IOT MARKET AND NXP SOLUTION

JAMES HUANG
REGIONAL MARKETING
GREAT CHINA, MICR
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The Internet of Things is Driving **Explosive Growth** In Connected Devices

- **World Population**
  - 2003: 6.3B
  - 2008: 6.5B
  - 2010: 6.8B
  - 2015: 7.2B
  - 2020: 7.6B

- **# Connected Devices/Person**
  - 2003: <1x
  - 2008: 1x
  - 2010: 2x
  - 2015: 3.5x
  - 2020: 6.5x

*Sources: Ericsson, February 2011; Cisco Internet Business Solutions Group (IBSG), April 2011*
IoT Security Needs

- Secure Storage
- Secure Content
- Secure Network Access
- User Identification
- Tamper Resistance
- Secure SW Execution
- Secure Data Communications
- Over-the-air FW upgrades
Data > Information > Knowledge and Business Value

Signals and Data
Tera Bytes /day/person

Information
Giga Bytes /day/person

Knowledge
Mega Bytes /day/person

Cloud

Edge/Sensing Nodes

Gateway

BAN/PAN
LAN/HAN
Zigbee
BTLE
Wi-Fi
HPGP
BAN/PAN
LAN
LAN/NAN
LAN/NAN
LAN/NAN
WAN

Data > Information > Knowledge and Business Value
Why Now? Enablers of IoT

- **Low-cost sensors** – the average cost of a sensor now costs $0.60 vs. $1.30 10 years ago.

- **Smartphones** – Ubiquitous smartphones are now becoming the personal gateway to the IoT, serving as a remote control or hub for the connected home, connected car, or for the health and fitness devices consumers are increasingly starting to wear.

- **Cheap bandwidth** – The cost of bandwidth has also declined precipitously, by a factor of nearly 40X over the past 10 years.

- **Cheap processing** – Similarly, processing costs have declined by nearly 60X over the past 10 years.

- **Ubiquitous wireless coverage** – With Wi-Fi coverage now ubiquitous, wireless connectivity is available for free or at a very low cost, given Wi-Fi utilizes unlicensed spectrum and thus does not require monthly access fees to a carrier.

- **Big data** – As the IoT will by definition generate voluminous amounts of unstructured data, the availability of big data analytics is a key enabler.

- **IPv6** – IPv4 supports 32-bit addresses, which translates to about 4.3 billion addresses – a number that has become largely exhausted by all the connected devices globally. In contrast, IPv6 can support 128-bit addresses, translating to approximately $3.4 \times 10^{38}$ addresses – an almost limitless number that can amply handle all conceivable IoT devices.

Source: IDC, Goldman Sachs Global Investment Research
Our Products Power The Internet of Things
Microcontrollers | Digital Networking | Auto MCU | Analog and Sensors | RF
Industrial Robotic

NXP Technology

Power Architecture (QorIQ):
Motion Control/PLC (Supervisor):
Kinetis V, MC56F84xxx:
Motor Driver:

Consumer Robot

Main Controller
i.MX6 SLX (A9+M4)

Software
O.S. A9
Image Recognition M4

WiFi Module
Camera
Audio In, Out
Sensor: G/Gyro, IR...

PWM UART
Motor modules for Joints

VGo Robotic Telepresence Nursing Care (User Case)

NXP Technology in VGo

i.MX27:
Host Linux processor, video management

i.MX31L:
Audio compression and Decompression

MPR084:
User interface
Hexiwear – Complete Wearable and IoT Development Solution

**Targeted Applications**
- Wearables
- IOT end nodes

**Value proposition**
- Smart Watch Form Factor with 7 NXP components inside
- Based on Kinetis K64 and Kinetis KW40 for BLE
- Includes battery, OLED screen and 6 sensors optical heart rate
- Open source hardware and software
- Complete software solution with embedded software, Android and iOS apps and cloud connectivity.
- Expandable with the choice from 180+ plug and play options.

**Key Components**
- High-performance Kinetis K64 MCU based on ARM Cortex-M4 core
- Kinetis KW40Z multimode BLE and 802.15.4 radio SoC
- 6 sensors:
  - Optical Heart Rate Monitor
  - Accelerometer, Magnetometer, Gyroscope
  - Temperature, Humidity, Light, Pressure
- Color OLED Display
- Rechargeable battery
- External flash memory

**Design Resources Available**
- Software
- Schematic & Design Files
- Bill of Material (BOM)
- iOS and Android App
- Resources are available [HERE](#).

**SW Development Environment**
- Kinetis SDK
- Kinetis Design Studio (IDE)
- FreeRTOS

**Where to Buy?**
- Sample’s available now for key opportunities
- Kickstarter Campaign going on live at [HERE](#).
- Available in mass market on April 15th. Will be available with major retailer’s (Mouser, digikey, E14) for purchase.
HexiWear Block Diagram

K64F MCU
120 MHz ARM cortex-M4F, 1MB flash, 256KB SRAM, USB

KW40Z MCU
ARM Cortex-MO+ with integrated BLE radio

K20 MCU
PK20KX128VFMS
JTAG/SWD

Micro-B USB
OpenSDA

Accel/ Mag
FXOS8700CQ

Gyro
FXAS1002

Barometric Pressure Sensor

Ambient Temperature Sensor

Digital Humidity Sensor

Ambient Light Sensor

Low Power Display

User LEDs/Touch Sense Buttons

Haptic Feedback

8 MB Serial Flash

SWD, RESET_B

Expansion Port

Optical Heart-Rate Monitor

Micro-B USB

External Docking Station

Rechargeable Li-Ion Battery and Battery Charger (MC34671)

FXOS8700CQ

FXAS1002

MPL3115A2

NXP Part

Interface Circuit

External connector
HexiWear Software Ecosystem

Complete open-source software package including the source code for Embedded Software, Application Examples, Android and iOS apps and out of the box cloud connectivity.

**Embedded Software**
- Running FreeRTOS as an embedded operating system.
- Application examples with IoT and Wearable application use cases.
- Drivers based on Kinetis SDK.
- OpenSDA as a serial and debug adapter.
- BLE communication is based on Kinetis Connectivity Software (available in binary).
- The software is available at [www.nxp.com/kinetisdesigns/hexiwear](http://www.nxp.com/kinetisdesigns/hexiwear)

**Cell Phone App**
- Android app available [HERE](http://HERE) and iOS App is available [HERE](http://HERE).

**Cloud Connectivity**
- Cloud connectivity integrated in Android and iOS apps.
HexiWear Infinitely Expandable

• HexiWear has a compatible docking station where you can collect up to 3 expansion module.
• 180+ plug and play add-on sensor boards currently available which comes with example code to get you started in minutes. More information is available here.
• Designed for expansion with easy access to SPI, I2C and other serial interfaces for customization. Supported by MikroBUS standard expansion port.
Automotive Internet of Things

Connecting Your Car to Your World

NXP Connected Vehicle Vision Powered by i.MX
Advanced Driver Assistance Systems (ADAS)
Automated Vehicle Model

**Driving Style**
- RPM, Gas pedal Monitoring, …

**Driver Attention**
- Eye FoV camera
- TSR, LDW etc

**3D Context**
- Surround See and Sense

**360° & Driver Model**

**Driver Fatigue**
- Drowsiness camera
- Steering trend

**Steer & Brake**

**Auto Navigation & Risk assessor**

**Vehicle Motion**

**HMI**
Multi-Camera Panorama View Park Assist

- Power Supply
- BroadR-Reach Ethernet Switch
- Very Low Dropout (Vbat)
- CNNs
- i.MX 6 Solo
- i.MX 6 Dual
- i.MX 6 Quad
- 64 bit MobileDDR
- Flash Memory
- NTSC/PAL Encoder
- CAN PHY
• Human beings’ vital statistics monitored via edge nodes communicating through body area networks (BAN) and personal area networks (PAN)

• Many other “things” in the smart home using local area networks (LAN)

• All communicate with a home hub/gateway, which in turn communicates to the cloud via wide area networks (WAN)
**WiFi Module Joint Development**

QFM-2202

- 2.4G, Single Stream, low-power, embedded MCU with 512K flash, Alljoyn stack build-in Wi-Fi module.

QFM-2202-A

- Same as QFM-2202, with MFi and HomeKit stack build-in Wi-Fi module.
Dual PAN Use Case – Smart Energy & Home Automation Network

- Smart Energy Network (Utility)

- Home Automation Network (Home Owner)

- Dual PAN
  - Smart Energy & Home Automation

Smart Energy | Home Automation | Dual PAN – SE/HA
IoT Dual PAN demo with XBMC Media Center

FSL i.MX6 Dual IOT Gateway

- XBMC Media Center
- Python Application Modules
- Python HTTP Server
- Python HTTP to Serial
- Python 2.7 Std Lib

Media Interfaces
- Linux USB cdc_acm VCP Driver
- HDMI

USB-KW24D512 Dongle

- Application
- USB VCP Driver
- 802.15.4 PHY
- 2.4GHz XCVR

Media Interfaces
- Ethernet
- WiFi

Remote Control
- Smart Plug
- Phillips Hue Bulb
- Remote Application

Axis WiFi Camera
- Camera Application
- H.264 Encoder
- RTSP, HTTP, HTTPS

USB - USB VCP Driver

TV / Display

Linux 3.10.53

- BSD Sockets
- TCP
- UDP
- Media Interfaces
- Ethernet
- WiFi

USB - KW24D512 Dongle

Remote Control
- Smart Plug
- Phillips Hue Bulb
- Remote Application

USB - USB VCP Driver

TV / Display
ARM® mbed™ Platform for NXP Freedom Development Platforms

Learn more at: www.nxp.com/mbed
IoT Connectivity Landscape

Application Layer / Profiles
- HomeKit
- AllJoyn
- IoTivity
- IPSO
- M2M
- MQTT
- Remote Controls (ZRC)
- Home Automation (HA1.2)
- Light Link (ZLL)
- Smart Energy (SE1.x)

Transport Layer / Network Layer
- Bluetooth Host Stack
- TCP / UDP
- IPv4 / IPv6
- 6LoWPAN

Physical / Link Layer (PHY/MAC)
- Bluetooth Link Layer
- IEEE 802.11n 1x1
- IEEE 802.15.4e
- IEEE 802.15.4 (low-power networking)

Wearables
- Gateways
- Border Routers
- Sub-1 GHz Industrial Wireless
- 2.4 GHz Home Automation & Control Networks

1
2
3
IPv6 - A Unified Convergence Layer for the Home

Support for many application layers
Any low bandwidth application layer that can run over IPv6
Target applications

Thread is designed for all sorts of products in the home

- Appliances
- Access control
- Climate control
- Energy management
- Lighting
- Safety
- Security

Devices working together to form a cohesive mesh network
The Thread Group was launched in July 2014

A nonprofit market education group offering product certification

Promoting Thread’s use in connected products for the home

Thread will offer rigorous product certification to ensure security and interoperability
Thread Certification

All Thread devices will require network certification to use Thread certified logo on commercial products.

Validation of device behavior

- Commissioning
- Network functionality and interoperability
- Device operation in network

The certification program addresses both components and end products. Sponsor and Contributor Members have access to standard test harness and sample commissioning apps.

Certification through an approved 3rd party test lab

Availability: Beta Certification now, Full Certification launch targeted for May 2016.
Product companies can start developing Thread-based products today
Compatible silicon is already available
Many new products are in development

Pre-certified Thread stacks will be available from 3+ sources
Please get in contact with the below companies
There will be more silicon and stack providers over time
Example Solution

NXP’s Thread Stack and scalable connected silicon provides one-stop shopping for Smart Home Connectivity Platforms (Kinetis ARM Cortex-M Class Microcontrollers, i.MX ARM Cortex A-class applications processors) to support all aspects of a Thread network from the end nodes to the border routers and to the cloud.

Visit [www.nxp.com/thread](http://www.nxp.com/thread) to learn more.
NXP Thread Hardware Offering

NXP Kinetis KW2x
Mesh Network Router / End Device
Thread and IEEE 802.15.4 compliant
Tower Board and Freedom Board coming up soon
Runs MQX for Kinetis SDK

NXP Kinetis KL46 + MCR20A Transceiver
Mesh Network Router / End Device
Thread and IEEE 802.15.4 compliant
Freedom Board format
Runs MQX for Kinetis SDK

NXP i.MX6 IoT Gateway
NXP Kinetis KW2x USB
Border Router / Cloud gateway
Provides IP data routing and infrastructure integration
Runs Linux operating system

NXP Kinetis K64F + MCR20A Transceiver + WiFi
Border Router with Ethernet and WiFi support
Thread and IEEE 802.15.4 compliant
Freedom Board format
Runs MQX for Kinetis SDK
### NXP Thread Stack Overview

#### Media Interfaces
- **WiFi**
- **Enet**
- **6LoWPAN**
- **2.4GHz - 802.15.4g**
- **<1GHz - 802.15.4g**
- **IPv4**
- **ARP**
- **ICMPv4**
- **ICMPv6**
- **ICMP6**
- **ICMP6 (Trickle)**
- **IPv6**
- **ND**
- **6LoWPAN**
- **IPv6 - ND**
- **Routing**
- **BSD Sockets API**
- **UDP**
- **CoAP**
- **DTLS**
- **HTTP**
- **HTTPS**
- **ICMPv6**
- **IPv4**
- **mDNS**
- **MME**
- **MIPv6**
- **NTP**
- **Security & App Layer**
- **Stacks (TCP/IP, USB)**
- **TPCP**
- **Transparent Bridge**
- **Transport Security**
- **& Session Management Plane**
- **User Application**
- **WIFI**
- **Enet**
- **6LoWPAN**

#### Product Features:
- **Multiple interfaces support**: 802.15.4 & 802.15.4g with 6LoWPAN, Ethernet and WiFi.
- **Designed for Low Power, Quick Wake-up Time and Low Memory footprint.**

#### Multiple Os support via Kinetis SDK OSA running on MQX and possible to port to FreeRTOS, uCOS and even Bare Metal.

#### Proven Interoperability with other vendors in various alliances.

#### NXP Border Router

### Thread Stack Complete

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#### EXTERNAL USE

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What can run over it

- Thread is a network and transport level stack
- Thread is “application-layer agnostic”
- Thread can support multiple application layers
  - Any low bandwidth application layer that can run over IPv6

Example protocols:
- IPSO Alliance
- ZigBee Alliance
- AllJoyn
- IoTivity
- Nest Weave

Other IP-based Application Protocols

- Application
- UDP
- IP Routing
- 6LoWPAN
- IEEE 802.15.4 MAC
- IEEE 802.15.4 PHY
NXP IoT Offerings

http://iot.nxp.com/

Xtrinsic Sensing
Intelligent Contextual Sensing.

Connectivity
BAN/ PAN/ LAN

The right combination of intelligent integration, logic and customizable software on the platform to deliver smarter, more differentiated applications.

For IoT it provides Context: Identity, Activity, Location, & Time

Edge products:
• Very small
• Low cost
• Low power
• Low complexity
• Industrial grade & robust

Kinetis Microcontrollers
Design Potential. Realized

Industry’s most scalable ultra-low-power, mixed-signal MCU solutions based on the ARM® Cortex™-M and Cortex™-M0+ architectures.

Vybrid Controller Solutions
Rich Apps in Real Time.

Real-time, highly integrated solutions with best-in-class 2D graphics to enable your system to control, interface, connect, secure and scale.

i.MX Applications Processors
Your Interface to the World.

Industry’s most versatile solutions for multimedia and display applications, with multicore scalability and market-leading power, performance & integration.

QoriQ Processors built on Layerscape Architecture
Accelerating the Network’s IQ

Industry’s first software-aware, core-agnostic networking system architecture for the smarter, more capable networks of tomorrow – end to end.

S Sensing

Embedded Processing

Communications

Scalable Industry Standard Solutions, Software and Development Ecosystem
SECURE CONNECTIONS FOR A SMARTER WORLD