Bring the full potential of the IoT to life

Freescale's practice in Healthcare and Wearable

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IoT Is More Than M2M

The Internet of Things (IoT) is about Machine to Entity (M2E):

- **Machine to Machine:**
  - Automatic diagnostics for cars: Automatic information collection from your car’s engine management system and sending real-time alerts to drivers or service centers

- **Machine to Infrastructure:**
  - Automatic bridge monitoring: Sensing and monitoring the structural integrity of a bridge in case of flooding

- **Machine to Human:**
  - Automatic health monitoring for people: Implant monitoring services or disease management via implantable electronics

- **Machine to Nature/Environment:**
  - Early detection of earthquakes: Distributed sensors to detect early tremors in specific places
INTERNET OF THINGS
Different Services, Different Technologies
Different Meanings for Everyone

And the Word “SMART” Is Everywhere!
The Internet of Things is Driving Explosive Growth In Connected Devices

- 2003: <1x
- 2008: 1x
- 2010: 2x
- 2015: 3.5x
- 2020: 6.5x

Sources: Ericsson, February 2011; Cisco Internet Business Solutions Group (IBSG), April 2011
Freescale’s Roadway of Innovation
Making the World a Smarter Place
A Global Leader in Microcontrollers and Digital Networking Processors

<table>
<thead>
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<th>5 Core Product Groups</th>
<th>4 Primary Markets</th>
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<td>Microcontrollers</td>
<td>Automotive</td>
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<td>Digital Networking</td>
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<td>Automotive MCU</td>
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<td>Analog &amp; Sensors</td>
<td>Consumer</td>
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<td>RF</td>
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>50 Year Legacy
>5,500 Engineers
>6,000 Patent Families
Our Products Power The Internet of Things
Microcontrollers | Digital Networking | Auto MCU | Analog and Sensors | RF
Freescale IoT Offerings

Xtrinsic Sensing
Intelligent Contextual Sensing.

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

Connectivity BAN/ PAN/ LAN

Fully integrated Short Range radios with best in class power performance, and Powerline Communications

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.

Scalable Industry Standard Solutions, Software and Development Ecosystem
Freescale One Box for IoT
Freescale One Box Platform

• One-Box is a **Scalable Gateway**.

• One-Box is using Freescale’s Kinetis microcontrollers, i.MX applications processors or QorIQ communications processors.

• One-Box is built with Oracle’s Java software for Oracle big data services.

• One-Box adopted ARM Sensinode software that securely connects edge node devices using standards-based technologies.
Configurable One Box

- Ethernet
- 802.11n WiFi
- USB HS
- Bluetooth 4.0 (includes BT Low Energy)
- Processor with Operating System
  - ZigBee Radio
  - Sub GHz Radio
  - 802.15.4j Radio
  - 802.15.6 Radio
  - Other

Optional Plug-In Modules
Communication Topologies Across Hierarchies

Edge/Sensing Nodes

- BAN/PAN/LAN/HAN
- Zigbee
- BTLE
- Wi-Fi®
- HPGP
- BAN/PAN/LAN

Gateway

WAN

Single family home/simple entity

Apartment building, enterprise campus, factory automation, neighborhood grid, road infrastructures, hospital wards, etc.

Edge/Sensing Nodes

- BAN/PAN/LAN/HAN

Gateway

LAN/NAN

LAN/NAN

LAN/NAN

LAN/NAN

Freescale

Edge/Sensing Nodes

Gateway
Healthcare
The Opportunity for IoT in Healthcare

(Source: West Health Investment Fund)
The Solution

Enable individuals to take an active role in their health care allowing them to proactively prevent costly chronic health problems later in life.

IoT Solutions In Healthcare

Wellness/Fitness
Younger Generations
Clinical Medical
Global Impact
Home Medical
Aging Populations
IoT ‘Box-Level’ Product View

Legend:
- **S** Sensors & Actuators
- **P** Embedded Processing
- **C** Connectivity: BAN/PAN/LAN/WAN

Medtronic’s glucose monitor uses Bluetooth to “talk” to Ford Sync

User-driven actions via devices with screens or automatically driven actions based on data parameters

Data analytics for business intelligence

Application/Action

Wired/Wireless Hierarchy of Aggregation / Hubs / Gateways

BAN/PAN/ & Wired/Wireless, Power Line LAN

Remote Cloud-based Processing

Hierarchical Layers

Wired/Wireless WAN

Concurrency of Actions/Insights/Big Data

User-driven actions via devices with screens or automatically driven actions based on data parameters

Data analytics for business intelligence

Application/Action

Wired/Wireless Hierarchy of Aggregation / Hubs / Gateways

BAN/PAN/ & Wired/Wireless, Power Line LAN

Remote Cloud-based Processing

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Data analytics for business intelligence
Healthcare Applications

- ECG
- Heart Rate
- CPAP
- Connected Pill Bottle
- Activity Monitor
- Blood Pressure
- Weight Scale
- Diabetes Care
- Lung Health
- Pulse Oximetry
Precision Analog Improves Accuracy

• The challenge: Increase device accuracy without increasing cost.
  - The FDA is requiring higher accuracy on most medical devices and changes to healthcare provide significant cost pressure.

• The solution: Integrated precision analog.
  - Integrating precise analog components such as Op Amps, Tri Amps, high resolution ADC, and DACs.

• Ideal solution – Platforms w/ Flexible Analog
  - Freescale offers customers fully integrated analog solutions that are pin compatible with solutions having key analog peripherals needed to connect to a custom analog ASIC.
Low Power Operation Extends Battery Life

- The challenge: Make the hardware as maintenance free as possible

- The solution: Low power technologies
  - Use ultra low power microprocessors as the “brain” of the device.
  - Make use of various sleep modes through efficient software design.

- Ultra Low Power Microcontrollers /
  - 75uA/MHz run current (MCU)
  - Stop Mode operation <150nA (MCU)
  - RTC operation in <600nA (MCU)
  - LCD Operation <500nA (MCU)
  - 4us wake up time (MCU)

- Ultra Low Power Microprocessors
  - 1600+ MIPS at <1W (MPU)
Healthcare Hierarchical Gateways

Wired, Wireless WAN

Cloud

Hospital Level

Hospital Hub / Gateway

Wired, Wireless WAN

Room Level

“OneBox - Patient” Gateway

Floor Level

“OneBox - Clinical” Gateway

ECG
SPO2
RESP
HRM
GM / CGMS

House Level

WEIGHT
ACTIVITY

“OneBox - Home“ Gateway

CPAP
BP
PANIC

MED DOSAGE

Cellular to Cloud

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Healthcare One Box Deployment Example

Tablet with Medical User Interface (i.MX6)

Reference Platform Gateway (i.MX28)

One Box

- Panic Alarm
- Pulse Oximetry
- Thermometer
- Blood Glucose Meter
- Blood Pressure Monitors
- Weight Scale

Ethernet

- Physician
- Social Networking
- Monitoring Center
- Loved Ones

Wired connection

Wireless connection

Medical monitoring

WWW connection
Healthcare Connectivity

Personal Device
- Thermometer
- Pulse Oximeter
- Pulse / Blood Pressure
- Weight Scale
- Glucose Meter
- Cardio / Strength
- Independent Living Activity
- Medication Adherence
- Physical Activity
- Electrocardiogram
- Insulin Pump

Aggregation Manager
- Low-Power Local Area Network (LAN) Interface
- Personal Area Network (PAN) Interfaces

Health Records
- Wide Area Network (WAN) Interface
- Health Record Network (HRN) Interface
- Telehealth Service Center
- EHR
- PHR
Wireless Bands Available for Healthcare

• US FCC recognizes several bands for medical applications
  - License-only, geographically restricted (FCC Part 95)
    ▪ 401 – 406 MHz, 608 - 614 MHz, 1395 – 1400 MHz, 1427 – 1432 MHz
    ▪ Implantables, in-hospital therapeutic devices, wearable devices
    ▪ 2360 – 2400 MHz band (not yet approved)

• US FCC also provides many license free bands for general Industrial, Scientific and Medical (ISM) purposes
  ▪ 902 – 928 MHz, 2400 – 2483.5 MHz, 5725 – 5875 MHz and others

• All standards-based approaches are now targeting these bands and others
Choices in Wireless Technology

• Standards-based
  - Local area (up to hundreds of meters range per hop) wireless
    ▪ Wi-Fi / IEEE 802.11
    ▪ ZigBee / IEEE 802.15.4 (ZigBee Health Care)
    ▪ IEEE 802.15.4j Medical Body Area Network (standardization in process)
  - Personal area wireless (up to ten meters)
    ▪ Bluetooth and Bluetooth Low Energy (standardization in process)
    ▪ IEEE 802.15.6 Body Area Network
  - Cellular (up to many km range)
    ▪ GSM, UMTS, CDMA

• Proprietary
  - Mostly <10m range MICS, MEDRadio, and WMTS devices
Healthcare Summary

• Healthcare costs are higher than ever before and increasing at a rate that is unsustainable. The time is NOW for technology to intervene.

• There is an unprecedented opportunity to utilize the IoT methodology to implement lower cost healthcare solutions that increase patient care.

• There are different HW/SW requirements for devices used to gather data vs devices used to transmit and transfer data.
  - Sensor Devices: Analog, Low Power, GUI, Connectivity
  - Gateway Solutions: Connectivity

• Freescale offers a comprehensive portfolio of embedded solutions that allow users to collect, connect, display, and share healthcare data.
  - More info at www.freescale.com/healthcare
Wearables
## Smart Watches Available

<table>
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<tr>
<th>Full Feature OS</th>
<th>Function Specific OS</th>
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<tr>
<td>WIMM</td>
<td>Pebble</td>
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<tr>
<td>Bambook</td>
<td>Basis</td>
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<tr>
<td>Shanda</td>
<td>Martian Watches</td>
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<tr>
<td>Samsung Galaxy Gear</td>
<td>Impulse</td>
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<tr>
<td>I’m Watch</td>
<td>Metawatch</td>
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<tr>
<td>Sony SmartWatch2</td>
<td>Garmin</td>
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<tr>
<td>Vea</td>
<td>Kreyos</td>
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<td>Aframe Digital</td>
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<td>Samsung</td>
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<td>Motorola ACTV</td>
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<td>Casio</td>
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Other Wearables

- **Wearable Ring Scanner**
- **Headset Running Voice Recognition**
- **Nymi**, Heart-rate Based Password Authentication
- **Kiwi Wearables** — Personal Tracker
- **Fitness/Activity Monitors**
- **Angel** — first open sensor for health and fitness
- **Bone Conduction Bluetooth headset cap**
- **Smart Glasses**
- **Virtual Reality Headset**
Wearable Market: Diverse Usage Models

Head:
- Augmented reality
- Navigation
- In-view notifications
- Email/text (view & edit)
- Web browsing
- Photography

Wrist:
- Notifications
- Calling (place/answer)
- Fitness & health monitoring
- Navigation / Location
- Photography

Neck / Chest / Arm:
- Fitness & health monitoring
  - Calories
  - Pedometer
  - Heart rate
  - Blood pressure
  - SOS / Emergency
  - Location tracking

Leg / Ankle:
- Fitness & health monitoring
  - Calories
  - Pedometer
  - Heart rate
  - Blood pressure
  - Location tracking
WearAble Reference Platform - *enabled by Freescale*

Speeds and eases development for creating wearable devices by addressing key technology challenges which frees developers to focus on creating differentiated features.

- Connectivity
- Usability
- Maximizing Battery Life
- Miniaturization
• Reference platform is based around a Hybrid Design that addresses some of the key challenges around wearable computing including form-factor and extended battery life while also providing an expandable architecture for further development of wearable devices.

• The design is separated into two parts:
  ▪ Processing core - Application Processor Board (APB)
  ▪ An application specific daughter-board
Hardware Overview

- Main board (APB) based on i.MX 6SoloLite applications processor, runs Android and provides:
  - Bluetooth and Wi-fi 802.11
  - Power Management - Integrated Lipo charger
  - 6-axis Accelerometer and Mag sensor
  - Supports LCD and E-ink display
  - Micro USB OTG for host USB and device power / battery charging
  - Daughter board expansion interface

- User replaceable Daughter Board for expansion, based on Freescale Kinetis L Series
  - Pedometer functionality with Freescale’s MMA9553L sensor
  - Wireless charging
  - User interface buttons
Application Examples

- Time, chrono, lap time, alarms
- Smart music player with audio streaming via BT to headset
- Photo and video player
- Wi-Fi connectivity
- Compass
- Free fall detection
- Pedometer / activity monitor
  - Step counter (pedometer)
  - Motion detection (walking, running)
  - Distance traveled
  - Calories
- ECG & Heart Rate
- Wake up on motion
- Charging over USB
- Wireless charging
Main Board PCB target size: 38 mm x 14 mm

Daughter Board PCB target size: 42 mm x 42 mm (1.65” x 1.65”)