Applications and Commercial Issues

Sensor Solutions Division

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Agenda

- Package Sizes & Complexity Issues

- Application Examples

- Looking Ahead to IoT Applications

Freescale Sensor Timeline

1980
We manufacture our first uncompensated pressure sensor

1982
Pressure sensors are supplied for manifold absolute pressure (MAP), enabling a major reduction in emissions and fuel consumption

1985
A temperature-compensated pressure sensor is unveiled

Late 1980s
Began developing the first surface micromachined inertial sensors for the auto airbag market

1991
Bipolar integrated pressure sensor production begins

1992—present
Dedicated supplier to the critical care medical market shipping over 90 million units for the invasive blood pressure market

1996
Inertial sensors start volume production

Late 1990s
A new wingback/PDIP package is developed for the Z-axis inertial sensor

2002
Began providing pressure sensors for respiratory medical equipment

Early 2000s
Inertial sensor portfolio expands with X-, XY- and Z-axis low-g products

2003
Tire pressure monitoring system developed, utilizing capacitive technology to save power

2003
Smarter, faster airbag deployment enabled by satellite accelerometer introduction

May 2005
Freescale introduces its first 3-axis MMA7260Q low-g inertial sensor

July 2006
First HARMEMS technology MMA62xxEG products shipped for airbags with robust accuracy

2008
TPMS highly integrated, single-package, low-power solution introduced with pressure sensor, 8-bit MCU, RF transmitter, 2-axis X- and Z-axis accelerometer

February 2008
Motion-sensing accelerometer enables interactivity of Guitar Hero® and other popular video games

November 2008
Synerject announces its ongoing use of Freescale pressure sensors for robust, cost-effective ECUs for two- and four-stroke engine management

December 2008
3-axis accelerometers offer reliable, cost-effective freefall detection to help protect data stored on laptop hard disks

April 2009
MMA7660, an intelligent 3-axis digital accelerometer and Freescale Energy-Efficient Solution, is introduced for advanced mobile phone interfaces

June 2009
MPL115A released, the first digital barometric pressure sensor with easy-to-use digital interface and low power

June 2009
Sensor Toolbox introduced

June 2009
Reached 1 billion units shipped milestone

June 2009
Tower System introduced

January 2010
Freescale Sensors Group marks thirty years of industry innovation and leadership

February 2010
MMA845xQ unveiled, a very low-power 12-bit digital (I²C) resolution accelerometer with embedded functions to enable next-generation intelligent motion features

June 2010
Freescale launches Xtrinsic sensing solutions, the first smart sensors in the market

January 2011
Freescale introduces the first magnetometer in its Xtrinsic sensor portfolio

February 2012
Award-winning Xtrinsic eCompass software introduced

June 2012
Joint announcement with Kinetis introducing the MMA8491Q

June 2012
Accelerometers for smart meter physical tamper detection debut

June 2012
12-axis Xtrinsic Sensor Reference Platform for Windows® 8 certified by Microsoft® for sensor fusion requirements

April 2013
Pressure sensor collects biosignal information in BAM Labs® Touch-free Life Care™ (TLC) System

June 2013
Xtrinsic intelligent sensing framework releases

August 2013
Xtrinsic MMA9550L motion-sensing platform detects falls and an Xtrinsic MAG3110 3-axis magnetometer works in conjunction for accurate compass-based location information in Numera's Personal Emergency Response System

October 2013
FXAS2100 Xtrinsic gyroscope released

November 2013
Freedom Platform for Xtrinsic sensors is Arduino™ footprint compatible with support for sensor expansion boards

Provide intelligent sensor solutions that expand contextual and environmental information to advance the human experience

Packaging vs. Content Challenges

Triple-Die with MCU Block Diagram

Dual-Die Block Diagram

Monolithic Block Diagram

Continuous Positive Airway Pressure (CPAP) Machine

- **Constant positive pressure** to prevent muscles from obstructing the airway

- **2 kPA pressure sensor** used for respiratory systems

- **Differential pressure sensor** can be added to detect airflow, monitor breathing behavior or to detect mask displacement

Continuous Positive Airway Pressure (CPAP) Machine Block Diagram

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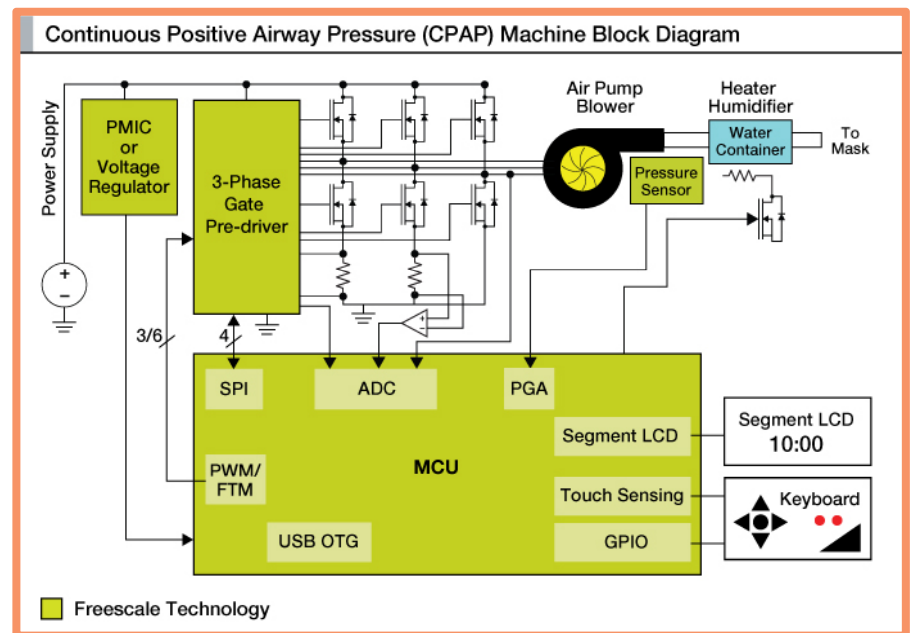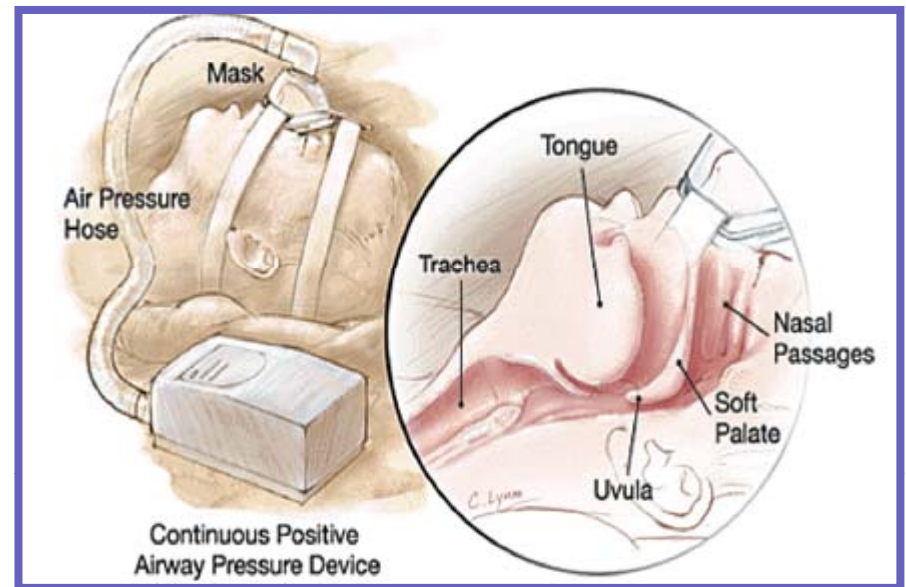
Local and Remote Patient Monitoring

- Increase comfort and eliminate bed sores

- Interprets patient movement and warns attendant before patients get out of bed to avoid falling

- Non-intrusively monitor heart and respiratory rates

Pressure Sensors for Ducati Fast-Track Motorcycle Performance

- Synerject uses Freescale pressure sensors and MCUs for engine management systems for precise control
- Synerject provides robust, cost-effective ECUs for two- and four-stroke engines

Intelligent Tire Sensors

Tire and Wheel Data to **Enhance Safety, Economy, and Security**

- Pressure, tread depth, inertia, temperature, battery life
- Calculations of contact patch, sidewall deflection
- Reduce vehicle assembly time
- Sensor and tire ID married to VIN
- Automatically determine wheel location

The Internet of Things is Driving **Explosive Growth** In Connected Devices

50 BILLION

25 BILLION

12.5 BILLION

World Population

6.3B — 6.5B — 6.8B — 7.2B — 7.6B

| <1x | 1x | 2x | 3.5x | 6.5x | # Connected Devices/Person |

2003 — 2008 — 2010 — 2015 — 2020
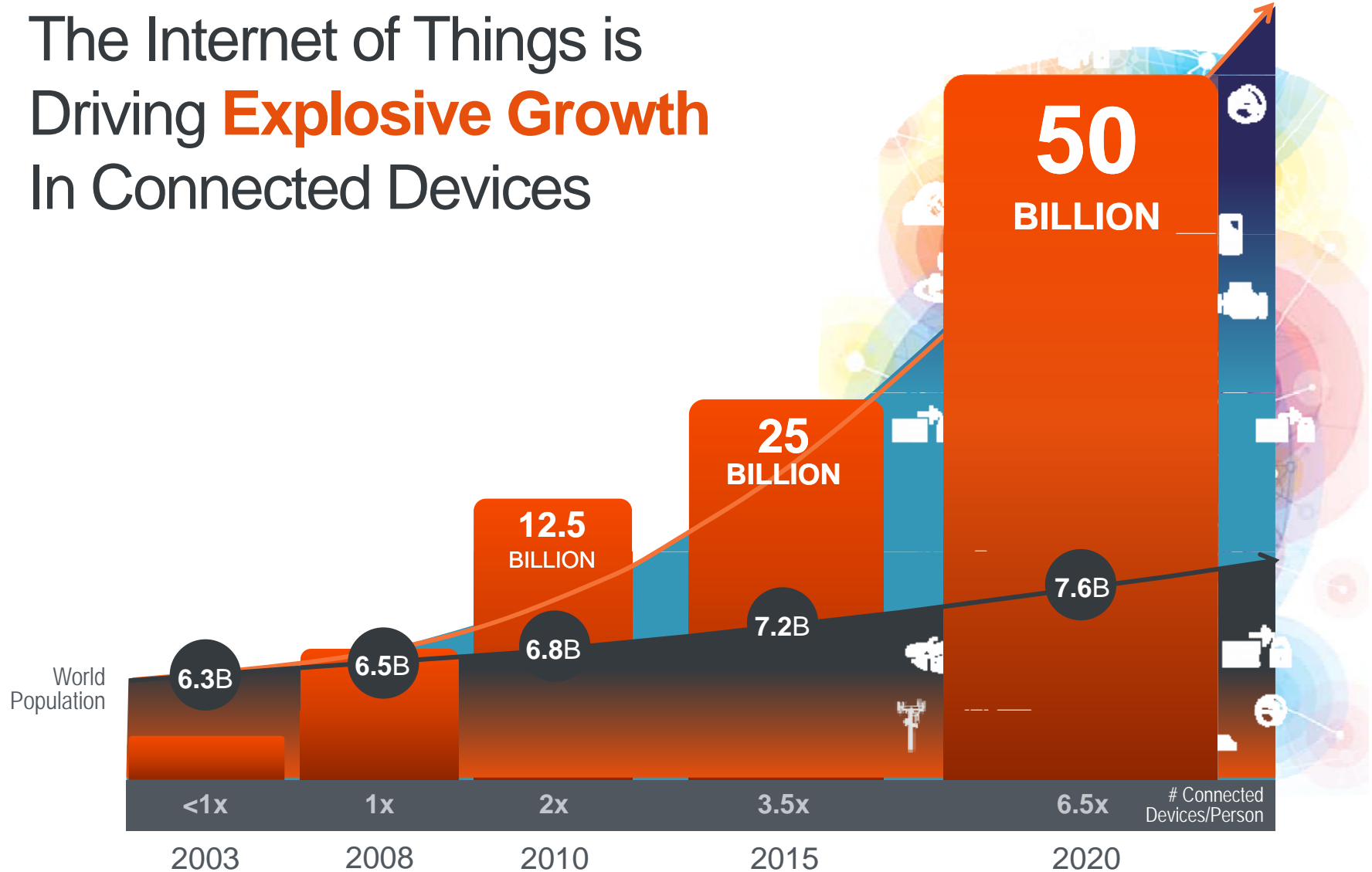
Our View
Pervasive Remote Monitoring and/or Control
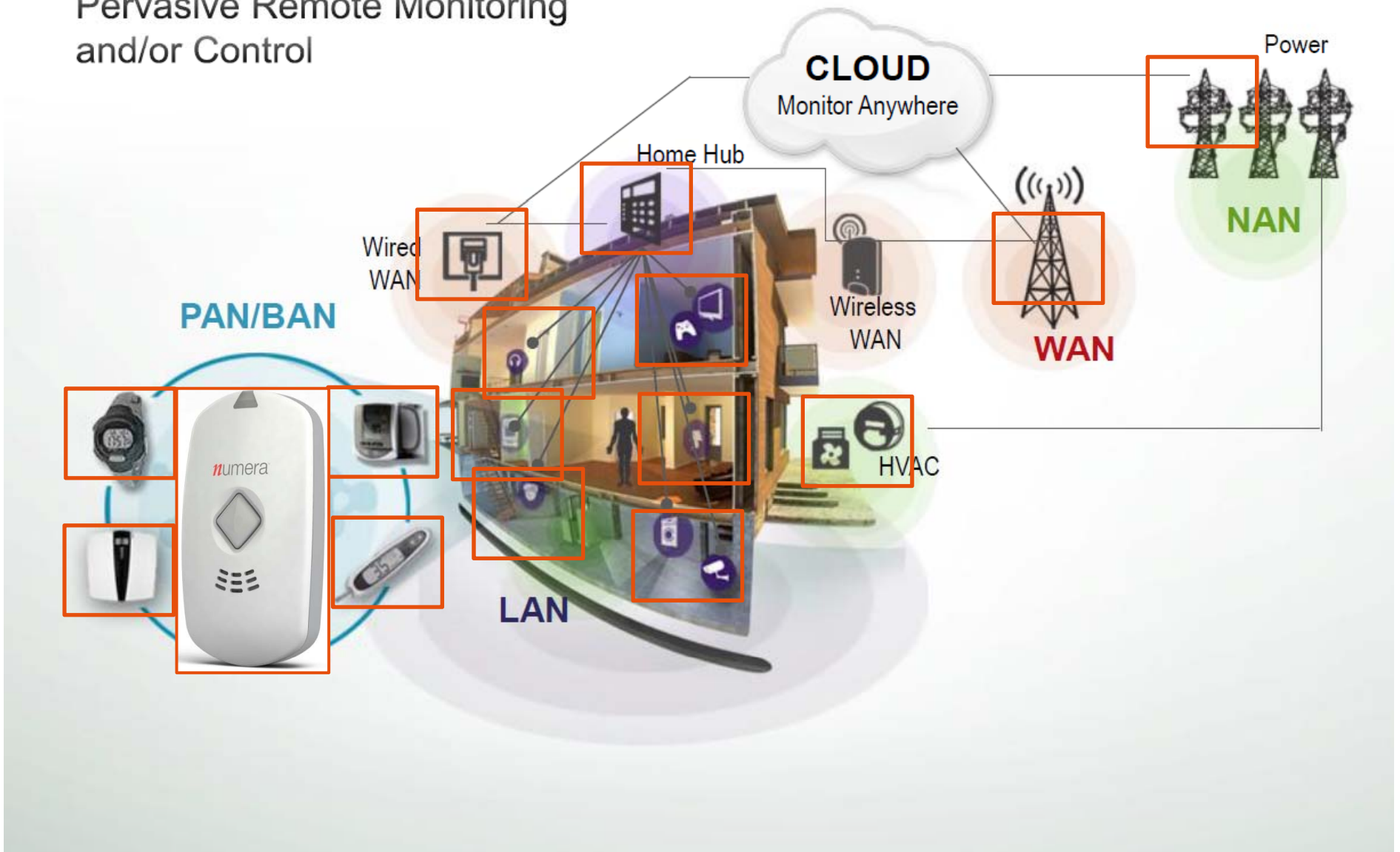
Wireless Sensing Platform **IoT Applications**

- **System-in-package**, high level of integration
- **Wide selection of sensors**: absolute pressure sensors, acceleration sensors, temperature sensors, battery voltage sensors
- **MCU with embeddable firmware** and software services
- **Low power RF** link
- **Ultra low-power system** wakes up on specific physical event detection

Wireless Sensor

Pressure → P-cell	RF Transmitter
Temperature → T-cell	Sensors Pre-Processing → MCU
Radial Acceleration / Tangential Acceleration → G-cell	Firmware
125 kHz Signal → LF Input	Power Management

3V Battery

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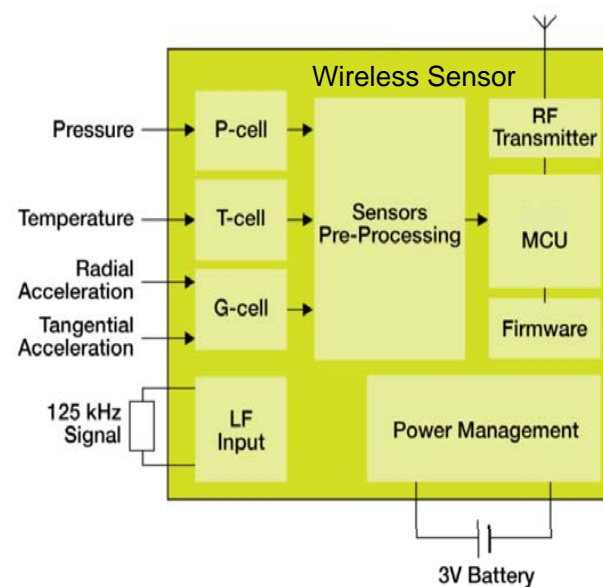
Industry-Leading Customer Programs

Functional Safety Simplified

Designed to help **simplify system compliance** with functional safety standards in the automotive and industrial markets and, at the end of the day, **keep people safe**

www.freescale.com/safeassure

Energy Efficient by Design

Enabling a new generation of applications that achieve **reduced energy consumption** while continuing to meet the **demand for increased performance and functionality**

www.freescale.com/energyefficiency

Supply Assurance

Enabling customers to design with confidence by identifying hundreds of Freescale products – including those for the medical and automotive markets – that **offer assured supply**

www.freescale.com/productlongevity

Summary

Long standing solution provider

Broad sensor portfolio

Broad ecosystem

Quality, product longevity, robustness

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