Autonomous Driving at Global Scale

James Peng, Founder & CEO, Pony.ai

11/29/2018
IMPACT OF AUTONOMOUS DRIVING
Transportation today is not efficient or enjoyable

- Roads are congested
- On-road safety not guaranteed
- Inefficient energy usage
Imagine a world in which...

- Traffic congestion is significantly reduced
- Vehicle accidents reduced by over 90%
- Energy savings achieved via vehicle electrification
- ...and commuting becomes enjoyable as time frees up
This technology will change the way we live and the face of our cities.

- Autonomous large volume transit
- Autonomous ride-share
- Micro-mobility
- Reshaped city infrastructure
AI will disrupt mobility-related sectors at the largest scale

<table>
<thead>
<tr>
<th>Sector</th>
<th>Potential incremental value from AI over other analytics techniques, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel</td>
<td>128</td>
</tr>
<tr>
<td>Transport and logistics</td>
<td>89</td>
</tr>
<tr>
<td>Retail</td>
<td>87</td>
</tr>
<tr>
<td>Automotive and assembly</td>
<td>85</td>
</tr>
<tr>
<td>High tech</td>
<td>85</td>
</tr>
<tr>
<td>Oil and gas</td>
<td>79</td>
</tr>
<tr>
<td>Chemicals</td>
<td>67</td>
</tr>
<tr>
<td>Media and entertainment</td>
<td>57</td>
</tr>
<tr>
<td>Basic materials</td>
<td>56</td>
</tr>
<tr>
<td>Agriculture</td>
<td>55</td>
</tr>
<tr>
<td>Consumer packaged goods</td>
<td>55</td>
</tr>
<tr>
<td>Banking</td>
<td>50</td>
</tr>
<tr>
<td>Healthcare systems and services</td>
<td>44</td>
</tr>
</tbody>
</table>

Source: 2018 McKinsey Global Analytics

Travel, Logistics, Automotive

Poised to generate the largest economic and social value
Investment in auto tech startups seeing strong momentum

- Willingness to bet and size of investment increasing substantially
- Almost 50% of investment dollars in 2017 & 2018 come from corporate players

Avg. deal size

- $8M
- $12M
- $11M
- $22M
- $50M

Source: CB Insights
Recent valuation analysis are reaching new highs
Case study: Waymo

Recent analysis on Waymo’s potential valuation represents just **tip of the iceberg** when it comes to the entire industry’s value potential.

### Ride-hailing

- **$80B**
  - Avg. $0.90 / mile
  - International fleet operations (ex-China)

### Freight & Logistics

- **$90B**
  - ~8% capture of global market share
  - Tech addresses driver shortage, increases vehicle utilization

### Tech Licensing

- **$7B**
  - Almost 20% of L4/L5 vehicles globally
  - ~7% of total vehicles

**$175B+**

In expected value
By 2040

*Note: Ex-China
Source: Morgan Stanley Analysis*
AUTONOMOUS DRIVING 101
What you might picture when you think self-driving car…
…but early versions look more like this:
Recent AV revolution is made possible by latest tech advancements…

Autonomous Vehicles

Machine learning

Vehicle technology (e.g. ADAS, electric)

Computing power & chip innovation

Innovation in sensor technology (LiDAR, radar, camera)

Big Data
Primer: What is autonomous?

Driver is in complete control of the vehicle at all times.

The vehicle can assist the driver or take control of either the vehicle’s speed or lane position.

The vehicle can take control of both the vehicle’s speed and lane position in some situations.

The vehicle is in full control in some situations, can monitor the road and traffic, and can notify the driver when she must take control.

The vehicle is in full control for the entire trip in these conditions such as urban ride-sharing.

The vehicle can operate without a human driver or occupants.

Source: SAE
Analogous to human driving

Where am I?
What is around me?
What will they do next?
What will I do next?
How do I execute?

Autonomous driving software modules

Localization
Perception
Prediction
Planning
Control

Autonomous driving hardware & supporting infrastructure

Sensors
Simulation
HD map
To do so, a suite of sensors and hardware are required:

- **GPS (global positioning system)** combined with readings from tachometers, altimeters and gyroscopes to provide the most accurate positioning.
- **Ultrasonic sensors** to measure the position of objects very close to the vehicle.
- **Odometry sensors** to complement and improve GPS information.
- **Central computer** analyzes all sensor input, applies rules of the road and operates the steering, accelerator and brakes.
- **Lidar (light detection and ranging)** monitor the vehicle's surroundings (road, vehicles, pedestrians, etc.).
- **Video cameras** monitor the vehicle's surroundings (road, vehicles, pedestrians, etc.) and read traffic lights.
- **Radar sensors** monitor the vehicle's surroundings (road, vehicles, pedestrians, etc.).
INTERESTING ROAD SCENARIOS
Scenario: Vehicle cutting in
Scenario: Road agents running a red light
Scenario: Nudging past reverse-direction traffic
Scenario: Sudden road obstacle
Scenario: Jaywalker at the nighttime
ABOUT
PONY.AI
Pony.ai’s end-product is a fully autonomous vehicle, core technology is AV software

Pony.ai spans full product ecosystem

**HARDWARE**
- Vehicle supply
- Vehicle by-wire
- Sensor design
- Sensor suite configuration
- Sensor installation

**SOFTWARE**
- Sensor fusion
- Perception
- Path planning
- Control
- HD Mapping & Localization
- In-house SW infrastructure (OS)

**FLEET DEPLOYMENT**
- Test fleet operations
- Robo-taxi fleet productization

Led by Pony.ai | Partnership (varying depth) | 3rd party (external)
Global presence with fleet operations in China and the U.S.

**BEIJING**
- Opened office in Mar 2017
- Awarded T3 permit for AV public road tests in Beijing, June 2018

**GUANGZHOU**
- Soft-launched consumer AV ride-sharing fleet in Nansha, Feb 2018
- Strategic partnership with Chinese OEM GAC Group
- Established Pony.ai AI Research Institute

**FREMONT**
- Established in Dec 2016
- R&D hub with public road testing since Jun 2017
Strong support from top investors...

...confirms Pony.ai as the highest-valued and best-funded AV startup with a strong dual US/China focus

- ~$1 billion in June 2018, 1.5 years post-launch
- $214 million in Series A funding alone
- First to launch autonomous ride-hailing fleet in China
Continuous product development – three generations to date

1st GENERATION
- First launched in Fremont
- Q2 2017

2nd GENERATION
- First robo-taxi test fleet in Guangzhou
- Q1 2018

3rd GENERATION
- Latest generation, debut at Shanghai World AI Conference
- Q3 2018

PonyAlpha
Seamless command in complicated road scenarios
Productizing fleet operations with concrete initiatives

We are building the **infrastructure**,...

<table>
<thead>
<tr>
<th>Pony Control Center</th>
<th>robo-taxi brand and service to...</th>
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<tbody>
<tr>
<td>• Centralized fleet management system</td>
<td>• Integrated Pony.ai roof rack solution</td>
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<tr>
<td>• Real-time vehicle dispatching and tracking</td>
<td>• More stable sensor housing solution</td>
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<tr>
<td>• Passenger-to-center communication</td>
<td>• PonyHi (Pony Human Interface) – in-vehicle HMI</td>
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<tr>
<td><strong>Routing capability</strong></td>
<td>• Robo-taxi mobile app</td>
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<tr>
<td>• In-app route optimization capability</td>
<td></td>
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<tr>
<td>• Efficient planning for pick up/drop off</td>
<td></td>
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<tr>
<td>• Enabling real-time traffic condition data feed</td>
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...enable near-term **scale up of fleet** to hundreds of vehicles
Pony.ai selected as AV topic leader at China’s largest AI conference

CEO James Peng part of high-profile keynote speakers

Jack Ma (Alibaba)  Pony Ma (Tencent)

PonyAlpha fleet debut and demo

Third generation AV system “PonyAlpha”  1000+ passengers served in 7 days  Fleet of 10 vehicles in continuous operation

Inaugural World AI conference hosted by Shanghai government
- 15,000+ attendees
- Largest AI conference in China

Pony.ai topic leader in AV
- Keynote speech by CEO James Peng: forum keynote by CTO Tiancheng Lou
- Debut of third generation AV system “PonyAlpha”
- 7-day robo-taxi demo operation with 1000+ passengers served
QUESTIONS?
THANK YOU