Autonomous Vehicle Update

SFMTA Board of Directors: Policy & Governance Committee

Julia Friedlander: April 25th, 2023

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Agenda: Autonomous Vehicles Update

1. AV Industry Vision and Status in SF

2. San Francisco AV Policy Foundation & Role

3. AV Operations and. . .

   A. Street Safety

   B. Network Efficiency – Congestion – Climate

   C. Equity and Disability Access

4. San Francisco Conclusions & Advocacy

5. Discussion

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"SAE Level 4" AV Industry: Vision & Status in SF

SAE Level 4 Automated Driving: Industry Vision

SAFETY:

Improve Safety by eliminating human driving errors

EQUITY:

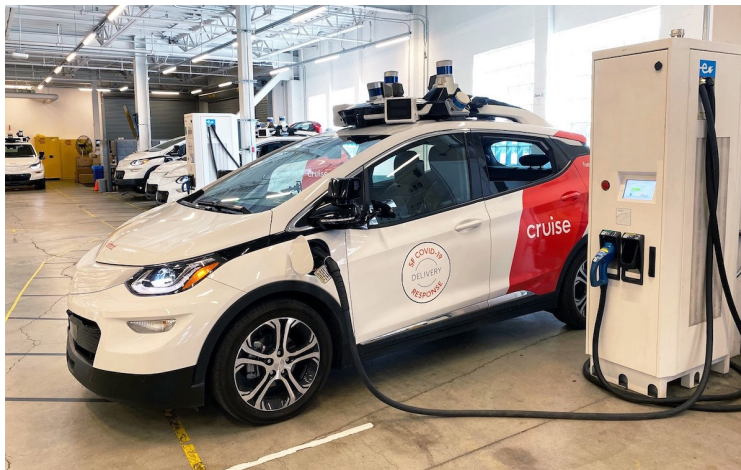Expand mobility choices for people with disabilities

CLIMATE:

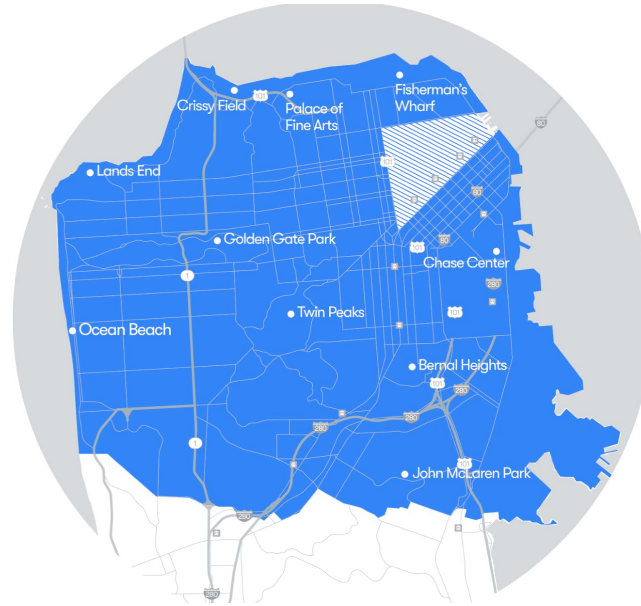Reduce GHG

TRANSPORTATION NETWORK:

Reduce congestion

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AV Industry Status in San Francisco

- Testing AV driving with safety drivers

- Testing passenger service with & without safety drivers

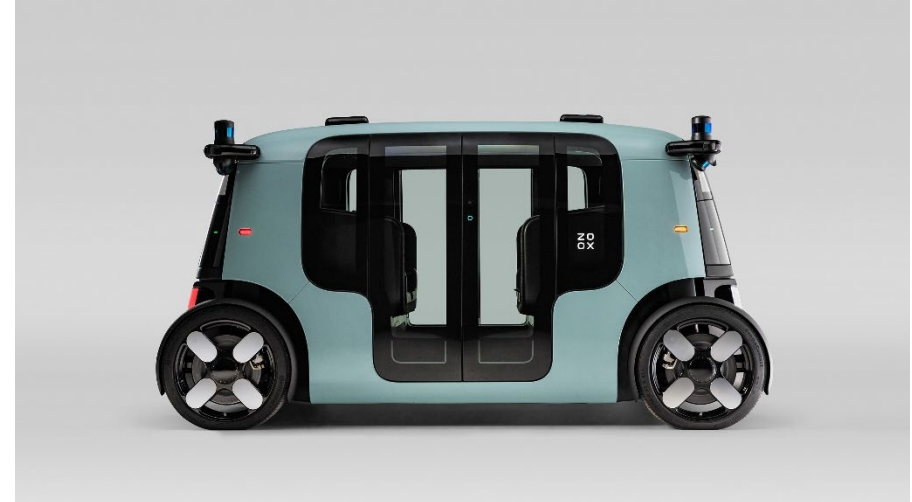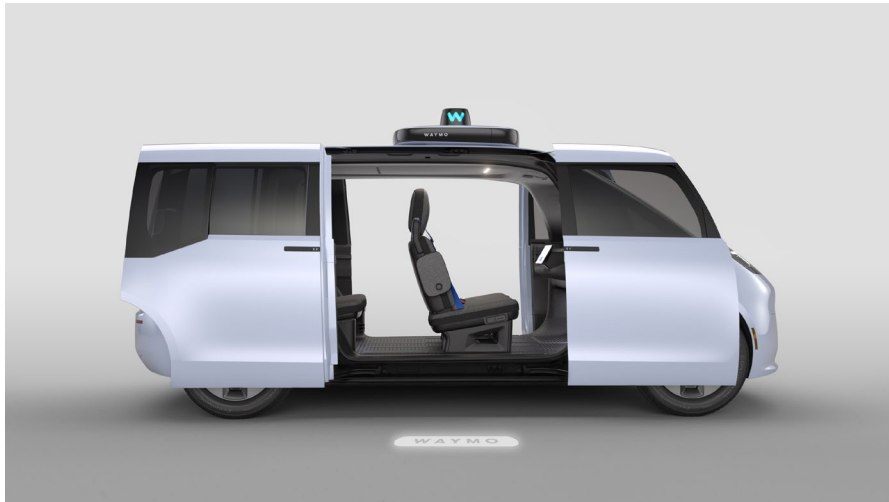- Testing passenger service with & without safety drivers

- Offering commercial passenger service in limited area from 10 pm to 6 am

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Level 4 AVs on the Roads Today

Level 4 AVs on the Roads Tomorrow

Foundation for SFMTA AV Policy

- **Transit First, Climate Goals, Vision Zero**
- **SF Guiding Principles for Emerging Mobility**

SAFETY
TRANSIT
SUSTAINABILITY
COLLABORATION
EQUITABLE ACCESS

LABOR
CONGESTION
FINANCIAL IMPACT
ACCOUNTABILITY
DISABLED ACCESS

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Private Emerging Mobility Service Goals

For any new private mobility service, we ask whether it will:

- Allow our streets to move more people and reduce travel time?

- Reduce greenhouse gas emissions (per capita or per person mile traveled)?

- Improve safety of transportation network - especially for vulnerable road users?

- Provide better mobility choices, especially for:

  - People with disabilities?

  - Low income and historically underinvested communities?

- Support economic recovery and resilience?

SAFETY   TRANSIT   SUSTAINABILITY   COLLABORATION   EQUITABLE ACCESS   LABOR   CONGESTION   FINANCIAL IMPACT   ACCOUNTABILITY   DISABLED ACCESS

Learning from TNC History: Claims vs. Research

TNCs Will…	Evidence/Research Results	AV?
Reduce congestion	**No.** TNC driving caused 51% of increased travel delay in SF 2010-2016	?
Reduce VMT	**No.** TNC driving caused 47% of increased VMT in SF 2010-2016. 40% of TNC VMT = deadheading (no passenger).	?
Serve 1st / last-mile	**No.** ~ 1% of TNC trips in Bay Area in 2018-19 made a transit connection	?
Facilitate car-free lifestyle	**No.** The # of vehicles/household remained unchanged in SF 2010-2019. A UC Davis 'chauffer study' simulating AV service found 85% increase in user VMT	?
Carry more passengers	**No.** TNCs have the same average occupancy as trips made in private vehicles.	?
Expand mobility for non-drivers	**Limited.** Less than 1% of TNC trips in Bay Area are made by people > 75 years. Wheelchair accessible trips required litigation & legislative mandate after years of advocacy.	?

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AV Policy Work to Date

Industry Engagement

- Meetings with operators (esp. Cruise, Waymo, Zoox)

- Industry Workshop

- ITS America Board (SFCTA)

Development of Regulations

- Actively engaged with all levels of government on regulatory processes and policy

- Federal: NHTSA, FHWA, Access Board, TRB

- State: DMV, CPUC

City & County Collaboration

- Coordination w/ first responder agencies

- City department workshop

- Coordination w/ League of Cities, CACTI, NACTO

City, State, & Federal AV Roles

Federal Role:
- **NHTSA**: sets minimum safety standards for vehicle features (FMVSS) to prevent unreasonable risk of injuries & fatalities
- **NHTSA:** approves exemptions from safety standards
- **NHTSA**: investigates defects & mandates recalls

State Role:
- **DMV**: tests human drivers; issues & revokes licenses
- **DMV**: issues permits to test & commercially deploy AVs on public roads
  - w/safety drivers
  - w/o safety drivers
- **CPUC**: issues permits to *carry passengers* in AVs

City Role:
- **San Francisco:** as early testing city, shares observations with industry, regulators & stakeholders
- **Adopts** traffic regulations, identifies proper use of street lanes & curbs
- **Designs and deploys** traffic control devices
- **Enforces** curb regulations & rules of the road

AV Operations & Street Safety

All Streets are Not Equally Challenging

- GM: When comparing San Francisco to Phoenix: *"our San Francisco vehicles predict an average of 32 times as many possible interactions as those in Phoenix."*

- GM: *"San Francisco challenges our self-driving system more because, as the number of objects increase, there are exponentially more possible interactions with objects that the self-driving system must consider."*

Maneuver / Scenario	San Francisco	Phoenix Suburbs	Ratio
Left turn	1462	919	1.6:1
Lane change	772	143	5.4:1
Construction blocking lane	184	10	19.1:1
Pass using opposing lane	422	17	24.3:1
Construction navigation	152	4	39.4:1
Emergency vehicle	270	6	46.6:1

Per 1,000 miles of autonomous driving

Source: 2018 Voluntary Safety Self-Assessment filed by General Motors with NHTSA

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AV Safety Optimism

Positive driving practices observed:

- Apparent compliance with posted speed limits

- Apparent compliance with traffic signs and signals

- Attention to details like stopping before limit lines

But actual *measured* safety performance is still uncertain:

- No industry regulator consensus on how to validate AV driving competency

- No state or federal minimum safety performance standards

- No monitoring of compliance with rules of the road (& some clear violations)

- Complaints of erratic driving & failure to yield right of way to pedestrians

- Planned & unplanned stops that generate hazards & violate Rules of the Road

- AV miles driven too few to effectively compare to human crash rates

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Vision Zero and AV-involved Crashes

California DMV reports:

- 549 AV-involved crashes statewide through January, 2023
- 17 AV-involved crashes in driverless vehicles through January, 2023
  - BUT both figures exclude crashes where AV was operating under commercial deployment permit
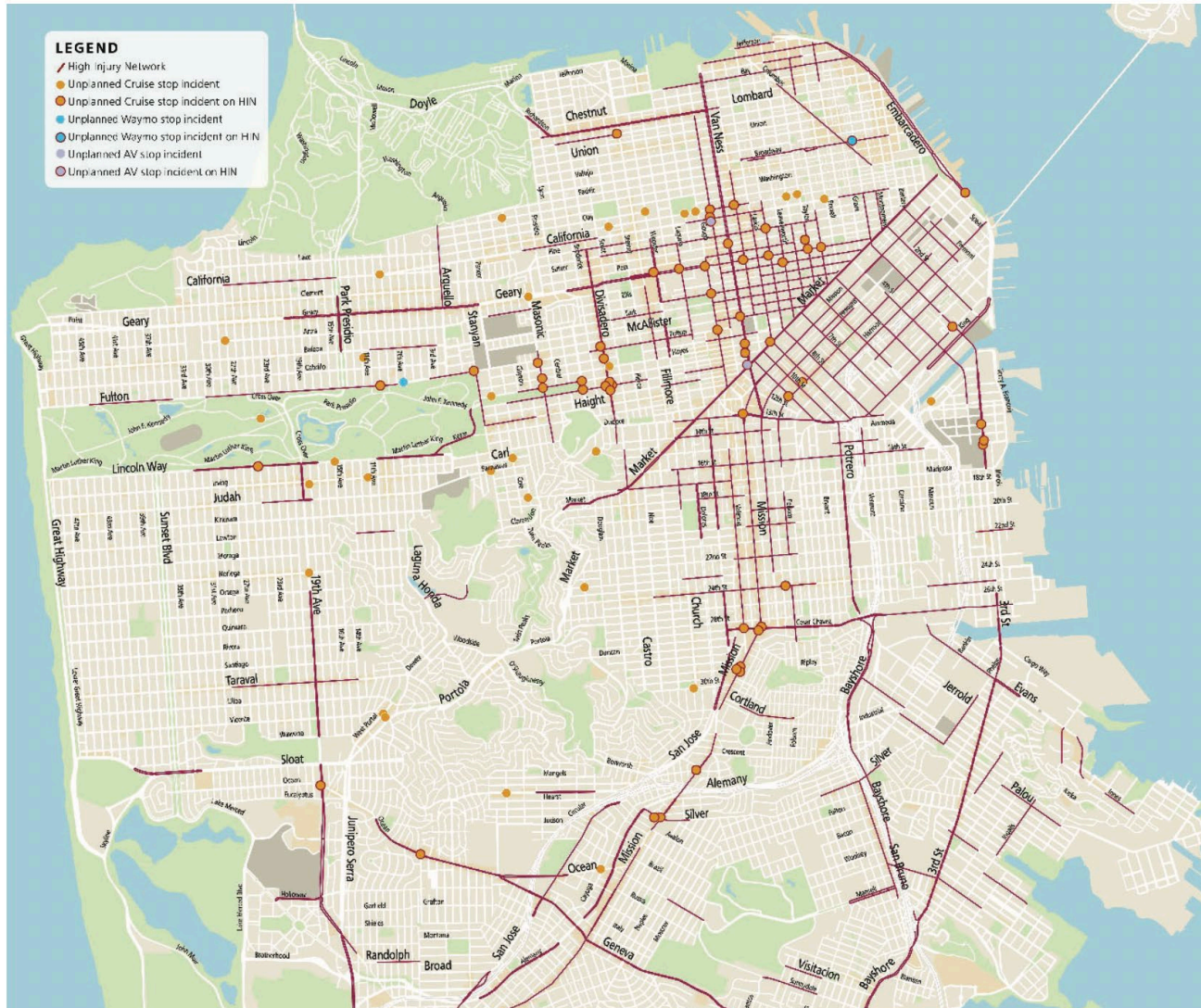
USDOT reports:

- 251 AV-involved crashes nationwide between July 2021 and February 15, 2023
- 142 of these crashes occurred in San Francisco:
  - 40 involved Cruise AVs
  - 82 involved Waymo AVs
  - 20 involved Zoox AVs

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Measuring Safety Impact of Driverless AVs

- Primary indicator for Vision Zero: serious injury & fatality crashes

- Crashes = "lagging Indicator"

- Safe Systems approach to driverless AV assessment calls for additional "leading indicators"

LAGGING INDICATORS OF SAFETY RISKS

LEADING INDICATORS OF SAFETY RISK

FATALITY

LOST TIME/ SERIOUS INJURY

MINOR INJURY

NEAR MISS

UNSAFE ACT

Reported Incidents: Leading Indicators?

May 29, 2022 – December 31, 2022

Incident Types:
- Unplanned stops in travel lanes
- Hazardous stops for passenger pick up or drop off
- Interference with emergency response & street-based work
- Slow response to human traffic control direction
- Erratic driving

Report Sources: Public calls to 911 , City staff reports, Media & social media

Companies:
- Waymo incidents increasing in 2023 with more driverless operation

Leading Indicator: Low Damage AV Crashes

- 3/23/23: Cruise AV rear ends 60' articulated bus

- 3/25/23: Cruise updates software to correct flaw re driving of articulated vehicles (>300 in Muni fleet)

- 4/3/23: Cruise issues Safety Recall Report (SRR) to National Highway Traffic Safety Administration (NHTSA)

- ***Cruise public statements:***
  - *Bus behavior was reasonable & predictable*
  - *We do not expect our vehicles to run into the back of a city bus under any conditions*
  - *Even a single incident is worthy of immediate & careful study*
  - *AV applied brakes too late and rear-ended bus at 10 mph*
  - *Cause: "unique error related to predicting the movement of articulated vehicles"*
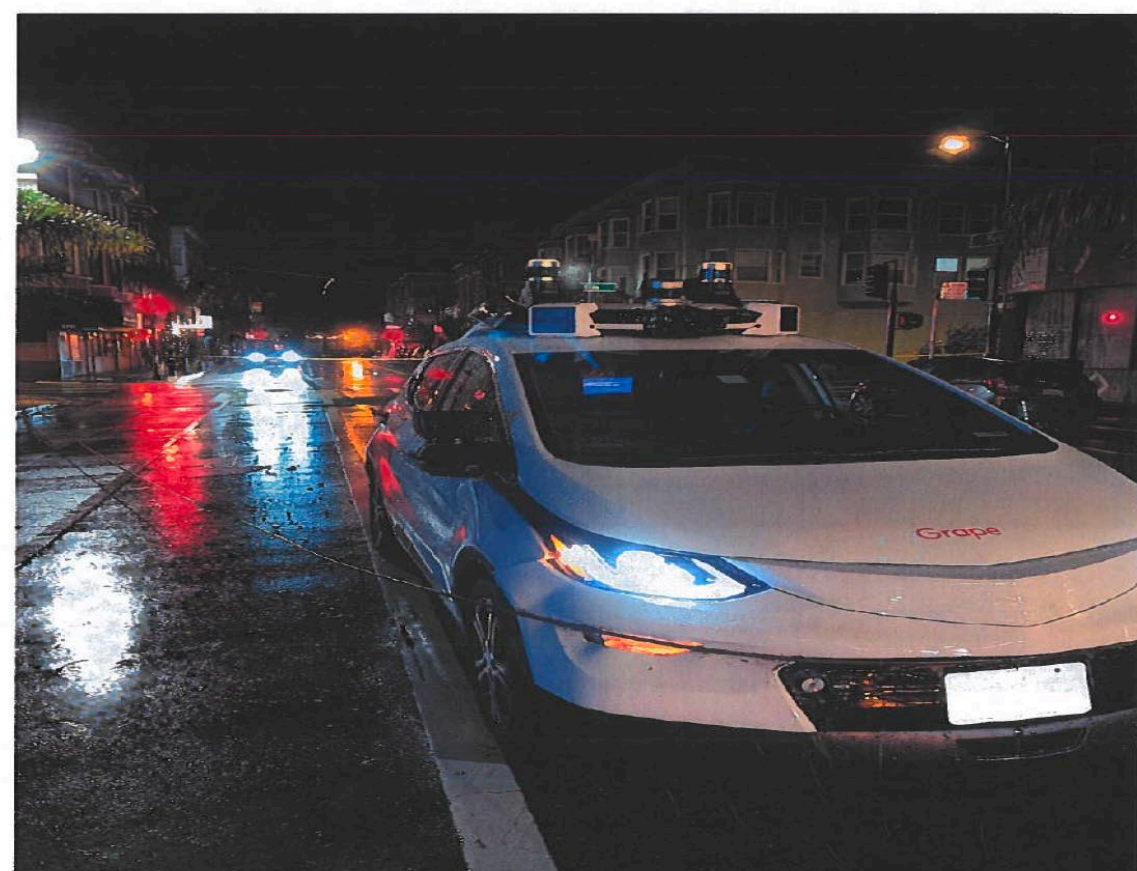
Leading Indicator: Near-Miss AV Crashes

- 9/30/2022: Cruise AV enters intersection after train has started:
  - *Hazard*: potential injury to Cruise passenger (none)
  - *Hazard*: potential injury to transit passengers (140)

- 11/22/2022 tweet from Cruise:
  - *Software update included "improved maneuvering around light rail vehicles"*

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Leading Indicator: Failure to perceive hazardous road conditions

- March 21-22, 2023 Cruise AVs snagged power lines brought down by storm damaged trees

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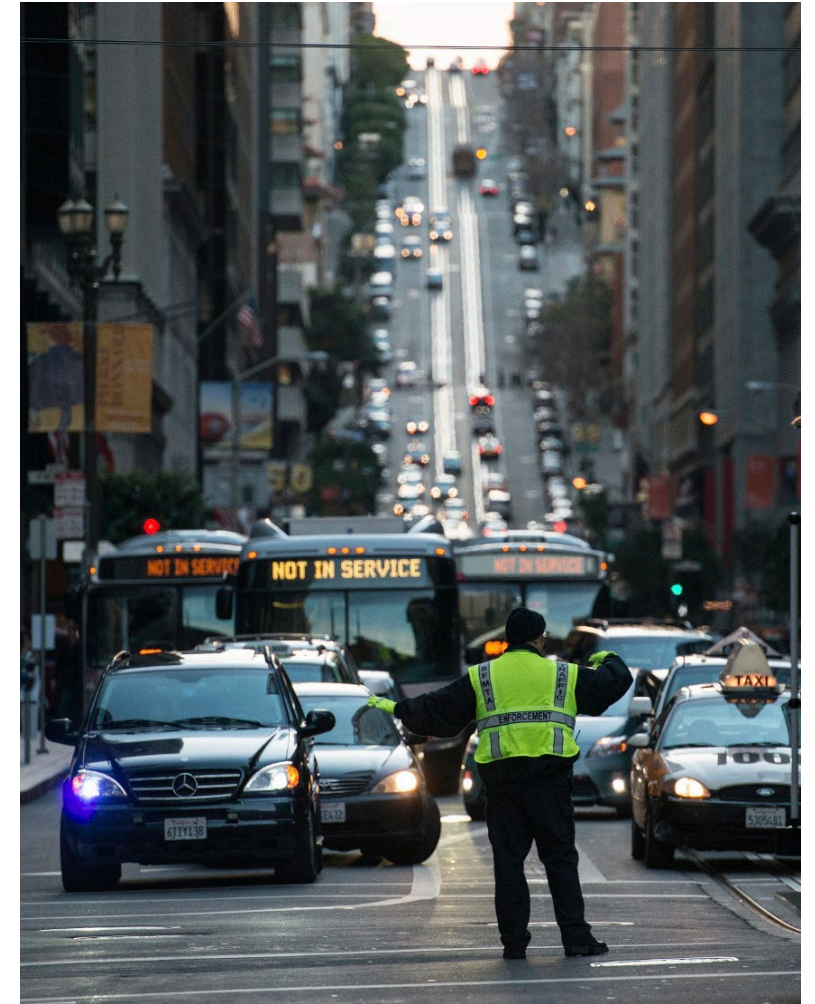# Leading Indicator: Emergency Response Incidents & Near Misses

- *Two incidents*: AV drove over fire hose

- *Multiple incidents*: AV failed to perceive & promptly avoid firefighting scenes

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Leading Indicator: Intrusion into Street Construction Sites

January 13, 2023: Waymo intrusion into work zone affecting SFPUC workers

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Leading Indicator: Hazardous AV Stops

- Loading in travel lane:
  - especially hazardous for people with disabilities, cyclists & pedestrians
  - may create service barrier for people with disabilities
- AVs should demonstrate ability to see curb space & make safe & lawful stops for passenger pick up & drop off at the curb

AV Operations: Traffic Interference

AV Operations: Rail Transit Interference

- Blocked line with highest rail ridership at 11:05 PM

- 140 passengers on board (projected daytime: 180)

- Passengers waiting at future stops also affected

- SFMTA aware of 3 other incidents of Cruise AV failures on rail tracks

- Market Street Subway study found that 15- minute delay causes 2.5 hours of residual system delay

AV Operations: Bus Transit Interference

September 23, 2022 at 9:07pm

- 5 Cruise AVs trap bus for at least 13 minutes

- 45 passengers on board (projected daytime: 100)

- Unknown # affected passengers waiting at later stops

- Lines carry 63,400 riders/day

AV Operations: Climate and Health

Industry Climate Commitments

- Cruise & Waymo driverless AVs: ZEV

- Zoox purpose-built vehicle: ZEV

Other factors affecting climate and health outcomes

- ***Vehicle occupancy*:** Will Cruise, Waymo & Zoox improve on Uber and Lyft record for shared rides and occupancy?

- ***Mode shift*:** Shift from low carbon modes to less space and energy efficient AVs will not support climate goals

- ***VMT*:** UC-ITS & Caltrans research projects that AVs will be high source of VMT growth in CA

- ***Grid Impact:*** Research notes that computing for AV driving requires high energy consumption

AV Operations & Equity – Disability Access

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AV Operations: *Equitable Access and Impacts?*

TNC Wait Times Relative to Regional Average by Income
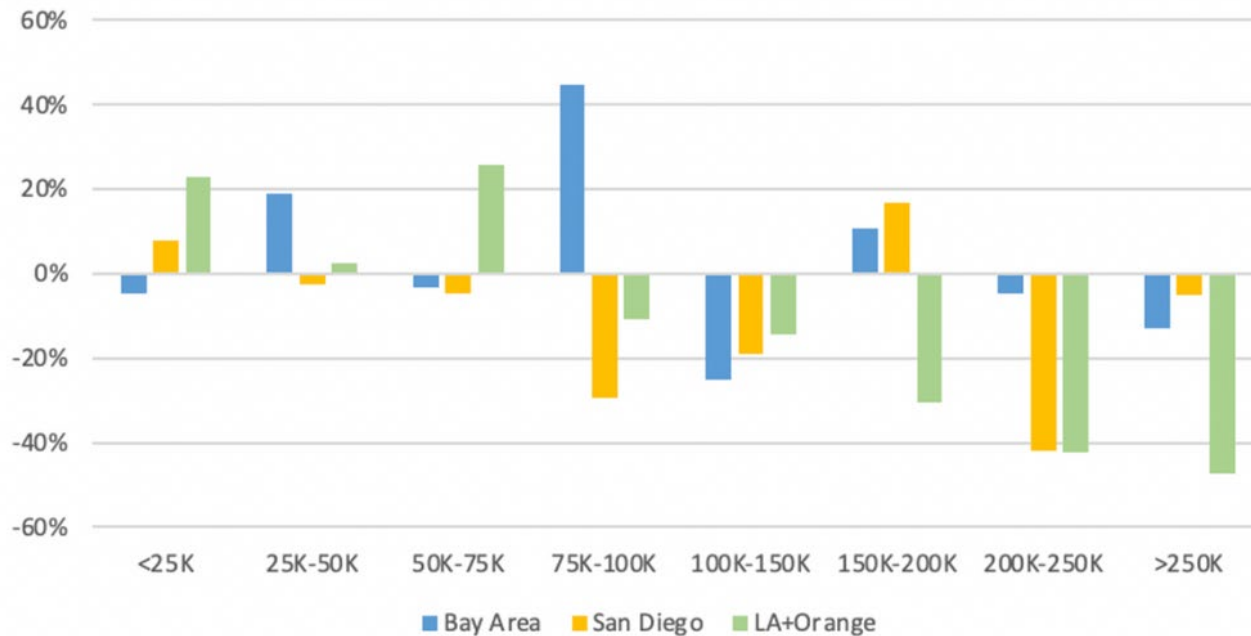
Low-income users wait longer for Uber/Lyft than high income users

AV disruption of transit operations burdens transit-dependent riders the most

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AV Operations: *Disability Access & Impacts*

- **No operator is currently testing wheelchair accessible AVs in SF**

- **Regulation needed to prevent race to the bottom where new services inaccessible to wheelchair users compete against legacy accessible services**

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San Francisco Conclusions and Policy Advocacy

Data reporting and public transparency is critical to evaluation of whether AV driving performance can achieve the vision without negative unintended consequences.

Data is needed:

- To analyze safety performance
- To analyze network and climate impacts
- To analyze equity access and impacts
- To analyze disability access and impacts

AV Data for Policy & Accountability

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Conclusions

- **AVs are a *system* not just vehicles:**
  - Regulation must address system as a whole
  - Must include performance of human advisors & field responders

- **AV Driving Performance**:
  - Still under development
  - *Still working on critical competencies for safe urban driving*

- **Data Collection**:
  - Existing state and federal data collection are not adequate
  - Must capture more than collisions to assess unreasonable risks
  - Impacts of driverless operation on climate, disability access, and transportation equity are also going unrecorded

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Key Points of State & Federal Advocacy

- **Performance:** Permits should be based on performance, not just stated vision, across broad policy goals

- **Incremental Growth:** Growth should be incremental, not exponential, until safe driving competence has been demonstrated

- **Data collection:** Must be expanded to support development of performance standards and permit authorizations

- **Data transparency:** Data documenting performance should be available for public analysis -- with protections for personal privacy & trade secrets – and should be used to inform permit decisions

- **Collaboration not Preemption:** Federal, state and local agencies should collaborate across different areas of expertise

Other Areas of Potential Concern

Jobs:

- Displacement of driving jobs (taxi, TNC, transit operator, etc.)
- Poor alignment between jobs displaced & those created

Cybersecurity:

- Does operation of large fleet create new cybersecurity risks?

Machine Learning Bias:

- Do AV machine learning datasets incorporate bias inconsistent with City equity and accessibility goals?

Thank you