Can automated vehicles really make our cities better?

Designing the Internet of Vehicles

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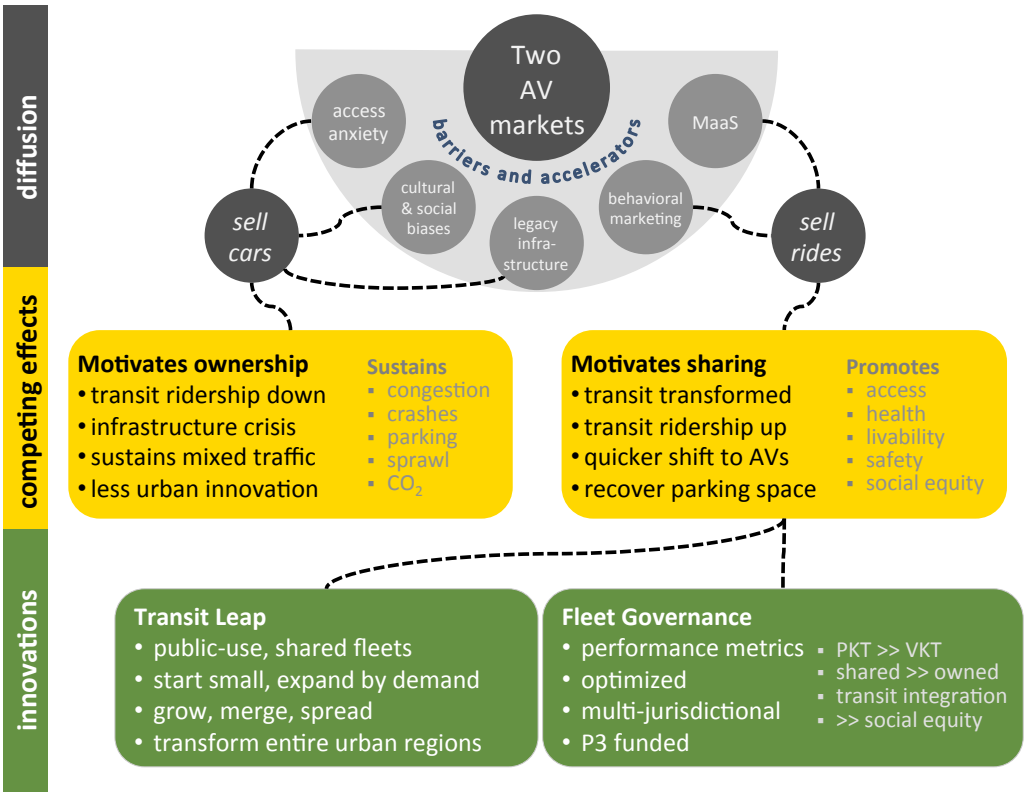
Two markets for vehicle automation

The successive levels of vehicle automation define two markets:

Personal, owned

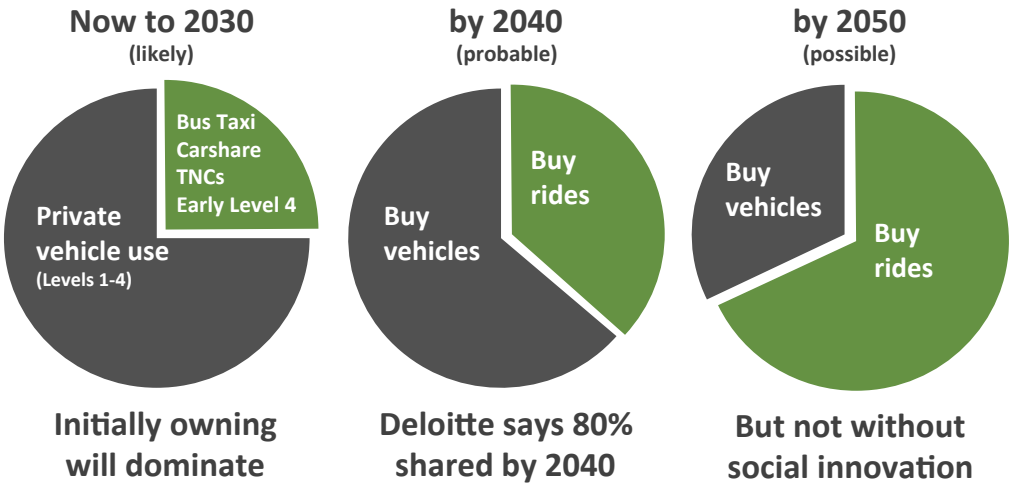
Public, shared

The most critical social attribute of the era of new mobility is how we consume. Will we really shift toward consuming rides or will we consume vehicles by continuing to own 0.8 vehicles per capita (0.65 in Canada)? Will these ownership figures drop significantly as some people assume?

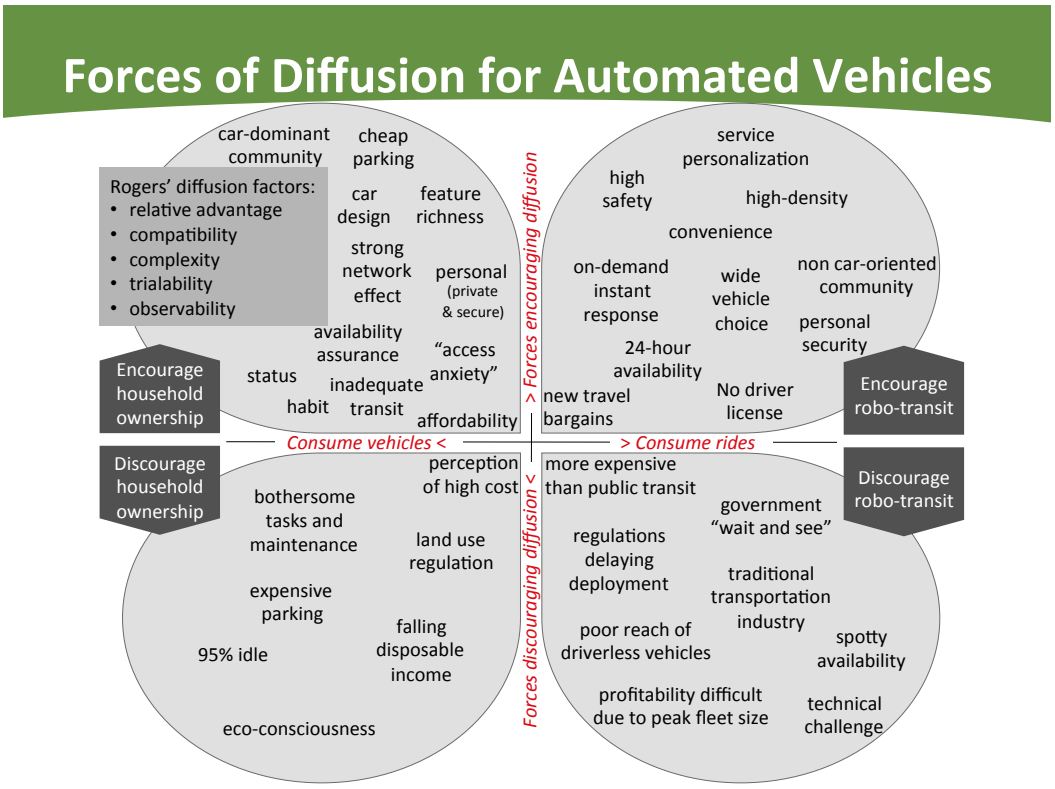


There are reasons many people prefer owning a vehicle, and many reasons why not owning can be attractive. These barriers and accelerators can be understood and used by car sellers and ride sellers to compete. There is no reason this competition will stop. To help the ride-selling market, we propose Transit Leap as a method to grow shared fleets from local to regional and Fleet Governance standards to allow rapid, managed expansion of integrated commercial and public fleets.

Will ride-buying disrupt ownership?



During the early commercialization of automated vehicles, most ride-buying will be from people who currently buy rides from transit, taxi, ride-hailing, limos, and carshares. Most current car owners will purchase Level 2 or 3 vehicles for ownership. What is uncertain is how fast and how far purchasing vehicles will morph into purchasing rides. Many pundits suggest "No one will own cars in the future". But vehicle ownership is not only a matter of technology or finance. The desired shift requires considerable social innovation.

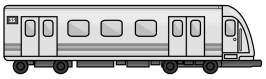


There are many factors that motivate or demotivate vehicle ownership. The graphic shows only a few. The same will be true for encouraging or discouraging the use of robo-vehicles in commercial or public fleets. All of the above are examples of the competing factors that will sell more cars or sell more rides. Many of these factors have operated for over a century. A few are new. Almost all are changing. The balance is currently in favor of ownership.

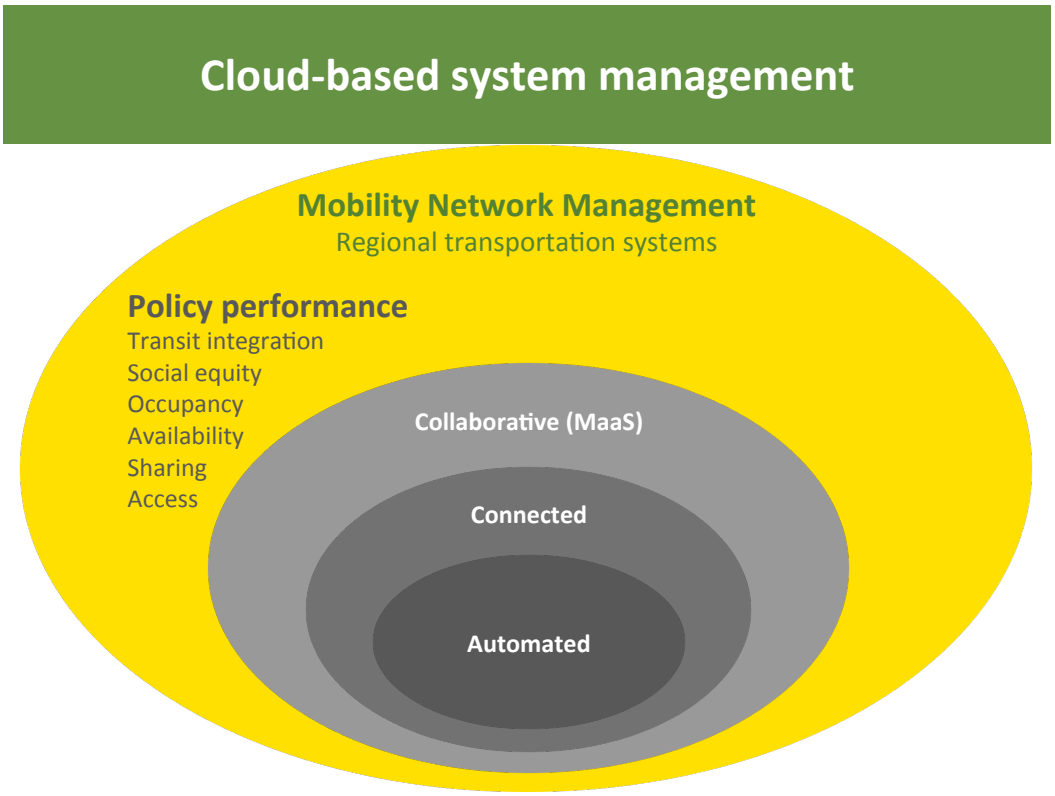
Robo-fleets and public policy goals
(Fleet Governance)

Privately owned cars	Fleets **competing** with public transit	Fleets **integrated** with public transit
Poor mobility	Better mobility	Best mobility
Unsustainable	Less efficiency	Sustainable
More car traffic	Increase in VMT	Better equity
	Drop in transit use	Increased efficiency
		More transit use
		Lowest cost

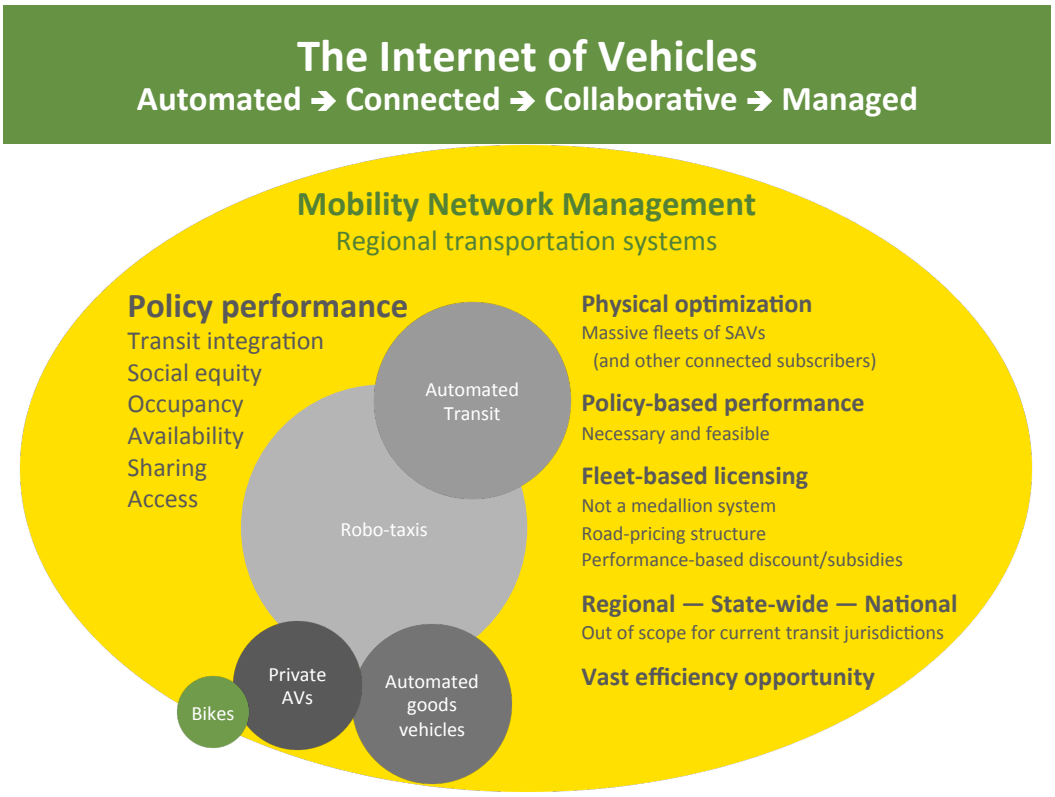
UITP: Union Internationale des Transports Publics; International Association of Public Transport



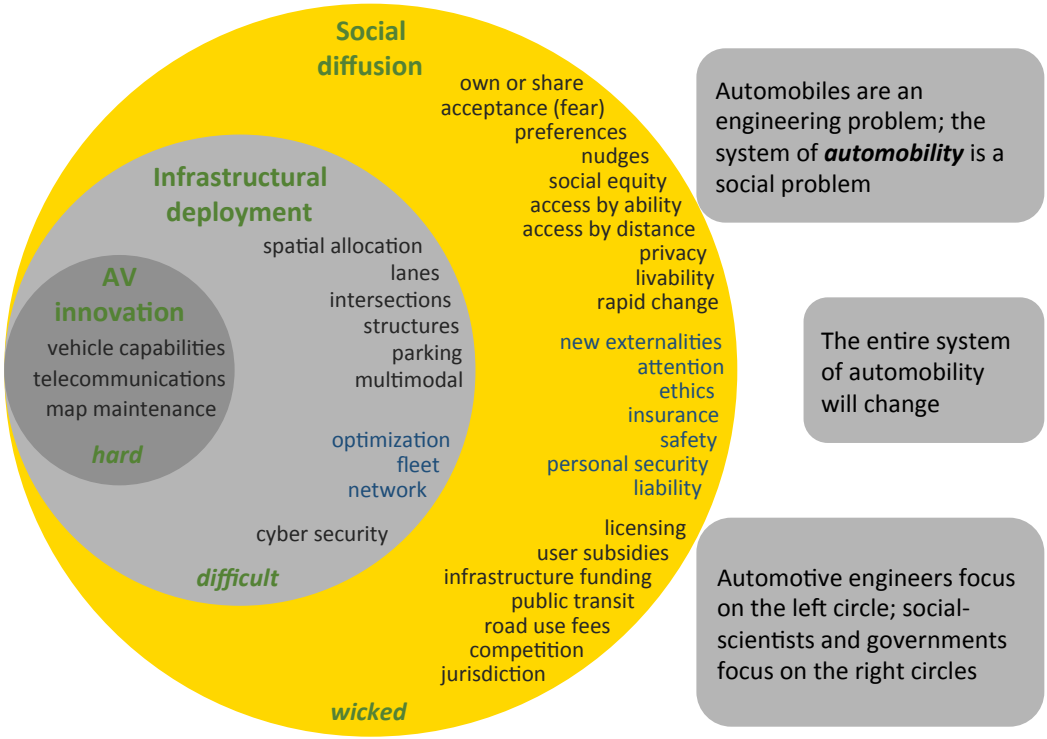
The International Association of Public Transport (UITP) has delineated three potential futures for the coming robo-fleets: [1] mostly private, [2] lots of commercial competition, and [3] coordinated fleets (commercial or public) that are integrated with transit — especially rail and bus rapid transit (BRT). Collaboration and management are more critical than automation and connectivity.



There are four technology layers that comprise the full system for automobility in the 21st century. These layers move through personal, local, trip and region. The personal layer is the automated vehicle — tangible, exciting and easily imagined. The local layer for connection is less well-understood but critical to deliver many related services and has considerable potential for both additional safety and concerns for latency and cyber security. Mobility as a Service, MaaS, is the nascent layer that manages whole trips or even monthly planning for mobility. It is this layer that enables the change from car-buying to ride-buying. The final layer Mobility Network Management is concerned with entire regional fleets — hundreds of thousands of vehicles. This final layer unlocks the social value that is the assumed potential of massive robo-fleets.



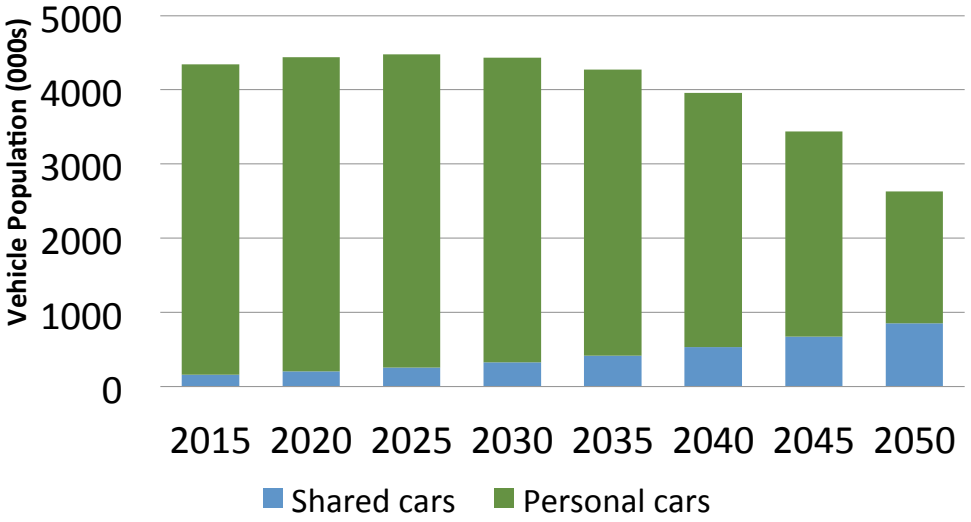
Mobility Network Management is a cloud-logistics system for hyper-governance and has both operational and social performance goals. Assumption 1: Subscribing fleets provide anonymized data that permit performance-based road pricing in place of a taxi medallion system. Subsidies are structured as a form of negative road pricing. This allows commercial fleet operators to profit from high-end services, then subsidize social equity and address other performance issues listed above. Government sets prices on roads. Fleet operators set prices on rides. Assumption 2: Ride providers will not be jurisdictionally constrained, because differences will be settled by the pricing scheme as a trip crosses boundaries. Assumption 3: All motorized, automated vehicles and fleets must subscribe. Bikes are not required to subscribe, but can do so to gain value from participating in the network.



Industry and media have focused on AV innovation — automation and connectivity — for over a decade. However, consideration of difficult infrastructure issues as well as attention to wicked social questions have been slower to materialize. If we are over-focused on technology solutions for our urban transportation problems, we will fail to address the underlying issues.

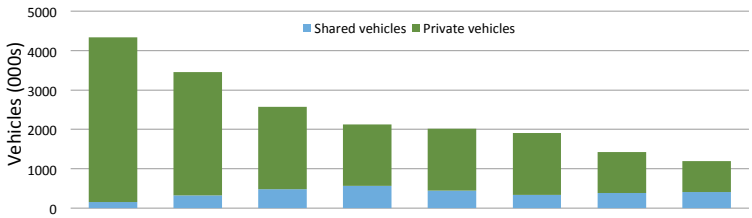
"Reframing social problems as a series of technological problems distracts policymakers from tackling problems that are non-technical in nature." Evgeny Morosov, The Net Delusion, p 305.

A future of smaller urban vehicle fleets



Simple performance variables, to be nudged by the Mobility Network Management system, are manipulated in a simulation of a fleet sized for a population of 6.5M growing to 10.5M (Toronto). Per capita PKT was held constant, vehicle occupancy was nudged from 1.6 to 1.9, and the proportion of PKT in shared vehicles was nudged from 20% to 80%.

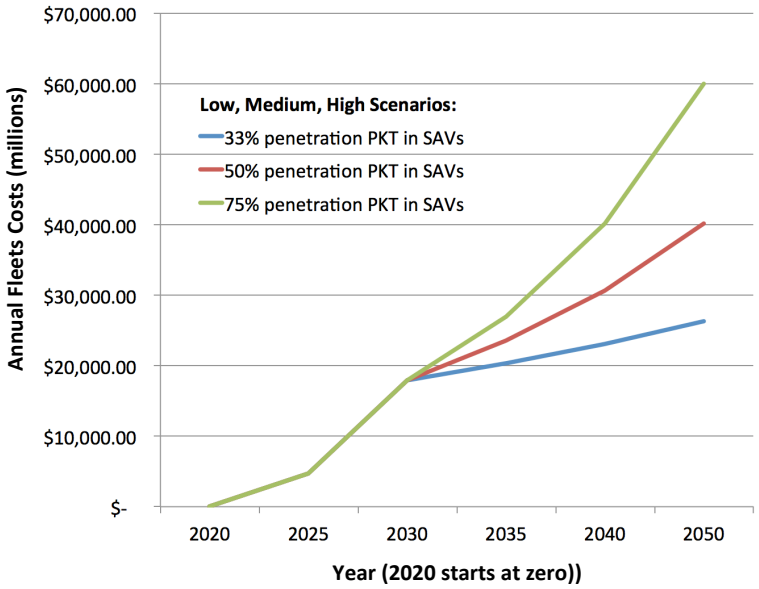
Sensitivity modeling



Case	1	2	3	4	5	6	7	8
PKT in shared vehicles	20%	40%	60%	70%	70%	70%	80%	85%
Occupancy rate in shared vehicles	1.6	1.6	1.6	1.6	2.0	2.0	2.0	2.0
Daily Km per shared vehicle	300	300	300	300	300	400	400	400
Daily PKT/vehicle overall	89	111	150	181	191	202	269	323

Simple performance variables were manipulated to simulate the policy performance of a managed network for a city of 6.5 million people. Over the eight cases shown, a fleet of 4.25 million registered vehicles were reduced by more than three million vehicles. Note that the shared vehicle fleet will turn over much more frequently than the private fleet, meaning that vehicle manufacture count does not necessarily drop. However, some vehicle manufacturers have stated intentions to build and operate such fleets, so they could be expected to design and build vehicles for this new purpose. Employment would change, but as these companies take over the driving labor of the general public, new service levels will increase employment.

Fleet costs | Trip costs

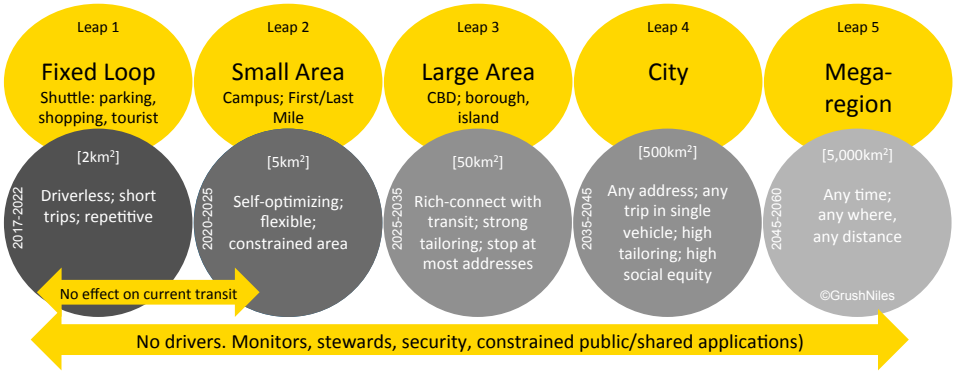


Costs per PKT depend on commuter dispersion: 26 to 84 cents

Based on simple assumptions such as a 16-hour duty cycle, 24-kph average, two- to 12-seat vehicles, 50 percent occupancy, and annual vehicle costs ranging around $100,000, we calculated fleet costs for several ranges of ride-buying market penetration after the initial easy-to-achieve penetration of 20 percent. This first stage is easy as it is disrupting transit and multiple household vehicles. Costs per PKT depend on peak demand because fleet size must be scaled accordingly. Performance incentives from the Mobility Network Management system can be designed to push demand away from peak times which will tend to decrease fleet size and increase profits.

Recommendation #1: Transit 2017-2022
Grow ride-buying

Skip Level 3 AVs
Start Level 4 AVs in modest doses



Even while preparing for hyper-governance, there is an immediate starting place for transit agencies. While addressing first/last mile and small-area starter systems with Level 4 vehicles, municipalities will gain experience for later governance while citizens gain experience in the systems that they will be asked one day to consider in place of vehicle ownership. Even these Transit Leap stages are candidates for P3 involvement and baby-steps in hyper-governance. They can be started now.

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Pathways to *Transportation as a Service*

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