Future mobility, autonomous driving and IoT leading to the paradigm shift of automotive industries

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Smart Embedded System Lab
Kookmin University

Aug. 18, 2016
Introduction

Smart Embedded System Lab@Kookmin Univ.

Smart Car
Smartphone
Smart Robot

Embedded System - Hardware
Embedded System - Software

Control
Pattern Recognition
Network
Smart Embedded System Lab@Kookmin Univ.

Embedded System & CPS
- Embedded HW & SW
- Automobile, Smartphone and Robot

Embedded Systems
- Application
- Platform/Middleware
- RTOS
- HW (SoC, MCU, MP)

Automobile

Smartphone

Robot
Introduction

Smart Embedded System Lab@Kookmin Univ.

Education/Training Center

- Embedded SW for Automobile MCU & OSEK 2011
- Advanced Android Programming 2011
- Automobile Embedded Systems 16/32/Multicore MCU, OSEK/AUTOSAR 2007~Now
- Automotive Control System 2014~Now
- Smartphone programming Mobile Embedded System 2010~2013
- UC Irvine Mobile Embedded SW with Android 2012 SQ
- Internet of Things 2014~Now

- AUTOSAR platform OSEK/AUTOSAR, Odin Tool, Multicore MCU 2015~Now
News Articles

- News articles about CES, MWC, IFA and Motor show
- News articles on smart car and IoT
What to cover

- Paradigm shift of the automotive industry
- Evolution of intelligent vehicle
- Future mobility
- Trend of recent exhibition
- Other main issues
- Autonomous driving
- Changes due to autonomous driving and future mobility
- Summary and conclusion
Reorganization of the automotive industry

- Reorganization of car manufactures
  - Segmentation
  - Ergonomics
  - Personalized automobile

- Changes in future mobility
  - Small cars
  - Autonomous driving
  - Electric car
  - Car sharing
  - Wireless charging

- Challenges of emerging companies
  - Automotive cloud
  - Internet of Cars
  - Autonomous Driving
  - Sharing Economy
  - Electric Vehicle

Smart Embedded System Lab
Insight from CEOs’

- We do not plan to become the Foxconn of Apple (Aug. 2015)
  - Dieter Zetsche, Chairman of the Board of Management of Daimler

- Mercedes-Benz sees business potential in offering on-demand limousine services using driverless cars (Sep. 2015)
  - Dieter Zetsche, Chairman of the Board of Management of Daimler
  - Car2Go + autonomous driving
  - Challenge to Uber’s future model

Reinvention of VW (Sep. 2015)

- Winterkorn, CEO of Volkswagen
- The challenge of Tesla, Uber, Google, Apple, etc.
- Electric Vehicle, connectivity and autonomous driving

Toyota wants to virtually eliminate gas engines by 2050 (Oct. 2015)

- Toyota
- Hybrid and fuel-cell vehicle
- Reducing emission 90% by 2050 compared with 2010 levels
Insight from CEOs’

- **Driverless cars are coming sooner than you think (Mar. 2015)**
  - Ron Medford, Director of Safety for the Google Self-Driving Car Project
  - The arrival of autonomous cars to have a dramatic effect on our lives

- **The Car is the Ultimate Mobile Device (May 2015)**
  - Jeff Williams, Apple's senior vice president of operations
  - Titan project-Electric vehicle (2019)

- **We'll ease the transition to self-driving cars (Sep. 2015)**
  - Travis Kalanick, CEO of Uber
  - 2020, transportation system using autonomous driving

- **Musk said it will be technically feasible for the driver to fall asleep and let the car do the driving in about three years (Oct. 2015)**
  - Elon Musk, CEO of Tesla
  - Autonomous driving 2018
Insight from CEOs’

- **Mercedes isn’t losing any sleep over the Apple Car (Feb. 2016)**
  - Dieter Zetsche, Chairman of the Board of Management of Daimler
  - Doesn’t seem to be concerned about the recent rumors that Apple may be developing its own automobile

- **Relax car dealers, don’t fear self-driving cars (Mar. 2016)**
  - John Krafcik, CEO of Google’s self-driving car project
  - Self driving cars are going to be more expensive physical assets

- **I hate to admit it, but Tesla did everything right (Mar. 2016)**
  - Stefan Niemand, Audi’s EV chief
  - Supercharger network

- **When I look at the automobile, what I see is that software becomes an increasingly important part of the car of the future (Apr. 2016)**
  - Tim Cook, CEO of Apple
  - CarPlay + iPhones

- **BMW will launch its first self-driving car in 2021 (May 2016)**
  - Harald Krueger, CEO of BMW
  - HERE mapping tech for autonomous driving
Paradigm shift of the automotive industry

- **Strategies of competitors**

  **Carmakers**
  - Automotive cloud
    - 3G network (eCall)
    - Collecting vehicle/driving information
    - Standard on Extended Vehicle (2014~)
  - Buying Nokia ‘Here’ (Audi/BMW/Benz, 2015. 8)
    - Common platform for carmakers
    - Against Carplay and Android Auto
  - Toyota-Ford cooperation on SDL (2016.1)
    - Smart Device Link
    - Against Carplay and Android Auto
  - Autonomous driving technology
    - Commercialization on 2020
    - Applying partial technologies
      - ACC+LKAS
      - Autonomous Emergency Braking
      - Autonomous parking

  **Emerging companies**
  - Apple/Google
    - Merging industries with smartphone/cloud
    - Vision for EV/ autonomous vehicle
      - Google: autonomous driving 2020
      - Apple: EV 2019
  - Tesla
    - Autonomous driving 2018
    - Successive launching of autopilot function
    - Innovative development methodology
      - Emphasis on SW
  - Uber
    - Vision for autonomous driving (2020)
    - Autonomous transportation
    - Car sharing
## Evolution of intelligent vehicle

### Evolution of vehicles

<table>
<thead>
<tr>
<th></th>
<th>Past</th>
<th>Current</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Device</strong></td>
<td>Industrial Device</td>
<td>Personal Device</td>
<td>Cooperative Convergence Device</td>
</tr>
<tr>
<td><strong>Keywords</strong></td>
<td>Driving</td>
<td>Safety, convenience, comfort, ergonomics</td>
<td>Autonomy, cooperation, convergence</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td>Mechanical engineering Engine</td>
<td>EECS Human engineering/ergonomics</td>
<td>SW and convergent technologies AI, Communication, Multimedia, Big data, Cloud, Sensor fusion</td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td>Carmakers</td>
<td>Carmakers with the help of IT industries</td>
<td>Reshaping the industries</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Complicated business model</td>
</tr>
<tr>
<td><strong>User</strong></td>
<td>Small number of users</td>
<td>Mass users Personalization</td>
<td>To the elderly or disabled drivers</td>
</tr>
</tbody>
</table>

- **Driving**
- **Autonomy, cooperation, convergence**
- **EECS**
- **Complicated business model**
- **Reshaping the industries**
- **Small number of users**
- **Mass users Personalization**
- **SW and convergent technologies**
Evolution of intelligent vehicle

**Past**
- Industrial device
- American makers
- Mechanical engineering

**Current**
- Personal device
- German makers
- EECS and ME

**Future**
- Cooperative Convergence Device
- All things
- Reshaping
- Cloud and converging technologies

**Keywords**
- Car
- Driver, Car
- Driver, Pedestrian, Road, Car

**Industry**
- American makers
- German makers
- Reshaping

**Technology**
- Mechanical engineering
- EECS and ME
Platform evolution of carmakers

Automobile

- Android
- Multi-Media Platform
- Cloud
- ADAS (Advanced Driver Assistance System)
- Autonomous Driving
- In-Vehicle infotainment - GENIVI
- Autosar (Automotive Open System Architecture)/HW platform
Evolution of intelligent vehicle

- Platform evolution of Google

Google

- Vehicle: Google’s Robot Car
- Android
- Smart Phone: Android
- ROS.org
- Robot: ROS
- Google Cloud
- Cloud service: Drive
Background and motivation

Population concentration in mega cities
- 60% of the population will live in mega-cities
- Transportation problem
- Time and resource problem
- Pollution problem
  ◆ Trans. policy–small car–autonomous driving

Air pollution problem
- City environment and pollution problem
- Fine dust
- Transportation problem
  ◆ EV-fuel cell car – transportation policy

Changes in society
- Single house hold
- Single-occupancy vehicle
- Aging society
- Changes in ownership
  ◆ Small car-autonomous driving-car sharing

Changes of customers and users
- Space continuity
- Changes in usage and consumption
- Ergonomics
  ◆ Ergonomics-Apps-Connectivity
Basic concept of future mobility

Between cities
- Middle · large car
- Logistics
- Platooning
- Autonomous driving

Inside cities
- Small car
- EV
- Car sharing
- Autonomous driving
- Wireless Charging
Future mobility

- **How to implement future mobility**
  - **Small electric vehicle**
    - For transportation and environment
  
  - **Car sharing**
    - Resource management
    - Car sharing & ride sharing
    - Autonomous parking
  
  - **Autonomous driving**
    - EV
      - Easy-to-control rather than engine based cars
      - Easy-to-detect malfunctions
  
  - **Wireless charging**
    - Usability
  
  - **Connection to grid system**
Paris’ policy for Future mobility (2014 Paris motor show)

- **Environment-Friendly Policies**
  - Encouragement for EV car sharing, public bicycles
  - EV free parking, High parking charges imposed on the high rate of automobile traffic zones
  - Speed limit 50km/h
  - License free driving for small EV(45km/h)
  - Charging stations

- **Small cars**
  - 80% for new cars in France

<table>
<thead>
<tr>
<th></th>
<th>PM10</th>
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<tbody>
<tr>
<td></td>
<td>Average</td>
</tr>
<tr>
<td>Paris</td>
<td>38 µg/m³</td>
</tr>
<tr>
<td>Seoul</td>
<td>46 µg/m³</td>
</tr>
</tbody>
</table>

PM10 Average Warning level

- PM10: Average 38 µg/m³, Warning level 50 µg/m³
- PM10: Average 46 µg/m³, Warning level 80 µg/m³
Future mobility

- **Ford Smart Mobility (CES 2015)**
  - Connectivity
    - Ford Sync 3.0
  - Autonomous driving
    - Sensor/SW/Big data
  - Information sharing
    - Car sharing
    - Parking lot
  - 25 experiments
    - Rapid Recharge & Share (Dearborn, U.S.)
      - Use electric vehicle for solving the refueling problem of the existing Share-Car
    - Multimodal Transportation Platform (Chongqing, China)
      - Solving urban mobility using various transportation
        - taxi, bike rental, rickshaw and etc.

- **Audi urban future 2014**
  - Seoul, Mexico city, Berlin, Boston
Future mobility

Future mobility at Hyundai motor group (2016 Geneva motor show)

- Project IONIQ
  - A long-term research and development project that will redefine future mobility through innovation, enhancing the lives
  - Three eco-friendly powertrain (HEV, PHEV, EV)
  - ‘Freedom in mobility’ with the four key directions
    ✓ Freedom to effortlessly access mobility whenever and wherever
    ✓ Freedom to connect everyday life while on the move
    ✓ Freedom from accidents and inconveniences
    ✓ Freedom from environmental pollution and energy exhaustion
Future mobility

- Evolution to future mobility
  - On-demand transportation system
  - Logistics

- Uber
  - Ride sharing
  - Autonomous driving
  - On-demand transportation

- Tesla
  - Solar power
  - Heavy vehicles
  - Fully autonomous car-sharing

- Benz
  - Autonomous driving
  - Car2go
  - Mytaxi (Sep, 2014), Hailo (July, 2016)
  - EV Truck

- Toyota
  - Autonomous driving
  - Cooperation with Uber
  - Evolution of taxi service using autonomous driving

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2014 IFA, Bosch/Tomtom

- ADASIS (Advanced Driver Assistance System Interface Specification)
  - Connection between navigation (map data, vehicle position, speed etc.) and ADAS system

- Bosch & TomTom
  - Merging ADAS (Bosch) and LBS (Tomtom)
  - Tomtom knows the road
  - Bosch knows the car
  - Enhance gas mileage

- TomTom
  - Navigation information

- Bosch
  - ADAS
    - Intelligent cruise control
    - Upcoming curve alerts
    - Jam tail warnings

Source: http://www.erticonetwork.com/
Trend of recent exhibition

- 2014 Paris motor show, Citroen automotive app model
  - 130 euro per year
  - 18 apps for head unit
  - 2 apps for smartphone (Link mycitroen, Scan mycitroen)

Using 3G network key
379 euro

Eco-Driving
Find My Car
Last Mile Guidance

Download

Cloud

Diagnosis and management

<Link mycitrien>

<Multicity connect>

<Scan mycitroen>
Trend of recent exhibition

- CES 2015
  - Android auto and Carplay
    - For major OEMs
**CES 2015 – GM, Prognostics based on cloud**

- **Target year: 2016**
  - 2016 Chevrolet Equinox
  - 2016 Chevrolet Tahoe
  - 2016 Chevrolet Suburban
  - 2016 Chevrolet Corvette
  - 2016 Chevrolet Silverado
  - 2016 Chevrolet Silverado HD

- **Uploading sensor data**
  - GM OnStar 4G LTE Connection

- **Data analysis in server**
  - OnStar’s secure servers

- **User notification**
  - RemoteLink
  - SNS
  - E-mail

Source: GM
eCall and automotive cloud (Paris/Geneva/Shanghai motor show)

- **eCall service**
  - Mandatory service in Europe
  - New BM

- **Bosch in 2015 Shanghai motor show**
  - Extension to automotive cloud from eCall
  - Data analysis of the automotive information

![Ecall button of Benz AMG GLE (Geneva motor show 2015)](image)

- **Remote monitoring system**
- **Connection to call center**
- **eCall module of Bosch**
‘Mobility Connects’, 2015 IAA

- Continental
  - V2X
    - Left-turn Assist based on Vehicle-to-X (V2X) technology
      - Let-turn assist in intersection
    - Electronic Brake Light
  - Roadworks Assistant
  - Remote diagnosis system
    - Extended Vehicle
    - Main information
      - Battery voltage, speed, engine speed(rpm), etc.

- T-mobile
  - Data ownership
Trend of recent exhibition

- **CES 2016**
  - **Nvidia**
    - Deep learning based autonomous driving
    - Sensor fusion
      - 6 Cameras, 4 LIDAR sensors
      - Map from Here
    - Volvo cooperation
  - **Ford Smart mobility**
    - Ford Sync 3
    - SDL cooperation with Toyota
    - Amazon Alexa
    - Smart car-Drone
  - **Faraday Future**
    - Autonomous EV
Trend of recent exhibition

➢ CES 2016
  ▪ Benz
    • Carplay and Android Auto (From Dec. 2015)
    • Benz navigation
      ✓ Using touch and Jog shuttle
    • SW upgrade (T.B.D.)

  ▪ Toyota
    • Deep learning based autonomous driving
    • Crowd mapping
    • Agent plus
      ✓ Prediction based navigation
Trend of recent exhibition

- **MWC 2016**
  - **Ford pass**
    - Solving mobility

- **AT&T**
  - 4G hotspot service in Europe
  - Connection to 7 devices
  - OnStar service
  - eCall

- **Vodafone**
  - Small Cell concept with BMW
  - Driving
    - 4G service in the vehicle
  - Stopping
    - Network service to outside
2016 Beijing Motor Show

- Changan Automobile - Raeton
  - Autonomous driving
    - 2000km test to Beijing from Chongqing
    - Maximum speed: 120km/h
  - Mass production plan from 2025

- LeEco - LeSEE
  - Changes of human life using Autonomous EV
    - Merging various services
      - Car sharing, shopping mall, etc.
    - Proposing new direction of electric vehicle
    - Adapting contents related internet of LeEco
2016 Busan motor show

- Hyundai Genesis G80
  - HDA
    - ISO TC204 WG 14
  - AEB
    - ISO TC22 SC 33
  - eCall
    - ETSI
  - Extended Vehicle
    - ISO TC SC 31
  - Connectivity and Infotainment
    - Apple CarPlay
    - Google Android Auto
    - MirrorLink
  - ADASIS
    - ADASIS Forum

- Map-ADAS (ADASIS)
- Highway Driving Assistance (HAD)
- Apple Carplay (Connectivity and Infotainment)
- Bluelink’s Car Diagnostic (Extended Vehicle)
- emergency Call (eCall)
- Autonomous Emergency Braking System (AEB)
Other main issues

- **Reshaping into 5 major companies**
  - 2015
    - Toyota
    - VW
    - GM
    - Renault-Nissan Alliance
    - Hyundai-Kia

- **Keywords**
  - M&A
  - Alliance
  - Vertical integration
  - Segmentation

- **Chinese companies**
  - **Rising Chinese companies**
    - Shanghai group
    - Cherry
    - Changan
    - BYD
    - Etc.

Leading automobile manufacturers worldwide in 2015, based on vehicle sales

<table>
<thead>
<tr>
<th></th>
<th>Previous Years</th>
<th>2014</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worldwide sales</td>
<td>80 million</td>
<td>85 million</td>
<td>100 million</td>
</tr>
<tr>
<td>Production in China</td>
<td>0</td>
<td>25 million</td>
<td>58 million</td>
</tr>
<tr>
<td>Existing Motor Co.</td>
<td>80 million</td>
<td>60 million</td>
<td>40 million</td>
</tr>
</tbody>
</table>

Source: Jae-Kwan Lee, KISTEP forum, 2016. 5
**Other main issues**

### Scenarios of the market reorganization

<table>
<thead>
<tr>
<th>Apple/Google+Low rank carmakers</th>
<th>EV from Tesla and Apple</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Reshaping into 5 major carmakers</td>
<td>- <strong>SW oriented methodology</strong></td>
</tr>
<tr>
<td>- <strong>Production technologies of carmakers</strong></td>
<td>- <strong>Easy implementation of autonomous car</strong></td>
</tr>
<tr>
<td>- Merging smartphone and cloud</td>
<td>- Paradigm shift to EECS</td>
</tr>
<tr>
<td>- <strong>Safer cars through big data analysis</strong></td>
<td>- Better in future mobility</td>
</tr>
<tr>
<td>- User analysis</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Production Apple/Google on their own</th>
<th>Uber based model</th>
</tr>
</thead>
<tbody>
<tr>
<td>- HW optimization based on cloud</td>
<td>- Vision on autonomous transportation model</td>
</tr>
<tr>
<td>- Smart factory</td>
<td>- <strong>Centralized autonomous transportation</strong></td>
</tr>
<tr>
<td>- <strong>New mobility design</strong></td>
<td>- Ownership change due to car sharing</td>
</tr>
<tr>
<td>- Merging robot and automobile</td>
<td>- <strong>Decreasing number of vehicles</strong></td>
</tr>
<tr>
<td></td>
<td>- <strong>Increasing usage rate</strong></td>
</tr>
</tbody>
</table>
Main issues for Automotive IoT

- Connected car
  - Connection to smartphone
  - Vehicular Network module (eCall)
  - V2X
  - App download
  - Automotive cloud
  - Autonomous driving

- Autonomous driving
  - Precise map
  - Precise location determination
  - Space continuity
  - Enhancing gas mileage
  - Automotive cloud
  - Centralized autonomous transportation

- Space continuity
  - Car as a living space
  - Continuous interface
  - Geofencing
  - Payment
  - App usability

- Automotive cloud
  - Driving information
  - Navigation and map
  - Car sharing
  - Car information/ Diagnosis
  - Making Safer car
  - Centralized autonomous transportation
Other main issues

- **Extended Vehicle**
  - ISO TC 22(Road vehicles) SC31(Data Communication) WG6
    - Standardization of automotive cloud
    - Germany and France
    - Starting on May 6, 2014
  - Basic concept
    - Virtualized data communication road vehicles
    - Defining data types, data representation, communication methods, etc.

- **HERE**
  - Audi, BMW and Mercedes-Benz acquired Here
    - Nokia’s Mapping Unit
  - HD map for autonomous driving
  - Map platform for carmakers
Autonomous driving

- Recognition
  - Data collection using various sensors
  - Radar, lidar, camera, ultrasonic, GPS, etc

- Judgement
  - Map - Mapping on a variety of data in advance
  - Localization - Identify the exact current location using the map information and sensor values
  - Perceive - Identify all information in the circumstances (lanes, obstacles, etc.)

- Control
  - Correct the problem that caused the way to the destination

Source: NVIDIA
Autonomous driving

- **Core technology**
  - **Sensor technology**
    - Sensors-LiDAR, Radar, Camera, etc.
  - **Positioning**
    - High precision GPS
    - Integration of GPS and INS
  - **High definition Map (HD MAP)**
    - Contains all of the information in the road
    - Error – less than 10cm ~ 20cm

- **V2X**
  - V2I, V2V, V2N

3D image using lidar <Source : Here>

Mapping high definition <Source : Here>
Audi A7 piloted driving concept

- 3 Cameras (1 Front Camera, 2 Top View Cameras)
- 2 Laser Scanners (1 front laser scanner, 1 rear laser scanner)
- 6 Radar Sensors (2 corner radar sensors, 2 front radar sensors, 2 rear radar sensor)
- 2 Ultra Sonic sensors
- **Connected Automation for Greatest Benefits**

  - **Autonomous Vehicle**
    - Operates in isolation from other vehicles using internal sensors

  - **Connected Vehicle**
    - Communicates with nearby vehicles and infrastructure

  - **Connected Automated Vehicle**
    - Leverages autonomous and connected vehicle capabilities

*Source: U.S. Department of Transportation, `Beyond Traffic: The Smart City Challenge` (2015.12.17)*
Autonomous driving

Road map example for autonomous driving

- 2016: Partially autonomous driving (HDA/TJA)
- 2018: WAVE based V2X (V2I), eCall mandatory
- 2020: Multi-lane driving, Intersection driving, Extended Vehicle standard
- 2025: Here HD map for autonomous driving, Cloud based diagnostics, Wireless charging standard, On-demand mobility service using autonomous driving
- 2030: Fully autonomous driving, 5G based V2X, HD map for all over the world
- 2035: Autonomous vehicle > 50%

Extended Vehicle standard
HD map for HDA
Ride sharing service
Taxi booking app
On-demand transportation service
Autonomous cars

Transforming Personal Mobility (2013. 1)
- Earth Science Institute at Columbia University
- Simulation for the data for Ann Arbor, Michigan, 2009
- Main Results
  ✓ Data
    - Population: 285,000
    - Number of vehicles: 200,000, for local traffic: 120,000
    - Average of local driving distance: 9.3 km, Average of passengers: 1.4
    - Operating ratio: 5%
  ✓ After autonomous driving
    - Small car - Car sharing - Centralized autonomous driving
    - Needed number of cars for local traffic: 18,000
    - Waiting time: under 1 min.
    - Operating ratio: 70%
Autonomous driving

- Autonomous vehicles deployment regulations by California DMV (Department of Motor Vehicles)
  - Not ‘Sale’, but ‘Lease’
    - Operator’s diagnosis and management

- Diagnosis and management
  - Automotive cloud
  - Extended Vehicle

- Connection to ISO TC 22 standards
  - Clarification for autonomous driving cases
  - Extended Vehicle
  - Driving policy

- First regulation for autonomous vehicle
Changes due to autonomous driving and future mobility

- **Expected changes**
  - Autonomous cars: Breakthrough for electric vehicles 2014
  - Transforming personal mobility, 2013

- **Major possibilities**
  - Small car-oriented urban mobility
    - Various types of mobilities
  - Increased operating ratio
    - Decrease of number of vehicles
    - Pre-diagnostics of automobile
    - Crisis of low rank OEM
  - Fault detection and diagnostics
    - Automotive O2O
    - Big data related industry
  - Centralized transportation system
    - Big data related industry
    - Transportation related industry
  - Insurance
Main change in automotive industry forecast (Autonomous Driving, Roland Berger, 2014)

- Divided the automotive future into personal vehicle ownership and mobility-on-demand
- **Scenario A1**
  - Possibility of maintaining vested rights by traditional OEM
- **Scenario A2**
  - New company takes leadership
  - Decrease OEM revenues
- **Scenario B3**
  - Car sharing company / OEM Beneficial to all
  - Large platoon system
- **Scenario B4**
  - New mobility company gets high position
  - OEM gets lower position
  - Crisis of low rank OEM
Changes due to autonomous driving and future mobility

- **Operator-centric services**
  - Services
  - Operators
  - Smartphone
  - Services
  - Operators
  - Autonomous Vehicle

- **On-demand mobility service**
  - Car sharing
  - Ride sharing
  - Taxi booking
  - On-demand Mobility Service
Changes due to autonomous driving and future mobility

- **Space continuity related industries**
  - Car as a living space
  - Changes in entertainment, sightseeing, leisure, etc.
    - Movie
    - Mobile office
    - Rest area
Changes due to autonomous driving and future mobility

Main concept cars

Benz F015 luxury in motion (CES 2015) source: Benz

Concept 26 (Source: Volvo)

Faraday future FF zero1 (Source: Faraday future)

Rinspeed Buddie (Source: Rinspeed)

LeSEE [Beijing motor show 2016]

BMW Ivision [CES 2016]
### Changes due to autonomous driving and future mobility

#### Vision for future mobility
- Small car-EV-autonomous driving
- Car sharing-Wireless charging

#### Fault detection and diagnostics
- Automotive O2O
- Big data related industry

#### Centralized transportation system
- Big data related industry
- Transportation related industry

#### Increased operating ratio
- Decrease of number of vehicles
- Pre-diagnostics of automobile
- Crisis of low rank OEM

#### Insurance
- Decrease of accident rate
- From personal insurance to automotive company insurance or operator insurance
- Malfunction related insurance model

#### Related industry
- New industry related to interior and usability
- Various technologies from EECS, furniture, architecture, material, etc.
- Changes in entertainment, sightseeing, leisure, etc.
Summary and conclusion

- **Paradigm shift of automotive industries**
  - Reshaping of the automotive industry
    - Future mobility, autonomous driving and IoT
  - Competition between carmakers and IT companies

- **Future mobility**
  - Small car-EV-autonomous driving-Car sharing-Wireless charging
  - On-demand transportation service
  - Logistics

- **Autonomous driving**
  - Reshaping of the autonomous industry
  - Car as a living space

- **IoT**
  - Internet of Cars
  - Automotive cloud
Thank you!

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