Tiburon Sunset Rotary

Driving Change – Autonomous Vehicles' Big Impact

National Economic Education Delegation

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1

National Economic Education Delegation

- **Vision**
  - One day, the public discussion of policy issues will be grounded in an accurate perception of the underlying economic principles and data.
- **Mission**
  - NEED unites the skills and knowledge of a vast network of professional economists to promote understanding of the economics of policy issues in the United States.
- **NEED Presentations**
  - Are **nonpartisan** and intended to reflect the consensus of the economics profession.

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2

2

Who Are We?

- **Honorary Board: 46 members**
  - 2 Fed Chairs: Janet Yellen, Ben Bernanke
  - 6 Chairs Council of Economic Advisers
    - Furman (D), Rosen (R), Bernanke (R), Yellen (D), Tyson (D), Goolsbee (D)
  - 3 Nobel Prize Winners
    - Akerlof, Smith, Maskin
- **Delegates: 487 members**
  - At all levels of academia and some in government service
  - All have a Ph.D. in economics
  - Crowdsource slide decks
  - Give presentations
- **Global Partners: 45 Ph.D. Economists**
  - Aid in slide deck development

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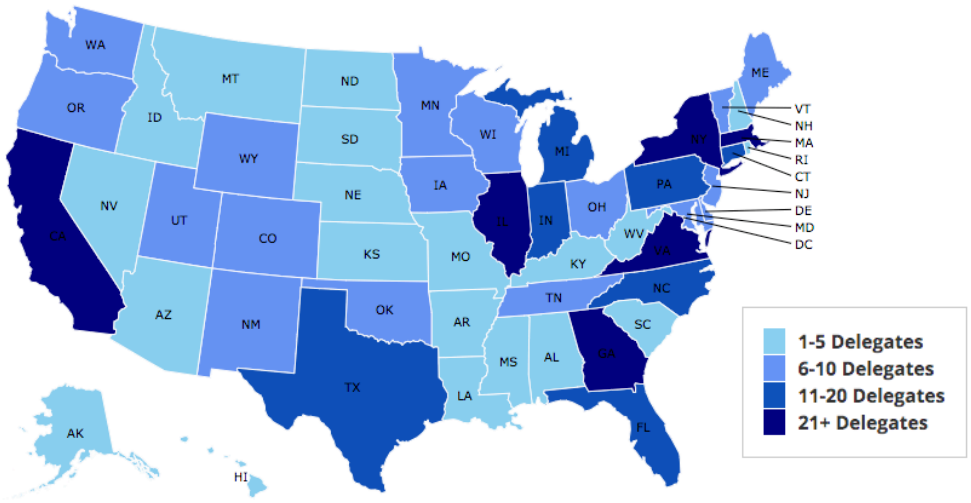
3

3

Where Are We?



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4

4

NEED Presentation Topics

- US Economic Update
- Trade and Globalization
- Trade Wars
- Climate Change Economics
- Economic Inequality
- Economic Mobility
- Economics of Immigration
- Housing Policy
- Government Budgets and Debt
- Autonomous Vehicles

5

Autonomous Vehicles

6

Outline

- Where does the AV path lead?
- Transition
- Policy/Planning Issues
- Major Economic/Development Changes
- Environmental Implications

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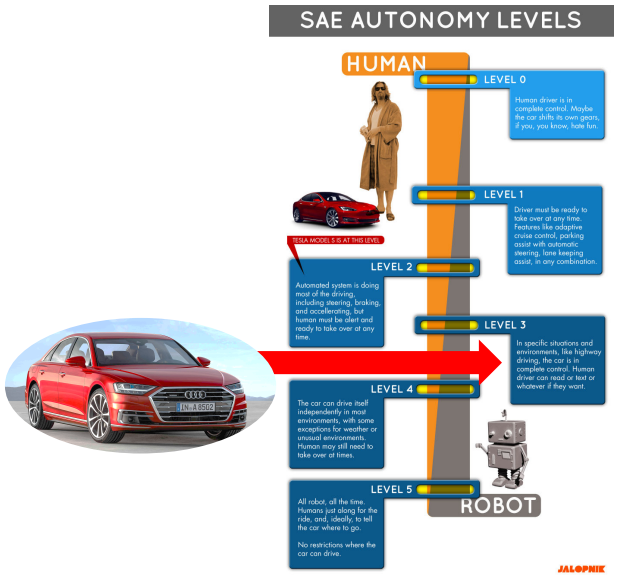
7



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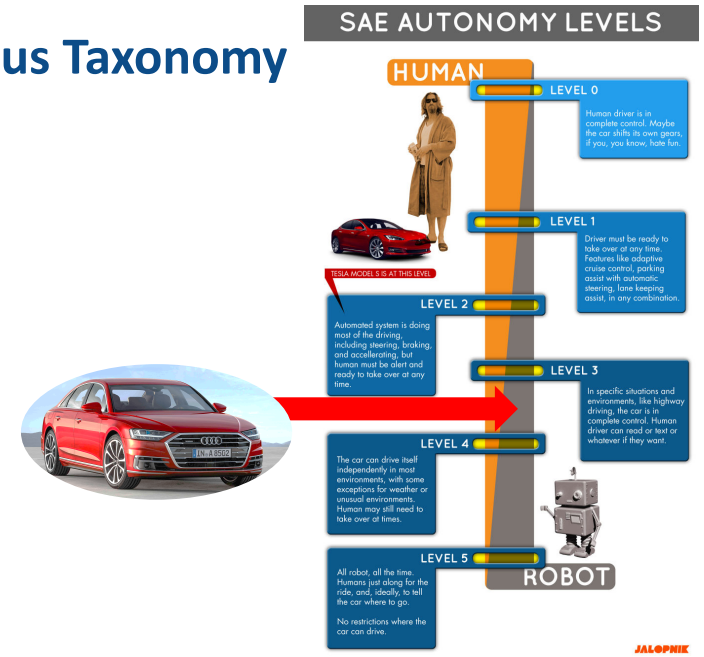
8

Autonomous Taxonomy



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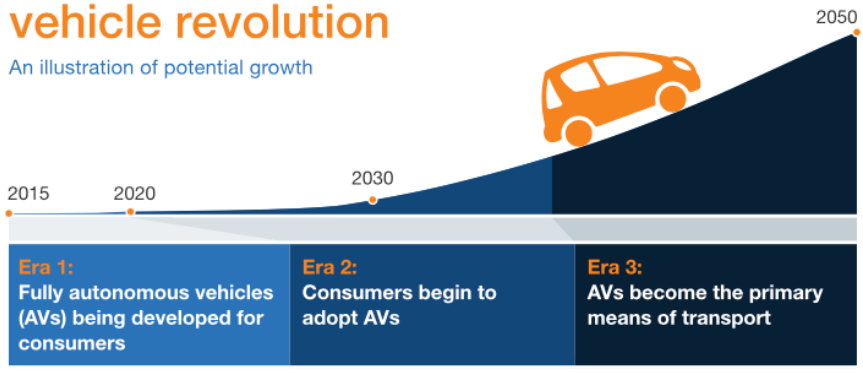
9

9

Growth Path

The self-driving vehicle revolution

An illustration of potential growth



McKinsey & Company

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Two Important Questions:

1. When will Transportation as a Service (TaaS) be available?

1. How quick will the transition be?

11

WHEN?
What do the headlines say?

NVIDIA to introduce level-4 enabling system by 2018

Audi to introduce a self-driving car by 2020

Volkswagen expects first self driving cars on the market by 2019

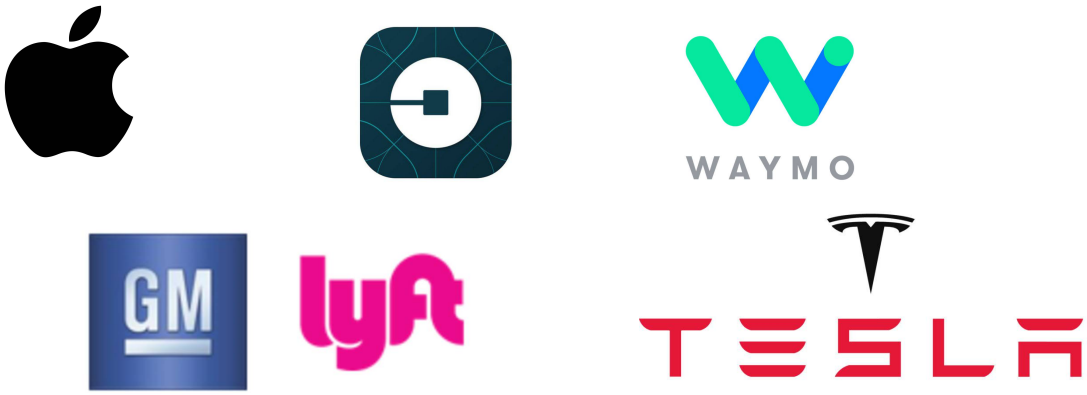
First autonomous Toyota to be available in 2020

Elon Musk now expects first fully autonomous Tesla by 2019, approved by 2021

12

Wildly Optimistic, But…

40+ Corporations Working On Autonomous Vehicles



13

Wildly Optimistic, But…

40+ Corporations Working On Autonomous Vehicles

14

WHEN?
What is possible?

- **By 2025**
- **Potentially 95% of VMT by 2035.**
- **Last 5% is going to be very difficult to achieve.**
- **Is this possible?**
  - Horses to cars: 10 years – early 1900s
  - But adoption of EVs is so slow!
  - Adoption of AVs will be rapid.

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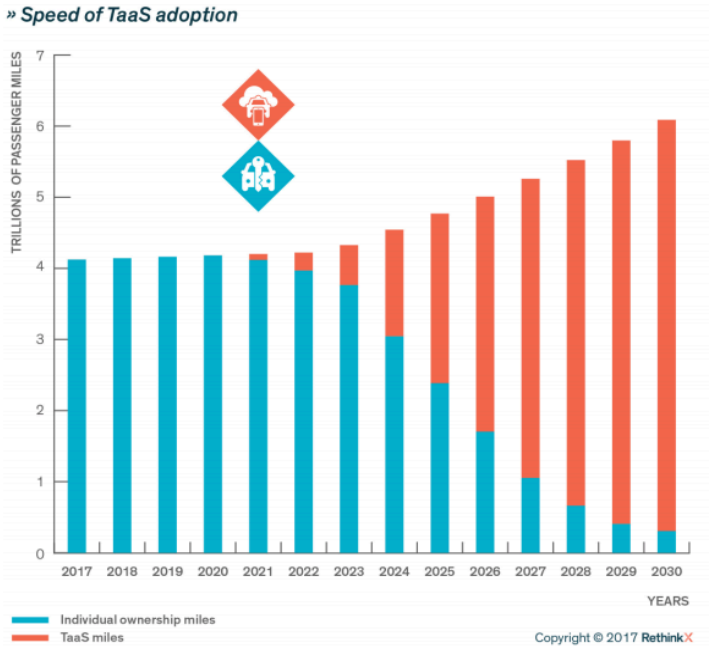
Forecast

Timing may be off.

But the point is:

RAPID ADOPTION!



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16

Waymo's self-driving cars are now available on Lyft's app in Phoenix

Hyundai plans to launch a free robot taxi service in California

Singapore's self-driving cars can now be hailed with a smartphone

NuTonomy joins forces with 'the Uber of Southeast Asia'

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17

17

What will the future look like?

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But, Will it be:

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19

Hell

- **Primarily individual private car ownership**
  - Much as today
- **Combustion engines**
- **Why Hell?**
  - Dramatically increased VMT and pollution
  - Potentially increased congestion
  - Parking

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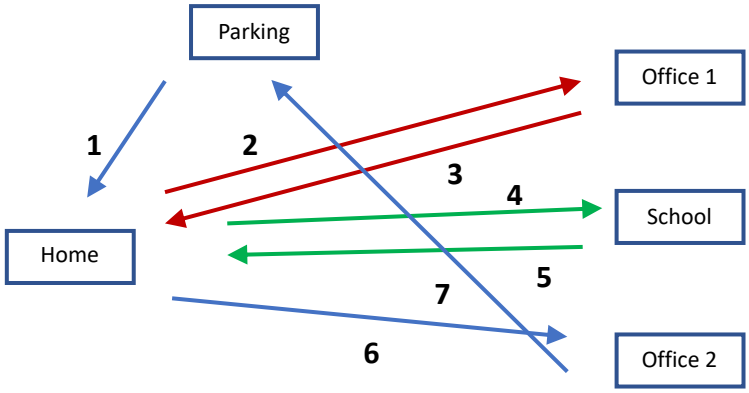
20

Two Adults and a Child: Morning Miles



And this is just the morning…..

21

Heaven

- **Vehicle ownership will be very limited**
  - Private ownership for those with specialized vehicle needs.
  - Fleet ownership will serve everybody else.
- **Engines: electric**
- **Insurance: product liability**
- **Not clear when we will get there, but this is the likely model.**
  - 2030 for widespread adoption in many regions.

22

Why is this Heaven?

- **Not only autonomous, but:**
  - Shared
  - Connected
  - Green
- **Far fewer cars in existence.**
  - Better resource utilization.
- **VMT could go up or down, but more productive than in Hell.**
- **Congestion effects – unclear, but likely reduced.**
  - Right-sized vehicles, platooning, sharing, V2V communication
- **Minimal need for parking.**

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23

Transition

- **Short term: Tesla model of highway autonomy**
  - Level 2, adaptive cruise control
- **Medium term:**
  - Short period of personal vehicle ownership with level 3 capability.
  - Introduction of independent private fleets – Uber, Lyft, Google, nuTonomy, etc., with level 4/5 capability.
- **Long term:**
  - Personal vehicle ownership is largely a thing of the past.

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24

Economics Drives Transition: Private

- **ADOPTION DIVIDEND for private individuals**
  - Eliminate car ownership
    - Ave annual cost of owning a car: $9,576
    - Cost per mile will fall: $0.59 to $0.19
  - Repurpose your garage
    - $50,000 from transition to bedroom
- **Time recovery**
  - 50% of Bay Area workforce has a commute in excess of 30 minutes.
- **It will become too annoying to drive around all of those autonomous vehicles!**

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Economics Drives Transition: Public

- **Economic and social costs associated with human drivers are enormous:**
  - ACCIDENTS:
    - Drive 25% of congestion
    - Result in 40,000 deaths
    - And 2 million injuries
    - 90+% caused by human error
  - Costs of human drivers estimated at $0.8 to $1.3 **TR**illion each year

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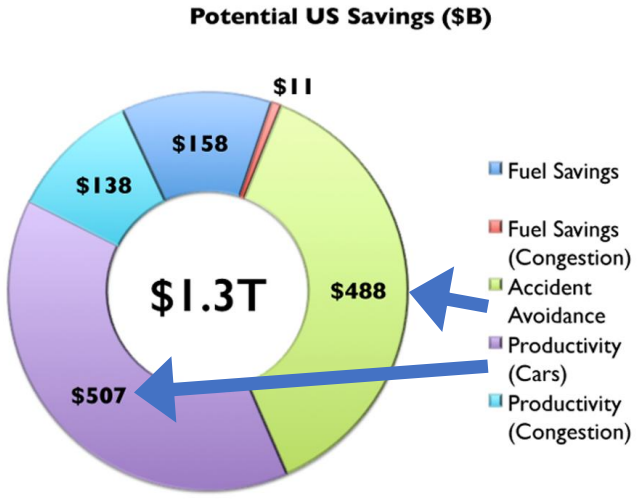
26

Potential Savings



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Morgan Stanley

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Public Policy/Planning Issues

- **Government buy-in:**
  - Essential – gov't must encourage progress
  - Difficult – because of displacement issue
- **Important transitional issues:**
  - What infrastructure should be developed?
  - What to do about public transportation?
  - What to do with all of the parking spaces?

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Planning

- **Respond to the coming changes**
  - The planning horizon for any investment in transportation infrastructure based on today's predominant technology has changed.
    - It may have gotten **MUCH shorter.**
- **Encourage the changes to happen more quickly**
  - Mobility, safety, productivity, and environmental benefits abound.

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29

Encourage Change

- **Mobility and equity considerations**
  - Elderly/disabled/impoverished
- **Safety:** only way to reduce traffic fatalities is by coordinated effort
- **Productivity:** reduced congestion
- **Environment:** speed transition to electric vehicles

These are all societal benefits that come about too slowly if the private market is left to itself.

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Mobility and Equity

- **Mobility**
  - Handicapped
  - Elderly
  - Lower income
- **Equity**
  - Public Transportation often does not work well for low income workers/residential workers
    - Does not go from residential to residential, but from residential to commercial

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31

Safety and Productivity

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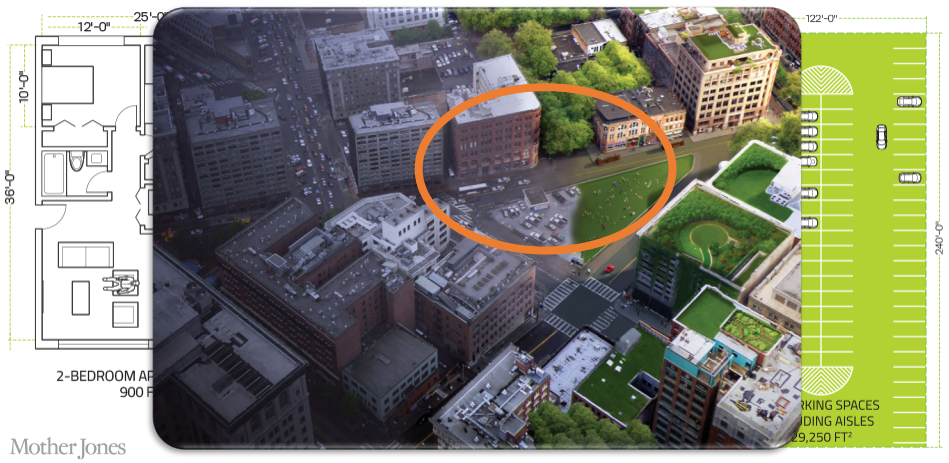
32

Environment



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Incentives Through Policy and Planning

- **Allow vehicles equipped with ACC into HOV lanes**
  - Eventual conversion of HOV lanes to ACC/AV lanes
- **Allow ACC equipped vehicles to travel faster in HOV lanes**
- **Subsidize ACC upgrades**
  - Arguably more concrete benefits than electric vehicles
- **Sticks: higher costs of vehicle ownership**
  - Registration fees, VMT taxes, etc.

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34

Interim Summary

- **Transition is coming very quickly!**
  - Most reports are extremely conservative.
  - Apply generally, but faster in many regions.
- **Very important to start incorporating AVs into planning now.**
  - Sacrifice expansion for maintenance.

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35

What Changes Will This Bring?

- **Disposable Income**
- **Employment**
- **Government Finances**
- **Transportation**
- **Public Transportation**
- **Infrastructure**
- **Housing**
- **Parking**

Potentially dramatic improvements in infrastructure planning and maintenance - Data sharing and integration

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Freeing Up Urban Space from Parking

- **Los Angeles: 14% of incorporated land area**
  - 200 Square miles
- **San Francisco: 275,450 on-street parking spaces**
  - Enough to parallel-park a line of cars 60 miles longer than California's entire 840-mile coastline
  - Enough parking to fill parking lots that would cover the **Presidio, Golden Gate Park, and Lake Merced**.
- **Nationwide: (estimate) 500 million spaces**
  - That's larger than Delaware and Rhode Island combined.
  - Could be as many as 2 billion (add in Connecticut and Vermont).

37

Summary of Change

- **Massive employment upheaval**
- **Local government finances will look very different**
- **Housing will be easier to build and more plentiful**
- **Parking conversions will be commonplace**
- **Demand for transportation infrastructure will likely decline**
  - Transportation infrastructure technology will be a booming business
- **Demand for public transportation may well decline**

38

Environmental Implications Depends: Heaven or Hell

- **Improved resource utilization**
- **More efficient travel**
  - Right sized vehicles
  - Optimized routes
  - Reduced congestion
  - No searching for parking
- **Increased VMT**
- **Cleaner technologies**
  - Electric
  - Lighter vehicles
- **Energy use of onboard electronics**
  - Weight and functional

Bottom line: push governments at all levels to embrace and to implement policies deterring private vehicle ownership and zero passenger miles

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39

Thank you!

Any Questions?

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40