NXP and the Internet of Things (‘IoT’)

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VP Marketing – Greater China
Agenda

- The Internet of Things (‘IoT’): a New and Exciting Application Space
- A typical IoT application – Lighting for Home and Commercial
- Jennet-IP and Zigbee Wireless Protocol Stacks
- NXP Jennet-IP IoT Wireless MCU Product Portfolio
- NXP IoT Development Eco-System
- Executive Summary
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What is the Internet of Things?

Any Machine to Machine (M2M) or Human to Machine (H2M) devices which can be connected to the www to communicate, exchange data and/or provide mechanisms for feedback and control

- Mobile Phones
- Tablets
- Computers
- Gateways/Routers
- Automobiles equipped with www connectivity
- RFID devices

Some examples
Evolving Technology Roadmap: The Internet of Things is in its Infancy

As IoT technology evolves, so will the range of potential applications

Source: based on SRI Consulting Business Intelligence
IoT will Drive improved performance in two key Domains: 1.) Information + Analysis and 2.) Automation + Control

<table>
<thead>
<tr>
<th>Information and analysis</th>
<th>Automation and control</th>
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<tbody>
<tr>
<td><strong>1</strong> Tracking behavior</td>
<td><strong>1</strong> Process optimization</td>
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<tr>
<td>Monitoring the behavior of persons, things, or data through space and time.</td>
<td>Automated control of closed (self-contained) systems</td>
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<tr>
<td><strong>2</strong> Enhanced situational awareness</td>
<td><strong>2</strong> Optimized resource consumption</td>
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<tr>
<td>Achieving real-time awareness of physical environment.</td>
<td>Control of consumption to optimize resource use across network</td>
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<td><strong>3</strong> Sensor-driven decision analytics</td>
<td><strong>3</strong> Complex autonomous systems</td>
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<tr>
<td>Assisting human decision making through deep analysis and data visualization</td>
<td>Automated control in open environments with great uncertainty</td>
</tr>
<tr>
<td>Examples: Sniper detection using direction of sound to locate shooters</td>
<td>Examples: Collision avoidance systems to sense objects and automatically apply brake</td>
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<td>Inventory and supply chain monitoring and management</td>
<td>Clean up of hazardous materials through the use of swarms of robots</td>
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<td>Continuous monitoring of chronic diseases to help doctors determine best treatments</td>
<td>Continuously precise adjustments in manufacturing lines</td>
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Source: McKinsey Quarterly Report - 2010
IoT is Driving a New Wave of Economic Opportunity

<table>
<thead>
<tr>
<th>The wider Economy</th>
<th>For Semiconductor and Software Industries</th>
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<tbody>
<tr>
<td>Logistics</td>
<td>IoT RxTx Modules to allow comms – everything will be connected</td>
</tr>
<tr>
<td>Control and Automation</td>
<td>Applications boards and Development tools</td>
</tr>
<tr>
<td>Security</td>
<td>Embedded Applications Software for IoT modules (‘doing things’)</td>
</tr>
<tr>
<td>Automotive</td>
<td>Cloud Services and web based applications s/ware</td>
</tr>
<tr>
<td>Asset tracking and location</td>
<td>Data Analysis and metrics s/ware</td>
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<tr>
<td>Medical</td>
<td></td>
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<tr>
<td>Banking</td>
<td></td>
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<td>Services</td>
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</table>
To achieve Level 5 (Infrastructure level systems incorporating fully autonomous systems gathering data, analysis, control) and the full monetization potential* of IoT, requires all the levels below to be in place and ubiquitous.

We can conclude that as of today, IoT is in its infancy, with decades of high growth still to come.

* According to Cisco, potentially $14 Trillion
IoT is Driving the Next Semiconductor Growth Wave

Bringing the industry to over $400Bn…

Connected devices in use, bn Units

- Machine-2-machine (M2M)
- PC, laptop, Smartphones

Driver
- Computer
- Smartphone
- M2M

Source: WSTS (extrapolated after 2011), Cisco, BBC, Gartner, GSMA, OECD
By 2020 there will be between 20 Billion* and 50 Billion** IoT nodes

Source: Ericsson

* Ericsson  ** Cisco
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IoT Adoption at the I/O Module Level

Key Enabler for Intelligent distributed apps

3rd Party Cloud Services

Gateway: Required to provide www connectivity

Gateway Ethernet & USB Dongle

Jennet-IP Empowered I/O:
Independent 3rd Party I/O module manufacturers
+ Standard Jennet-IP IoT Transceiver (see next Slides)

Independent 3rd party apps developers: Any OS, and in many end market applications

iOS

Android

Linux

PC

MAC

H.A.

Security

C.R.A.P.

In

Asset tracking

Lighting

Etc

Independent 3rd party Hardware developers in many application segments
The Smarter Home – Talking to the Internet

Home network

- Distributed electricity generation and storage
  - Wind Turbine
  - Solar Panel

- Security
  - Light

- Appliances
  - Sensors

- Temperature
  - Smart home devices

Home displays
- TV
- Computer

In-Home Energy Display

Smart
- Elec.

- Gas

- Heat

- Water

Breakers

Home Gateway

Displays

IP network

- Independent service providers
- Utility Data centers

Smart home devices
- Blood pressure meter
- Glucose meter
- Assisted Living Healthcare devices
- Thermometer
In-Home Low Power Wireless Network

An IP address for every “thing”
A Typical Commercial LED Fixture Installation

1. A **lighting driver module** (open board or housed) is located in or close to the fixture. Driver modules are available commercially that can take PWM signal and/or 0-10V analog signal for dimming and on/off control. These types of drivers would for example be used with DALI for lighting control.

2. A **Lighting Fixture** that contains the LED light source mounted on a heatsink (called ‘light engine’) with a lens or light filter; screws into ceiling or on wall.
... becomes a Smart Lighting Solution with the addition of a low cost Jennet-IP IoT module

3. Jennet-IP IoT Lighting Module
- Jennet-IP JN516x Chip
- Basic circuit to convert JN516x I/O output to 0-10V and PWM
- Small 1.5W power supply
- Antenna (PCB, wire or plug-in)
- Plastic enclosure (could be bare board in certain applications)
- Leverages existing commercial LED (or other) lighting driver module to create a smart lighting network
- Fast time to market – retrofit and new build
- Low cost
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JenNet-IP Wireless Networking

- Wireless networking for the Internet of Things (IoT)
- IPv6 addresses for every node
  - Standalone mode for simple remote control
  - Connected mode for internet control
- Using IEEE and IETF standards
  - IEEE802.15.4
  - IETF IP, UDP, 6LoWPAN
- Based on proven JenNet networking layer
  - Self healing tree network
- JIP Application layer dedicated for low power devices
  - Similar to SNMP, using fewer resources
  - Standard device types provide interoperability
- Connected lighting applications available initially
  - Provides whole house coverage
  - Extending applications to cover IoT
- Uses JN5168 single chip wireless microcontroller
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NXP wireless microcontrollers & modules JN516x

Single-chip solutions for ZigBee, JenNet-IP & IEEE802.15.4 apps

Advanced 32 bit RISC MCU’s equipped with high performance wireless connectivity and peripherals for IoT applications
Jennet-IP JN516x IoT Wireless uController – Hardware Platform

JN516x chip memory specifications

<table>
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<tr>
<th></th>
<th>Flash</th>
<th>RAM</th>
<th>EEPROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>JN5161</td>
<td>64 kB</td>
<td>8 kB</td>
<td>4 kB</td>
</tr>
<tr>
<td>JN5164</td>
<td>160 kB</td>
<td>32 kB</td>
<td>4 kB</td>
</tr>
<tr>
<td>JN5168</td>
<td>256 kB</td>
<td>32 kB</td>
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The Jennet-IP Evaluation Kit comes pre-configured to run a networked lighting demo to help engineers kick start network development. The Eval Kit supports any IoT module end application development. The kit includes a Gateway to support www access.
Easy Connection to the WWW through a Low Cost Gateway Bridge Reference Design

- Leverages existing Router – plugs into any available Ethernet port on a standard router
- Allows communication with up to 500 Jennet-IP IoT nodes
- Low cost, NXP based ARM design
- On board facility for RFID
- Ref design pack incl. Gerbers, Software and BOM available FOC from NXP
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NXP IoT Executive summary

- The IoT application space is in its infancy: there will be a rapid and sustained increase of up to 50 Billion* in IoT nodes in the coming years.
- IoT means locating things, control and data can be moved from any device to any other device or system globally via the www, opening up new and exciting applications.
- IoT Monetization rests on two key pillars: eco-system maturation and application proliferation.
- Key components in the eco system: IoT empowered I/O modules, Gateways, Cloud Services and 3rd Party Apps.
- NXP Jennet-IP is the perfect solution for IoT end module applications: low power 32 bit RISC based MCU with comprehensive set of hardware and software development tools, including low cost gateway reference design for www connectivity.

* Cisco Estimate for 2020
Thank you!

http://www.jennic.com/products/
Backup

- MAC = Media Access Control
  ([http://en.wikipedia.org/wiki/Media_access_control](http://en.wikipedia.org/wiki/Media_access_control))
- O-QPSK = Quadrature Phase Shift Keying
- IETF IP = Internet Engineering Task Force
- UDP = User Datagram Protocol
- MIB = Management Information Base