Self-Driving Cars

Knowledge Sharing Webinar

Dolcera
Your Knowledge Partner
About Us

**Dolcera** is an information services company based in California, and India.

“We help companies make better business decisions regarding every technology involved in their business”

Dolcera’s clients include dozens of Fortune 500 companies across US, Europe and Asia.

Current team strength of about **130 employees** with experts in engineering, electronics, computer science, physics, biotechnology, biomedical, pharmaceutical etc.
Some Recent Webinars

- Drones
- Cloud Computing
- 3D Printing
- Ambient IQ
- Wearable Technology
- 4G LTE
## Executive Summary

### Business
- Major companies planning to commercially launch self-driving cars during 2020-2025
- Global sales of self-driving cars estimated to be 11.8 million in 2035, at 48.3% CAGR
- Revenue opportunities total $87 billion in 2030, electronics and software command 50% share
- Mobility as a Service emerge as the most lucrative business model

### Technology
- Major innovations happening in processing platform, LiDAR and mapping technology
- Camera technology may substitute laser and radar technology in future; Mobileye emerging as the game-changer
- Software will become key competitive differentiator

### Patent Landscape
- Patent activity has witnessed a surge during last four years from Automobile OEMs and suppliers
- US, Japan, China and Europe are major geographies for filing patents
- China has surpassed US in terms of patents filed on year-on-year basis

### Key Challenges
- The major challenges for the increased adoption of self-driving cars will be
  - Consumer acceptance
  - Technology improvement and
  - Regulatory
What is Self-Driving Car?

- Capable of sensing its environment and navigating without human input
- Technologies such as radar, LiDAR, GPS and camera vision help the vehicle feel their surroundings
- Advanced control systems (algorithms) interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage

ADAS (Advanced Drive Assistance System) applications enabling self-driving:

- Adaptive cruise control (ACC)
- Lane-departure warning (LDW)
- Lane-keep support (LKS)
- Lane-change Assist (LCA)
- Rear collision warning (RCW)
- Forward collision warning (FCW)
- Blind-spot detection (BSD)
- Pedestrian detection
- Traffic-sign-recognition (TSR)
- Emergency brake assist (EBA)
- Park assist (PA)
- Night vision (NV)
Autonomy is not a binary function

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**SAE distinguishes between High and Full level of automation; NHTSA consider both classes as Level 4!**
We still have a long way to go

Safety & Convenience
- Seatbelt reminder, Antilock Braking System, Airbags, 1970’s
- Electronic Stability Control, 1987

Advanced Driver Assisted Systems
- Forward Collision Warning, Rear Camera, Park Assist, 2000-2002

Partially Autonomous
- Lane Departure Warning, 2014
- Surround View, Drowsiness Alert, 2007-2010

Autonomous
- Urban Autopilot, 2022+
- Highway Autopilot with Lane Changing, 2018
- Auto-parking, Traffic Jam Autopilot 2016-17
- Single Lane Highway, 2016

1970-2000
2000-present
2016-2022
2022+
Driverless Trucks are already in operation

Caterpillar

- Utilizes a combination of sensors such as radar and GPS to navigate the vehicle
- Operated around a pre-defined course from loading units to dump locations (waste dumps, stockpiles and crushers)
- The trucks contain a supervisory computer that collects and directs information on target course
- The speed of the trucks is sent wirelessly from the supervisory computer to the trucks, while the GPS provides their position
- Remotely monitored and controlled from the central control room
- Deployed predominantly in mines to address SAFETY of workers and increase in PRODUCTIVITY

Komatsu

Remotely Controlled – Not Truly Autonomous!
Self-Driving Cars: Launch Timeline

Google

Nissan

Tesla

Jaguar Land Rover

Toyota

Audi

Honda

Hyundai

Volvo

Baidu-BMW

Daimler

Volkswagen

GM

Uber

Ford

Miles travelled per disengagement
- **Google**: 1,244 miles
- **Delphi**: 41 miles
- **Volkswagen**: 57 miles
- **Nissan**: 14 miles
- **Bosch**: 1.5 miles
- **Mercedes**: 1.2 miles

- Drivers in Google’s SDV took control for less than 1% of the overall miles driven
- **Perception discrepancy** and **Software discrepancy** were the top reasons for disengagement
How Big is The Market?

Sales of Self-driving Cars

- Global sales of self-driving cars will grow at **CAGR of 48.3%** from nearly 230 thousand in 2025 to 11.8 million in 2035
- Initial adoption would be high in US and Europe
- By 2035, China will surpass Europe and capture the second largest share

Market Share: 2035

- **ROW**: 27%
- **NA**: 29%
- **Europe**: 20%
- **China**: 24%

Where is the VALUE?

- **Elec & Software grabs 50% of the $85 Bn opportunity**!

Software will create a huge chunk of the value

Source: IHS Reports, Lux Research Report, Yole Report, Press releases
A lot of components go into making a car Self-Driven

**LiDAR**
Light Detection and Ranging System. The car uses lasers, spinning at upwards of 900 rpm, to bounce pulses of light off the surroundings to generate a 360 degree view.

**GPS**
Geo Positioning Service combined with tachometers, altimeters and gyroscopes to pin-point the car with high accuracy.

**Video Cameras**
Camera recognizes lane markings, road signs, objects, traffic lights, pedestrians and keep track of the position of the other vehicles.

**Radar Sensors**
Track nearby objects and vehicles and alert to possible collisions.

**Ultrasonic Sensors**
Measure velocity and proximity to nearby objects in traffic and during parking.

**Processing Platform**
The processor analyzes information from various sensors and controls steering, acceleration and braking. The software understands the rules of the road.

*Figure illustrates how hardware technologies work together to sense 360° around the vehicle, to maximize safety, and enabling driving automation.*
LiDAR in Self-driving Car

A pulse of light is emitted and the precise time is recorded.

The reflection of that pulse is detected and the precise time is recorded.

Using the constant speed of light, LiDAR instrument can calculate the distance between itself and the target with high accuracy.

Knowing the position and orientation of the sensor, the XYZ coordinate of the reflective surface can be calculated.

*By repeating this in quick succession the instrument builds up a complex and accurate map of the car’s surroundings.*
Innovation in LiDAR

PUCK™ from Velodyne

- 3X Form Factor Reduction
- 10X Price Reduction
- 200m range with +/- 3 cm accuracy
- 16 lasers, 300,000 points per second
- 360° Horizontal FOV, ± 15° Vertical FOV
- Dimensions: 103 mm diameter x 72 mm height, 830 g
- Price: $7,999

S3 from Quanergy

- 3X Form Factor Reduction
- 300X Price Reduction
- 150m range with +/- 5 cm accuracy at 100 m
- 8 lasers
- 120° Horizontal & Vertical FOV
- Dimensions: 9 cm x 6 cm x 6cm
- Price: $250 (in mass production)
Cameras in Self-Driving Car

Camera systems follow the human model

One or more cameras view the scene and provides overlapping images to the software

Image processing algorithms then identify objects such as cars, road markings, road signs and pedestrians

Applications include
- Road sign recognition
- Lane departure warning
- Forward collision warning
- Pedestrian collision warning

The image processing software intuit a 3D world from the 2D image, determining things like depth of field, peripheral movement, and dimensionality of objects
Innovation in Processing Platform

Mobileye EyeQ4®

- Innovative multi-threading technology, including multiple MIPS CPUs, for superior handling of data control and management
- **2.5 teraflops computational capabilities** at amazingly low 3 watts of power
- Multiple specialized Vector Microcode Processors (VMPs) take care of ADAS-related image processing tasks
- Accept input from multiple systems including cameras, LiDAR and radar
- Ability to process information from 8 cameras simultaneously at 36 frames per second

NVIDIA DRIVE PX 2

- Consists 2 next-generation Tegra® processors and 2 next-generation discrete GPUs, based on the Pascal™ architecture
- **8 teraflops computational capabilities**, or **24 trillion operations per second**
- Ability to process inputs of 12 video cameras, LiDAR, radar and ultrasonic sensors
- **Integrated with NVIDIA DIGITS™**, a trained neural network model serving as deep learning platform, Drive PX 2 system is able to recognize up to 2,800 images per second
Radar in Self-Driving Car

A radar transmits radio waves or microwaves that reflect from any object in their path.

**Long range radar (76 to 81 MHz)**
- Range up to 200 m
- Adaptive Cruise Control

**Medium range radar (76 to 81 MHz)**
- Range up to 60 m
- Lane change assist
- Blind spot detection
- Emergency brake assist
- Cross-traffic alert

**Short range radar (24 to 26 GHz)**
- Range from 0.2-30 m
- Rear collision warning
- Parking assist

The radio waves are processed to determine the range, angle, or velocity of objects.
Innovation in Mapping Technology

Mobileye REM (Road Experience Management)

Crowd Sourcing Mapping Technology

- Scalable camera based mapping technology
- **Accuracy of about 4in (10cm)** compared with GPS’ 33ft (10m)
- EyeQ processing platforms extracts landmarks and roadway information
- Low bandwidth usage, approx. 10Kb per kilometer of driving
- Backend software on the cloud integrates the segments of data sent by all vehicles with the on-board software into a global map
Short & medium-range radar/laser sensors might be replaced with camera systems

WHY?
- Raw video can be used to identify and assess hazardous conditions (not possible with radar)
- Image analytics can process the video to extract key information

HOW?
- Support both video processing and image processing
- Provision of parallel data paths for associated algorithms
- High connectivity, memory bandwidth and processing power
A very complicated industry value-chain

Is Mobileye the next game-changer?
Auto players are looking to acquire technology

### Software & Processing Platform

<table>
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<tr>
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<tr>
<td>Mar, 2016</td>
<td>GM</td>
<td>Cruise Automation</td>
<td>Cruise develops sensors to turn regular vehicles into self-driving vehicles</td>
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<td>Mar, 2016</td>
<td>TOYOTA</td>
<td>JAYBRIDGE ROBOTICS</td>
<td>Toyota hired the 16-member Jaybridge team with experience in developing, testing and supporting autonomous vehicle products</td>
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<td>Dec, 2015</td>
<td>TOYOTA</td>
<td>Preferred Networks</td>
<td>Preferred Networks develops real-time machine learning technologies (artificial intelligence)</td>
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<td>Dec, 2015</td>
<td>Valeo</td>
<td>Peiker</td>
<td>Peiker develops on-board telematics and mobile connectivity solutions</td>
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<tr>
<td>Aug, 2015</td>
<td>DELPHI</td>
<td>Ottomatika</td>
<td>Ottomatika develops software and systems for advanced driving assistance and vehicle automation systems</td>
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<td>May, 2015</td>
<td>Continental</td>
<td>Elektrobit</td>
<td>Elektrobit develops embedded solutions, cloud computing and services for the automotive industry</td>
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<tr>
<td>April, 2016</td>
<td>Intel</td>
<td>Yogitech</td>
<td>Yogitech is a chipset designer focused on safety in Robotics and self driven cars, Arynga focuses on OTA (Over the Air) updates</td>
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### LiDAR & Sensors

<table>
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<tbody>
<tr>
<td>Mar, 2016</td>
<td>Continental</td>
<td>Cognivue</td>
<td>Cognivue develops Image Cognition Processors for ADAS applications</td>
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<td>Sep, 2015</td>
<td>Freescale</td>
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<td>German automakers acquired Nokia’s mapping technology for use in development of self-driving cars</td>
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### Mapping Technology

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<td>Aug, 2015</td>
<td>Airbus, Mercedes-Benz, Audi</td>
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<td>German automakers acquired Nokia’s mapping technology for use in development of self-driving cars</td>
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</table>
**A lot of marriages & alliances to bolster position**

### Software & Processing Platform

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<th>Company 2</th>
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<td>May, 2016</td>
<td>Google</td>
<td>FCA</td>
<td>To build a fleet of 100 2017 Pacifica by integrating Google's self-driving system, including its sensors and software</td>
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<td>May, 2016</td>
<td>Ford</td>
<td>Pivotal</td>
<td>To develop cloud-based software platform and analytics capabilities for autonomous vehicles</td>
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### Mapping Technology

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<td>Feb, 2016</td>
<td>Mobileye</td>
<td>GM, Nissan, VW</td>
<td>To integrate Mobileye’s new Road Experience Management™ mapping technology in their fleet</td>
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### LiDAR

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<td>Jul, 2015</td>
<td>Delphi</td>
<td>Quanergy</td>
<td>To develop affordable LiDAR for real-time 3D mapping and object detection, tracking, and classification</td>
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### Ecosystem

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<td>Jan, 2016</td>
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<td>Lyft</td>
<td>To develop and create an integrated network of on-demand autonomous vehicles in the U.S.</td>
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<td>Oct, 2015</td>
<td>Volvo</td>
<td>Autoliv</td>
<td>To collaborate on development of integrated active and passive safety systems for autonomous vehicles</td>
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**Partnerships happening across multiple technologies!**
OEMs & Suppliers have been investing in the technology for a while.

Patent Activity has witnessed a surge in last 4 years.
A huge surge of activity in China

Patents by Geography

- High patent activity in all major countries

Patents Trend by Geography

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### Google: Patents

#### Patents by Technology Category

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#### Country-wise Patents

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This invention provides a method for changing the control strategy of an autonomous vehicle by determining the behavior of its nearby objects.

- Detecting an object indicated by sensors
- Classifying the object based on stored previous data
- Identifying the behavior of the object, where behavior could be the change in control strategy like changing from traveling on a first lane to travelling on a second lane
- Based on the behavior of the object, altering the control strategy of the autonomous vehicle.
Methods and systems for detecting weather conditions including wet surfaces using vehicle onboard sensors

This invention provides a method for detecting weather conditions including wet surfaces using vehicle onboard sensors

- Receiving laser data collected for an environment of a vehicle, wherein the laser data includes a plurality of laser data points
- Receiving radar data collected for the environment of the vehicle, wherein the radar data is indicative of a presence of one or more tracked objects in the environment of the vehicle
- Determining laser data points which are associated with the one or more tracked objects in the environment and which are not associated with any of the tracked objects in the environment indicated by the radar data
- Identifying that a surface on which the vehicle travels is wet because some of the laser data points are unassociated with the one or more tracked objects in the environment indicated by the radar data.
Mobileye: Patents

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This invention provides a method for estimating distance to an obstacle from a moving automotive vehicle equipped with a monocular camera.

- The camera acquires in real time multiple image frames including respectively multiple images of the object within a field of view of the camera.
- An edge is detected in the images of the object.
- Based on the edge detection, a smoothed measurement is performed of a dimension the edge.
- Range to the object is calculated in real time, based on the smoothed measurement.
This invention provides a method for an autonomous vehicle to navigate safely and accurately by curb detection and pedestrian hazard assessment.

- The detection system acquires a plurality of images of an area forward of the vehicle, the area including a curb separating a road surface from an off-road surface or including a pedestrian.

- It determines a plurality of curb edge lines in the plurality of images and identifies at least one edge line as an edge line of the curb or assess whether the pedestrian presents a hazard.

- It performs an action to avoid a collision with the pedestrian, based on the assessment.

- Vehicle navigates safely and accurately by curb detection and pedestrian hazard assessment.
The car experience will completely change once they go autonomous

- **Playing Games**
  Utilize the car’s gaming center to play games with friends

- **Watching Movies**
  Self-driving cars will serve as entertainment hubs, featuring built in tablets and TVs

- **Working**
  Engage in office work while the car becomes a mobile office

- **Texting / Talking with Friends**
  Technology, both new and current, will adapt to social travels

- **Sleeping**
  Some commuters might consider planning their lives to get a full 8 hours of sleep during their commutes

- **Reading**
  Reading a book of choice, articles or stories based on the expected travel time.

- **Other**
  These respondents listed activities such as ‘watch the road’ or ‘enjoy the scenery.’

Source: Sparks & Honey
Huge market potential populous geographies

### Willingness to try Self-driven Car

<table>
<thead>
<tr>
<th>Country</th>
<th>Global</th>
<th>US</th>
<th>UK</th>
<th>France</th>
<th>Germany</th>
<th>Netherlands</th>
<th>China</th>
<th>Japan</th>
<th>India</th>
<th>Singapore</th>
<th>UAE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willingness</td>
<td>58%</td>
<td>52%</td>
<td>49%</td>
<td>58%</td>
<td>44%</td>
<td>41%</td>
<td>75%</td>
<td>36%</td>
<td>62%</td>
<td>60%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Global willingness to take a ride in a fully self-driving car (for example as a test drive, taxi or rental car)

Willingness to try self-driving car more in developing countries like India and China

### Ideal manufacturer of a self-driving car

<table>
<thead>
<tr>
<th>Country</th>
<th>Traditional Car Manufacturer</th>
<th>Technology Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>46%</td>
<td>15%</td>
</tr>
<tr>
<td>US</td>
<td>32%</td>
<td>21%</td>
</tr>
<tr>
<td>UK</td>
<td>44%</td>
<td>10%</td>
</tr>
<tr>
<td>France</td>
<td>50%</td>
<td>13%</td>
</tr>
<tr>
<td>Germany</td>
<td>58%</td>
<td>7%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>33%</td>
<td>10%</td>
</tr>
<tr>
<td>China</td>
<td>45%</td>
<td>20%</td>
</tr>
<tr>
<td>Japan</td>
<td>57%</td>
<td>9%</td>
</tr>
<tr>
<td>India</td>
<td>47%</td>
<td>25%</td>
</tr>
<tr>
<td>Singapore</td>
<td>47%</td>
<td>16%</td>
</tr>
<tr>
<td>UAE</td>
<td>44%</td>
<td>19%</td>
</tr>
</tbody>
</table>

The most preferred manufacturer of a self-driving car is a traditional OEM

Ideal combination would be a traditional OEM in cooperation with a technology company

Source: World Economic Forum
Consumers are willing to pay up to $5,000 more for a fully self-driving car.

### Willingness to pay for self-driving car

- **Global**: 62% willing to pay up to $5,000 more
- **US**: 57% willing to pay up to $5,000 more
- **UK**: 64% willing to pay up to $5,000 more
- **France**: 61% willing to pay up to $5,000 more
- **Germany**: 73% willing to pay up to $5,000 more
- **Netherlands**: 57% willing to pay up to $5,000 more
- **China**: 52% willing to pay up to $5,000 more
- **Japan**: 58% willing to pay up to $5,000 more
- **India**: 51% willing to pay up to $5,000 more
- **Singapore**: 85% willing to pay up to $5,000 more
- **UAE**: 72% willing to pay up to $5,000 more

**Consumers willing to pay up to $5,000 more for a fully self-driving car**

### Engine technology in self-driving car

- **Hybrid**: 37%
- **Electric**: 29%
- **Don't Know**: 16%
- **Trad. Combustion**: 9%
- **Fuel Cell**: 9%

**In consumers’ minds, self-driving cars will be either hybrid or electric**

Source: World Economic Forum
Consumer Concerns

**Willingness to allow children to ride alone in a fully self-driving car**

- **Global**: 45% Not likely, 20% Neutral, 35% Likely
- **US**: 51% Not likely, 22% Neutral, 27% Likely
- **UK**: 59% Not likely, 23% Neutral, 18% Likely
- **France**: 49% Not likely, 24% Neutral, 27% Likely
- **Germany**: 53% Not likely, 23% Neutral, 24% Likely
- **Netherlands**: 68% Not likely, 19% Neutral, 13% Likely
- **China**: 40% Not likely, 14% Neutral, 46% Likely
- **Japan**: 54% Not likely, 20% Neutral, 26% Likely
- **India**: 19% Not likely, 23% Neutral, 58% Likely
- **Singapore**: 53% Not likely, 25% Neutral, 22% Likely
- **UAE**: 46% Not likely, 25% Neutral, 29% Likely

45% Parents averse of allowing their children to ride alone in a fully self-driving car

**Willingness to use a shared self-driving taxi**

- **Global**: 38% Not likely, 25% Neutral, 37% Likely
- **US**: 46% Not likely, 26% Neutral, 28% Likely
- **UK**: 56% Not likely, 27% Neutral, 17% Likely
- **France**: 45% Not likely, 21% Neutral, 34% Likely
- **Germany**: 49% Not likely, 25% Neutral, 26% Likely
- **Netherlands**: 55% Not likely, 30% Neutral, 15% Likely
- **China**: 17% Not likely, 21% Neutral, 62% Likely
- **Japan**: 51% Not likely, 25% Neutral, 24% Likely
- **India**: 16% Not likely, 18% Neutral, 66% Likely
- **Singapore**: 36% Not likely, 35% Neutral, 29% Likely
- **UAE**: 27% Not likely, 25% Neutral, 48% Likely

38% Consumers, specially women, are reluctant to share a self-driving taxi with strangers

Source: World Economic Forum
Consumer acceptance might be the key challenge in speedy adoption of the technology

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Addressing the challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Acceptance – 56%</td>
<td>✓ Requires a significant <strong>cultural change</strong></td>
</tr>
<tr>
<td></td>
<td>✓ Public has to <strong>get used to</strong> self-driving cars gradually</td>
</tr>
<tr>
<td></td>
<td>✓ <strong>Trust</strong> in self driving cars would be developed gradually</td>
</tr>
<tr>
<td>Technology – 44%</td>
<td>✓ Technical challenge of <strong>interacting with pedestrians</strong> in the city needs to be solved</td>
</tr>
<tr>
<td></td>
<td>✓ Technology needs to be <strong>safe and approved</strong> and consumers need to feel safe using them</td>
</tr>
<tr>
<td></td>
<td>✓ Programming the crashes: Who decides on the <strong>right priority for saving lives</strong>?</td>
</tr>
<tr>
<td>Regulation – 28%</td>
<td>✓ California, Nevada, Michigan and Florida have <strong>passed laws</strong> related to the testing of autonomous vehicles</td>
</tr>
<tr>
<td></td>
<td>✓ Washington, Texas, Illinois and New York are <strong>considering passing laws</strong></td>
</tr>
<tr>
<td></td>
<td>✓ The National Highway Traffic Safety Administration (NHTSA) said the <strong>artificial intelligence</strong> system piloting a self-driving Google car could be <strong>considered the driver</strong> under federal law</td>
</tr>
<tr>
<td></td>
<td>✓ UK, Germany, France and Singapore have <strong>started testing</strong> self-driving cars</td>
</tr>
</tbody>
</table>

Source: World Economic Forum, News Articles, Company News
Self-Driving Cars will change every aspect of our lives

**Social**

- **Fewer traffic accidents and traffic congestion** – Self-driving cars can be programmed to obey traffic laws and space out automatically, thereby eliminating the problem.

- **Fuel efficiency** – Self-driving cars can auto-tune acceleration profiles to increase fuel efficiency and reduce harmful emissions. Additionally, with *drafting* amount of fuel required will decrease considerably.

- **Reduction of car parking spaces** – Self-driving cars could be parked far from actual site and summoned as and when required.

**Individual**

- **Improved mobility** – Self-driving cars will improve mobility for the elderly, disabled and children.

- **Enhanced productivity** – Self-driving cars would make commute time productive time, for whatever pursuits we desire.

- **Reduced stress** – Self-driving cars would enable people to have a relaxing and enjoyable ride.

**Business**

- **Affordable real estate** – As more parking space in cities become available, property values would decline and become more affordable.

- **Development** – Valuable real estate could be reclaimed for more beneficial social and economic purposes.

- **Increased suburbanization** – More people would shift to suburbs, as longer commutes become more palatable.

- **Increased savings from rent** – Businesses can move to suburbs as customer mobility ceases to be constraint.

- **Lower delivery costs** – Self-driving cars can reduce delivery costs for florists, dry cleaners, and pizza companies.
A huge sleuth of business opportunities will be opened up

<table>
<thead>
<tr>
<th>Sector</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive OEM</td>
<td>✓ Value shift from asset ownership and driving performance to <strong>enhancing passenger experience</strong>&lt;br&gt;✓ Investment in advanced <strong>systems and sensors</strong></td>
</tr>
<tr>
<td>Telecom Companies</td>
<td>✓ Increased demand for connectivity (<strong>4G/5G network</strong>) and broadband&lt;br&gt;✓ <strong>New revenue opportunities</strong> due to increased need for higher data transfer speeds, greater data storage capacities, faster V2V and V2I data exchanges</td>
</tr>
<tr>
<td>Media Companies</td>
<td>✓ <strong>Increased consumption of multimedia and information</strong>&lt;br&gt;✓ <strong>Increase in advertising and subscription revenues</strong> and data monetization opportunities&lt;br&gt;✓ Development of innovative <strong>marketing campaigns</strong></td>
</tr>
<tr>
<td>Technology Providers</td>
<td>✓ High demand for <strong>user data analytics</strong> to develop customized offering&lt;br&gt;✓ Rise of <strong>Mobility Management providers</strong>, a new service&lt;br&gt;✓ Emergence of new business model like <strong>subscription based autonomous drive OS</strong> (operating system)&lt;br&gt;✓ Increased demand for <strong>data privacy and security services/software</strong></td>
</tr>
<tr>
<td>Financial Services</td>
<td>✓ <strong>Growth of fleet financing</strong> as shared drive phenomenon picks up&lt;br&gt;✓ Emergence of new business model around <strong>Machine-to-Machine payments</strong> for fuel and toll</td>
</tr>
<tr>
<td>Insurance Providers</td>
<td>✓ Emergence of new <strong>Risk-based and Usage-based insurance products</strong>&lt;br&gt;✓ Paradigm shift from personal liability to <strong>systems-failure insurance</strong> model</td>
</tr>
<tr>
<td>Retail Providers</td>
<td>✓ <strong>Expansion of home delivery options</strong>&lt;br&gt;✓ Opportunity to <strong>relocate from costly downtown area to inexpensive suburbs</strong>, increasing savings</td>
</tr>
<tr>
<td>Public Sector</td>
<td>✓ Development of new <strong>consumption-based dynamic taxation models</strong>&lt;br&gt;✓ Real time data analytics from cars provide opportunity to assist with <strong>urban network planning</strong></td>
</tr>
</tbody>
</table>

Source: Deloitte, McKinsey and Accenture Reports
The business models of future will look completely different

**MaaS - Mobility as a Service?**

1. **Move from personal ownership** of vehicles to a system more reliant on shared access, like Uber
2. **Systematic shift of control** from *driver-only* to *driver assist* to *autonomous drive*
3. **Adoption** of driverless technology by individuals *(will depend on personal preference and economics)*
4. **Adoption** of driverless cars in world of car-sharing

**Google announces plan to create self-driving taxi hiring service as a separate firm!**

- GM invests $500 million in Lyft, sets out self-driving car partnership
- Ford partners with online car-sharing service Getaround (US) and EasyCar Club (UK)
- Daimler AG launched car2go car sharing services in 2013
- Avis Group acquired car-sharing company Zipcar for $500 million in 2013

*Source: Deloitte report, company news and press releases*
For any queries or concerns, please feel free to contact us @ info@dolcera.com