Today

• Production and Sales Outlook
• The New Mobility: Evolutionary Progress
• Self-Driving Vehicles and Mobility Services
Production Outlook
Future growth is entrenched in emerging markets

Global production walk: 2018 to 2025

Future growth is entrenched in emerging markets.
North America outlook
Declines ahead before return to growth

North America production

Short-term pain, long-term gain

- Finding balance
  - Incentives
  - Fleet
  - Inventory
  - Production planning
  - Quality versus quantity
- Growth due to localization and portfolio expansion
  - 2019 = 807,000 units of total
  - 2020 = 714,000 units of total
  - 2021 = 1.2 million units of total
- Off-shoring
  - Cancellations
  - Backfilling
Sales Outlook
Global auto sales: Growth in emerging markets

Global auto sales forecast, by region

Source: IHS Markit

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2015 to 2025

- Greater China: 28%
- Europe: 21%
- North America: 23%
- South Asia: 9%
- Japan/Korea: 8%
- Middle East/Africa: 6%
- South America: 5%

Source: IHS Markit

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North American auto sales: Topline steady

- North American volume steady: 19.9 to 20.0 million units
- Third largest region—behind China, Europe
- US remains second largest single global market, behind China
- US light-vehicle sales contract through 2022—remain above 16.3 million
- Mexico impacted by election and trade uncertainties in 2018. Growth returns in 2019
- Canadian sales in 2018 decline after 8 years of growth
US market: Declining plateau

Between 2015-2025
- Premium price class sales increase
- Exotic price class sales increase
- Utility vehicle sales increase
- Pickup truck sales increase
- Car sales decline
- Total sales down

In 2015:
- Exotic share 0.1%
- Premium share 11.7%
- Pickup share: 14.6%
- Car share: 39.9%
- SUV share: 36.9%

In 2025
- Exotic share 0.3%
- Premium share 15.0%
- Pickup share 17.8%
- Car share 22.4%
- SUV share 52.5%
The New Mobility: Evolutionary Progress
The “New Mobility Paradigm Shift”
A race to the finish?
The “New Mobility Paradigm Shift”
Or a need for a reality-check?

New mobility convergence

Traditional mobility

Future mobility

Ride hailing
MaaS aggregators
Regulators
Regional variation
Consumer acceptance
Autonomous vehicle technology
E-mobility
The mobility (r)evolution will take some time to materialize

The value evolution of the new mobility market (revenue in US dollars)

2000

$0

Initial slow start to new mobility market; only really becoming noticeable when the ride-hailing sector booms after 2015.

2017

$70 billion

In the next 17 years, new mobility revenue is expected to grow almost fifteen-fold due to the availability of so-call robo-taxi services. Revenue growth will mainly originate from China and the United States.

2035

$1 Trillion

Notes: MaaS could also bring economic benefits to consumers through money saved by not buying a personal car.
Source: IHS Markit

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Autonomous vehicle growth steadily increases
Cautious early introductions expand through both shared mobility fleets

Global autonomous vehicle sales 2020–40

- **33M in 2040** up from **51,000 in 2021**
- First production-line L4 autonomous vehicles in 2019, all deployed in mobility fleets. Limited scale
  - GM—Bolt for Maven, Lyft, or Cruise
  - Waymo—Chrysler Pacifica, Jaguar iPace
  - Volvo—Uber’s 24,000 XC90 order still on
- Mobility services drive early volumes into fleets in China and the United States
- Ownership remains strong in Europe and the United States

*Note: Autonomous is defined as SAE Level 4 or Level 5*
On an evolutionary trajectory

• The US market characteristics of low urban density, high average per capita mileage, and the “built-around-the-car” infrastructure will slow the pace of adoption and cap the potential long-term market size for new MaaS services. Eventually, L5-capable private autonomous cars will become a tough competitor for autonomous MaaS services.

• Cities face a difficult nexus of challenges, compounded by the quick advent of ride hailing. Hence city policymakers’ decisions will determine the adoption speed of new mobility.

• New mobility technology and consumer awareness/comfort need to further evolve before widespread adoption will occur in urban environments.

• The sudden “disruption” threat to our established mobility system has receded, turning the outlook more in-line with our base-case outlook.

While still of huge importance looking forward, the much lauded mobility revolution appears to be on a evolutionary trajectory now.
Self-Driving Vehicles and Mobility Services
## Language defined—Real-world examples of SAE Levels

**Autonomous = Level 4 and Level 5**

<table>
<thead>
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<th>Level</th>
<th>Description</th>
<th>Examples</th>
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<tr>
<td>L5</td>
<td>Full automation</td>
<td>Fully autonomous driving (Driverless car)</td>
</tr>
<tr>
<td>L4</td>
<td>High automation</td>
<td>Fully autonomous driving (Self-driving car)</td>
</tr>
<tr>
<td>L3</td>
<td>Conditional automation</td>
<td>Advanced autopilots (Drivers intermittently re-engage)</td>
</tr>
<tr>
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<td>Autopilot (Traffic jam assist)</td>
</tr>
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<td>Driver assistance</td>
<td>Adaptive cruise control, Lane keep assist, Autonomous parking</td>
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<td>Collision warning, Lane departure warning, Blind spot information</td>
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Based on Society of Automotive Engineers levels of automation (SAE J3016)
Challenges from ADAS to AD

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<td>L1</td>
<td>Driver assistance</td>
<td>Unsupervised driving, no driver required in any area</td>
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**Revolutionary Development**
- Geofenced automation → fewer geofences → full autonomy everywhere
- Unsupervised driving, no driver required in any area
- Driver out of the loop
- Vehicle fallback control

**Evolutionary Development**
- Warnings → emergency intervention → proactive control
- Driver assistance and supervised automated driving
- Driver in the loop
- Driver fallback control

- **Performance**
- **Robustness**
- **Redundancy**
- **Validation**

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- **Autopilot**
- **Traffic jam assist**
- **Adaptive cruise control**
- **Lane keep assist**
- **Autonomous parking**
- **Collision warning**
- **Lane departure warning**
- **Blind spot information**
Future Mobility Strategies

All in
- Develop vehicle
- Develop autonomous drive system—either internal or through acquisition
- Develop mobility services model and business, also including partnerships

System development for MaaS
- Develop autonomous drive system
- Develop mobility services model, infrastructure
- Develop ability to integrate on any vehicle
- Use OEM for vehicle supply
- Commercialization of autonomous drive system, supply to others

Partner Up
- Partnerships for developing autonomous drive system
- Independent commercialization, integration
The new automotive supply chain and an expanding ecosystem

Source: IHS Markit

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Ecosystems and partnerships reign—even amongst competitors

There is growing recognition that cooperation is necessary for the industry to succeed at scale in the long term, especially considering:

- Complexity of autonomous driving technology
- Limited initial volumes of autonomous vehicles
- Initial deployment in fleet business model

Industry alliances for fully-autonomous vehicles:

- Intel-Mobileye: BMW, FCA | Aptiv, Conti, Magna
- Waymo: FCA, Jaguar plus Lyft, Intel

Compute platforms enabling full autonomy:

- NVIDIA: 300+ development partners including Mercedes-Benz, Audi, Toyota
- Baidu: 100+ development partners including critical mass of Chinese OEMs

Mostly internal development or acqui-hire:

- GM, Ford, Renault-Nissan-Mitsubishi, Mercedes-Benz, Toyota, VW-Audi, Volvo
General Motors: All in

*Developing eco-system for future mobility services. AV as platform for revenue generation. All in, with room for partners*

- Cruise Automation acquisition enabled integrated development of AV with internal product development and manufacturing
- OnStar and Marketplace, Maven and DoorDash
- Cruise AV ride-hailing deployment target 2019. Dependent on meeting minimal viable performance expectations for safety
  - FMVSS exemption requested
- Partnerships: Softbank, Honda have invested in Cruise AV

**Strengths**
- Iterative, fast development of Cruise AV has included manufacturing and attention to rapid scale
- Investment from Softbank, Honda eases the cost burden

**Weaknesses**
- Taking risk as among first to market
- Being first on scene may drag out return on investment, even with clear strategy and focus on revenue and profit

Image courtesy of General Motors
Ford Motor Company: All in

*Plans for AV development slower; trying to be everything to everyone*

- Ford focused on a role in developing “smart cities” and ensuring its AV and mobility programs are part of a larger transportation solution
  - Ambitious and forward-thinking
  - Difficult to quickly get to market and identify near-term priorities
- First autonomous vehicle will be hybrid electric van, 2021
- Ford acquired Argo AI to further autonomous vehicle development
- Ford Smart Mobility LLC
  - Includes Transportation Mobility Cloud Platform
- Partnerships
  - Miami testing AV delivery (Dominos, PostMates)
  - SharedStreets data-sharing public-private partnership
  - Lyft on self-driving ride-hailing fleet
- Strengths
  - Long history in commercial fleet business helps understand demands of taxi/ride fleet as well as goods delivery
  - Decade of AV technology development
- Weaknesses
  - Development seems slow and scattered
  - Sales of traditional light-vehicles have been soft, potentially jeopardizing future funding
Tesla: All in

*Tesla has vertical integration, and difficulty working with partners. However, full self-driving still elusive*

- Autopilot program increasing capability
- Master Plan includes allowing Tesla owners car-sharing program
- After working with Mobileye and Nvidia, Tesla brought development of camera sensors and AI chip internal
- Future plans for getting into mobility services taking a back seat to production, distribution and product development

**Strengths**
- Significant value in Tesla brand image as EV leader and technology leader
- Image as industry disruptor

**Weaknesses**
- Finding (predictable) difficulty scaling production/distribution
- Has Tesla underestimated the ability of traditional OEMs?
- Go-fast, reinvent-the-wheel approach has enabled costly mistakes, with no apparent recognition of the issue internally
- EV adoption in mass market remains elusive

Image courtesy of Tesla
Honda: Partner Up

- Honda has recently partnered with GM
  - Honda has not invested as significantly in AV development, though has competitive advanced driver assist systems
  - Was rumoured to be in talks with Waymo
  - Hooked up with GM instead, expanding a relationship which started with a fuel-cell stack
  - Example of focused partnerships developing across the industry

- Strengths
  - Shared development costs
  - Speeds Honda’s time to market
  - Enables independent deployment schedule, integration

- Weaknesses
  - Could slow time to market—GM will deploy first
  - Some lack of control over product deployment cadence, investments
Waymo
- End game: Mobility as a Service business
- More than 10M miles testing (live and simulated)
- Partnerships for vehicle supply, hardware
  - FCA: Chrysler Pacifica Hybrid
  - Jaguar: iPace EV
- 2019 Ride-hailing commercialization
  - Phoenix, Arizona; Atlanta, Georgia
  - Limited Phoenix pay service late 2018
- Internally developed self-driving program
- Strengths
  - Massive financial support for development, patient bosses
  - Most testing complete to date
  - Comfortable with OEM as supplier
- Weaknesses
  - Scaling up deployment may be difficult
  - Dependent on OEM for vehicles

Uber: Stalled on AV?
- End game: Mobility as a Service business, moving goods and people
- Expected IPO in 2019; raised USD2-bil on bond market
- Partnerships for vehicle supply, hardware
  - Volvo
- Timeline for AV commercialization TBD
- Commercial-vehicle efforts stalled
- Internally developed self-driving program
- Strengths:
  - Awareness
  - Network of service users
  - Global presence
- Weakness:
  - Corporate distraction
  - Lack of focus on forward plan—wants to be everywhere, today
System Development: Supplier strategy
Traditional vehicle supply is business driver

Aptiv
- End game: Supply system
- Las Vegas test with Lyft
- Internally developed self-driving program
- Aptiv is also part of BMW-Intel-Mobileye consortium
- Strengths
  - Existing OEM relationships may speed commercialization
  - Development pace is strong—As Delphi, Aptiv has been demonstrating technology for several years
  - OEM neutral deployment potential
  - Leverage component production capability
- Weaknesses
  - Dependent on OEM for deployment
  - Low development of concurrent business model
Toyota: Combination strategy

Developing eco-system for future mobility services and AV technology internally. Also executing several global partnerships

- Toyota developing “stages” of self-driving technology: Guardian and Chauffer
- Culture prioritizes societal good and relationships; resistance to taking the driver out of the equation
- Focus shifting to speeding deployment of Guardian level—support the human driver with available technology for more immediate benefit
- Toyota has heavily invested in collaborative research
- Toyota is developing Mobility Services Platform
- Plans connected-car services for near-term revenue
- CES 2017: Artificial intelligence concept Yui. AI to build relationship
- CES 2018:e-Palette. Configurable
  - e-Palatte Alliance: Amazon, DiDi, Pizza Hut, Uber, Mazda
- CES 2018: Guardian deployment is new focus; will share technology with industry
- Partnerships for Toyota have included:
  - JV with Softbank on mobility services
  - MOU with Uber on vehicle supply, USD500 mil investment
  - USD1 billion investment in ride-hailing service Grab

Images courtesy of Toyota
Thank you