Public fleets of automated vehicles and how to manage them

Bern Grush and **John Niles** outline a scenario in the not-too-distant future when our roads are populated with fleets of shared driverless cars, buses and trucks.

In the 2020s, regional governments will be faced with governing growing numbers of automated and semi-automated vehicles. These vehicles might be privately owned by households, owned by new mobility firms such as Uber and Google which would operate them as taxis, shuttles and jitneys, or government operated and sometimes owned by infrastructure investors under public-private partnership (P3) contracts. It is likely that by the mid 2030s such automation will be significant, perhaps pervasive, bringing with it the end of urban bus transit, the potential for service gaps, unexpected congestion due to service redundancies and risks of poor coordination with existing rail transit

There are two common scenarios for the future of automobility as vehicles become increasingly automated. The first is that most North American households will retain at least one personal automated vehicle (PAV), as now. The alternative view is that almost no-one will bother to own a personal vehicle because it will be so cheap, easy and convenient to obtain a ride in a shared autonomous vehicle (SAV) such as a publicly accessible, robo-taxi or robo-shuttle.

While the latter scenario occurs to many urban-transportation thought-leaders as the more desirable of the two, this is neither guaranteed to occur, nor has it been determined how such an outcome might be governed in order to achieve a high level of optimization with respect to time, energy and fleet size. In addition, given such fleets, how can we improve aspects of urban liv-

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ability related to congestion, walkability and sprawl? How can we ensure social equity with respect to mobility affordability, availability and accessibility for lower income or disabled travelers?

WHAT MIGHT BE ACHIEVED WITH AUTOMATED VEHICLE FLEETS?

In one of the most insightful discussion papers of 2016, Tom Cohen and Clémence Cavoli of UCL Centre for Transport Studies (London) outlined several governance choices and the associated difficulties and risks of preparing for automated vehicles in a paper called: "Automation of the driving task".

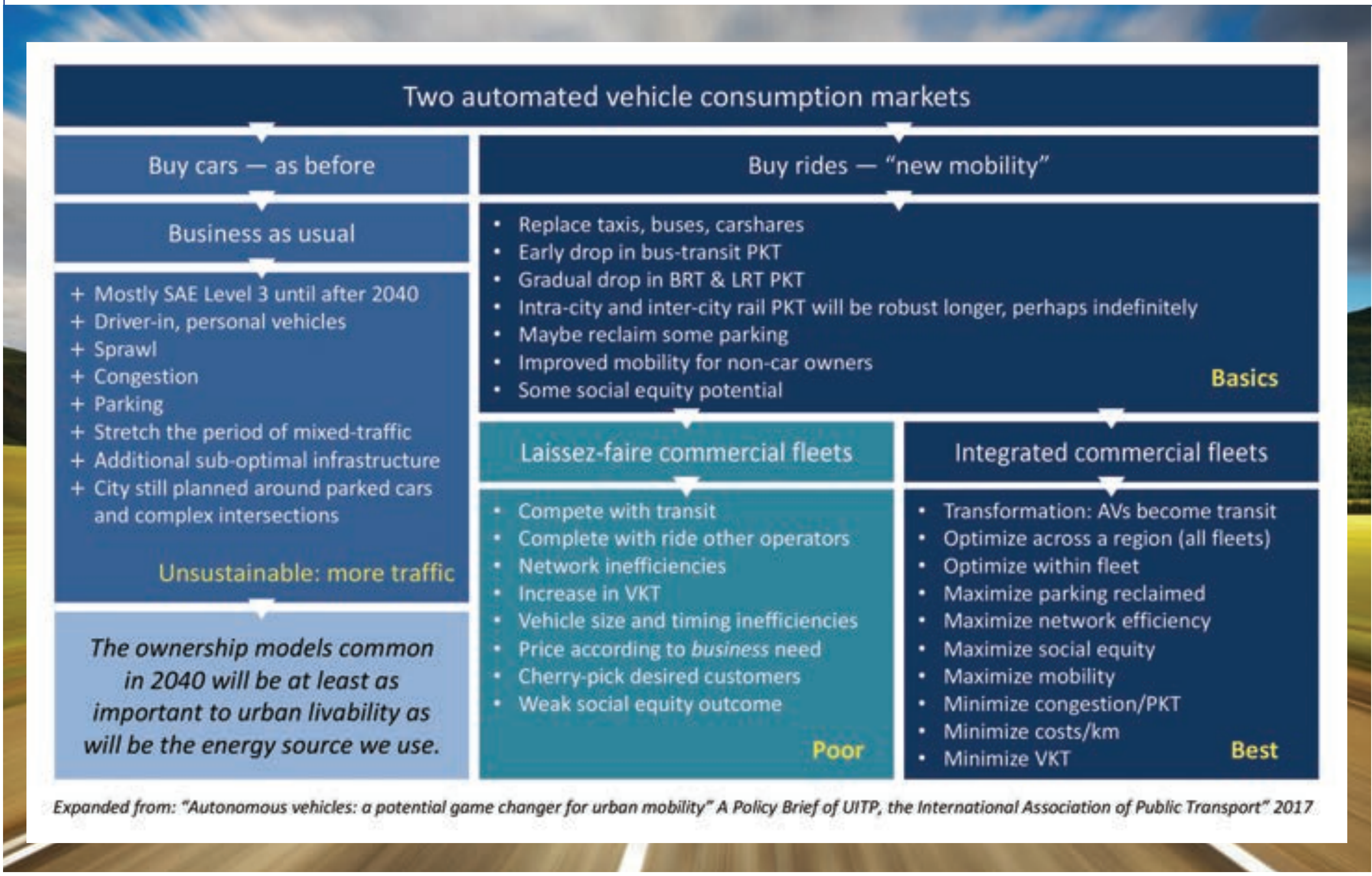
They contrasted three approaches to fleet ownership: [1] private-ownership, i.e., business-as-usual, except with automated vehicles; [2] shared automated-taxi fleets, an essentially laissez faire continuation and growth of today's taxi and fledging transportation network company (TNC) approaches; and [3] strong integration of AVs with public transit systems, a more definitively interventionist approach for improved social and network outcomes. Their paper discusses the governance issues and potential pitfalls for each.

In 2017, a parallel discussion appeared in the UITP report, "Autonomous vehicles: a potential game changer for urban mobility" outlining the pros and cons of each of the three approaches to the coming regional fleets of automated people-moving vehicles. The panel on the next page shows the two major markets: buying cars (PAVs) and buying rides (SAVs) and further splits SAVs into either laissez-faire commercial fleets (similar to current taxis or TNCs) or integrated commercial fleets. Each of these have very different social and urban outcomes due to the operating differences in collaboration and coordination, which, in turn, would be due to the degree of private versus public management of the fleets.

To frame the governance problem: how can we most effectively unleash the promised benefits of automation, maximize personal freedom, preserve or increase social equity and reduce or at least not increase congestion and environmental harms — all while rewarding for-profit operators who finance and operate massive fleets? In comparing a laissez-faire approach with more interventionist styles of governance, Cohen and Cavoli concluded that while a laissez-faire approach would carry the greatest risk, intervening to integrate multiple private fleets with transit may not be comfortable for many governments to engage. In any case, it would be risky.

There are a number of governance difficulties with shared fleets highlighting the complex road ahead. One critical factor is that laissez-faire commercial fleets will by default act as entities to maximize their operators' profit, while the nature of a more interventionist governance to engender transit integration would more likely maximize social equity. The former might ignore optimization of coverage (access) with ridership volumes, while the latter would tend to balance those but constrain profit opportunities.

Key is that "a large set of individuals making decisions that are individually optimal will generally produce an



▲ If we want to encourage buying rides instead of buying cars, we need to understand the governance of massive shared fleets

aggregate situation that is suboptimal" [Cohen,p.19]. This would certainly occur with the laissez-faire fleets, but could be mediated with appropriate governance structures tending to promote coordinated integration.

Further, Cohen and Cavoli's comment: "…a laissez-faire approach to the arrival of AVs is likely to consolidate any existing inequality" [p.22] would apply at least as much to a predominance of personally owned vehicles as it would to laissez-faire commercial fleet management.

WHAT ELEMENTS SHOULD BE CONSIDERED FOR GOVERNANCE OF AUTOMATED FLEETS?

This implies that a carefully considered governance-planning model for massive SAV fleets is important. Some of the critical assumptions for such a governance model would be:

1. The three ownership models outlined in the panel above will each continue to have strong proponents; hence financial, spatial and social competition will be unavoidable and ongoing. We are accustomed to this in the long-standing competition among private cars, taxis and transit, as well as in goods movement and with active transportation modes. We should plan accordingly.

2. Most governments — especially in North America — would be slow to ban or significantly limit personal vehicle ownership, notwithstanding that a few prohibit vehicles in central city zones while others employ nudges or high taxes to reduce driving or ownership.

3. The history and reasons for commercial operators to own and manage transportation service fleets are significant.

4. Most local governments would be ill-disposed to acquire and operate the massive fleets needed to provide a majority of regional trips in SAVs.

5. Most governments would be severely limited by both budget and mandate to offer the multiple levels of service needed to persuade middle-to-higher-income travelers to abandon personal vehicle ownership, while still addressing social equity.

6. No specific instance of governance can work in all locations or for unlimited time spans, hence any sustainable model will need to have numerous levers to make working adjustments — critically, it must be able to dial up or down the degree of intervention for reasons of both acceptability and effectiveness.

7. Any workable model must be widely understandable and produce results easy to measure.

Because we assume that many, often massive, SAV fleets will be owned and operated by private operators, the logistical methods to optimize for fleet, energy and network will be guided by cost and profit considerations on the part of the operator. We propose that government jurisdictions distribute regional, performance-based operating licenses to a regulated number of participants by auction. The goal of a governance model, then, should be to ensure attention to the elements that a profit regime might ignore. Below, we will propose four parameters that

"The maximization of social equity is more difficult because it is enveloped in numerous social and political layers. Regardless, metrics and methods of oversight can and must be designed"

put social and environmental concerns on the operator's ledger.

Governance should assume that SAV fleets will be accessed via Mobility as a Service (MaaS) applications so that the differences between laissez-faire and integrated fleet approaches will be visible mostly in the aggregate and essentially only to transportation managers.

Users will be focused primarily on getting to their intended location quickly, comfortably and cheaply. "Comfortable" would convey many individualized meanings. We assert that users will make choices based on personal preferences and budgets – as most do now – and seldom for urban livability or broader equity and environmental reasons.

Governance should incorporate four performance components — three of which are new —that if optimized would cause many livability and environmental externalizations such as congestion, route efficiency, safety, customer satisfaction, ridership, parking reduction and regional connectivity to become issues that would be more effectively addressed by fleet operators seeking to maximize profit. These four performance-based elements, more fully described below, are:

- **Higher vehicle occupancy:** Maximize the PKT:VKT (Passenger Kilometres Travelled:Vehicle Kilometres Travelled) ratio.
- **Fewer private vehicles:** Maximize the shared:private PKT ratio.
- **Safeguard social equity:** Maximize access, affordability and reach for all users.
- **Leverage existing transit:** Maximize connectivity to transit trunk lines.

There are, of course, many other governance issues such as privacy, security, safety, parking and road pricing. Such issues would apply to all forms of automated vehicle ownership. The four performance metrics proposed in this discussion comprise a fleet management architecture to replace the management formula now provided by taxi medallion systems to ensure a constrained fleet size and public access assurance. An additional metric is proposed to preserve connectivity to existing rail, as suggested by the UITP report mentioned above. Details follow:

HIGHER VEHICLE OCCUPANCY: MAXIMIZE THE RATIO OF PKT TO VKT (PKT:VKT)

Designing services that increase occupancy and minimize deadheading can optimize PKT:VKT. This can be addressed by participating operators who determine optimal vehicle sizing (fleet tailoring) and routing as well as improvements in and promotion of ridesharing. The numerous ways this can be done are matters of creativity, innovation and marketing — all of which can be guided by the same sorts of behavioral economic and social approaches that automotive marketers use today.

This is not to say that selling cars is identical to selling rides. We merely assert that given the scale of disruption in this multi-trillion dollar market, motivated companies can find ways to maximize PKT:VKT. In 2016, both Uber and Lyft have experimented with heavily discounted bulk purchases of ride-share trips that amounted to app-and-reputation mediated jitney services. Offers changed rapidly and it is clear that experimentation continues. While promotions for these offers imply competition between these two players, the overall impact of success will affect taxi and bus ridership. With sufficiently large robo-vehicle fleets traversing significant areal extents, service innovations could be designed to increase average occupancy and eventually encroach on personal ownership.

Given a sufficiently flexible governance model to be used across regions with billions of customers, creative solutions will arise, especially in the potential for within-operator cross-subsidies between profitable high-end SOV services and coach-class small group ride-share services.

FEWER PRIVATE VEHICLES: MAXIMIZE THE SHARED:PRIVATE PKT RATIO

The overarching goal here is to move more people in SAVs and fewer in PAVs — all while the demand for PKT continues its year-over-year global average three per cent increase driven by the growth in human population wealth. There is a non-coercive way to reach this goal: make individual SAV experiences significantly better than individual PAV experiences for a significant number of travelers so that many car owners would consider switching to ride-buying.

Behavioural economics shows us that there are many reasons people resist change and many reasons they make economically non-rational choices. Today most people who own cars, while often complaining about driving and parking them, do not seriously consider forgoing them for the current spectrum of alternative modes of transportation. Conversely, a person without a car, who currently uses those other forms of transportation, is more often likely to want to own a car.

The reasons most people own cars are understandable. A significant number of those reasons must be satisfied through shared vehicles services in order for large numbers of car owners to convert to becoming everyday ride-buyers. If instantly available, safe, clean and comfortable rides can be offered reliably to all destinations that an individual car owner reasonably desires to visit, then a significant number of such car owners may decide to buy rides exclusively. But we are a long way from being able to fill such a promise — and today's fledgling automated vehicle technology is only an enabler. We need focused and intentional programs to design and sustain SAV services that upend the current ownership paradigm.

Initial robo vehicle services operating in defined areas would tend to replace current shared manual services: transit and taxis. They might diminish PAV ridership somewhat, but will not replace car ownership in any wholesale manner. Massive, robo-fleets with operators motivated to provide reliable, continuous, convenient, 24/7 coverage and access throughout broad regions for every traveler purpose are the only way to reduce car ownership significantly. This will require coordination beyond the bounds of each town or city transit or taxi service. It will require regional fleets more massive than any single municipal operator can fund or manage and will be fundamentally different from the way public-service fleets are managed and governed today.

Behavioural economics: today's car owners and aspiring owners are unlikely to flee from the option of owning their own vehicle

SAFEGUARD SOCIAL EQUITY: MAXIMIZE ACCESS, AFFORDABILITY AND REACH FOR ALL USERS

While many public transit systems are managed to assure a measure of coverage for lower income families, provide access to mobility for people unable to use normal transit or unable to drive and grant subsidies for its users, such purposes and any related largesse may not readily translate to commercial SAV fleets. Cities currently struggle with this independently and piecemeal as TNC operators like Uber and Lyft cherry-pick the traditional customers of taxi operators and more recently, commuter bus routes.

Even for fleets that would provision SAV rides relatively uniformly across a connected region of cities and towns (coverage), the issue of ride provision for all incomes and abilities (access) would be a significant extra step in terms of fare affordability and customer assistance. Governance that ensures a satisfactory level of equity in all of these aspects needs more than marketing creativity or massive systems capability. The level of equity many regions might demand would require oversight and subsidies. Both of these need metrics that are easily understood so that users understand their rights and that both operator and overseer can easily agree on performance.

The maximization of social equity is more difficult because it is enveloped in numerous social and political layers. Regardless, metrics and methods of oversight can and must be designed. The struggle will be to agree on the facets of equity to be supported and measured, which would be tailored necessarily region-by-region. Still a guideline across regions and across a country would be desirable.

LEVERAGE EXISTING TRANSIT: MAXIMIZE CONNECTIVITY TO TRANSIT TRUNK LINES

There are many reasons to believe that transit is threatened by SAVs and even PAVs that attract riders. The main reason is the economic limits on public transit providing on-demand, 24/7 available, door-to-door trips with a variety of comfort levels depending on the economic resources of the traveler. We've heard the argument that a three-to-one or four-to-one replacement of city buses with 10- and 12-passenger autonomous shuttles on more flexible routes and schedules could mark an improvement over transit services without generating additional congestion at peak. However, the same is harder to argue for the replacement of those buses with 20 to 40 two- and four-passenger vehicles, although this is a potential outcome. Harder still would it be to argue for the replacement of existing rail carriage with such vehicles. It would almost certainly be more advantageous to incentivize the use of smaller-scaled automated vehicles as feeder vehicles into existing trunk lines: rail and bus rapid transit (BRT).

The desired level of such integration would depend on a number of local variables. A governance model which rewarded connectivity to existing transit trunk lines would be able to leverage massive existing investments and to constrain the volume of independent vehicles moving in and out of the urban core at peak times. This could be done with pricing, or managed lanes, or outright area-based restrictions.

One of the unknowns facing regions as they consider integration of automated small vehicle systems with existing fixed trunk lines is the degree to which passengers are willing to switch conveyances at least once for each such journey. One of the fears is that for shorter trunk-line distances, passengers might find continuing on in a vehicle that collects them at their doorstep to be more convenient than transferring to transit. This might be an area of optimization conflict for any operator that can gather multiple people into small vehicles, take those passengers to their destinations without connection to trunk lines then to collect other passengers without dead-heading so as to maximize PKT:VKT. Modeling needs to begin now.

SHARING: NEITHER THE DEFAULT START-STATE NOR THE SOLE END-STATE

For this discussion, we simplify ownership models into two critical categories: private and shared. Combining the two non-owned scenarios described in the UCL and UITP reports (laissez-faire and integrated), SAVs may be operated in an on-demand fashion such as one imagines for robo-taxis or in a transit-like fashion such as regularly scheduled buses and shuttles of various sizes on fixed routes or in jitney-like fashion within delineated neighborhoods, or as first/last mile systems connecting to trunk lines.

We make this simplification because we believe that with the right incentive structure each of these styles of operation would find their own appropriate deployments in neighborhoods, between residential and working zones and among centers of commerce in a self-leveling regional balance. This can evolve from incentive-based governance rather than with rigid and scheduled planning using constrained service classifications or per-vehicle medallion approaches.

We assume that all publicly available SAVs will be regulated in some way and that it is desirable to optimize a regional shared fleet in order to maximize the four desired impacts, described above, while readily providing all the PKT demanded in that region.

We assert that travelers will always seek ways to satisfy their trip desires and will prefer not to make compromises within their personal tolerances for time, cost and comfort. When these are not satisfied by SAV services, all travelers that can afford to do so would elect to own a PAV — i.e., basic personal travel expectations habituated over a century of expanding vehicle ownership will continue to be satisfied in whatever way each individual finds preferable and possible.

"One of the unknowns facing regions as they consider integration of automated small vehicle systems with existing fixed trunk lines is the degree to which passengers are willing to switch conveyances at least once for each such journey"

It is not reasonable to project the mix of vehicles or vehicle ownership for 2050 or 2070. However, we assume that there will always be some portion of vehicles that are privately owned, some will be government operated such as rail or heavy trunk lines and many will be operated within commercially managed robofleets. The desired goal is a governance system that is flexible enough to permit varying likelihoods of ownership even if/as we move toward more SAVs and fewer PAVs. We assume that there will never be a world of only SAVs and that the shared:private PKT ratio would not likely exceed three, i.e., 75 per cent shared. We claim this from considering the realistic requirements for carrying special personal appliances, work tools and loads, or demands for specific comfort or privacy.

ANTICIPATING 2030-2040

We begin by assuming cities in the very near future will be little changed in densities, distribution of residential and employment zones and commuting distances. There might be a reduction in street parking and an increase in sprawl, but cities – and people – change slower than does the pace of technological innovation.

We expect that SAV fleets would comprise vehicles of the sizes and speeds as we have now, suitable to existing roads and mixable with pedestrians and bicycles. There might be a reduction the average vehicle size; there would be new designs and most will be electric.

In spite of the beginning of a downturn in personal car ownership, trip-takers *in aggregate* will continue to use motorized conveyances at least as much as now and for much the same spectrum of purposes. Many urban populations will continue to grow. Travel per-capita might occur slightly more or less often and for somewhat shorter or greater distances, though always influenced by the reality that humans tend to consume more of whatever becomes more economically available. Entrepreneurs continue to create place-based experiences that masses of people want to see, hear and taste in person.

Commuter rail, subways and light rail transit would still be in critical use for high-popularity peak visitation seasons and daily commuting hours. There would not be significantly more or fewer of these high-capacity systems although they could be upgraded, automated, expanded and rescheduled. In other words, we anticipate a highly recognizable urban world with two particular changes: (a) many vehicles won't have drivers and (b) individuals and families own or lease fewer private, motorized vehicles for travel on public roads.

Of course there would be many other ancillary changes and it would likely take until after 2050 to get to an anticipated "mostly shared" state, but let's just jump ahead for now, since we are merely assuming in this discussion one of the most commonly described automated vehicle future scenarios.

SIZING A MASSIVE SAV FLEET

In 2016, the consultancy Roland Berger published: "A CEO agenda for the (r)evolution of the automotive ecosystem" projecting that 27 per cent of all PKT globally will be provided by robo-taxis by 2030.

It is unremarkable that an urban region might supply a quarter of all its surface, motorized person-travel by shared, automated vehicles soon after the robo-taxi becomes reliable. In cities in North America and Europe between 10 and 30 per cent of all PKT are already taken in vehicles that are not personally owned: bus, train, taxi, carshare, hailed ride, or airport limo. As we showed in our 2016 report "Ontario Must Prepare for Vehicle Automation" the early consumers for robo-taxis will already be users of shared vehicle modalities – disruption always hits the markets most poorly served first. This first 27 per cent is global, low-hanging fruit, since the shared modalities will be disrupted by the robo-taxi first.

Regardless of the time-accuracy of this prediction for any particular region, such a milestone will certainly come to pass. As a thought exercise, what might such a fleet look like, how big would it be, what might it cost?

Here are some assumptions for a simple calculation; the reader is invited to alter them:

1. Target a region with a population of five million – 27 per cent is 1.35 million users.
2. Each person in the population averages 15,000 PKT per annum, or 20.25 billion PKT.
3. Let fleet vehicles carry two, four, six and 12 passengers; have these comprise 50, 25, 20 and five per cent of the fleet, respectively.
4. Assume vehicles are 50 per cent occupied on average, including deadheading. This provides a highly achievable 1.9 weighted-average fleet occupancy rate.
5. Assume vehicles have an average daily duty cycle of 16 hours runtime (excludes charging, parking when not in use, but includes deadheading and waiting for riders).
6. Assume vehicles average 24kph (top vehicle speed is the posted speed, but most actual travel is in-city, stops, pickups, waiting, heavy traffic, lights, etc); this means daily distance (if trip assignment is optimized) is 16 x 24 = 384km/day (140,000km annually; NYC taxi averages 112,000km). This implies we need 144,500 vehicles.
7. Assume we require a 20 per cent buffer due to imperfect ride matching and machine downtime. This increases the vehicle requirement to 173,400.
8. In the event 20 per cent (of the 27 per cent) of the population is on the road at peak hour (non-uniform demand), the fleet would need to serve 5.4 per cent of the population concurrently. This requires 142,000 vehicles, hence 173,400 is sufficient.
9. Assume fleet operations (management, payment systems, security, police and emergency, maintenance (repairs and cleaning), oversight, stewards on the minibuses, map maintenance, roadway watchdogs) requires 1 FTE per 5 vehicles.
10. Average staff salary and overhead per FTE is US$80,000 per annum, or US$16,000 staff expense per vehicle (34,700 jobs).
11. Assume Capex and Opex (exclusive of staff costs) for a vehicle is US$100,000 per annum. That means total cost per vehicle is US$116,000 per annum or a total annual fleet cost of US$16.5 billion or US$0.81 per service km.

81 cents per km is high relative to personal ownership, but lower than current costs for taxi, carshare or unsubsidized costs for transit bus. This figure would be raised by insurance costs, road-use fees, parking costs and unexpected security expense. And it might be lowered as technology improves and staff/vehicle rates drops. It is also expected that other forms of revenue (data, advertising, commercial services) could lower effective average usage charges.

What would happen if we could nudge occupancy by 1/10th of a passenger from

▼ **Resisting change: applying psychological insights into human behaviour to explain economic decision-making, or "behavioural economics", is key to future progress**

1.9 to 2.0? In this calculation, it shaves one billion from annual costs and four cents from each km.

A variety of network optimizations could be made for route, schedule and load distribution across all vehicles (subject to user demand and including the distorting effects of personal preferences). Add creative service packages and behavioural nudges to increase and distribute demand and costs can be decreased to lower the effective per km cost far below 81 cents.

Total employment for these first 20 billion kilometres in this 2030 scenario would not drop even though these early-adopter trips are largely replacing labour-intensive taxi and bus kilometers, becasue the ratio of human-support to robo-vehicle will be high in the beginning. For the second 20 billion kilometres employment per PKT might decrease, but absolute employment would increase, since by then the declining effort of the household owner/driver is increasingly replaced by service-staff effort from the fleet operator. No matter how advanced the technology, these fleets will require human staff far into the future. Certainly, by the time 75 per cent robo-vehicle penetration would be achieved in public service vehicles, aggregate job rates for public transportation (including taxi) will be equal to or higher than current average employment rates even as the staff-to-vehicle ratio declines.

THE PERFORMANCE OPPORTUNITY OF MASSIVE FLEETS

Rather than create a new form of medallion system for the coming SAV fleets, local and regional governments have a remarkable opportunity to innovate a replacement for this system: performance-based fleet licenses auctioned to bidders who bid for kilometers of road access paralleling the way in which governments auction radio spectrum.

Operators of automated fleets would bid a per-kilometer fee (essentially a road-use fee) for access to existing roads in tranches of 100 million kilometers. Associated with the fee set by the winning bidders would be a number of rules:

Competition. No single bidder can bid for more than 20 per cent of the available kilometers on auction. This preserves competition.

Complexity. No bidder can bid for less that 10 per cent of the available kilometers. This limits user confusion, unreliable bidders and undue integration complexity.

High occupancy. Winning bidders pre-agree to an average occupancy ratio (set by the government). This promotes innovation for ridesharing and rewards the bidder with lower vehicle counts.

Social equity. Winners would pre-agree to a social-equity formula. This would be an agreement to service a given fraction of low-fare customers (this might be subsidized) and a given fraction of less-desirable service areas. Since winners would likely be for-profit operators, they will be incented to offer higher-end services to offset their social equity commitment. They will optimize fleet turnover so as to cascade older, lower-status vehicles into lower-fare service potentially to realize targeted subsidies.

Connect with transit. Winners would pre-agree to a given fraction of connections with existing transit stations or hubs.

Rewards. Winners who exceed occupancy, social equity or connection targets are rewarded on ensuing bid competitions. Those failing to do so are penalized on following bids.

Attract car owners. In order to compete, winners would be inclined to expand their user-base beyond existing users of taxi, transit and carsharing. They would seek to offer services that would attract car users to consider owning fewer personal vehicles. (This is a measureable effect, not a performance rule.)

WITHOUT REGION-WIDE FLEET GOVERNANCE

Fleet optimization on the scale of billions of kilometers is unavailable when city fleets comprise a few thousand buses, taxis and carshare vehicles — all competing. But such optimizations are second nature to the thinking of private companies that understand logistics and artificial intelligence, exploit big data and telecommunications, have marketing expertise and enjoy skilled access to social platforms.

There is nothing surprising in this to people such as Uber's Travis Kalanick, Ford's Bill Ford, or Morgan Stanley's Adam Jonas. In fact, they are counting on this. Digitization and automation always advantages its exploiters. Transportation is no different. What has been happening to newspapers, music, retail and taxis will now happen to our municipal and personal transportation systems, threatening both Big Auto and public transit.

Left to compete in the 20th century world of proprietary information stovepipes, companies and cities would continue to operate an uncoordinated world of multiple taxi, bus and carshare fleets targeted at different demographics or regions. When you called for a taxi in the pre-Uber world there was almost always a competitor's taxi closer to you, but there was no way for you to know that. Uber bridged that information barrier to a limited degree. MaaS is poised to finish the job by choosing the best option from all user-acceptable suppliers at the time of demand.

The current world of every driver for himself — the core of today's surface transportation reality — implies urban transportation systems of incomprehensible non-optimality mixed with struggling transit systems. This is the world's largest market mostly wasted in execution. According to Jonas, "… a century-old ecosystem being ogled by outside players hungry for a slice of a US$10-trillion mobility market. Many want in. It's just beginning. And it won't stop."

For these reasons a new governance system for public conveyances is needed as this privatized and optimized technology pushes our existing mobility systems aside.

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