Technology Platforms for the Car of the Future

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STMicroelectronics

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The Pillars of the Car of the Future

- **safer**
  - Autonomous Driving
  - Enhanced Vision
  - Adaptive Lighting

- **greener**
  - Vehicle electrification, EV, HEV
  - Engine (ECU) Efficiency
  - Eco Navigation
  - LED lighting

- **more connected**
  - Semi & Autonomous driving
  - V2X communications
  - Smartphone integration
  - Embarked Telematics
  - Data, video streaming
  - Cyber security

- **digitization and computerization**
- **power and analog**
IOT Interoperability
Car Technologies of the Future

Smart….Driving, Cities, Industry and Objects

Ubiquitous computing
- Intelligent environments
- Collaborative innovation networks

Everything connected
- People, smart things, V2X
- Mobile technologies

Societal changes
- Better traffic management
- Safer driving conditions
- Lower environmental impact
Automotive Application Portfolio
ST Offers a Broad Range of Products

Rich application elements enabling Autonomous Driving Systems

- **Powertrain**
  - Thermal Engine, Electrical Engine, Transmission, Vehicle control, Automatic gearbox

- **Infotainment Telematics**
  - Telematics, Car Radio, Positioning, Infotainment Systems, Multi-media Content, Tuners

- **Chassis**
  - Passive Safety: Airbag, Braking, Active Safety: ADAS, V2X

- **Body Electronics**
  - Steering, Door Module, Lighting, Wipers, Control Motors, Networking, Steering, Head Unit, Seat Power Trunk, Water Pump
Greener Power Train

Environmental Contribution

**Engine Management**
- Direct injection system (GDI)
- Engine downsizing, Turbocharger
- Cylinder deactivation

**Transmission**
- Increased Gears
- Dual clutch
- CVT

**Charging**
- Market trends
  - Start/Stop with separate S&A
  - Start/Stop with belt driven S&A
Key Electric Vehicle Technology

Towards the mass deployment of electrical vehicles

• ST is enabling greener driving with advanced technology for
  • Battery management and energy recovery
  • OBC (on-board battery chargers)
  • Main Traction inverters
  • DC/DC converters
  • 48V Applications

• Including
  • Battery Management (ASICs) and 32-bit MCUs
  • MOSFETs, Rectifiers, SiC Diodes,
  • GAPdrives, HV SCR for Soft-start
  • IFBT & Soft Diodes
Increasing Autonomy on Electric Vehicle
SiC MOSFETs Technology

Increased Efficiency, Minimum Power Dissipation, Reduced Size, Cost Saving

**Freedom of Driving**

**Efficient Power Conversion (**)**

**SiC Diodes**

- 4X more efficient than IGBT

**SiC MOSFETs**

**Smart Battery Controllers**

- Reduced Battery Cost -20%
- Extended Mileage +8%
- X5 form factor reduction

**Power Control Unit**

**Fast Charging**

- Extended Mileage +20%

(*) 20% power savings can result in gains of over $6,000 in battery cost, or 8% of the vehicle cost
Would you recommend the use of human-like capabilities that eliminate the need for human effort and intervention creating a vehicle:

- with sensorial fusion
- with vision and object recognition
- that exhibits automated behavior
- that interacts and communicates with the road, cities, infrastructure
- that is connected to the world

“LIKE” to give your approval
The Connected Car is a Technology Hub
In a Secure Environment

IoT Smart Things

Wearable

Smart Intersection
Toll Systems

GNSS

CELLULAR WAN

City Traffic Management
Construction
Work-In-Progress

SMARTPHONE INTEGRATION

CAMERAS

RADARS

HANDSFREE CALL

The App. Universe
Mobile Communication
Fleet Management
Insurance
Emergency Services
Financial Services
Services & Maintenance
Online Shopping
...

V2X
V2I
V2V
V2P

IN-CAR NETWORK

Remote Car Access

Radio Broadcast
## MEMS Sensor Technologies

**Bring Life to the Intelligent Car**

### Sensors

<table>
<thead>
<tr>
<th>Acoustic/Video</th>
<th>Motion</th>
<th>Environmental</th>
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</thead>
<tbody>
<tr>
<td>Voice process.</td>
<td>Accelerometer</td>
<td>Humidity</td>
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<tr>
<td>Microphone array</td>
<td>Gyroscope</td>
<td>Temperature</td>
</tr>
<tr>
<td>Digital microphone</td>
<td>Magnetometer</td>
<td>Pressure</td>
</tr>
<tr>
<td>Camera/Stabilization</td>
<td>6, 9-axis Inertial</td>
<td>UV index</td>
</tr>
</tbody>
</table>

**Sensors for Engine control:**
- Pressure sensor

**Sensors for Electronic Stability Control (Brakes):**
- Airbag G-Sat

**Sensors for Airbag Control:**
- Airbag Central Unit

**Sensors for Navigation assistance:**
- Telematics
- Infotainment

**Sensors for Key Fobs:**
- TPMS G-sens

**Sensors for Anti-theft Systems:**
- Electronic Stability Control

**Sensors for ST FULL NAVIGATION SOLUTION:**
- (TESEO + Sensors)

**Sensors for ST FULL AIRBAG SOLUTION:**
- (System IC + MCU + Sensors)
Interactive Infotainment

Display and Interfaces

Terrestrial Radio
• AM/FM Receivers
• Digital Receivers for DAB, DMB, HD

Infotainment Processors
• Processors with Phone Connectivity, Media-player & Display control

Satellite Radio
• Sirius XM Receivers (ASICs)

• Car audio / Tuner
• Display audio applications
• Head-unit and external sound systems
• Smartphone screen mirroring
• Rear view camera
• Connectivity
• HW-SW turn-key solution
Telematics Systems
Multi-Core Processors Embedded Computing

Connected Automotive Software Solutions are changing our driving style...

ST has a complete range of solutions for Telematics Processors

Scalable,
Modem Independent,
Rich Set Of Interfaces,
Automotive Grade Qualified
Connect your smartphone to the vehicle

- Makes Car Diagnostics Info available on your smartphone
- Remote parking
- Remote vehicle settings

BlueNRG-1 Wireless System On Chip
- Automotive Grade SOC -40\(^\circ\)C to +105\(^\circ\)C
- Bluetooth Low Energy 4.2 Compliant

OTA firmware support
- 160kB Flash – 24 kB ULL RAM

Extended Battery Life
- Integrated DCDC converter enables ultra low power operation

CSP package option
- QFN32 5x5x1mm
- WCSP34 2.66x2.56x0.5mm for PCB space optimization

BlueNRG-1 adds Bluetooth\textsuperscript{®} Smart connectivity to ST Telematics processors
ST In-Vehicle Connectivity

Enabling the volume deployment of the features that matter, when they matter

- Aux in
- Memory
- USB
- Bluetooth
- Analog converters & DSP
- Rear view cam
- Mirroring
- Secure network

>70Mu Car Radio processors

Accordo+
Accordo2
Accordo5

Sampling
Car-Makers Facing Seismic Changes

Supporting our customers building the self-driving car of the future

<table>
<thead>
<tr>
<th>Actors in China</th>
<th>Technologies</th>
<th>System Features</th>
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</thead>
<tbody>
<tr>
<td>• Chinese legislator</td>
<td>• V2X</td>
<td>Telematics</td>
</tr>
<tr>
<td>• Universities</td>
<td>• Connectivity, Positioning, Sensors, Image processing, Radars, Processors</td>
<td>E-CALL</td>
</tr>
<tr>
<td>• Design labs</td>
<td>• Secure MCUs, Adaptive lighting, Passive safety, Intelligent braking, Stability control</td>
<td>In-car Wi-Fi hotspot, Navigation &amp; Traffic Info</td>
</tr>
<tr>
<td>• Car manufacturers</td>
<td></td>
<td>Energy saving route, Tolling</td>
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<tr>
<td>• Tier-1</td>
<td></td>
<td>ADAS</td>
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<tr>
<td></td>
<td></td>
<td>Radar-based car &amp; hazard detection, Crash avoidance, Cooperative cruise assist</td>
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<tr>
<td></td>
<td></td>
<td>Traffic sign recognition, Remote parking, Lane Departure</td>
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<tr>
<td></td>
<td></td>
<td>V2X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crash avoidance, Cooperative cruise assist, Emergency vehicle approaching</td>
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<td></td>
<td></td>
<td>Roadwork alert, Green light speed advisory</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Level</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
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<tbody>
<tr>
<td>• Autonomy</td>
<td>Driver Only</td>
<td>Assisted Driving</td>
<td>Partly Automated</td>
<td>Highly Automated</td>
</tr>
<tr>
<td>Level</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
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Intelligent & Connected
State-of-the-art of Technology Innovation

Leading edge Electronics toward the self-driving car of the future

<table>
<thead>
<tr>
<th>Sensors/ MEMS</th>
<th>Embedded Processing</th>
<th>CENTRAL Unit</th>
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<tr>
<td>• See</td>
<td>• Distributed</td>
<td>• Vision Processing</td>
</tr>
<tr>
<td>• Measure/Evaluate</td>
<td>Intelligence</td>
<td>Park Pilot</td>
</tr>
<tr>
<td>• Distance</td>
<td>• Improved Security</td>
<td>Real-time high performance</td>
</tr>
<tr>
<td>• Pressure</td>
<td>• Augmented Safety</td>
<td></td>
</tr>
<tr>
<td>• Temperature</td>
<td>• ISO 26262 Safety</td>
<td></td>
</tr>
<tr>
<td>• Movement</td>
<td>• Security</td>
<td></td>
</tr>
<tr>
<td>• Orientation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Communicate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Identify Position</td>
<td></td>
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</tr>
</tbody>
</table>

Camera & GPS Sensors, Radars, MEMS
SPCxxx, STM32, 8-bit Microcontrollers
Working with the leaders in a win-win market approach
ADAS with MOBILEYE – V2X with Autotalks

SENSE
CONTROL
ANALYSE
COMPUTE

Adding automated driving features

• Estimating Free-space
• Detecting more objects, more precisely
• Reconstructing road profiles
• Monitoring environmental elements
• Fine Sensing of road conditions for automatic suspension, steering adjustment
GNSS Precise Positioning

Enabling more safety features for Autonomous Driving

Precise Positioning
- Lane detection
- Positioning data for V2X sharing
- Collision avoidance
- Autonomous parking
- Autonomous driving
- eCall accident location
- < 1 metre precision
ST Performance: The best positioning accuracy on the market

Beidou represents a key enabler for our business in China
GPS+BeiDou simultaneously

STA8090x – Teseo III
Constellations supported
GPS-BeiDou-GLONASS-Galileo-QZSS

Automotive leading consumer market as concrete opportunity
Road tolling
Anti-theft
Emergency call
Insurance
Fleet management
Modules

Pioneer in multi-constellation
• GPS, Galileo, GLONASS, BeiDou, QZSS

Unique automotive scalable solution
• Stand alone, MCU, host based

State-of-the-Art autonomous & predictive AGNSS

Proprietary Dead Reckoning Automotive Way (DRAW) sensor fusion
ST Automotive Camera System

Camera System Offer for Automotive

High performances 1.3MPix HDR sensor & versatile system-on-chip with advanced and instant HDR image signal processing

Compact, low component count & low energy automotive camera system

New smart camera system designed to help customers develop secure and advanced automotive camera applications

VG6640 1,3MPIX HRD SENSOR
45fps @ full resolution - Ultra Lower power
Motion & LED Flicker Mitigation - AEC-Q100 Grade2 - Automotive Safety Integrity Level (ASIL) - Min Die Illumination 1mLux - RGB/RCCC Monochrome variants

STV0991 IMAGING SIGNAL PROCESSOR
Camera System Benefits

Significant reduction of system cost & complexity

- Rear view pre-processing in STV0991 (optical correction, video compression, video analytics support)
- No need of additional video-processing ECUs between STV0991 and Infotainment ECU
EyeQ4™
4th generation vision processor

Extends EyeQ™ Family Performance, Designed using ST’s 28nm FD-SOI Technology

- Long term Roadmaps on key ADAS Technologies
- Machine Vision with Mobileye
- 24GHz and 77GHz RADAR, FD-SOI
- Sensor Fusion SPC5 32-bit MCUs
- Dedicated ADAS Power Management Ics
- Partnerships (public)

4th Generation

- Detection of more objects, more precisely
- More features required for automated driving
  Free-space Estimation, Road profile Reconstruction
- Monitoring of environmental elements
- Detailed understanding of the road conditions
  allowing automatic suspension, steering adjustment
- Highly automated vehicles
A radar system can use 2 classes of sensors to provide complete coverage:

**Short-range radar (24GHz)**
- Cover almost the entire azimuthal angle and can see all around the car (100° to 360°)
- Distances up to several tens of metres

**Long-range radar (77GHz)**
- Cover limited angle (±10°) but longer distance (up to 250m)
- Can be used for automatic cruise control

**SiGe BiCMOS technology**
- Solution for 24Ghz and 77Ghz

**Fully integrated transceiver**
- Modular transceiver for multiple channels configurations
V2X is Rapidly Growing

- Rapidly growing in automotive industry
- Key technology growth driver
- It requires great interoperability
- Safety and security are the key elements
- By 2020, 140M vehicles will use V2X technology
V2X Road Safety Evolution

The most comprehensive and technically advanced offering for V2X Market

Wireless Communication based on IEEE802.11p, operating on 5.9GHz band allocated for ITS apps

CAM /DENM messages broadcasted 10 times per second
  - car-to-car
  - car-to-infrastructure

Driver alert of potential dangers even in non-line-of-sight condition

Smart traffic management

- Potential to reduce road fatalities by 90% by combining V2X with other ADAS technologies
- Most advanced solution to handle cybersecurity risks
- Secured participation in trials preparing technology introduction into the market
- V2X 11-p Wi-Fi processor to Autotalks

*All needed V2X blocks
*Pre-integrated Software
*Uncompromised Security
V2X
More Safety and New Mobility

• Help to prevent up to 80% of crashes
• Real-world pilots worldwide
• To accelerate road safety innovation
• Lower emissions & energy efficiency through vehicle traffic optimization
• Recently announced trials
• Connected vehicle pilot deployment programs in US Smart Cities (NYC, FL, WY)

Today Social Figures

• 1.3M/year driving fatalities worldwide
• >3B gallons wasted fuel in 2014 in the US, estimated waste increase to 3.8B in 2020
• Travelers stuck 7B extra-hours in their cars due to traffic congestions

Sources
1. World Health Org
2. Texas A&M Transportation institute
3. US DOT
ST is making Driving More Connected and More Secure

More Secure Driving Technologies
Processors (Secure Gateway), Secure Elements

What More Secure Driving Means

- Securing the Vehicle to Infrastructure communications
- Securing internal car networks
- Securing remote user interactions with the vehicle
The automotive world is going to experience unprecedented changes

- New and alternative energies combined with more efficient and lower emission trends are defining the powertrain technologies of the future automotive

- Capabilities in computational power, connectivity, sensor fusion will be key in the electronics platforms of tomorrow’s car

- Safety, digitally connectivity and security are accelerating the arrival of autonomous vehicles

- ST is strategically positioned for growth in the key segments of vehicle electrification, Safety and autonomous driving
Thank you!

ST stands for life.augmented