The Future of Urban Transport & Metro's Mobility Strategy

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We'll Get You There

Transformations – Past and Future

Easter morning 1900: 5th Ave, New York City. Spot the automobile.

Source: US National Archives

Easter morning 1913: 5th Ave, New York City. Spot the horse.

Source: George Grantham Bain Collection.

With the rise of shared mobility and vehicle automation, we are on the cusp of an equally profound and equally swift revolution in human mobility as that of the early 1900s.

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Automation and Vehicle Size

- All Autonomous Vehicles are NOT created equal

- Light Duty Vehicle (LDV) Automation – Passenger Car

- Heavy Duty Vehicle (HDV) Automation – Commercial Truck

- Transit Bus Automation

- Each with different economics, incentives, business models and technical challenges

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Light Duty Vehicle (Passenger Car) Automation in Context
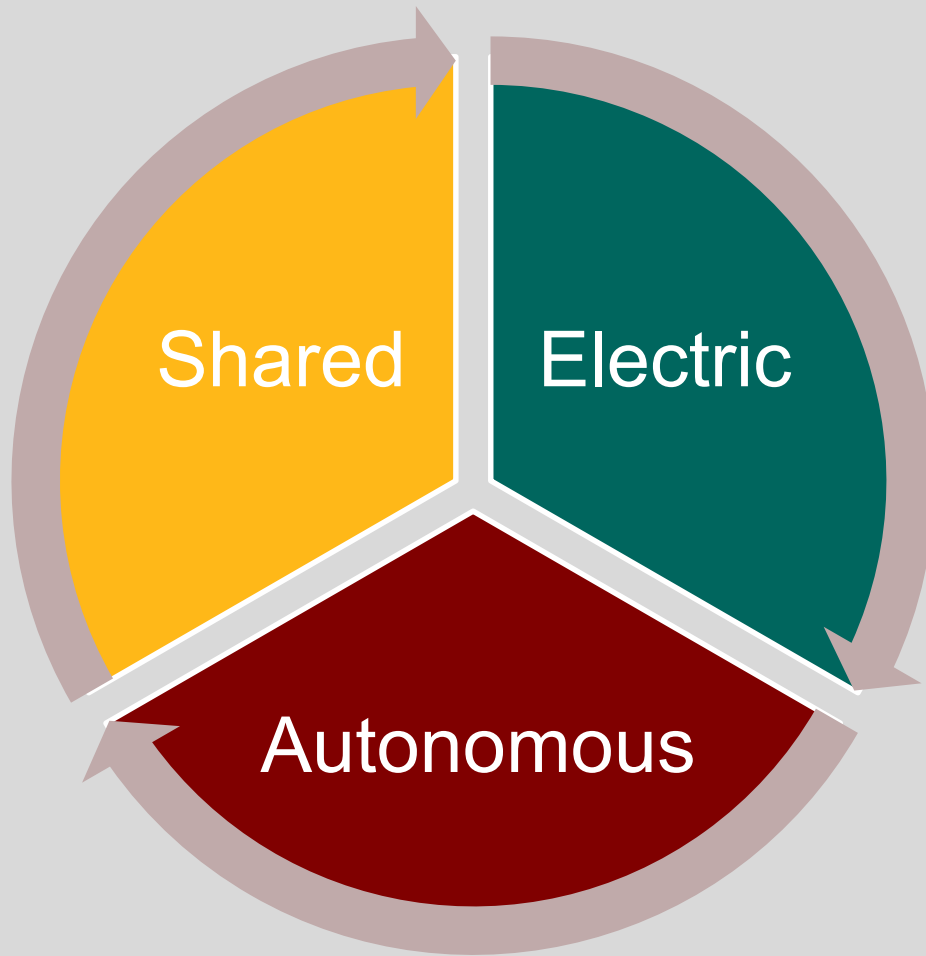
- Shared mobility, electrification and car automation, each can and does exist on its own

- But together, they can lead to a flywheel effect – technically and economically

- Important to think of each in the context of the others

Shared Mobility (Ride-hailing) Needs LDV Automation

- Ride-hailing (Uber, Lyft) – One of many modalities of Shared Mobility

- Rapid and meteoric rise faced with:

  o Negative margins

  o Driver supply issues

  o Growth ceiling

- Needs AVs to achieve sustained growth and positive margins

"Autonomous cars are the only way to get the cost down" from $2.50 per mile for a typical UberX ride to $1 per mile, a level that would tempt city and suburban residents to stop owning cars. - Uber CEO Dara Khosrowshahi at Goldman Sachs conference in February 2018

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LDV Automation Becomes Viable with Shared Mobility

- A typical car today is parked 95% of the time

- Makes individual ownership of Autonomous LDVs impractical

- Fleet based ownership providing on-demand mobility service

- The shift from 'productization' to 'servitization' to 'securitization' is critical to making the economics of LDV automation work

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Levels of Vehicle Automation

The 5 levels of driving automation

For on-road vehicles

| | 👤 Human driver | | 🚗 Automated system |

		Steering and acceleration/deceleration	Monitoring of driving environment	Fallback when automation fails	Automated system is in control
0	NO AUTOMATION	👤	👤	👤	N/A
1	DRIVER ASSISTANCE	👤/🚗	👤	👤	SOME DRIVING MODES
2	PARTIAL AUTOMATION	🚗	👤	👤	SOME DRIVING MODES
3	CONDITIONAL AUTOMATION	🚗	🚗	👤	SOME DRIVING MODES
4	HIGH AUTOMATION	🚗	🚗	🚗	SOME DRIVING MODES
5	FULL AUTOMATION	🚗	🚗	🚗	🚗

Human driver monitors the road (levels 0–2)
Automated driving system monitors the road (levels 3–5)

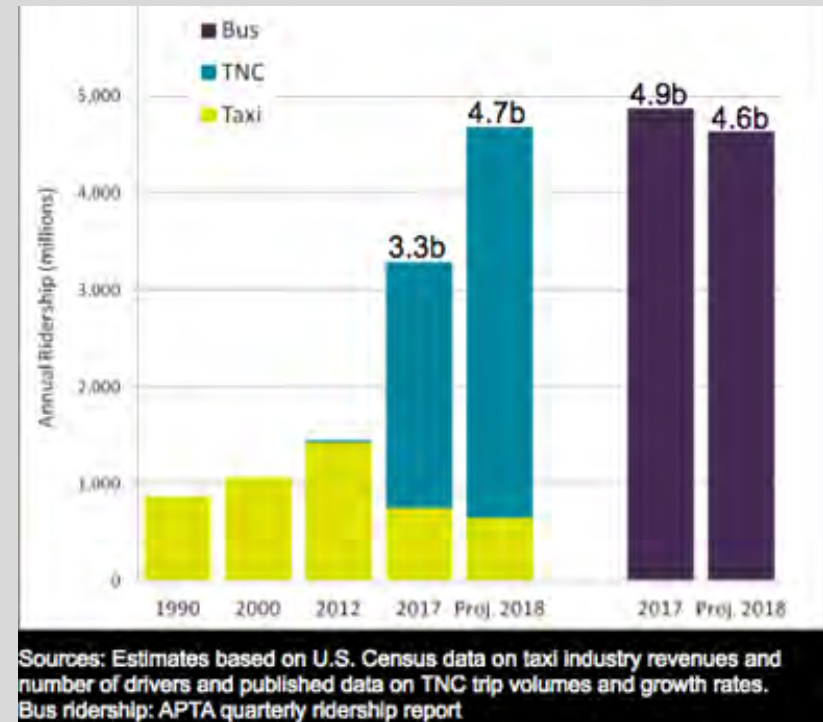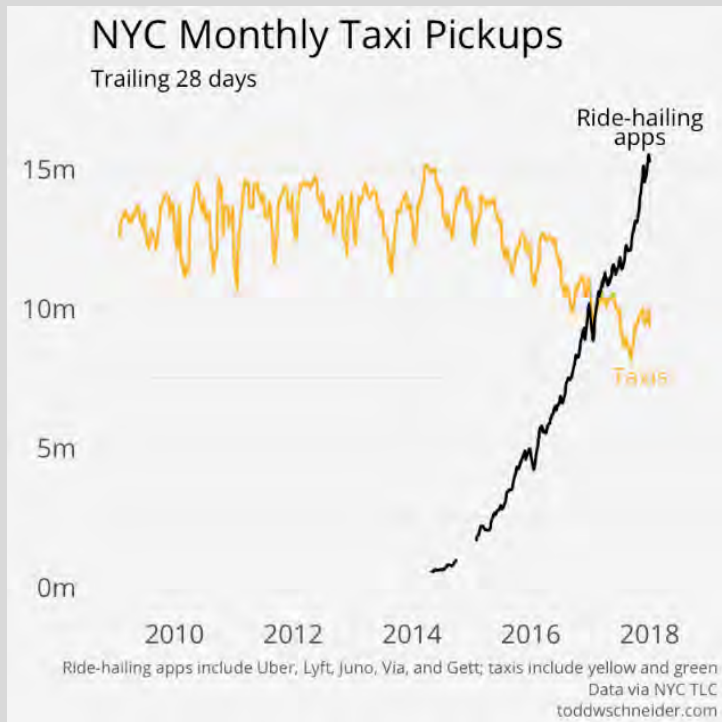Source: SAE International

Vox

Level 4 automation is expected to make self-driving cars viable in urban environments

Key Distinctions & Examples

- Completely manual
- Most cars pre 1990

- Cruise control
- Most cars since 2000

- Adaptive cruise control + self-steering
- Most luxury cars today

- Adaptive cruise control + self-steering at most times
- Tesla Autopilot

- Full autonomy – mapped areas only
- Waymo AV service live in Phoenix

- Full autonomy – anywhere, in any conditions
- Unlikely to be available for several years

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Implications of Ride-hailing for Transit and Congestion

NYC Monthly Taxi Pickups — Trailing 28 days. Ride-hailing apps include Uber, Lyft, Juno, Via, and Gett; taxis include yellow and green. Data via NYC TLC. toddwschneider.com

Sources: Estimates based on U.S. Census data on taxi industry revenues and number of drivers and published data on TNC trip volumes and growth rates. Bus ridership: APTA quarterly ridership report
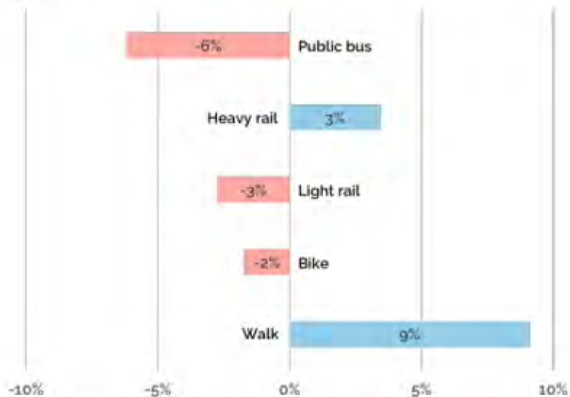
- The meteoric rise of Ride-hailing

- Faster, more flexible and convenient than transit, taxis and SOVs

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Implications of Ride-hailing for Transit and Congestion


Figure 12. Changes in transit use, biking, and walking after adoption of ride-hailing services

Survey question: "Since you started using on-demand mobility services such as Uber and Lyft, do you find that you use the following transportation options more or less?"

(UC Davis Institute of Transportation Studies)

Figure 14. Mode substitution, weighted by frequency of ride-hailing use
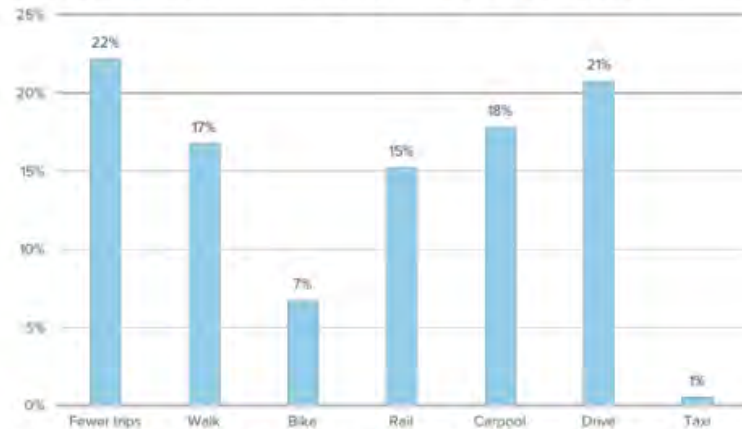
Survey question: If Uber or Lyft were unavailable, which transportation alternatives would you use for the trips that you make using Uber or Lyft?
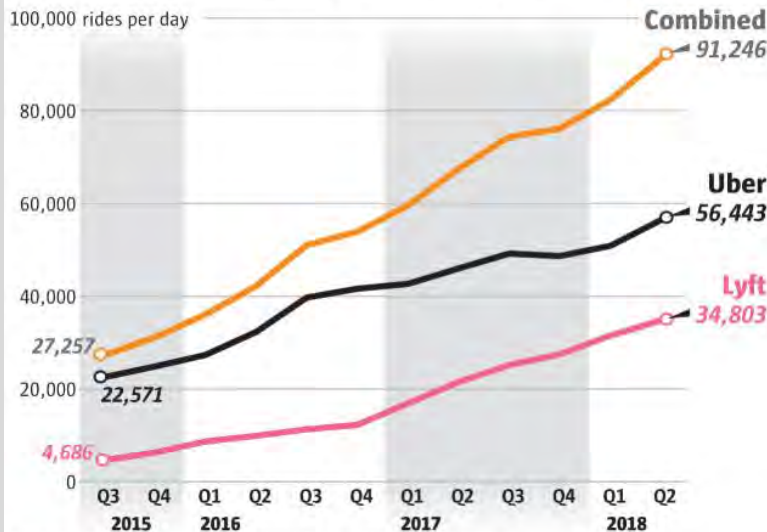
(UC Davis Institute of Transportation Studies)

- Uber and Lyft are adding car trips to city and suburban streets, and in many cases, cannibalizing transit – UC Davis Research Report covering 7 U.S. Metros

- TNCs are pulling from, not complementing, public transit and contributing to slower traffic - Analysis by Bruce Schaller in NYC and MAPC in Boston

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Implications of Ride-hailing for Transit and Congestion (Seattle)

Uber and Lyft carry 91,000 people a day in Seattle area

The ride-hailing services have grown rapidly and steadily since arriving in the city, and carry far more people than taxis ever did.
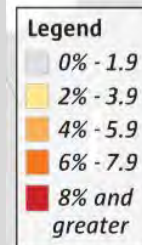
100,000 rides per day

Combined
91,246

Uber
56,443

Lyft
34,803

27,257

22,571

4,686

| Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 |
| 2015 | | 2016 | | | | 2017 | | | | 2018 | |

Source: Uber and Lyft quarterly reports to the city of Seattle

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Where Uber, Lyft rides are concentrated

More than 40 percent of all Uber and Lyft rides in the Seattle region happen in the city's most congested areas: ZIP codes containing downtown, Belltown, South Lake Union and Capitol Hill.

Legend
- 0% - 1.9
- 2% - 3.9
- 4% - 5.9
- 6% - 7.9
- 8% and greater

LAKE FOREST PARK
BOTHELL
SHORELINE
KIRKLAND
SEATTLE
98122
98109
98121
98101
BELLEVUE
MERCER ISLAND
VASHON ISLAND
BURIEN
98158
RENTON
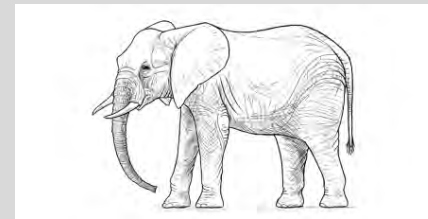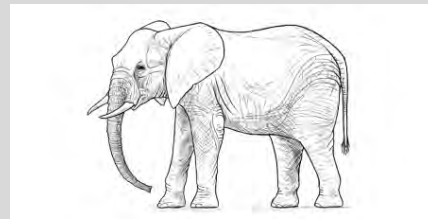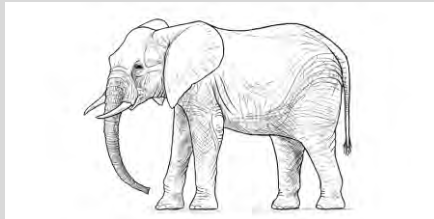Seattle-Tacoma International Airport
SEATAC

Sources: Uber and Lyft 2018 second-quarter reports to the city of Seattle

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- 40% of Uber and Lyft rides in the 39 city region taking place in just four neighborhoods of City of Seattle…
- … that are already densest, most congested, as well as best served by frequent transit, bike lanes and walkable streets

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# Implications of Autonomous LDV based Ride-hailing (AV Taxis)

- Autonomous LDVs will improve safety, roadway capacity, and enable cheaper travel and more productive use of time

- Autonomous LDVs will also lower Ride-hailing costs and could exacerbate the shift away from high capacity and active transport

- How many elephants can you fit in a wineglass? How many AV taxis on a city street?

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To solve for the geometry of dense environments

- Transport people in large vehicles (aka Transit)

- Or get them to ride vehicles no larger than themselves (bikes, scooters)

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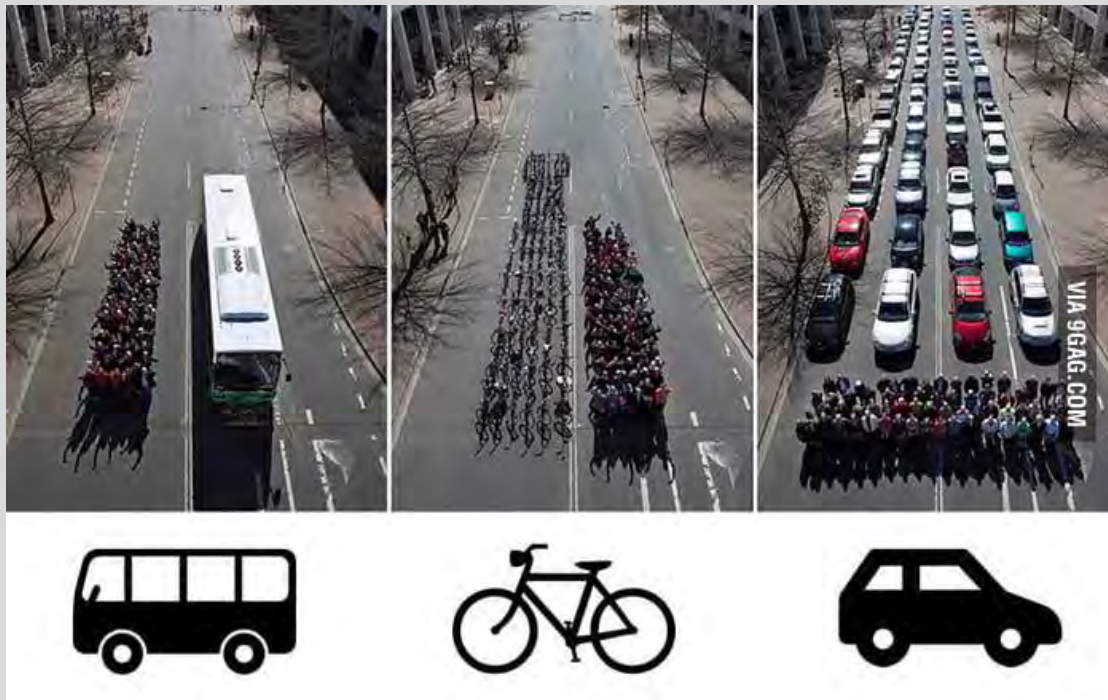
The Ridership-Coverage Tradeoff of Transit

- Competing demands of **Seeking Ridership** (service where lots of people ride) **Vs. Ensuring Coverage** (service to ensure that everyone can ride)

- Only 50-60% of transit is ridership seeking; The more coverage service you offer the less ridership you can seek

- Transport use cases and implications for the ridership vs. coverage tradeoff

Environment/ Use Case	Ridership Vs. Coverage
Dense Urban	Ridership
Intercity Suburban	Ridership
Low Density Suburban	Coverage
First and Last Mile Connectivity	Coverage

- Shared Mobility and LDV automation can complement rather than compete with transit and its cities' and transit agencies' job to ensure that it does

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Two Futures

Marginalized transit

- Shared autonomous LDVs draw riders from transit
- Higher VMT, congestion, and energy use
- Personal convenience; missed societal benefits
- Transportation gets highly inequitable
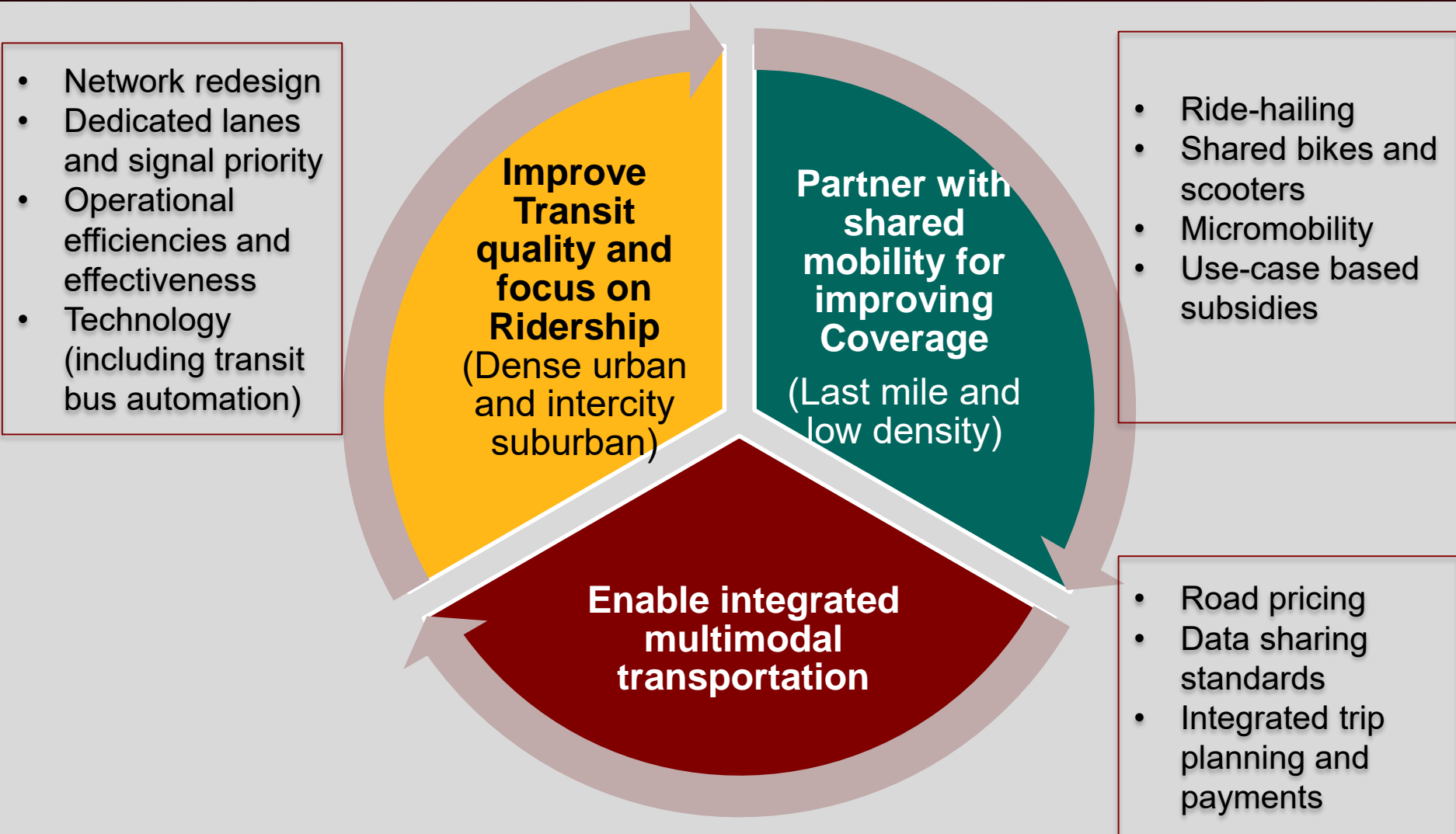

Transit at the center

- A transport network with transit as the backbone
- Autonomous LDVS complement transit
- Fewer vehicles; Lower VMT, congestion, and energy use
- Lower overall system costs and more equitable access

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Getting to the Desired Future State – Metro's Strategy

- Network redesign
- Dedicated lanes and signal priority
- Operational efficiencies and effectiveness
- Technology (including transit bus automation)

Improve Transit quality and focus on Ridership (Dense urban and intercity suburban)

Partner with shared mobility for improving Coverage (Last mile and low density)

Enable integrated multimodal transportation

- Ride-hailing
- Shared bikes and scooters
- Micromobility
- Use-case based subsidies

- Road pricing
- Data sharing standards
- Integrated trip planning and payments

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State of Full-sized Transit Bus Automation

Economics of Bus Automation

- Smaller commercial opportunity compared to car and truck automation
- Not enough Public R&D funding

Technical challenges with Transit Bus Automation

- Modifications, replacements or redesign needed to transfer existing automation systems from sensing and propulsion to steering and braking
- Time horizon for Level 4 autonomy unclear

Will the U.S. lead?

- Testing in Shenzhen, China
- Full-sized driverless buses slated on a 14-mile route in UK by 2021
- Five 40 seater buses to be converted from manual to autonomous by Fusion Processing, with £25m in state funding

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Full-sized Bus Automation would be a Game Changer

- Space efficiency of large vehicles with dramatically lower operating costs and increased safety

- Vehicle right sizing by passenger demand could unlock further efficiency gains

- Cost structure reversal (Form opex to capex)

- Loss or reclassification of operator jobs

- Public vs. private operations

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Metro's Efforts to Date

- Several 'New Mobility' pilots deployed/ under development (including Microtransit, Ride-hailing, Bikeshare for First & Last Mile and low density)

- Not enough interest in 7 to 14 passenger AV shuttles (Navya, EasyMile, May Mobility) due to speed, range and gradient limitations

- Regional cities interested but wary about AV Taxis

- Most providers of self-driving cars not ready for commercial deployment on city streets; ETAs are a moving target

- Waymo's First & Last Mile service in AZ off to a shaky start

- Seattle's light rain and mist can pose additional technical difficulties

- Metro interested in bus platooning for BRT and in-depot automation; Limited traction from OEMs; exploring FTA grant application

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Q & A

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