PUBLIC REVIEW DRAFT - TECHNICAL APPENDICES

2018 Regional Transportation Plan

Emerging Technology Strategy

A strategy for guiding innovation to support the greater Portland region's goals

May 25, 2018

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TABLE OF CONTENTS

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APPENDIX 1: FORECASTING THE FUTURE

Below we describe in more detail how technology is likely to develop in the coming decades, as well as how it will affect our goals if we don't act and the actions that public agencies need to take in order to prepare for successive waves of change.

The next five years

How we expect technology to develop

In the next five years, the first AVs will likely hit our streets, and will be operated by ride-hailing companies, freight companies, and other private fleets. These first-generation AVs will be significantly more expensive than regular vehicles, but Uber and Lyft, as well as other companies that enter the ride-hailing market, will be happy to pay for them because they reduce the cost of driver labor, which can make up most of the cost of a ride-hailing trip. Initially, AVs will likely be deployed on a pilot basis, with a human operator ready to take over if something goes wrong.[1] However, several of these pilot deployments could be large enough in scale to serve entire cities.[2]

Most of the first AVs will be EVs. Almost all passenger AVs available today are EVs, because it is easier to automate control of an EV than a regular vehicle.[3]

Ride hailing companies will also continue to expand and improve service throughout our region, independent of automation, as they recruit new drivers and more people have the opportunity to try them. Other shared mobility services will also likely grow. BIKETOWN and car share companies plan to launch service in new communities in the coming years, and new shared mobility models, such as dockless bike and electric scooter share, which is available in a small number of other U.S. cities, are also likely to begin service in our region.

Transit agencies and freight companies will have new opportunities to innovate. Transit agencies across the country are already testing new approaches such as microtransit, AV shuttles, and subsidized ride-hailing trips to connect people to transit. In our region, TriMet is developing resources to help people plan transit trips—including bike share and ride-hailing connections to and from transit stations. These trends mean that people in the region are likely to enjoy new ways to seamlessly make and plan connections to transit. Freight companies and retailers will also continue to experiment with new ways to distribute goods, particularly the growing amount of purchases made online. Innovations such as ride-hailing-style delivery services, drone deliveries and package lockers could change how goods travel along our streets.

Apps will become the dominant way to access travel information. Whether you're a driver, cyclist, transit rider, or pedestrian, apps are already the most widely-used way to get information on how to get around, and their popularity will continue to grow. Public agencies' success in managing the transportation system will depend increasingly on how well people can access information on public transportation options via smartphone—

particularly via third-party apps like Google Maps, moovel and Transit App, which are drawing a growing share of users while usage of many public agency apps and websites dwindles.

How it could impact our goals

Transportation choices: People in the region will have new ways to get around and plan trips. However, it is less clear whether emerging technologies will really improve our choices. New mobility services could compliment transit, bicyling, and walking by focusing on trips that transit can't service and bringing better options to areas where driving is currently the only reliable and convenient way to travel. Or they could compete with walking, bicycling, transit, and each other by focusing on serving those who already enjoy access to a variety of travel options.

Equity: As more people in the region turn to app-based transportation services and travel information, we risk leaving those who can't use or afford these services behind. Competition between new modes and transit could impact service that low-income people and communities of color disproportionately rely on.

Transparency: The public will have limited insight into how new technologies are affecting our communities. In most cases new mobility companies do not provide data on how people are using their services nor face requirements to provide safe and equitable service. Federal legislation may also prohibit state and local governments from requiring that AVs make vehicle data available.

How the region can prepare

- Develop policies to ensure that new mobility services—especially those that pilot test AVs—operate safely and equitably, and provide the information that we need to plan for our changing system.
- Understand the barriers that people face to using emerging technologies, and work with affected communities to overcome these barriers.

Emerging technologies and transit

The rise of ride-hailing and microtransit has some people wondering whether transit will soon become a thing of the past—especially if AVs enable more affordable, flexible and convenient shared service. So why do we focus so much on transit in this strategy?

The first reason is because a future with transit looks so much brighter than a future without it. Even with shared AVs on the road, transit will remain the most efficient way to move people through congested areas. Transit is the mode that historically marginalized people most rely on for everyday trips, and the one that we can all rely on to keep our region moving in the event of a natural disaster. And the transit network is the backbone of our land use vision, anchoring vibrant communities across our region. New mobility services can reach people in places where transit isn't efficient, and they but it's difficult to imagine them providing all these other benefits.

The second reason is because transit provides great opportunities to innovate. TriMet is already a leader in making it easy for riders to plan and pay for trips online. We'll soon have the chance to pilot test new technologies like microtransit and automated transit vehicles.

- Pilot test new technologies to see whether they support our goals.
- Forecast how changes in technology will shape the future so that we can better plan for it.

Five to ten years

How we expect technology to develop

As AV technology matures, **ride-hailing and freight companies will begin to phase out human drivers.** This will enable ride-hailing companies to cut the cost of trips, potentially making ride-hailing a viable option for trips to work, the grocery store, and other daily destinations—not only in Portland, but also in communities like Hillsboro, Oregon City, and Gresham. And it likely won't just be Uber and Lyft serving these communities; many traditional automakers, AV technology firms, and car share companies are planning to launch ride-hailing service when AVs arrive.[4] Autonomous transit vehicles should also become available, potentially lowering the cost of providing transit, particularly in areas that are challenging to serve with fixed routes.

We'll use the curbside differently. In addition to parking and bike lanes, the curbside will host increasing numbers of ride-hailing drop-offs, and potentially also more EV charging, microtransit boardings, and new models of freight delivery.

How it could impact our goals

Reliability: In the nearer term, more ride-hailing likely means more congestion for the region. Researchers have found that ride-hailing services increase vehicle miles traveled because they travel additional empty miles to pick people up and shift trips away from transit, bicycling and walking, and because they focus on serving areas that are already congested. If AVs enable ride-hailing companies to more efficiently provide shared trips, it could help with congestion, and eventually, AVs should streamline traffic because they will be able to platoon and travel at higher speeds. However, the benefits of AVs on congestion will be muted as long as they are in mixed traffic with human drivers.

Prosperity: Close to 30,000 people, or 2.5 percent of workers in the region, drive vehicles for a living, and thousands more drive part-time for ride-hailing services to supplement their incomes. These people could see their jobs threatened by automation. The transportation sector has long offered family-wage job opportunities to people who lack advanced educations, and driving for Uber and Lyft has become a way for people who do not have full time employment to make ends meet, so these job losses will mainly impact lower-income households. Also, advances in freight delivery are likely to benefit national businesses and online retailers, making it harder for local businesses to compete. New mobility companies will bring some new jobs to the region, but mostly for skilled workers, and there are unlikely to be enough of these new opportunities to compensate for lost transportation jobs.

The impacts on **transportation choices**, **equity**, and **transparency** discussed in the previous section will continue apace during this time frame, with some additional nuances. Autonomous transit could provide more flexible, efficient and affordable service, but if ride-hailing companies have a head start in deploying AVs it may be hard for transit to recapture riders. AVs could improve travel options for youth, older adults, and others who cannot drive. And the reduced cost of automated ride-hailing trips could make ride-hailing a more viable option for low-income travelers. However, it seems likely that without significant effort to expand physical, financial, linguistic, and digital access many people will continue to be unable to take advantage new mobility services.

How the region can prepare

- Create programs to help affected transportation workers transition to new jobs
- Continue to develop pilot projects and partnerships with new mobility companies.
- Redesign and manage curb space to reduce conflicts and congestion, prioritize shared trips, and maintain safety, especially for bicyclists and pedestrians
- Price vehicle travel to manage congestion and encourage shared trips.

Ten to 20 years

How technology could develop

Sometime in the next two decades we could reach the point when **the majority of new vehicles sold—and a significant portion of all vehicles on the road—are automated and electric**. If vehicles use common communications protocols, it will open up new possibilities for using connected vehicle infrastructure to manage the transportation system. Groups of AVs traveling side-by-side will be able to platoon, taking up less space on the roadway.

Ride-hailing and freight could be entirely automated. We could see ride-hailing service peak as companies fully deploy AVs and prices drop to the point that **significant numbers of people start to buy AVs for personal use**. Driving will become much more convenient, because people will be able to work, shop or rest in their cars, and it may be possible to dispatch an empty vehicle to run errands, pick up family members or someone who wants to rent the vehicle or circle the streets instead of parking.

EVs will become as affordable as gasoline-powered vehicles as the cost of making the batteries that power EVs falls. We may need more publicly-available EV charging to accommodate this growth, but if the range that EVs can cover on a single charge increases most EV charging needs could be met at home, work or wherever shared fleets are headquartered.

Will AVs be shared or owned?

Experts describe two potential future scenarios for AVs, one in which they are operated in shared fleets and one in which they are individually owned. Shared AVs would likely mean fewer vehicle miles traveled, less congestion, a richer variety of travel options, and more space for people instead of vehicles. The fact that ride-hailing will start using AVs at scale years ahead of when they become affordable for most people increases the likelihood of the shared scenario, but it may be hard to provide shared service in more suburban or rural areas where homes and destinations are farther apart, as well as reverse 90 years of car ownership culture. The policies that we put in place over the next five years could make a significant different in setting us on a path toward a shared future that better supports our regional goals.

How it could impact our goals

Vibrant communities: In regional centers, where shared mobility services will likely be concentrated, we could see much less demand for parking. This could make it possible to redesign streets that have on-street parking, leaving more space for people, as well as create new opportunities for development on now-vacant parking lots. It could also spur new development by saving developers money on building parking spaces.

Reliability: It is unclear whether congestion will increase or decline during this phase. On one hand, having more AVs on the road will likely mean that traffic moves more efficiently. On the other, by making it more convenient to drive and making it possible for vehicles to travel without passengers, AVs are projected to increase vehicle miles traveled by anywhere from 3 to 68 percent,[5] further straining the capacity of the region's roads, many of which are already packed.

Environment: Transportation-related pollution and GHG emissions could go up or down during this phase. Vehicles will emit much less pollution per mile, but they will travel more. The significant increase in electricity demand due to electric vehicles—which could grow to 300 times what it is today globally[6]—may require the construction of new dams or the use of other, dirtier sources of energy.

Safety: Safety will likely improve once there are significant numbers of AVs on the road. Automation would eliminate human error in driving, which is responsible for the vast majority of crashes.[7]

Fiscal stewardship: Revenues from two major sources of transportation funding—the gas tax and parking fees—will fall dramatically during this period. Drivers of all-electric vehicles will pay no gas tax, and even those who drive the next generation of more efficient gasoline-powered vehicles will pay less. Meanwhile, if AVs are shared or if drivers are allowed to send their private AVs on a cruise instead of parking them, local governments might not collect any parking fees.

Prosperity: Any decrease in congestion would be a boon for productivity, since many workers will be able to spend more time working and less time in traffic. Even if there is more congestion, AVs will turn the commute into working time for people with office jobs.

However, those whose jobs require them to be at a specific location, such as construction workers, healthcare professionals, and teachers, may not be able to work in their AVs, and their productivity may even suffer if congestion increases.

How the region can prepare

- Price travel and develop new revenue sources to fund construction and maintenance of the transportation system
- Develop policies, design communities, and price travel to encourage shared travel and discourage vehicle ownership
- Reduce parking requirements and redesign streets in urban areas

20 to 40 years

How technology is likely to develop

Even according to the most conservative projections, the **majority of travel will be in AVs by 2050**, and **the majority of vehicles on the road will be AVs by 2060**. These changes could come much sooner, particularly if AVs are shared. Platooning and high-speed AV travel could become the norm on our streets, which could be transformed, with fewer, narrower lanes and no traffic signals. The need for parking spaces—already disappearing in urban areas—could also diminish in the suburbs.

How it could impact our goals

Vibrant communities: Since cars will need less space on the roadway, and may not need to park at all, we will have more space for people throughout the metro that can be converted to housing, parks, and trails, helping us create thriving centers and neighborhoods—assuming we can find new sources of transportation funding to help us retrofit our streets. However, many of the people who are now able to work while commuting could decide to live further out at the edges of the region, or even travel to Portland-area jobs from areas that are now rural. This could create more development pressure on farmland and natural areas and siphon growth away from now-vibrant communities.

Many of the impacts discussed in the above section will gain force during this period. **Safety** will likely improve for all, those who can work while commuting in their AVs will **prosper**, and **transportation revenues** will continue to dwindle. Advancing technology will help to increase **reliability** and benefit the **environment**, but it might not be enough to achieve our goals if AVs trigger sprawl on a scale we haven't seen before.

How the region can prepare

- Develop new land use policies to discourage sprawl and maintain vibrant communities in regional centers
- Reduce parking requirements and redesign streets throughout the region

APPENDIX 2: ASSESSING THE IMPACTS OF EMERGING TECHNOLOGIES

Automated and vehicles (AVs)

Automated vehicles use sensors and advanced control systems to operate independently of any input from a human driver, and connected vehicles communicate with each other or with infrastructure like traffic signals and incident management systems. Until recently, automated and connected vehicles were developing independently of each other, but it seems increasingly likely that vehicles in the near future will be automated and may include some connected elements as well. Transportation experts have developed a five-level system to distinguish between different levels of automation;[8] in this plan we focus on Level 4 or 5 AVs, which can operate independently under most or all conditions.

Status: AVs are not available for purchase yet, but they are being pilot tested in a number of cities. The first consumer-ready models are expected to hit the streets within two years,[9] at a cost that is significantly higher than the cost of a conventional vehicle. Both the U.S. legislature and the State of Oregon are developing policies and regulations around the testing and deployment of AVs. The first generation of passenger AVs are likely to be operated in shared fleets by ride-hailing companies[10] because the money that these companies will save on driver labor will offset the additional cost of an AV. For similar reasons, freight companies will also likely be early deployers of AVs. The first AVs will mostly be electric vehicles; for engineering, economic, and environmental reasons nearly every model of AV currently runs on electricity.[11] Sales of AVs will likely outpace sales of non-automated vehicles in 15 to 20 years, and the number of miles traveled in AVs will likely outnumber miles traveled in conventional vehicles within 30 to 40 years.[12]

Local and regional influence: Federal and state agencies intend to regulate the testing, safety, and deployment of AVs, but it remains to be seen whether local and regional agencies will have enough oversight to ensure that AVs support policy goals. Draft federal AV legislation could pre-empt local governments from managing how AVs operate on their streets,[13] and few of the Portland region's public agencies have adopted policies regarding ride-hailing companies, which could affect how these companies deploy AVs.

Promise and peril: AVs will likely have sweeping impacts on the region—both for the better and for the worse. It seems likely that they will create a safer transportation system, but also lead to much greater vehicle use and eliminate jobs. The impacts of AVs on land use, equity, and the environment could be either positive or negative, and we need to start planning today to set the region on a positive course.

Goal	Promise	Peril
Vibrant communities	If shared, AVs could free up vehicle lanes and space currently devoted to parking to create space for people.	If AVs make driving more convenient, people are likely to move further from regional centers. If AVs are allowed to operate at higher speeds on local streets, it could create mini-highways bisecting communities.

Goal	Promise	Peril
Prosperity	Local companies are poised to play a role in deploying AVs.[14] Innovative approaches to AV technology could attract new companies and investment.	Many other metro areas are competing with the Portland Region as technology innovators, and automation will likely eliminate jobs in the transportation sector.
Choices	AVs create opportunities to expand the reach of transit and make carpooling convenient.	It seems likely that by making driving more convenient, AVs will reduce transit ridership,[15] which could in turn lead agencies to eliminate service.
Reliability	AVs will be able to safely follow other vehicles more closely and choose lanes more efficiently, cutting congestion and increasing travel speeds.[16] AVs could enable transit service in areas that are currently not cost-effective to serve.	AVs are likely to increase VMT by making driving more convenient, traveling empty miles to run errands or pick people up, and enabling people who don't drive to travel by car,[17] which could offset their operational benefits.
Safety	AVs are likely to eliminate human error in driving, which is responsible for the vast majority of crashes.[18]	
Environment	The majority of AVs will likely be electric.	By increasing VMT, AVs could lead to growth in emissions even as cars become cleaner. AV-induced sprawl could increase development pressure on farmlands and natural areas.
Equity	AVs will likely improve transportation access for those who are unable to or choose not to drive.	Shared-fleet AVs will involve many of the same barriers to equitable access as other new mobility services currently do, and by expanding the reach of these services AVs could exacerbate inequity.
Transparency	AVs will collect rich data that can be used to monitor, manage, and plan the system.	Federal legislation may prevent local and regional agencies from accessing AV data, and companies that operate shared AVs may want to avoid sharing data with public agencies in order to protect competitive information about their services.

Connected vehicles (CVs) and infrastructure

Connected vehicles (CVs) communicate with each other and with CV infrastructure to navigate the transportation system safely and efficiently. CV infrastructure can include traffic signals, incident management systems, sensors, and monitoring systems, as well as the communications infrastructure needed to transmit increasing amounts of data to and from the roadside environment.

Status: Some public agencies and automakers are already using or testing CVs and CV infrastructure, but most work in this area is still in the conceptual phase. Going back ovFor over a decade, several cities have used transit signal priority, an early form of CV infrastructure where traffic signals sense approaching buses and modify signal timing in order to move them quickly through intersections. One of the early commercially-available CV applications in passenger vehicles is in certain Audi models, which sense when a traffic light is red and display the number of seconds remaining until it turns green.[19] FHWA has also been piloting CV infrastructure in three different areas of the U.S. to improve safety and reduce congestion.[20] However, it is not clear whether or how the vehicles of the future will communicate with the roadside and with each other. The federal government recently withdrew a rulemaking process that would have required auto manufacturers to outfit all new models with similar communication equipment.[21]

Local and regional influence: Local and regional agencies have authority over many infrastructure decisions, including installations of CV infrastructure, but until there are consistent standards for how vehicles communicate it will be hard to identify worthwhile large-scale CV projects. Between now and then, there are still more limited ways that public agencies can prepare for CVs, such as increasing data connectivity to and from the roadside, developing policies on the use of CV infrastructure data to ensure that this data is used in a way that benefits the public, and piloting CV applications in transit vehicles, agency fleets, or in collaboration with private fleets.

Promise and peril: Public agencies will be able to manage the transportation system more efficiently, effectively, and safely if we can communicate with vehicles and they communicate with each other. However, it can be challenging to make sure that CV infrastructure investments are worthwhile given the uncertainly around how technology is developing. We also need to make sure that these investments benefit everyone, not just CV drivers.

Goal	Promise	Peril
Choices	There are early opportunities to use CV technology to make transit more efficient and reliable.	Passenger CVs are likely to make driving more convenient, which could mean more competition with transit and other modes
Reliability	CV technology could allow public agencies to active manage the transportation system, rerouting traffic on the fly to avoid congestion and crashes.	

Goal	Promise	Peril
Safety	CVs, whether they have a human driver or are automated, are likely to be safer.[22]	
Transparency	CVs capture data that can be used to operate and monitor the performance of the transportation system more efficiently and thoroughly.	Cars might not provide us with the information that we need to know whether CV infrastructure is helping to meet our goals.

Electric vehicles (EVs)

Electric vehicles (EVs) use electric motors for propulsion instead of or in addition to gasoline motors.

Status: Automakers have been offering EVs for over a decade. In Oregon, as in the rest of the country, only a small share—roughly 100,000 of the 3.1 million passenger vehicles in the state—are EVs.[23] However, EV sales are expected to increase dramatically in the coming years due to falling manufacturing costs, rising global demand, and state policies encouraging EV adoption.[24] According to more ambitious projections, EVs could cost the same as conventional vehicles by 2025 and outpace conventional vehicle sales by 2038.[25] If AVs take over the transportation system it could accelerate the growth in EV usage since almost all AVs available today are EVs.[26]

Local and regional influence: State agencies, including in Oregon, have actively worked to increase the number of EVs on the road. Oregon has adopted emission standards that are stricter than the national standards and require manufacturers to offer more efficient vehicles, potentially including EVs, as well as a zero emissions vehicle mandate that effectively requires that a certain percentage of all vehicles sold be EVs.[27] The state also offers a $2,500 rebate on EV purchases, with an additional $2,500 for low- and moderate-income drivers who trade in an older car when making their purchase.[28] However, local and regional agencies have typically focused on providing public charging, amending codes to require new developments to provide chargers or electrical capacity in parking areas, and outreach. Given that these strategies don't address the primary reasons consumers don't buy EVs—their high cost or the lack of an electric model for many types of vehicles[29]—that most charging occurs at home and at work[30] and that the pace of new development is relatively slow, it is hard to argue that these actions have a significant impact over EV adoption.

Promise and peril: Electric vehicles are better for the environment and for public health, but since EVs consume less gas we will need to find another way to finance the transportation system besides the gas tax.

Goal	Promise	Peril
Environment	EVs produce fewer emissions than gasoline-powered vehicles.	
Health	EVs emit fewer health-damaging criteria air pollutants	
Equity	Long-term savings on gasoline and maintenance mean that many EVs cost less to own overall than comparable gasoline powered cars—especially given federal and state rebates.	The higher up-front costs of an EV make it hard for low-income people to realize these long-term savings. The most affordable cars available are used, and used EVs are usually significantly more expensive than AVs.
Fiscal stewardship		EV owners buy less gas, and the gas tax is our main source of transportation revenue. It will be necessary to rethink how we fund transportation projects as vehicles get more efficient.

Ride-hailing

Ride-hailing services (also known as transportation network companies, or TNCs) use apps and websites to connect passengers with drivers who provide rides in their personal vehicles.

Status: Ride-hailing services are already changing the way that we travel in the Portland region. These services provided over ten million rides in the city of Portland in 2017,[31] carrying more people than taxis did,[32] and people in other areas of the region regularly use ride-hailing services for weekend trips and trips to the airport. Two companies, Uber and Lyft, dominate the ride-hailing market in the U.S. and are the only ride-hailing companies serving our region today. However, several other companies are poised to begin operating ride-hailing services in the near future.[33]

Local and regional influence: Ride-hailing companies have maintained that they are not transportation companies, but rather technology services, because they provide a platform that connects riders to drivers and do not operate vehicles. According to this line of thinking, ride-hailing services are not subject to the same local regulations as taxis and other transportation services, because they are not directly responsible for passengers' safety or mobility. However, several U.S. cities, counties, and states have challenged this argument and adopted ride-hailing ordinances,[34] and courts in the European Union recently rejected it outright. Unlike neighboring states,[35] the State of Oregon does not currently have any laws in place regulating ride-hailing services, and in our region only the City and Port of Portland currently have ride-hailing regulations in place.[36]

Promise and peril: Ride-hailing have significant long-term potential to expand transportation choices in suburban areas, increase carpooling and reduce vehicle miles traveled and car ownership. However, most of the evidence to date finds that ride-hailing services are increasing vehicle travel, competing with public transportation, and providing inequitable service.

Goal	Promise	Peril
Prosperity	Ride-hailing services provide flexible opportunities for drivers to earn extra money.	People who drive for ride-hailing companies lack benefits and job security. Ride-hailing companies have moved to cut drivers' pay,[37] and drivers' jobs will likely be eliminated as companies deploy AVs.
Choices	Ride-hailing services offer a new way to travel, and have launched carpooling services in the region.[38] Some transit agencies are subsidizing ride-hailing trips to transit stops in order to boost ridership.[39] Most ride-hailing trips take place during the evening and on weekends, when transit service is less frequent, which suggests that ride-hailing and transit are complimentary.[40]	Ride-hailing services generally focus on serving areas that already enjoy a variety of transportation choices, and attract riders away from transit.[41]

Goal	Promise	Peril
Reliability	Over time, ride-hailing services could help to reduce VMT by facilitating carpooling and allowing people to own fewer cars. In the future, shared management of AVs by ride-hailing services could help to reduce congestion.	Ride-hailing services increase VMT because they draw people away from transit, travel extra to pick riders up, and enable people to take trips they wouldn't otherwise take[42]—particularly in areas that are already congested.[43] In San Francisco, ride-hailing services accounted for two thirds of congestion-related traffic violations downtown over a three-month period.[44]
Safety		In Portland and other cities, ride-hailing companies frequently violate safety requirements and traffic laws.[45] There have been instances of ride-hailing companies allowing drivers cited for DUIs to continue driving in spite of zero-tolerance policies.[46]
Equity	In the City of Portland, ride-hailning services face minimum requirements for service equity and disabled access. As AVs lower the cost of service, ride-hailing services could offer options in marginalized communities that are nearly as affordable as transit and much more efficient.	Ride-hailing companies appear to offer worse service to communities of color,[47] and lower-income people are less likely to use these services.[48] In spite of efforts to increase access, few ride-hailing vehicles are wheelchair accessible.[49] People who are unbanked, undocumented, limited English proficiency, or lack access to the Internet also face barriers in accessing ride-hailing services
Transparency		In many cases, ride-hailing services have actively worked to avoid regulation[50] or have failed to enforce regulations.[51]

Microtransit

Microtransit refers to privately-operated transit services that use smart phones to allow riders to book trips and collect data to tailor routes that meet riders' needs, and that typically serve these routes with vehicles that are smaller than conventional buses but larger than passenger vehicles.

Status: There are several microtransit services operating in major cities across the U.S., though none are currently serving our region. Some services, such as Chariot and Leap in San Francisco, essentially offer luxury alternatives to transit, operating along crowded bus lines charging higher fares for guaranteed seats, wi-fi, and other amenities.[52] Others are more coordinated with public transportation and focus on serving areas or high-demand routes that are currently not well-served by transit, such as Via's pilot service in West Sacramento.[53] It remains to be seen whether microtransit is a viable business model, and a number of services have already failed.[54] Riders are satisfied, but microtransit faces competition from both transit and from ride-hailing services, and it is challenging to operate any transit service at a profit, especially when regulations are in place.[55]

Local and regional influence: Many cities and states regulate microtransit, licensing services, conducting safety inspections, or requiring disabled access. Some agencies are also funding microtransit pilots in areas that are underserved by transit.[56]

Promise and peril: The benefits of microtransit depend on the service model. Services that offer luxury alternatives to conventional transit would do little to support our goals, but coordinated microtransit that provides first- and last-leg connections or serve areas that are hard to serve with conventional transit offers a promising new option.

Goal	Promise	Peril
Choices	Because microtransit offers more flexible service, it could bring new choices to areas that are hard to serve with transit, including providing connections to transit stations that boost ridership.	Microtransit services that operate as luxury alternatives to public buses likely attract users away from transit.
Reliability	Microtransit facilitates shared trips among people who would likely otherwise drive.	
Equity	Some microtransit pilots offer phone-based bookings for people that do not have access to apps or the internet.	Most microtransit serves high-income neighborhoods and employment areas at a premium. People who are unbanked, disabled, undocumented, limited English proficiency, or lack access to the Internet also typically face barriers in accessing microtransit.
Fiscal stewardship	Microtransit could provide better service at lower cost in areas with underperforming transit.	Luxury microtransit attracts choice riders away from transit, diminishing revenues.

Goal	Promise	Peril
Transparency	There are many models for how to regulate microtransit, and some companies actively share data and collaborate with public agencies.	Many of the jurisdictions where microtransit could provide benefits do not have any regulations in place.

Car share

Car share services allow people to rent a nearby vehicle for short trips and pay only for the time that they use.

Status: Car share has been around for nearly two decades. Today, several different companies are active in the Portland region, operating over 1,000 vehicles and offering different service models.[57] These include:

- Stationary car share (ZipCar, in some cases ReachNow), under which cars are kept at fixed stations, and users typically pick up cars from and return them to the same station. Compared to other models, stationary sharing is better-suited for suburban areas, longer trips, and errands (since a wider variety of vehicle types are available). Stationary car share is currently available throughout Portland's central neighborhoods and Beaverton, Hillsboro, Clackamas Town Center, and the PCC Sylvania campus.[58]
- Free-floating car share (Car2Go, ReachNow), which allows people to pick up and drop off cars anywhere within a defined service area. Free-floating car share allows for more flexible travel than stationary car share, and typically offers only compact cars. It is used mainly for short one-way trips in urban areas, and within the region free-floating carsharing is currently only available in Portland's central neighborhoods.[59]
- Peer-to-peer car share (Getaround, Turo), which enables people to rent cars from their neighbors on a short-term basis through services that provide insurance, enable payment, and manage booking and access. Peer-to-peer services are available in Portland, and used primarily for round trips and daily rentals.

Rapid change makes it hard to anticipate what car share will look like in ten years. Stationary car share, which a decade ago was the only type of car share available, is now facing strong competition from free-floating car share, and both of those models are threatened by the continued growth of ride-hailing services.

Local and regional influence: Public agencies have a fair amount of influence over most car share services. Stationary car share often requires space in the right of way or in public parking lots. Free-floating car share typically operates in areas where parking is at a premium, and relies on cities waiving parking fees or restrictions for shared vehicles.

Promise and peril: Research has found that car share users typically drive less and own fewer cars. However, since marginalized communities often lack access to car share not everyone shares in these benefits.

Goal	Promise	Peril
Vibrant communities	Car share members own fewer cars, potentially reducing the space needed for parking in areas where car share is available.[60]	
Choices	Car share provides residents with a new transportation choice.	

Goal	Promise	Peril
Congestion	Stationary car share users, and to a lesser extent, free-floating car share users, drive fewer miles overall.[61]	
Environment	Car share vehicles are more fuel efficient than the average vehicle.[62]	
Equity	Car share can offer an affordable alternative to car ownership.	Car share services are focused on central neighborhoods that tend to be whiter and higher-income.[63] People who are unbanked, disabled, undocumented, limited English proficiency or lack access to the Internet also face barriers in accessing car share.
Transparency	In many cases, car share services openly collaborate with public agencies in exchange for space or waived parking regulations.	

Bike and scooter share

Bike and scooter share systems make fleets of bicycles and scooters available for short-term rental within a defined service area.

Status: Over the past decade, cities around the world have created bike share systems. The City Portland launched its system, Biketown, in 2016. Biketown serves Portland's central neighborhoods[64] with a fleet of 1,000 bikes, and riders logged over 300,000 trips in its first year.[65] As with car share (see above), early bike share systems required users to pick up and leave bikes at designated stations, while modern systems are more likely offer users the flexibility to leave a bike anywhere within their service area. Biketown is a hybrid system; bikes are usually kept at stations but users can pay an extra fee to leave a bike at another location in the service area. Station-based bike share sytsems are usually operated in close coordination with public agencies. More recently, a number of fully dockless systems operated by companies such as Ofo, Limebike and Spin allow users to pick up and leave bikes (or electric bikes and scooters, which many companies now offer) within a defined service area and require less coordination between the public and private sector; in many cases multiple dockless providers serve a single city.

Local and regional influence: In most station-based bike share systems, a city enters into an exclusive agreement with a private operator to run its bike share system, and maintains oversight to plan and designate space for stations and make sure that the system is safe, equitable, and meet community members' needs. However, dockless bike share companies have been threatening to undermine this sole provider model. Companies like Ofo, Limebike, and Spin operate dockless systems in Seattle, Washington D.C., and other U.S. cities, often independently of public oversight, which has led to complaints about illegal parking, safety, and other issues.[66] Several cities have created program to permit dockless systems on a pilot basis in an attempt to address some of these concerns,[67] but cities could continue to face a choice between opening the market and making bike share more widely available versus maintaining control over the system.

Promise and peril: Bike share provides an active, environmentally-friendly alternative to driving, but since marginalized communities often lack access to bike share not everyone shares in these benefits.

Goal	Promise	Peril
Choices	Bike share provides people with a new travel option. Even though Biketown does not serve many residential neighborhoods, it provides people who work in central Portland another option for midday trips that they might otherwise need to drive for, and potentially enabling them to commute by transit instead of driving.	

Goal	Promise	Peril
Reliability	Bike share shifts trips away from driving.	
Environment	Bike share provides a low-emissions alternative to driving, particularly electric bikes, which allow people to take longer trips.	
Health	Bike share promotes active transportation.	
Equity	Programs like Biketown for All, which offer discounted memberships, rider training, and easy enrollment for low-income people,[68] can overcome some of the barriers that disadvantaged people face in using bike share. Some systems are also offering or exploring adaptive bikes[69] for disabled riders or electric bikes[70] and scooters[71] that make it easier for people of all abilities to use them.	Bike share systems generally focus on serving central neighborhoods that tend to be higher-income. People who are unbanked, disabled, undocumented, limited English proficiency or lack access to the Internet also face barriers in accessing bike share.
Transparency	Traditional bike share systems are operated in partnership with public agencies.	Many dockless bike share companies are working to operate independently of public oversight.

Traveler information and payment

Technology is enabling a slew of new ways for people to learn about and pay for their travel options online.

Status: Traveler information and payment have been around for as long as maps and coins, but the rise of the Internet and smart phones have created an array of new ways for people to plan and pay for their trips. A growing and at times bewildering number of applications are available to help people compare different ways of getting around (moovel, Google Maps), get detailed information on their mode of choice (TransitApp, Ride Report, Waze), track and share their trips (Strava, MapMyWalk), and pay for trips (TriMet's Tickets app, Uber/Lyft). Some experts envision a future where all of these information streams are combined into a single app that enables people to seamlessly pick and pay for the best option for any trip, choosing from a variety of convenient shared and active options instead of relying on a personal vehicle. This concept, known as mobility as a service (MaaS), is being tested in Europe,[72] but it faces significant barriers to deployment in our region, including agencies that lack digital data on transit service and the bike/ped network and new mobility companies' reticence to show comparative information on travel times and costs.

Local and regional influence: Initially, the challenge for public agencies was in making their data available online, and many agencies created their own travel information websites and apps. With the growing number of third-party websites and apps, including many that are more widely used than agency-owned options, the challenge now lies in making sure that the information available is presented in a way that supports positive outcomes. For example, some driver information apps direct drivers through school zones to avoid congested routes, and some transit apps display information alongside advertisements for ride-hailing or car share services, potentially diverting riders away from transit. At the same time, the popularity of third-party apps means that it is seldom worthwhile for public agencies to develop their own platforms for the sake of controlling how information is presented. Public agencies have had limited success influencing how third-party apps present information, and some are considering placing conditions on third-party usage of public data.

Promise and peril: Making more information available on transportation choices supports our regional goals—if that information is presented in the right way and made available to all.

Goal	Promise	Peril
Choices	Better travel information makes people more aware of their choices, and comprehensive information combined with competitive pricing could enable people to better identify the mode that works best for them.	Third-party sites may direct people toward privately-operated services that pay for advertising and away from transit and active transportation.

Goal	Promise	Peril
Equity	A MaaS-style system would enable public agencies to offer flexible subsidies to low-income and transit-dependent travelers that they could use to pick the mode that works best for them.	Marginalized people frequently lack access to apps, data plans, and the Internet. Without additional investment in digital access, underserved communities will not benefit from enhanced travel information.
Transparency		Third-party apps sometimes use and present public data in ways that don't support our goals.

APPENDIX 3: EMERGING TECHNOLOGY WORKING GROUP MEMBERS

The Emerging Technology Working Group met monthly, beginning in 2018, to help refine the Emerging Technology Strategy and coordinate among public agencies in the greater Portland region on technology-related initiatives. Due to a late start in staffing and developing the Emerging Technology Strategy the working group is less formal than the other working groups involved in developing the 2018 Regional Transportation Plan. Agendas were not posted to the Metro website, and the group continues to add members and meet to discuss implementation of the Emerging Technology Strategy. Below is the current list of working group members as of May 2018.

Member	Organization
Todd Juhasz	City of Beaverton
Katherine Kelly and Carly Rice	City of Gresham
Taylor Eidt and Peter Brandom	City of Hillsboro
Charlie Tso	City of Wilsonville
Peter Hurley and Ingrid Fish	City of Portland
Erin Wardell	Washington County
Jessica Berry	Multnomah County
Joe Marek	Clackamas County
Jeff Owen	TriMet
Andrew Dick	ODOT
Becky Steckler	University of Oregon
John MacArthur	Portland State University

ENDNOTES

[1] AV pilots have already resulted in fatalities and other safety issues; see https://www.nytimes.com/2018/03/23/technology/uber-self-driving-cars-arizona.html.

[2] The draft federal legislation governing AVs allows for each manufacturer to deploy 50,000 AVs that are exempt from safety standards in its first year of making AVs, rising to 100,000 AVs in the third year. https://www.congress.gov/bill/115th-congress/senate-bill/1885/text

[3] https://www.usatoday.com/story/money/cars/2016/09/19/why-most-self-driving-cars-electric/90614734/

[4] Ibid.

[5] http://www.fehrandpeers.com/autonomous-vehicle-research/

[6] https://www.bloomberg.com/news/articles/2017-07-06/the-electric-car-revolution-is-accelerating

[7] https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

[8] https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

[9] https://www.wired.com/story/gm-cruise-self-driving-car-launch-2019/

[10] https://www.redchalk.com/industry/automotive/shifting-gear-future-scenarios-autonomous-vehicle-development/

[11] https://www.usatoday.com/story/money/cars/2016/09/19/why-most-self-driving-cars-electric/90614734/.

[12] http://library.rpa.org/pdf/RPA-New-Mobility-Autonomous-Vehicles-and-the-Region.pdf, p. 16-17; https://www.vtpi.org/avip.pdf, Table 7.

[13] https://nacto.org/2017/10/03/senate-fails-to-address-concerns-of-cities-in-av-bill/

[14] https://newsroom.intel.com/news/intel-mobileye-integration-plans-build-fleet-autonomous-test-cars/

[15] http://www.fehrandpeers.com/fpthink/nextgenerationvehicles/ (Looking for the white paper in which they discuss transit impacts; may need to pester F+P to repost/provide for citation.)

[16] http://www.fehrandpeers.com/av-simulation-research/

[17] http://www.fehrandpeers.com/wp-content/uploads/2017/03/CNU-Article-Autonomous-Rapid-Transit.pdf

[18] https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

[19] https://www.theverge.com/2016/12/12/13923254/audi-v2i-las-vegas-test-drive-traffic-signals

[20] https://www.its.dot.gov/pilots/index.htm

[21] https://apnews.com/9a605019eeba4ad2934741091105de42

[22] https://www.its.dot.gov/cv_basics/cv_basics_20qs.htm

[23] http://www.oregon.gov/ODOT/DMV/Pages/News/factsstats.aspx; http://blog.caranddriver.com/oregon-adds-rebate-for-electric-vehicles-and-tax-on-bicycles/

[24] https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf, p. 98

[25] https://www.bloomberg.com/news/articles/2017-07-06/the-electric-car-revolution-is-accelerating

[26] https://www.usatoday.com/story/money/cars/2016/09/19/why-most-self-driving-cars-electric/90614734/

[27] http://www.autonews.com/article/20160627/OEM11/306279987/zev-mandates-get-harder-to-ignore

[28] https://forthmobility.org/news/HB2017

[29] https://www.nrel.gov/docs/fy16osti/65279.pdf

[30] http://www.seattle.gov/Documents/Departments/OSE/FINAL%20REPORT_Removing%20Barriers%20to%20EV%20Adoption_TO%20POST.pdf

[31] Conversations with Portland Bureau of Transportation staff.

[32] http://www.oregonlive.com/commuting/index.ssf/2015/10/uber_lyft_now_dominate_portlan.html

[33] These include car share companies such as ReachNow (operated by BMW; https://www.geekwire.com/2016/bmw-launch-uber-lyft-competitor-seattle-launches-reachnow-car-sharing-brooklyn/), autonomous vehicle manufacturers like Waymo (https://www.cnbc.com/2017/10/03/alphabet-waymo-self-driving-car-service-fall.html), and automakers , including General Motors (https://www.theverge.com/2016/1/21/10802240/gm-maven-car-sharing-service-price-launch-date-michigan). The rapid growth of new ride-hailing options that Austin, TX saw when Uber and Lyft stopped service (https://www.bizjournals.com/austin/news/2016/06/07/the-complete-field-guide-to-austins-ridesharing.html) also illustrates how quickly ride-hailing services can multiply.

[34] For examples from Washington State, see http://mrsc.org/Home/Stay-Informed/MRSC-Insight/September-2016/Regulating-Rideshare-Companies-Like-Uber-and-Lyft.aspx.

[35] Washington has insurance requirements for ride-hailing services (http://mrsc.org/Home/Stay-Informed/MRSC-Insight/September-2016/Regulating-Rideshare-Companies-Like-Uber-and-Lyft.aspx), and in California the Public Utilities Commission is responsible for licensing ride=hailing services, and has adopted rules and regulations related to drivers, vehicles, drug policy, insurance, data reporting, fares, and wheelchair accessibility.

[36] See the Portland City Code beginning at §16.40.200 (https://www.portlandoregon.gov/citycode/?c=28593). The City of Portland's regulations cover permit applications and fees, vehicle and driver certification, company and vehicle operations, wheelchair accessibility, and insurance; riders pay a 50 cent per ride fee that supports enforcement and accessible service. The Port's regulations are similar except that there is an additional $2.00 fee.

[37] https://thedriverscollectivepdx.com/tnc-rate-info/

[38] https://www.bizjournals.com/portland/news/2017/12/19/uber-follows-lyft-with-carpool-service-in-portland.html

[39] For example, see https://www.psta.net/about-psta/press-releases/2016/psta-expands-transit-partnership-with-uber-lyft-across-pinellas-county/ (there are others we can cite too)

[40] http://www.apta.com/resources/reportsandpublications/Documents/APTA-Shared-Mobility.pdf

[41] http://usa.streetsblog.org/wp-content/uploads/sites/5/2017/10/2017_UCD-ITS-RR-17-07.pdf

[42] http://usa.streetsblog.org/wp-content/uploads/sites/5/2017/10/2017_UCD-ITS-RR-17-07.pdf, http://www.schallerconsult.com/rideservices/unsustainable.pdf

[43] http://www.sfcta.org/tncstoday

[44] http://www.sfexaminer.com/sfpd-uber-lyft-account-two-thirds-congestion-related-traffic-violations-downtown/

[45] Ibid and https://www.portlandoregon.gov/saltzman/article/637492; according to data from the City of Portland 35% of ride-hailing audits revealed at least one violation, and the majority of violations were for safety-related issues, such as failing to carry adequate insurance or a hands-free device.

[46] http://www.cnbc.com/2017/04/13/uber-may-face-1-million-dollar-fine-over-california-drunken-driving-complaints.html.

[47] https://www.portlandoregon.gov/saltzman/article/637492 https://www.washingtonpost.com/news/wonk/wp/2016/03/10/uber-seems-to-offer-better-service-in-areas-with-more-white-people-that-raises-some-tough-questions/?utm_term=.2d881b8cfe5b

[48] http://www.trb.org/TCRP/Blurbs/174653.aspx.

[49] http://www.oregonlive.com/commuting/index.ssf/2015/10/uber_lyft_now_dominate_portlan.html / Greyball report

[50] https://www.nytimes.com/2017/03/03/technology/uber-greyball-program-evade-authorities.html

[51] http://www.cnbc.com/2017/04/13/uber-may-face-1-million-dollar-fine-over-california-drunken-driving-complaints.html

[52] https://www.citylab.com/transportation/2015/04/how-the-microtransit-movement-is-changing-urban-mobility/391565/

[53] http://www.sacbee.com/news/local/article183340381.html

[54] https://www.citylab.com/transportation/2017/11/dont-believe-the-microtransit-hype/545033/

[55] http://www.fehrandpeers.com/microtransit/

[56] http://www.arlington-tx.gov/residents/via/, http://www.sacbee.com/news/local/article183340381.html

[57] For a more detailed summary of car share business models, see https://www2.deloitte.com/content/dam/Deloitte/de/Documents/consumer-industrial-products/CIP-Automotive-Car-Sharing-in-Europe.pdf

[58] Service areas come from the ZipCar website (http://www.zipcar.com/portland) and conversations with ReachNow, and are current as of November 2017.

[59] Service areas come from the car2go (https://www.car2go.com/US/en/portland/where/) and ReachNow (https://reachnow.com/en/portland-or/drive/) websites, and are current as of November 2017.

[60] For an evaluation of the impacts of stationary car share, see http://trrjournalonline.trb.org/doi/pdf/10.3141/1992-09 and http://innovativemobility.org/wp-content/uploads/2015/07/Zipcar_Corporate_Final_v6.pdf. For an evaluation of free-floating car share, see http://innovativemobility.org/wp-content/uploads/2016/07/Impactsofcar2go_FiveCities_2016.pdf.

[61] Ibid.

[62] http://trrjournalonline.trb.org/doi/pdf/10.3141/1992-09.

[63] See service area maps for the different car share companies. Even peer-to-peer carsharing services, which do not provide any vehicles or physical infrastructure, sometimes redline disadvantaged communities; see http://www.opb.org/news/article/electric-car-sharing-low-income-housing/.

[64] https://www.biketownpdx.com/map

[65] Portland Bureau of Transportation. (2017, July 17). News Release: News Release: BIKETOWN celebrates first birthday with a week of prizes, Free Ride Day on Wednesday, July 19. Retrieved July 31, 2017, from https://content.govdelivery.com/accounts/ORPORTLAND/bulletins/1aaac54

[66] https://www.washingtonpost.com/news/dr-gridlock/wp/2017/10/05/abandoned-vandalized-and-illegally-parked-bike-share-bikes-now-a-d-c-problem/?utm_term=.90eaf6bf986a; https://nextcity.org/daily/entry/seattle-private-bike-share-experiment-stationless.

[67] Examples include Seattle (http://www.seattle.gov/transportation/projects-and-programs/programs/bike-program/bike-share), San Francisco (https://www.sfmta.com/getting-

around/bike/bike-share) and Washington D.C. (https://ddot.dc.gov/release/ddot-extends-dockless-demonstration-project).

[68] https://www.biketownpdx.com/pricing/biketown-for-all.

[69] Both Portland and Detroit are exploring offering adaptive bike share bikes (http://betterbikeshare.org/2017/05/10/two-cities-explore-adaptive-bike-rentals-people-disabilities/).

[70] JUMP Mobility, operated by the same company that supplies BIKETOWN bikes, is now operating in San Francisco and Washington, DC (https://jumpmobility.com/).

[71] Scoot operates in San Francisco (https://scoot.co/).

[72] http://maas.global/maas-as-a-concept/

If you picnic at Blue Lake or take your kids to the Oregon Zoo, enjoy symphonies at the Schnitz or auto shows at the convention center, put out your trash or drive your car – we've already crossed paths.

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