Purpose

• Establish 2018 base year emissions inventory
• Discuss data sources, methodology and assumptions
• Present preliminary results
• Solicit feedback on the assumptions
Important Note

• The data analysis and results presented in this workshop are **preliminary**
• The analysis is conducted using **March 2019** data submittals
  • Staff has worked closely with TNCs since March to QA/QC the data – updates were incorporated
  • Preliminary results presented in this workshop may not reflect all of the latest updates
Outline

• Introduction to SB 1014
• Base year inventory methodology
• Data description
• Assumptions (overlap removal/occupancy/fuel efficiency)
• Preliminary Results
• Next Steps
Clean Miles Standard

SB 1014 requires CARB and CPUC to adopt and implement a program to reduce GHG emissions from transportation network companies (TNCs).

The new regulation will encourage zero-emission vehicles and VMT reduction strategies and account for automated vehicles in TNC fleets.

- **January 2020**
  - CARB establishes base year emissions

- **January 2021**
  - CARB adopts annual targets via regulation

- **January 2022**
  - Each TNC proposes GHG reduction plan every 2 years

- **January 2023**
  - CPUC implements program & tracks compliance
Transportation Network Companies

• California Public Utilities Commission (CPUC) Definition: “A Transportation Network Company (TNC) is a company or organization operating in California that provides transportation services using an online-enabled platform to connect passengers with drivers using their personal vehicles.”

• In California, the CPUC oversees regulation and permitting of TNCs such as charter-party carriers. There may up to 14 different companies providing services
Principles of the New Regulation

1. Decrease GHG emissions and increase zero-emission miles
2. Promote pooling, active transport, and transit usage
3. Forward-looking with automated vehicles
4. Aligned with other State policies
5. Maximize transportation access equity
Base Year Emissions Inventory

• SB1014 requires CARB to establish a GHG base year (2018) emissions for TNCs on a per passenger mile

Grams of CO2 per passenger-mile depend on

**Vehicle Technology**
- Fuel efficiency by vehicle specifications

**Vehicle Operation**
- Vehicle Speed
- Vehicle Occupancy
- Trip Miles:
  - Vehicle trip miles/Ride VMT
  - Transit miles
  - Active miles

Affect PMT
Periods Defined for TNC Miles

Period 0 (not captured in rule)
Work session not started

Period 1
Driver looking for riders

Period 2
Driver en route to riders

Period 3
Rider(s) in vehicle
### Methodology

**Equation:**

\[
\text{Grams CO}_2 = \frac{\text{VMT in periods 1, 2, & 3} \times \text{Real World Fuel Consumption (gal/mi)} \times \text{Conversion Factor (gCO}_2/\text{gal)}}{\text{PMT}}
\]

- **Ride VMT (miles)**
  - Only period 3 VMT
  - Does not include driver
- **Occupancy + Active/Transit PMT**
  - Assumed - zero

**Additional Notes:**

- **Occupancy** affects only the denominator.
- Increasing occupancy reduces:
  - TNC gCO2/PMT
- **Deadheading** affects only the numerator.
- Decreasing deadhead VMT reduces:
  - TNC gCO2/PMT
  - CA Fleet GHGs
  - CA Fleet VMT
- **Fuel economy** affects only the numerator:
  - Increasing fuel economy reduces:
    - TNC gCO2/PMT
    - CA Fleet GHGs
    - No affect on VMT

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**Methodology**

- **Introduction**
- **Methodology**
- **Data Description**
- **Overlap Removal**
- **Occupancy**
- **Fuel Efficiency**
- **Preliminary Results**
Data Description

- CARB received approximately 1.4 billion trip records for 600k vehicles operating for TNCs
- Data from 14 TNC companies received in March, 2019
- Data issues: Faulty VINs; Self-overlapping trips

Data Fields

|---|-------------------|---------------------|----------------------|-----------------------|-----------------------------|------------------------------------------|---------------------------------------|--------------|---------------------------|------------------|----------------------------|------------------|
Some preliminary statistics...

<table>
<thead>
<tr>
<th></th>
<th>TNC wide/Proportion (%)</th>
<th>California Passenger Vehicles (EMFAC2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of vehicles</td>
<td>600 thousand (2.3%)</td>
<td>25.2 million</td>
</tr>
<tr>
<td>Total VMT</td>
<td>4.2 billion miles (1.2%)</td>
<td>342.3 billion miles</td>
</tr>
<tr>
<td>Number of trips</td>
<td>0.37 billion (0.9%)</td>
<td>41.4 billion</td>
</tr>
<tr>
<td>(Only P3 Trips)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average trip length*</td>
<td>11.4 miles per trip</td>
<td>8.3 miles per trip</td>
</tr>
<tr>
<td>Cars vs. Trucks</td>
<td>79% Cars &amp; 21% Trucks</td>
<td>63% Cars &amp; 37% Trucks</td>
</tr>
<tr>
<td>VMT Weighted Average Model Year</td>
<td>2010.5</td>
<td>2009</td>
</tr>
</tbody>
</table>

* Total VMT/ Number of P3 Trips
Methodology

Let’s start with VMT and Ride VMT

\[
\frac{\text{Grams CO}_2}{\text{PMT}} = \frac{\text{VMT (miles)} \times \text{Real World Fuel Consumption} \times \text{Conversion Factor}}{\text{Ride VMT (miles)}} \times \text{Occupancy + Active/Transit PMT}
\]

- Calculating actual VMT
- Revising data to identify unique, real VMT for each vehicle

(CARB)
Multi-Apping

• A common practice of drivers being available for service on multiple platforms at the same time.
• To avoid double counting, instances of multi-apping should be identified and removed accordingly (i.e., “combined”)
Combined – Trip Overlap Removal

“Stick Painting algorithm”

• Assume that time is a long stick that can be painted on
• Assign a color to each time period, i.e. P1, P2, P3
• Start with a VIN; for each trip record using the assigned trip period colors paint a segment on the stick that corresponds to the beginning and end times of that trip record
  • Start with painting P1 trip periods on the stick first, then move on to P2 trip periods, and at last to P3
• Reconstruct the trip records by identifying the color of each painted segments on the stick and converting the beginning and end locations to beginning and end of the trip periods
Trip Overlap Removal: Example
(One VIN with Multiple TNC Apps)
Trip Overlap Removal: Example
(One VIN with Multiple TNC Apps)

Step 1: Paint P1 trips on the “Combined” stick
Trip Overlap Removal: Example
(One VIN with Multiple TNC Apps)

Step 2: Paint P2 trips on the “Combined” stick
Trip Overlap Removal: Example (One VIN with Multiple TNC Apps)

Step 3: Paint P3 trips on the “Combined” stick
Trip Overlap Removal: Example
(One VIN with Multiple TNC Apps)

Step 4: Reconstruct the records
Methodology

**Occupancy is a key factor determining PMT**

\[
\text{Grams CO}_2 = \frac{\text{VMT (miles)} \times \text{Real World Fuel Consumption} \times \text{Conversion Factor}}{\text{PMT}}
\]

\[\text{Ride VMT (miles) \times Occupancy} + \text{Active/Transit PMT}\]

- Occupancy data is not provided by TNCs
Occupancy

- CA fleet average occupancy (PMT/VMT) is 1.68, estimated using data from the 2010 – 2012 California Household Travel Survey
- Scientific studies have found the following on average occupancy for TNCs:
  a) Circella et.al 2019 CA average occupancies: 1.90 (N = 1,287)
     \[\text{Weekday} = 1.69, \text{Weeknight} = 1.93, \text{Weekend Day} = 1.95, \text{Weekend Night} = 2.16\]
  b) Henao et.al 2018 Colorado average occupancy = 1.34 (N = 416)
- CARB has also conducted an in-house study to collect occupancy information
CARB Occupancy Project

- **Goal**: Determine occupancy rates for pooled and non-pooled rides, and collect activity information to develop drive cycles
- 2 week study period
- TNC drivers maintain a daily trip diary
- Data loggers record on-board vehicle data
# Trip Diary and Data Logger Parameters (Examples)

## Daily Trip Diary

<table>
<thead>
<tr>
<th>Event Code</th>
<th>TNC Type</th>
<th>Number of Passengers (not including driver)</th>
<th>Circle one for each line:</th>
</tr>
</thead>
<tbody>
<tr>
<td>S: Start the App</td>
<td>AP: Pooled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O: App turned Off</td>
<td>AN: Non Pooled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W: Waiting</td>
<td>BP: Pooled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R: Receive Call</td>
<td>BN: Non Pooled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P: Pick Up</td>
<td>CP: Pooled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D: Drop Off</td>
<td>CN: Non Pooled</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time (AM / PM)</th>
<th>Event</th>
<th>TNC Type</th>
<th>No of Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>S O W R P D F</td>
<td>AP AN BP BN CP CN</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>S O W R P D F</td>
<td>AP AN BP BN CP CN</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>S O W R P D F</td>
<td>AP AN BP BN CP CN</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
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</tr>
<tr>
<td>S O W R P D F</td>
<td>AP AN BP BN CP CN</td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
</tbody>
</table>

** etc. **

** Fuel Consumption **

** Catalyst Temperature **

** Altitude **

** Vehicle Speed **

** Road Grade **

** Engine Load **

** Engine RPM **

---

** etc. **

** Fuel Consumption **

** Catalyst Temperature **

** Altitude **

** Vehicle Speed **

** Road Grade **

** Engine Load **

** Engine RPM **
Preliminary Occupancy Analysis

- 22 trip diaries have been returned (almost 2,000 fares)
- Staff expecting to receive a total of ~40 trip diaries by the end of October
- Occupancy data from this study is used for this analysis

<table>
<thead>
<tr>
<th></th>
<th>Pooled Ride</th>
<th>Non-Pooled Ride</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Occupancy</strong></td>
<td>1.48</td>
<td>1.50</td>
</tr>
<tr>
<td><strong>(264 fares)</strong></td>
<td></td>
<td>(1,754 fares)</td>
</tr>
</tbody>
</table>
Methodology

Now let’s move on to fuel efficiency

\[
\text{Grams CO}_2 = \frac{\text{VMT (miles)} \times \text{Fuel Consumption} \times \text{Conversion Factor}}{\text{PMT}}
\]

\[
\text{Ride VMT (miles)} \times \text{Occupancy + Active/Transit PMT}
\]

• Real-world TNC fuel efficiency is not the same as CA fleet average
First staff assigned each vehicle with a Fuel efficiency rating derived from Federal Fuel Economy Data.
Fuel Economy Data Processing Flow Chart

Vehicle Specs incl. transmission type, # of cylinders, fuel type, advance vehicle type, drivetrain type

VINs from DMV and VINtelligence including VIN

EPA Fuel Economy (FuelEconomy.GOV)

Advanced string matching algorithm

Fuel economies and vehicle specs

VIN and fuel economies

Note: CO2 emissions are calculated assuming complete conversion of fuel carbon to CO2 and using conversion factors: 8,887 and 10,180 grams of CO2 per gallon of fuel, for gasoline and diesel, respectively.
TNC fleet tend to have higher rated fuel efficiency values than California average passenger vehicles.
In-Use Fuel Efficiency Varies by Driving Condition

- Fuel efficiencies are corrected for various driving conditions

City Fuel Efficiency

Real MPG (EMFAC2017*)

*MY2012 – 2018 Passenger Vehicles
EMFAC2017 vs. TNC 40-Vehicle Study

CO2 Normalized at 30 mph: TNC vs. EMFAC

TNC fleet has lower emission rates compared to EMFAC at higher speeds.
How Electric Vehicles are identified?

- Decoded VIN numbers to identify Battery, Plug-in hybrid, and Fuel Cell Electric vehicles
- Assumed 15% eVMT for PHEVs (preliminary assumptions)
- 0.7% eVMT (30.2 million miles) as compared to total TNC VMT (i.e., 4.2 billion miles)

<table>
<thead>
<tr>
<th></th>
<th>Plug-in Hybrid Electric Vehicles</th>
<th>Battery Electric Vehicles</th>
<th>Fuel Cell Electric Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>5,400 (1%)</td>
<td>2,800 (0.5%)</td>
<td>50 (0.01%)</td>
</tr>
<tr>
<td>(Proportion of TNC fleet)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMT (million miles)</td>
<td>43.6</td>
<td>23.6</td>
<td>0.17</td>
</tr>
<tr>
<td>eVMT (million miles)</td>
<td>6.5</td>
<td>23.6</td>
<td>0.17</td>
</tr>
</tbody>
</table>
Preliminary Results
# VMT By Time Period

<table>
<thead>
<tr>
<th>Period</th>
<th>VMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3</td>
<td>2.53 billion miles</td>
</tr>
<tr>
<td>P2</td>
<td>444 million miles</td>
</tr>
<tr>
<td>P1</td>
<td>1.25 billion miles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3</td>
<td>60%</td>
</tr>
<tr>
<td>P2</td>
<td>11%</td>
</tr>
<tr>
<td>P1</td>
<td>30%</td>
</tr>
<tr>
<td>Deadheading</td>
<td>40%</td>
</tr>
</tbody>
</table>
## Change in VMT Before And After Trip Overlap Removal

<table>
<thead>
<tr>
<th>Trip Periods</th>
<th>VMT Before Removal (miles)</th>
<th>VMT After Removal (miles)</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Periods</td>
<td>4.49 billion</td>
<td>4.22 billion</td>
<td>6%</td>
</tr>
</tbody>
</table>
VMT Distribution By Speed Bin

- Average Speeds are lower for TNCs
Vehicles operating for TNC fleet are in general newer than California average passenger vehicles.
Fleet Average In-Use Fuel Efficiency (Corrected for Driving Conditions)

- The efficiency gain of newer model years vehicle might get slightly offset by slower trip average speeds
Out of 2.53 Billion Miles of P3 VMT

- Pool ride do not necessarily reflect the rides that were matched to another passenger. It may include rides that were not matched too.
• Although TNC fleet has better in-use fuel efficiency, lower occupancy and higher deadhead VMT drive higher emissions (+ 75% emissions per PMT)
• For California fleet average; PMT/VMT of 1.68 was used
Base Year g CO$_2$ per PMT
Sensitivity Analysis

Fraction of deadheading VMT

CA fleet

Occupancy = 1.5, 1.6, 1.7, 1.8, 1.9, 2.0

TNCs
Next Steps

- Finalized data analysis using latest data submittal by TNCs
- Late 2019 - Release draft emissions inventory documentation
- Early 2020 – Potential informational board item on initial inventory and program overview
- Q4 2019 – Workshop on regulatory concepts
Take Home Questions

• How can we further improve our estimates of occupancy? Are there other data sources than those presented here?

• Are there available data on %eVMT for PHEVs operating in ridesharing business?

• What assumptions should we make for active transportation in the base year emissions inventory?

• What are better ways to reflect the impact of congestion/driving conditions on real world fuel efficiency?
Comments and Questions

• Please submit your comments related to 2018 base year emissions by October 25, 2019
• Questions and comments can be emailed to cleancars@arb.ca.gov
• For more information on the Clean Mile Standards, please visit our website at: https://ww2.arb.ca.gov/our-work/programs/clean-miles-standard