Turning IoT Vision into Reality: Semiconductors Lead the Way

Jean-Marc Chery
President & CEO
STMicroelectronics
• A global semiconductor leader
• 2017 revenues of $8.35B with year-on-year growth of 19.7%
• Listed: NYSE, Euronext Paris and Borsa Italiana, Milan

• Approximately 45,500 employees worldwide
• Approximately 7,400 people working in R&D
• 11 manufacturing sites
• Over 80 sales & marketing offices

As of December 31, 2017
IoT Vision & Promise

Enabling billions of connected smart devices to communicate with each other

Almost any system can leverage the Internet and the ecosystem of Cloud Computing to innovate and make objects smarter and more aware.
The IoT Enables a Smarter World

Smart Things

Smart Home & City

Smart Industry

Smart Driving

Connected Objects

300 million in 2017

800 million in 2021

Wearable computing devices

0.4 billion in 2017

1.8 billion in 2021

Excluding PCs & digital home

4 billion in 2017

10 billion in 2021

Retail, advertising, supply chain & Industrial IoT

1.1 billion in 2017

2.2 billion in 2021

Source: ABI
Smart Driving

Making driving Safer, Greener and more Connected

Safer

• Having cars drive better than we can and always watching for threats
• Making driving safer for car occupants and other road users by actively avoiding accidents

Greener

• Improving power and fuel efficiency, and helping minimize emissions and car maintenance
• Moving towards electric vehicles

More Connected

• Enabling personalized car entertainment and connectivity
• Allowing vehicles to communicate with each other and the infrastructure (V2X)
Connected vehicles enable additional services

Vehicle-to-Cloud
- Diagnostics
- Software Upgrades
- Traffic information
- Infotainment
- Payment services
- Internet services
- eCall

Vehicle-to-Infrastructure
- Real-time traffic information

Vehicle-to-Vehicle
- ADAS

Consumer device integration
- Smartphones
- Tablets
The Safer Connected Car

The connected car is revolutionizing vehicle safety

TELEMATICS/GNSS

Vehicle diagnostics
eCall accident location
Navigation & Traffic Info

ADAS

Radar-based car & hazard detection
Machine Vision for high definition hazard & traffic sign recognition
Remote parking

V2X

Crash avoidance
Cooperative cruise assist
Emergency vehicle approaching
Roadwork alerts
Green light speed advisory
V2X (Vehicle to Everything) Benefits

Safety
Over 80 percent of accidents can be avoided by V2X and Connected Vehicle applications

Mobility
42% reduction in travel time on freeway (with cooperative adaptive cruise control)

Environmental
22% of fuel savings (signal operations and freeway lane management applications)

Source: USDOT
Silicon Carbide
A Key Enabler for Electric Vehicles

Mileage extension, smaller battery (or increased reliability), fast & efficient charging

SiC vs Silicon IGBT

- Efficiency gain @750V: ~8% to~12%
- Switching losses: ~7x lower
- Chip size: ~5x smaller
- Total loss: ~50% lower
- Switching frequency: ~ 5 ..10 X

Si IGBT  vs  SiC MOSFET
Enabling smarter, safer and more efficient factories and workplaces

- Factories that produce in a more efficient manner
- More flexibility and customization
- More sustainable production with less waste
- Safer working environments for people
- Better man-machine cooperation in the workplace
- Optimized usage of machines and tools
IoT Opportunities in Smart Industry

- **Connected Utilities & Industrial IoT Devices**
  - 1.5B
  - By 2021
  - (0.7B in 2017)
  - Source: ABI

- **Increase machine life by up to**
  - 20%
  - with condition-based maintenance
  - Source: McKinsey

- **Industrial electric motors installed worldwide**
  - 300M
  - Increasing by 10% per year
  - Source: ABB

Source: ABI, McKinsey, ABB
Remote Condition Monitoring

Functional Needs
- Vibration Capture
- Connectivity
- Processing
- Secure Connections
- Power Management

Semiconductor Products
- Motion sensors
- Bluetooth, Sub-GHz
- IO-Link
- MCU
- Secure MCU
- Power ICs

Mechanical vibration
- Displacement
- Speed
- Acceleration
- Acoustic noise
- Angular speed
- Torque

Smart Industry
Predictive Maintenance

Equipment to be monitored

Smart Sensing

Connectivity

Data collection + Processing + Analytics
Security: authentication

Secure communication

Immediate Actions

• Decisions
• Actions

Maintenance

Smart Industry

Analytics
Storage

Smart Industry
Role of Semiconductor Companies in enabling the IoT

Connected Device

- Device-specific Application e.g. Smart Thermostat app
- Application Enablers
- Middleware
- HW enablement Firmware

- Mechanical Parts
  - MMI elements
  - PCB
- Semiconductor Building Blocks

Connectivity Services

Cloud Applications

Cloud Services

Product Development Tools

Evaluation and Prototype Development Tools

Enabled directly by Semiconductor Companies

Enabled through Partnerships
## The Building Blocks of the IoT

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of sensors and actuators</td>
<td>Ultra-Low Power to High Performance</td>
<td>Scalable security solutions</td>
<td>10 cm to 10 km</td>
<td>Nano Amps to Kilo Amps</td>
<td>Power conversion Monitoring Drivers</td>
<td>Nano Watt to Mega Watt</td>
</tr>
</tbody>
</table>
Some of the Challenges of IoT Devices

- Security at all levels
- Low-power devices & Energy Efficient
- Adapted connectivity
- The right types of Sensors
- Intelligent processing
The 5G Disruption

**What it brings to the end users**
- Very high data rate – $x100^*$
- Reduced latency – 5 times lower*
- Very high reliability – 99,999%
- Connections of millions of nodes
- Improved coverage

**What is changing in the infrastructure**
- New architecture with denser network (small cells)
- New technologies: Advanced beam forming, massive MiMo
- New spectrum: Use of millimeter waves

**What is required from microelectronics**
- Higher silicon integration
- Improved RF performance
- Enhanced power efficiency
- Cost-optimized solutions

* vs 4G
Advanced Process Technologies

Semiconductors

Continuous Investment in Process Technologies

- Range of microcontrollers
- Intelligent sensors
- Advanced connectivity
- Smart power and energy management
## Beyond the Building Blocks

### The right building blocks for IoT devices

- Microcontrollers
- Secure solutions
- Sensors & actuators
- Connectivity solutions
- Power management
- Motor control
- Analog components

### Lower barriers for developers getting started

- Stackable boards & modular SW
- Pre-integrated software for vertical applications

### Lower barriers from prototyping to first product

- STM32 Nucleo Development & Expansion boards
- Development ecosystem

### Enable product & service commercialization

- Integration of Cloud Provider SDKs
- Partner program and ST community

<table>
<thead>
<tr>
<th>Stackable boards &amp; modular SW</th>
<th>Pre-integrated software for vertical applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>STM32 Nucleo Development &amp; Expansion boards</td>
<td>Smart Things</td>
</tr>
</tbody>
</table>

### Development ecosystem

- Code generators
- Prototyping software
- Development environments
- Debug solutions
- Simulation and analysis tools
- On-line design tools
Close Partnership with Key Enablers

- To develop SW to connecting to the Cloud & Cloud services for IoT users
- To develop NB-IoT/LoRa modules and FW package compatible with STM32 ecosystem
- To customize stack and develop RF modules compatible with STM32 ecosystem
- To implement secure solutions from device to cloud
Close Partnership with Key Enablers

- To develop SW to connect to the Cloud & Cloud services for IoT users
- To develop NB-IoT/LoRa modules and FW package compatible with STM32 ecosystem
- To customize stack and develop RF modules compatible with STM32 ecosystem
- To implement secure solutions from device to cloud