FTF FREESCALE TECHNOLOGY FORUM 2015

Healthcare and Fitness Applications
Built With a Wearable Reference Platform

FTF-HCW-F1200

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freescale™

External Use

Presenters

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Agenda

- Introduction and Market Overview
- Fitness Wearable Devices (Building Blocks)
- Pedometers
- Sleep Monitors
- Heart Rate Monitors
- Medical Wearable Devices (Building Blocks)
- Portable Electrocardiograph
- Cuff-less Blood Pressure Monitors
- Freescale Wearable Reference Platform WaRP
- Conclusion
- Q&A

Introduction and Market Overview

Wearable: *The Evolving Usage Case of Wearable Tech*

Infotainment

?

Utility

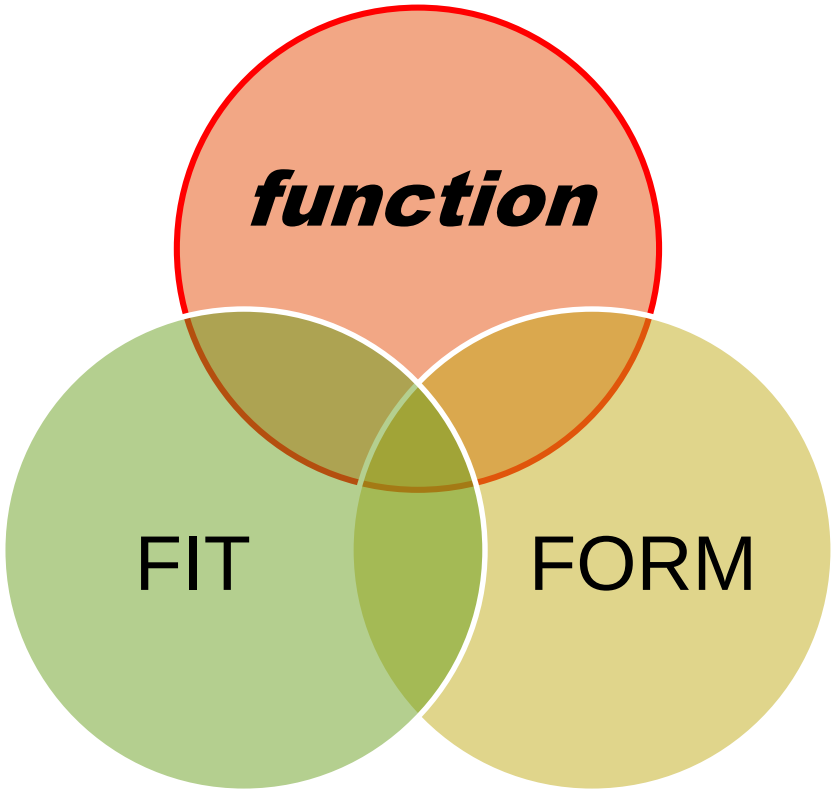
Identification and Access

Fitness

Glamour

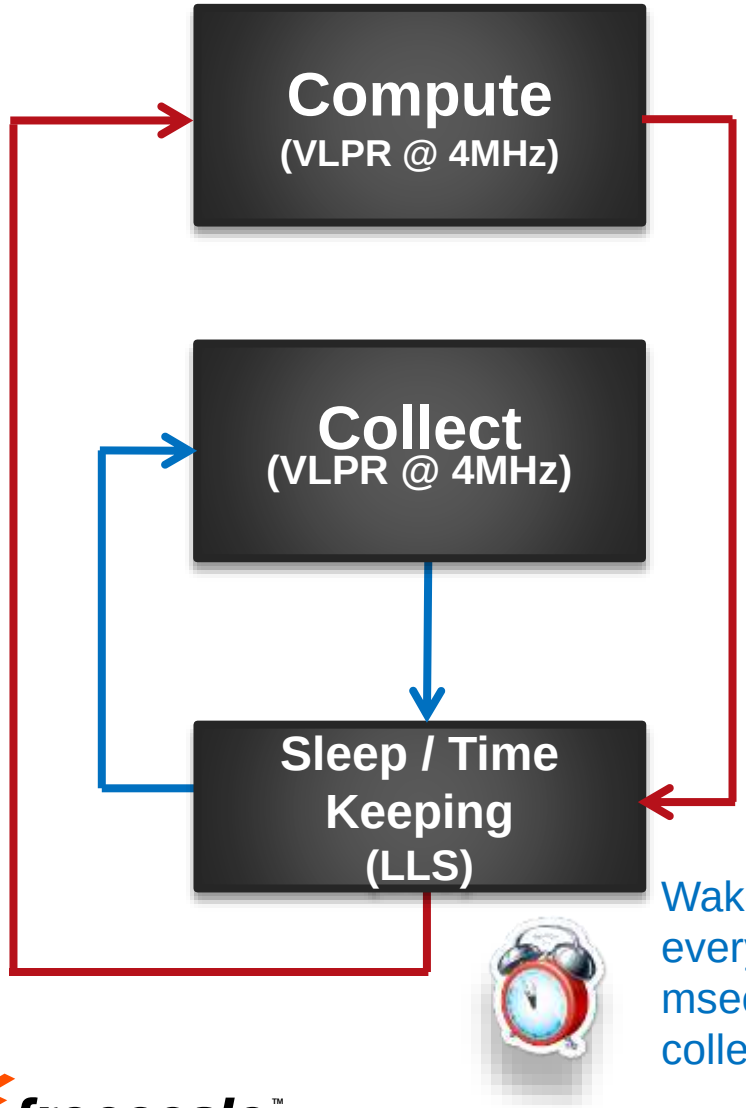
Giant Wearable Mecha Robot Suit Currently for Sale on Amazon…

Wearable: *From Head to Sole*



Building Blocks for Health/Fitness Devices

Fitness Watch Use Case
(Activity Tracking and Time Keeping Mode)



Phases	Kinetis KL27
Compute Phase and Update Time (10 msec. duration) every second	0.83 mA
Collection Phase taking ADC samples (50 samples per second)	1.2 mA
Sleep and Time Keeping Phase using RTC	2.5 uA

CR2032 225 mAh, 3V battery

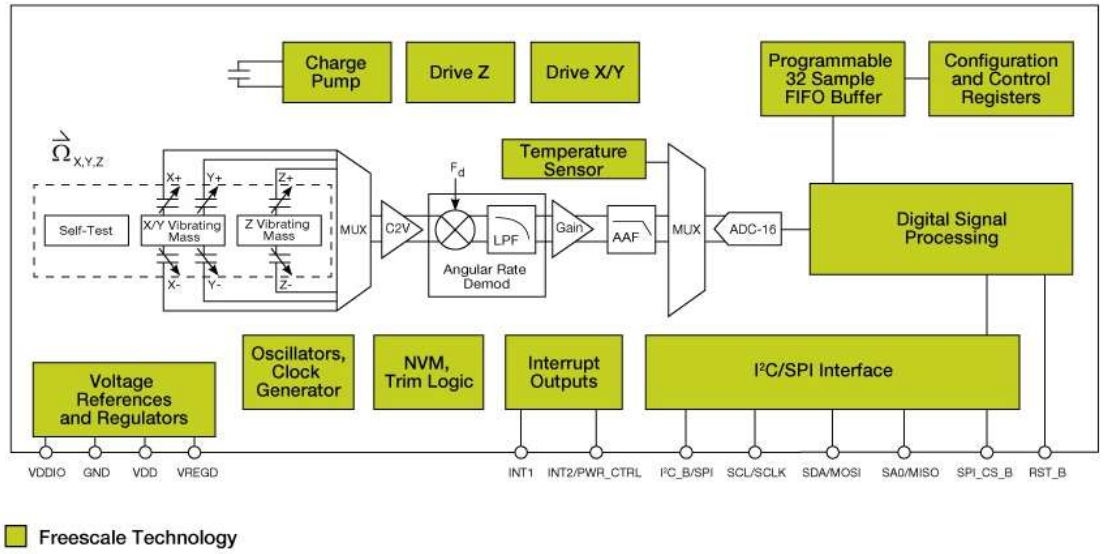
~ 2 Years Battery Life

Wearable/Active Lifestyle: Freescale Sensors Proposal

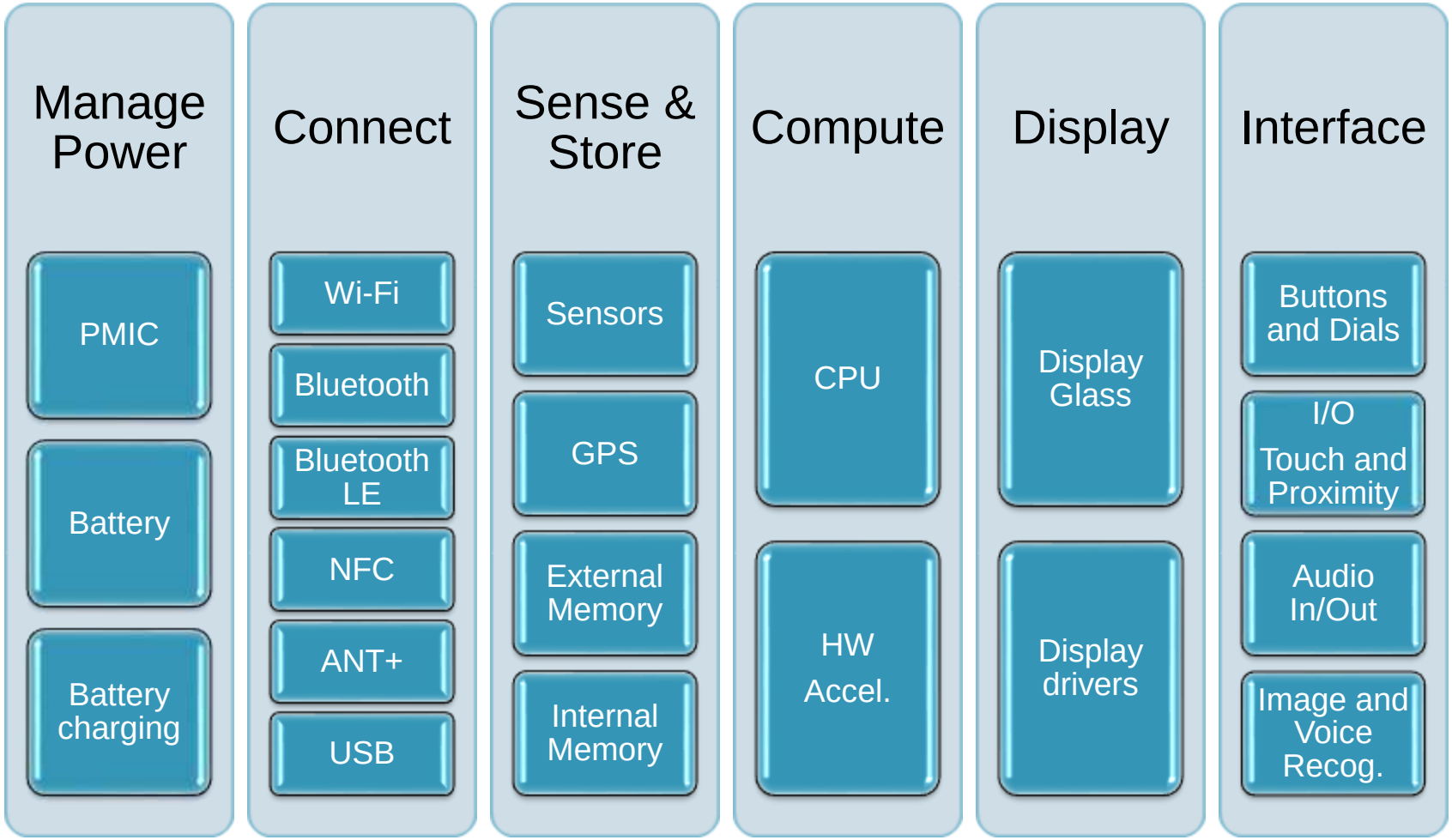
Enabled by Freescale Accelerometers, Gyroscopes, Sensing Platforms, Magnetic, Sensors and Touch Sensors

- **MMA9553L** is the intelligent pedometer platform
- **FXLC95000** as a sensor hub and datalogger
- **MAG3110** and **MMA8491** combined in the **FXOS8700**, for orientation, motion, vibration, shock, fall, g-force, etc. are present
- **MPL3115A** digital pressure sensor for altimetry
- **MPR121** for touch sensing
- **FXAS21002** gyroscope provides the stability needed for a drift free readings; *when talking accelerometer think gyroscope too…*

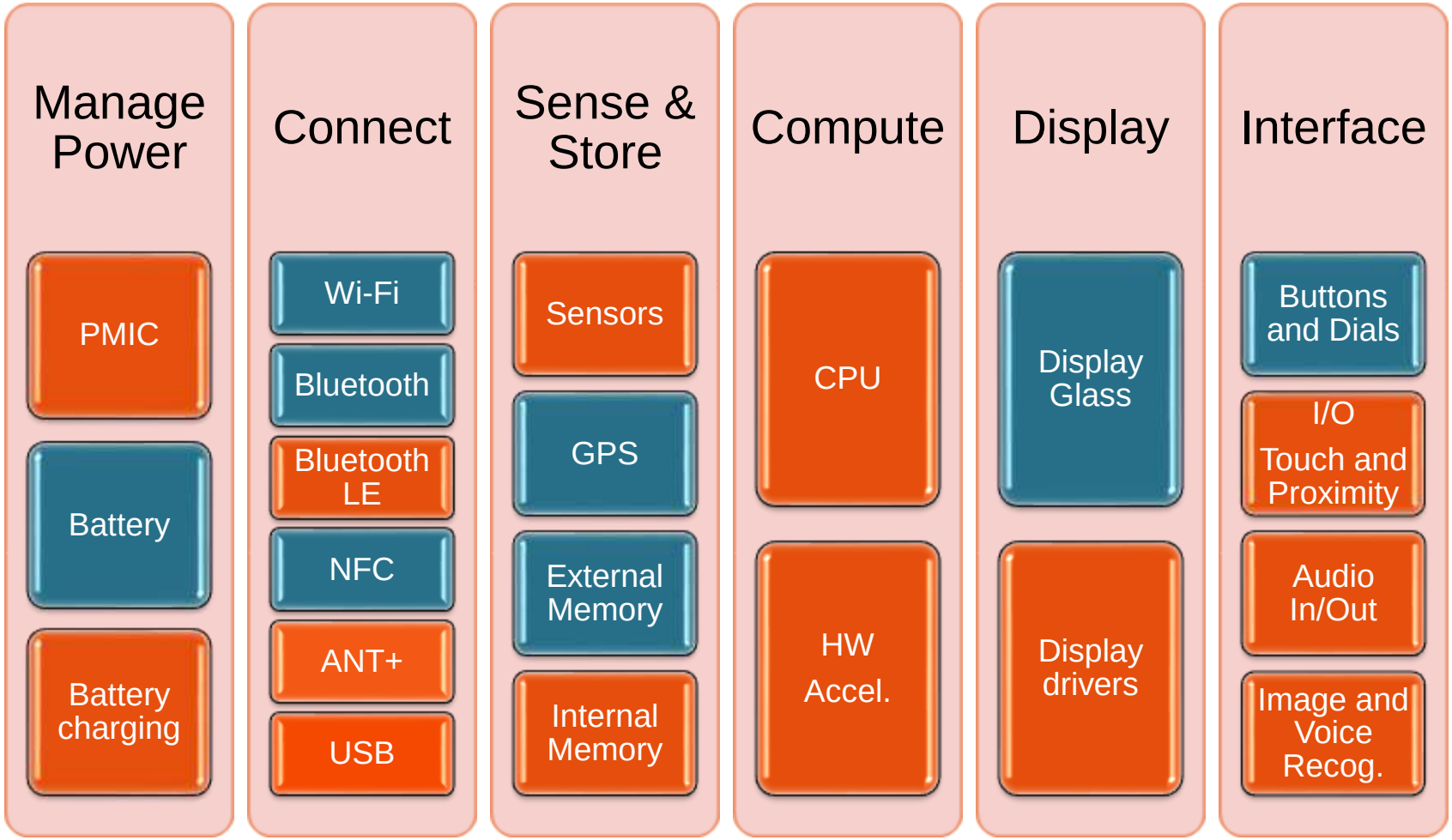
FXAS21002: 3-Axis Digital Gyroscope



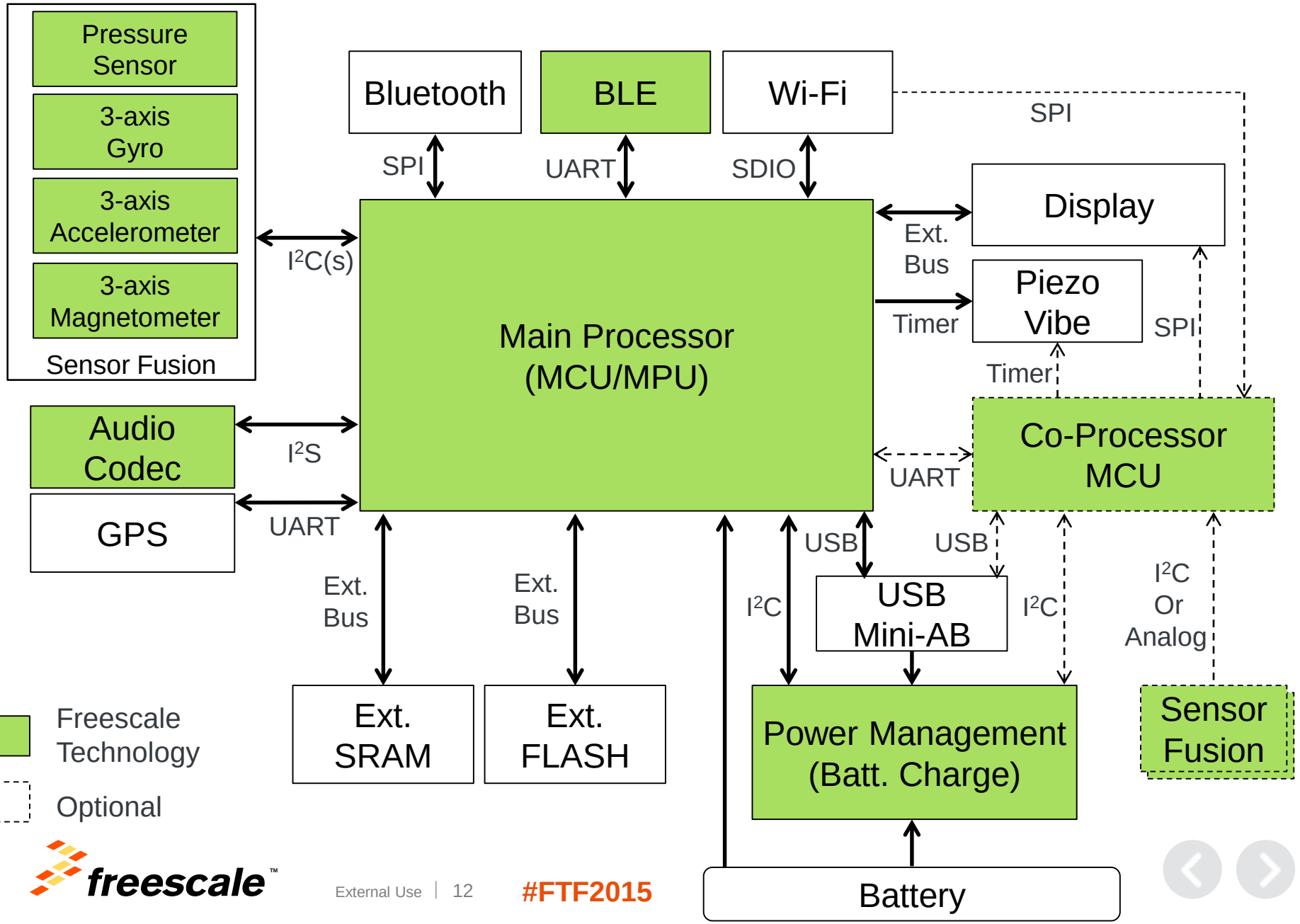
Wearable Blocks



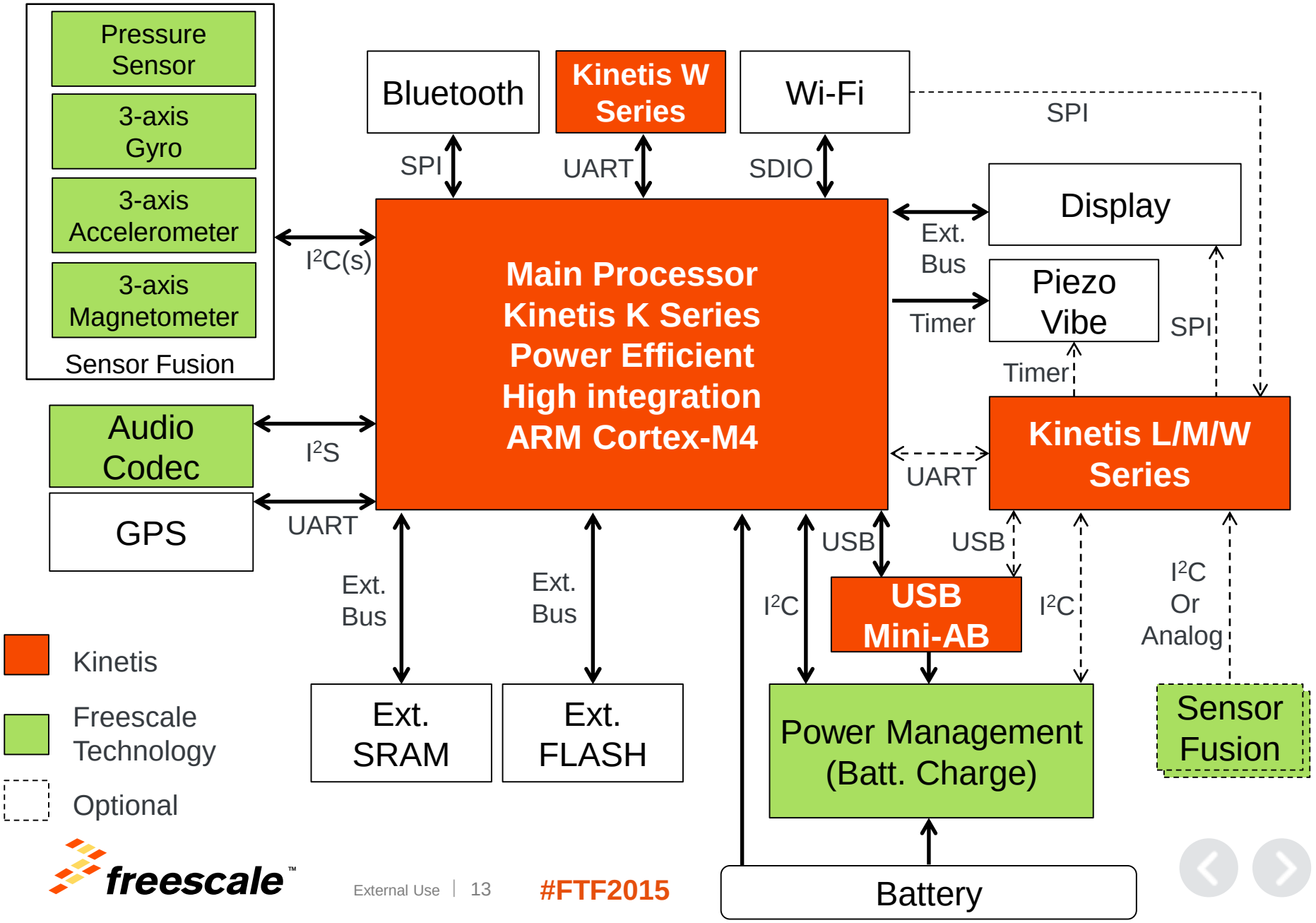
Wearable Blocks: Freescale Solutions

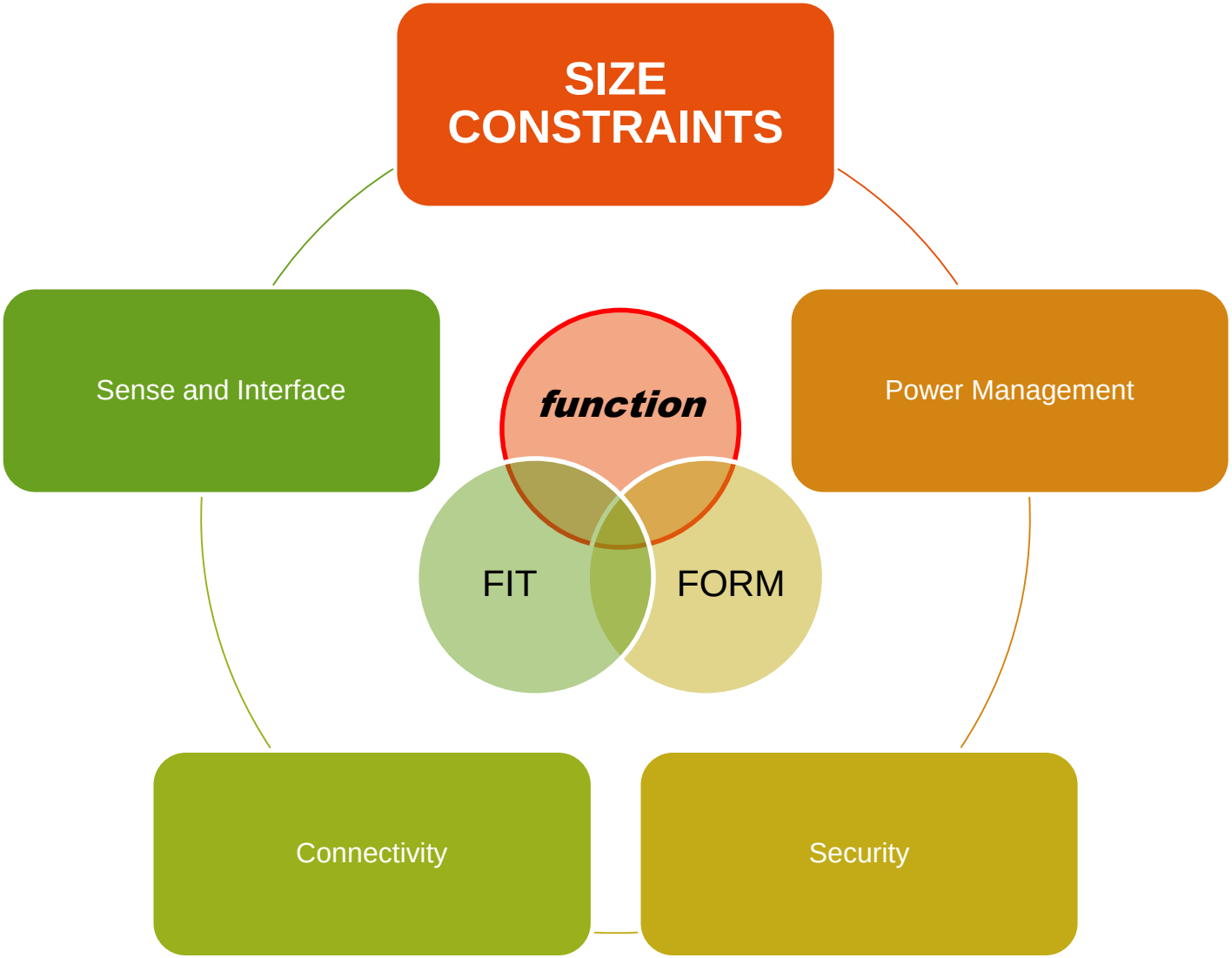


Wearable Functional Diagram



Wearable Functional Fiagram: Where Kinetis Fits




SIZE CONSTRAINTS
Sense and Interface
function
Power Management
FIT
FORM
Connectivity
Security

Kinetis: *It's Bigger on the Inside*

- **Kinetis delivers small and highly functional devices...**

- Integration of space saving features such as
  - Crystal-less USB
  - USB PHY
  - Higher internal memory space
  - Integration of 3V regulator
  - High precision analog peripherals

- Small package options
  - Kinetis KL03 is the World's smallest ARM powered solution

Freescale Kinetis L combined with WLCSP packing brings the next World's Smallest ARM® Powered MCU

Microscopic Package. Massive Potential.

- 1.6 mm x 2.0 mm x 0.56 mm
- Advanced wafer-level chip scale package for the ultimate in PCB area reduction
- 35% less PCB area, yet delivers 60% more GPIO than the next competing solution
- 32-bit ARM® Cortex™-M0+ core with high density feature integration: 32 KB flash, precision analog, ultra low power and more
- Start developing with the Kinetis L series Freescale Freedom development platform
- Available now!

For more information, visit
freescale.com/Kinetis/KL03CSP

WLCSP Advantages and Applications

- Key Advantages:
  - Small form factor allows **miniaturization of applications** while delivering outstanding processing performance, integration **(K series)** and ultra low-power operation **(L series)**.

  - Ideal for **any space constrained application in** consumer, healthcare and industrial markets.

Target Applications

Consumer

- Wearables
- IOT devices, edge nodes
- Smartphone, tablet, laptop
- Digital cameras
- Gaming accessories
- Portable navigation devices

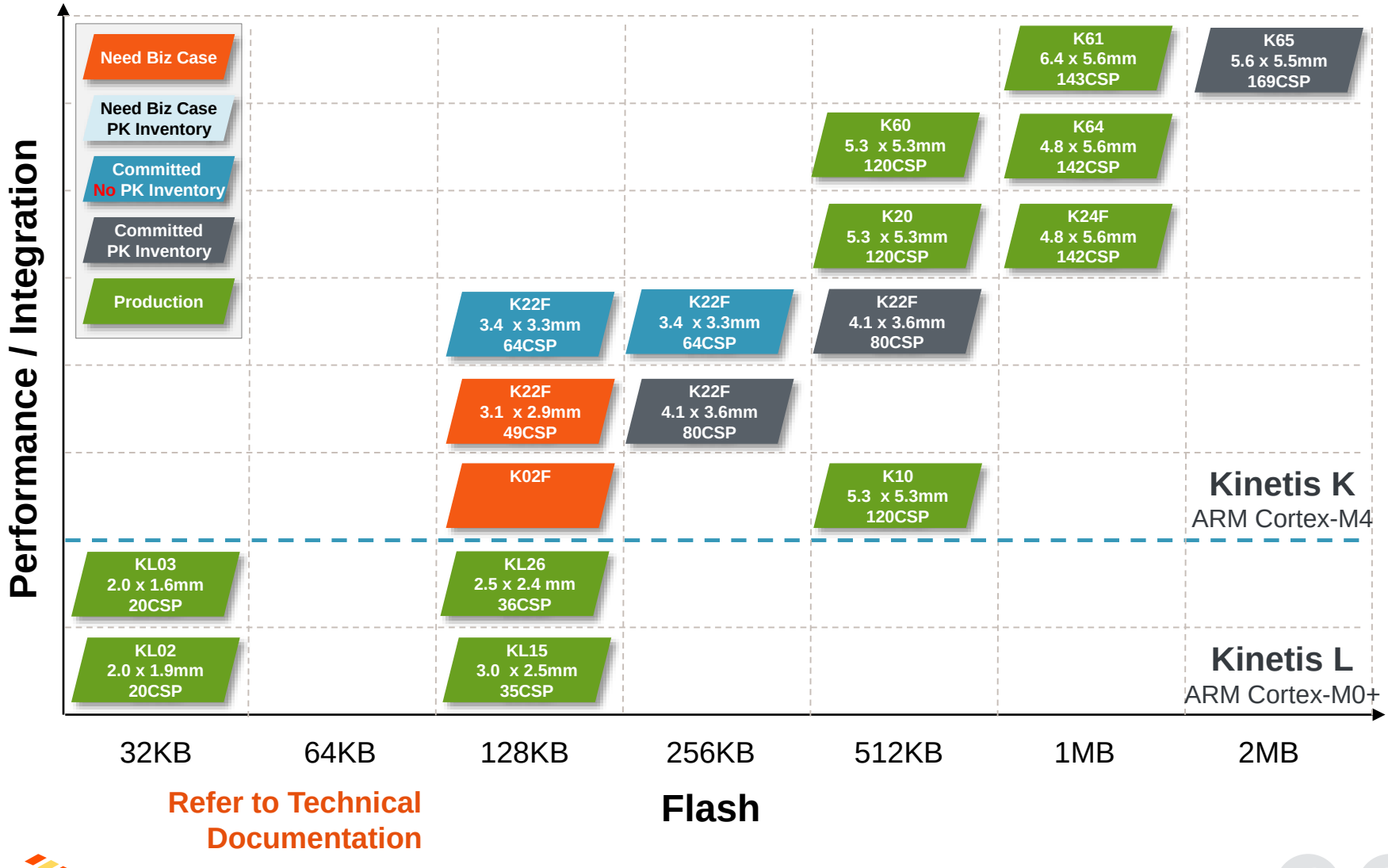
Healthcare

- Health and fitness trackers
- Portable medical monitoring
- Remote monitoring
- Invasive and non-invasive sensing
- Disposable devices

Industrial

- Industrial sensors
- Embedded control in motors

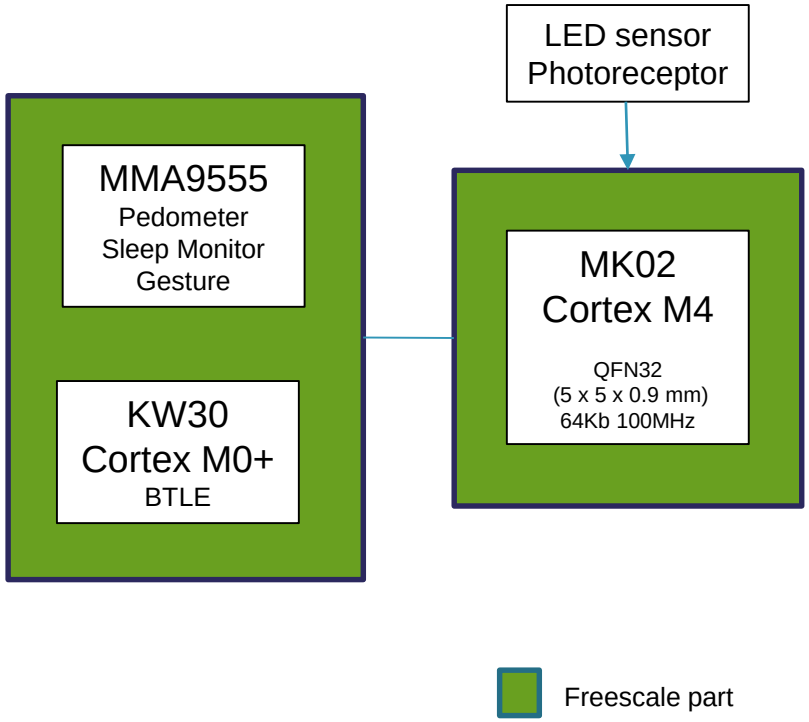
Kinetis WLCSP - Roadmap



Refer to Technical Documentation

Application Example: Pedometer

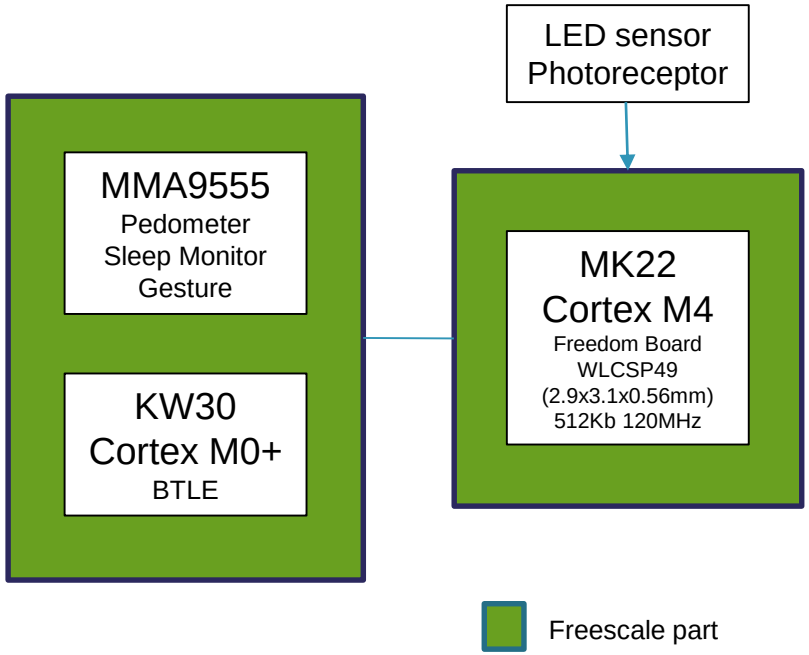
Pedometer Application Block Diagram



Functionality:
Pedometer
Heart Rate
BTLE

Application Example: Sleep Monitor

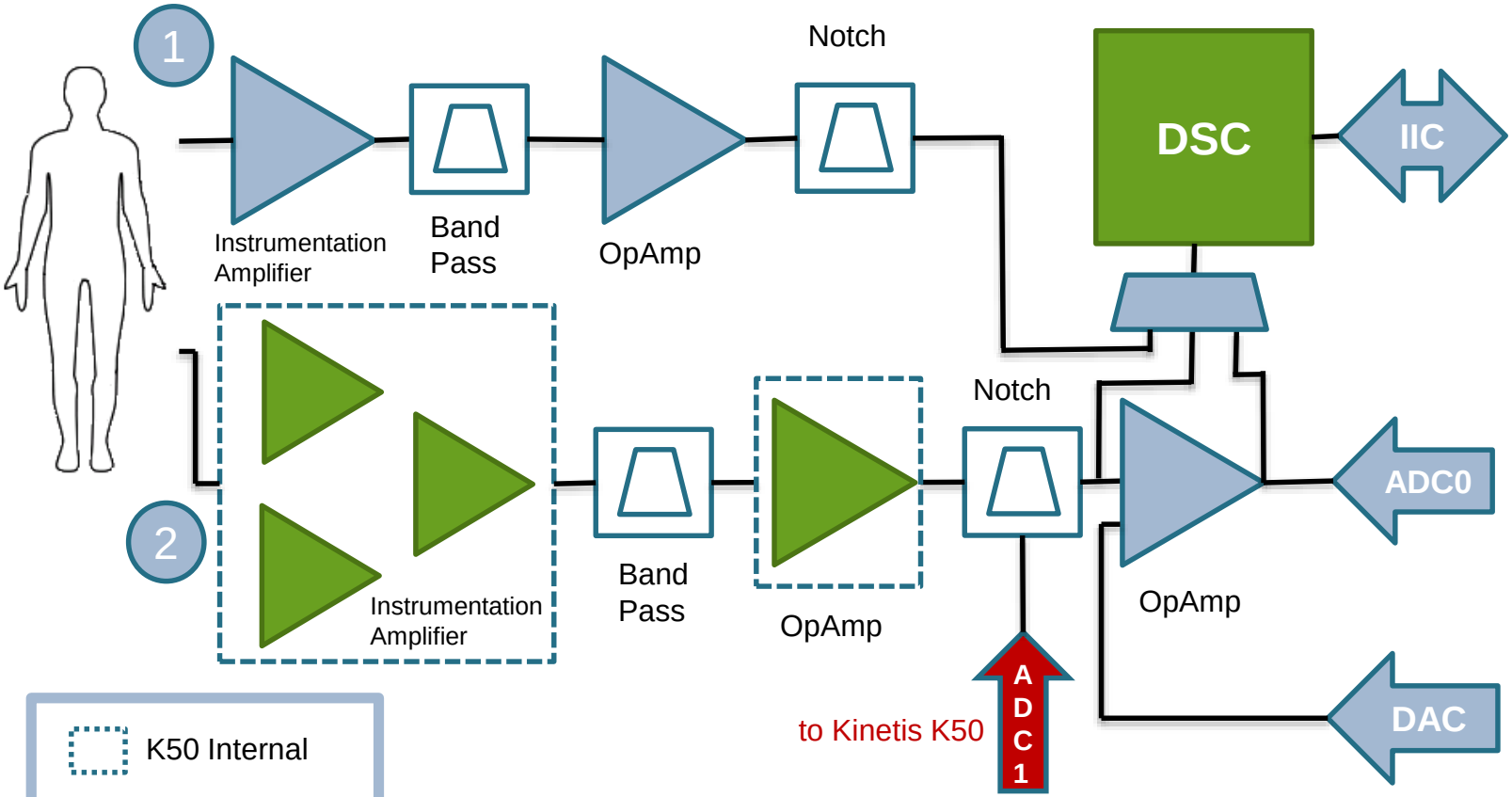
Sleep Monitor Application Block Diagram



Functionality:
Pedometer
Heart Rate
Sleep Monitor
Gesture
BPM
SpO2
BTLE

Application Example: Electrode Based ECG

MED-EKG AFE

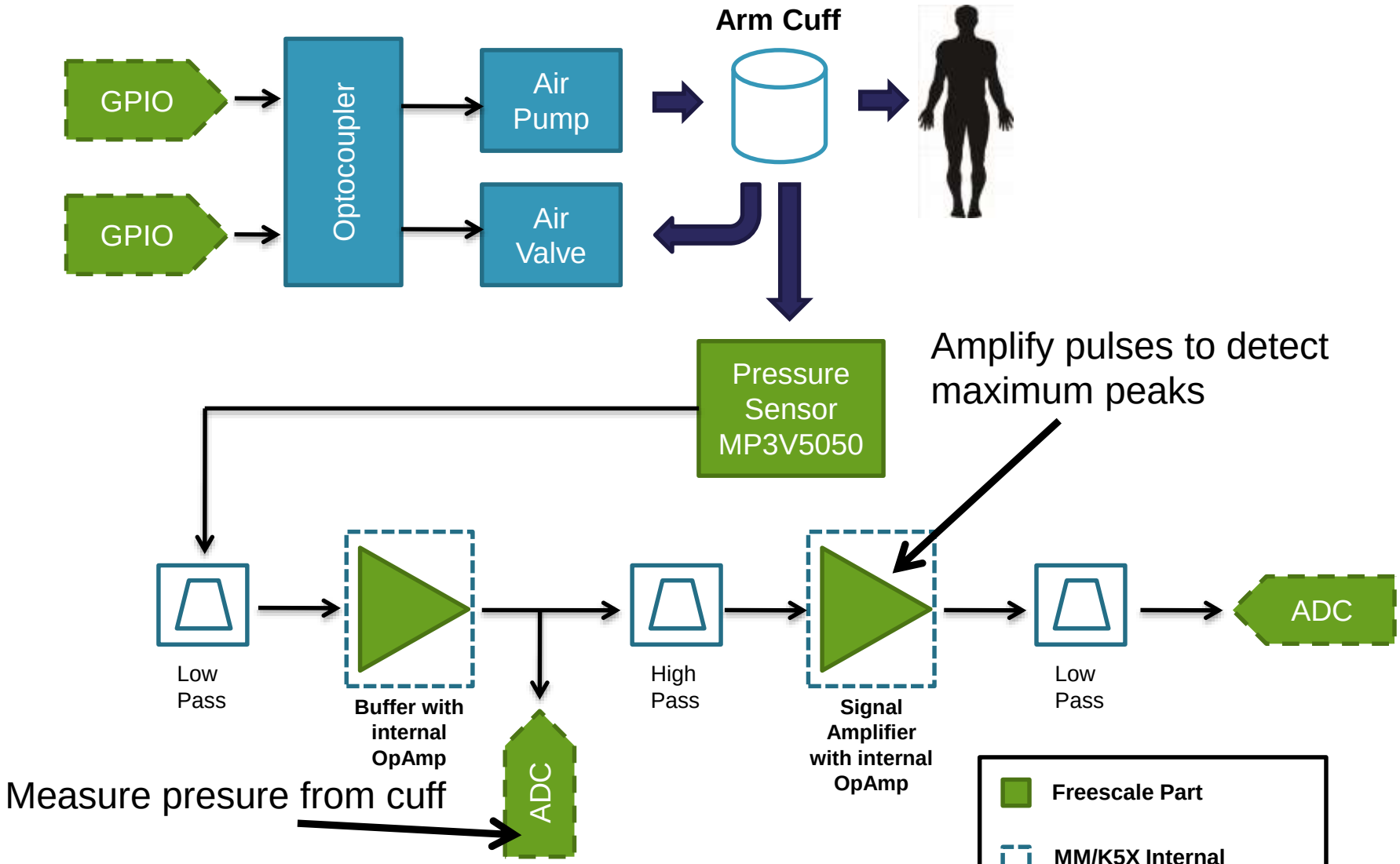


1 Using external instrumentation amplifier

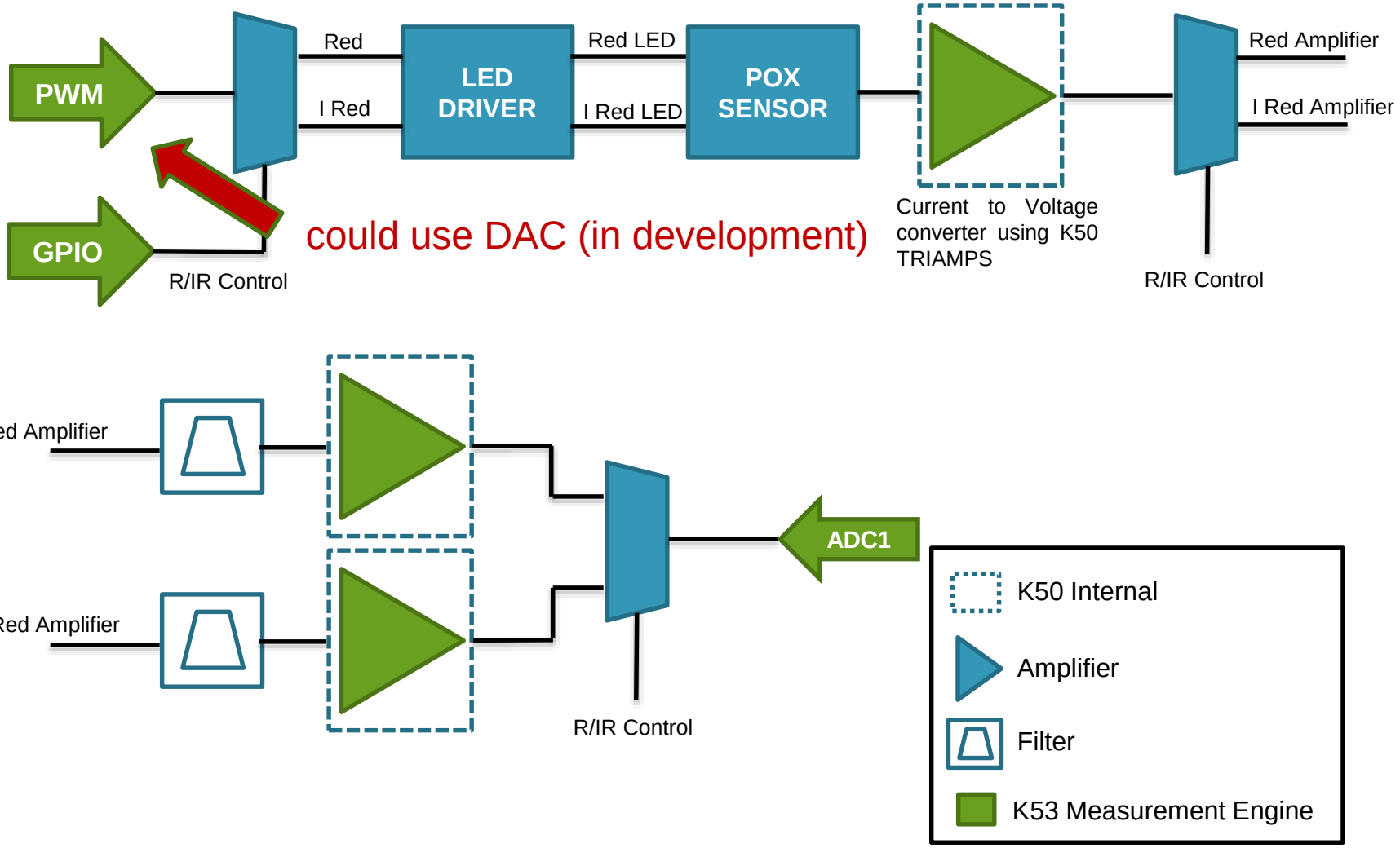
2 Using complete Measurement Engine

Application Example: Blood Pressure Monitor

DEMO 4: MED-BPM



MED-POX AFE


PWM
GPIO
R/IR Control
Red
I Red
LED DRIVER
Red LED
I Red LED
POX SENSOR
could use DAC (in development)
Current to Voltage converter using K50 TRIAMPS
Red Amplifier
I Red Amplifier
R/IR Control
Red Amplifier
I Red Amplifier
ADC1
R/IR Control
K50 Internal
Amplifier
Filter
K53 Measurement Engine

Plan and Goals

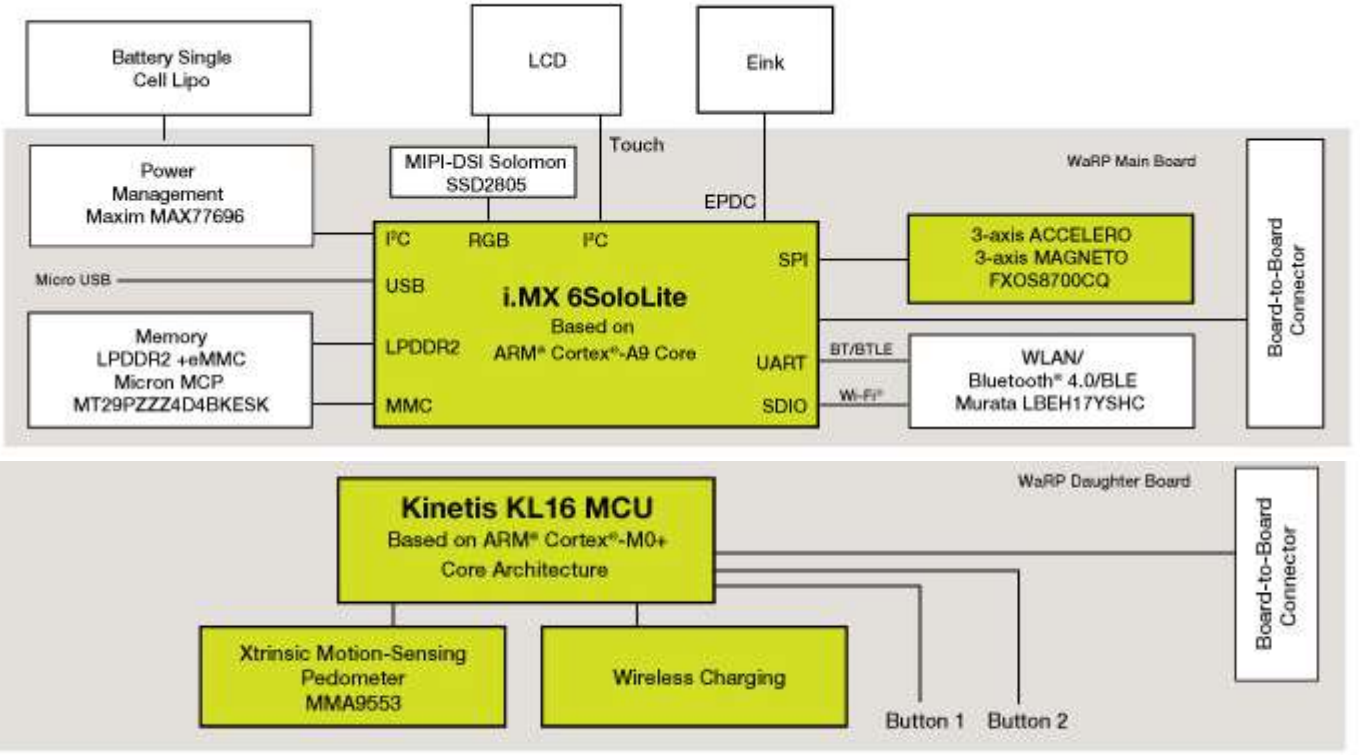
- New method that uses LEDs to measure plethysmography and indirectly measure the blood pressure
- Early phase of adoption
- Could innovate the traditional way of measuring blood pressure

Freescale's Wearable Reference Platform (WaRP)

WarP Block Diagram

Main Board PCB size:
38 mm x 16 mm
(1.4”x 0.6”)

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

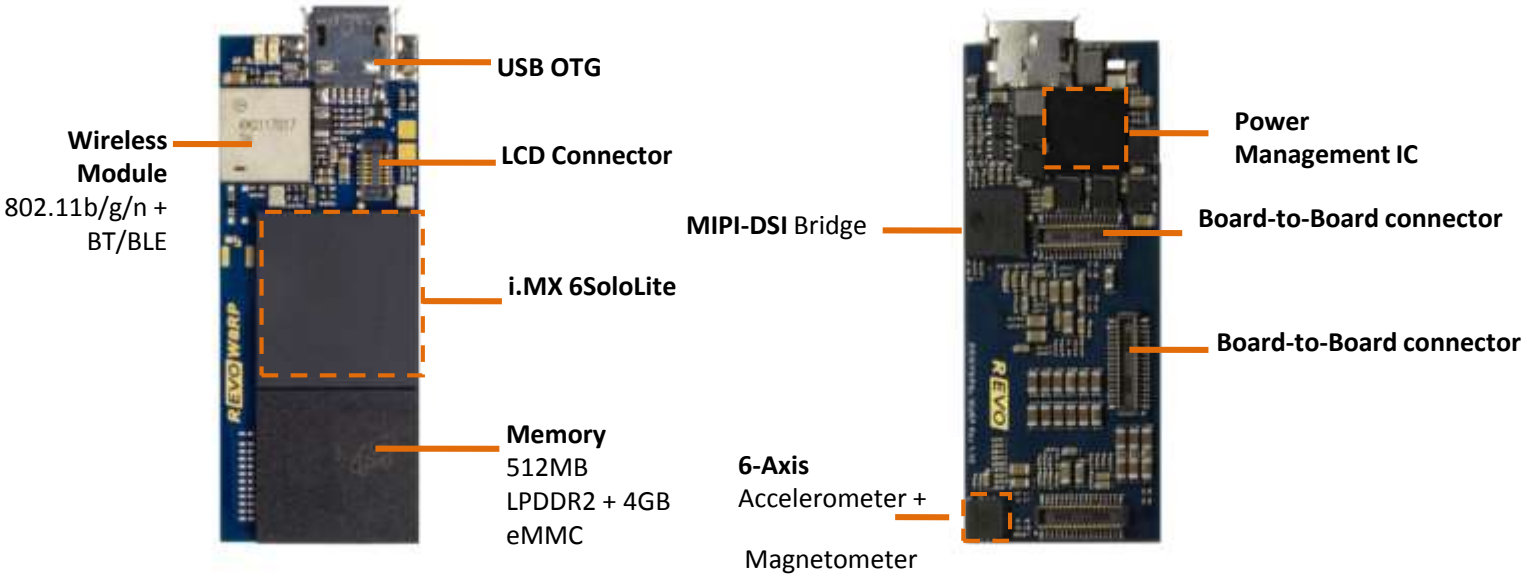


Freescale Technology

Designed to be able to productize

Wearable Form Factor..

- Main Board PCB size: 38 mm x 16 mm (1.4” x 0.6”)

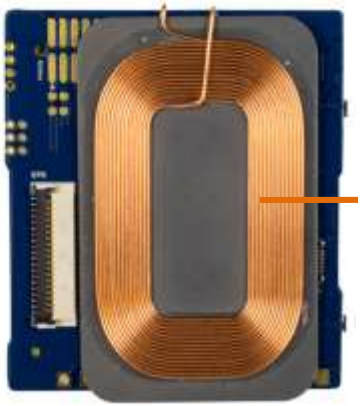


Battery Management/Scalability

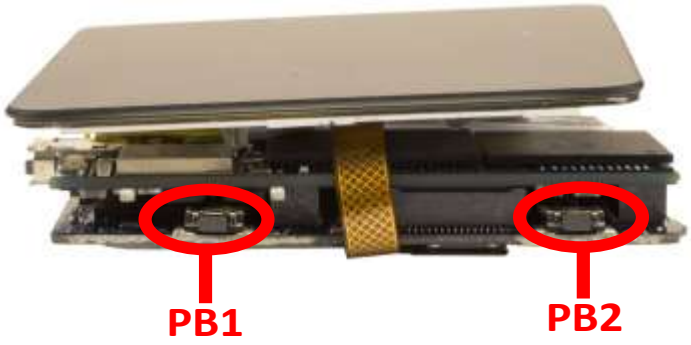
Daughter Board PCB size:
42 mm x 42 mm
(1.65” x 1.65”)

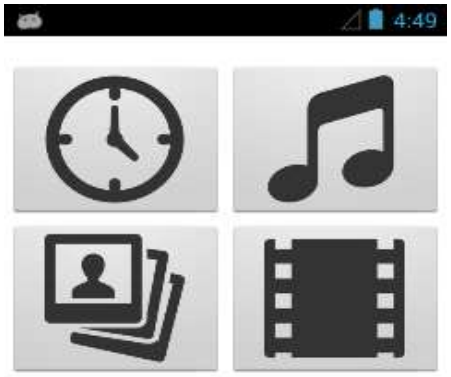
Top view

Bottom View



Usability


PB1
PB2


4:49


1:00


1:11
Settings
WIRELESS
Wi-Fi
Bluetooth
DEVICE
Sound

Open Source/ Community

WaRP

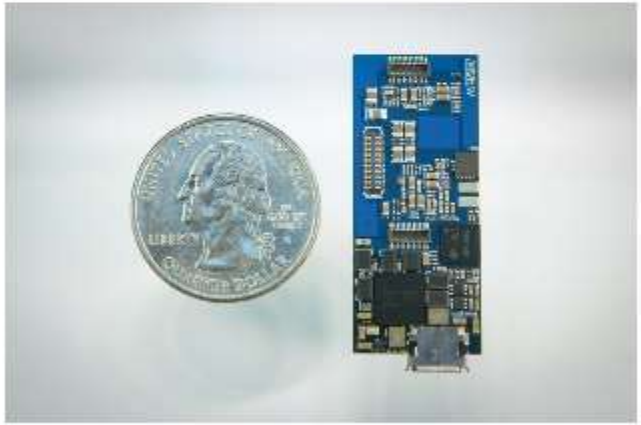
Wearable Reference Platform

Home | Press | Community | Technical Features | Where to Buy | About Us

WaRPboard.org is a nonprofit community based organization providing service and support for the **w**ear**a**bles **r**eference **p**latform (WaRP). The solution's hardware and software will be open sourced and community driven. No closed development tools or licensing fees are required when used in conjunction with open source resources.

WaRPboard implements a hybrid architecture to address the evolving needs of the wearables market. The platform consists of a main board and an example daughtercard with the ability to add additional daughtercards for different usage models. In this hybrid architecture, the guts of the design is done on the main board with Freescale's i.MX 6SoloLite applications processor, and a secondary microcontroller, Freescale's Kinetis KL16 MCU, is implemented on the daughtercard, which is used as a sensor hub as well as a wireless charging MCU.

Technical Features

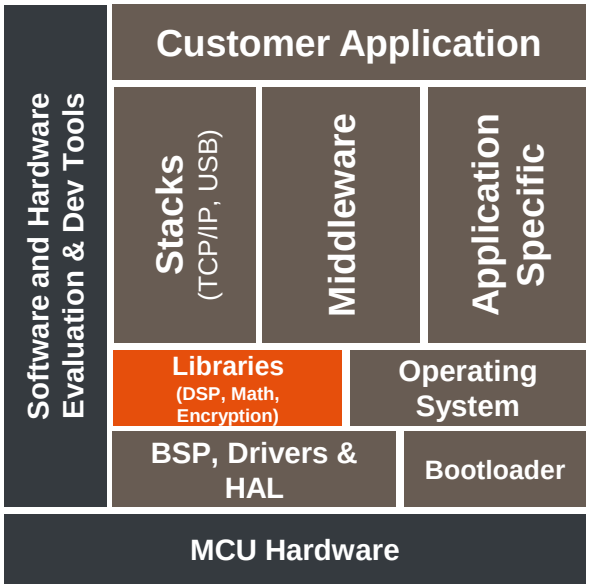


See the Technical Features page for additional board photos.

Freescale Sensor Fusion Library

Full featured sensor fusion library, including the award winning e-compass software

Fully open source, eliminating proprietary constraints, increasing flexibility, and decreasing time-to-market



Product Features

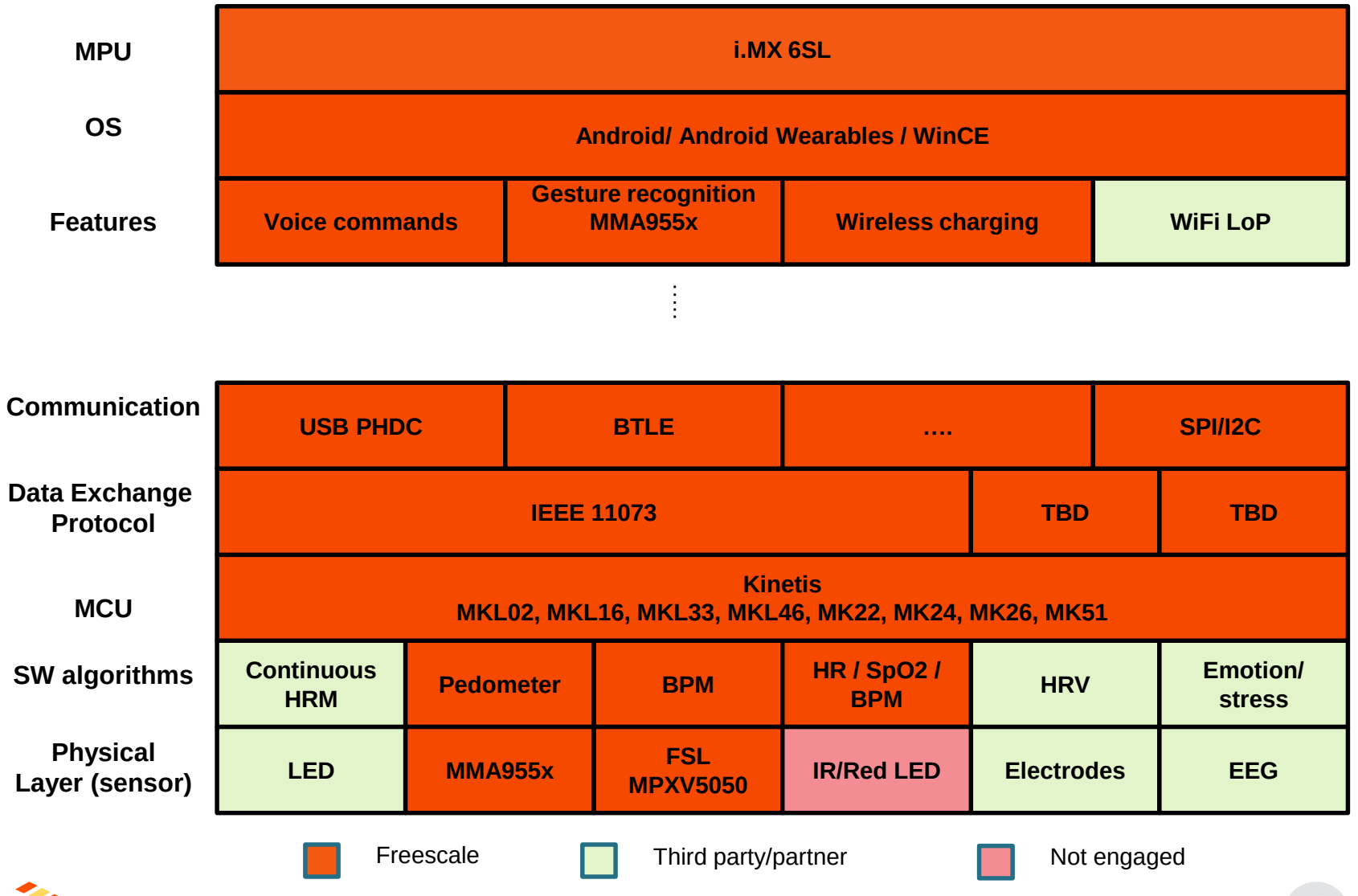
- Functionality
  - 3-axis, 2-axis heading, 6-axis eCompass,6-axis indirect Kalman filter, 3-axis relative rotation, and 9-axis indirect Kalman filter
  - Programmable sampling, fusion rates, and frame of reference,
- Included projects
  - Kinetis K20, KL25Z, KL26Z, KL46Z, and K64F Freedom boards
  - Use of Freescale Multi sensor boards
  - CodeWarrior and Kinetis Design Studio
- Additional commercial support and services available

Freescale Sensor Fusion Library for Kinetis MCUs

- Optimized for the computation of orientation with respect to a global frame of reference as a function of sensor readings from:
  - accelerometer
  - and/or gyroscope
  - and/or magnetometer
- Along with orientation, also computes:
  - linear acceleration
  - magnetic interference and correction factors for same
  - magnetic inclination angle
  - gyroscope zero-rate offset
  - compass heading
  - virtual gyro from accelerometer / magnetometer

Summary

Wearable for Healthcare and Fitness Summary



Q & A

www.Freescale.com