

# Solutions to Tackle the New Challenges of Medical Device Designs

EUF-HCR-T1235

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Medical Business Development Manager EMEA



#### November 2013

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### **Agenda**

- The Challenge
- Trends for innovation
- Solutions for cost effective, portable, user friendly and connected devices
- Already there

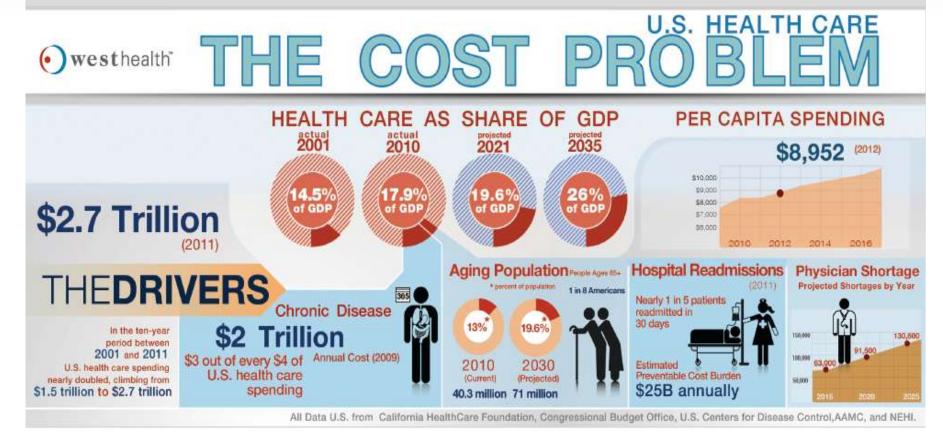


We See a Healthier, Safer Population





## The Challenge



Source: West Health, 2013





#### **Cost of Care in Detail**

- US Healthcare spending > 18% of GDP
- Hospital care: 30% of Health Care cost
- Physicians & Clinical: 21% of HC costs
- Equipment: only 4% of Health Care cost

Projected 20% of U.S. GDP per capita health-care annual spending in 2017 spending as health-care a percentage spending of GDP per capita Public funds \$6,369 health-care U.S. Private insurance \$5,310 spending \$7,026 16% Out of pocket \$1,422 \$13,101 '90 **■** Luxembourg \$6,610 One benefit of all that spending is 31¢ Hospital care Norway that the U.S. \$6,267 leads the world in medical innovation. Hospital care Physician and clinical Switzerland services remains the \$5,878 largest expense, Prescription drugs driven by demand Nursing-home care\* from an aging Administrative costs population. Here 4¢ Dental care is how the U.S. 4¢ Equipment Switzerland spends each 2¢ Research 11.3% health-care dollar All other Iceland France ▶ 4\$4,962 11.1% The Federal Government has health programs for the Denmark poor and elderly, leaving the states to fill in gaps or Germany ▶ \$4,828 10.4% expand what's available. The result is a wide disparity in per-person spending across the country Canada 10% Sweden 8.9%▶ France ◀ \$4,056 Utah Australia. \$8,295 \$3,972 Canada Highest Norway Lowest \$3,912 8.7% Per capita health Japan spending \$4,000 \$5,000 \$6,000 \$7,000 7.9% Britain **4**\$3,361 Spain Portugal Israel Czech Rep. Mexico Russia \$2,690 \$2,263 \$500 \$1.830 -\$1.618 \$943 -\$369 Mexico. Lithuania. Poland China Indonesia India 6.2% 5.3% 4.9% 2.2%

Health-care spending—already rising rapidly—will be one-fifth of the U.S. economy in nine years. Per-person

spending will nearly double. Half of that money will come from public programs like Medicare

Source: World Health Organization - McKinsey, Continua Alliance, Frost & Sullivan



\*Incudes home health-care workers. Sources: World Health Organization; U.S. Department of Health and Human Services; Centers for Medicare and



### The Solution

Enable individuals to take an active role in their own healthcare ... proactive prevention of costly chronic health problems later in life

**IoT Solutions** 

Healthcare

Wellness/Fitness
Younger Generations

Clinical Medical Global Impact Home
Medical
Aging
Populations

















## ... and its Challenges

- Move from a treatment based system to prevention:
  - Educate people about their own health
  - Develop **cost effective** solutions for people to easily track their vital signs
- Patients to take ownership of their disease:
  - Develop medical devices easily operable by the patient
- Move from a centralized to a distributed healthcare system:
  - Develop connected solutions to remotely monitor patients
  - Bring hospital equipment to the Doctor's office and patients house





### **Trends for Innovation**

Home Portable Medical Diagnostic,
Patient Monitoring
and Therapy

Medical Imaging



Portable



Doctor's office



Radiology center



Connected



Patient's home



In the field

**Cost Efficient** 

**Portable** 

Connected





## Health Care Technology Leadership





Prescrib, the Prescrib logs, ARMIC C-3. Cost/EST, Cost/Marcs Cost/Marcs Cellina, Cost/Marcs Children, Edition of Cost Cost, Cost Cost, Cost Cost, Cost



#### Freescale Medical Focus

#### The Facts

- Dedicated Medical Vertical team
- Dr. Jose Fernandez Villasenor, Practicing Surgeon, EE, leads Freescale's Medical Center of Excellence
- Formal Longevity Program to ensure a minimum of 15 years part availability

www.freescale.com/productlongevity

- Present in FDA/CE Class I/II/III applications
- Member of the Continua Health Alliance for Medical devices interoperability

www.continuaalliance.org

 Strategic Partnerships to expand design and system capabilities:

Cactus Semiconductors

Low power Analog Mixed Signal solutions

Monebo

ECG algorithm for a complete ECG solution

To Learn More: www.freescale.com/medical



http://s.eeweb.com/pulse/eeweb-pulse-2012-36.pdf





### **Medical Market Solutions**

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



## Portable Medical

- Ultra Low-Power, Highly Integrated Mixed Signal MCUs
- High Performance Analog
- Connectivity
- Sensors



## Diagnostic and Therapy

- Scalable MCU/MPU solutions for processing, display
- High Performance Analog
- Connectivity
- Sensors



#### **Imaging**

- High Performance & Multi-core DSP and MPUs for advanced processing
- High Performance Analog
- RF amplifier



Member & Golden Unit for **802.15.4 Medical Solutions** 



**Product Longevity:** Up to 15 Years of Assured Supply for Medical Products





# Designing Portable & Cost effective solutions

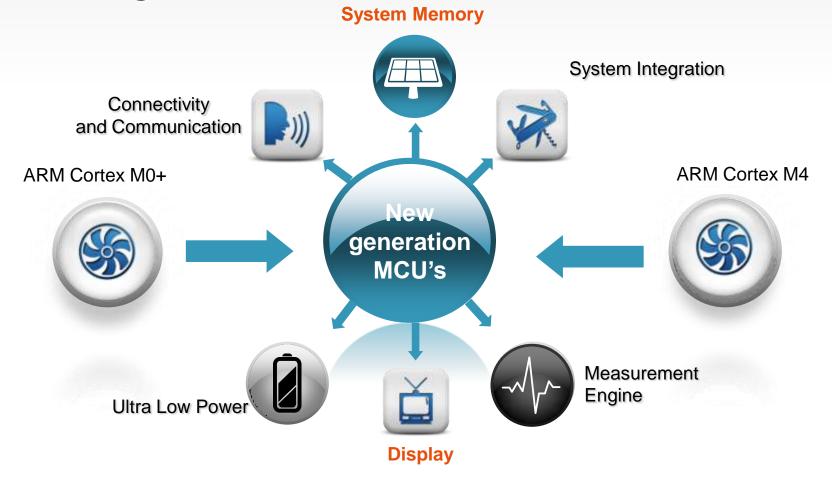




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## **HW Integration for Cost Efficient Solutions...**

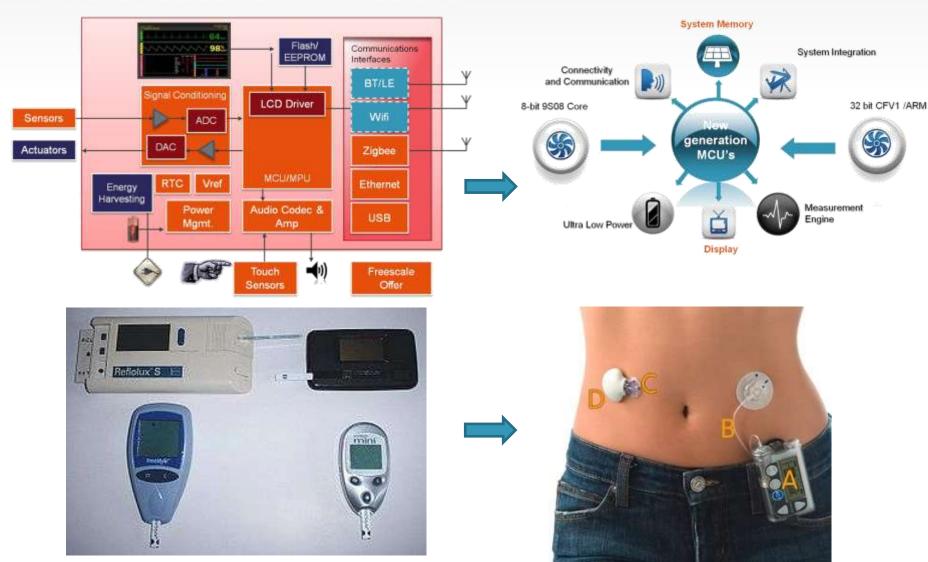


Integration reduces overall BOM, development cost and time to market





### ... And reduced form factors





## NP Illy Refreshed And Expanded

Portfolio: Industry's Widest Portfolio of ARM **Based MCU + MPU Products** 

i.MX7 Coming 2014

i.MX Applications **Processors** 

Availability NOW!

Your Interface to the World.

NOW!

Performance

Launching Aug 2013

#### Kinetis E Series

Robust, 5V ARM Cortex-M0+ & ARM Cortex-M4 MCU families for use in high electrical noise environments. Safety features for highreliability applications.

## NOW!

#### Kinetis K Series

Industry-first **ARM** Cortex-M4 MCU families from 50MHz / 32KB with low power, FlexMemory, mixed-signal and broad connectivity, HMI and security features.

#### Kinetis X Series

Industry-first **ARM** Cortex-M4 MCU families with advanced memory and feature integration for robust, networked industrial and consumer systems.

Coming

**Vybrid Controller** Solutions

Rich Apps in Real Time.

Availabilit NOW!

2014

**General Purpose** 

**Segment Focused** 

Just announced

#### Kinetis W Series

Kinetis L Series

Ultra-low power/cost

ARM Cortex-M0+ MCU

families from 48MHz /

8KB with mixed-signal,

connectivity and HMI

features in low pin-count packages.

Integrated wireless connectivity ARM Cortex-M4 and M0+ MCU families with classleading sub-1 GHz and 2.4 GHz RF transceivers.

#### Kinetis M Series

High accuracy metrology ARM Cortex-M0+ MCU families for single chip smart meter implementations.

Sampling

#### Kinetis V Series

High efficiency, high speed peripherals ARM Cortex-M0+ & Cortex-M4 MCU families for use in motor control & power conversion.

Coming Q3'13

Integration

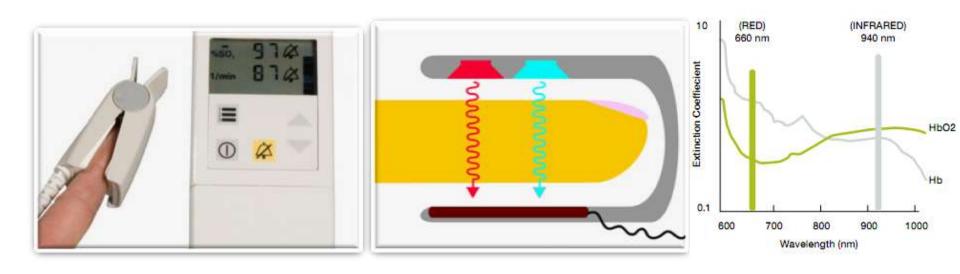
Leading Performance - Low Power - Scalability - Industrial-grade Reliability & Temp

Freescale Bundled IDE, RTOS & Middleware - Rapid Prototyping Platform - Broad ARM Ecosystem Support



## NOW the Application Pulse Oximeter

- The light intensity will decrease logarithmically with path length according to the Beer-Lambert Law
- When the light attenuated by body tissue is measured, DC components and AC components will indicate absorption by the arteries





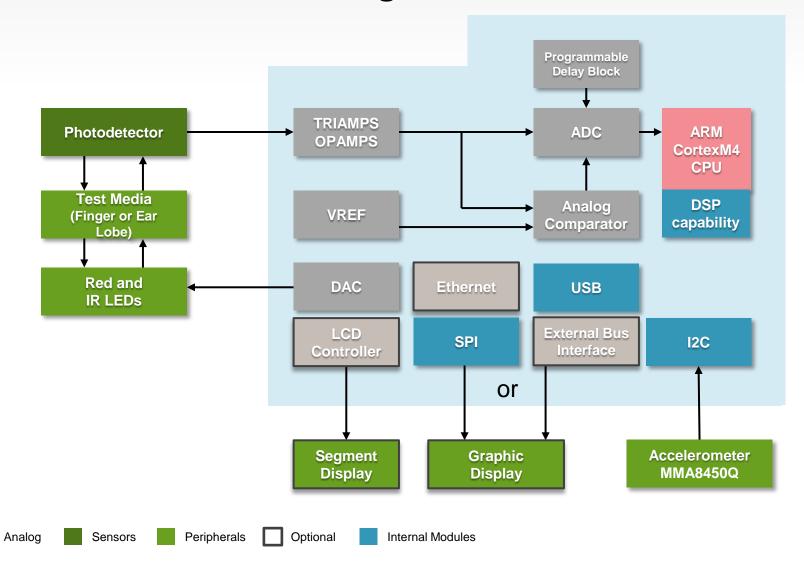
# Sign Challenges Pulse Oximeter

Problem	Solution		
Measurement accuracy	Increase the ADC resolution		
Battery oriented	Extreme low power consumption specially		
Finger misplaced	Analog comparator to setup thresholds		
Calibration	Stable voltage reference on the whole temp. and voltage Range		
Connectivity	Wires and/or wireless communication capability		
Low cost	BOM reduction, hardware design optimization		
Finger motion	Accelerometer		
Room light	Differential analog inputs		
Appropriate display	Segment or graphic LCD display capability		



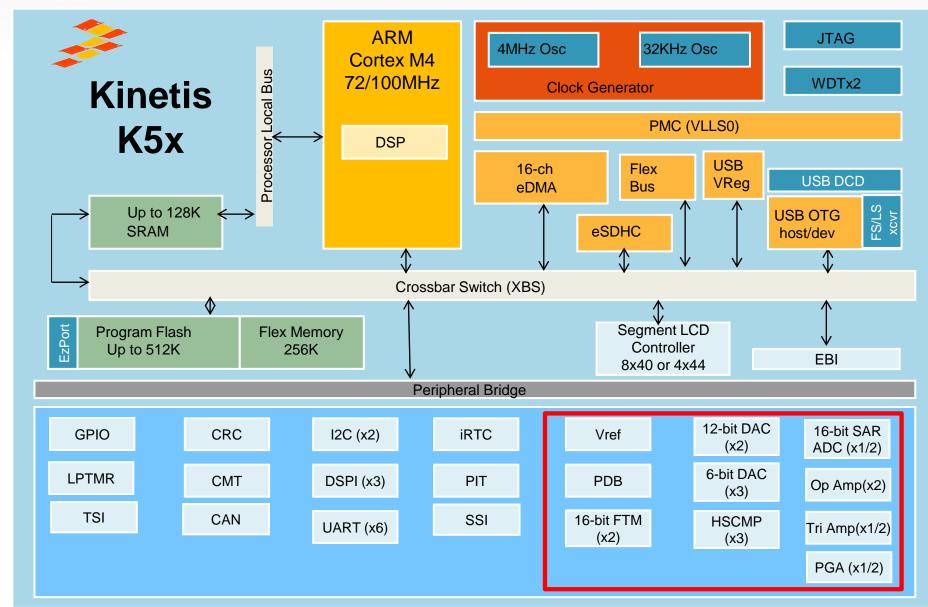


## **Pulse Oximeter Block Diagram**



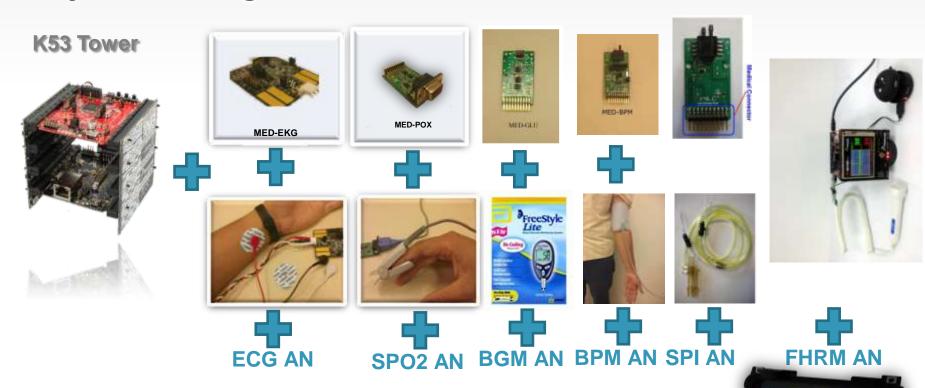


## tegrated Analog for BGM, SPO2, ECG, ... applications





## **System Integration for Quicker Time to Market**



- Easy and quick prototyping
- Detailed AN for each application
- SW, schematics, ... for free

To Learn More: www.freescale.com/medical

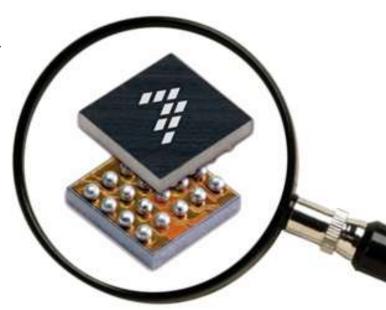




## One Step Beyond: The World's Smallest ARM® Powered MCU

Microscopic Package. Massive Potential.

- 1.9 mm x 2.0 mm x 0.56 mm
- Advanced wafer-level chip scale package for the ultimate in PCB area reduction
- 25% smaller with 60% more GPIO than the next competing solution
- 32-bit ARM® Cortex<sup>™</sup>-M0+ core with high density feature integration: 32 KB flash, precision analog, ultra low power and more
- Start developing today with the Kinetis L series FRDM-KL05Z Freescale Freedom development platform
- Mass Production planned for June 2013



For more information, visit freescale.com/Kinetis/KL02CSP





## Kinetis K/L Series: Packaging

#### Common Packages



32QFN 5 x 5 mm 0.5mm pitch (K10/20)(KL0/1/2)



48QFN 7 x 7 mm 0.5mm pitch (K10/20)(KL0/1\*/2\*)



48LQFP 7 x 7 mm 0.55mm pitch (K10/20) (KL0/1\*/2\*)



64LQFP 10 x 10 mm 0.5mm pitch (K10/20/30/40/50) (KL1/2/3/4)



80LQFP 12 x 12 mm 0.5mm pitch (KL1/2/3\*/4\*)



100LQFP 14 x 14 mm 0.5mm pitch (K10/20/30/40/50) (K10/20/30/40/50/60) (KL3/4)



64MAPBGA 5 x 5 mm 0.5mm pitch (K10/20) (KL1\*/2\*/3\*/4\*)



121MAPBGA 8 x 8 mm 0.65mm pitch (K10/20/30/40/50/60) (KL2/3/4)

#### **Kinetis L Series Only**



20WLCSP 2x2x0.56 mm 0.4mm pitch (KL0)



25WLCSP 2.3x2.3x0.56 mm 0.4mm pitch (KL0\*)



35WLCSP 2.55x3x0.56 mm 0.4mm pitch (KL1\*/2\*)



16QFN 3x3x1 mm 0.5mm pitch (KL02)



24QFN 4 x4x1 mm 0.5mm pitch (KL0x)



32LQFP 7 x 7 mm 0.8mm pitch (KL0)

#### **Kinetis K Series Only**



90WLCSP 3.9x4.4x0.56 mm 0.4mm pitch (K10/20\*)



110WLCSP 3.9x4.4x0.56 mm 0.4mm pitch (K10/20\*)



120WLCSP 0.4mm pitch (K10/20/60)



143WLCSP 5.3x5.3x0.56 mm 6.5x5.6x0.56 mm 0.4mm pitch (K61)



144LQFP 20 x 20 mm 0.5mm pitch (K10/20/30/40/50/60)



144MAPBGA 13 x 13 mm 1.0mm pitch (K10/20/30/40/50/60)



256MAPBGA 17 x 17 mm 1.0mm pitch (K60/70)



Presents, the Francolo logs, AWIvo, D.S., Code/EST, CadeMartor, CateFire, CodeFires, C. Mare, the Energy Efficient Solutions legs, Xinsta, mobileCT, PSC, ForeerQUCC. Processor Eaguer, Contil, Commus, Establishan, the Satelliessaw logic, StatCore: Symptomy and Vontile are trademarks of Freezoste Earneconductor, toc. Reg. U.S. Par. 5 Tm. Off. Arrian, Seville, BeeStack, CoreNet, Fleets, Laywestees, MilgreV, MRC, Platform in a Pantage, GorG Gorverge, GUIDC Engine, Ready Play, SWARTWOS, Tower, TurboLote, Vytraf and differences of Freezons Semiconductor, Inc. All other product or service regions for the projective service service service. O 2019 Freezons Semiconductor Inc.



# **Designing Mobile solutions**





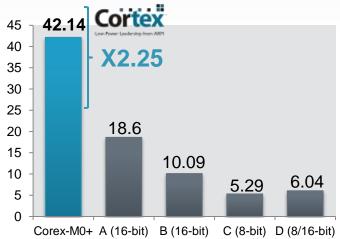
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## **Low Power Operation for Mobile devices**

- The challenge: Small form factor and long battery life
- The solution: Low power technologies & Integration
  - Ultra-efficient Cortex-M0+ & M4 processors
  - Ultra-low power modes
  - Energy-saving architecture

### Processor Energy Efficiency in CoreMark/mA



All values shown in chart are core consumption estimates with optimal operation from flash @ ~1.8-2.2V. Values extracted from public data sheets











## Kinetis Power Modes (e.g. K Series)

Typical Power Modes in an embedded system	Cortex M4 Power Modes	Kinetis Extended Power Modes	Recovery Time	"Typical" Idd Range
in an embedded system	Fower wodes	Run	-	From 270uA/MHz
Run	Run	VLPR	-	From 710uA
	Sleep	Wait		
Wait		VLPW	4us	Wait from 6.5 mA VLPW From 450uA
	DeepSleep	Stop	4us	From302 uA
Stop		VLPS	4us	From 5.1uA
Freescale Adds Low Leakage Wake-up Unit		LLS	4us	2.1 uA - 10uA
<ul><li>Enables complete shut-down WIC, further reducing leakage c modes</li></ul>	VLLS3	35us	1420 nA - 8uA	
<ul><li>Supports 16 external input pir as wakeup sources</li></ul>	VLLS2	35us	1420 nA - 4uA	
<ul><li>Wakeup inputs are activated</li></ul>	VLLS1	100us+EE restore	690nA – 2uA	
 		VLLS0		190 nA





## The Blood Glucose Monitor Use Case



Prepare your tools



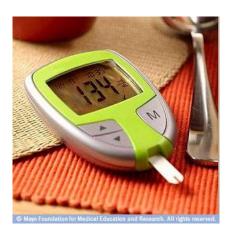
**Insert Test Strip** 



Pick your finger



Apply blood on Test Strip



Read the results





## The Blood Glucose Monitor Use Case (Cortex M4)

	STANDBY	BUTTON WAKE UP	POLLING (2-5min)	MEASUREMENT (5s)	DISPLAY DATA
BGM ACTIONS	NONE	LCD BLINKS INSERT STRIP	LCD BLINKS PLACE BLOOD	LCD DISPLAYS MEASUREMENT	LCD DISPLAYS MEASUREMENT
FUNCTIONS NEEDED	RTC PIN WAKEUP	RTC PIN WAKEUP (STRIP)	RTC ADC COMPARE MODE ANALOG	RTC ANALOG CPU/DSP	RTC CPU/DSP
FREESCALE MCU MODE	VLLS0	VLLS1 with LCD ENABLED	VLPS with ANALOG ENABLED	VLPR mode with ANALOG ENABLED	VLLS1 with LCD ENABLED
FSL SYSTEM POWER	750nA	<4.0uA	160uA – 1.0mA	<3.5mA	<4.0uA
EXIT CONDITION	USER PRESSES BUTTON	STRIP INSERTED	BLOOD DETECTED	MEASUREMENT COMPLETE	TIMEOUT

Battery life extended from 0.9 year to 1.6 year (CR2032, 240mAh)





# Designing User Friendly Solutions





Presentable, the Presentable Sops, AllaMac, C. S., Clark TST, Dobblewins, Cachina, Costillania, C. Wars, the Imange Stickent Tobulanian Stops, Nilvesti, reduting TST, Province Capital, Capital, Copper, David, Quarkon, Salichera, Italian Sanzara Inga, Salichera, Jampfanny and InstNo. An emphasis of Presentable Cachina, Cachina, Capital, Salichera, Salichera, Capital, Salichera, Salichera, Capital, Salichera, Salichera, Capital, Capital, Salichera, Salichera, Capital, Salichera, Capital, Salichera, Capital, Salichera, Capital, Salichera, Capital, Salichera, Salichera, Capital, Salichera, Salichera, Capital, Salichera, Sal



## The Cost of Non-Compliance

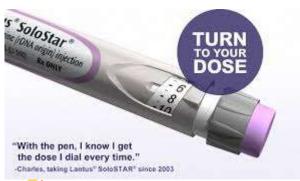
- According to a meta-analysis published in the Annals of Internal Medicine,
   Americans are failing to comply with medication prescriptions for a variety of
   reasons -- and it's costing them anywhere between \$100 billion to \$289 billion
   a year.
- Why patients are not compliant:
  - Cost of treatment
  - Difficulty of the regimen: life invasive, complexity to take treatment, ...
  - Pain of the therapy
  - Denial of the problem
  - ...



## Interfaces for Enhanced User Eperience, Better Usability and Improved Comfort

- · The challenge: Make advanced UI low cost and easy to implement
- The solution: Integration and Software
  - MCU/MPU with integrated segment/Graphical LCD controllers
  - Integrated Touch Sense interface
  - Graphics libraries, GUI builders, touch sense libraries













## Freescale LCD Medical HMI Solution Roadmap



**S08L** 

LL/LH/LG

8bit/64Kflash

charge pump

regulator for

Up to 288

Internal

Voltage

contrast control

segments









#### i.MX53

#### Cortex-A8

- 1 GHz
- 32-Bit CPU NEON DSP
- FPU
- NANDFlash IF
- DDR2/DDR3
- Ext Bus
- I ow Power

#### Ext Bus Camera IF

DDR2/DDR3

i.MX6x

Cortex-A9 1-2-4 cores

32-Bit CPU

NEON DSP

■ 1080p enc/dec

NANDFlash IF

■ 1 GHz+

FPU

- Low Power
- Camera IF

#### Kinetis L

#### Cortex-M0+

- 256K Flash Up to 320 segments
- Segment failure detection
- Low power blinking mode

#### **Kinetis** K30/40/50

- Cortex-M4
- DSP/FPU
- 1M Flash
- Analog Front End
- Up to 320 segments
- Segment failure detection
- Low power blinking mode

#### Cortex-M4

**Kinetis** 

K70

- DSP/FPU
- 1MB Flash
- Analog Front
- End Up to WVGA
- B&W, Grayscale and color LCD
- Capacitive touch I/F

#### i.MX28X

i.MX233

ARM926EJ-S

32-Bit CPU

NANDFlash IF

■ 454 MHz

DDR2

Ext Bus

Audio Amp

Low Power

On chip Power

Management

and Battery

Charger

- 454 MHz

- Management and Battery Charger

- ARM926EJ-S
- 32-Bit CPU
- NANDFlash IF
- DDR2
- Ext Bus
- Dual Ethernet with L2 Switch
- Low Power
- On chip Power

#### MCU: **MPU**





### Segment LCD Controller

#### Segment fault detection capability

- Hardware support for segment LCD display errors
  - Essential when displayed data is safety critical
  - Automates factory test for end product

#### Up to by 8 multiplexing

- Fewer pins required to drive LCD segments
  - Kinetis: 48 pins needed to drive 320 segments
  - Competition: 80 pins needed to drive 320 segments

#### Low power blinking mode

- LCD glass blink capability in low power modes
- Alternate display feature can be activated to display alternate data (i.e. blink temperature and time)

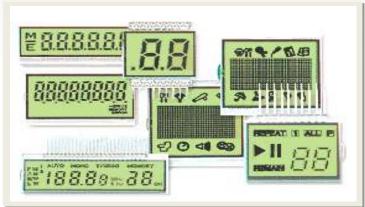
#### Front and back plane re-assignment

- Any LCD pin can be a frontplane or backplane pin or GPIO function
- Assist in vertical scrolling on dot-matrix displays

#### Internal charge pump provides voltage required to power LCD glass

- Internally regulated voltage for constant contrast across MCU VDD
- Trim register for software contrast control
- Drive for 3V or 5V LCD glass

### Support for up to 320 segments!!



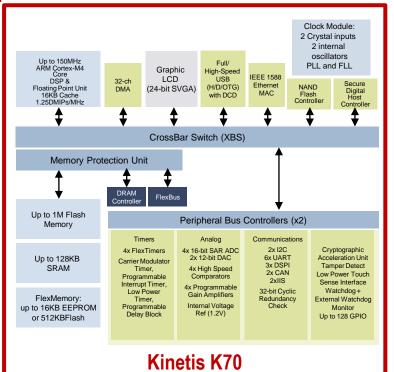




## tegrated & Low cost, High end Application MCU for advanced UI

High EndARM Cortex-M4 with FPU For animated Graphics, 6 times faster!



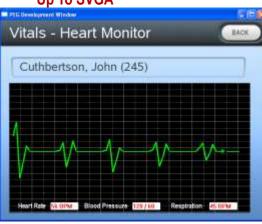


Ethernet USB including Continua profile



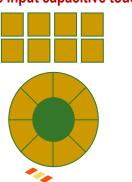


Graphics LCD controller on-chip Up To SVGA



16 input capacitive touch sensing pins

freescale ™







# Breaking the Hurdle For Connected Designs





Presental, the Prosposit logs, Albitoc. C.S., Cosk 1531. Dobblivanis Cashina, Cashin

**Se Case: Patient with Hypertension and Diabetes** 

type 2

#### **Biometric Data:**

- 1. Systolic/Diastolic pressure
- 2. Heart Rate/ Activity Monitor
- 3. Electrocardiography
- 4. Glucose
- Weight and body composition.

Patient unaware of potential life threatening conditions.





#### Heart attack

50% deaths occur the first hour after the attack.

#### Renal Failure

Leading to dialysis.

studies have suggested that tight control can reverse damage.

Hyperglycemia/ hypoglycemia Could lead to coma or death.

Therapy adjustment



Corrective and preventive actions

Raise patient awareness and ownership

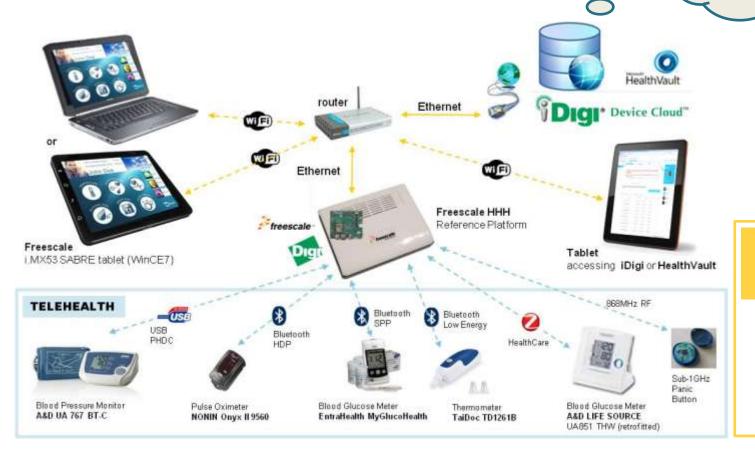


## **Sonnected HC: The Home Health**Hub concept...

 Home Health Hub Reference Platform : out-of-the box experience



Physician
Monitoring Center,
Loved One's
Social Network



## HOME AUTOMATION Expansion Capabilities

Smart Plugs Smart Appliances Safety/security Lighting Control Local Display









### **Continua Health Alliance**

**Personal Device** Aggregation Telehealth Health Service Manager Records Center Thermometer **Pulse Oximeter** ISO CCD Continua<sup>-</sup> Pulse / **�IEEE** PCD 01 **Blood Pressure** Weight Scale W3C Glucose Meter Continua BT Profiles Cardio / Strength 🚱 Bluetooth EHR Independent **Living Activity** HIE Peak Flow PHR ZigBee" Health Medication Wide **NHIN** Record Adherence Area Network Network **Physical Activity** Interface (WAN) Device Interface Connectivity Continua

To learn more: <a href="http://www.continuaalliance.org">http://www.continuaalliance.org</a>





### **Continua Promoter Members**





















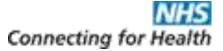








NOVARTIS







Roche

















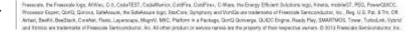








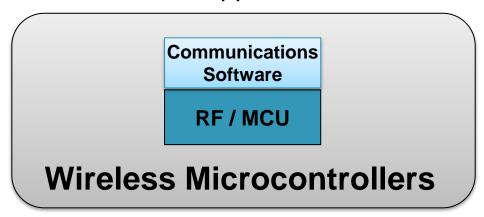






## Freescale Wireless Connectivity Strategy

To provide all wireless solutions (from antenna to bits) required for control and monitoring applications in consumer, residential, metering, medical and industrial applications.



- All ISM frequency bands: 315 MHz, 434 MHz, 868 MHz, 915 MHz, 2.4
   GHz
- Scalable wireless protocol: From simple point-to-point lightweight protocol, up to full ZigBee-compliant applications.







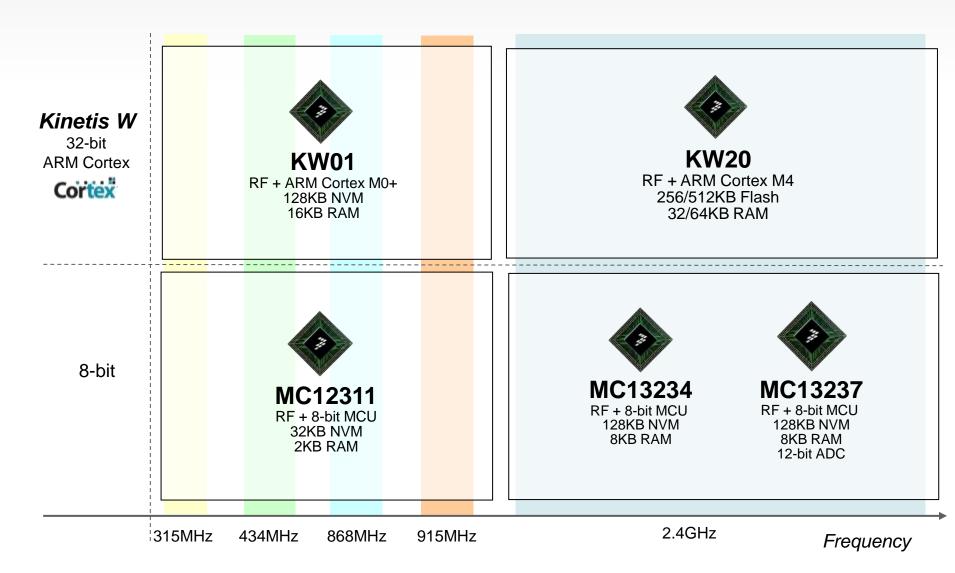








### Wireless Microcontrollers Portfolio







## **Already There**





Prescript, the Prosposit logs, Albitoc, C.S., Cosk/EST, Cosk/Barras, Cost/Pas, Cost/Pa

## שנים Cost, Easy to Use and Wearable Insulin Pump Insulet Omnipod®

### Challenge:

 Create a low-cost, disposable wireless insulin pump for continuous delivery.

#### Solution:

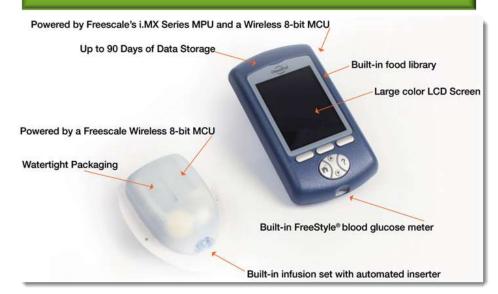
Custom MCU, RF Radio,
 Analog SoC and application processor.

#### Benefit:

 Discrete, durable, wireless, low-cost, disposable, and easy-to-use Freescale Technology

i.MX: Applications Processor (PDM)

Custom ASIC: MCU, Analog, Wireless connectivity (Pod)



To Learn More: www.freescale.com/omnipod



## The Cool Factor

- Challenge: Create a complete line of easy-to-use, connected health monitoring devices that offers a sleek, consumer friendly design.
- Solution: Withings health devices rely on the Freescale Kinetis microcontroller family to enable advanced functionality in a low profile, low power package.
- Benefit: The unique combination of low power, performance, cloud connectivity and attractive design makes Withings healthcare devices more than appealing to today's active, health-conscious consumer. The availability of a wide range of capabilities within the Kinetis family of microcontrollers makes designing new devices more efficient and costeffective for Withings.

Freescale Technology
Kinetis Cortex M4 familly







Presents, the Freezolds logs, AMWs, C.S., Coto/EST, Coto/Marin, CotoFine, CotoFine, CotoFine, Cotorine, English Solidions legs, Xineta, included. Proceedings of Cotorine, September 1997, Cotorine, Sep



## Orcam – See For yourself

- Challenge: Create a portable solution for the visually impaired that allows them to access activities that most people take for granted but which pose tremendous challenges for them riding the bus, shopping for groceries, reading the newspaper.
- Solution: The OrCam solution employs sophisticated visual computing algorithms run by Freescale's high performance and energy efficient i.MX6 Quad processor to interpret visual inputs and communicate their meaning in real time to the person wearing the technology.
- Benefit: For people whose visual impairments
  prevent them from easily interacting with the world
  around them, OrCam offers a wearable, affordable
  intuitive solution for those who have trouble seeing
  faces and objects.









#### To Learn More

#### **Available now**

- FSL Medical website
  - www.freescale.com/medical
- Reference Designs / Demos
  - Intelligent Hospital
  - Medical Suit Case
  - Continua USB PHDC software
  - Home Health Hub
- Application Notes:
  - ECG, BGM, SPO2, Spirometer, BPM
  - Digital Stethoscope
- Beyond Bits Magazine
  - Health & Safety focus
  - Collection of technical / medical articles authored by FSL and physicians
- Medical Brochure
  - <a href="http://www.freescale.com/files/industrial/doc/brochure/BRMEDICAL.pdf">http://www.freescale.com/files/industrial/doc/brochure/BRMEDICAL.pdf</a>
- Medical Applications Guide
  - http://www.freescale.com/files/microcontrollers/doc/user\_guide/MDAPPUSGDRM118.pdf







