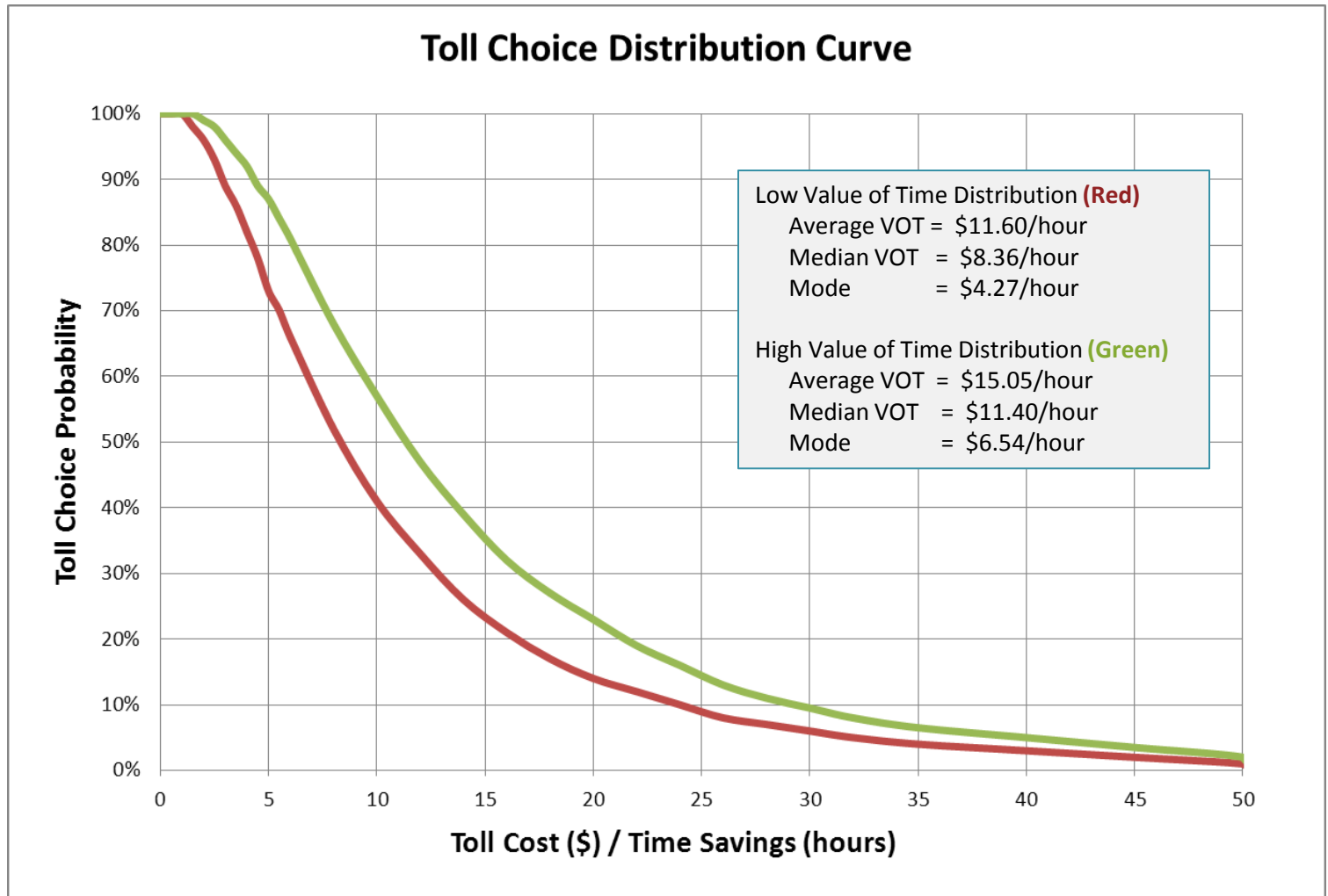   - Travelers choose to pay based on their value of time

Toll Choice in Mode Choice

Toll Choice in Assignment

Vehicle Trip Types

Toll/No-Toll Skims

Toll Choice

Value of Time by Vehicle Type
Toll Choice Probability Distribution

Pay-Toll Vehicles

No-Toll Vehicles

Traffic Assignment

Toll Choice Probability

Next Steps

- Get INRIX data and call other MPOs
  - Start validating freeway speeds
- Identify potential data sources for joint trips
  - May affect only peak period HBW trips
    - A simple concept test may be adequate to determine if a multi-class assignment can reproduce HOV 3+ volumes
- Identify one or more value of time groups
  - Purpose, income, time of day, vehicle type, etc.
- Test computationally efficient methods of setting HOT lane toll rates
  - Incremental or partial assignments may be sufficient