# Autonomous Vehicles

## Insights Conference Team 16

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# Introduction

*Analyze & Recommend strategic choices* *for the focals firms in Autonomous vehicle industry, to navigate the complexity and dynamism.*
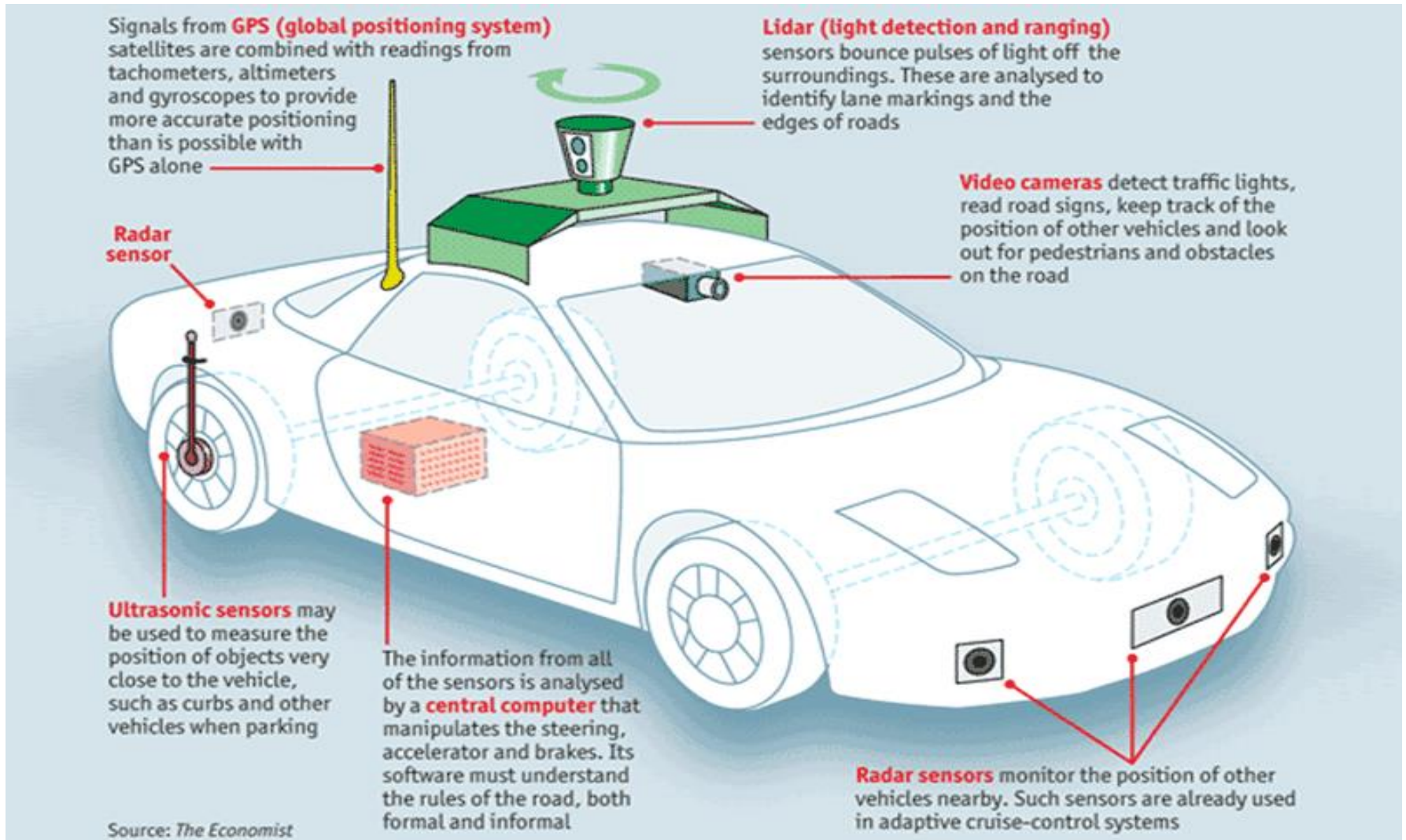
# What is an Autonomous Vehicle?



Signals from **GPS (global positioning system)** satellites are combined with readings from tachometers, altimeters and gyroscopes to provide more accurate positioning than is possible with GPS alone

**Lidar (light detection and ranging)** sensors bounce pulses of light off the surroundings. These are analysed to identify lane markings and the edges of roads

**Radar sensor**

**Video cameras** detect traffic lights, read road signs, keep track of the position of other vehicles and look out for pedestrians and obstacles on the road

**Ultrasonic sensors** may be used to measure the position of objects very close to the vehicle, such as curbs and other vehicles when parking

The information from all of the sensors is analysed by a **central computer** that manipulates the steering, accelerator and brakes. Its software must understand the rules of the road, both formal and informal

**Radar sensors** monitor the position of other vehicles nearby. Such sensors are already used in adaptive cruise-control systems

Source: *The Economist*

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# Vehicle Autonomy Exists on a Spectrum

SAE International created a standard to categorize levels of automation

Today, cars sold to consumers have Level 2 automation, but most car-makers are focused on skipping to Level 4 automation

No-one is close to achieving Level 5 Autonomy - when a car can drive completely autonomously in any traffic or weather condition
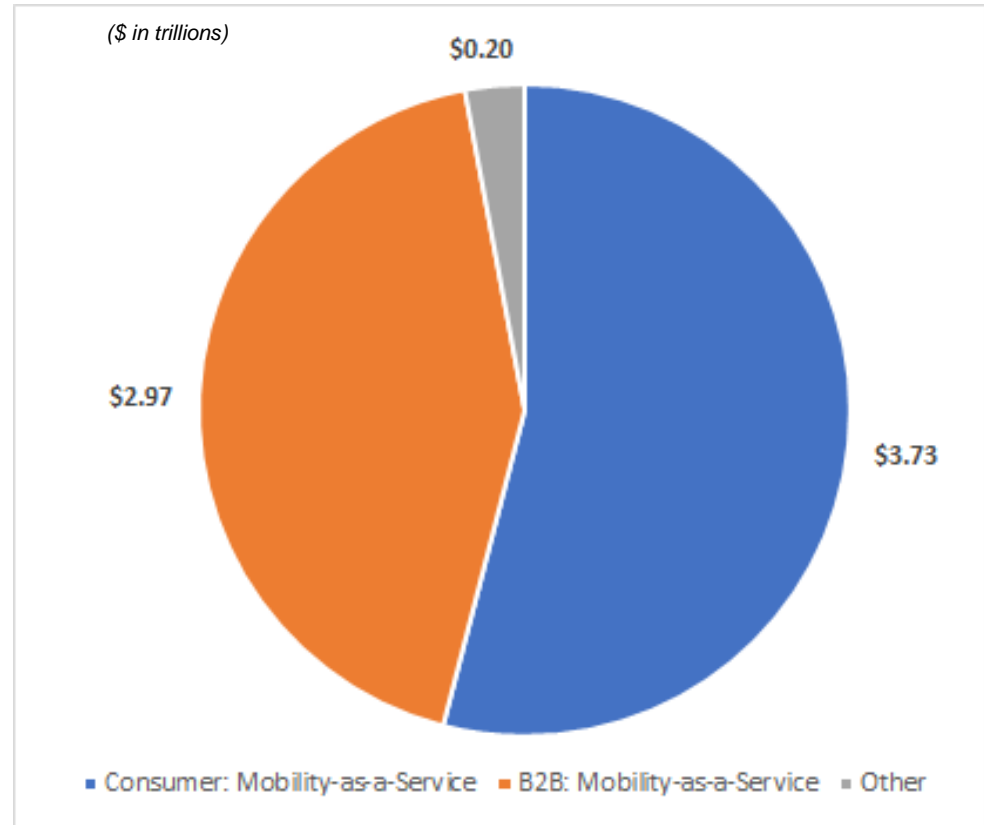
# Autonomous Driving will enable a $7 Trillion Opportunity

The "Passenger Economy" is the economic and societal value that will be generated by SAE Level 5 vehicles and is estimated to be $7T by 2050
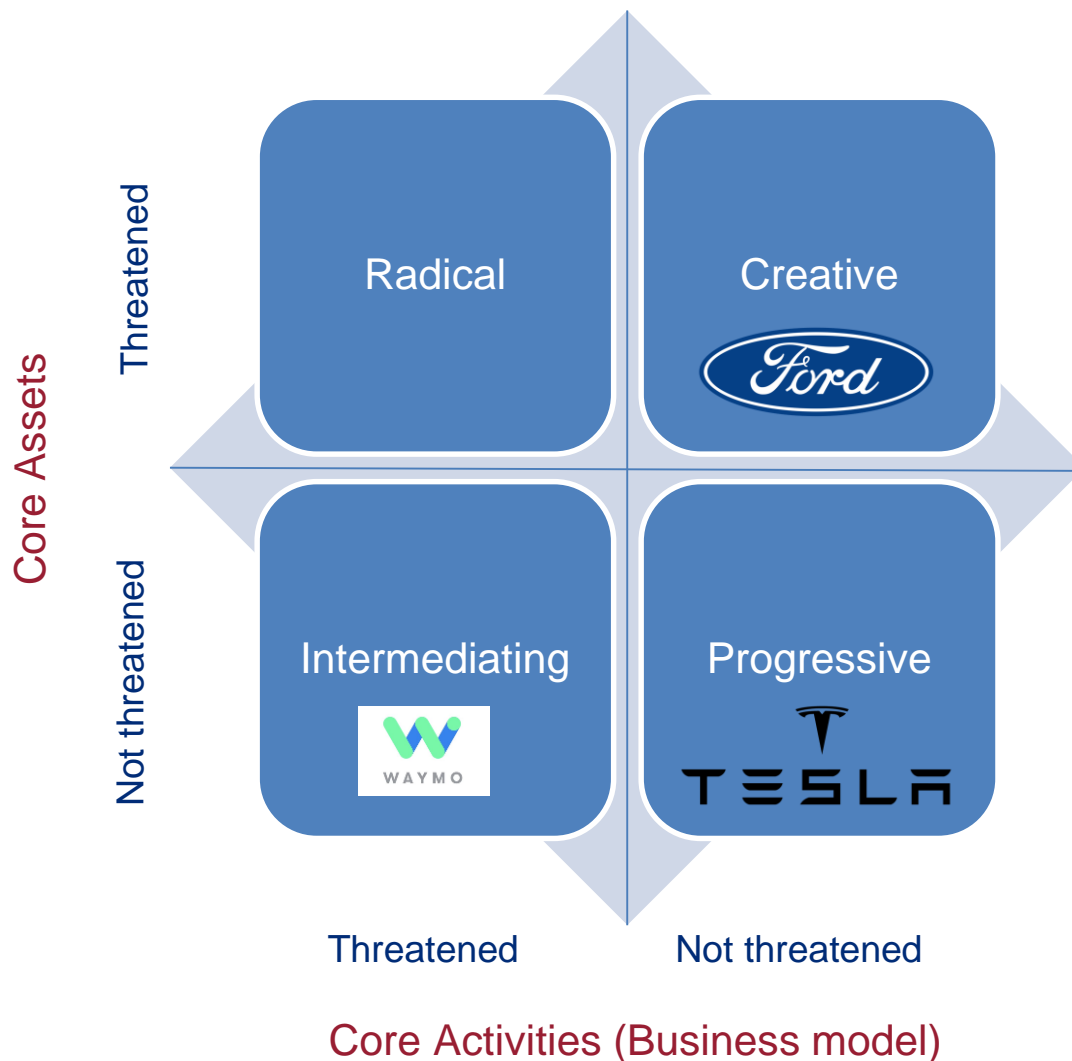
*Consumer*: Mobility-as-a-Service will account for 55% as consumers forgo ownership

*Business*: Mobility-as-a-Service will account for 43% as businesses use autonomous vehicles in freight and service delivery

## Passenger Economy: Global Sales 2050E



*($ in trillions)*

$0.20

$2.97

$3.73

- Consumer: Mobility-as-a-Service
- B2B: Mobility-as-a-Service
- Other

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# What kind of a change is this industry undergoing?



**Core Assets** (vertical axis: Threatened / Not threatened)

**Core Activities (Business model)** (horizontal axis: Threatened / Not threatened)

Quadrants:
- Radical (Core Assets Threatened, Core Activities Threatened)
- Creative (Core Assets Threatened, Core Activities Not threatened) — Ford
- Intermediating (Core Assets Not threatened, Core Activities Threatened) — Waymo
- Progressive (Core Assets Not threatened, Core Activities Not threatened) — Tesla

## Waymo
Core asset of data expertise isn't threatened, but business model of how data is ultimately used for AV is threatened

## Tesla
Core assets and activities aren't threatened due to its presence in semi-autonomous vehicles

## Ford
Core asset of manufacturing expertise is being threatened as AV technology starts to add more value in the equation, but core activities of how cars are sold aren't threatened

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# Technology: Era of Ferment

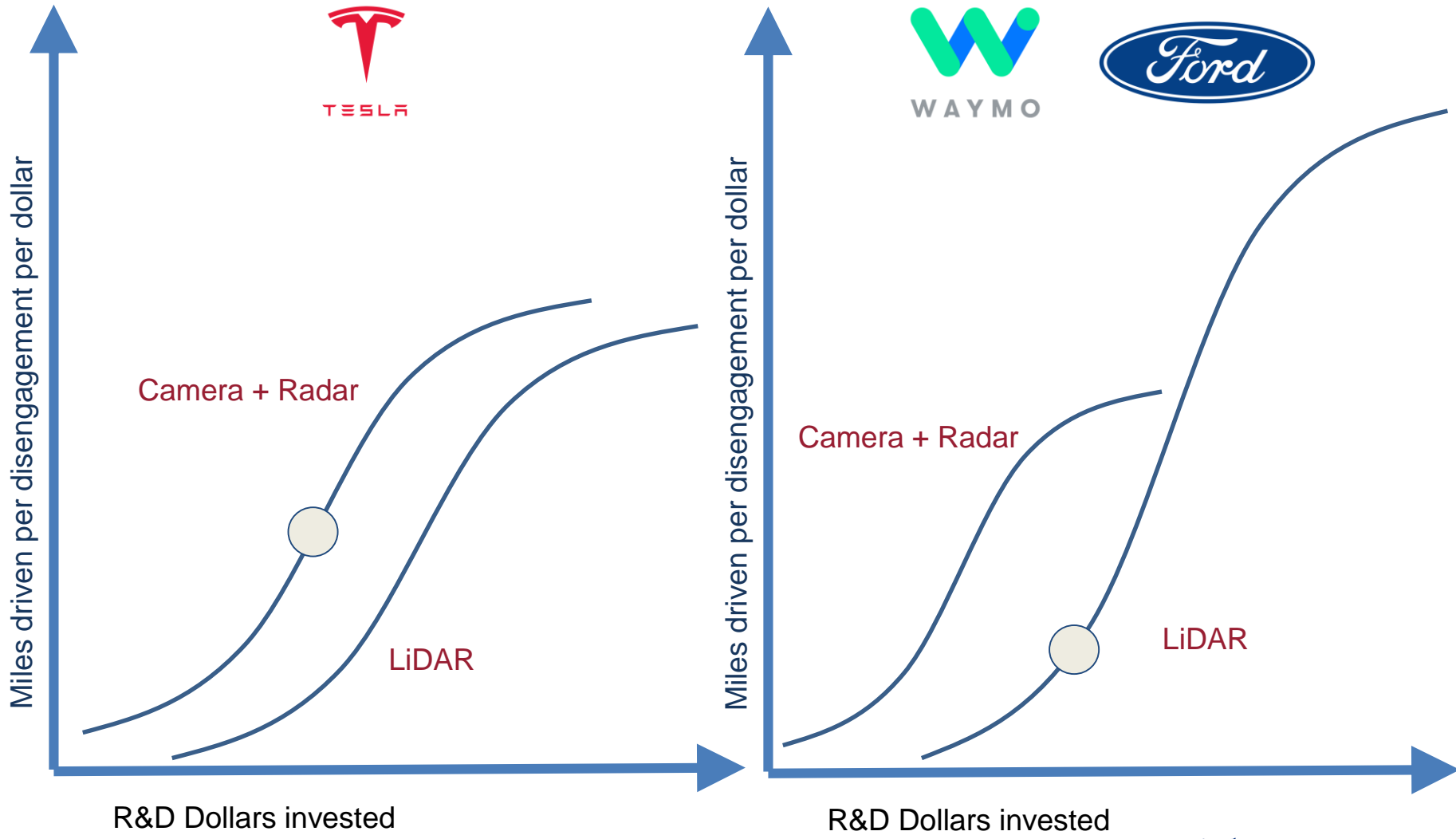|  | **WAYMO** | **TESLA** | **Ford** |
|---|---|---|---|
| **Sensors** | In-house LiDAR(s) + Ultrasonic Radar(s) + Cameras<br>Supports Level 4 autonomy | Camera(s) + Ultrasonic sensors + radar, no LiDAR<br>Supports Level 3 autonomy | LiDAR - invested in *Velodyne*<br>Camera(s) + Radar investments |
| **Software / AI** | Algorithm development since '09<br>Extensive data & compute resources<br>Core competency in AI | Algorithm developed internally<br>Access to data - installed base<br>Price-safety trade-off (disengagements / million miles) | Acquired<br>*SAIPS* - AI/computer vision<br>*Argo AI* - Virtual driving system<br>*CivilMaps* - 3D mapping |
| **Hardware** | Intel's suite of processors + Memory + FPGA + Mobileye camera technology | Mobileye in past<br>Now, Nvidia Drive PX + discrete GPUs | Existing suppliers<br>Purchase chips from outside vendors / undisclosed |

*NO DOMINANT DESIGN…*

# Tesla bets on riding existing S-curve while Waymo invests in future



Miles driven per disengagement per dollar

Camera + Radar

LiDAR

R&D Dollars invested

Miles driven per disengagement per dollar

Camera + Radar

LiDAR

R&D Dollars invested

# Markets: B2B, B2C, or Technology Provider

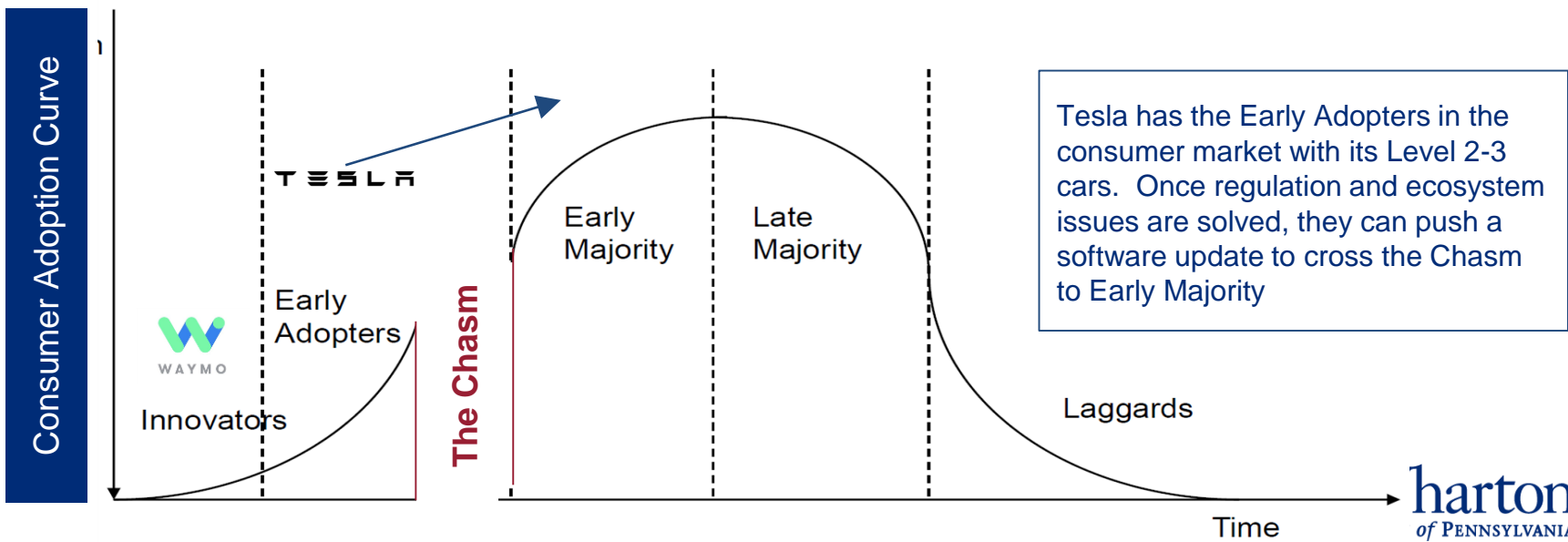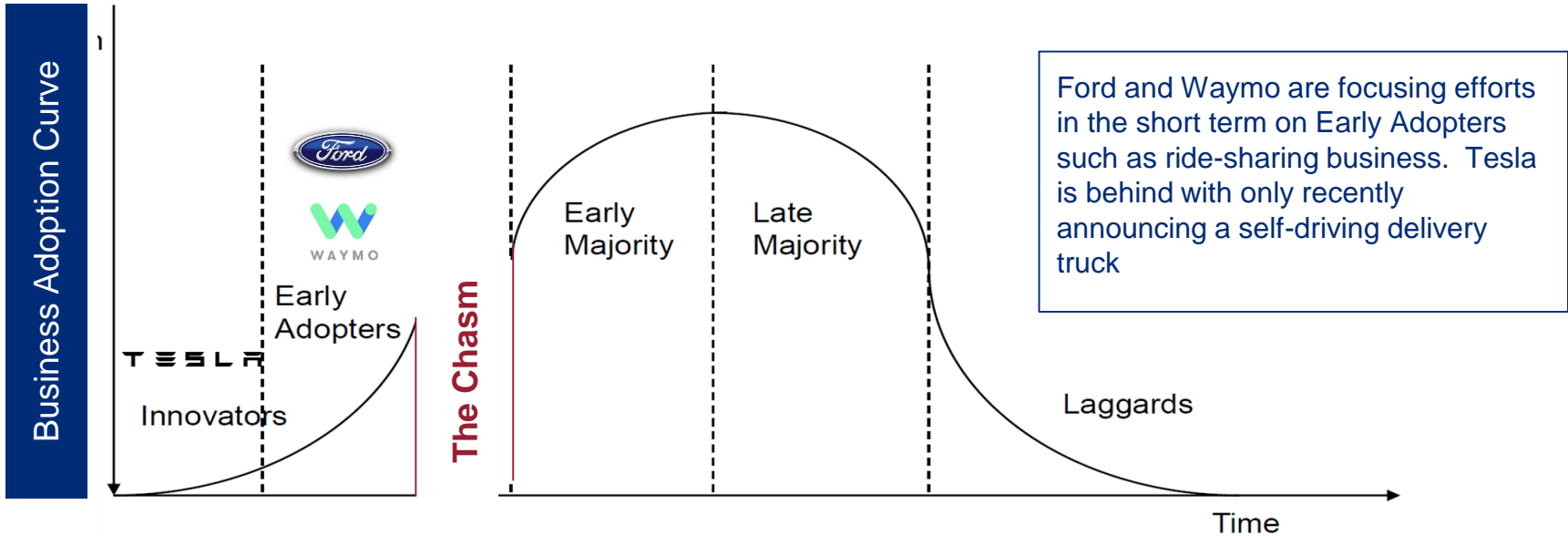|  | | |
|---|---|---|
| **WAYMO** | **TESLA** | **Ford** |
| *Short-term goal* - Waymo is targeting ride-hailing and trucking businesses | Started by serving high-income individual consumers | By 2021, Ford aims to create an AV Fleet for businesses - Delivery & Taxi Services |
| *Long-term goal* - target to mass market of consumer-owned vehicles | From Roadster to Model 3, Tesla's goal has been to progressively move to mass-market consumers | Vehicles will be able to operate in specific "geo-fenced" areas |
| Initial launch in Phoenix structured as a ride-hailing service in limited parts of the city | With unveiling of Semi-Truck in Nov 2016, Tesla is now entering the business market. The trucking industry is a potential early adopter of AVs | No announced plans to release a consumer autonomous vehicle |

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# Forecasted Adoption Curve of Autonomous Vehicles

**Business Adoption Curve**

Ford

WAYMO

The Chasm

Early Adopters

TESLA

Innovators

Early Majority

Late Majority

Laggards

Time

Ford and Waymo are focusing efforts in the short term on Early Adopters such as ride-sharing business. Tesla is behind with only recently announcing a self-driving delivery truck

**Consumer Adoption Curve**

TESLA

WAYMO

The Chasm

Early Adopters

Innovators

Early Majority

Late Majority

Laggards

Time

Tesla has the Early Adopters in the consumer market with its Level 2-3 cars. Once regulation and ecosystem issues are solved, they can push a software update to cross the Chasm to Early Majority

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# Value creation and Value Capture move away from OEM's



**Value Capture in Auto Industry (2017)**

Software(10%)
Hardware(90%)

**Value Capture in Auto Industry (2040)**
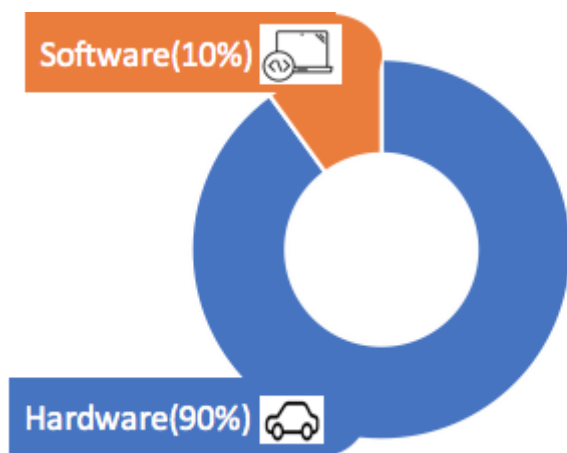
Content(20%)
Software (40%)
Hardware(40%)
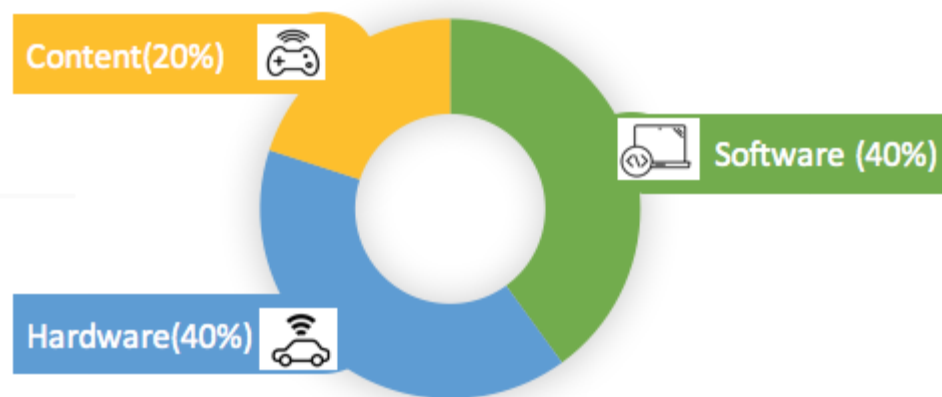
*Industry structure going the way of the PC/smartphone industry where value capture is driven by building an ecosystem*
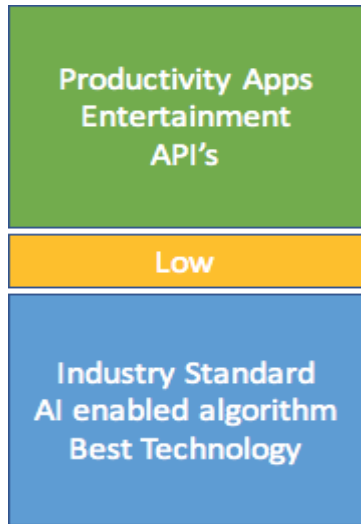
# Business Models



**Waymo**

*Value capture* - Sell software suite in partnership with OEM's

Monetize via data and content partnerships

Lead industry standards for sensing technology

| Productivity Apps Entertainment API's |
|---|
| Low |
| Industry Standard AI enabled algorithm Best Technology |

**Tesla**

*Value capture* - Direct sales

*Tipping Strategy* - Complements such as free charging, software upgrades, improved design

| Limited content |
|---|
| High |
| Software upgrades EV ecosystem Value for money |

**Ford**
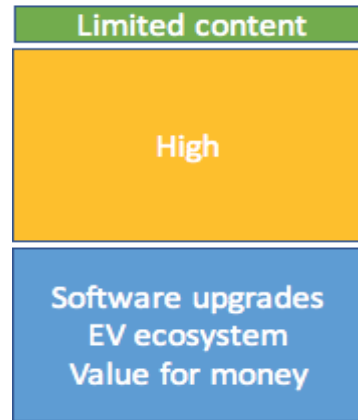
*Value capture* - Sale of autonomous fleet to businesses - Domino's, Lyft

No plans to develop content partnerships

Technology potential is unproven

| High |
|---|
| Existing relationships Brand Value Network of suppliers, vendors etc. |

🟩 Complementary goods   🟧 Installed base   🟦 Core offer

# The Autonomous Vehicle Ecosystem is Not Ready

- Increased mobility of underserved segment (eg. seniors)
- Develop improved home delivery options
- Change in retail landscape due to demographic shift

- Fleet financing models and companies to support growth of shared mobility model
- Auto loans and leasing models will cease to exist due to decrease in personal owned vehicles

- New business model to develop experience based insurance
- Shift from personal liability models to catastrophic system failure insurance
- Develop new risk models to evaluate autonomous cars and shared mobility

- Invest in infrastructure to meet increased demand for connectivity
- Identify advertising, subscription and data monetization opportunities
- Develop multimedia and information solutions for autonomous vehicles

**Effects on complements in the ecosystem**

Retail

Finance

Insurance

Public Sector

Telecom and Media

Transportation

Legal

Energy

- Create and approve regulations for autonomous vehicles
- New consumption-based, dynamic taxation models
- Reduction in revenues due to decreased number of vehicles

- Develop new business models for long haul trucking and movement of goods
- Substitution of traditional taxis, limos and rental vehicles

- Develop Legal expertise to litigate accidents caused by autonomous vehicles

- Drop in revenues due to lower miles driven and reduced no. of automobiles
- Accelerated transition to alternative fuels
- Business models such as subscription service for fueling autonomous cars

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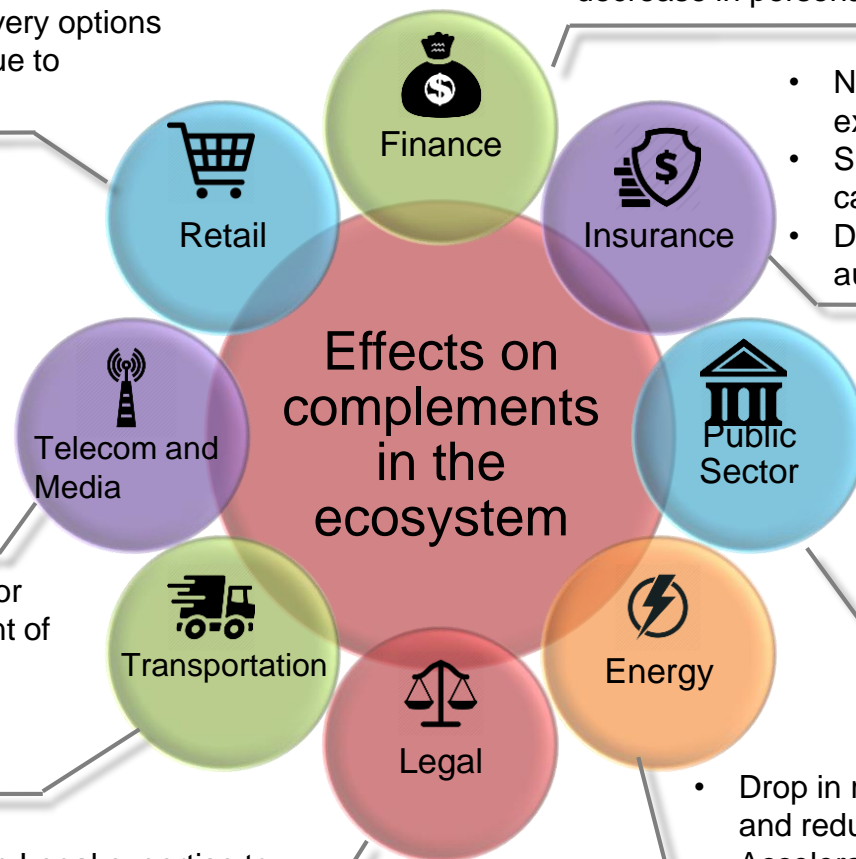
# Recommendations

|  | WAYMO | TESLA | Ford |
|---|---|---|---|
| 👍 | Focus on Technology R&D<br>Advertising, Entertainment | Vertically Integrated Low-cost solution | Supply-chain and manufacturing expertise<br>Track record of delivering fleet vehicles (e.g. business) |
| 👎 | Dependence on OEMs Lack of Car brand | Lack of LiDAR<br>Limited experience in car manufacturing<br>Low adoption of EV | Lack of expertise with building newer technologies<br>Integrating acquisitions with their existing R&D and operations |
| 📋🔍 | Primary focus on Software/AI driven ecosystem<br><br>Leverage extensive partnerships<br><br>Become pioneer, build industry standard | Partnerships with complementary goods to increase EV installed base<br><br>Invest in LIDAR directly or by acquiring a startup | Focus on Tech development, business development and finding fleet buyers for vehicles<br><br>Collaborate with others to lobby government |

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# Learnings

- **Autonomous Vehicles is an emerging class of transportation technology, and is perhaps building a new platform**
  - Highly complex and dynamic
  - Sensors + Hardware + Software + Manufacturing + Services
  - To drive network effects AVs will need developers/partners to build services and drive more business/consumer adoption

- **Strategy is about making choices.** Each firm has made choices on business models. which markets to enter, and what technology to use:
  - Ford - focus on building cars, acquiring tech, and selling to businesses
  - Waymo - focus on algorithms/software
  - Tesla - focus on consumers and utilizing existing sensor

- **Ecosystems are needed for new technologies to succeed and overtake existing technologies.**
  - In order for any of these firms to succeed the ecosystem still needs to be built out, namely government safety and infrastructure

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Q&A