The Software of Things

TYSON TUTTLE | CEO | SILICON LABS
ASPENCORE CEO SUMMIT | SHENZHEN | 8 NOVEMBER 2018
“Most technology we’ve built so far was for the Internet of People (IoP). Whether it was an e-commerce or search application, it was built to serve people—and to accumulate specific types of data that we could analyze later.

But people are not things. Things produce vast amounts of data nonstop and can give us information whenever we ask for it. So why would we think the technology we built for the Internet of People would work for the Internet of Things?”

Timothy Chou
Lecturer, Cloud Computing at Stanford
Former President of Oracle Cloud
Silicon, software and solutions for a smarter, more connected world
Connected Hardware + Software – A Powerful Combination

- Software defines the next generation of things
- Connected hardware requires more software
  - Wireless protocols
  - Apps, middleware, over-the-air updates
  - Abstraction of human controls
  - Sensor data processed, sent, stored and secured
- IoT device lifecycle needs reliable software
Connected Hardware + Software – Enabling New Applications

BROODMINDER
Cloud Connection | Large Data Sets

sengled
AI | Predictive Analytics | Visualizations

INBOARD
Alerts | Functions | Management
Connected Hardware + Software – Transforming Industries

$10T  |  $1T  |  $100B

- Economic Impact
- IoT Revenue
- Silicon, Software and Solutions TAM

Source: Silicon Labs estimates for 2025
Fueling the Growth of Connected Devices

Global Internet Connectable Device Shipments
In Billions per Year

- **Consumer**
  - 2016: 8.5B
  - 2017: 9.2
  - 2018: 10.2
  - 2019: 11.6
  - 2020: 13.3
  - 2021: 15.4
  - 2022: 17.3
  - 2023: 19.1
  - 2024: 21.1
  - 2025: 23.0
  - 2026: 5.4

- **Computers**
  - 2016: 4.0B
  - 2017: 4.4
  - 2018: 11.1

- **Communications**
  - 2016: 1.6

- **Industrial**
  - 2016: 8.5B

- **Automotive and transportation**
  - 2016: 23.0

Source: IHS Markit Q2 2018 Report
IoT Creates New Business Models

- Purchase Device
- Monthly Subscription
- Recurring Revenue
IoT Applications Have Significant Constraints

- **Storage**
  - PB
  - TB
  - GB
  - MB

- **Power**
  - kW
  - 100 W
  - 10 W
  - µW

- **Battery Life**
  - AC Powered
  - 100 Wh/1 day
  - 10 Wh/1 day
  - 1 Wh/10 years

- **Cost**
  - $10,000
  - $1,000
  - $100
  - $10
Integrating Wireless Connectivity Is Hard
IoT SoCs Integrate Wireless Connectivity

2014
IoT SoC Concept

2018
EFR32xG1x SoC Portfolio
# IoT SoCs Integrate Wireless Connectivity

## CPU and Memory
- ARM Cortex-M4 w/ FPU + MPU
- Debug Interface
- 32 to 1024 kB Flash
- ETM
- 8 to 256 kB RAM
- LDMA Controller

## 32-bit bus

## Peripheral Reflex System

## Serial Interfaces
- 4x USART
- Low Energy UART
- 3x I2C

## I/O Ports
- External Interrupt
- Up to 31 GPIO (5V Tol)
- Pin Reset
- GPIO Wakeup

## I/O Ports
- 3x Timer/Counter
- Low Energy Timer
- LESENSE
- Watchdog
- Pulse Counter
- Protocol Timer
- RTC
- Cryotimer

## Analog Modules
- ADC
- 32 to 1024 kB Flash
- ETM
- Debug Interface
- 32 to 1024 kB Flash
- ETM
- 8 to 256 kB RAM
- LDMA Controller

## Clock Management
- High Freq Crystal Osc
- High Freq RC Osc
- Auxiliary RC Osc
- Ultra Low Freq RC Osc
- Low Freq Crystal Osc
- Low Freq RC Osc
- Precision Low Freq RC Osc
  (Replace External 32 KHz XTAL)

## Energy Management
- Voltage Regulator
- Voltage Monitor
- DC-DC Converter
- Brown-out Detector
- Power-on Reset

## Security
- Crypto
  - AES, ECC, SHA
- CRC32
- TRNG

## Radio
- 2.4 GHz (int. balun)
- Sub-GHz
- Integrated PA
- Radio Controller
- Packet Trace
- Radio Crypto
The Best Software Will Decide the IoT’s Future
Models for IoT Software Development

Volume

Customer #

Custom Functionality
SDK

Simplicity
Command API

“The Long Tail”

1 10 100 1,000 10,000
IoT Requires Integrated Hardware + Software

<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
<th>Power</th>
<th>Battery Life</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servers</td>
<td>PB</td>
<td>kW</td>
<td>AC Powered</td>
<td>$10,000</td>
</tr>
<tr>
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</tr>
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</table>
## Integrated Gecko Hardware + Software Platform

### Applications
- Home Automation & Security
- Lighting
- Industrial Automation
- Smart Metering
- Commercial & Retail
- Medical
- Transportation

### Simplicity Studio
#### Host Environment
- Energy Profiler
- Network Analyzer

#### Toolchains
- IAR
- GCC

#### Enablement
- Sample Apps
- MISRA, Static Analysis
- Large Network Testing

### Connectivity Software
#### SILICON LABS PROVIDED
- Bluetooth
- WiFi
- Thread
- Zigbee

#### CUSTOMER IMPLEMENTED
- Sigfox
- LoRa
- 802.15.4

### Platform Software
#### RTOS
- KAL
- Kernel

#### Core Platform
- Sleep
- Timers

#### Drivers
- IPC
- Events

#### Security
- Memory
- System

#### Utilities
- POSIX
- CMSIS

#### Middleware
- Security Libraries
- C-Lib, Diag, Stats, Error Codes, Assert

### Hardware
#### IoT SoC
- Secure MCU
- eFlash & RAM

#### Modules
- Crypto HW, PUF, DPA, Key Storage
- Antenna & Match

#### Development Boards
- PCB, SIP
- Shield

### Other
- Device Management / Updates
- Network Analyzer
- Radio Config
- Secure Programming
- GCC
- MISRA, Static Analysis
- Large Network Testing
- App Notes & Documentation

### SILICON LABS PROVIDED
- Radio Abstraction Layer
- Connectivity Software

### CUSTOMER IMPLEMENTED
- Connectivity Software
- Radio Abstraction Layer

### Plattform Software
- RTOS
- Core Platform
- Drivers
- Security

### Hardware
- IoT SoC
- Modules
- Development Boards

### Simplicity Studio
- Host Environment
- Toolchains
- Enablement

### Connectivity Software
- SILICON LABS PROVIDED
- CUSTOMER IMPLEMENTED

### Platform Software
- RTOS
- Core Platform
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Connected Hardware + Software – Silicon to Cloud

**Device Updates**

**Analytics**

**NB-IoT**
**LTE Cat-M**

**IP**

**LTE**

**Web**

**IoT Devices**

**Gateway**

**Mobile Handset**

**Bluetooth**

**Wi-Fi**

**Zigbee**
Key Takeaways

- Software unlocks the value of IoT from silicon to cloud
- There will be many hardware + software platforms enabling the IoT in China and globally
- Market success requires highly optimized, tightly integrated platforms that meet the constraints of IoT
- IoT winners will be those who collaborate for the benefit of all
Collaborating to Build the IoT
Thank You　谢谢
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