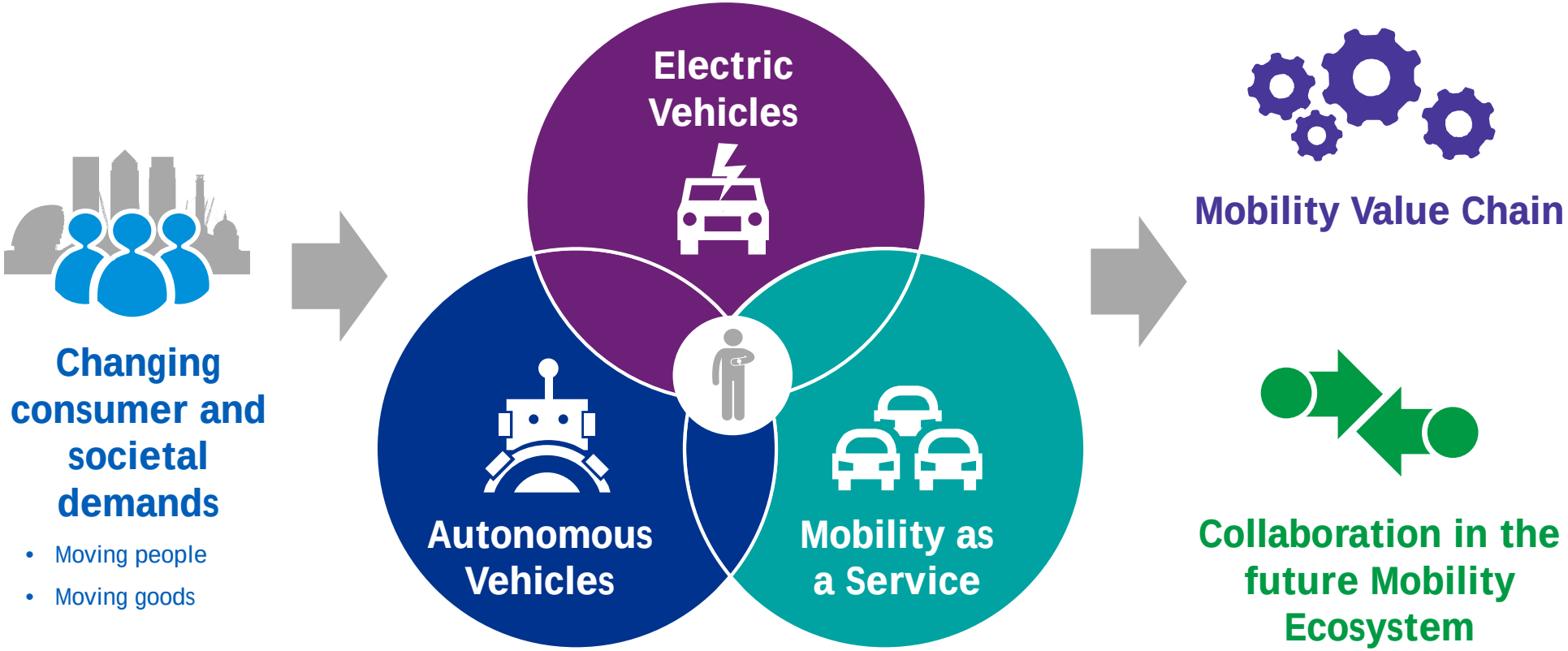
Connected and Automated Vehicles – The Market View

ARPA-E NEXTCAR Program Kickoff

April 2017

Three main disruptive forces will fundamentally transform how people and things move in the future



This is one of the most pervasive global mega-trends and will have far reaching implications

Industry execs believe that....

Up to 50%

...of consumers will not want to own a car, as new mobility services begin to meet consumer needs

Passenger miles travelled will increase....

Up to 10%

...following the growth of the mega-city and their suburbs

Cost per mile could go down...

Up to 40%

...due to removing the driver cost, longer vehicle lives, new energy sources, technologies and mobility scaling

5x

Miles per vehicle could increase....

...as fleet services use vehicles more efficiently

The number of major ecosystem players will decline...

?

...as sector convergence leads to consolidation

Sources: Department for Transport, KPMG Global Auto Executive Survey 2017,KPMG UK Mobility 2030 analysis

Autonomous drive is coming faster than many realize

2016

Autonomous features are already commercially available and impacting accident rates:

- Collision warning & brake support have been shown to reduce incidents of rear-end crashes with frontal impacts by 45%[1]
- Tesla's autopilot autonomy feature demonstrated a 50% reduction in the number of accidents[2]

2020

The number of car accidents falls by ***15%***[8]

Fully Autonomous vehicles become commercially available in the U.S.,

Toyota, Nissan, and Volvo offer models, Tesla to follow soon after[3, 4, 6]

9% of vehicles on the road will

2025

Ford to sell line of fully autonomous vehicles[13]

2026

100% of cars sold will have some level of autonomy[7]

2030

Fully autonomous cars without manual control options become available[9]

Full and partially autonomous cars will be an $87 billion industry[10]

The number of car accidents falls by ***50%***[8]

2035

75% of all the passenger vehicles bought will be fully autonomous[11]

2040

75% of the traffic will be full or partially autonomous vehicles[12]

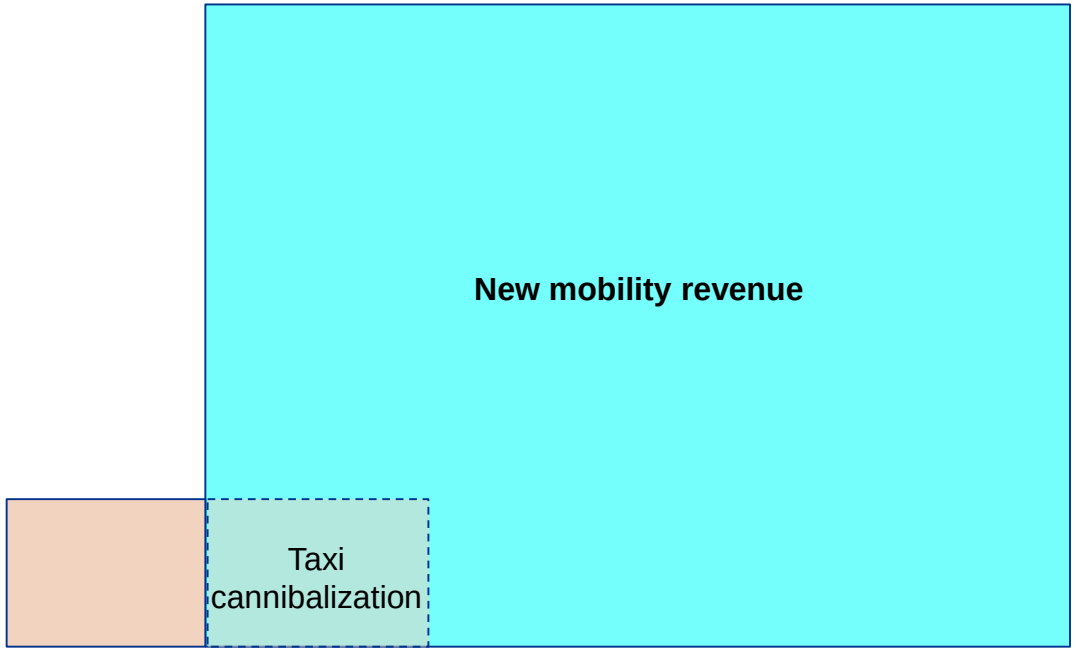
The number of car accidents falls by ***70%***[8]

Source: 1) Evaluation of Rear-End Collision Avoidance Technologies, Volvo Car Corporation; 2) Eletrek; 3) Wired; 4) Nissan Motors; 5) Strategy Analytics; 6) CNN, Volvo; 7) Adam Jones, Morgan Stanley; 8) KPMG analysis; 9) HIS; 10) LUX Research; 11) Navigant Research; 12) Institute of Electrical and Electronics Engineers; 13) Raj Nair, Ford Group Vice President

Uber demonstrated that Mobility as a Service (MaaS) can very quickly and materially unlock value (even with “driver required”)

Uber captured $1B from a $200M local taxi market – how did they do that?

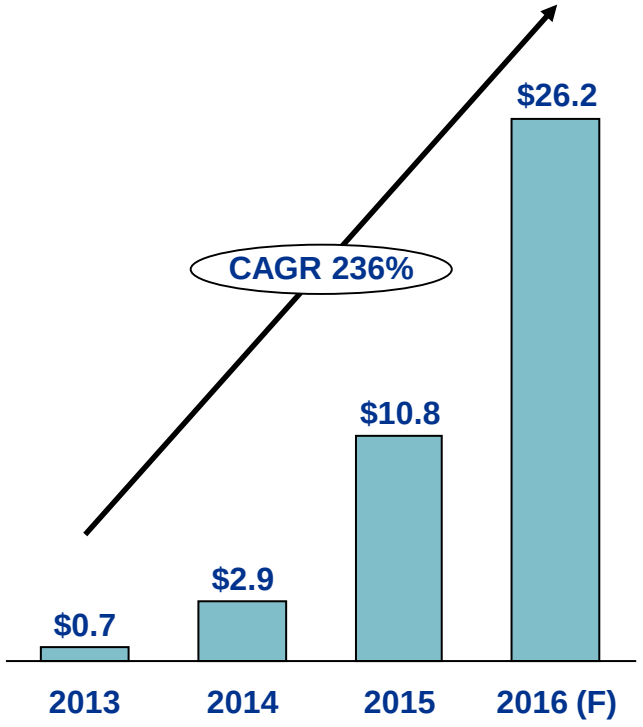
$1B in Bay Area Uber revenue (2015)



$200M Bay Area taxi market

Disruption occurred in roughly five years after 2010 launch so this can happen very fast

Uber Global Bookings Revenue ($B)



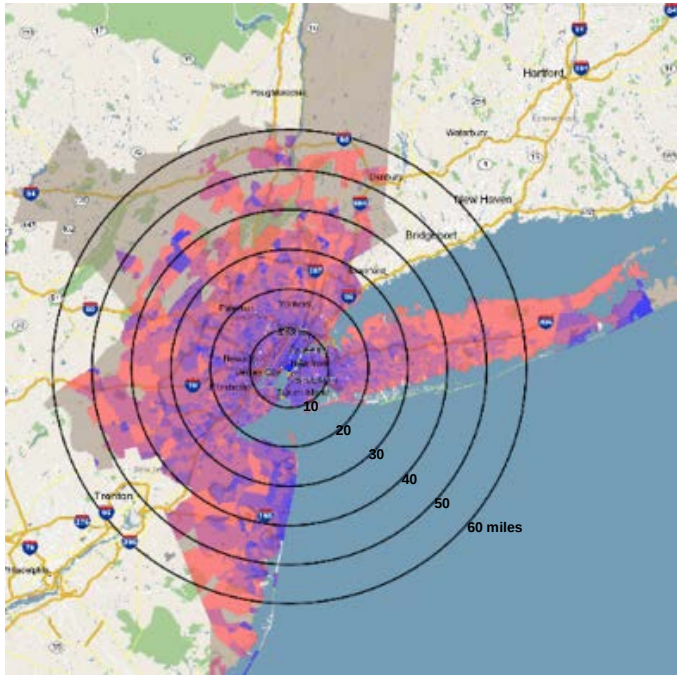
In fact, Uber is expanding very rapidly

Note: Uber revenues are gross paid by passengers
Sources: Business Insider; LA Times

Uber networks already provide access to 69% of US population in and around most cities

New York City MSA

Type A: Dense urban center, large suburban metro area, high public transit usage

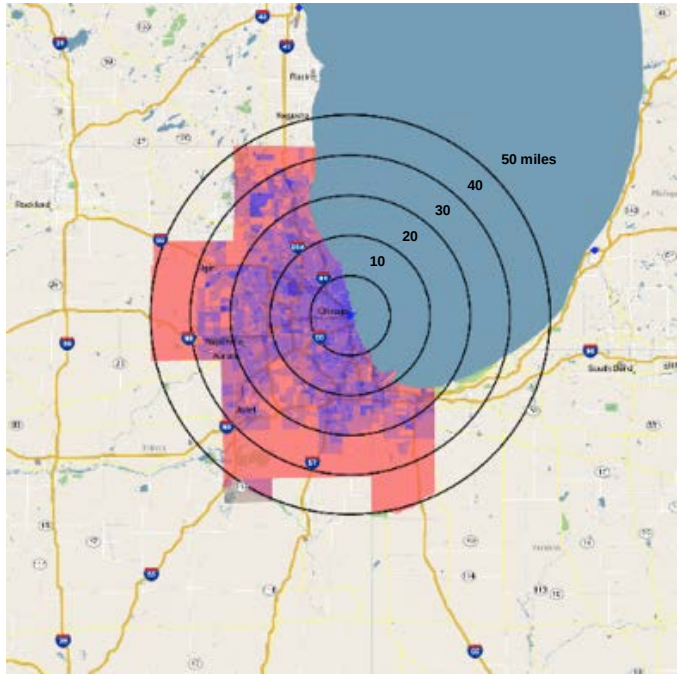


Average Wait for Closest Uber: 6:09

n = 27,908

Chicago MSA

Type B: Significant urban center, sprawling suburban metro area, medium public transit usage

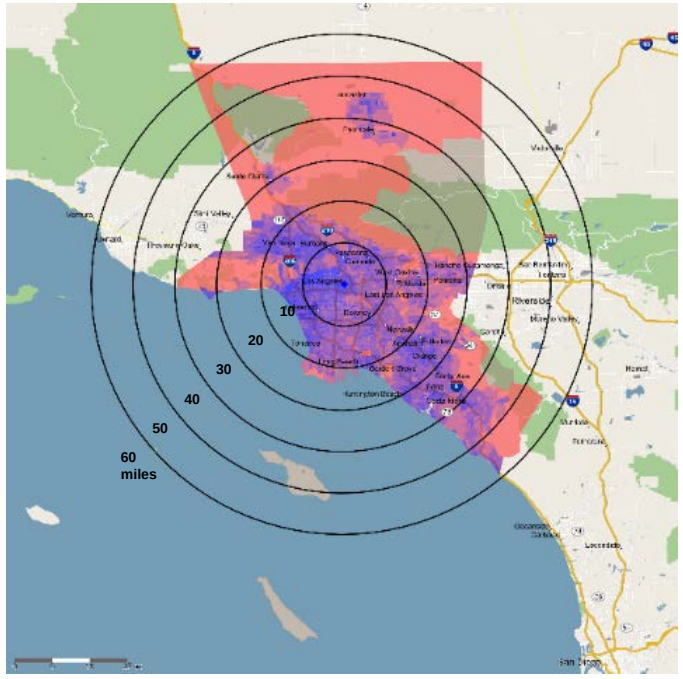


Average Wait for Closest Uber: 6:43

n = 12,928

Los Angeles MSA

Type C: Unclear urban center, vast suburban metro area, low public transit usage



Average Wait for Closest Uber: 5:24

n = 18,107

Minutes Wait:	Less than 3:00	3:00 – 5:00	5:00 – 7:00	7:00 – 10:00	More than 10:00	Not Available

1) Census tracts were sampled a minimum of four times. Those that returned an available Uber at least once were defined as having regular Uber service
2) Average wait time calculation is population weighted and only includes areas where Uber is available

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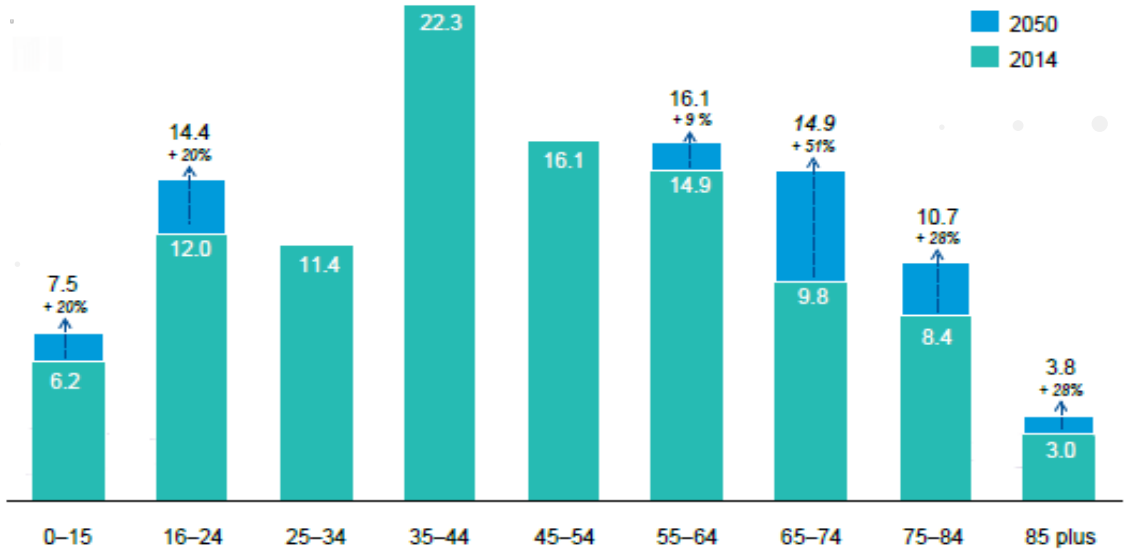
This combined with autonomy will drive over a trillion mile increase in Passenger Miles Traveled (PMT) for underserved populations

U.S. personal miles traveled (PMT) per capita 2014–2050 (Kmiles)

Parents can be everywhere at the same time

82 % of people asked in focus groups would want mobility options for kids



"I do not have to take keys away from dad"

79 % of people asked in focus groups would want mobility options for seniors

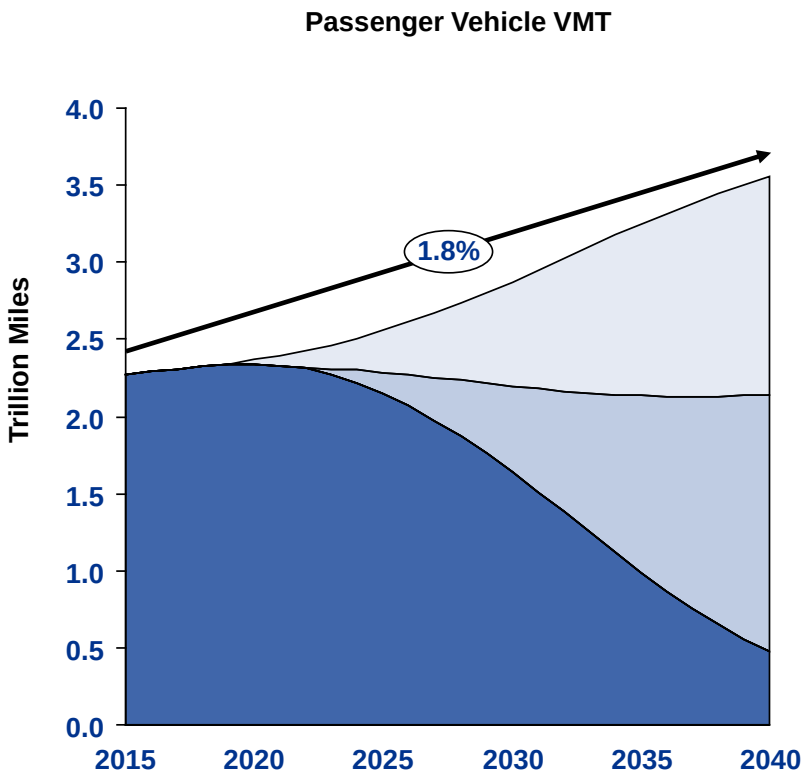
Safe independence for the kids

Convenience of "my time"

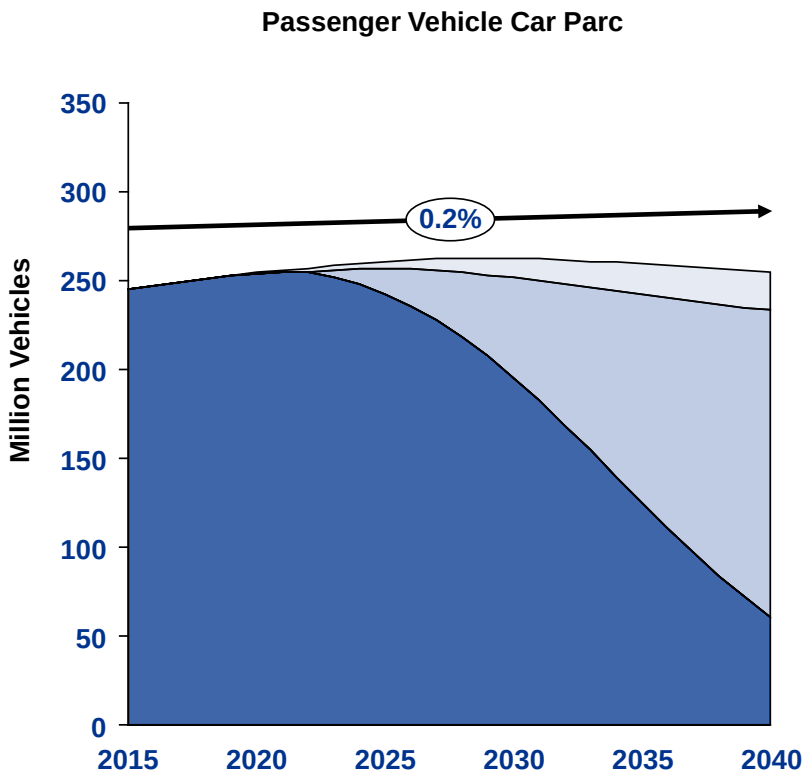
Independence for seniors

Note: (a) Discounted 25 percent from U.S. Bureau of Transportation Statistics (BTS) total Vehicle-miles traveled (VMT) for 1995, 2001, 2009, 2014 (assumed to be commercial miles), (b) multiplied by NHTS occupancy rates applied 2009 rate to 2014 numbers. Source: U.S. BTS data, NHTS data, U.S. Census data, KPMG Analysis

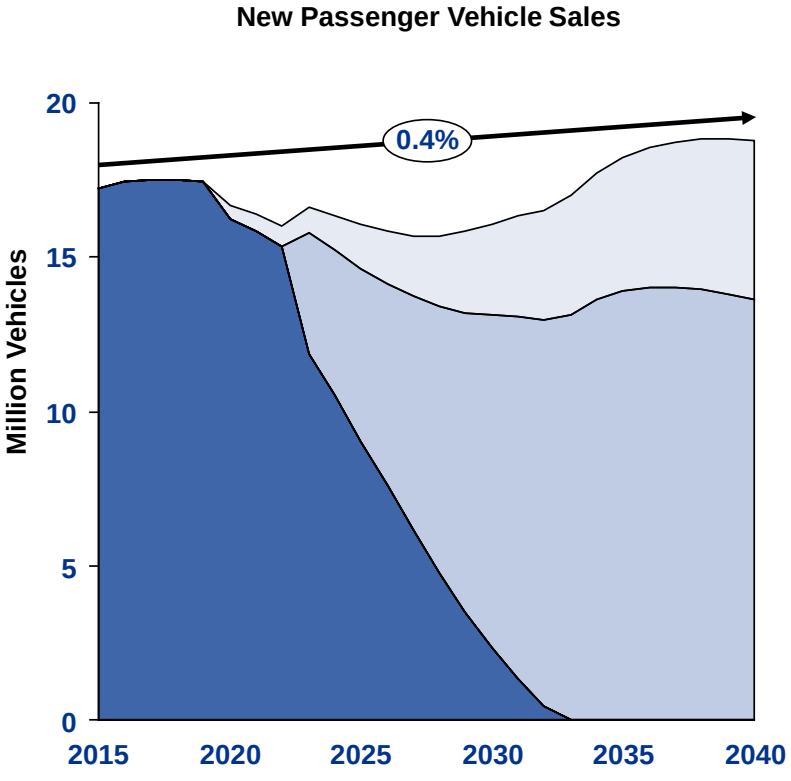
By 2040 autonomy and mobility as a service adoption will reshape car ownership models and reset the market…



VMT grows more rapidly than PMT due to a drop in average occupancy per vehicle



Growth in the car parc declines as AV MaaS vehicles eliminate the need for a portion of personally owned vehicles



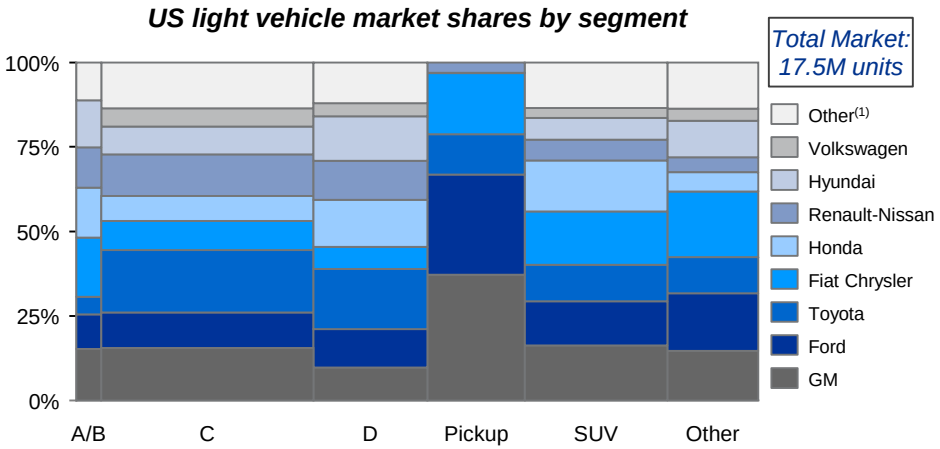
Non-autonomous vehicle sales fall, but are replaced by autonomous personal and MaaS vehicles

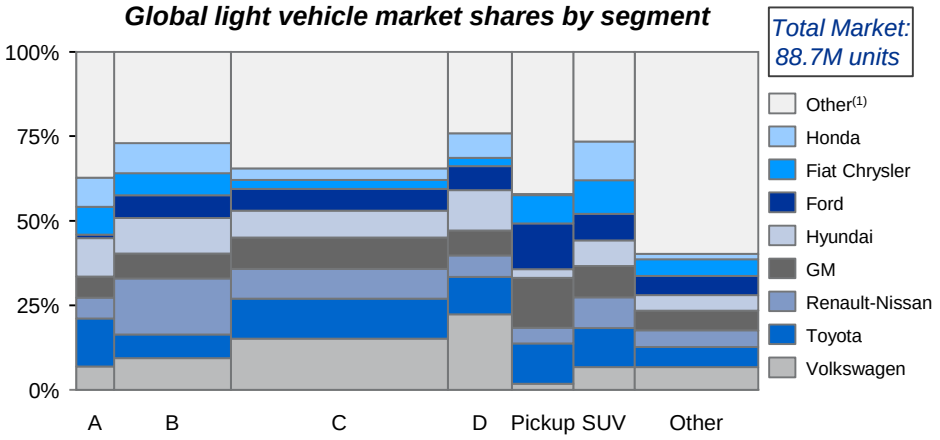
POV AV POV AV MaaS

Source: KPMG Analysis
Note: Passenger vehicle VMT analysis excludes non-MaaS commercial POV

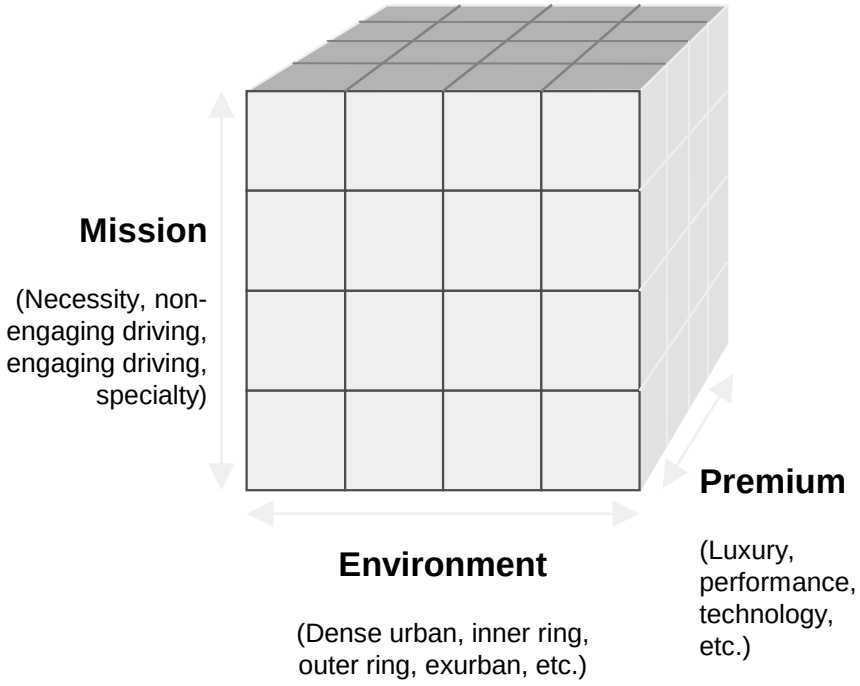
We will likely see a fundamental reinvention of the car around mission segments

Shift from multi-mission share by vehicle class…



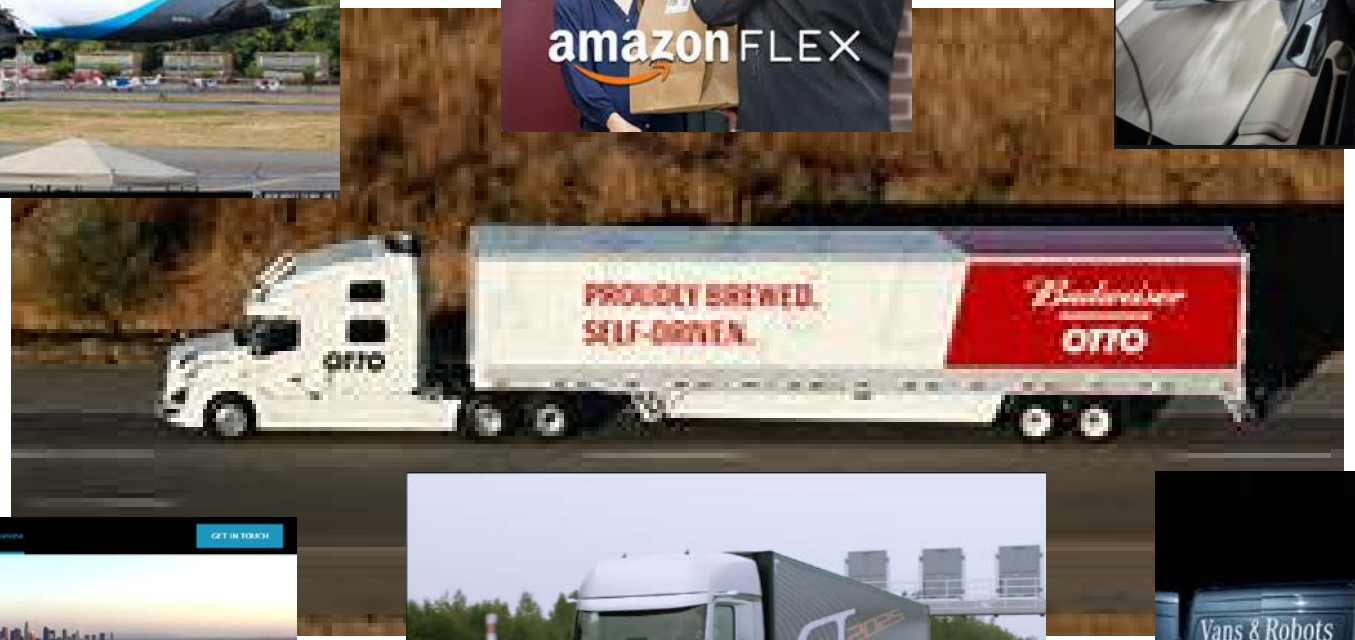


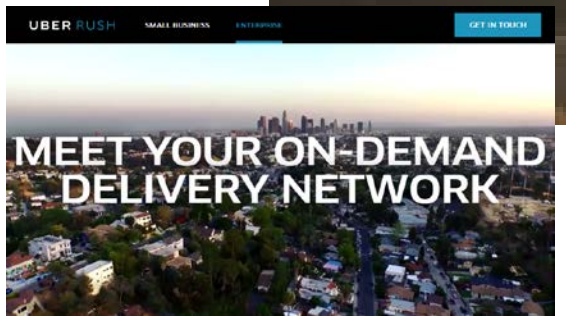
…to mission, environment and premium tailored solutions



Notes: (1) Other in US includes Fuji Heavy, BMW, Daimler, Mazda, Mitsubishi, Tata and other OEMs. Other in global includes PSA, Suzuki, SAIC, BMW, Daimler, Mazda and other OEMs.
Source: LMC Global Automotive Sales Forecast (Q4 2015)

Changes will be at least as impactful in commercial vehicles and logistics…





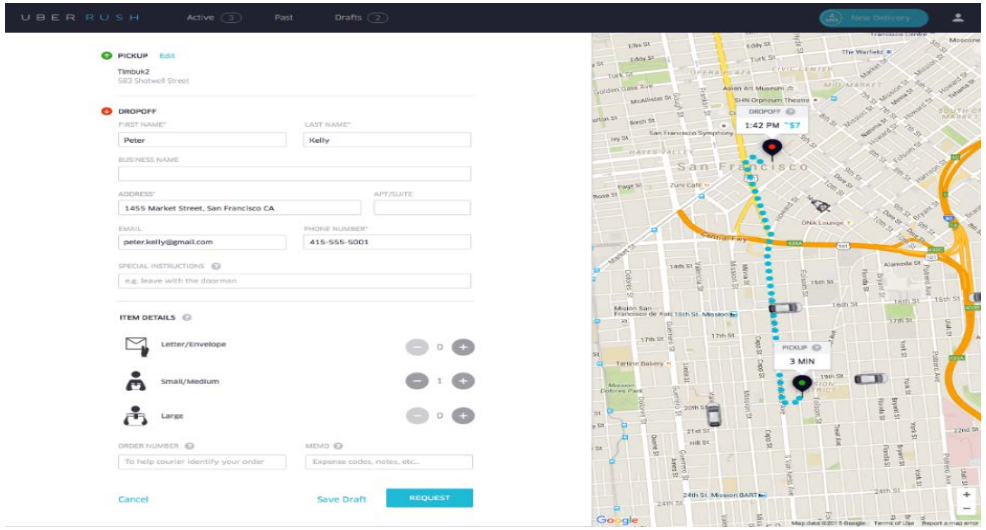
Amazon and Uber have already started to disrupt the parcel delivery market

Amazon Flex (Sept. 2015~)

- Allows same day delivery, available in 30+ US cities
- Costs Amazon **$2-3 per package**[1,3]
- Amazon pays the driver hourly fees based on demand (no fixed cost)

Uber RUSH (Oct. 2015~)

- Same day delivery available in NYC, San Francisco and Chicago
- Cost to the sender can be as low as **$5-7 per package**[2,3]
- Offers real time tracking
- Uber pays the driver 75-80% of the fee (no fixed cost)



UPS Ground: ~$8 for next day delivery within a local area[3]

Note: *Cost from an Amazon facility to the delivery location based on the $18-25 cost to deliver 7 to 15 packages per hour; 2) minimum charge for the first mile; 3) Average UPS Ground shipment cost per package in 2015 was $7.98; 4) guaranteed delivery time is by end of day next day for shipment within Manhattan based on UPS website

Sources: Uber, Amazon websites

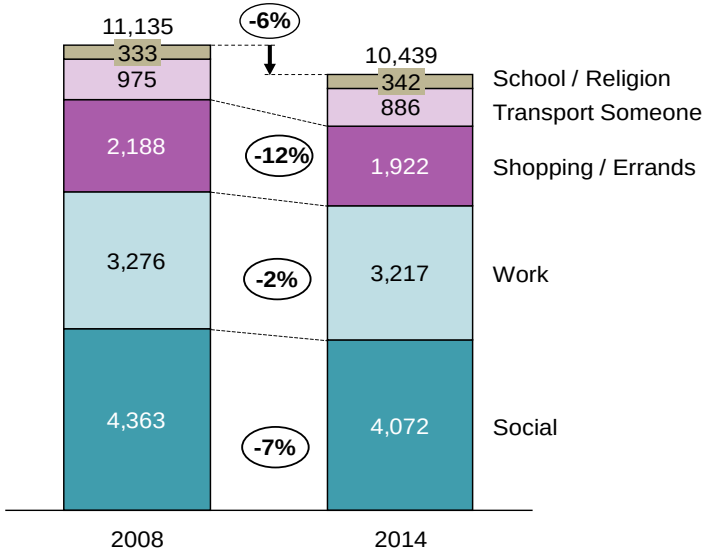
Some segments of the local pick-up / delivery market, exposed to MaaS disruption, present significant growth opportunities

	B2B		B2C		P2P	
	Express / Overnight	**Multi-day**	**Express / Overnight**	**Multi-day**	**Express / Overnight**	**Multi-day**
Parcel / Small Packages	Restocking during peak demand UBER RUSH	Recurring inventory shipments	Retail deliveries from local shops UBER RUSH	Retail deliveries from local shops	Birthday gift deliveries UBER RUSH	Birthday gift deliveries
Perishables	Restaurant restocking during the day	Scheduled restaurant food shipments Gordon FOOD SERVICE	Grocery and flower deliveries UBER EATS	Baked goods from retailers	Flowers delivered to family members UBER RUSH	Baked goods delivered to friends
Fragile Packages	Fragile impromptu inventory restocking	Fragile inventory restocking	Pottery, glassware, etc. UBER RUSH	Pottery, glassware, etc.	Fragile personal items UBER RUSH	Fragile personal items
Sensitive Materials	Inter-firm legal documents USPack	Inter-firm legal documents	Court documents USPack	Court documents	Intra-firm legal documents USPack	Intra-firm legal documents
Large / Heavy Packages	Impromptu inventory restocking	Recurring large inventory shipments YRC FREIGHT	Furniture deliveries FUTONLAND	Furniture deliveries GoShare TaskRabbit	Personal Furniture shipment GoShare TaskRabbit	Personal Furniture shipment SHIPSMART

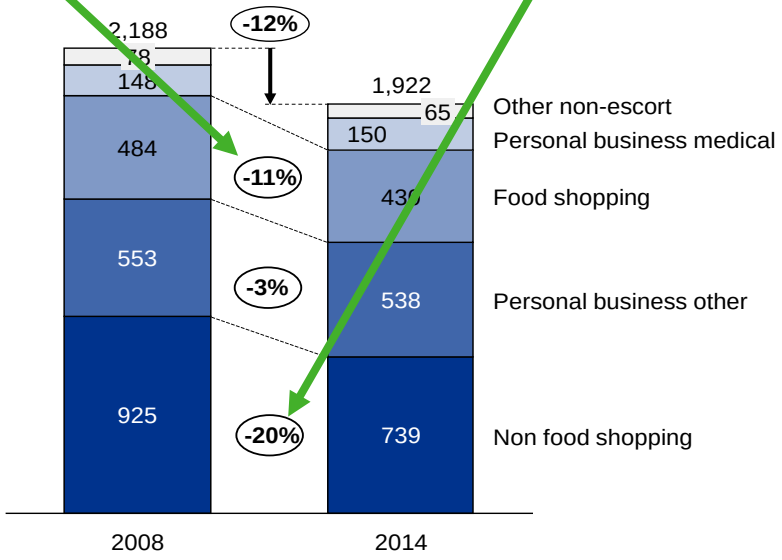
High Growth Area

What could this mean? The UK may be informative:

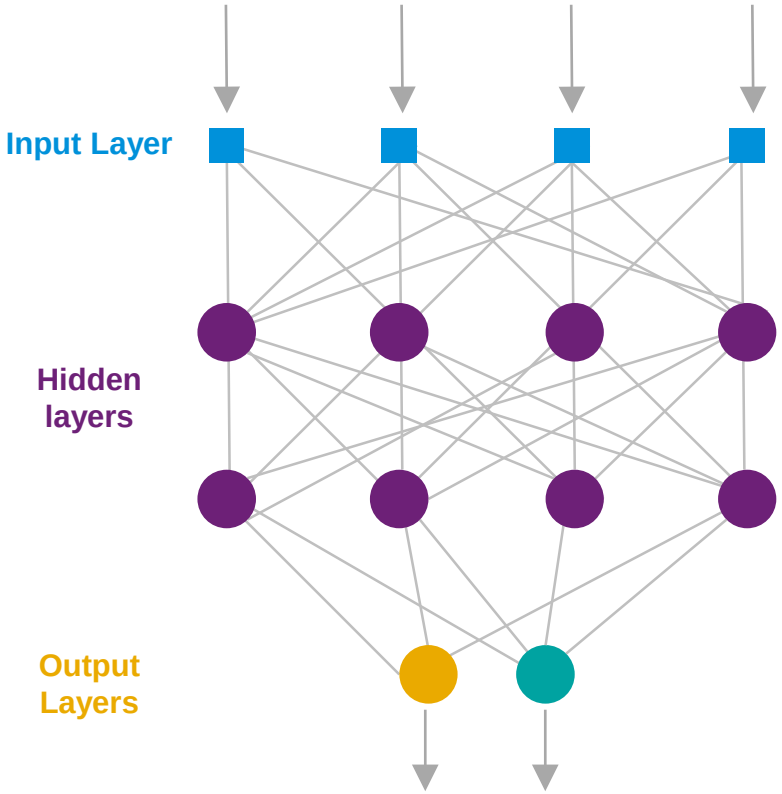
Annual PDT per Capita by Mission by Year (km)[a]



Annual PDT per Capita by Shopping/Errands by Year (km)[a]



Deep Learning development will be critical to this future to enable vehicles to handle complex situations



- A neural network is organized into layers, with each layer using the layer directly upstream as inputs
- Information is fed into the input layer
- Artificial neurons (nodes) within several “hidden layers” trigger when a certain characteristic within the input data is identified
- Nodes identify a characteristic by comparing a weighted total of identified upstream characteristics to a threshold value
- While upstream nodes identify basic characteristics, such as a gradient in a picture, downstream nodes are able to identify more complex objects, such as an eye
- Training the network involves adjusting the input weights between nodes so that it gives the desired response when presented with particular inputs

Deep neural networks allows computers to handle traditionally difficult tasks such as identifying animals, people, and objects in a picture, despite them having no set shape, color, etc.

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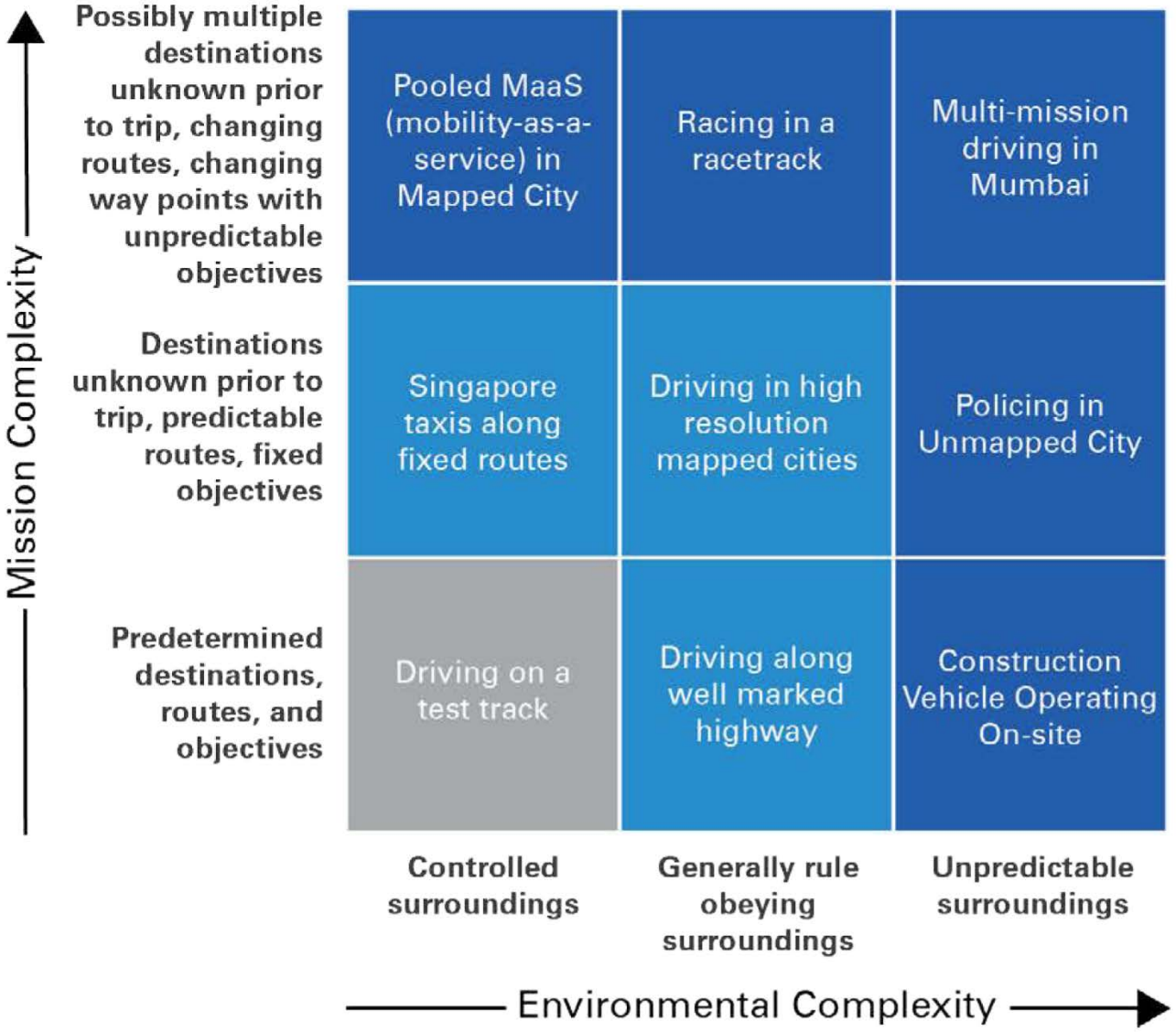
With Deep Learning, miles are like gold



The emergence of autonomous vehicles is placing more emphasis on the 'nervous system' consisting of sensors, CPU, and software

Deep Learning summary

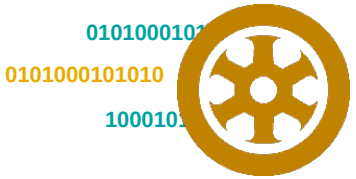
From man to machine, driving is rapidly changing.

Vehicle operation and ownership is changing.

Mobility services will be a major new market and therefore a critical battleground.

Most car companies won't simply be automakers anymore.

Investment focus is changing.



Miles are like gold!

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Deep Learning summary

Power of the fleet will eclipse the importance of the individual car.

Highly secure, fleet-wide software architectures will be a new basis of competition.

Ideation and innovation will change.

Talent is the new arms race.

The nervous system will become the center of the vehicle design.

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Key questions/ideas:

How can we most sustainably support the massive increase coming in PMT/VMT?

If a car “can’t” crash what will it look like?

The economics of electric vehicles dramatically change with a low speed “autonomous taxi bot” for urban areas. What technologies could make the promise real?

Mission specific vehicles could unlock significant societal value. How can you support and exploit this idea?


Deep learning enabled
cars only