Emerging Trends and Applications of IoT in Post-Smartphone Era

Jui-Lin (Ray) Yang
Deputy Program Director
ITRI / IEK
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Five Must-know for Semiconductor Industry in Internet of Things, in 2014 the same forum

• **Wearable:** huge opportunity for combining semiconductor devices and indirect-approach algorithm. Semiconductor companies should consider to extend its arm to OS platform.

• **Smart Home:** a potential new war between the OTT and semiconductor "pipe" companies.

• **Vertical market:** Even if it's inevitable to be a "pipe", wireless connectivity solution vendors are still provided to address business opportunity of resolving unfulfilled needs.

• **Infrastructure:** The foreseen distributed architecture and local computing/server node shall create new business opportunity for semiconductor industry.

• **China:** in IoT if you cannot beat it, Join him.

Source: ITRI/IEK(2014/09)
Outline

• Taiwan Semiconductor Industry Overview

• Market trends of IoT in B2C and B2B sectors

• Development trends of IoT and AI applications

• Conclusion
Taiwan’s key sub-industries of manufacturing

Semiconductor is the largest

Manufacturing

Production value (share): 19,183(100%)

Unit: NT$ billion (2014)

Source: DGBAS; ITRI/IEK(2015)
2014 Semi industry ranked first in value-added among Taiwan’s manufacturing sectors

Bubble size represents the production value

Source: MOEA; ITRI/IEK(2015)
Taiwan IC industry outperformed W/W in last 10 years, and about to reach $74.9B in 2016

2005-2017 CAGR
Taiwan: 7.1%
Worldwide: 3.2%

Source: TSIA; ITRI/IEK (2016/08)
Foundry contributes the most to Taiwan IC industry, with fabless the 2nd

Taiwan IC production value distribution

Source: TSIA ; ITRI/IEK(2016/08)
Taiwan IC packaging and testing service accounts for more than half of W/W SATS

Worldwide SATS Revenue

Source: TSIA ; ITRI/IEK(2016/08)
Market trends of IoT in B2C and B2B sectors
IoT is driving both Smart Living and Productivity

- Smart Living: B2C focus; Data analytics as latest thrust
- Productivity: B2B focus; Industry 4.0 as latest thrust

Source: Michael Porter (2014); ITRI/IEK (2015)
These are what we have today for Smart Living…

- Home Energy Management
- Home Security and Safety
- Personal Drone
- Information and Entertainment
- Healthcare and Fitness

- Smart Plug
- Smart Meter
- In Home Display
- Smart Appliance
- Smart Lighting
- Smart Locks
- Gas Detector
- Smoke Detector
- IP Cam
- Smart Feeding Bottle
- Fitness Tracker
- VR HMD
- Gesture Recognition
- Game Console
- Robotics
- Smart Shoes
- Smart Blood Glucose Meter

Source: ITRI/IEK(2016/09)
Potential in automotive, home security, and smart energy sectors

Millions of IoT endpoint unit shipments

- **Automotive**
  - CAGR(2016~20): 16.3%

- **Home Energy Management**
  - CAGR(2016~20): 42.4%

- **Home Security and Safety**
  - CAGR(2016~20): 48.4%

- **Information and Entertainment**
  - CAGR(2016~20): 59.4%

- **Health and Fitness**
  - CAGR(2016~20): 25.4%

Source: Gartner; ITRI/IEK(2016/09)
Wearable device’s potential in smartwatch, head-mounted display, and smart garments

- Bluetooth Headsets
- Smartwatches
- Wristbands
- Sports Watches
- Other Fitness Monitors
- Wearable Cameras
- HMD
- Smart Garments

Source: Gartner; ITRI/IEK(2016/09)
High BOM of smartwatch and HMD creates larger wearables semiconductor revenue

- **Smart Watches**: 28% of semi revenue
- **Other Wearables**: Bluetooth headsets, miscellaneous wearables…
- **Fitness Wearables**: Sports watches, smart garments, wristbands… 18% of semi revenue
- **Smart Glasses and HMD/cameras**: 26% of semi revenue

Source: Gartner; ITRI/IEK(2016/09)
These are what we have for Smart Business...

- **Security & Safety**
  - Commercial Security Cameras
  - Motion Sensor
  - Electronics Door Locks

- **Farming Equipment**
  - Connected Field Devices-Manufacturing
  - Oil / Gas Well Sensor

- **Transportation & Automotive**
  - Shipment Condition Monitor
  - Heavy Truck Subsystem
  - Asset Tracking-Freight Pallets

- **Manufacturing & Natural Resources**
  - Smart Electric Meters
  - Smart Gas Meters
  - Smart Plant Integrity (Process Sensor)

- **Utilities & Energy Management**
  - Commercial Security Cameras
  - Door Locks

Source: ITRI/IEK(2016/09)
Potential in utilities, security, and transportation sectors

 Millions of IoT endpoint unit shipments

CAGR(2016~20): 51.7%
CAGR(2016~20): 39.6%
CAGR(2016~20): 15%

Source: Gartner; ITRI/IEK(2016/09)
ADAS developments for drivers’ & passengers’ safety

- NHTSA defines 5 levels for driving automation, and most of existing ADAS in smart vehicle can only reach Level 2 to control speed or direction via Adaptive Cruise Control, Autonomous braking, Lane Keeping Assist, and Park Assist.
- ADAS will continue to upgrade thus bring about huge opportunities for semiconductor industry.

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>L5</td>
<td>Self-driving only</td>
</tr>
<tr>
<td>L4</td>
<td>Full Self-driving</td>
</tr>
<tr>
<td>L3</td>
<td>Limited Self-driving</td>
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<tr>
<td>L2</td>
<td>Partial Autonomy</td>
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<td>L1</td>
<td>Driver Assistant</td>
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- Control speed and direction
- Control speed or direction
- Assistance

Source: NHTSA(National Highway Traffic Safety Administration) ; ITRI/IEK(2016/09)
Sensing, Understanding, Action as 3 key requirements for autonomous vehicle

- **Sensing:** Variety of sensors (CMOS Image/IR Sensor, mm Wave Radar, LIDAR, Ultrasound...) will need to work together thus a multi-sensing fusion solution is required.
- **Understanding:** Sensor fusion solution will need to work with high performance CPU/GPU with AI (Machine Learning, Deep Learning) capability to understand the environment completely around the car.
- **Action:** the controller/actuator/communication system will start to work and process to realize autonomous functions.

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**Autonomous Vehicle**

<table>
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<tr>
<th>NO-Off</th>
<th>Feet-Off</th>
<th>Hands-Off</th>
<th>Eyes-Off</th>
<th>Minds-Off</th>
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<td>L1: Driver Assistant</td>
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</tbody>
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**Sensing**
- Stereo Cameras (CIS, FIR)
- mm Wave Radar, Ultrasound
- LIDAR

**Understanding**
- High Performance CPU/GPU
- Big Data, Cloud Computing
- AI (Machine Learning, Deep Learning…)

**Action**
- Actuator, Controller
- V2V Communication
- Other Connected Car Communication Protocol

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Source: ITRI/IEK(2016/09)
Imaging processing a key element across applications

Source: Gartner; ITRI/IEK(2016/09)
ADAS and HMD are among the fast semiconductor revenue growth segments.
Development trends of IoT and AI applications
The higher gross margin, the higher P/E (positive correlation) with some exception

X-axis: Gross Margin as of fiscal year 2015
Y-axis: P/E Ratio as of 2016/07/E

Source: ITRI/IEK(2016/09)
P/E Ratio seems to be not closely related to Sales Revenue

Bubble size represents the revenue of 2015

X-axis: Gross Margin as of fiscal year 2015
Y-axis: P/E Ratio as of 2016/07/E

Source: ITRI/IEK(2016/09)
Any potential M&A you expected?

Bubble size represents the market cap. of 2016/08/E

X-axis: Gross Margin as of fiscal year 2015
Y-axis: P/E Ratio as of 2016/07/E

Source: ITRI/IEK(2016/09)
Olli - Local Motors’ first self-driving vehicle

Powered by IBM Watson

• Olli, an electric-powered mini bus, can carry up to 12 people designed by Local Motors

• The cars will start operations first in Washington DC, before expanding to deployments in Miami-Dade County and Las Vegas later this year (2016)

Source: IBM
Vast amount of data generated by IoT is a driving force to deep learning development.

 Millions of IoT units
 Installed base - B2B

Source: Gartner; ITRI/IEK(2016/09)
Pay attention on emerging IoT in Information & Entertainment of B2C sector

Millions of IoT units
Installed base - B2C

Source: Gartner; ITRI/IEK(2016/09)
Conclusion
• Besides exploring emerging semiconductor opportunities derived from DNNs especially in edge computing, I would rather suggest Foundry / OSAT, as a user, to consider in the future to adopt deep learning technology to maintain your leading edge position of solutions, while dealing with thermal and mechanical and electrical issues, with the advisory support of smart machines, to help your clients time-to-market and to increase your competitive advantages and values with higher margin and market capitalization.

Source: ITRI/IEK(2016/09)
Thank you

Ray, Jui-Lin Yang
Deputy Program Director
ray@itri.org.tw
+886-3-5919207

http://ieknet.iek.org.tw/