FROM ADAS TO AUTONOMOUS – SEEING THE WAY FORWARD

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AGENDA

1. Strategy Analytics Overview
2. ADAS Demand Overview
3. Autonomous Vehicle Market Development
4. Supplier & Ecosystem Challenges
5. Conclusions
STRATEGY ANALYTICS OVERVIEW

Supply Side Research and Consulting

- 12-month syndicated subscription services on specific industries and/or technologies
- Custom Consulting on Companies, Brands, Products, and Technologies
- Market Intelligence on Buyer Behaviors, Consumer Attitudes, Brand Preferences, and Emerging Behaviors
- Design Guidance and Competitive Intelligence on User Experiences and Opportunities for Innovation
- Intelligence on Consumer Activities, Behavioral Patterns, and Usage Profiles through Big Data Analytics
AUTOMOTIVE PRACTICE – SINCE 1988

LEADING-NAME CLIENTS ACROSS THE VALUE-CHAIN

- 70% of Tier One Automotive Suppliers
- 90% of Major Automotive Semiconductor Suppliers
- 70% of Top Global OEMs

FOUR SERVICES TO COVER ALL AUTOMOTIVE OPPORTUNITIES

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• 2022 production down from 113.8 M in Q2 2015 forecast to 109.4M in Q2 2016 forecast – a 4% drop

• Most risks remain on the downside
• 2022 system demand up from $331B in July 2015 forecast to $346B in July 2016 forecast – a 5% rise
OWN OR SHARE?

• Automated driving forces us to consider this question

• Like infotainment systems in car – we are seeing a fragmentation of car owning/using scenarios

• Wild card: role of regulators, traffic/municipal authorities

• Safety, congestion mitigation, emissions reductions will out
2022 COMPARISON - DOMAINS

- Expected demand for body & chassis systems is now flat or lower. These systems typically have very high penetration rates, and thus are hit by production changes.

- Expected demand for powertrain & driver info up a little. Higher volumes expected for HEV/EV, as well as more complex cluster etc.

- Biggest gain in safety – driven by increasing ADAS demand
• Growth outside of ADAS and HEV/EV is comparatively weak. These two systems areas are the major growth drivers. More risk to HEV/EV forecast than for ADAS. Most ADAS risk is on the upside, in the event of more legislation
ADAS IS ONE OF THE FASTEST GROWTH AREAS FOR AUTOMOTIVE ECUs

- ADAS was only 2% of global automotive ECU demand in 2007 – but will account for almost 18% of all auto ECU demand in 2023
- ECU demand = value of packaged ECU + software as supplied from T1 to OEM
WHICH ADAS APPLICATIONS ARE DRIVING GROWTH?

- Best growth / size combination by far is “distance warning” – which includes the AEB function
- Growth in almost all systems except for ultrasonic-only park assist
- Vehicle made in China to rapidly grow as percentage of the overall market
GROWTH IN MAINSTREAM VEHICLES

- Slowest ADAS growth now in high-end F-Segment sedans (e.g. S-Class, 7-Series, Lexus LS) vehicles. Fastest is B-Segment (e.g. Fiesta, Vitz/Yaris)
- A, B & C Segments (Ka, Fiesta, Focus) to grow from around 20% of ADAS demand in 2007 to approaching 50% of demand by 2023. These segments are 55 to 60% of global production
IMAGE SENSORS TO SEE HIGH VOLUMES

- Volume demand for camera sensors to outstrip all other sensor types (excluding ultrasonic)
- Over one camera-per-vehicle forecast in 2019
- Strong regional variations
  - Most cameras/vehicle in NAFTA, followed by Japan & Europe
  - Strong growth in camera use in China

- LRR = Long-Range RADAR
- SRR/MRR = Short/Medium-Range RADAR
- LIDAR includes both low-end (e.g. Continental SRL 1) and emerging high-end (e.g. Quanergy) devices
- Bolometer = dedicated night vision sensor
**CAMERA MARKET GROWTH (1/2)**

- NAFTA largest market due to reversing camera mandate
- Around 1.8 cameras/vehicle in 2023 on average – but HUGE variation
  - 0.1 cameras per vehicle on Indian-produced A-Segment
  - 5.3 cameras per vehicle on NAFTA-produced SUV
  - 8.9 cameras per vehicle on European-produced F-Segment
CAMERA MARKET GROWTH (2/2)

- **CAAGR 2015-2020 growth ranking:**
  - Interior – 73% (e.g. driver monitoring)
  - Side – 36% (e.g. surround view, camera mirror replacement)
  - Front – 32% (e.g. LDWS, distance warning)
  - Rear – 14% (e.g. parking, surround view, camera mirror replacement)

- **Front & Interior cameras tend to be “smartest” with highest vision processing requirements**
  - Mobileye clear lead for vision processing today – TI (TDAx) likely #2
Blindspot solutions currently dominate RADAR volumes (2 sensors per vehicle)

Front-mounted distance warning solutions (AEB, ACC) to see strong growth

Front-corner alert systems to emerge towards end of forecast period (Euro NCAP reward in 2020?)

79 GHz to emerge, but 24 GHz NB will remain popular for cost reasons
LIDAR MARKET TO TRANSITION

- Long-term LiDAR volumes linked to automated drive features
- Used for both obstacle detection / free space classification as well as positioning / mapping
• Processor and Linear (e.g. RADAR RF Front-end) devices dominate
• CAAGR over 2015 to 2022 to exceed 22%
THE SENTIENT CAR
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CONSUMER ADAS INTEREST IS GROWING


- In general consumers are getting MORE interested in ADAS and autonomous features
- Caveat: Willingness to pay remains modest!
- 2015 survey included:
  - 1200 consumers in US
  - 1200 consumers in Europe (split UK/FR/IT/DE)
  - 2000 consumers in China

Source: Strategy Analytics In-Vehicle User Experience Team – April 2015
AUTONOMOUS ADOPTION SCENARIOS

• “Building Blocks in Place” = vehicles with multiple cameras / RADARs / LIDARs / Comms technology etc. — but not fully autonomous under NHTSA level 4 or SAE Level 5 definition
  • These vehicles will typically offer NHTSA L2 / L3 automation technologies and a comprehensive range of advanced safety systems
WHICH SENSORS FOR AUTONOMOUS?

• Huge debates over RADAR vs. Camera vs. LiDAR...

• The following are exaggerations – but have an element of truth
  • If you talk to Mobileye the camera can do everything...
  • If you talk to Quanergy the LiDAR can do everything...
  • If you talk to RADAR vendors then anything without RADAR is a death-trap in bad weather...

• Using sensors for positioning/mapping is as much about the wider software / value chain / cloud as the absolute sensor performance

• Ultimately we see a continuing role for multiple sensor types – very much including cameras – in automated driving:
  • Different strengths / weaknesses
  • Redundancy & safety
  • “Driver” confidence
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• We are moving into the era of the onboard software-defined vehicle
• Traditional automotive value chain has been slow to invest in software and has often failed to attract the best talent and innovation
• Next paradigm-shift could be to increasing off-board control ??
• Conclusions...
  • Strategy Analytics sees rise in importance of IP Innovators and Systems (T 0.5) Integrators, at the potential expense of traditional T1 & T2s
  • Potential new OEMs / Service Providers are looking at different ways of architecting their vehicles and thus working with the supply chain. Not bound by legacy
  • Rise of importance of IT service providers
AV VALUE CHAIN IS COMPLEX!

### OEM
- Volvo
- Tesla
- BYD
- GM
- Ford
- BMW
- Changan
- FCA/Google
- Kia Motors
- Mitsubishi
- JLR
- Nissan
- Toyota
- VW
- Audi
- PSA

### Startups/ New Players
- FaradayFuture
- Uber
- Apple
- Lyft
- comma.ai
- OTTO
- Nutonomy
- ZMP
- Zoox
- Drive.ai
- PilotLab
- AuroRobotics
- WePod
- Nauto
- Neurala
- NextEV

### Sensors & Systems
- Bosch
- Ibeo
- Continental
- ZF TRW
- Panasonic
- Hitachi
- FLIR Systems
- Quanergy
- Velodyne
- ublox
- MediaTek
- Denso
- PointGrey
- Valeo
- Autoliv
- LeddarTech
- Melexis
- infineon
- Visteon
- OmniVision
- Novatel
- Delphi
- Xsens
- Lumina
- F10

### Security
- TowerSec
- Lookout/
Microsoft
- QNX
- Mentor
Graphics
- ARGUS
- GHS

### Connectivity
- Preferred Networks
- Cohda Wireless
- QNX
- TTech
- Harman
- Savari

### MAP/Cloud
- TomTom
- Mobileye
- HERE
- Google
- Amazon
- Mapbox

### Algorithms/ Software
- Mobileye (REM)
- Polysync OS
- ADASWorks
- Nutonomy Core OS
- comma.ai (chfr)
- NVidia Drive
- BAIDU AutoBrain

### SoC/ Processing/ Sensor Fusion
- Nvidia (Drive PX)
- Renesas (R-Car)
- Qualcomm
- Mobileye (EyeQ*)
- NXP (BlueBox)
- Movidius
- imagination technologies
- Intel
- XILINX
- Infineon

### Dev Tools / OS
- MathWorks (Matlab/ Simulink)
- Polysync OS
- KISHONTI
- Elektrobit
- Luxoft
- QNX (Neutrino)
- Mentor Graphics (Nucleus OS)
- dSPACE
- tassInternational
- WindRiver (VxWorks)
- GHS (INTEGRITY)
- ROS (Robotic Operating System)
- Vector Software

The Value chain theoretically flows from bottom to top, but in reality interactions are far more complex and non-linear, e.g. OEMs interacting in significant ways with semiconductor and software companies, bypassing much of the “traditional” value chain.
AUTOMATED DRIVING TO SHIFT ELECTRONICS SPEND

• **Winners?**
  - Electrified Powertrain
    • If car is driving itself then fuel economy and environmental compatibility become more important than power & performance
  - ADAS / Automation
    • Needed to implement the autonomous functions!
  - Comfort/Convenience
    • Autonomous driving will mean that we are more demanding about our comfort and convenience on-board.
  - Start-ups, IP developers, non-auto companies
    • Reported $1B for Cruise Automation!!!

• **Losers?**
  - Conventional Powertrain
    • Who wants a massively powerful engine if the car is driving itself?
  - Conventional Safety
    • Less need for airbags etc. if cars crash less?
  - Chassis
    • Comfort will be priority
  - Infotainment
    • Will self-driving cars just free people to use personal devices even more?
  - Conventional auto suppliers?
  - **Overall Vehicle Production/Sales??**
    • Will autonomous driving help drive new ownership models?
KEY CHALLENGES FOR TRADITIONAL AUTOMOTIVE VENDORS (1/2)

• **Dedicated automotive devices becoming less attractive for auto semiconductor vendors**
  - Increased leverage of non-automotive IP & devices
  - Continued rise in use of non-proprietary (e.g. ARM) architectures
  - New entrants cherry-picking some high-growth automotive areas, e.g. Nvidia, Qualcomm

• **Rise in importance of software**
  - Impacts all parts of value chain
  - Paradigm of shipping hardware and software as integrated unit developed by a T1 supplier starting to break-down
  - Conventional T1s not always the best software developers – and can they compete with contract manufacturers on producing hardware?

• **Vehicle connectivity is changing value propositions**
  - Android Auto & CarPlay will be on ~60% of vehicles shipped globally in 2022
  - FOTA / SOTA will change relationship between customer, car maker and dealer
KEY CHALLENGES FOR TRADITIONAL AUTOMOTIVE VENDORS (2/2)

• Long-term shift to personal mobility as a service?
  • Already seeing rise of Uber, Lyft, Car2Go etc. – as recognized by those carmakers investing in this field
  • Potential new entrants are often companies with significant service & IT expertise
  • Shift towards more automated driving could accelerate trend, breaking the emotional attachment that some consumers have towards buying and driving

• The short-term impact of these changes is easy to over-estimate
  • Things tend not to change that fast in automotive
  • Remember, Tesla was formed in 2003, delivered its first cars in 2008 and will have a 0.1% global market share in 2016, forecast to hit 0.2% in 2022

• The long-term impact of these changes is easy to under-estimate
  • “I fear that ADAS will be the last technology that the automotive industry invents” – quote from senior executive at Chinese automaker during meeting with Strategy Analytics
AUTONOMOUS POTENTIALLY IMPACTS OTHER ECOSYSTEMS

• Public transportation
  • Small “pod” type vehicles most likely to compete initially with public transportation / taxis

• Smart Cities
  • Autonomous transportation will potentially be more controllable by local administrations, and provide even greater data flows

• Wireless
  • Autonomous vehicles generate data! (But remember – Mobileye REM is only roughly 10 Kb per kilometer)
  • Autonomous vehicles potentially free up "drivers" to use personal devices more
  • Autonomous will not be the key connected car driver – that is happenning faster for other reasons (e.g. FOTA/SOTA, E-Call etc.)
DEVELOPMENT PLATFORMS

- **NXP** has recently released its new BlueBox processing platform for developing autonomous driving systems. Although it is more oriented in the classic control systems approach, the BlueBox has a more realistic level of power consumption when compared to the original version of Drive PX2. It is meant for sensor fusion system applications and the development platform is running Linux Operating Systems.

- **Renesas** has announced its third generation R-Car H3 SoC (system-on-chip) which combines a powerful high performance ARM processor with a high performance graphics processor for image recognition, advanced DSP and other peripheral functions. It delivers ISO 26262 (ASIL-B) compliance and a system in package with external memory to enable a wide range of automotive applications. The SoC includes the PowerVR GX6650 graphic engine from Imagination Technologies which is aimed at delivering a smooth experience for future cockpits and clusters. Mass production of the R-Car H3 SoC is scheduled to begin in March 2018.

- **Mobileye** introduced the EyeQ5 platform last year which supports up to 16 cameras, multiple radars and LiDARs, including the low-level processing of all sensors. Although the EyeQ5 seems like the best candidate to compete against NVIDIA’s Drive PX2 platform, the platform will reach production in 2022 and volume in 2025 based on what Marco Monti from STMicroelectronics said earlier this year. The EyeQ4 vision processor will enter production in 2017 and Mobileye is targeting SAE Level 2/ Level 3 autonomy with this processor.

- **PolySync** is a relatively new player into the autonomous vehicles space (2012) and automation in general. It is a 50-person enterprise based in Portland, Oregon. PolySync has created its own OS called POLYSYNC which is basically a software development kit that combines Ubuntu Linux 12.04 LTS as the master host OS (Yocto Linux and others are coming soon) with a suite of software tools and distributed middleware to provide a set of standardized APIs that can be used to build autonomous drive applications. PolySync is working closely with Renesas for the autonomous driving developments.

- **CEVA** is targeting ADAS processor applications with the introduction of a new DSP-based vision and imaging platform. This is claimed to offer advanced Deep Learning and Artificial Intelligence capabilities to low power embedded systems. Centered around a new imaging and vision DSP, the CEVA-XM6, the platform introduces a more scalable, comprehensive and smart integration of hardware and software that is mainly focused on imaging and vision applications. The XM6 solution is also positioned as an energy efficient alternative to power hungry GPU-based vision processors. The main applications where CEVA is currently aiming at to harness the power of neural networks is autonomous vehicles, smartphones, surveillance, robotics, drones/ UAV’s and other camera-enabled devices.

- The **NVIDIA** SDK: A universal Software Development Kit for engineers, researchers and scientists which consists of numerous toolkits to help accelerate development on NVIDIA platforms. The tool for automotive development is called NVIDIA DRIVEWORKS. NVIDIA claims that it will give developers a foundation upon which to build applications that leverage “the computationally intensive algorithms for object detection, map localization, and path planning”. At present only selected NVIDIA partners have access to this SDK. NVIDIA has stated that the will be freely available from Q1 2017. The NVIDIA SDK is compatible with the DRIVE PX, DRIVE PX2 platforms and also some of NVIDIA’s standalone GPUs.
AFTERMARKET

  - Company Link: [http://comma.ai/](http://comma.ai/)

  - Company Link: [http://www.pilotlab.co/](http://www.pilotlab.co/)

- Pearl Auto (ex. Apple guys) 500$ backup camera: [https://checkout.pearlauto.com/sca-dev-denali/checkout.ssp?is=checkout&n=2#product](https://checkout.pearlauto.com/sca-dev-denali/checkout.ssp?is=checkout&n=2#product)

- Perrone Robotics: [http://www.perronerobotics.com/](http://www.perronerobotics.com/)


STATUS OF AUTONOMOUS DEVELOPMENT

• Autonomous Vehicle Start-ups & Small Companies (73):

• Autonomous Vehicle Carmaker Announcements (61):

• Report, covering the Local Motor ecosystem, navya, Easy Mile etc.:
CONCLUSIONS

• ADAS is one of the fastest growing application areas for automotive electronics

• Your next car will not be fully autonomous – but it will almost certainly be more automated
  • Consumer acceptance is a barrier
  • Continued push of ADAS technologies will help to build trust

• Image sensors and vision processing are some of the key technologies to make this happen
  • If there is a single sensor at the front of a vehicle, it is most likely to be a camera
  • If there are multiple sensors on your vehicle, there will almost certainly still be a camera there

• Autonomous technologies could revolutionize the industry and are changing the value chain
  • OEMs getting much more open to working with / acquiring smaller companies with innovative and compelling IP
  • Big challenges for T1s and T2s to remain relevant.
THE SENTIENT CAR
Questions?
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