McKinsey&Company

Capturing the public benefits of AVs: design, finance and regulation

September 2018

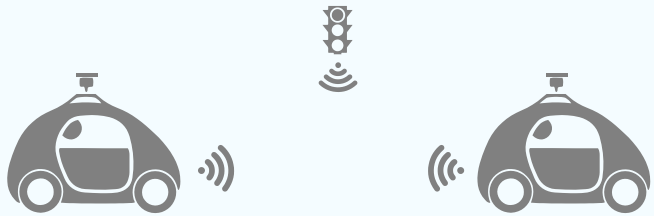
WORKING DRAFT
Last Modified 9/5/2019 8:17 AM Eastern Standard Time
Printed

1 AVs are currently being designed to operate in the world as it is: most technology will be in-vehicle

Stand alone autonomy –
"Built to operate in the world as it is"

- Vehicles are **self-sufficient,**
- Relies on **object detection sensors** (lidar, radar, camera) and **HD maps**
- Capable of being **developed independently**

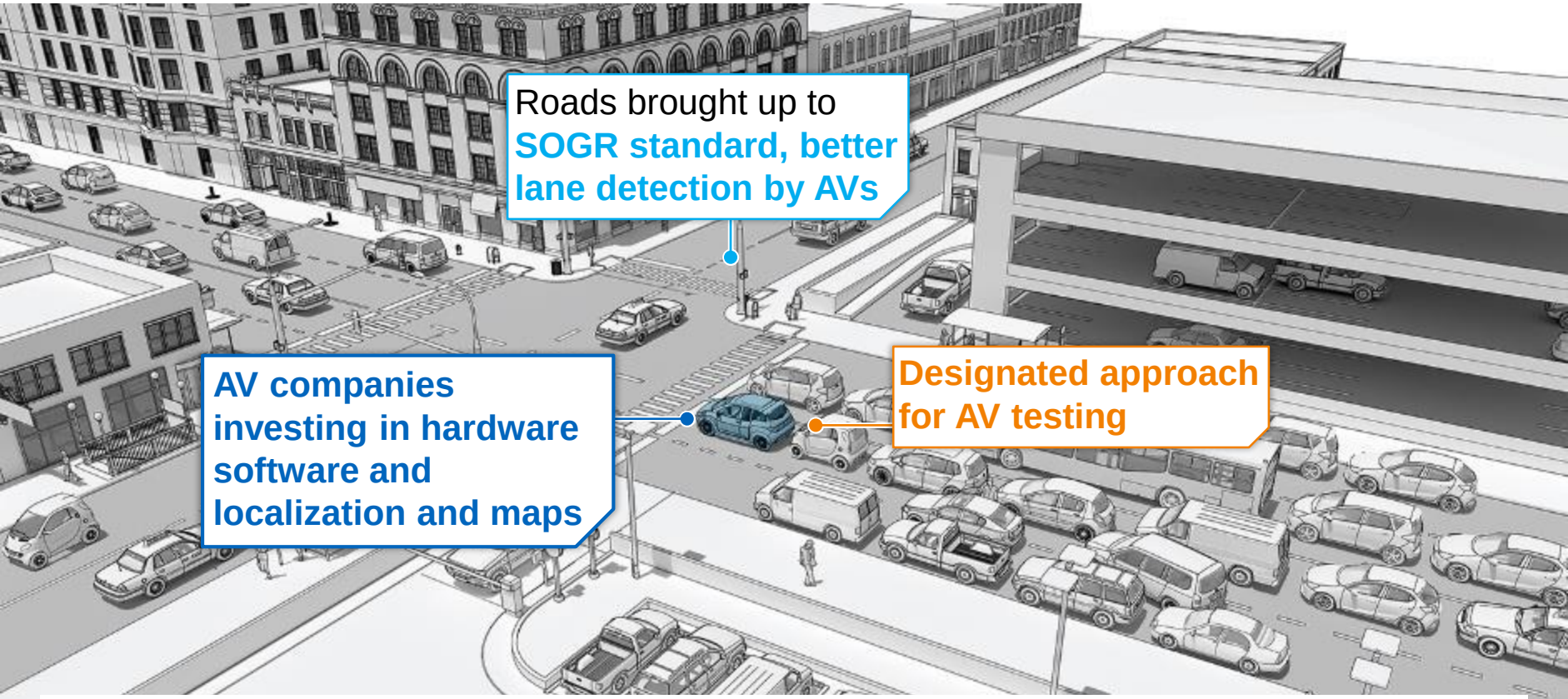
Connected autonomy –
"Vehicle to everything connection"



- **Decentralized V2X communication**
- Must connect **vehicle, infra and pedestrian data**
- Requires **communications standards and** greater investment

2A In the current testing stage, public sector should focus on getting existing assets to a state of good repair

Public investments | Private investments | Public or private investments | Regulatory changes



Autonomous testing world

- Autonomous testing is the state of the world in which L3/L4 vehicles are **deployed primarily to test performance** and have **dedicated drivers inside the vehicle ready to take over**
- **Autonomous testing is happening today**, testing areas include Boston, California, Pittsburgh, Phoenix and Singapore

2B As AVs begin to reach a critical mass, critical interventions in the right of way and off-street, will help cities get the most out of this new technology

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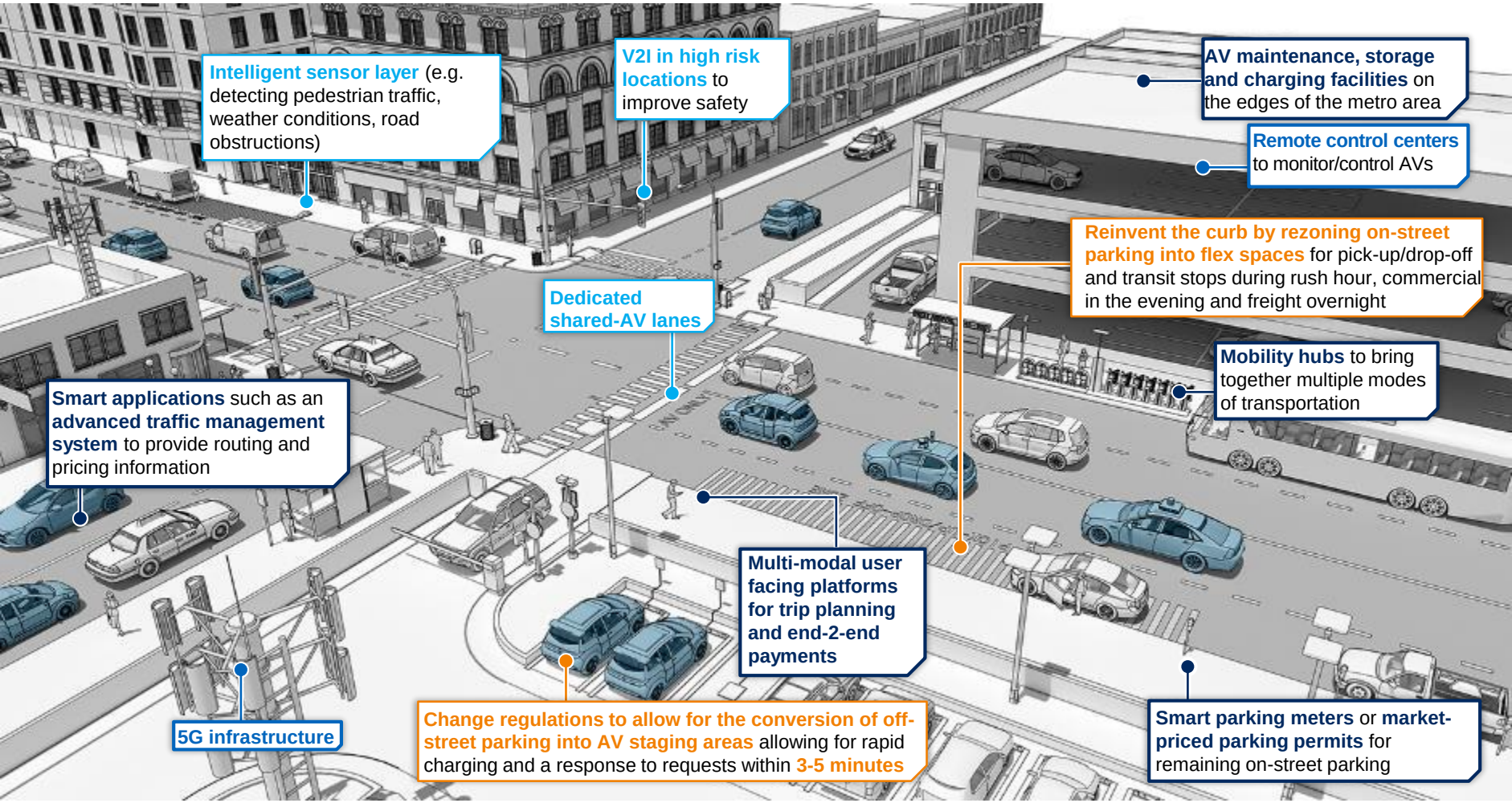

Mixed traffic world

- In partial autonomy the **commercial fleets have transitions to AVs while most private vehicles remain human operated**
- **30% of vehicles and 60% of VMT in most developed metro areas is autonomous**
- **50% reduction in parking spaces** frees up **500-1500 square feet per household**

2C A fully autonomous world, with shared ownership and shared ridership, creates a massive unlock in the provision of seamless mobility

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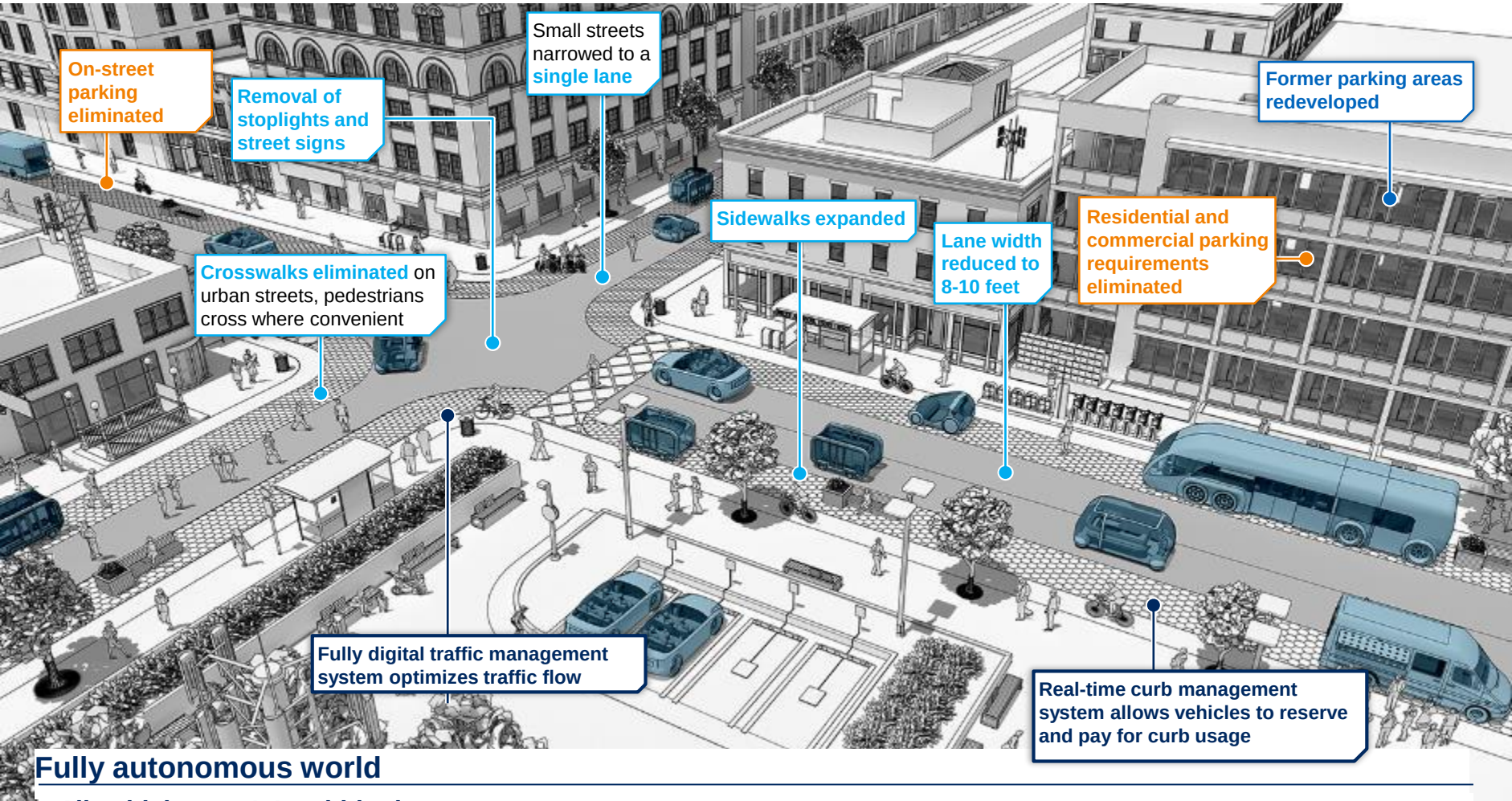


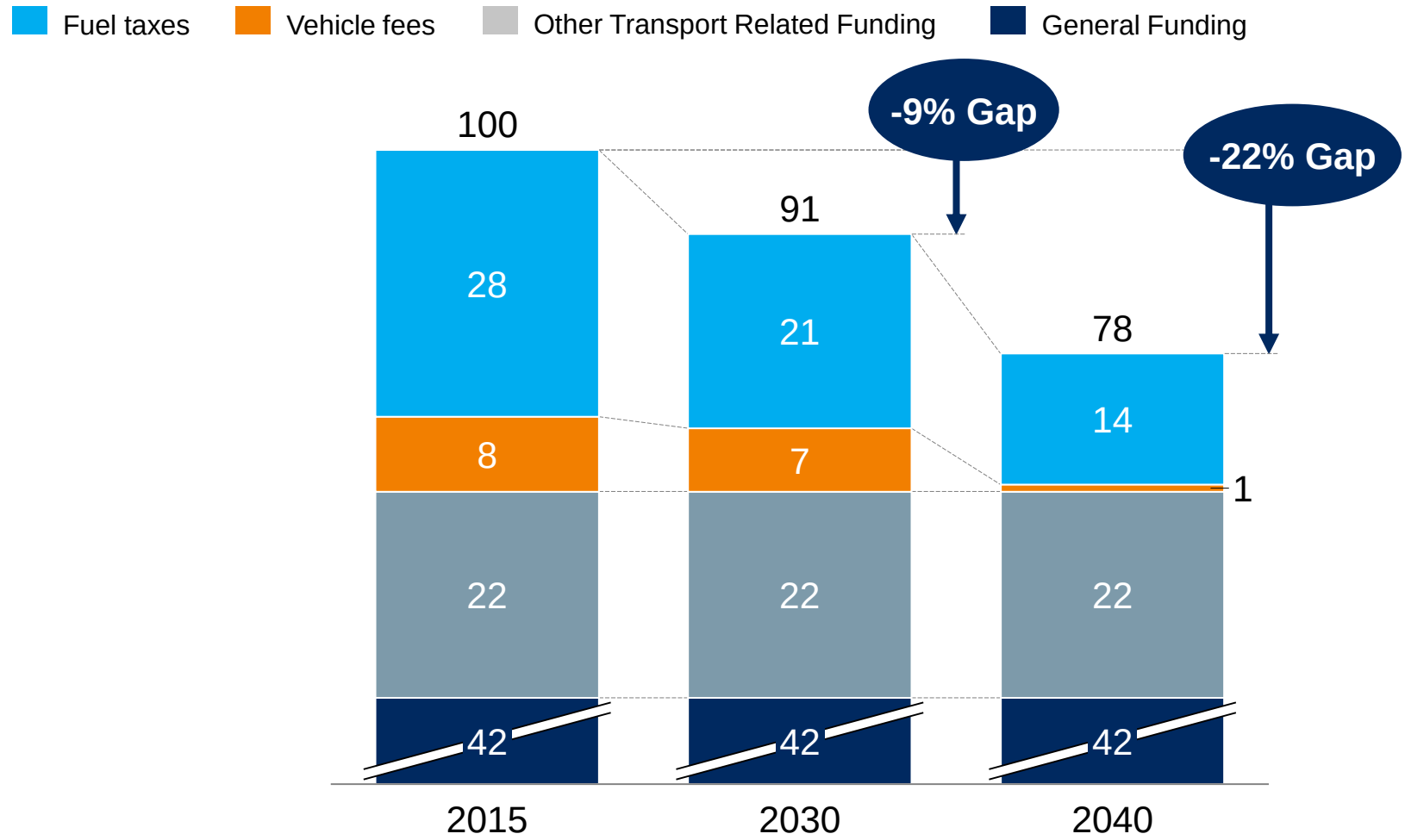
Fully autonomous world

- **All vehicles are L4+ within the metro area**
- **Pricing policies** implemented to lead to a world of **shared autonomy in which shared-autonomy and mass transit**
- **Traffic rules** are moved from **physical signs/signals** on the street to the **live layer of the AVs allowing for a digital traffic management system to dynamically adjust traffic flow** based on time of day, street usage, traffic volumes, etc.

3 AVs will reduce sources of funding for transportation by 22% (~$80B), as fuel taxes and vehicle related fees decline

Funding for S&L road spending across U.S., historical (2015) mixed traffic (~2030) fully autonomous world (~2040)

Portion of total road funding covered (%)



SOURCE: Federal Highway Authority, 2015

4 Tolled AV lanes, and a dynamically priced curb, could generate revenues to enable PPPs, and help cover investment costs

EXAMPLE FOR LOS ANGELES

Primary candidates for PPPs

Components	Interventions	Total cost	Potential revenue source	Potential 2030 revenue/yr current$
AV enablers	Smart intersections	$206M	...	...
	Traffic Management Systems	$121M	...	...
	AV only lanes in high-speed arterials	$500M	Tolls	$80M - $200M[1]
On-road	On-road package (e.g., reflective striping, elimination of railings, dividers and shoulders, narrowing lanes from 10' to 8')	$496M	...	...
Curbs and sidewalks	Reduction of on-street parking	...	...	...
	Increased use of dynamic pricing for curb usage as well as short-term uses in lieu of standard public parking	$1.1B	Curb fees	$200M-550M[2]
	Expansion of sidewalk width to 10' (increasing throughput, walkability of area)	$400M	...	...
Off-street	Development of non-residential off-street and on-street parking into more productive uses	N/A -- private	Rents / sales	N/A -- private
	Initial development of mobility hubs to concentrate multiple forms of transit	$34M	...	...
Total		**$2.9B**		**$0.3-0.8B**

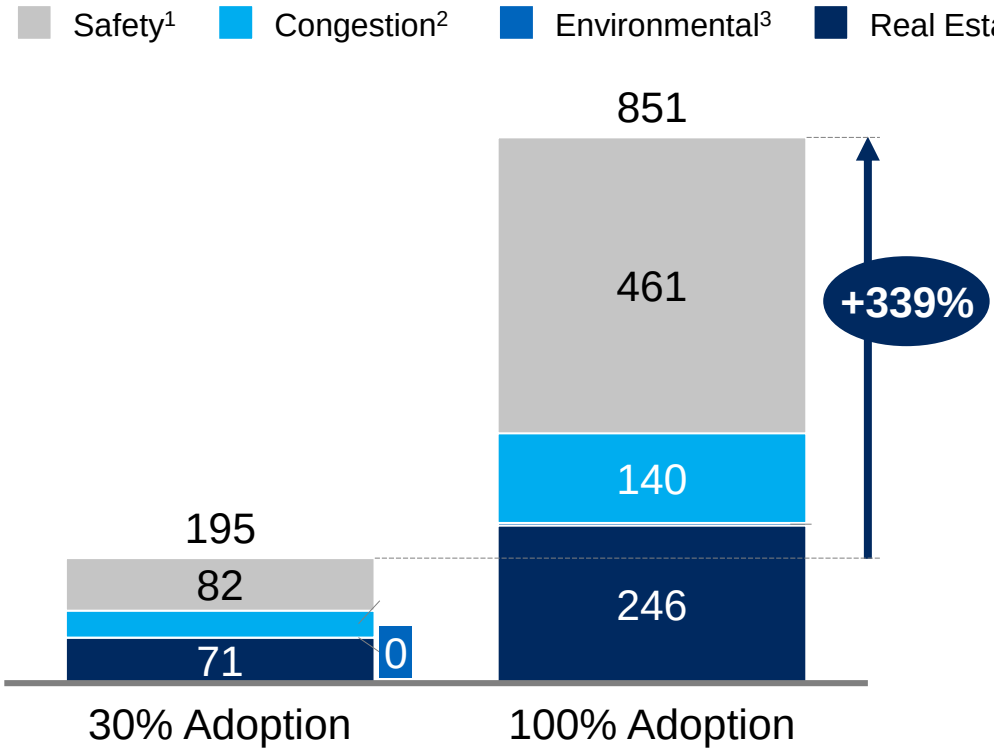
1 Assumes a $0.04 per mi charge (lowest toll per mile charge of any state) on 10-25% of total robotaxi projected VMT in 2030 for LA
2 Forecasted ~1.5B robotrips (50% of 2030 forecasted robotaxi VMT divided by 2018 avg miles per Uber trip) at $0.07 - $0.20 per drop off and pick up, does not include other curb uses (including delivery)

4 Full AV adoption represents a ~$850B annual opportunity in the US, but active policy decisions must be made to capture this full value

PRELIMINARY

Estimated public value creation of AV adoption in US

$ Billions of annual estimated benefit



Safety: avoidance of fatal and non-fatal accidents

Congestion: Decreased commute times

Environmental: Prevented environmental damage

Real Estate: Redevelopment of parking spaces into more productive uses

These benefits will not be fully realized without the implementation of key infrastructure and regulatory changes that promote shared AVs, maximize safety, decrease congestion, and redevelop real estate

1 Based on Exponential Growth Regression of DOT Estimate of 10,50, and 90% adoption rate total economic cost savings of AV growth. Based on assumption that 10% adoption leads to 211,000 fewer crashes, while 90% adoption will reduce 4.2M crashes

2 Assumes a 5 minute improvement in commute times delivered by seamless mobility (potential range found in modeling major US cities 5 – 15 minutes), does not include free time in vehicle gained by autonomy or non commute benefits

3 Based estimate from Climatic Change Journal that cost of burning standard gasoline is $3.80. gallon. This also assumes AV and EV adoption rates are independent

4 Based on marginal tax return of redevelopment of parking in Houston and a McKinsey estimate that full transition to AV will lessen U.S. parking needs by 5.7B sq. meters

5 Changes in vehicular safety and data standards are needed first, other regulatory changes could then follow

Traffic laws and zoning
- Redesign traffic laws
  Reduce set back and parking minimums
- Zone AV parking

C

Primarily set on a city or municipal level

Insurance, liability, and licensing & registration
- Mandate insurance for AV owners
- Determine liability
- Require regular updates for licensed software

B

Primarily set on a state (US) or national (EU) level

Safety, hardware, and data standards
- Update physical requirements
- Create cybersecurity and data protection laws
- Regulate autonomous conversions of human-driven vehicles
- Regulate sharing of data including incident and usage data
- Set V2X communication standards

A

Primarily set on a federal (US) or supranational (EU) level

Regulatory changes can follow a natural hierarchy

1) Updated safety standards
2) New rules on insurance, liability, and licensing
3) Optimized traffic laws and zoning regulations

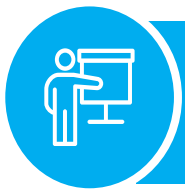
SOURCE: Volpe Review of FMVSS; EU Common Approach on the liability rules and insurance related to the Connected and Autonomous Vehicles; Autonomous Vehicle Regulations – Near-Term Challenges and Consequences, TechEmergence

6 Capturing the full benefits of shared and autonomous mobility will require the government to act as a convener of multiple stakeholders

Integrating AVs with existing transit

Optimizing the curb

Rethinking road construction and maintenance



Capital planning for an uncertain future

Redeveloping off-street parking