Audi makes heavy upfront expenditure into strategic fields

- Electric mobility
- Autonomous Driving
- Digital Services
spectacular upbeat for Audi e-tron
Audi e-tron GT 2020* concept
Audi Transformation Plan (ATP)

- Transforms and prioritizes resources
- Frees up a total of €10bn until 2022
- Secures Operating RoS 8-10%
focus on revenues and costs

strong C-/D-portfolio

enhance China business

transformation of skills

utilize synergies & lower material costs

reprioritize & focus on USPs

MEB & PPE for profitable EV
strong focus on Cash Flow remains imminent

Net cash flow (EUR m)

<table>
<thead>
<tr>
<th>Year</th>
<th>Net Cash Flow (EUR m)</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-9/2017</td>
<td>2,552</td>
<td></td>
</tr>
<tr>
<td>1-9/2018</td>
<td>3,116</td>
<td>+22.1%</td>
</tr>
</tbody>
</table>

Net cash flow increased by 22.1% from 1-9/2017 to 1-9/2018.
# Levels of Driving Automation

<table>
<thead>
<tr>
<th>Assisted</th>
<th>Automated</th>
<th>Autonomous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present and fully responsible</td>
<td>Available and vigilant</td>
<td>Not necessary</td>
</tr>
</tbody>
</table>

**Level 1/2**
- ACC

**Level 3**
- ACC
- Traffic Jam Pilot/Highway Pilot L3

**Level 4**
- ACC
- Traffic Jam Pilot/Highway Pilot L3
- Highway Pilot L4

**Level 5**
- ACC
- Traffic Jam Pilot/Highway Pilot L3
- Robo Taxi/Shuttle
- Every domain every street
AUTONOMOUS DRIVING – THE LOGIC IS CHANGING

**Assisted World (L1/2)**
- Driver
- Safety and controllability
- Global
- Known regulations

**Automated/Autonomous World (L3/4)**
- Technology
- Safety and driving performance
- Company
- Local
- Regulations not yet defined

- Driving capability
- Release criteria
- Liability
- Scalability
- Homologation

**Global**
- Known regulations

**Local**
- Regulations not yet defined

**Company**
- Technology

**Regulations not yet defined**

**Known regulations**

**Technology**

**Safety and driving performance**

**Company**

**Local**

**Regulations not yet defined**

**Known regulations**

**Technology**

**Safety and driving performance**

**Company**

**Local**

**Regulations not yet defined**
DIFFERENT APPROACHES TOWARDS AUTONOMY

Assisted  Automated  Autonomous
MASTERING HIGHWAY AND URBAN TRAFFIC DOMAINS IS QUITE A DIFFERENCE AND THE USE CASE HAS NOTICEABLE IMPACT ON THE SYSTEM DESIGN

<table>
<thead>
<tr>
<th><strong>Highway</strong></th>
<th><strong>Urban</strong></th>
</tr>
</thead>
</table>
| **Scenarios** | » Highway driving up to 130km/h  
» Lane Changing  
» Limited sideline activities |
| » 50km/h  
» Lane Changing, Intersections  
» All sideline activities |
| **Corner Cases** | » Small Obstacles @ far distance  
» 360° perception @ lane changing  
» High availability of all functions (e.g. lane keeping) |
| » Pedestrians, crowded streets, crossing bikes, intersections – 360° perception @ all times  
» rear approaches, blind spots |
| **Technical implications** | » Sensors: High resolution @ far range, wide FoV  
» Platform: Redundancies, timing  
» Vehicle: Fail-Op architecture incl. braking, steering |
| » Sensors: Mid-Range, Wide FoV, medium resolution  
» Platform: Redundancies, timing, >10x interpret. effort  
» Vehicle: Fail-Op architecture for shorter times |
| **Cost driver** | » Validation / approval for vehicle lifetime (ownership)  
» Sensor frontends, semi-conductors, redundancies  
» Dimension: 10k€ |
| » Validation / approval for veh. lifetime (serviced cars)  
» Different service concept over lifetime  
» Dimension: 50k€¹ |

¹) Estimation incl. external references
Use cases of autonomous driving can be divided into urban and highway as well as owned and shared:

<table>
<thead>
<tr>
<th>Highway</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Owned</strong></td>
<td></td>
</tr>
<tr>
<td>Highway Pilot (HWP)</td>
<td>L3</td>
</tr>
<tr>
<td>Traffic Jam Pilot (TJP)</td>
<td>L3</td>
</tr>
<tr>
<td>Traffic Jam Assist (TJA+)</td>
<td>L2</td>
</tr>
<tr>
<td>ADAS functions and Integral Safety</td>
<td>L2</td>
</tr>
<tr>
<td><strong>Shared</strong></td>
<td></td>
</tr>
<tr>
<td>Mobility as a service (MaaS)</td>
<td>Transportation of people</td>
</tr>
<tr>
<td></td>
<td>Transportation of goods</td>
</tr>
</tbody>
</table>

**MaaS** (Mobility as a service)
AUDI’S ROADMAP TOWARDS AUTONOMOUS DRIVING

- **L1/2**: Advanced Driver Assisted System
- **L3**: Traffic Jam Pilot
- **L3**: Highway Pilot
- **L4**: AICON
THE CURRENT GENERATION OF VEHICLES ALREADY OFFERS A WIDE SCALE OF ADAS SENSORS & SOFTWARE WITH A STRONG FINANCIAL CONTRIBUTION

**City assistance package**
- Audi side assist
- Exit warning
- Audi pre sense rear
- Park assist plus
- Rear cross-traffic assist
- Reversing camera

**Standard features**
- Hold assist
- Audi pre sense basic
- Audi pre sense city
- Park assist rear
- Adjustable speed limiter
- Cruise control system
- Break recommendation function

**Parking assistance package**
- Surroundings camera
- Park assist

**Additional options**
- Trailer assist
- Main beam assist
- MMI navigation plus with MMI touch
- Night vision assistant

**Tour assistance package**
- Turn assist left
- Adaptive cruise control
- Audi active lane assist
- Audi pre sense front
- Obstacle avoidance assist
- Camera-based traffic sign recognition
- Predictive efficiency assistant
- Traffic jam assist
LESSON LEARNED FROM TRAFFIC JAM PILOT DEVELOPMENT:
IT’S NOT ONLY IMPORTANT HOW MANY MILES, BUT WHICH MILES

One use case is enough to cause a complete system redesign, i.e. vertical resolution insufficient:
» New sensor
» new package, new design
» more ECU Power, more cooling, more voltage etc.
» new architecture
» etc.

Years & Millions
out of one use case!
AUDI’S HIGHWAY PILOT AND AICON

L1/2
ADVANCED DRIVER ASSISTED SYSTEM

L3
TRAFFIC JAM PILOT

L3
HIGHWAY PILOT

L4
AICON

2023
HWP

2025
Hub to Hub

20xx
Door to Door
REGIONAL APPROACH

USA
development center with local partners and talents

GERMANY and EUROPE
organic growth and extension of partner network

CHINA
development center with local partners and talents
AID’S ROLE
AID’S ROLE IN THE VW GROUP
## VW GROUP MAAS LAYER ORGANIZATION AND ROLES IN THE GROUP

### MAAS LAYER

<table>
<thead>
<tr>
<th>Layer 5</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer 4</td>
<td>Mobility Platform &amp; Services</td>
</tr>
<tr>
<td>Layer 3</td>
<td>Fleet Operations</td>
</tr>
<tr>
<td>Layer 2</td>
<td>Vehicle</td>
</tr>
<tr>
<td>Layer 1</td>
<td>Self-Driving System (HW/SW)</td>
</tr>
</tbody>
</table>

- Content & Advertisement
- Mobility clients
- Mobility platform
- Fleet intelligence platform
- Fleet operations
- Fleet & service hubs
- Fleet ops platform
- SDV components
- Base vehicle interface
- Base vehicle
- SDS software
- Map data
- SDS Hardware
AID’S ORGANIZATION
FOR THE STRATEGIC, TACTICAL AND OPERATIONAL LEVEL THERE ARE DIFFERENT ROLES

<table>
<thead>
<tr>
<th>STRATEGIC LEVEL</th>
<th>TACTICAL LEVEL</th>
<th>OPERATIONAL LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head of Product</td>
<td>Product Manager</td>
<td>Product Owner</td>
</tr>
<tr>
<td>HP</td>
<td>PM</td>
<td>PO</td>
</tr>
<tr>
<td>Head of Technology</td>
<td>System Architect</td>
<td>Tech Lead</td>
</tr>
<tr>
<td>HT</td>
<td>SA</td>
<td>TL</td>
</tr>
<tr>
<td>Head of Engineering</td>
<td>Line Manager</td>
<td>Scrum Master</td>
</tr>
<tr>
<td>HE</td>
<td>LM</td>
<td>SM</td>
</tr>
</tbody>
</table>
MANY EXPERTS WORKING HARD ON ACHIEVING OUR MISSION: TO DRIVE COMPLETELY AUTONOMOUSLY BY 2021

AVERAGE AGE: 36 years

INTERNATIONALITY - 30 DIFFERENT NATIONALITIES:
Austria, Brazil, Bulgaria, Canada, China, Croatia, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, India, Ireland, Israel, Italy, Lebanon, Mexico, Poland, Portugal, Romania, Russian Federation, Spain, Sweden, The Netherlands, Ukraine, United Kingdom, United States of America, Venezuela

BROAD EXPERIENCES FROM A VARIETY OF DIFFERENT INDUSTRIES:
TECHNICAL DEVELOPMENT
CORE BELIEFS ON AUTONOMOUS DRIVING

» This has never been done before and there is a lot of unknown. We plan for this by:
  • Generating feedback quickly
  • Building infrastructure that supports quick iterations
  • Writing many automated tests to make changes and refactoring easier

AUTONOMOUS DRIVING IS ONE OF THE HARDEST ENGINEERING CHALLENGE SINCE PUTTING A MAN ON THE MOON

» We’ll need a system level optimization:
  • T-shaped people, cross-functional teams and mono-repository to avoid silos
  • In car testing by engineers to build insight into the whole system
  • Make data-driven design choices compatible with first principles
DEVELOPING AN AUTONOMOUS VEHICLE

PRODUCT VISION / GOALS

Questions which **product** is possible
- E.g. if a realistic sensor distance is <= 250m, how much slower does a vehicle have to be, that we can still overtake
  → Tools to analyze Use-Cases at physical / users limit

Questions which **system** is best
- E.g. which Interpretation & Prediction concept is most robust
  → Tools to record & replay data, quickly mock / evaluate behavior and determine robustness of solution

Questions which **technology** is best
- E.g. best way to detect walls as landmark from LiDar data.
  → Tools to quickly prototype solutions and break scenario tests down to component and unit tests

» **Large group of people having to iteratively work together on the same problem**
  → Need an environment that supports lots of developers in all of the tasks above, to enable all steps be done in high quality!
The presentations contain forward-looking statements and information on the business development of the Volkswagen Group. These statements may be spoken or written and can be recognized by terms such as "expects", "anticipates", "intends", "plans", "believes", "seeks", "estimates", "will" or words with similar meaning. These statements are based on assumptions relating to the development of the economies of individual countries, and in particular of the automotive industry, which we have made on the basis of the information available to us and which we consider to be realistic at the time of going to press. These statements are based on assumptions, which we have made on the basis of the information available to us and which we consider to be realistic at the time of going to press. These assumptions relate in particular to the development of the economies of individual countries and markets, the regulatory framework and the development of the automotive industry. Therefore the estimates given involve a degree of risk, and the actual developments may differ from those forecast. The Volkswagen Group currently faces additional risks and uncertainty related to pending claims and investigations of Volkswagen Group members in a number of jurisdictions in connection with findings of irregularities relating to exhaust emissions from diesel engines in certain Volkswagen Group vehicles. The degree to which the Volkswagen Group may be negatively affected by these ongoing claims and investigations remains uncertain.

Consequently, a negative impact relating to ongoing claims or investigations, any unexpected fall in demand or economic stagnation in our key sales markets, such as in Western Europe (and especially Germany) or in the USA, Brazil or China, will have a corresponding impact on the development of our business. The same applies in the event of a significant shift in current exchange rates in particular relative to the US dollar, sterling, yen, Brazilian real, Chinese renminbi and Czech koruna.

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