June 22, 2010

Introduction to USB Personal Healthcare Device Class

USB, Continua Alliance, IEEE 11073, (FTF-IND-F0688)

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Introduction

- As medical devices become more of a consumer product, these requirements are more critical:
  - Ease of use
  - Interoperability
  - Time-to-market
- This course provides an introduction to:
  - Personal healthcare devices
  - Communication standards focusing on USB
  - Continua Alliance
  - IEEE 11073 specifications
  - Freescale's Medical Connectivity solutions

Objective

- After completing this session, you will be able to:
  - Understand medical connectivity requirements
  - Understand Freescale's Medical Solutions
  - Start developing with Freescale's USB medical firmware

Agenda

- Medical Market Solutions
- USB and Continua Alliance
- Software Solutions
- Hardware Offerings
- Hands-On and Source Code
- Applications and Demos

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Freescale's Value to the Medical Market

Freescale is a trusted provider of high quality technical solutions that enable the development of breakthrough medical systems.

Trusted Partner	Medical Technology Leadership	Product Portfolio
Freescale is on your team, delivering innovative products with long lives and the quality you expect from a leader.	Freescale is committed to the medical device marketplace and has put together the technical infrastructure to provide the highest level of support in the IC industry.	Freescale has one of the largest and most diverse IC portfolios in the industry, giving customers access to nearly all the necessary components for designing breakthrough medical systems.

History of Innovation	**Medical Center of Excellence**	**MCUs and MPUs**
Long Product Lives	**Continua Alliance**	**Sensors** (Medical Grade)
Quality	**Medical Advisory Board**	**Analog**
Service	**Strategic Partnerships**	**Wireless**

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Freescale Product Longevity Program

The embedded market needs **long-term product support**

Freescale has a longstanding track record of **providing long-term production support** for our products

Freescale is pleased to introduce a **formal product longevity program** for the market segments we serve

- For the automotive and medical segments, Freescale will make a broad range of program devices available for a minimum of **15 years**
- For all other market segments in which Freescale participates, Freescale will make a broad range of devices available for a minimum of **10 years**
- **Life cycles** begin at the time of launch

A list of participating **Freescale products** is available at: www.freescale.com/productlongevity

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Mission Statement

To be a trusted provider of high quality technical solutions that enable the development of breakthrough medical systems.

Freescale's Legal Position

▶ FDA Class I and Class II Medical Devices

- Standard sales operating procedure followed

▶ FDA Class III Medical Devices

- Risk analysis performed
- **All** opportunities must reviewed by Freescale
- Examples of Class III applications for which we are currently providing solutions:
  - Wireless interface for cardiac implantable
  - External defibrillator
  - Life vest with built-in defibrillator

Freescale Datasheet Disclaimer

Freescale Semiconductor products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Freescale Semiconductor product could create a situation where personal injury or death may occur. Should Buyer purchase or use Freescale Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold Freescale Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Freescale Semiconductor was negligent regarding the design or manufacture of the part.

How to properly interpret this statement:

- This statement does **not** mean that standard Freescale products cannot be used in Class III medical devices.
- Proper written consent from Freescale must be in place.
- Freescale **can** guarantee that the product characteristics match the test program as specified in the datasheet.
- Freescale **cannot** warrant the application nor the functionality of the device in the application.

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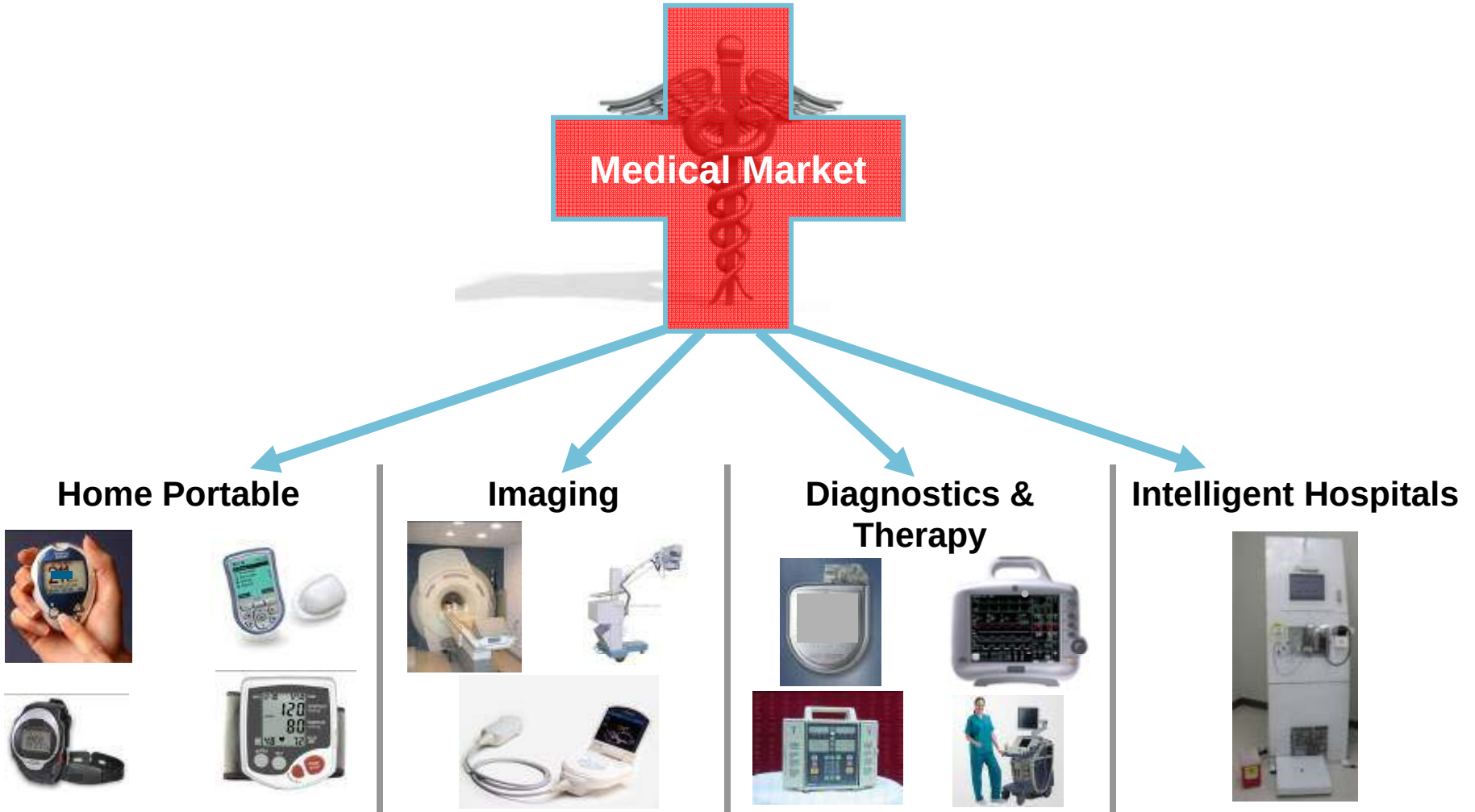
Our View of the Medical Market



Freescale Medical Market Segments

Business Unit	Freescale Product	Home Portable	Diagnostics & Therapy	Imaging
Sensors	Pressure	✓	✓	
	Accelerometers	✓	✓	
	Proximity	✓	✓	✓
MCU	MCU / Flexis	✓	✓	
	i.MX / Power	✓	✓	✓
Analog	Power Management	✓	✓	✓
	Battery Chargers	✓		
DSP	DSC, StarCore	✓		✓
RF	802.15.4 Wireless	✓	✓	✓
	High power			✓

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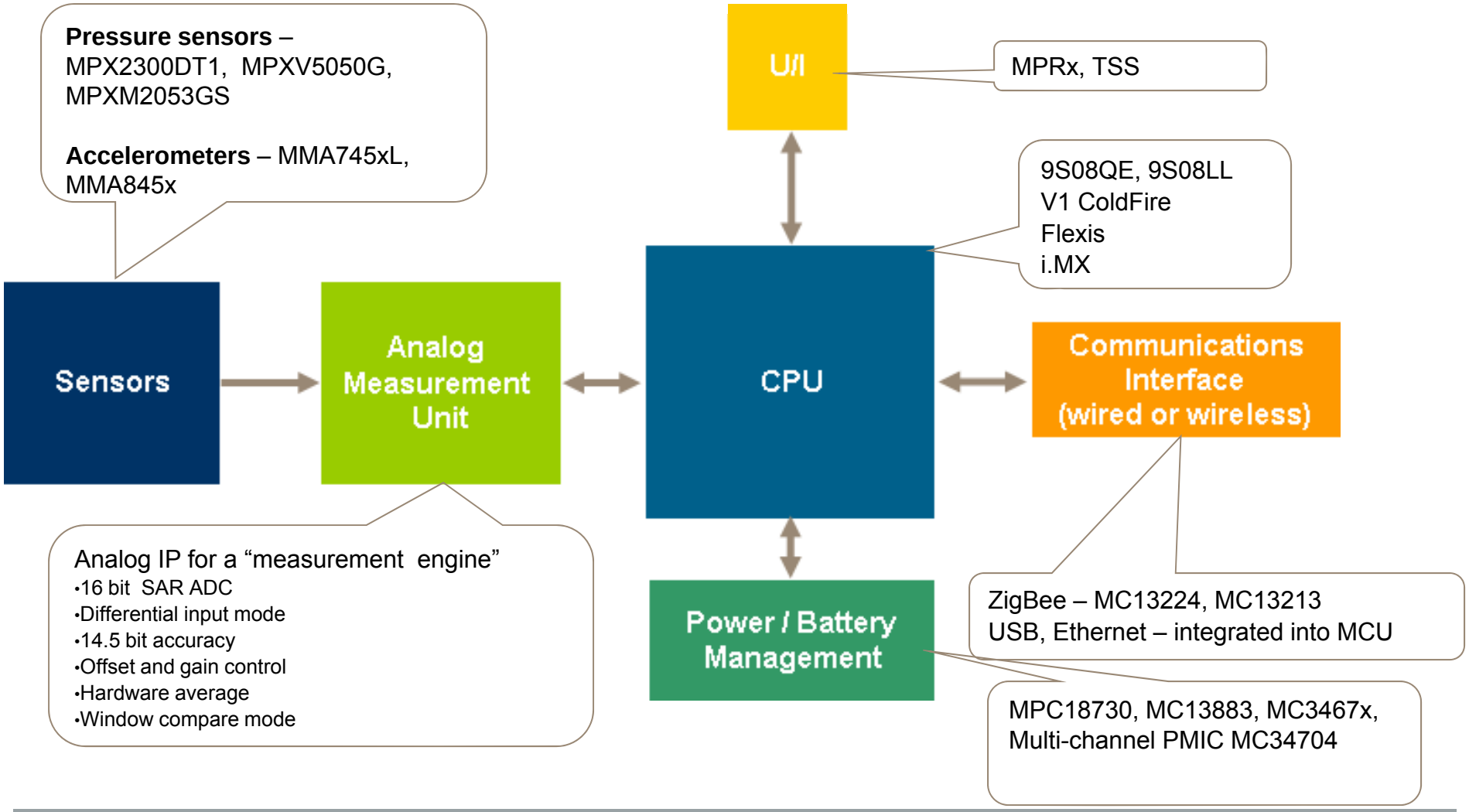
Medical USB Applications

Medical Instrumentation

- Pulse oximeter
- Blood pressure monitor
- Glucose meter
- Cardiovascular fitness activity monitor
- Fitness equipment
- Thermometer
- Weighing scale
- Independent living activity hub

Freescale Medical USB stack provides ***connectivity*** *to standard medical applications.*

Solutions for Home Portable Medical



Key Attributes within our Portable Medical MCU Portfolio

Portable Medical Portfolio

- Scalable and Differentiated
- Low Power
- ASSP Solutions focused on:
  - Precision Analog Integration
  - Display and Connectivity Support

Measurement Engine for Fast Accurate Readings

- 16-bit ADC
  - 14.5 ENOB
  - 320 kSps
- Transimpedance Amp
  - 270pA offset current
  - Low power
- General Amp
  - 1nA offset current
  - Low power
- Accurate V_{REF}
  - 33PPM/°C
  - Up to 1mA drive
- 12-bit DAC
  - Low power
  - 1us settling time
- Program. Delay Block
  - Sync Engine ADC-DAC

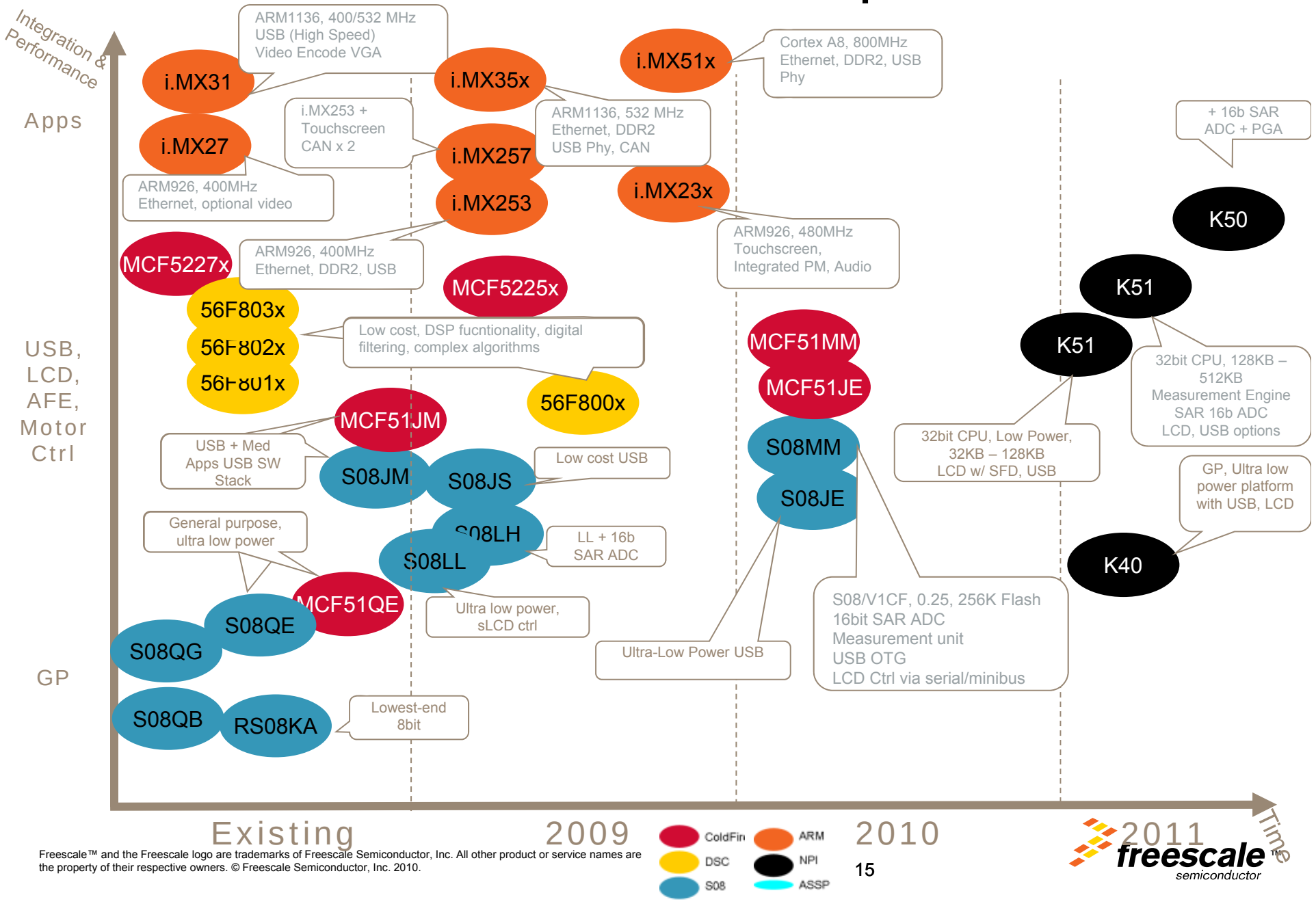
Ultra-Low Power for Extended Battery Life

- S08 Solutions STOP I_{DD}
  - 400nA to 550nA
- 32-bit Solutions STOP I_{DD}
  - 500nA to 750nA
- Two External Crystal
  - 32Khz track time
  - Up to16MHz (USB)
- Clock Gating
  - Disable unused peripherals
- Low Power Blinking Mode
- Low Power TOD

Display and Connectivity for Ease of Use

- USB OTG (Host/Device)
- USB Stacks (PHDC)
- Medical Connectivity Library
- Built -in LCD Driver
- LCD Libraries
- MiniFlexbus (graphics)
- FIFO SPI
- MQX: Real Time Operation System

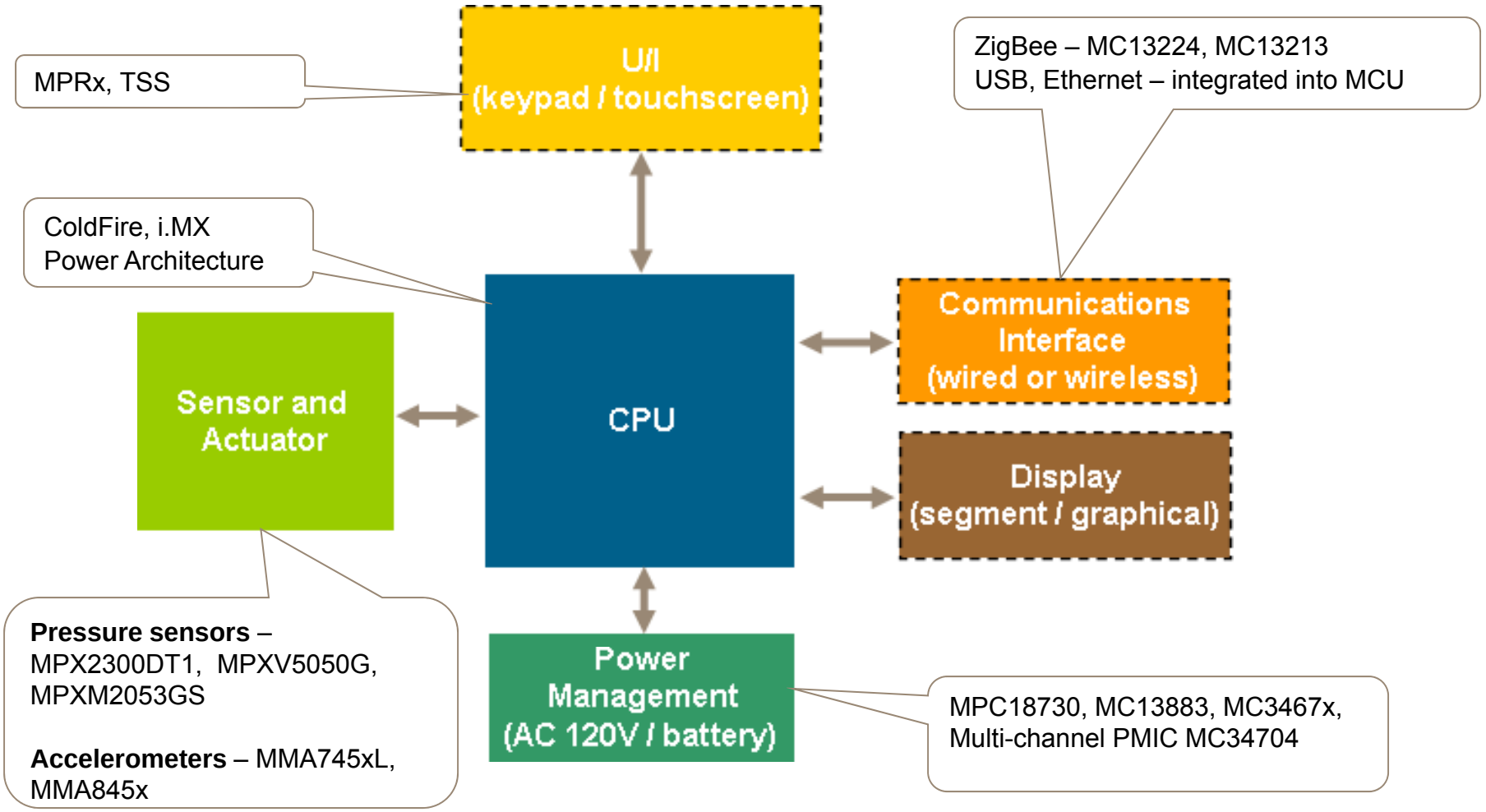
FSL MCU / MPU Roadmap for Portable Medical



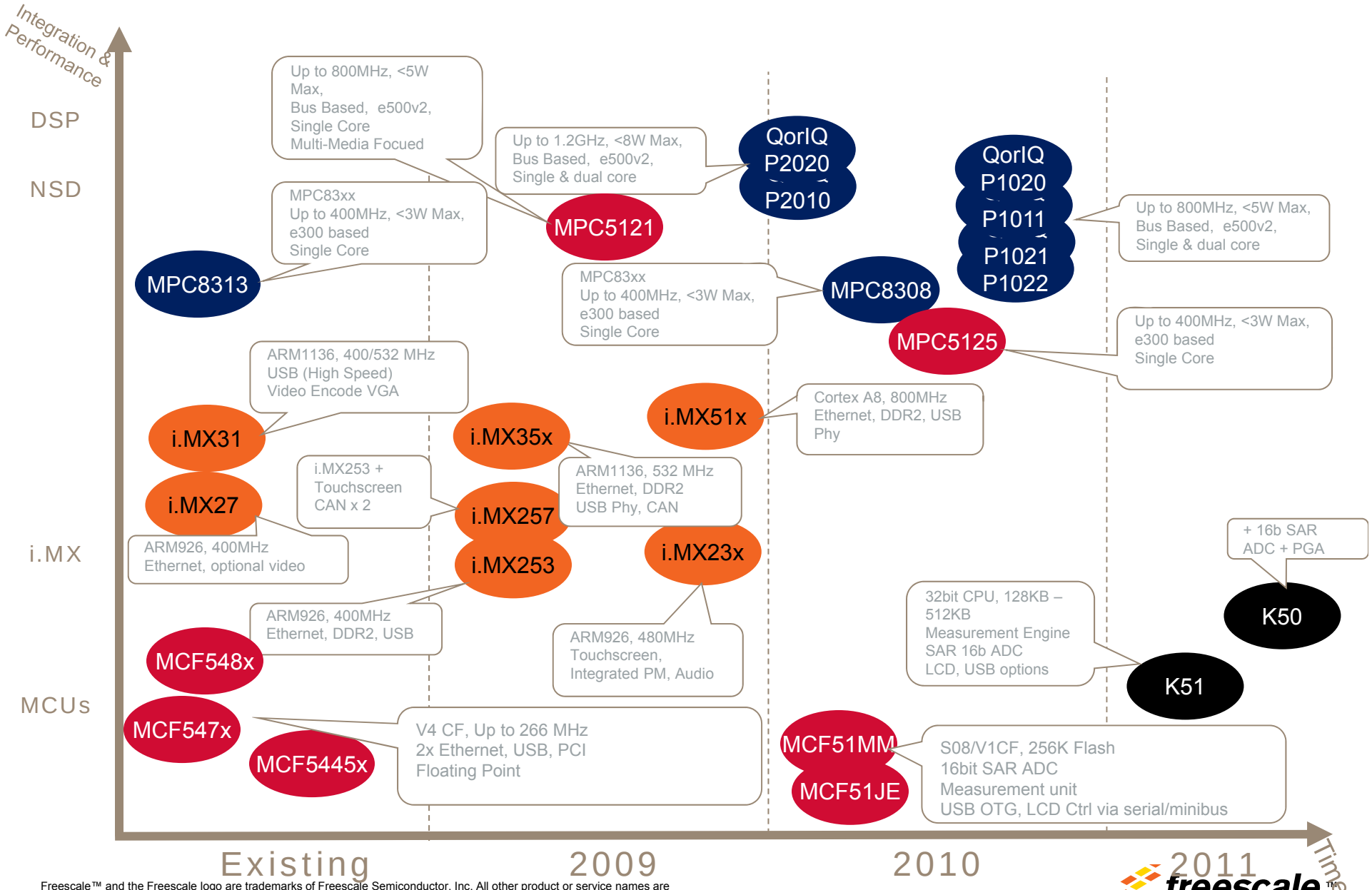
MCU Solutions Matrix for Home Portable Medical

	9S08QE8	9S08LL16	MC51QE128	MC51JM128	MC51MM256
Key Features	**Ultra-Low Power**	**192 Segment LCD Ctrl**	**8-bit / 32-bit Compatibility, Ultra-Low Power**	**8-bit / 32-bit Compatibility, USB OTG**	**8-bit / 32-bit Compatibility, Measurement Engine, USB OTG**
Core	S08 (8-bit) 20 MHz core 10 MHz bus	S08 (8-bit) 20 MHz core 10 MHz bus	V1 ColdFire 50 MHz core 25MHz bus	V1 ColdFire 50 MHz 25 MHz bus	V1 ColdFire 50 MHz 25 MHz bus
Flash / SRAM	8K Flash / 512B RAM	16K (dual 8K Flash arrays) 2K RAM	128K Flash 8K RAM	128K Flash 16K RAM	256K Flash 32K RAM
A/D	10ch 12-bit	12-bit	24ch 12-bit	12ch 12-bit	12ch 16-bit
Timers	2x 3ch 16-bit	2x 2ch 16-bit	1x 6ch 16-bit 2x 3ch 16-bit	6ch 16-bit 2ch 16-bit	4ch 16-bit 4ch 16-bit
Communications	SCI, SPI, IIC	SCI, SPI, IIC	SCI, SPI, IIC	USB OTG SCI, SPI, IIC, CAN	USB OTG SCI, SPI, IIC
Package	16 TSSOP, 16 PDIP, 20 SOIC, 28 SOIC, 32 LQFP	65 LQFP	64 LQFP, 80 LQFP	44 LQFP, 64 QFP, 64 LQFP, 80 LQFP	64 LQFP, 80 LQFP, 100 LQFP, 81-MAPBGA, 104-MAPBGA

Solutions for Diagnostics & Therapy



FSL MCU / MPU Roadmap for Diagnostics &Therapy



MPU (i.MX) Solutions Matrix for Medical Applications

	i.MX31	i.MX27	i.MX356	i.MX25	i.MX51
Key Features	**ARM11/L2 Cache, Video Encode, 3D Graphics, Camera Port, LCD Controller**	**ARM9, Video Decode/Encode, Ethernet, Camera Port, LCD Controller, Security**	**ARM11/L2 Cache, Ethernet, 2D Graphics, Camera Port, LCD Controller (WVGA), USB Phy, CAN**	**ARM9, Ethernet, Camera Port, LCD Controller, CAN**	**Cortex/L2 Cache, Ethernet, 2D/3D Graphics, Video Encode/Decode, Camera Port, LCD Controllers (2) (WXGA), USB Phy**
Core	ARM1136 532 MHz	ARM926 400MHz	ARM1136 532 MHz	ARM926 400MHz	Cortex A8, 800-1GHz Neon coprocessor
Memory	16K I-Cache & D-Cache 128KB L2 Cache, 128KB on-chip SRAM mDDR/SDRAM NOR Flash, NAND Flash	16KB I-Cache & D-Cache, mDDR/SDRAM NOR Flash, NAND Flash	16KB I-Cache & D-Cache 128Kb L2 Cache, 128KB on-chip SRAM mDDR/SDRAM, DDR2, NOR Flash, NAND Flash	16KB I-Cache & D-Cache 128KB on-chip SRAM, mDDR/SDRAM, DDR2, NOR Flash, NAND Flash	32KB I-Cache & D-Cache, 256KB L2 Cache, 92KB on-chip SRAM, mDDR, DDR, DDR2, NOR Flash, NAND Flash
Multimedia	OpenGL ES 1.1 3D Video Encode QVGA	D1 Video E/D	OpenVG 1.1, Enhanced serial audio interface	Enhanced serial audio interface	720p Video Decode D1 Video Encode OpenGL ES 2.0 OpenVG 1.1
Connectivity	USB OTG HS, USB Host x2, ATA-6, PATA, MMC/SD x2, Memory Stick, UART, SPI	Ethernet HS USB OTG Host x2, UART, SPI PCMCIA/CF, MMC/SD, CMOS sensor interface, ATA-6, Memory Stick	Ethernet, USB Phy x2, CAN, UART, SPI	Ethernet, USB PHY, CAN, UART, SPI	Ethernet,, HS USB OTG PHY, USB Host HS x3, MMC/SD x4, CE-ATA, ATA-6, CMOS sensor interface, UART, SPI

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MPU Solutions Matrix for Medical Applications

	MPC8536	MPC8313	MPC8610	MPC8377	MPC5121e
Key Features	**Advanced Power and Energy Management, Graphics Enablement**	**Power/ Performance Ratio**	**LCD Controller, AltiVec™ Technology**	**SATA**	**Performance & Integration for Multimedia**
Core	E500 667-1.5GHz	E300 266-400MHz	E600 667-1333GHz	E300 400-667MHz	E300 200MHz
Memory	32I/32D 512 KB L2 Cache	16I/16D	32I/32D 256 KB L2 Cache	32I/32D	32I/32D 128K RAM
Floating Point	Double precision, SPE	Single precision	Double precision 4 x integer units	Single precision	Double precision
I/O/ Features	DDR2/3, Integrated security engine,USB, SD/MMC flash, SPI, SATA, GBe, PCI Express®,PCI, IEEE® 1588	DDR/DDR2, GBe ports, PCI, TDM, I²C, DUART, DMA, SPI, security engine, IEEE® 1588	DDR/DDR2, I²S/AC97 audio ports, PCI-Express®, PCI , I²C, DUART, Fast/Serial IrDA channel, DMA SPI, GPIO, Watchdog and 2-global timers	DDR/DDR2, GBe ports, PCI, PCIe, I²C, DUART, DMA, SPI, SATA, security engine	AXE, MBX Lite – 2D/3D graphics engine, Display interface unit, DDR1, DDR2, and low-power mobile DDR (LPDDR) SDRAM memory controllers, USB 2.0 OTG, Flexible multi-function external memory bus interface, Ethernet, PCI, PATA, SATA, SDHC, CAN

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DSP Solutions Matrix for Medical Market

	DSP563xx	MSC711x	MSC811x	MSC812x	MSC8144
Key Features	**Single Core+ Co-processor, 24-bit**	**Single Core, 16-bit**	**2 or 3 Core, 16-bit**	**4 Core, 500MHz, Optional Turbo/Viterbi Co-processor**	**4 Core, 1GHz, Optional Security**
Core	DSP56300 Up to 275MHz	SC1400 Up to 300Mhz	SC140 Up to 400MHz	SC140 Up to 500MHz	SC3400 Up to 1GHz
Memory	Up to 576KB, optional 1K I-cache	Up to 256KB M1, 16K I-cache	896KB M1 memory, 476 M2 Memory, 64K I-cache	896KB M1 memory, 476 M2 Memory, 64K I-cache	10.5MB incl cache and SDRAM
I/O/ Features	SDRAM, SCI, 2 ESSI, 24-bit memory interface, GPIO, 3x 16-bit timers, EFCOP, HI8, DMA	DDR1, I^2C, UART, DMA, GPIO, Watchdog and global timers, 16-bit timers, optional 10/100 Ethernet, 2 or 3 TDMs, event port, HDI-16	SDRAM, I^2C, UART, DMA, GPIO, Watchdog and global timers, 16-bit timers, SRIO, 2x Gbe, ATM, 8 TDMs, 8 HW semaphore, DSI	SDRAM, I^2C, UART, DMA, GPIO, Watchdog and global timers, 16-bit timers, SRIO, 2x Gbe, ATM, 8 TDMs, 8 HW semaphore, DSI	DDR/DDR2, PCI , I^2C, UART, DMA SPI, GPIO, Watchdog and global timers, 16-bit timers, SRIO, 2x Gbe, ATM, 8 TDMs, 8 HW semaphore, QUICC Engine Technology

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Freescale/Monebo Partnership

Providing medical device designers and their customers optimized ECG solutions to speed product development of more functional, accurate and energy-efficient solutions.

Summary of Benefits:

- Easy for customers to integrate ECG analysis
- World-class hardware and software platforms
- Freescale portfolio has a device for every application
- Specific hardware and software support better serves the customer

Additional Resources:

- http://www.freescale.com/monebo
- http://www.monebo.com/

Freescale's Value to the Medical Market

- **Standard products that can help solve key customer problems for medical systems**
  - Maximize battery life → ultra-low power 8-bit & 32-bit MCUs
  - Reliable readings → fast & accurate on-chip ADCs
  - Integration → memory, LCD ctrl, analog
  - Communication I/F → USB, ZigBee, …
- **Commitment to the market with products and solutions that have characteristics important to the medical segment**
  - Longevity | Track Record | Quality
- **Breath of products with a strong medical applications focus**
- **Mix & match IP allowing specific medical solutions**
- **Medical technology ecosystem of tools, applications & systems, and partnerships**
  - Medical Center of Excellence
    - Reduce product development cost and improve time-to-market and time-in-market
  - Key partnerships with Continua
  - Medical advisory board
  - Design partner program

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Agenda

- Medical Market Solutions
- USB and Continua Alliance
- Software Solutions
- Hardware Offering
- Hands-On and Source Code
- Applications and Demos

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Why Medical USB?

Issues when designing medical applications with conventional USB stack…

1. Fulfills USB connectivity for general purpose applications.
2. Medical device specialization layer not available.
3. Connectivity not available within vendor devices.
4. Medical applications certification may not be available.
5. General standards. Medical standards might not be available.

Benefits when designing medical applications with Medical USB stack…

1. Designed specifically for USB medical devices.
2. Eases medical applications data exchange due to specific device specialization layer
3. Connectivity is supported by several vendors
4. Ready for certification on medical applications
5. Continua Health Alliance defined standard

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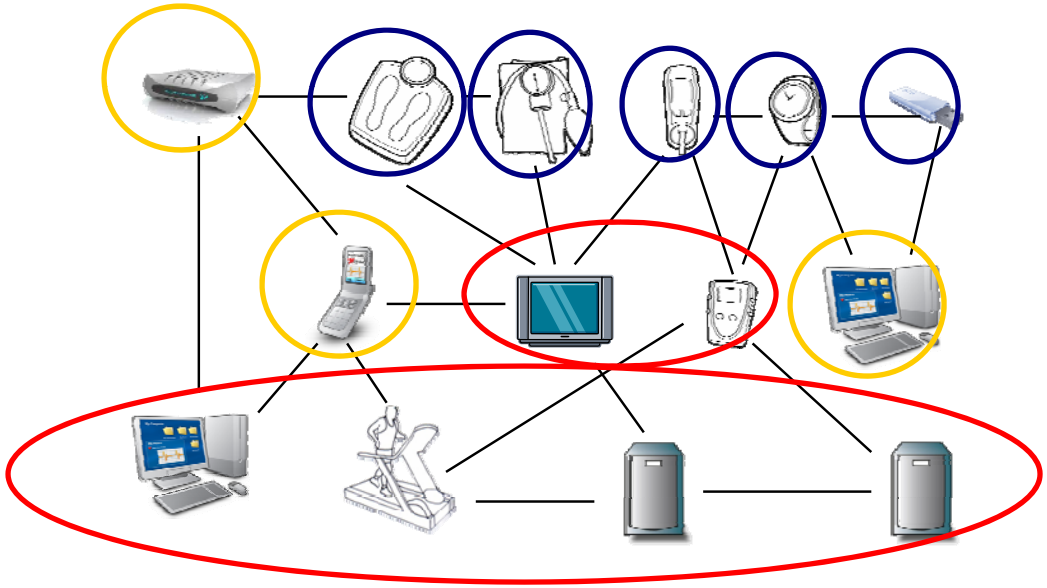
Continua Health Alliance

- The Continua Alliance is a forum of member companies that have come together to form workgroups to set standards for medical systems.



Continua HEALTH ALLIANCE

PAN Devices

Application Hosting Devices

LAN/WAN Devices

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Connectivity Trends

▶Non-Clinical Environments

- 3 Continua approved standards
  - Bluetooth (classic)
  - USB – Freescale has a PHDC (personal healthcare device class) stack available
  - ZigBee – Freescale is working to create a healthcare profile for ZigBee
- Continua is considering Bluetooth Low Energy (BTLE) as well, however, BTLE does not yet have a ratified spec
- Non-Continua standards are also being considered for point-to-point connections
  - Cellular
  - Ethernet

▶Clinical Environments

- Wi-Fi is the de-facto standard
- MICS (medical implant communication service)
  - 402 – 405MHz
  - Range of about 2m

Adding communications is often listed as the customer's top concern. "My biggest problem is to get data from a device in one location to a central system without much user intervention."

▶ The Facts

- Freescale is the leader in 802.15.4 wireless solutions.
- ZigBee has been adopted as a wireless standard for Continua's V2 design guidelines.
- ZigBee has incredibly strong security and depending on the use case can have link, network, and application keys. It fully supports AES128 encryption.
- Wi-Fi is prevalent in clinical environments. ZigBee and Wi-Fi can co-exist much more smoothly than BT and Wi-Fi (see notes for details).
- BTLE specification has not yet been finalized.

Continua HEALTH ALLIANCE

Continua Health Alliance Looks to the Future with the Selection of Two New Low Power Radio Standards, Enabling Expanded Use Cases

Addition of Bluetooth low energy technology and ZigBee Health Care to provide connectivity for mobile and home sensors

BEAVERTON, Ore. – June 8, 2009 – Continua Health Alliance, the non-profit, open industry coalition of leading health care and technology companies, has selected two wireless technology standards for inclusion in the next version of its interoperability Design Guidelines. The selection of two low power standards will allow additional devices used for health and fitness, as well as aging independently, to join the Continua ecosystem. This decision enables Continua to advance its mission of establishing a system of interoperable, personal telehealth solutions, empowering people and organizations.

The two wireless technology standards are targeted to support mobile and fixed location devices as defined by the next iteration of the Continua Health Alliance Design Guidelines. The alliance has selected *Bluetooth* low energy wireless technology (pending finalization of the specification) to enable low power mobile devices such as activity monitors and heart rate sensors to be used to monitor a user's health and fitness levels. Additionally, Continua has selected ZigBee Health Care technology for low power sensors that can be networked in a variety of settings, and utilized in devices such as motion detectors and bed pressure sensors to enhance the daily living of those who require assistance aging independently.

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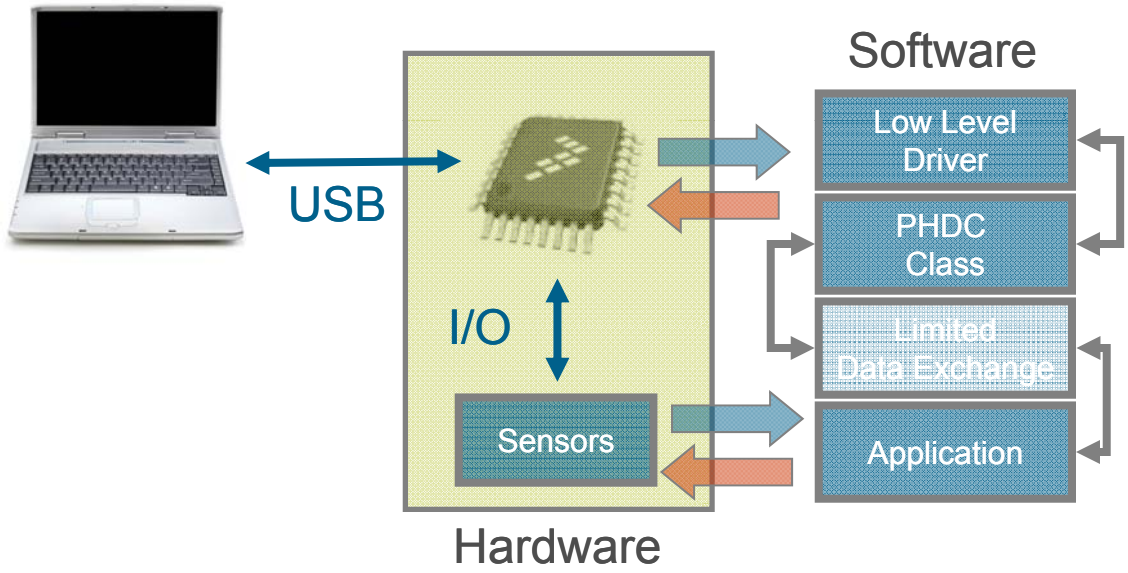
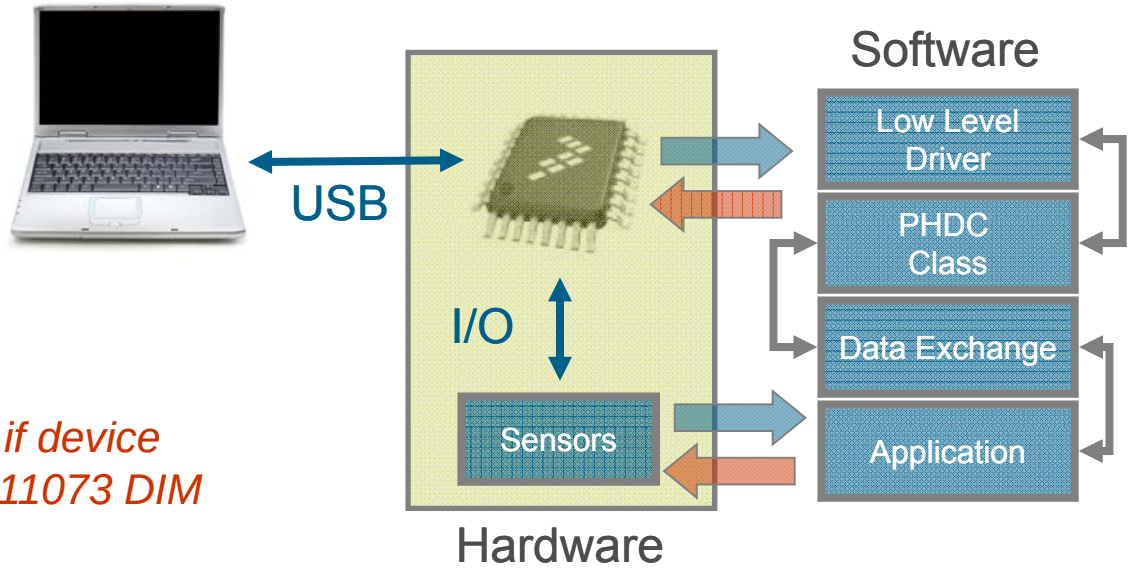
This is a model of a low-end device.

The medical device connects directly to the system and passes measurements to the system after acquisition.



PAN Device

- Provides more functionality than low-end PANLite.
- These devices, with adequate RAM, ROM and processing power, will implement agent/device functionality.
- They will be mostly running on ColdFire V1 or higher power-based MCU's with more than 64K flash and 8K RAM.

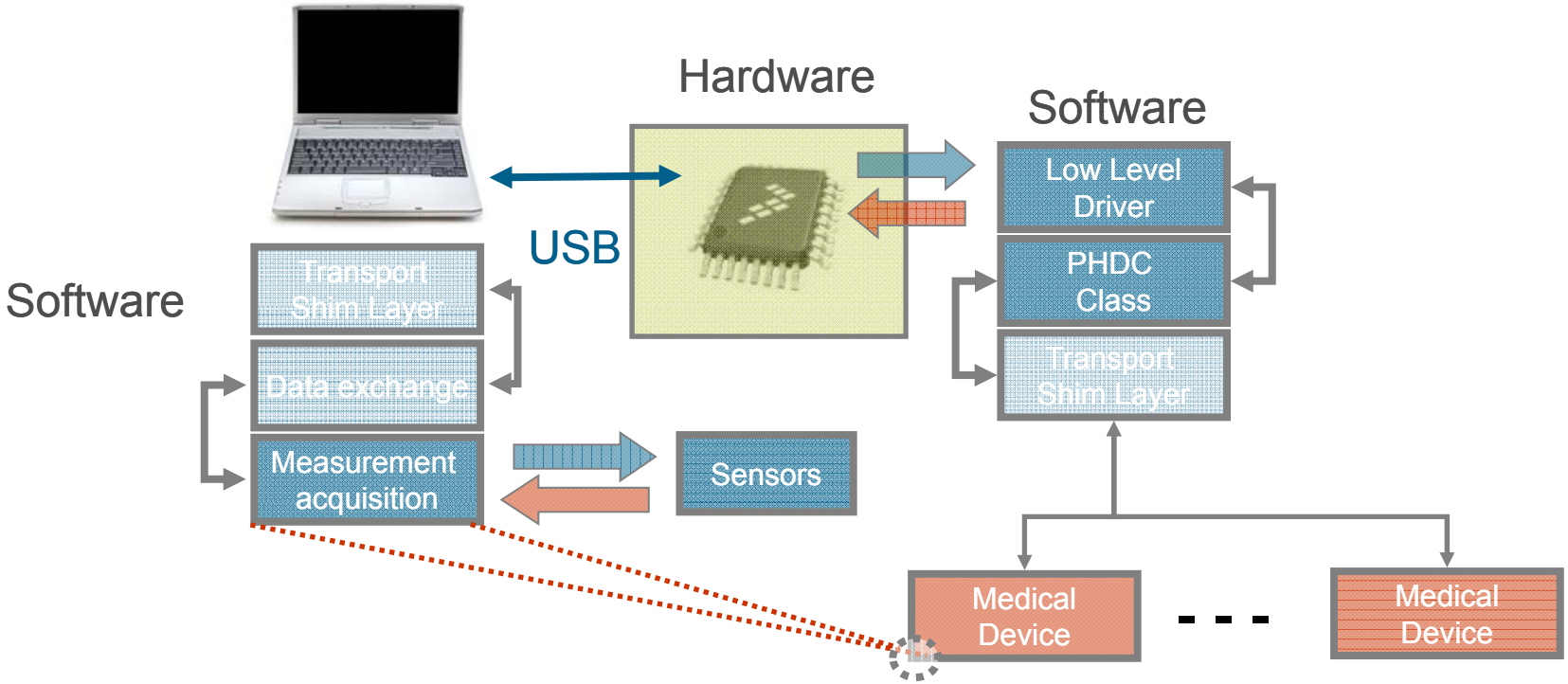


Note:

Higher RAM may be required if device needs to support bigger IEEE11073 DIM configurations

PHD Bridge Model

- Device implements a bridge between the application hosting system and the medical device that acquires the measurement.
- The bridge device would implement the low-level driver, the PHDC class and a transport shim layer that forwards the data it receives (through serial cable or other media) to the external connected medical device.
- It also sends the data received from this external medical device to the system running the IEEE11073 manager.



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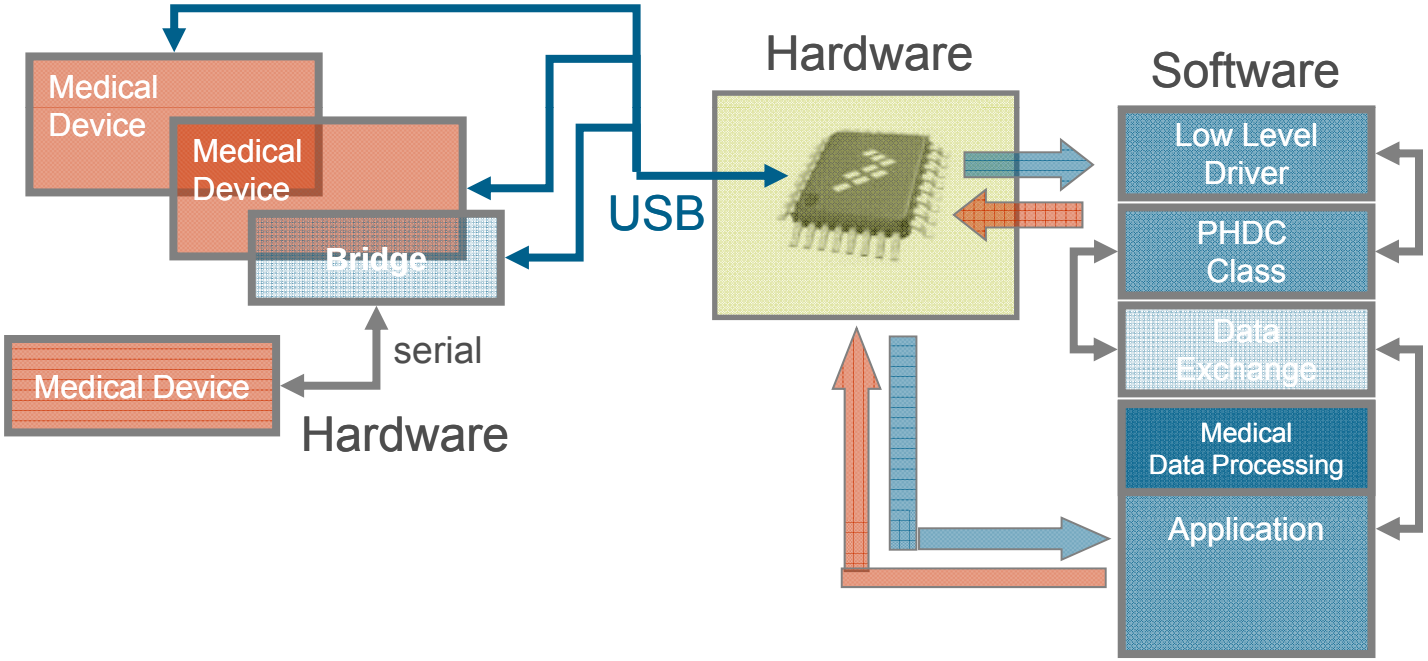
Application Hosting Device

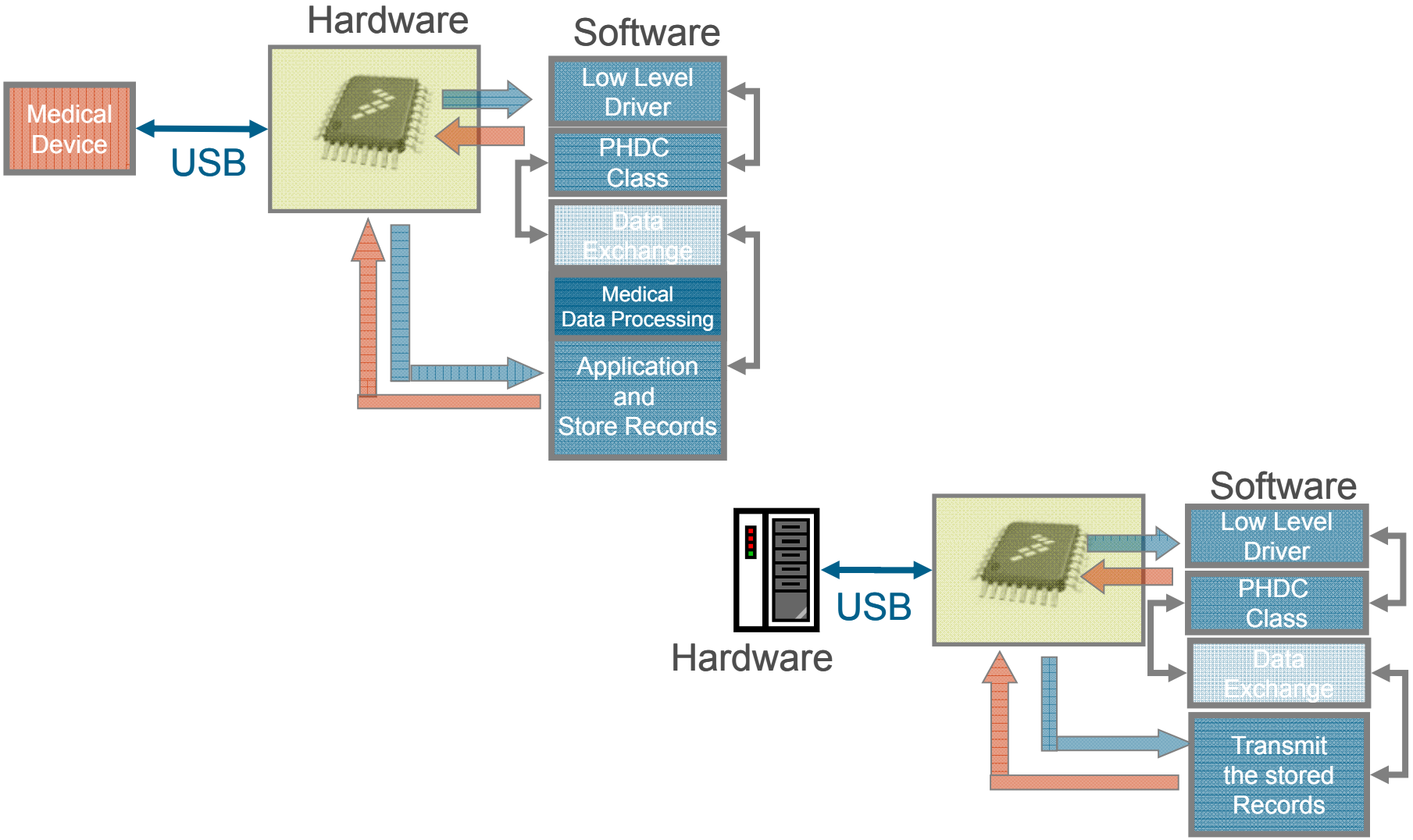
- These devices will implement host/manager functionality.
- They can run on an embedded device running an RTOS
- These devices will have the ability to connect to one or more PAN devices over one or more transports.
- They can also be connected to the LAN/WAN interfaces to send this data over the transport.



Hybrid Devices

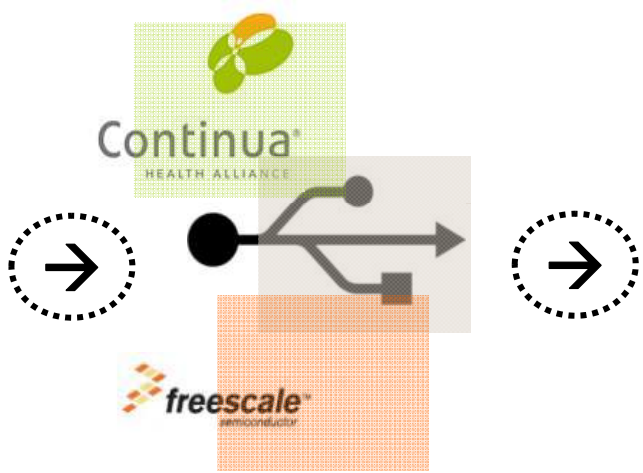
- Hybrid devices implement host/manager as well as agent/device functionality.
- They initialize themselves as a manager or agent, based on the user's choice. When they are connected managers, they will act as agents and vice-versa. These kinds of devices will use the OTG feature of the USB transport.
- This device can be used in remote areas as a manager to collect data from agents. At the lab it can be connected to a manager and act as an agent to send all the collected data. This is why manager as well as device functionality is built into the same device.
- The use model would be represented by two modes.

Hybrid Device (Manager/Agent)



Freescale Model Options

- Low-End PAN Device
- PHD Bridge
- PAN Device
- Application Hosting
- Hybrid



- 9S08JS16
- 9S08JM16
- 9S08JM60
- 9S08(MM/JE)128
- MCF51JM128
- MCF51(MM/JE)256
- MCF5225x

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IEEE 11073 Overview

The following slides give an overview of the IEEE 11073 Terminology

- IEEE 11073 Software Layers
- Domain Information Model
- Transport Interface Layer
- PM Store Class
- PM Segment Class
- Scanner Class
- Event Reporting Service

IEEE 11073 Software Layers

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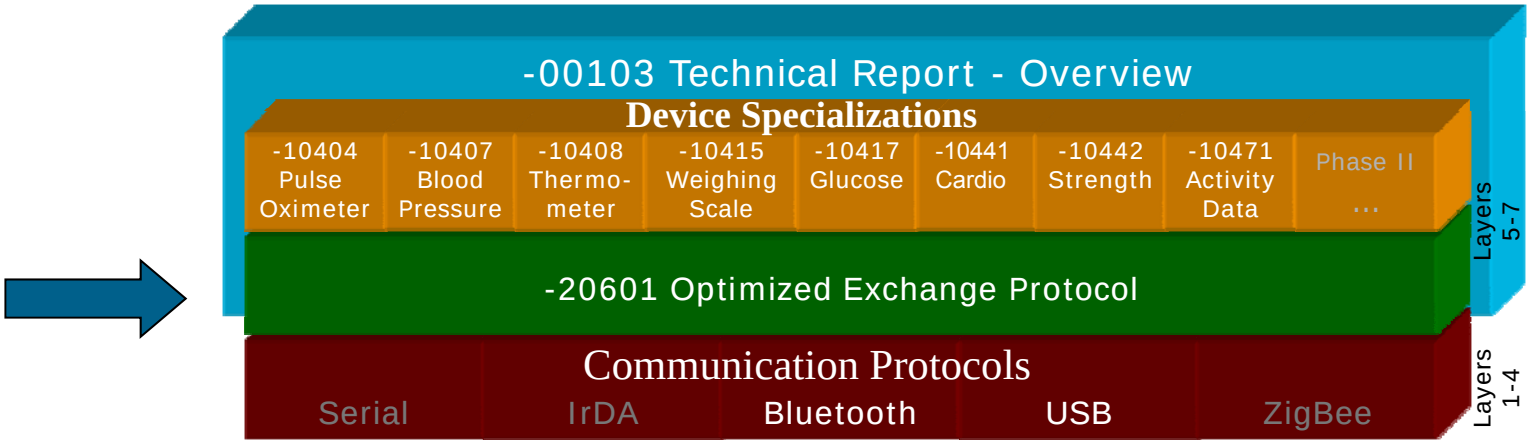
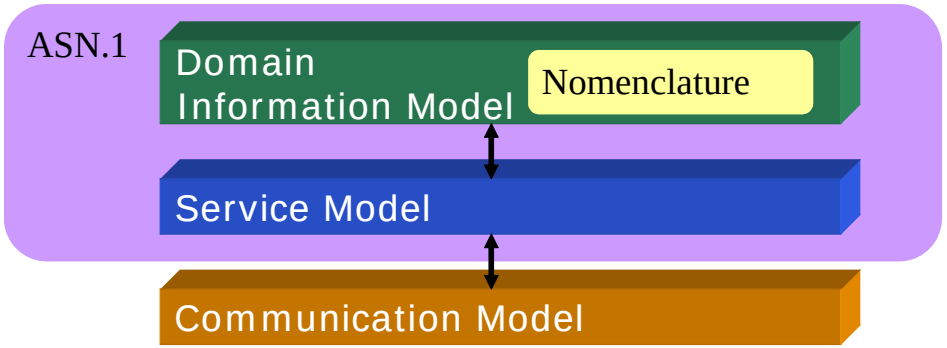
IEEE 11073-20601 Details

- Exchange Protocol
  - Places more burden on managers than agents
  - Supports multiple data types (episodic, streaming, store and forward)
  - Designed to be transport portable (Bluetooth, USB, etc.)
  - Optimizes data exchange
  - Enables efficient reconnections
  - Targets personal health in home and mobile environments



Domain Information Model (DIM)

- Object-oriented model
  - No requirement to implement in object-oriented language
- Generic set of classes created
- Classes define attributes and methods
  - Attribute type defined in ASN.1
  - Objects are tailored using the attributes
- Attributes may be
  - Mandatory, optional, or conditional
  - Static or dynamically changing



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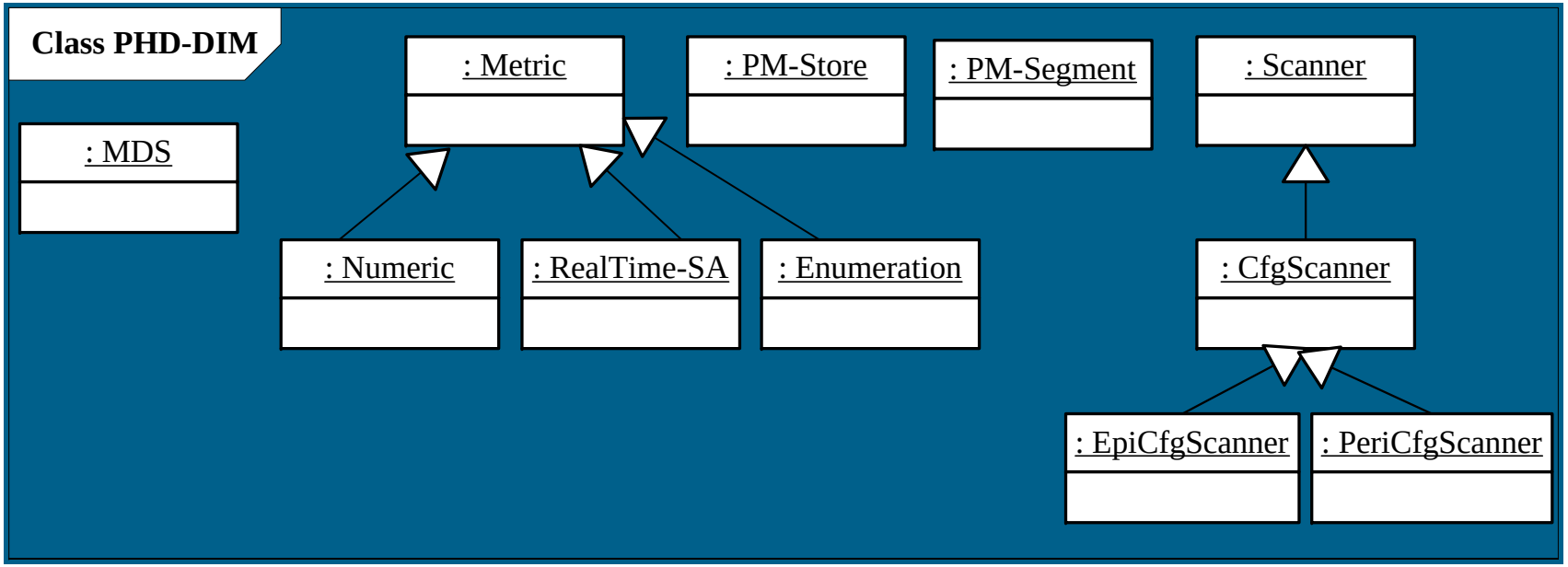
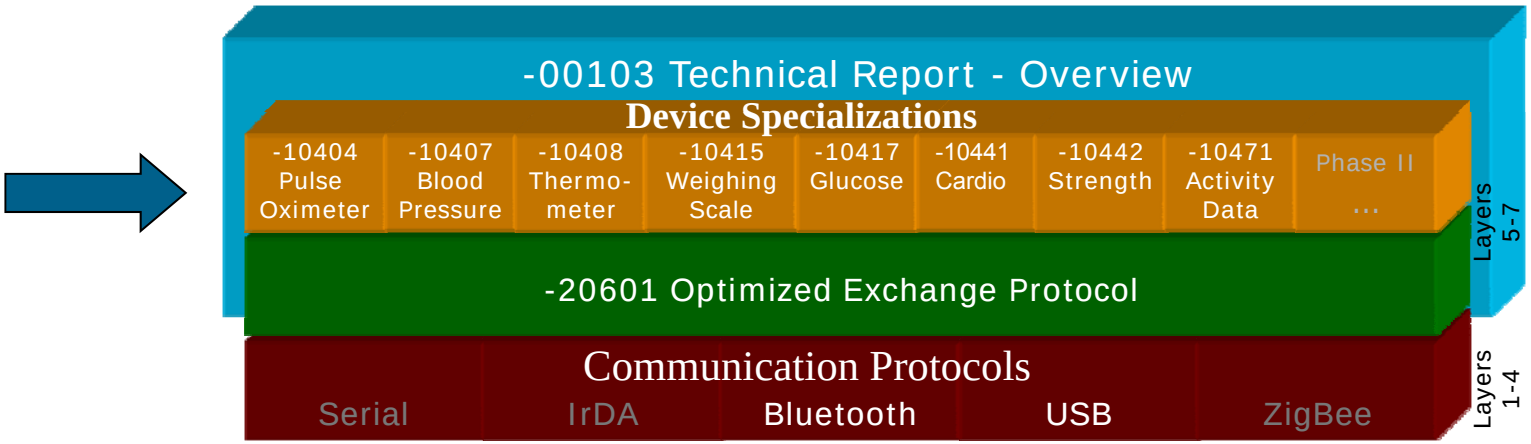
DIM Classes

- Medical Device System (MDS) – represents the device
- Metric – models different forms of measurements
- Persistent Metric Store (PM) – provides mechanism to store data for a period of time
- Scanner – groups and optimizes data transmission



Device Specialization Overview

- Device specializations describe particular usages of -20601
- Narrows definitions to constructs required for type of device
- Increases likelihood of interoperability by defining specific objects, attributes, nomenclature IDs, and services

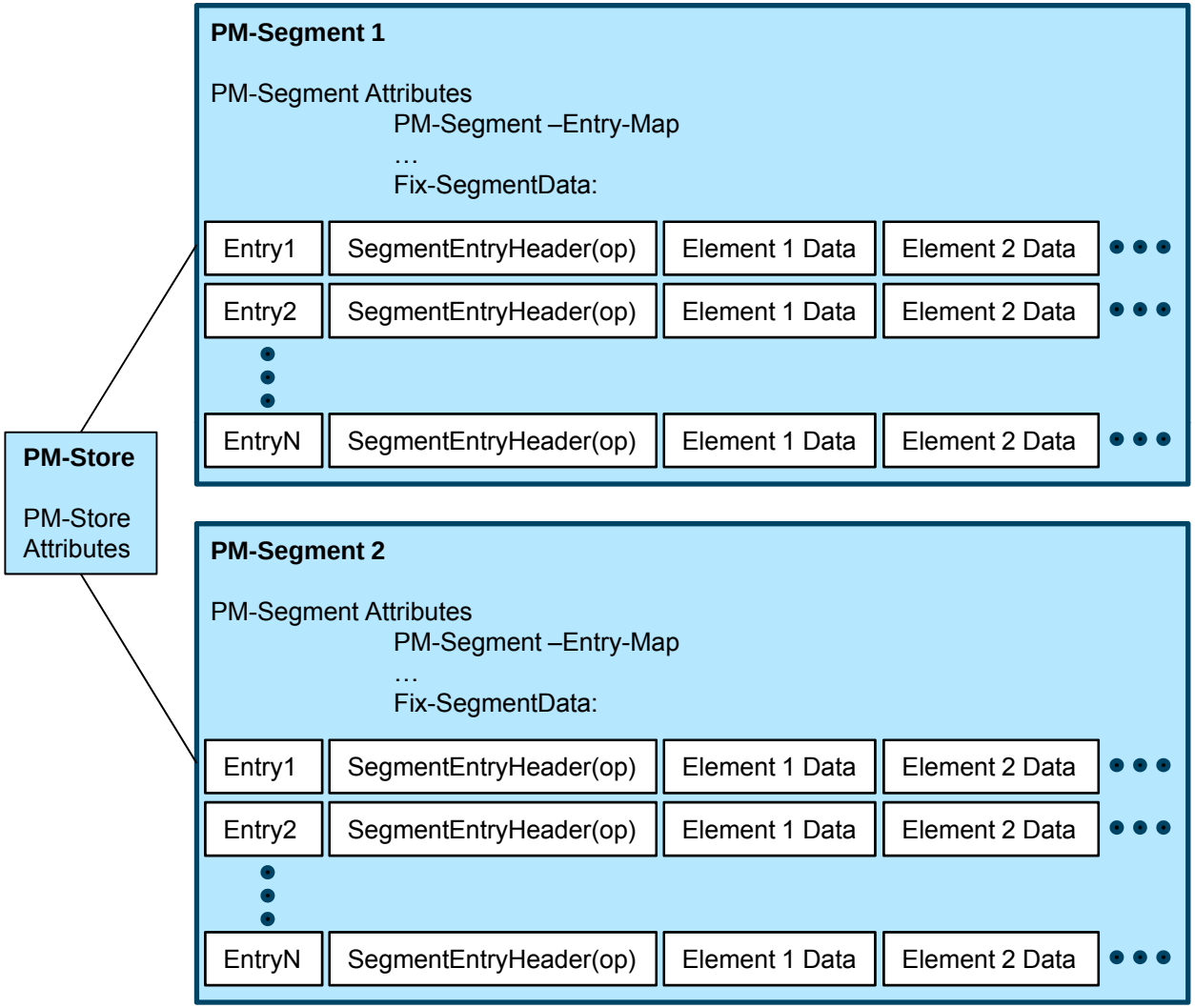


TIL Overview

- Transport Interface Layer (TIL) is software below the IEEE 11073-20601 stack that enables multiple transport layers
  - Like an “IP” layer in that it isolates the application from the different transport semantics
- Provides an interface for both transport consumers (TCI) and transport providers (TPI)
- Abstracts out many transport details allowing application to see single common interface
- Supports TCP, USB, and Bluetooth

PM Store Class

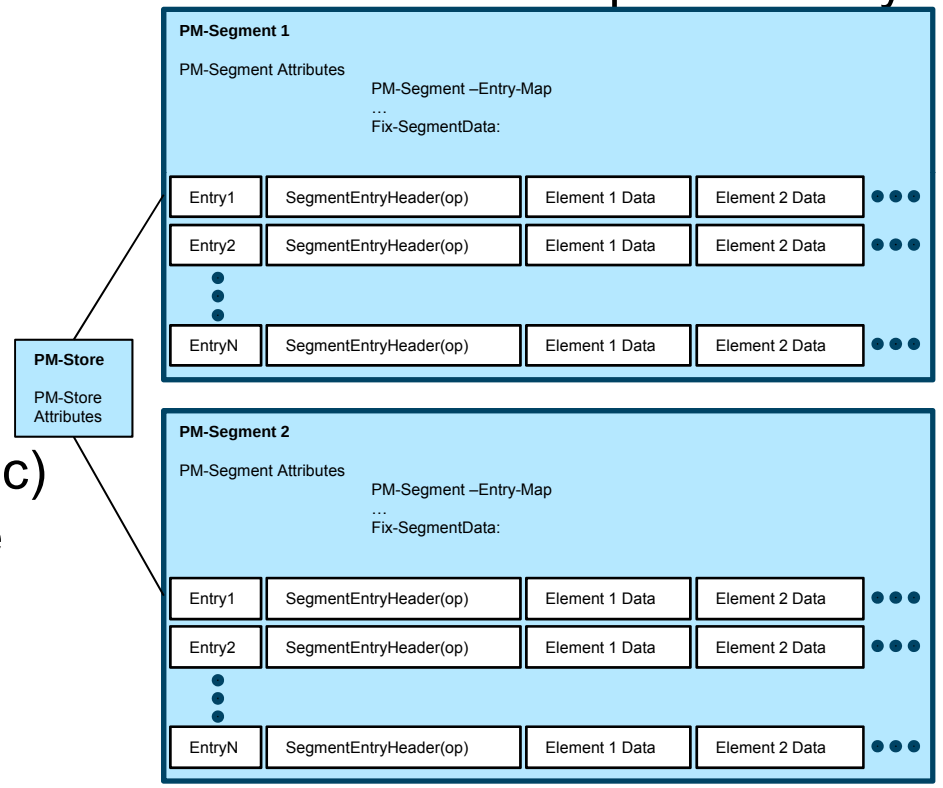
- Used for storing batches of data for later transmission
- May be used in both episodic and streaming cases
- Optimizes data transfer and size by defining the data structures



PM Classes Explained

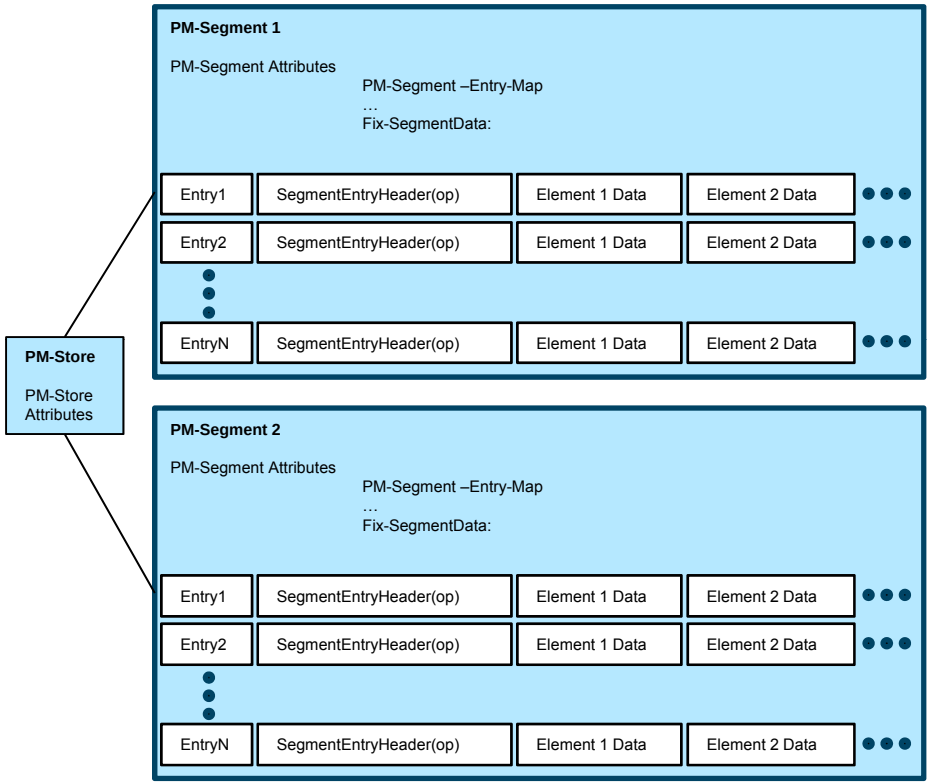
- These classes are hierarchical and allow for a wide range of use.

- Each Element holds data for a metric measurement.
- An Entry is a group of Elements taken at the same time. An optional Entry header is available for Time Stamp
- A PM-Segment is a group of Entries, that share the same format defined by the PM-Segment-Entry-Map attribute
- A PM-Store is a group of PM-Segments and describe common characteristics of their stored data (e.g. periodic or episodic)
- Agents can have multiple PM-Store objects



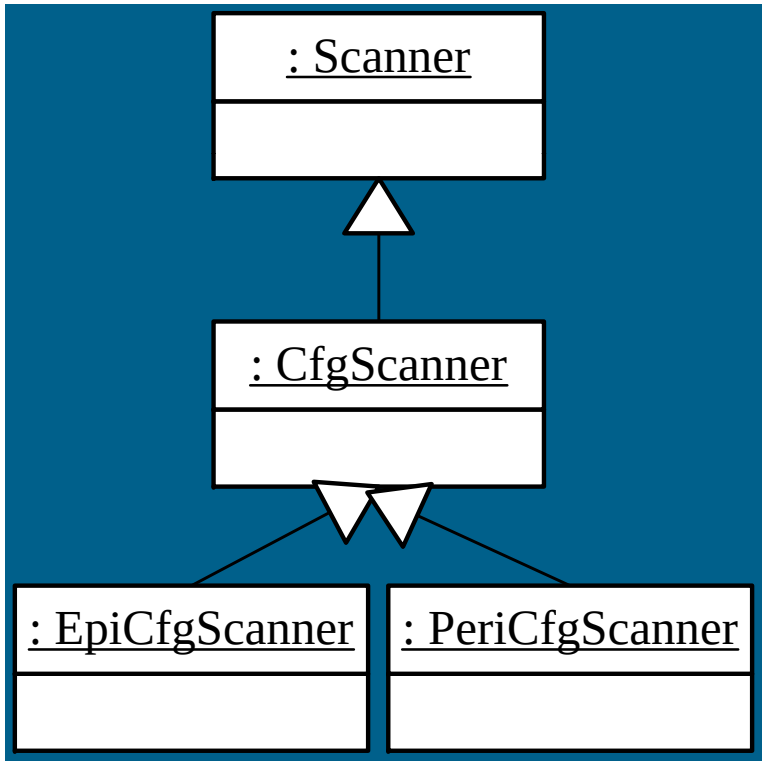
Example using PM Classes

- As an example, think of a wrist watch that acts as a heart rate monitor and pulse oximeter during physical training.
- The watch has 2 PM-Store objects: a periodic and an episodic
- The periodic PM-Store has multiple PM-Segments, one for each training cycle.
- The PM-Segment stores an Entry every second.
- Each Entry has 3 Elements to store the heart rate, running speed, and Sp02 value.



Scanner Class

- Class of objects that scan and group other object data
- EpiCfgScanner - Scans episodic objects (no fixed period)
- PeriCfgScanner - Scans periodic objects using a fixed time interval



Event Reporting Service

- Configuration Event Report
  - Describes a particular configuration
  - Describes all Agent objects
  - Transmits infrequently changing attributes
  - Manager accepts / rejects based on ability to support
- Data Update Event Reports
  - Formats
    - Variable – sends type, length, data
    - Fixed – send the type and length at configuration time
    - Scanner (grouped) – further optimization to remove transmission of handles
  - Support for
    - Single person reporting
    - Multi-person reporting
- PM-Segment Data Event Report
  - Used when transferring PM-Segments to Manager

Continua Alliance Software Package

The Continua Alliance distributes free software libraries to its member companies as part of their **Vendor-Assisted Source Code (VASC)** program.

The distribution consists of:

- Shared software modules for building Continua-compliant devices (host is not supplied → Continua provides host emulator).
- Tools and utilities useful for developing Continua devices.

- The Software is a reference for development, to help speed time-to-market and improve interoperability. It is not final production software.
- The Certification tool to test for Continua certification is based on this software library.
- This software does not ensure Continua Certification. All final product certifications are done by Continua Health Alliance.
- Using this software does not guarantee any regulatory compliance.

Freescale's Medical Connectivity Library already implements Continua-Ready software on the supported families

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Agenda

- Medical Market Solutions
- USB and Continua Alliance
- Software Solutions
- Hardware Offering
- Hands-On and Source Code
- Applications and Demos

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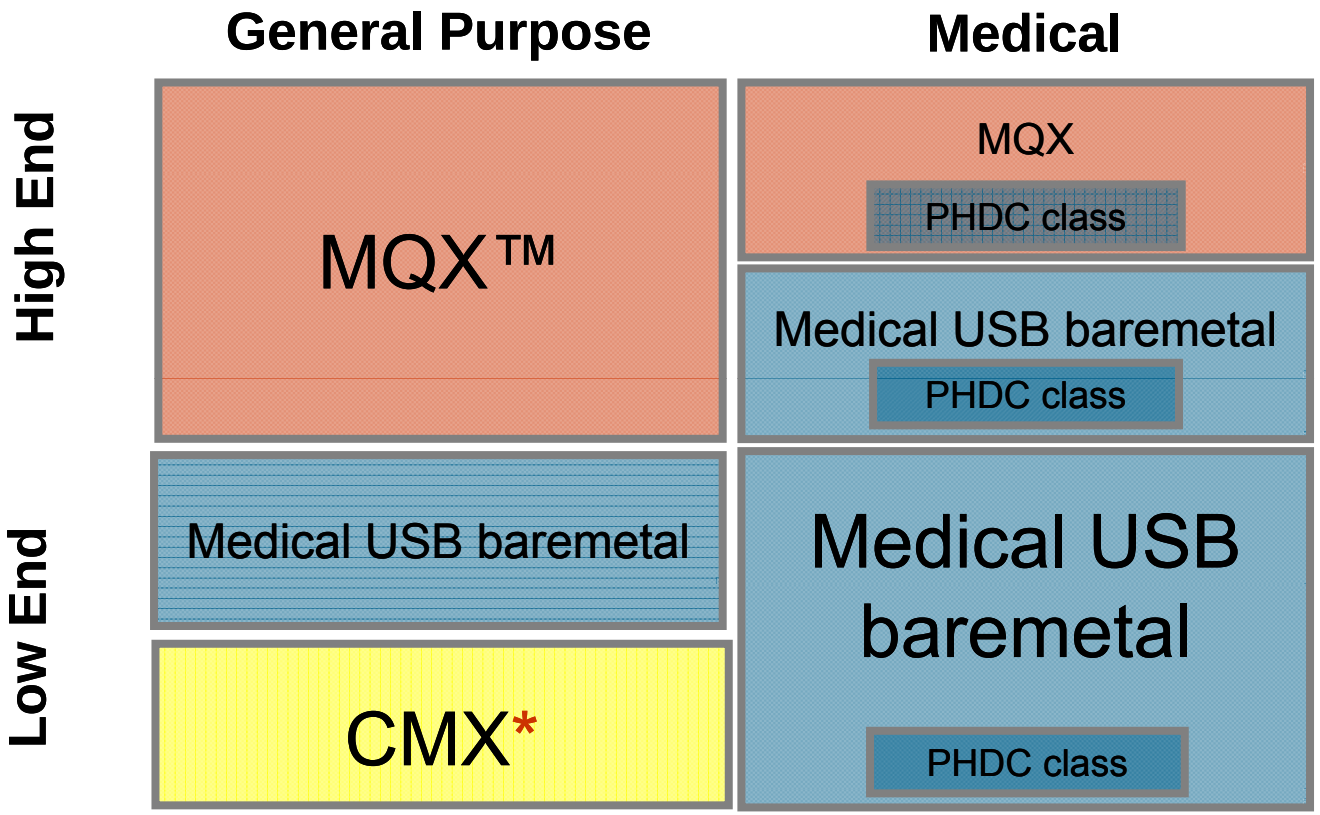
Freescale Microcontroller USB Solutions



* = Freescale third party solution

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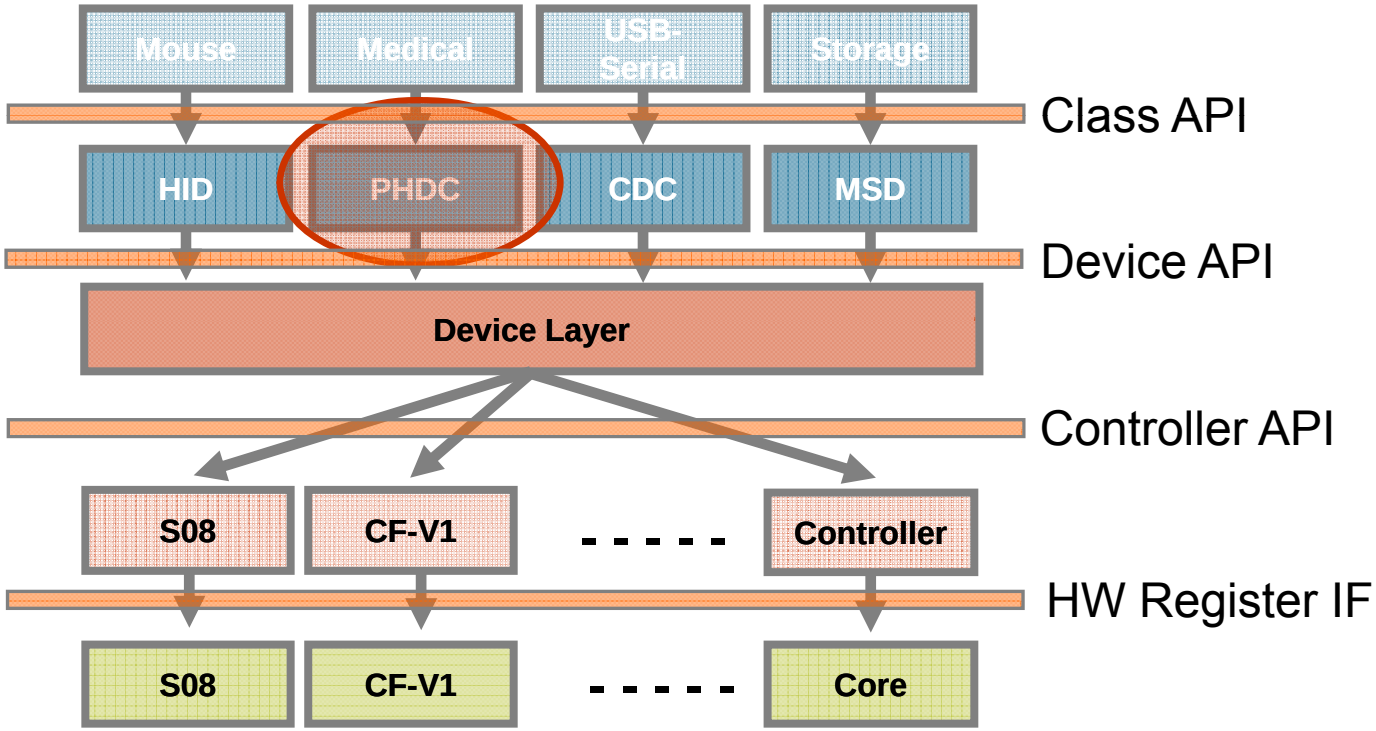
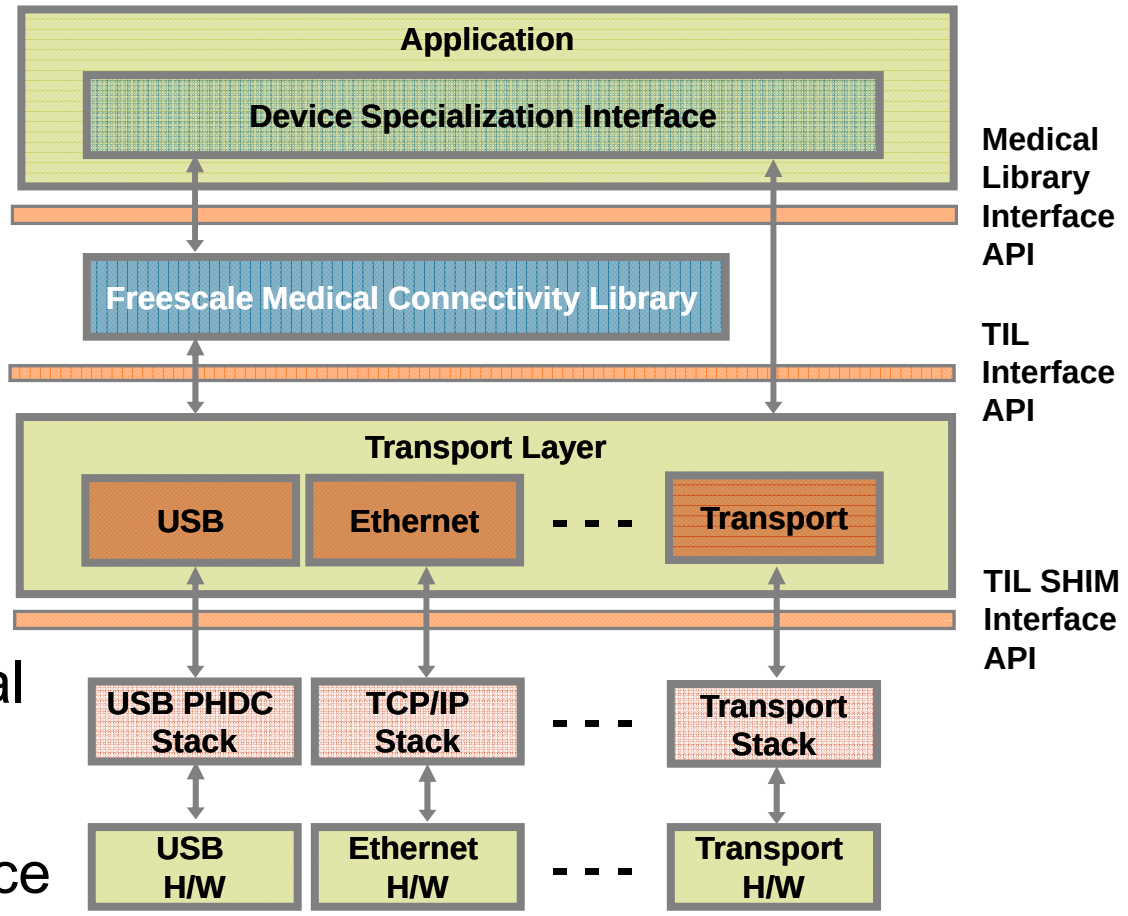
Medical USB Device Stack with PHDC Support

- Easily portable within Flexis portfolio
- Supports double buffering endpoints
- Supports Suspend, Resume and Remote Wake Up
- Flexible Architecture – easy to add more classes, devices and applications
- USB-IF chapter 9 compliant
- Applications can be easily portable to MQX due to similar architecture



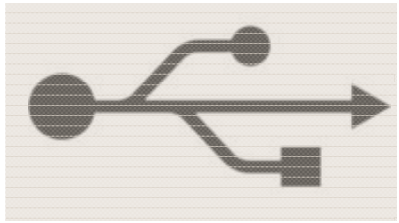
Freescale Medical Connectivity Library

- Installed on top of USB Medical Stack
- Transport Independent; provides TIL to work with other Transport Layers
- Provides IEEE 11073 layers
- Provides APIs for medical agent to associate and send measurements to Application Hosting Device



Freescale Software Key Features

- Guidelines to comply with recognized industry standard
- Continua's PHDC testing environment compatible
- Ensures readiness for Continua certification
- Speed up medical device development
- Allows multi-vendor product connectivity
- Portable and reliable software library
- Wide support within Freescale USB portfolio
- Graphical user interfaces (host emulator supplied by Continua)
- Code examples and documentation
- Existing demos for several medical devices
- Reduced footprint available for MCUs down-to
  16 KBytes Flash and 512 Bytes SRAM
- FREE of charge while using Freescale products



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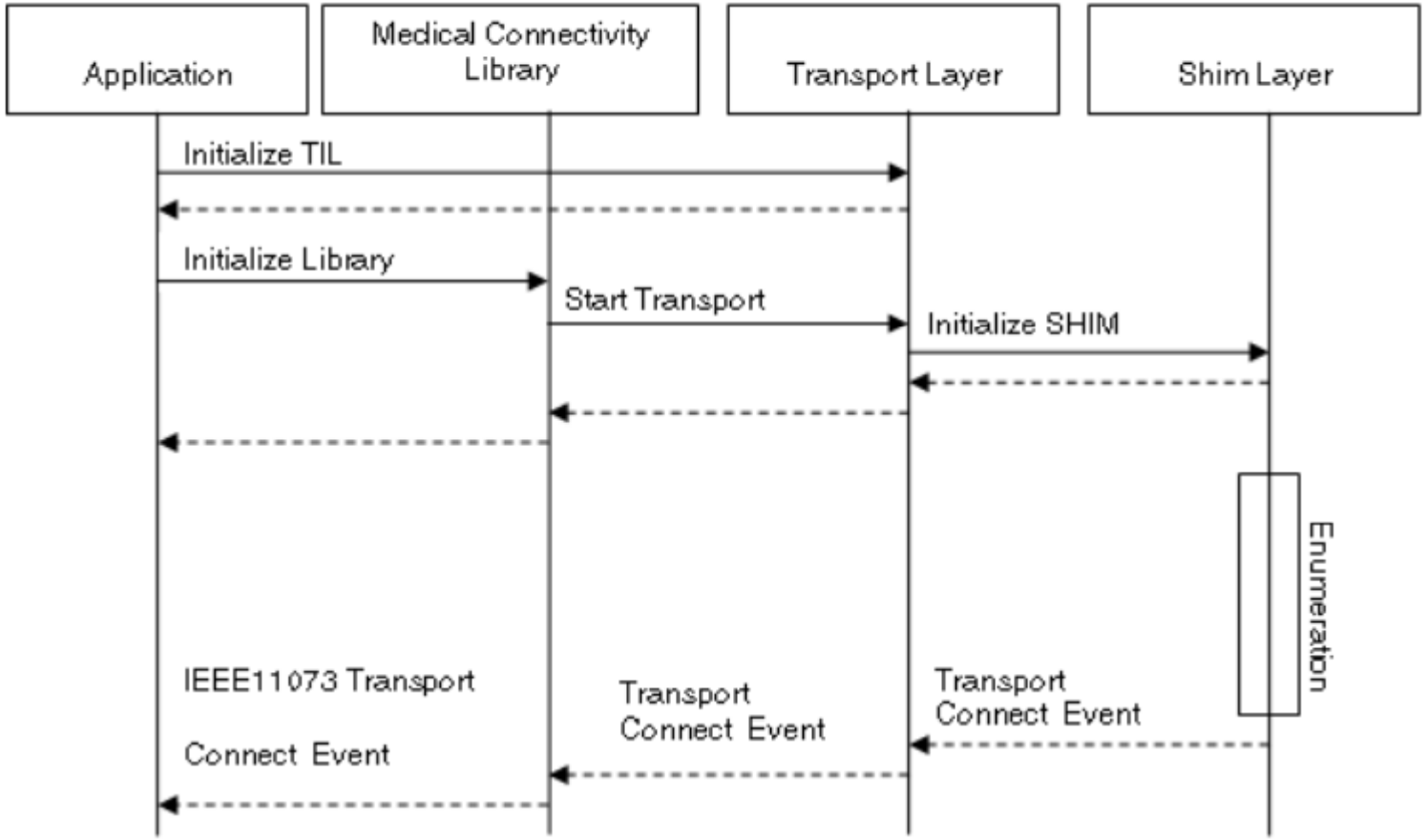
Freescale's Layered Architecture

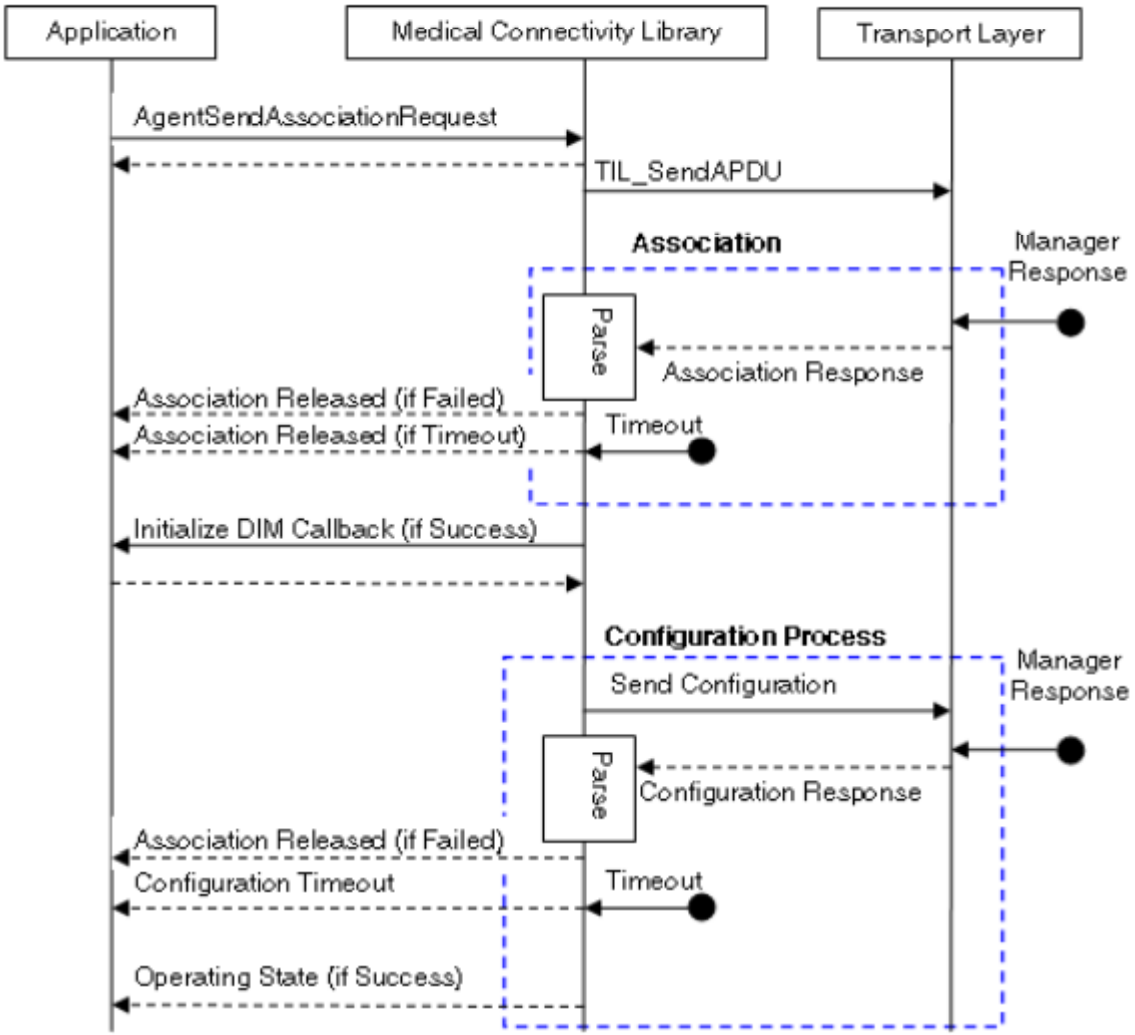
Layer	Component	Description
1 IEEE-11073 Device Specialization Layer	Reference Agent Application	Blood Pressure Glucose Meter Living Hub Pulse Oximeter Thermometer Weight Scale
2	Service Layer	Generic Agent + Manager Commands
3	Association Layer	Agent Module Manager Module
4	Transport Independent Layer	Layer above the various transport layers
5	Transport Shim	Map transport to upper layer
6 USB PHDC	USB PHDC Device Driver	Device side USB PHDC class implementation
7	USB low level driver	Low level driver

- Medical USB Stack – provides Layers 6 & 7
- Medical Connectivity Library – provides Layers 2 – 5
- Application – Layer 1, using Device Specializations from Medical Connectivity Library

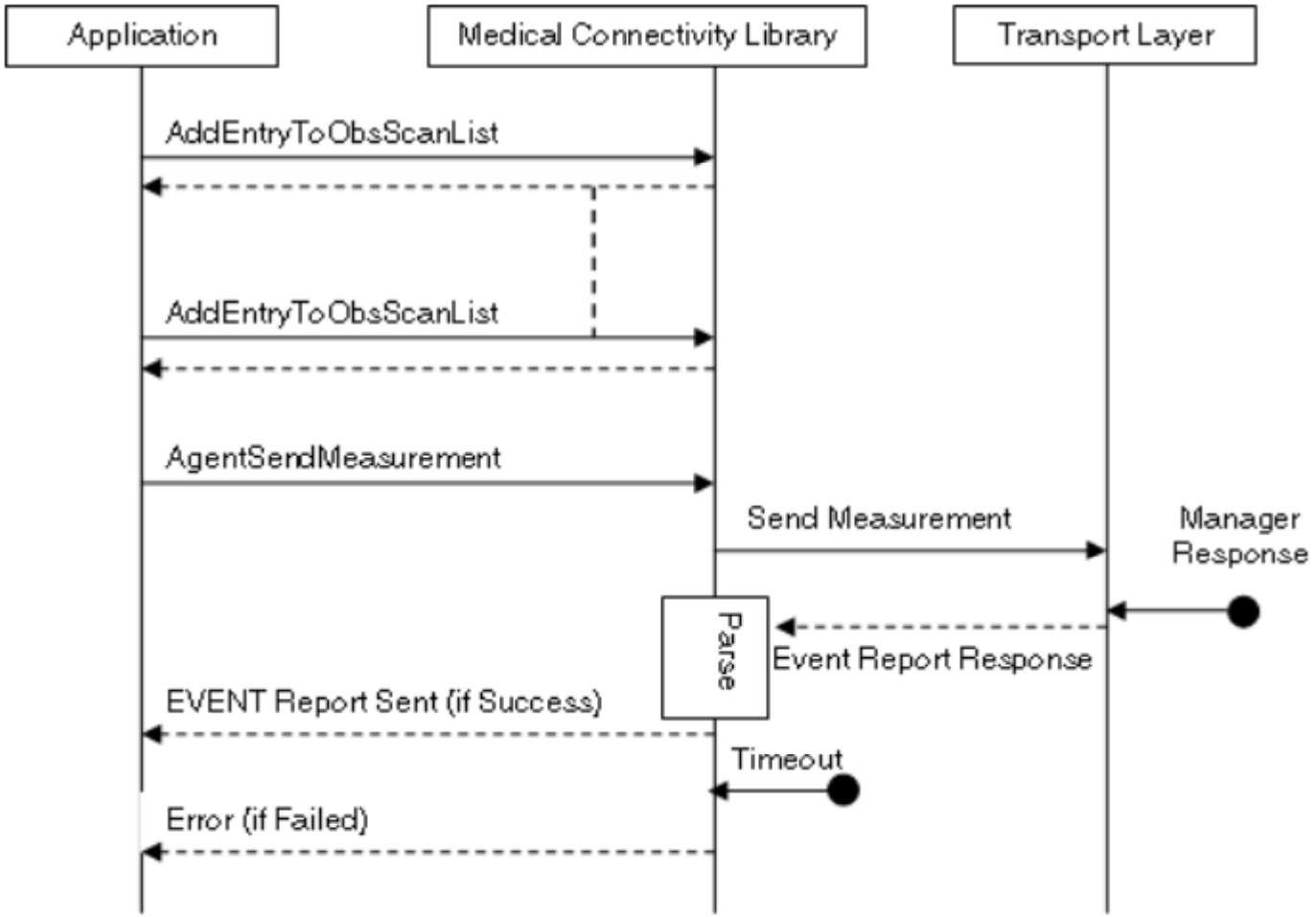
Medical Connectivity Initialization Flow



Medical Connectivity Association Flow



Medical Connectivity Send Measurement



Medical USB Stack Snapshot

What is Continua Health Alliance?

Forum of member companies (+200) that define multi-vendor device interoperability by setting standards for medical systems.

What is PHDC?

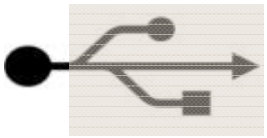
USB.org Personal Health Care Device Class is a standard implementation of USB communication for medical Industry devices

What is IEEE11073?

IEEE 11073 provides structure to your communication interface:
•Defines commands to access data
•Structures data to be transmitted
•Defines communication states

Freescale's Medical USB Stack

Provides first step to standardize medical USB connectivity through a multi-device independent layered USB stack



STANDARDIZATION

Compatible with Personal Health Care Device Class (PHDC), Continua standards and IEEE-11073

CONNECTIVITY

Device compatibility to multi-vendor Continua Ecosystem Topology. Code examples, documentation and host emulator (provided by Continua).

PORTABILITY

Portable 7-layered architecture allows finding the right match for medical devices within multiple Freescale entry-level USB solutions

Agenda

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- Software Solutions
- Hardware Offering
- Hands-On and Source Code
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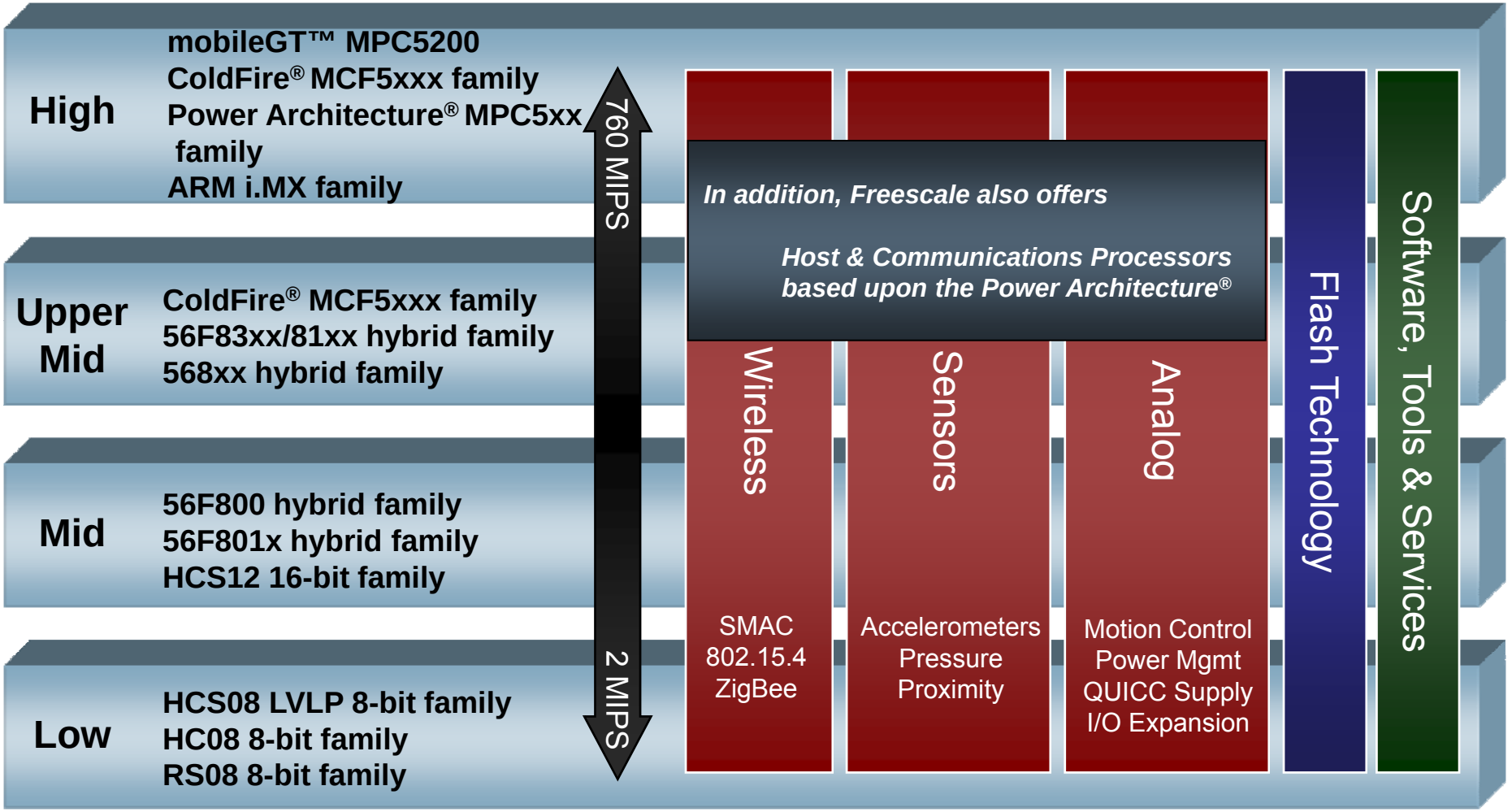
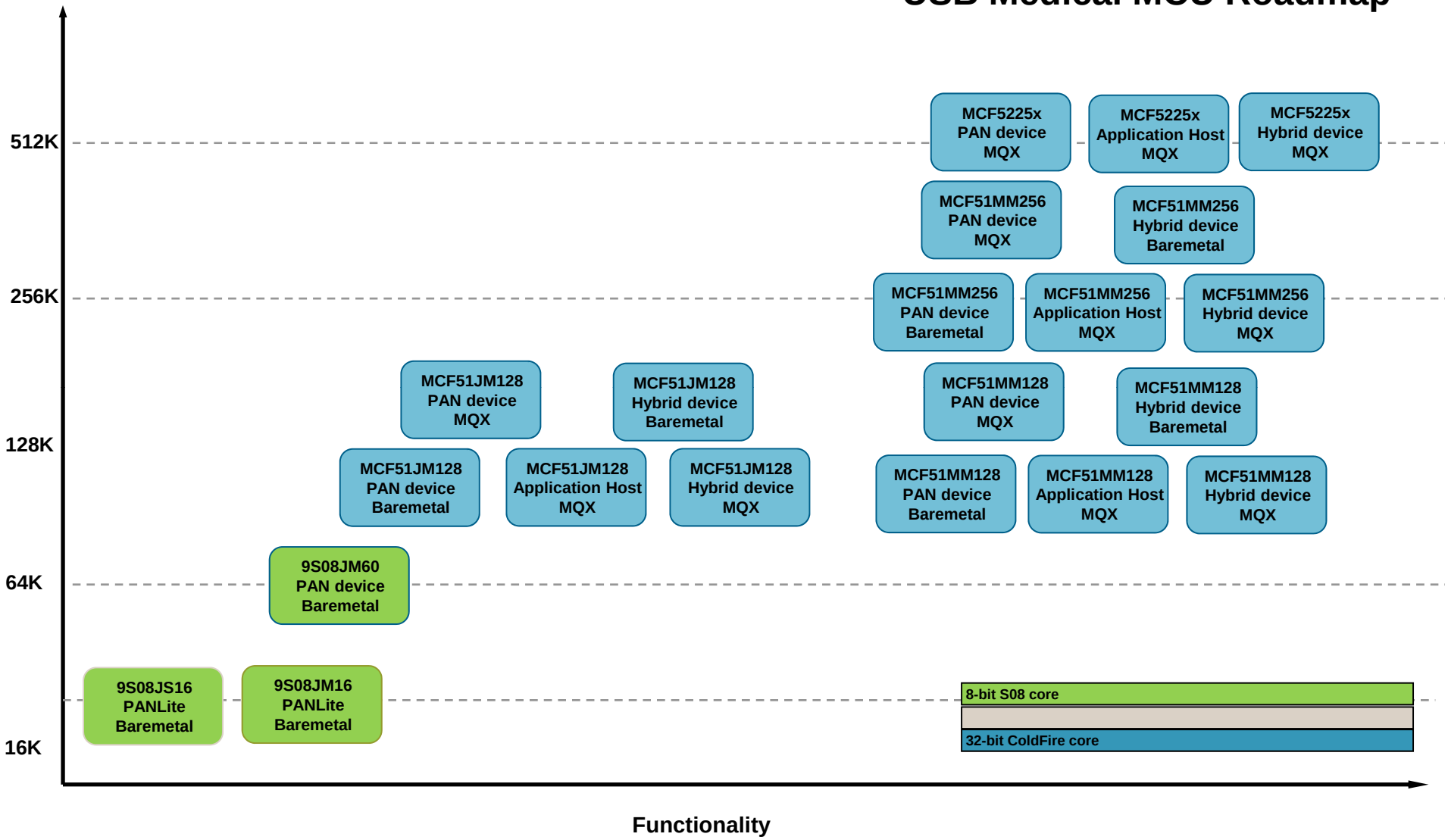
The Freescale Controller Portfolio



USB Medical MCU Roadmap



MCF51MM256

Core and Memory

- 32-bit ColdFire V1 core running up to 50 MHz
- Supports up to 256 KB Flash and 32 KB SRAM

Measurement Engine

- 2 x Trans-impedance amplifiers
- 2 x General Purpose Amplifiers
  - Configurable, Low pass Filters, unity gain buffer, PGA
- 16 bit ADC (Up to 14.5 bits ENOB)
- 12 bit DAC (16 x FIFO word Buffers)
- Voltage Reference
  - 1.17V 40PPM/°C + 8 bits trimmable register
- Programmable Delay Block
- Timing and synchronizing measurement events

Graphics and external memory expansion support

- MiniBus – External Bus Interface

Connectivity Support

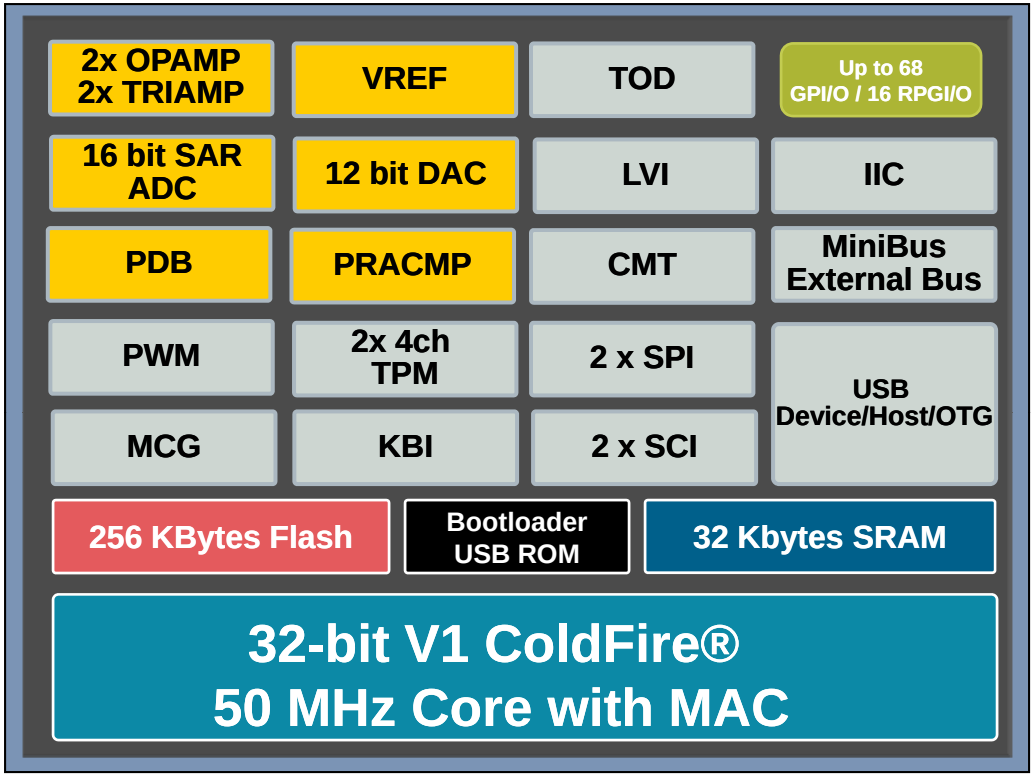
- USB 2.0 / On the Go available on 32bit…..
- 2x SCI
- 2x SPI
- IIC

Low Power

- MCF51MM256 - 650 nA STOP2
- Low power time of date (TOD)

Energy Efficient Solutions by Freescale

Measurement Engine




80-LQFP
12mm x 12mm


81-BGA
10mm x 10mm


100-LQFP
14mm x 14mm


104-BGA
10mm x 10mm

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9S08MM128

Core and Memory

- 8-bit 9S08 core running up to 50 MHz
- Supports up to 128KB Flash and 12 KB SRAM

Measurement Engine

- 2 x Trans-impedance amplifiers
- 2 x General Purpose Amplifiers
  - Configurable, Low pass Filters, unity gain buffer, PGA
- 16 bit ADC (Up to 14.5 bits ENOB)
- 12 bit DAC (16 x FIFO word Buffers)
- Voltage Reference
  - 1.17V 40PPM/°C + 8 bits trimmable register
- Programmable Delay Block
- Timing and synchronizing measurement events

Connectivity Support

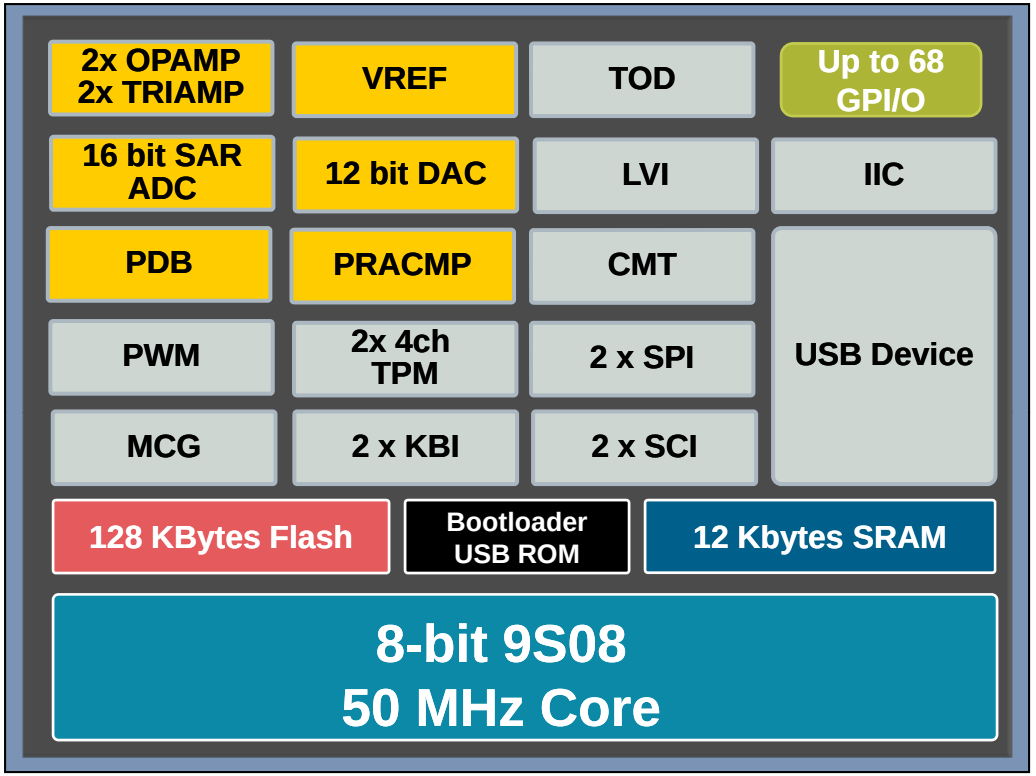
- USB 2.0 / On the Go available on 32bit…..
- 2x SCI
- 2x SPI
- IIC

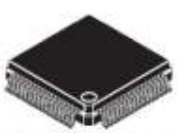
Low Power

- 9S08MM - 480 nA STOP2
- Low power time of date (TOD)

Energy Efficient Solutions by Freescale™

Measurement Engine





64-LQFP Case 840F

80-LQFP Case 917A

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MCF51JE256

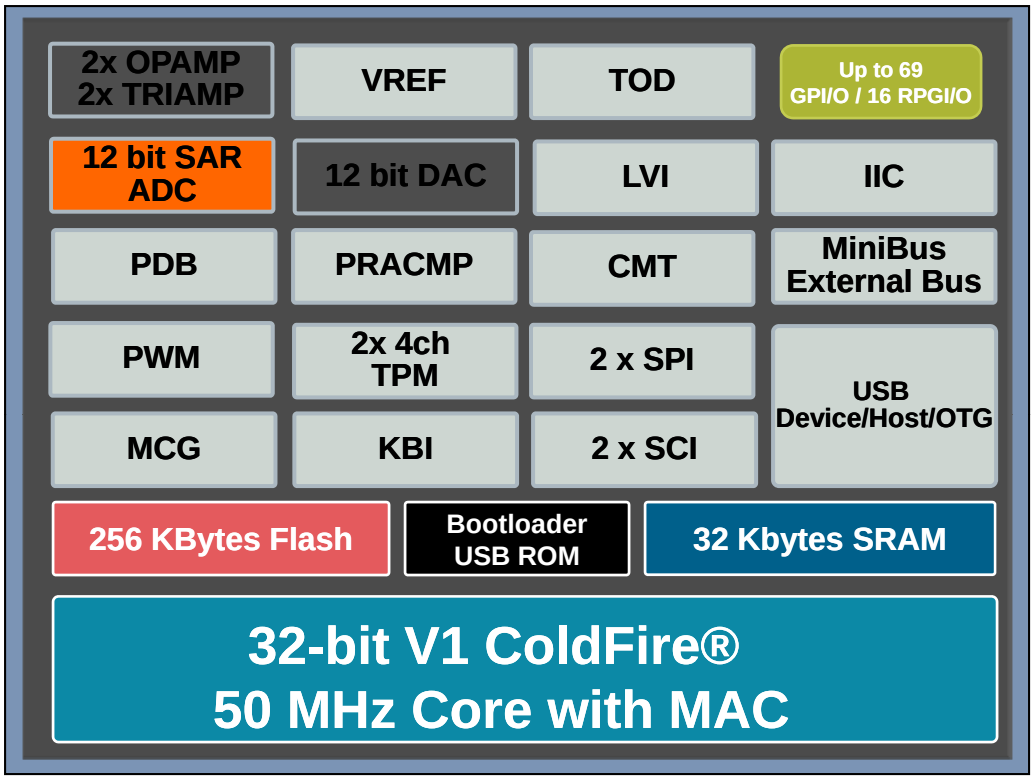
Core and Memory
- 32-bit ColdFire V1 core running up to 50 MHz
- Supports up to 256 KB Flash and 32 KB SRAM

Analog Peripherals
- 12 bit ADC
- Voltage Reference
  - 1.17V 40PPM/°C + 8 bits trimmable register
- Programmable Delay Block
- Timing and synchronizing measurement events

Graphics and external memory expansion support
- MiniBus – External Bus Interface

Connectivity Support
- USB 2.0 / On the Go available on 32bit…..
- 2x SCI
- 2x SPI
- IIC

Low Power
- MCF51JE256 - 650 nA STOP2
- Low power time of date (TOD)



Removed from MM

Changed from MM

Energy Efficient Solutions by Freescale


80-LQFP
12mm x 12mm


81-BGA
10mm x 10mm


100-LQFP
14mm x 14mm


104-BGA
10mm x 10mm

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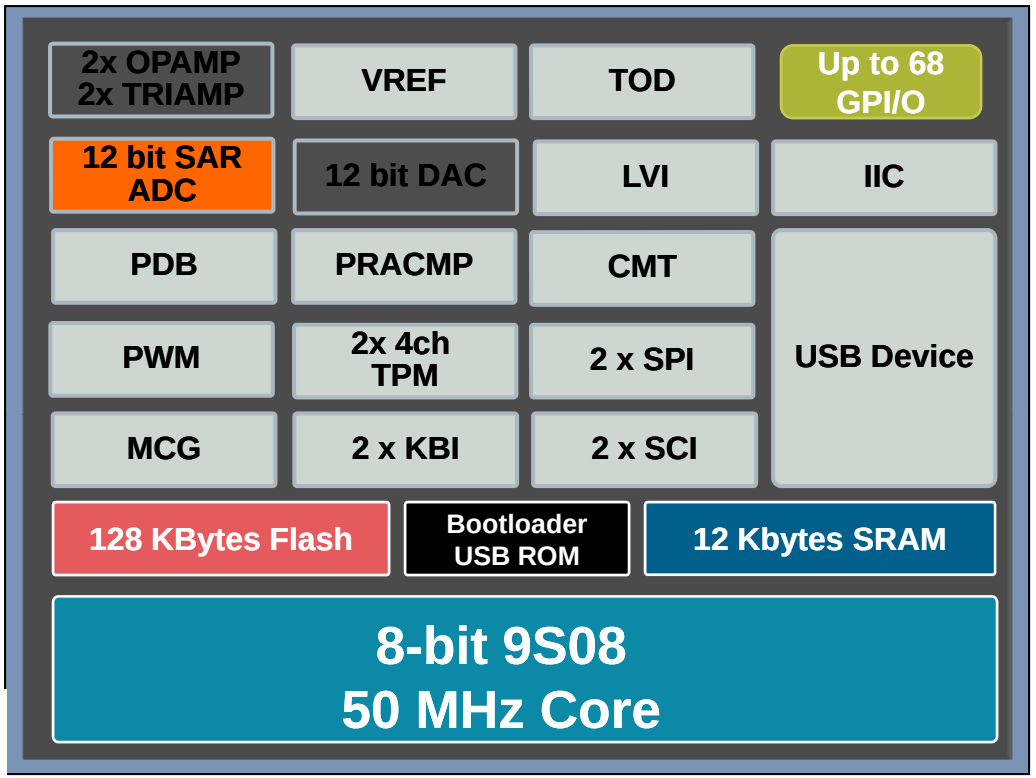
9S08JE128

Core and Memory
- 8-bit 9S08 core running up to 50 MHz
- Supports up to 128KB Flash and 12 KB SRAM

Analog Peripherals
- 12 bit ADC
- Voltage Reference
  - 1.17V 40PPM/°C + 8 bits trimmable register
- Programmable Delay Block
- Timing and synchronizing measurement events

Connectivity Support
- USB 2.0 Device
- 2x SCI
- 2x SPI
- IIC

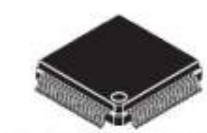
Low Power
- 9S08JE - 480 nA STOP2
- Low power time of date (TOD)



Removed from MM

Changed from MM

Energy Efficient Solutions by Freescale


64-LQFP Case 840F


80-LQFP Case 917A

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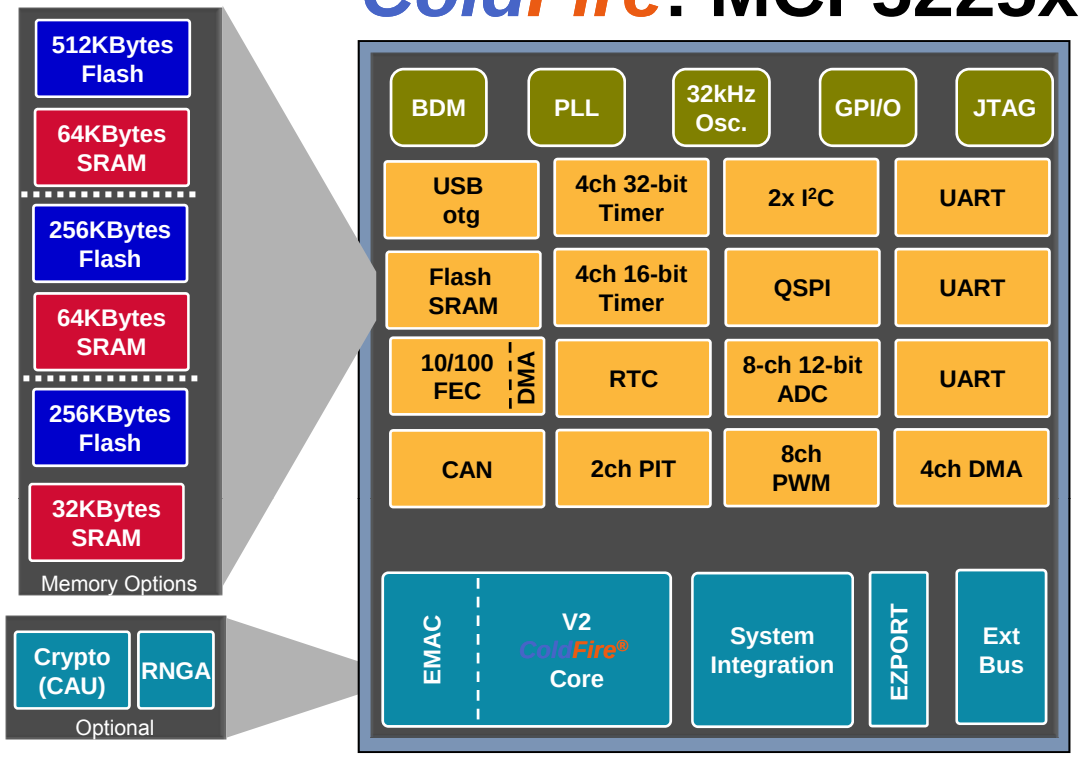
ColdFire: MCF5225x

ColdFire V2 Core

- Up to 76 Dhrystone 2.1 MIPS @ 80 MHz
- EMAC Module and HW Divide
- **Encryption – CAU**
- **Mini-FlexBus**
- Up to 64K bytes SRAM
- **Up to 512K bytes Flash**
  - 100K W/E cycles, 10 years data retention
- **USB 2.0 full-speed Host/Device/On-the-go Controller**
- **CAN – (FlexCAN)**
- **FEC (10/100 Ethernet)**
- 3 UARTs
- Serial Peripheral Interface (Queued SPI)
- Two I²C bus interface modules
- 4 ch. 32-bit timers with DMA support
- 4 ch. 16-Bit Capture/Compare/PWM timers
- 2 ch. Periodic Interrupt Timer
- 8 ch. PWM timer with enhanced DAC capabilities
- 2nd Watchdog timer with independent clock
- Real Time Clock with 32kHz crystal oscillator
- 8 ch. 12-bit A-to-D converter with simultaneous sampling
- Up to 96 General-Purpose I/O
- System Integration (PLL, SW Watchdog)



- Single 3.3V supply
- Temperature Range: -40°C to +85°C
- Available Speeds: 66 and 80MHz
- Available packages: 100 LQFP, 144 LQFP, 144 MAPBGA
- Target Prices start from $4.13 @ 10k qty

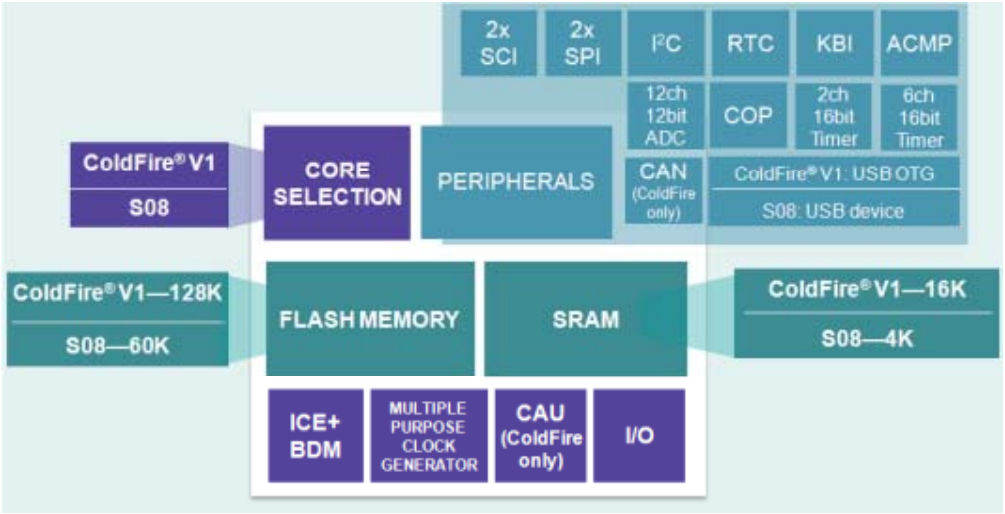
Flexis USB Family
S08JM60 and MCF51JM128

- ***Performance***
- 48 MHz S08 or ColdFire V1 core
- 24 MHz bus frequency
- 2.7V - 5.0V operating range

- ***Memory***
- **S08**
  - Up to 4 KBytes SRAM; up to 60 KB flash
- **ColdFire V1**
  - Up to 16 KBytes SRAM; up to 128 KB flash

- ***Features***
  - 2x SCI, I²C, 2x SPI
  - 8-channel keyboard interrupt (KBI)
  - 16-bit timers: 1x 2-ch, 1x 6-ch
  - 12-bit 12-channel ADC
  - Analog comparator
  - Up to 51 general purpose I/O (GPIO)
  - Multiple purpose clock generation (MCG)
  - PLL
  - On-chip oscillator
  - External crystal support
  - Integrated CAN module (ColdFire V1 only)
  - Cryptographic acceleration unit (ColdFire V1 only)

- ***Complete USB Solution***
  - Integrated USB device (S08) or USB OTG (ColdFire V1)
  - Complimentary USB SW stack
  - CodeWarrior for Microcontrollers with Processor Expert



S08JM60 Packages
64 LQFP, 64 QFP 48 QFN, 44 LQFP

ColdFire JM128 Packages
80 LQFP, 64 LQFP, 64 QFP, 44 LQFP

Temperature Range
-40C to +85C

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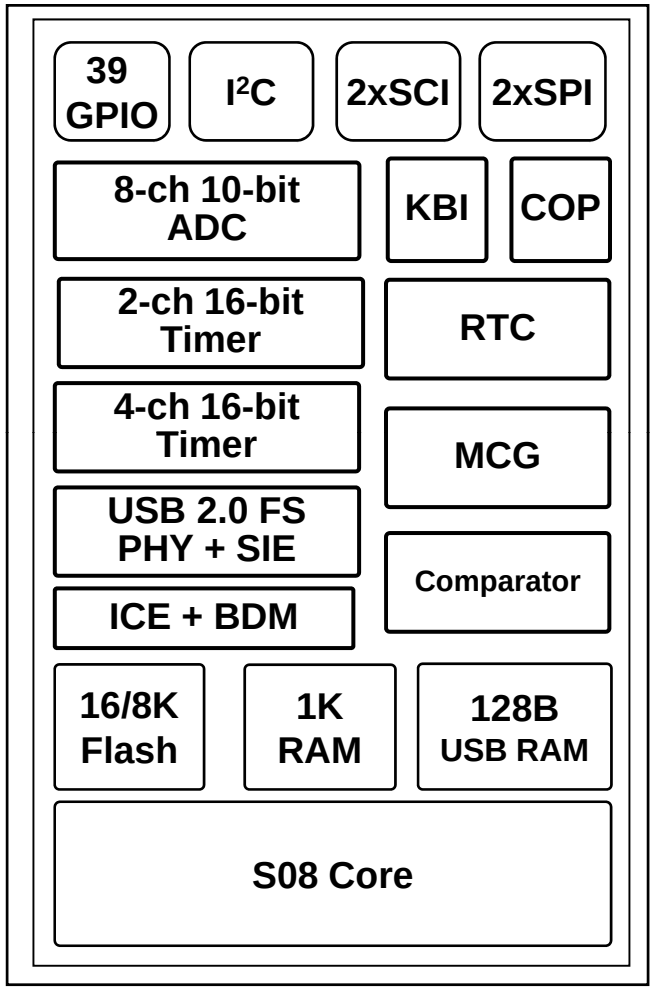
MC9S08JM16/8

- *Features / Benefits*
  - Timers – 1x 2-ch, 1x 6-ch
  - Upgraded SPI configurable for 8-bit or 16-bit data length
  - Analog comparator
  - 8-ch keyboard interrupt (KBI)
  - 8-bit 12-ch ADC
  - LVI
  - 39 (muxed) GPIOs for 48-pin package
  - Integrated USB 2.0 FS PHY and SIE
  - MCG
    - PLL
    - On-chip oscillator
    - External crystal support
  - On-chip ICE and BDM
- *Supply Voltage / Performance*
  - 2.7V - 5.0 V operation
  - -40 to +85°C operation
- *Core*
  - 48 MHz HCS08 core
  - 24 MHz bus frequency
- *Memory*
  - 16K Flash, 1K RAM, 128B USB RAM
- *Communications*
  - SCI, SPI, I^2C w/ broadcast mode feature
- *Packages*
  - 32 LQFP, 44 LQFP, 48 QFN



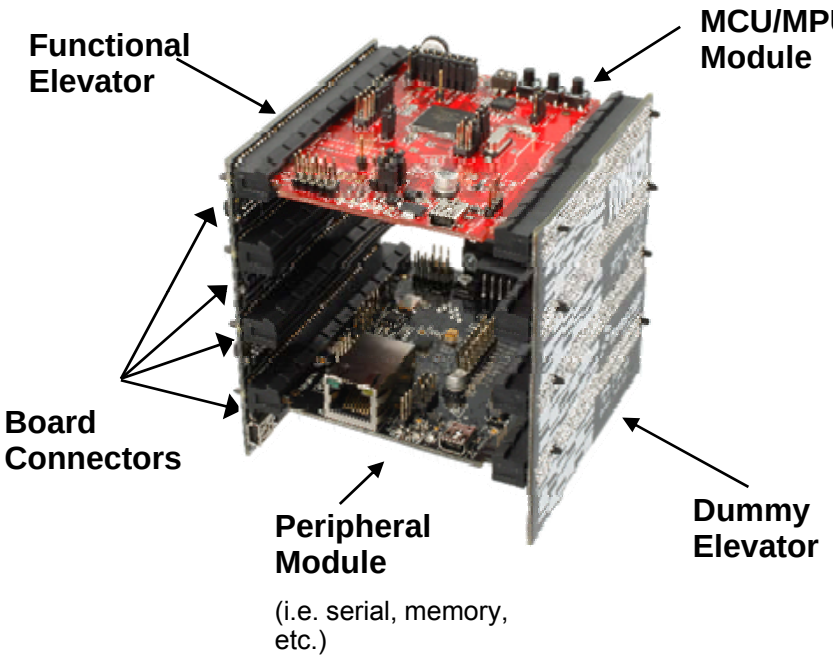
Last updated September 5, 2007

Current Medical USB MCUs
At a glance

		Part Number	Status	Key Features	Package	Speed
Medical USB available implementations	PANLite	9S08JM16	Released	Up to 16 KB Flash and 1 KBytes SRAM 2 x SCI, 2 x SPI, I2C, ACMP	48 QFN 44/32 LQFP	48 MHz
		9S08JS16	Released	Up to 16 KB Flash and 512 Bytes SRAM 1 x SCI, 1 x SPI	20 SOIC 24 QFN	48 MHz
	PAN device	Flexis JM	Released	Up to 128 KB Flash and 16 KB SRAM 2 x SCI, 2 x SPI, 2 x I2C, CAN, Crypto	80 LQFP 64 LQFP 48 QFN 44 LQFP	48 MHz
	PAN device	Flexis MM/JE	Announced	Up to 256 KB Flash and 32 KB SRAM Up to 2xSCI, 2xSPI, I2C, PRACMP, ADC, DAC, Op-Amps	64 LQFP 80 LQFP 100 LQFP 81 MAPBGA 104 MAPBGA	48 MHz
	PAN device/host/ hybrid	MCF5225x	Released	Up to 512 KB Flash and 64 KB SRAM, Ethernet MAC, mini-FlexBus, CAN, 3xSCI, QSPI, 2xI2C, ADC	100 LQFP 144 LQFP 144 MAPBGA	80 MHz

- **PANLite:** Low end Personal Area Network (PAN) USB device
- **PAN device:** Higher integration/functionality in device

Development Board - Tower



- Modular, reconfigurable demonstration and development platform
- Expansion Cards (Story Boards) plug into backplane boards called the Elevator
- Hosts a single MCU/MPU Story as the main control board (9S08MM / MCF51MM)

First three peripheral Story boards already in design:

Medical Applications Story	Memory Story	Graphical LCD Module
Thermometer Weighing Scale Height Measurements BGM BPM EKG HRM Spirometry Pulse Oximeter	• Serial Flash • MRAM • SD Card (for memory and SDIO peripherals) • CompactFlash • Reprogrammable CPLD	• QVGA • Touch Screen • SPI Interface • Memory/Parallel Bus Interface • Audio Buzzer • Bidirectional Joystick

Tools

DEMOJM – $99
Supports 9S08JM60 and MCF51JM128

*Medical USB available now!

DEMO9S08JS16 – $79
Supports 9S08JS16 - $10

M52259DEMOKIT – $99
Supports MCF52259

*Medical USB Available July 2010

M52259EVB – $299
Supports MCF52259

CodeWarrior Development Studio MCU v10.0
Supports 8-bit RS08 and S08, and 32-bit ColdFire Derivatives

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Agenda

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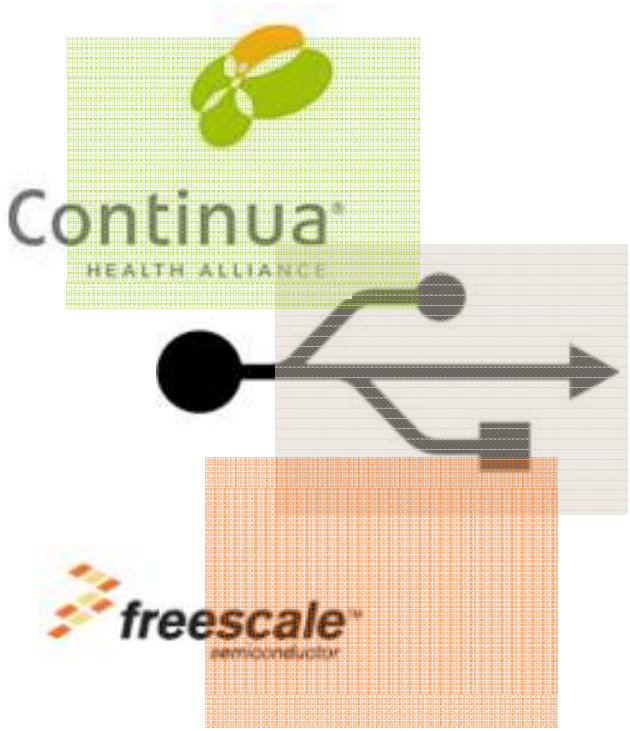
- Software Solutions
- Hardware Offering
- Hands-On and Source Code
- Applications and Demos



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HealthLink software from LNI

Use Cases

1. Medication Adherence Programs
2. Wellness support
3. Professional Remote Monitoring
4. Health Enthusiast

Features

1. Implements Continua PAN, WAN, and HRN interfaces
2. Supports all Continua V1 devices
3. Works with Google Health, Microsoft Health Vault and others (search: Google Health, www.healthvault.com)
4. Supports both Windows and Linux
5. Allows additional electronic health repositories, transports, and non-Continua devices to be supported

Benefits

1. Single platform for deploying multivendor remote health and wellness monitoring solutions
   - Devices: Any V1 device can be deployed
   - Manager: PC based or Mobile
   - Repositories: HealthLink can be customized
2. Supports freedom of choice in personal health repository usage, as well as health device selection.
3. Low cost consumer focused solution
4. Addresses concerns with elderly patient monitoring
5. Powerful provisioning capabilities allows flexible deployment for the professional service provider

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20601 Manager from LNI - OXPlib

Features

1. Hardened Commercial Quality
   - API validated with over 3403 tests
2. Transport Independent Interface
   - Bluetooth, USB, and TCP currently available
   - Zigbee in Q3/Q4
3. Simple High Level Interface
4. Full Featured Manager
   - Supports all V1 devices

Benefits

1. Industry accepted API consistent with CESL
2. Enables rapid development of manager applications
3. Limited ISO/IEEE 11073-20601 knowledge required
4. Allows for additional transports without software updates

Hands-On Lab

- Follow instructions in lab hand-out to do the following:
  - Assemble the Tower with the MM256 MCU card
  - Use CodeWarrior to load the project and program the MCU
  - Run the Agent example and interface with HealthLink

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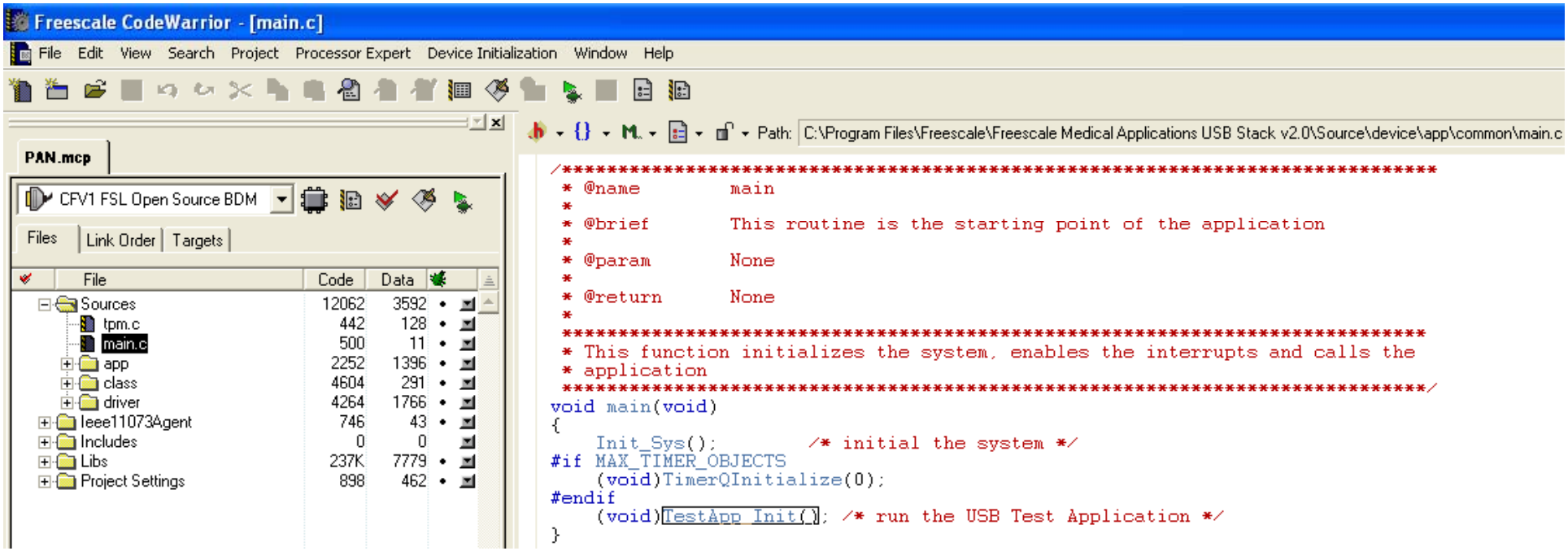
Intro to Using Library and Stack

- This section covers the basics for using the Library and USB Stack by looking at the source code for the USB Agent demo application, and includes:
  - Configure the Medical Connectivity Library and USB stack for the specific application
  - Initialize the Library and Stack at runtime
  - Handle IEEE 11073 Events with Callback function
  - Create/Add data to Scan Lists
  - Send Measurement Data
  - Send PM Segment Data

Main() in Main.c

- Main() already provided by USB Stack in main.c
- Calls TestApp_Init(), which is in Application's source files



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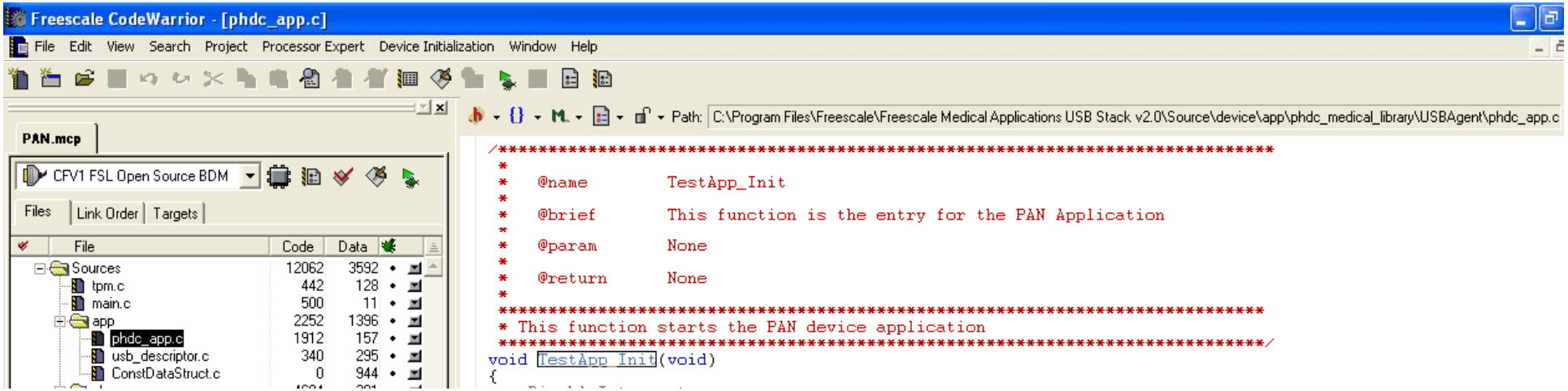
Phdc_app.c

- Phdc_app.c is main source file in USBAgent demo
- TestApp_Init() starts application



Initialize TIL

- TIL_Initialize() – Initializes Transport Interface Layer
- API provided in Medical Connectivity Library
- Takes pointer to structure of SHIM objects

```
void TestApp_Init(void)
{
    DisableInterrupts;
  #if (defined _MCF51MM256_H) || (defined _MCF51JE256_H)
  usb_int_dis();
  #endif
    event_rpt_sent = TRUE;
    gAppBuffer = (intu8*)mempool_malloc(OBSERVATION_SCAN_SIZE);
    gObsPtr[0] = (ObservationScanList*)&gAppBuffer[0];
    gObsPtr[1] = (ObservationScanList*)&gAppBuffer[100];
    gPerObsPtr[0] = (ScanReportPerVarList*)&gAppBuffer[200];
    gPerObsPtr[1] = (ScanReportPerVarList*)&gAppBuffer[300];

  /* Initialize TIL */
  TIL_Initialize((PTIL)&g_Til);
  /* Initialize IEEE11073 and start Transport */
  (void)Ieee11073Initialize((PTIL)&g_Til, SHIMID, MedAppCallback);
```

Initialize IEEE 11073 Layers

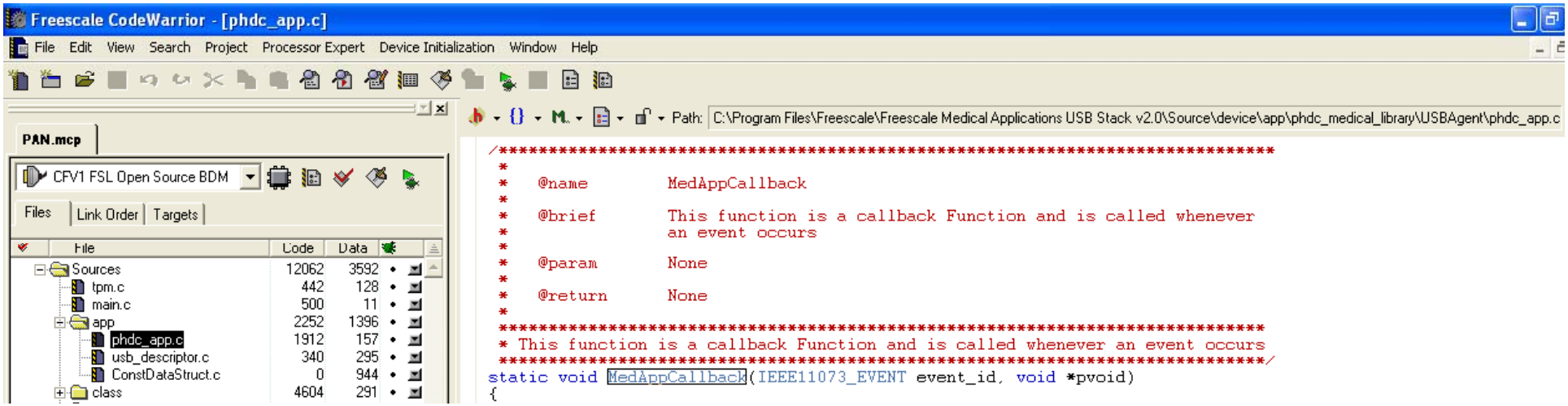
- Ieee11073Initialize() – Initializes Medical Connectivity Library
- API provided in library
- Starts the transport identified by SHIM pointer
- Registers callback function for application

```
void TestApp_Init(void)
{
    DisableInterrupts;
  #if (defined _MCF51MM256_H) || (defined _MCF51JE256_H)
  usb_int_dis();
  #endif
    event_rpt_sent = TRUE;
    gAppBuffer = (intu8*)mempool_malloc(OBSERVATION_SCAN_SIZE);
    gObsPtr[0] = (ObservationScanList*)&gAppBuffer[0];
    gObsPtr[1] = (ObservationScanList*)&gAppBuffer[100];
    gPerObsPtr[0] = (ScanReportPerVarList*)&gAppBuffer[200];
    gPerObsPtr[1] = (ScanReportPerVarList*)&gAppBuffer[300];

  /* Initialize TIL */
  TIL_Initialize((PTIL)&g_Til);
  /* Initialize IEEE11073 and start Transport */
  (void)Ieee11073Initialize((PTIL)&g_Til, SHIMID, MedAppCallback);
```

Application Callback Function

- MedAppCallback() – Application callback provided to Library
- Key method for USB stack and Library to alert and communicate with Application
- When Library calls Callback, IEEE11073_EVENT ID provided



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IEEE11073_EVENT IDs

- Library provides the following IEEE11073_EVENT IDs
  - IEEE11073_TRANSPORT_CONNECT,
  - IEEE11073_TRANSPORT_DISCONNECT,
  - IEEE11073_ASSOCIATION_RELEASING,
  - IEEE11073_ASSOCIATION_RELEASED,
  - IEEE11073_CONFIGURATION_TIMEDOUT,
  - IEEE11073_CONFIG_REJECTED,
  - IEEE11073_ERROR,
  - IEEE11073_REJECT,
  - IEEE11073_ABORT,
  - IEEE11073_OPERATING,
  - IEEE11073_EVNTRPT_SENT,
  - IEEE11073_PERIODIC_SCANNER_EVENT,
  - IEEE11073_CLEAR_PMSEGMENT,
  - IEEE11073_TRIG_PMSEGMENT,
  - IEEE11073_INITIALIZE_DIM,
  - IEEE11073_GET_DATAPROTO,
  - IEEE11073_INITIALIZE_DIM_FAILED,
  - IEEE11073_EVENTRPT_TIMEDOUT

Operating Mode

- App waits for g_send_msr variable to be set
- Callback sets g_send_msr when event ID is IEEE11073_OPERATING
- Once in Operating Mode, App calls Button_Pressed()

```
void TestApp_Init(void)
{
    DisableInterrupts;
  #if (defined _MCF51MM256_H)
  usb_int_dis();
  #endif
    event_rpt_sent = TRUE;
    gAppBuffer = (intu8*)mempo
    gObsPtr[0] = (ObservationS
    gObsPtr[1] = (ObservationS
    gPerObsPtr[0] = (ScanRepor
    gPerObsPtr[1] = (ScanRepor

  /* Initialize TIL */
  TIL_Initialize((PTIL)&g_Til)
  /* Initialize IEEE11073 and
  (void)Ieee11073Initialize((P

    (void)memset(gAppBuffer, 0

    EnableInterrupts;
  #if (defined _MCF51MM256_H)
  usb_int_en();
  #endif

    while(TRUE)
    {
        __RESET_WATCHDOG();
        if(g_send_msr == TRUE)
        {
            /* When Device is
               check for any B
            Button_Pressed();
        }
```


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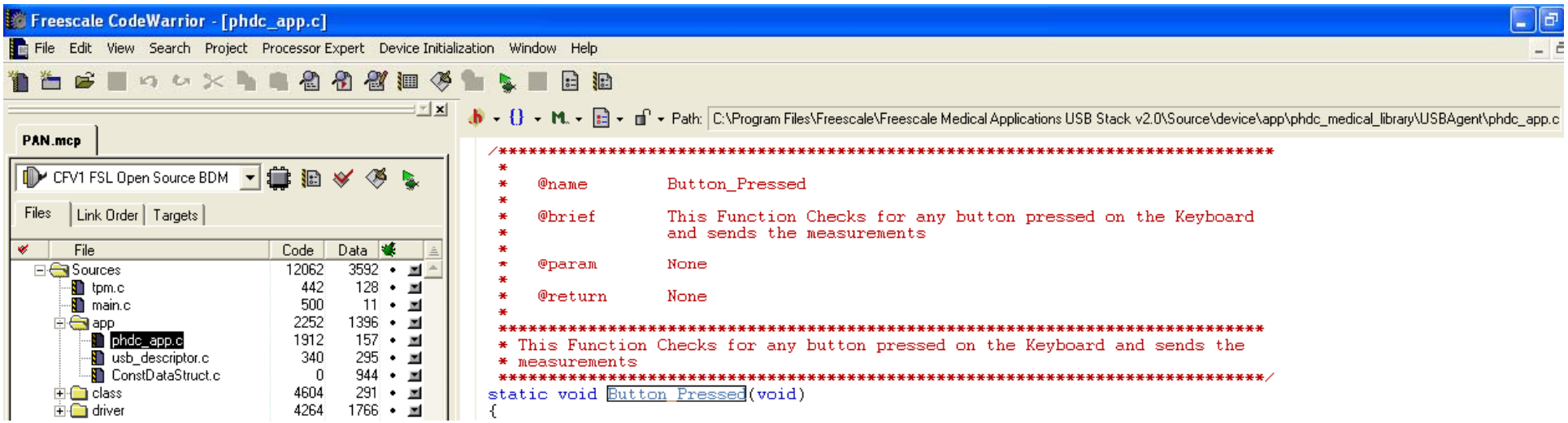
Button_Pressed()

- Demo uses Button_Pressed() to monitor buttons on demo board
- Updates Scan lists and Sends corresponding messages
- Take a closer look at case SEND_BPM_MSR, when button is pressed to send Blood Pressure Measurement



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Blood Pressure Measurement

- Once Demo updates report (next slide), Demo sends measurement

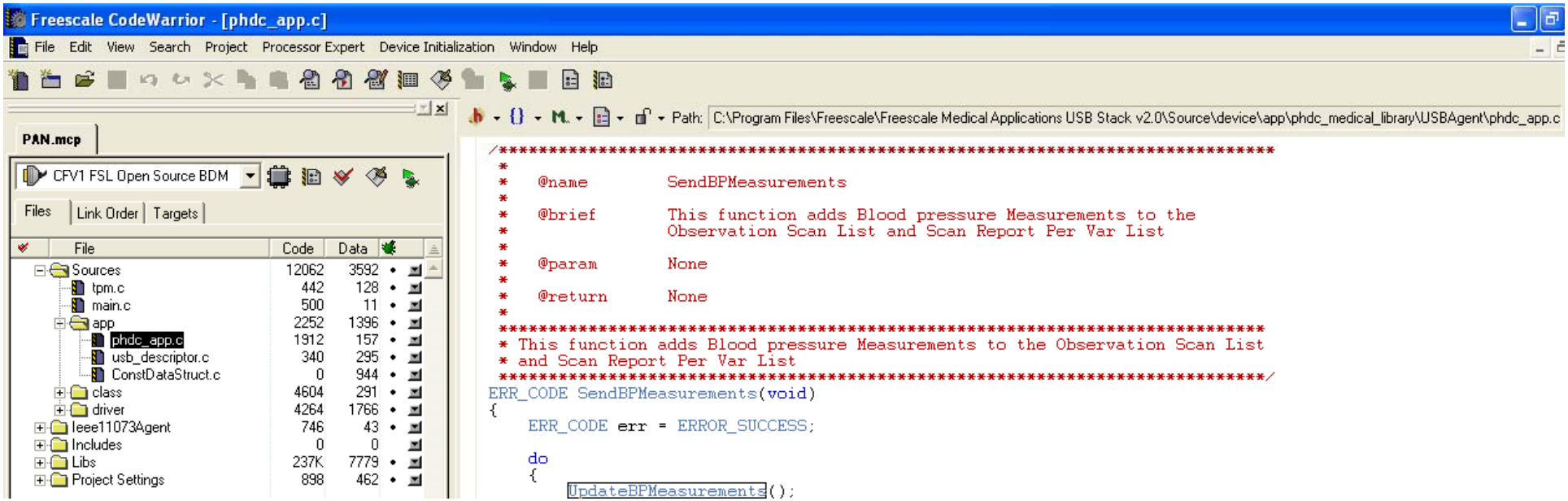
- AgentSendPersonMeasurements() – Library API
  - Sends multi-person measurements to Manager

```
case SEND_BPM_MSR : /* PTG1 is pressed */
{
    if(event_rpt_sent)
    {
        err = SendBPMeasurements();
        if(ERROR_SUCCESS != err)
        {
            break;
        }
        event_rpt_sent = FALSE;
        /* Send Multi Person Variable Format Event Report */
        err = AgentSendPersonMeasurements(
            (ScanReportPerVarList* (*)[])gPerObsPtr, 0,
            SCAN_REPORT_MP_VAR, 1, TRUE);
        if(ERROR_SUCCESS != err)
        {
            /* If any error, clear memory */
            event_rpt_sent = TRUE;
            (void)memset(gAppBuffer, 0x00, OBSERVATION_SCAN_SIZE);
        }
    }
}
break;
```

SendBPMeasurements()

- Demo's function for virtually generating BP Measurements and preparing scan list

- UpdateBPMeasurements() is used by Demo to virtually generate BP Measurements



SendBPMeasurements()

- AddEntryToObsScanList()
  - API from Library
  - Creates or Adds entry to Observation Scan List
  - Used before AgentSendMeasurements()
- AddEntryToScanRptPerVarList()
  - API from Library
  - Adds entry to variable scan report
  - Used before AgentSendPersonMeasurements()

```
ERR_CODE SendBPMeasurements(void)
{
    ERR_CODE err = ERROR_SUCCESS;

    do
    {
        UpdateBPMeasurements();
        /* Add Blood Pressure Measurements to Observation Scan List */
        if(ERROR_SUCCESS != (err = AddEntryToObsScanList(1,
            MDC_ATTR_NU_CMPD_VAL_OBS_BASIC, 10, (void*)&BloodPressure[0],
            (ObservationScanList*)gAppBuffer)))
        {
            break;
        }
        UpdateTime();
        /* Add Absolute Time Stamp to Observation Scan List*/
        if(ERROR_SUCCESS != (err = AddEntryToObsScanList(1,
            MDC_ATTR_TIME_STAMP_ABS, 8, (void*)&time[0],
            (ObservationScanList*)gAppBuffer)))
        {
            break;
        }
        UpdateBPMeasurements();
        /* Add Blood Pressure Measurements to Observation Scan List */
        if(ERROR_SUCCESS != (err = AddEntryToObsScanList(1,
            MDC_ATTR_NU_CMPD_VAL_OBS_BASIC, 10, (void*)&BloodPressure[0],
            (ObservationScanList*)&gAppBuffer[100])))
        {
            break;
        }
        UpdateTime();
        /* Add Absolute Time Stamp to Observation Scan List*/
        if(ERROR_SUCCESS != (err = AddEntryToObsScanList(1,
            MDC_ATTR_TIME_STAMP_ABS, 8, (void*)&time[0],
            (ObservationScanList*)&gAppBuffer[100])))
        {
            break;
        }
        UpdateBPMeasurements();
        /* Add Blood Pressure Measurements to Observation Scan List */
        if(ERROR_SUCCESS != (err = AddEntryToScanRptPerVarList(1, 1,
            MDC_ATTR_NU_CMPD_VAL_OBS_BASIC, 10, (void*)&BloodPressure[0],
            (ScanReportPerVarList*)&gAppBuffer[200])))
        {
            break;
        }
```

Sending PM Segment Data

- Back to TestApp_Init() in phdc_app.c
- SendSegmentData() – Library API
  - Sends PM Segment data to Shim Layer
  - Library sends PM segment data event to Manager

```
        /* Segment Data Transfer Triggered */
        if(g_send_PmSegmData == TRUE)
        {
#ifdef MDS_PMSTORE
            SegmentDataEvent *pSegm = (SegmentDataEvent *)g_SegmDataEvent;
            pSegm->segm_data_event_descr.segm_instance = ieee_ntohs(g_PmSegmDataXfer.SegInstNum);
            /* Send Segment Data */
            (void)SendSegmentData((SegmentDataEvent*)&g_SegmDataEvent, g_PmSegmDataXfer.Handle);
#endif
            /* Clear Segment Data Flag */
            g_send_PmSegmData = FALSE;
        }
```

ConstDataStruct.c

- Contains all Association and Configuration information for Library
- Defines classes, attributes, and configurations including:
  - Device Configuration
  - MDS Metric Class
  - MDS Numeric Class
  - MDS RTSA Object Class
  - MDS Scanner Classes
  - PM Segment configurations
  - PM Store Object Class
- To learn more, read the following specifications:
  - IEEE 11073-20601
  - MEDCONLIBUG – Freescale Medical Connectivity Library User Guide
- In summary, templates already provided for ease of use
  - Once Specifications and Application are understood, ConstDataStruct.c can be modified for Application

usb_descriptor.c

- Provides Descriptors and Functions for USB Enumeration
  - Part of USB Stack
- Functions do not need to be modified
  - Already written for proper USB enumeration
  - Can be altered if desired for Application
- Descriptors should be modified for specific Application, including:
  - VID and PID for USB driver
  - Application descriptor Strings, like company and product name
- Refer to the following for more information:
  - USB Specifications - http://www.usb.org
  - MEDUSBUG – Freescale Medical USB Stack User Guide

Agenda

- Medical Market Solutions
- USB and Continua Alliance
- Software Solutions
- Hardware Offering
- Hands-On and Source Code
- Applications and Demos

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Demo: Intelligent Hospital

- An acquisition system to assess the health of a person in a determined time
- Allows the user to acquire the following vital signs from medical devices and perform basic medical tests

- Monitoring System
  - Allows doctor to access the data needed from patient
  - Can also be used from the home – communication between doctor and patient without a trip to doctor's office. Medical control from the home.

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Intelligent Hospital Demo - Freescale Products

MCUs/MPUs

LL/LH/JM (Medical Device)

MCF5227 (Medical Devices)

Flexis MM (Medical Devices)

i.MX35 (Monitoring System)

Wireless

MC13224: Zigbee Healthcare Profile (Medical Devices, Monitoring System)

Intelligent Hospital Demo

Software Enablement

Touchscreen

USB Personal Healthcare Profile

IEEE 11073 Medical SW suite

Sensors

Single input and differential pressure sensors (Medical Devices)

Demo: i.MX51 with Continua Linux Application Hosting Device

- i.MX51 Development Platform
- Lamprey Networks Inc. (LNI) specialize in software certification
  - HealthLink Application Hosting Device (AHD)
  - Ported to i.MX51
- AHD communicating to a Nonin Pulse Oximeter
  - Continua Certified using USB
  - Uses Freescale S08 MCU
- Manage data on Internet in Google Health or Microsoft HealthVault

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Demo: Chumby Portable Medical Demo

- Chumby One Wi-Fi Connected Internet Device
  - ZigBee module added by Freescale to Chumby One device
  - Chumby developed “Health Tracker” widget which allows consumers to measure, record and review weight and resting blood pressure/pulse
- A&D Medical Weight Scale and Blood Pressure Monitor
  - Personal healthcare devices (prototypes) enabled with ZigBee wireless technology
  - Connects to the Chumby One to allow monitoring

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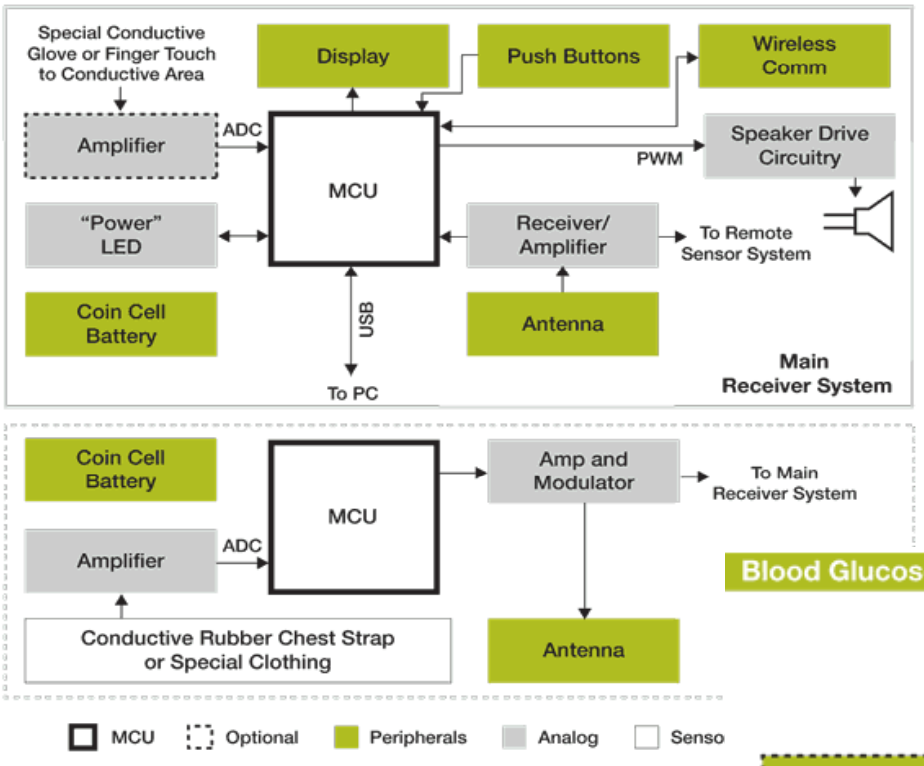
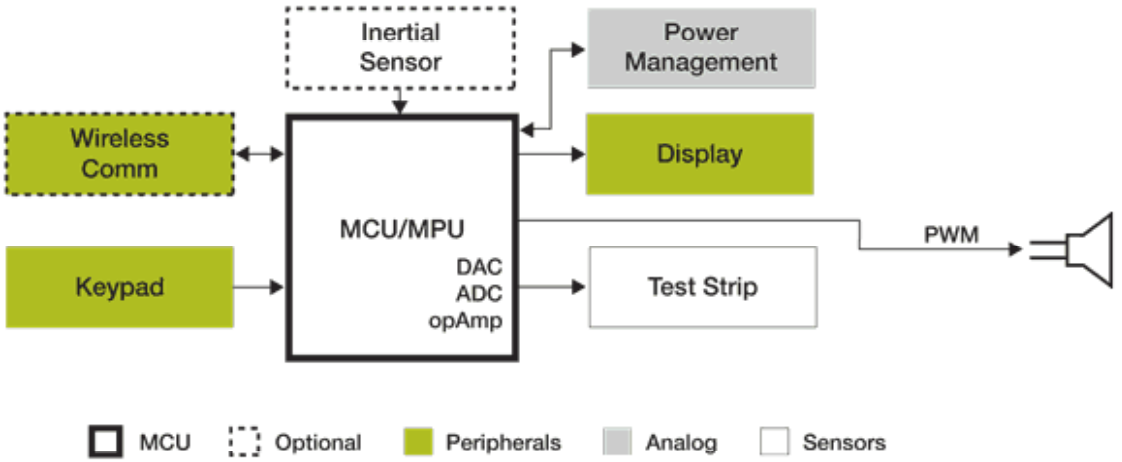
Reference Designs: Heart Rate and Blood Glucose Monitor

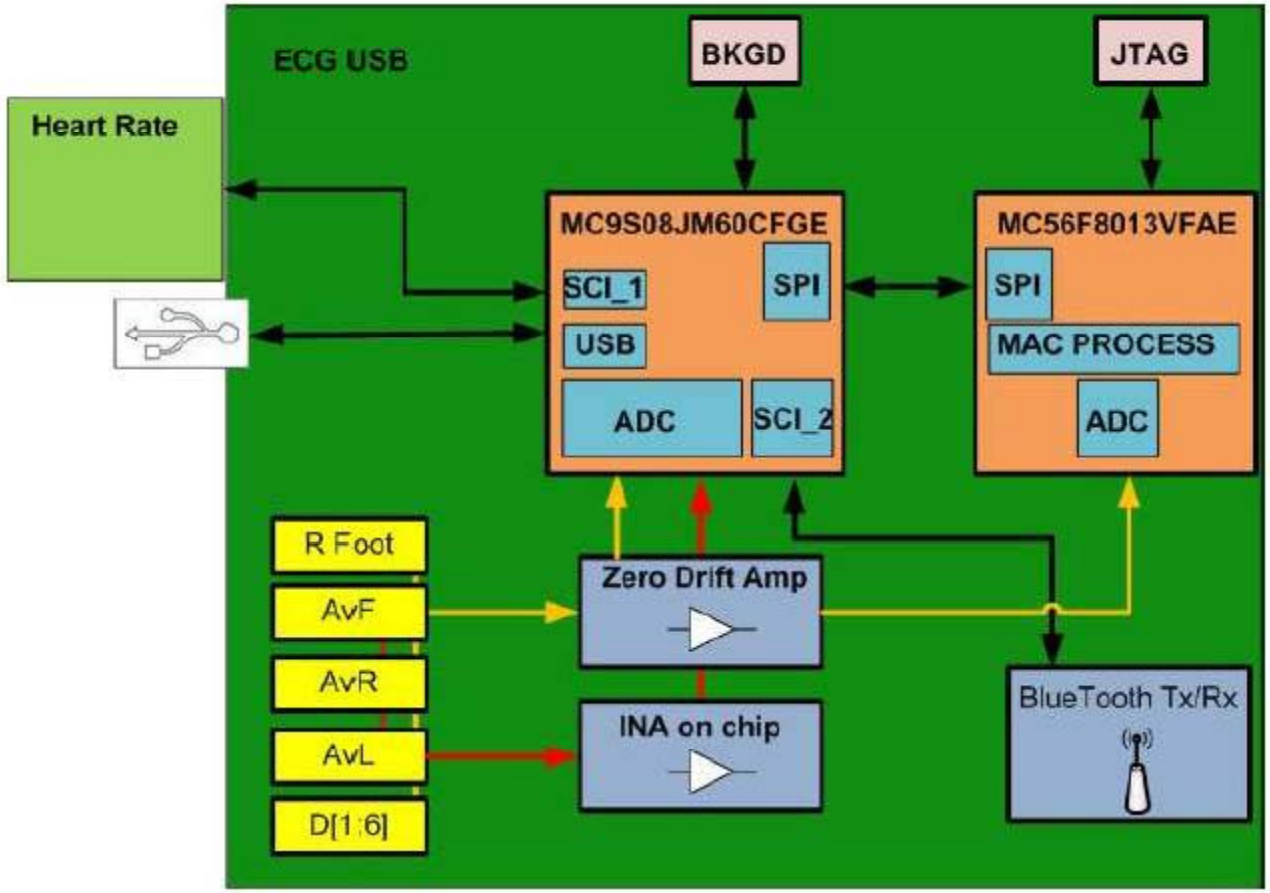
Heart Rate Monitor (HRM)



Blood Glucose Monitor (BGM)



Reference Design: ECG Solution



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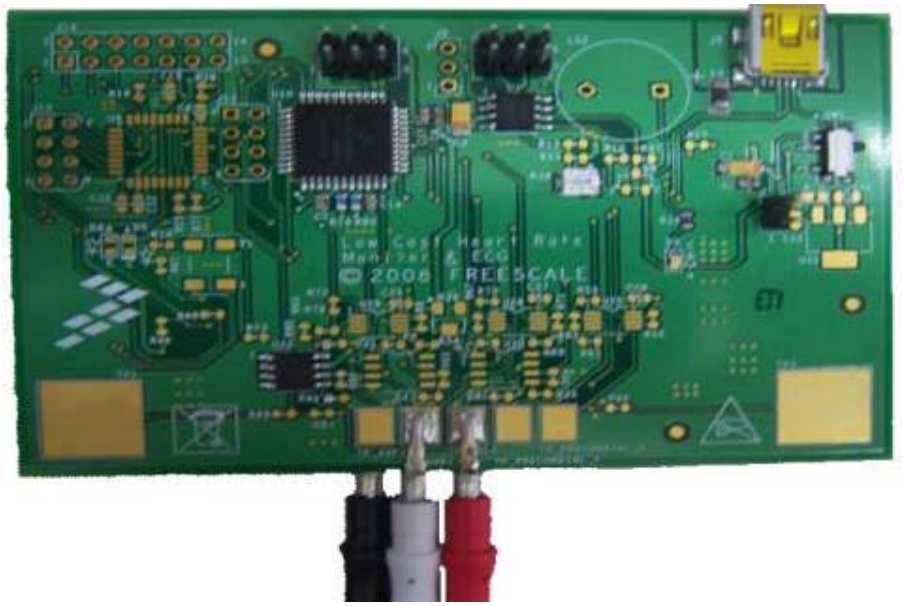
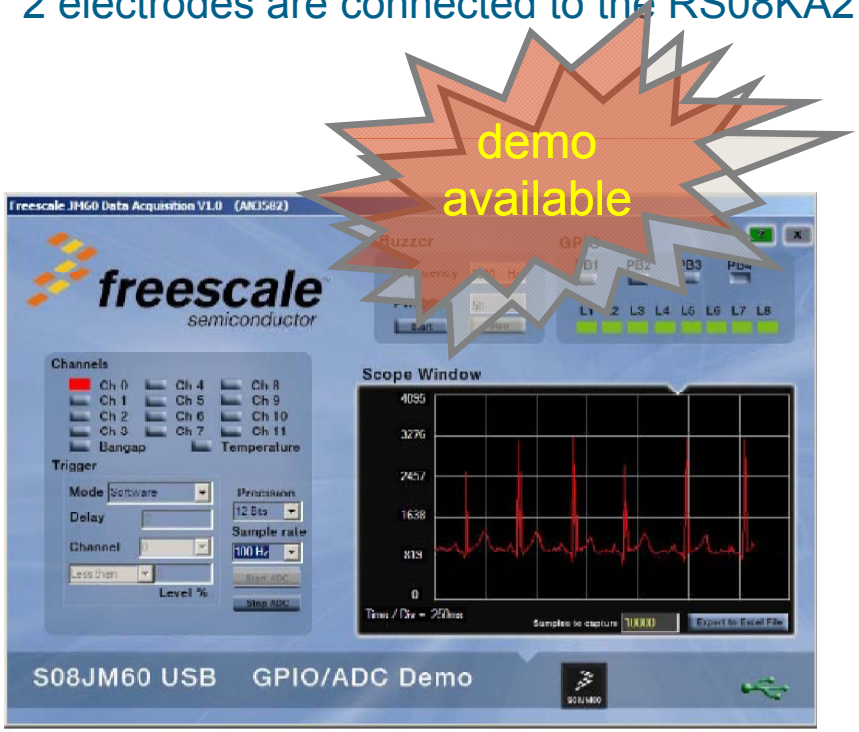
ECG and Heart Rate Monitor



- Features 9RS08KA2 and 9S08JM60 (USB controller)
- Alarm LED connected
- Heart Beat & Buzz LED
- 2 electrodes are connected to the RS08KA2



- Instrumentation amplifier is connected to MC9RS08KA2 (process electrode inputs)
- The reference signal is input to MC9RS08KA2, a comparison is made and output alarms are triggered
- 9S08JM60 interfaces with PC to send live and stored data to be graphed in a GUI

Continua Health Alliance Compliant Device
Blood Pressure Monitor Demonstration

Demo Application

- Device: Blood Pressure Monitor
  - JS16 for USB communication
- Host: PC with Windows OS
  - Contains host application graphical user interface
- USB Sniffer
  - Used to display all data sent between host and device

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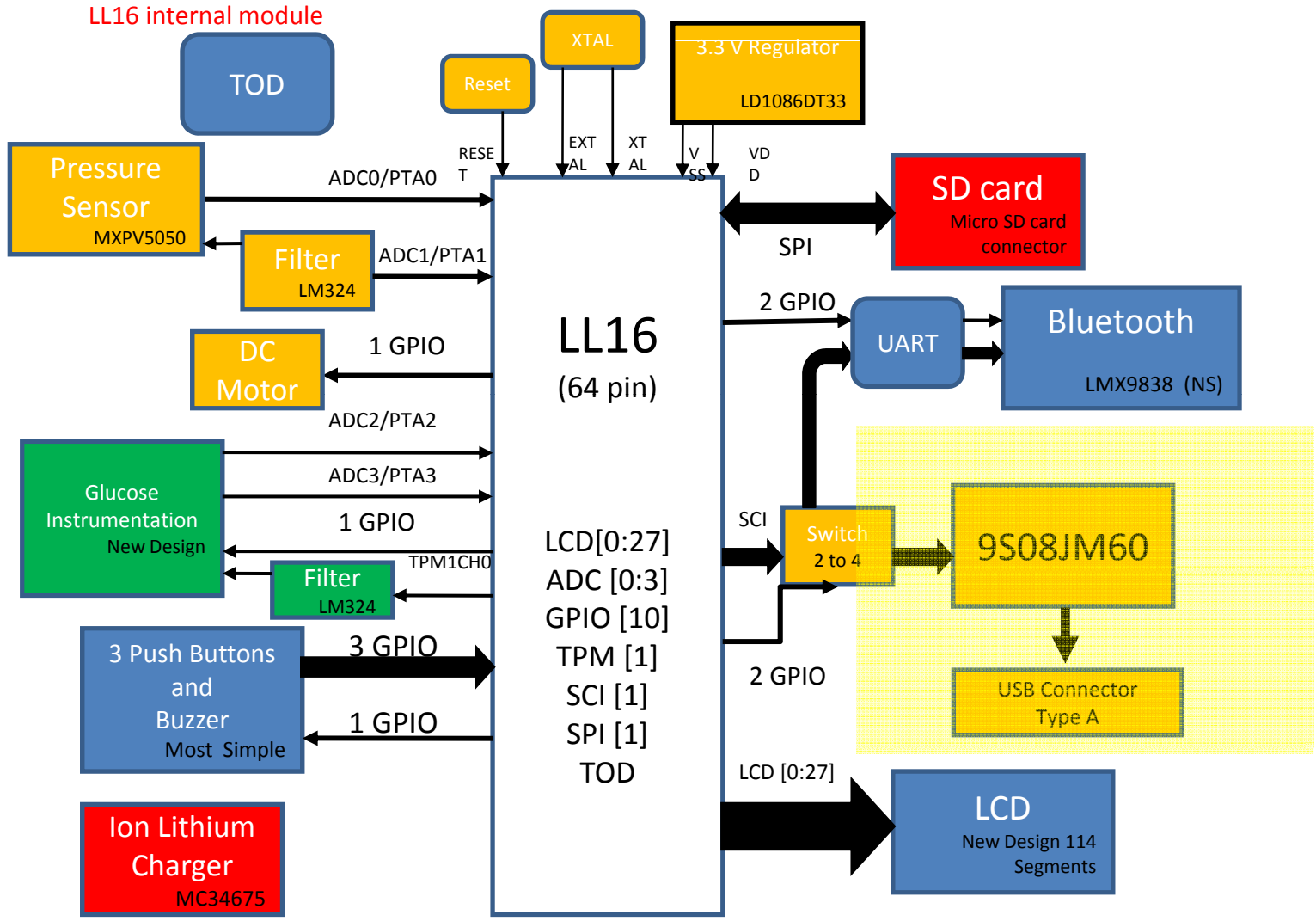
Low End Blood Pressure Monitor & Glucometer



For More Information

- Freescale
  - http://www.freescale.com/medical
  - http://www.freescale.com/usb
  - MEDCONLIBAPIRM.pdf – Library API Reference Manual
  - MEDCONLIBUG.pdf – Library User Guide
  - MEDUSBAPIRM.pdf – USB Stack API Reference Manual
  - MEDUSBUG.pdf – USB Stack User Guide
- Continua Alliance
  - http://continuaalliance.org
  - IEEE 11073-20601 Specifications
  - ISO-IEEE-PHD-tutorial_Spring_09.ppt
- USB
  - http://www.usb.org

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Glossary

AHD	Application Hosting Device
APDU	Application Protocol Data Unit - unit of data sent between software layers
ASN.1	Abstract Syntax Notation One - standard notation for data structures
BTLE	BlueTooth Low Energy
CESL	Continua Enabling Software Library
DIM	Domain Information Model
Flexis	Family of Freescale 8-bit and 32-bit compatible MCUs
HRN	Health Record Network
IrDA	Infrared Data Association
MCU	Microcontroller Unit - internal Flash memory
MDS	Medical Device System

MPU	Microprocessor Unit - no Flash memory
OSI	Open System Interconnection - Layered model for Software
PHD(C)	Personal Healthcare Device (Class)
PID	Product Identification - USB
PM	Persistent Metric - stored measurement data
RTSA	Real-Time Sample Array
TIL	Transport Independent Layer
TSS	Touch Sensing Software
VASC	Vendor-Assisted Source Code
VID	Vendor Identification - USB

Summary

- Continua Alliance offers a standard to enable medical devices to interoperate
- Freescale offers Continua certification-ready solutions to ease development of these devices
- Freescale's broad portfolio of products and enablement enable everyone to find a solution today

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Closing

- By now, you should be able to:
  - Understand Medical Connectivity Requirements
  - Understand Freescale's Solutions
  - Start development with Freescale's USB Medical firmware


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