

PARTITIONING BETWEEN SOFTWARE AND HARDWARE IS KEY TO ULTRA-LOW POWER

Tim Saxe, CTO, QuickLogic Corporation

saxe@quicklogic.com

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CORPORATE BACKGROUND

Large, High Growth Markets

- Smartphones, Tablets, Wearables, Mobile Enterprise
- TAM 1.6B+ units in 2017
- CAGR 10%+

Top Tier Customer Adoption



Disruptive Technology

- Mobile-specific ultra-low power, in-system reprogrammable & instant-on, non-volatile architectures
- Hard logic building blocks for scalable approach

Strong Ecosystem



Corporate

- NASDAQ: QUIK, HQ in Silicon Valley; R&D: Sunnyvale, Bangalore, Toronto
- Field Sales and Support: South Korea, Japan, China, Taiwan, UK
- Employees: 100; Technical Staff: 55

THE POWER CHALLENGE

- 3 Years ago everyone was thinking about always-on sensing for phones
 - Power budget: 1% of battery between charges can be tolerated
→ 30mAh/day → 3,500 μ W
 - But one OEM said 500 μ W

THE POWER CHALLENGE

- 2 years ago everyone was thinking about wearables
 - Power budget: one month from a 110mAh battery
→ 30mAh/week → 500μW
 - A 7x reduction in 1 year
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That is what people were *saying* they needed...
but I think they were afraid to ask for what they
really needed

THE POWER CHALLENGE

- Last year everyone was thinking about Enterprise and Industrial applications for wireless sensing (IoT)
 - Power budget: 240mAh/year → 20mAh/month → 80μW
- 2 years ago everyone was worried about wearables
 - Power budget: one month from a 110mAh battery
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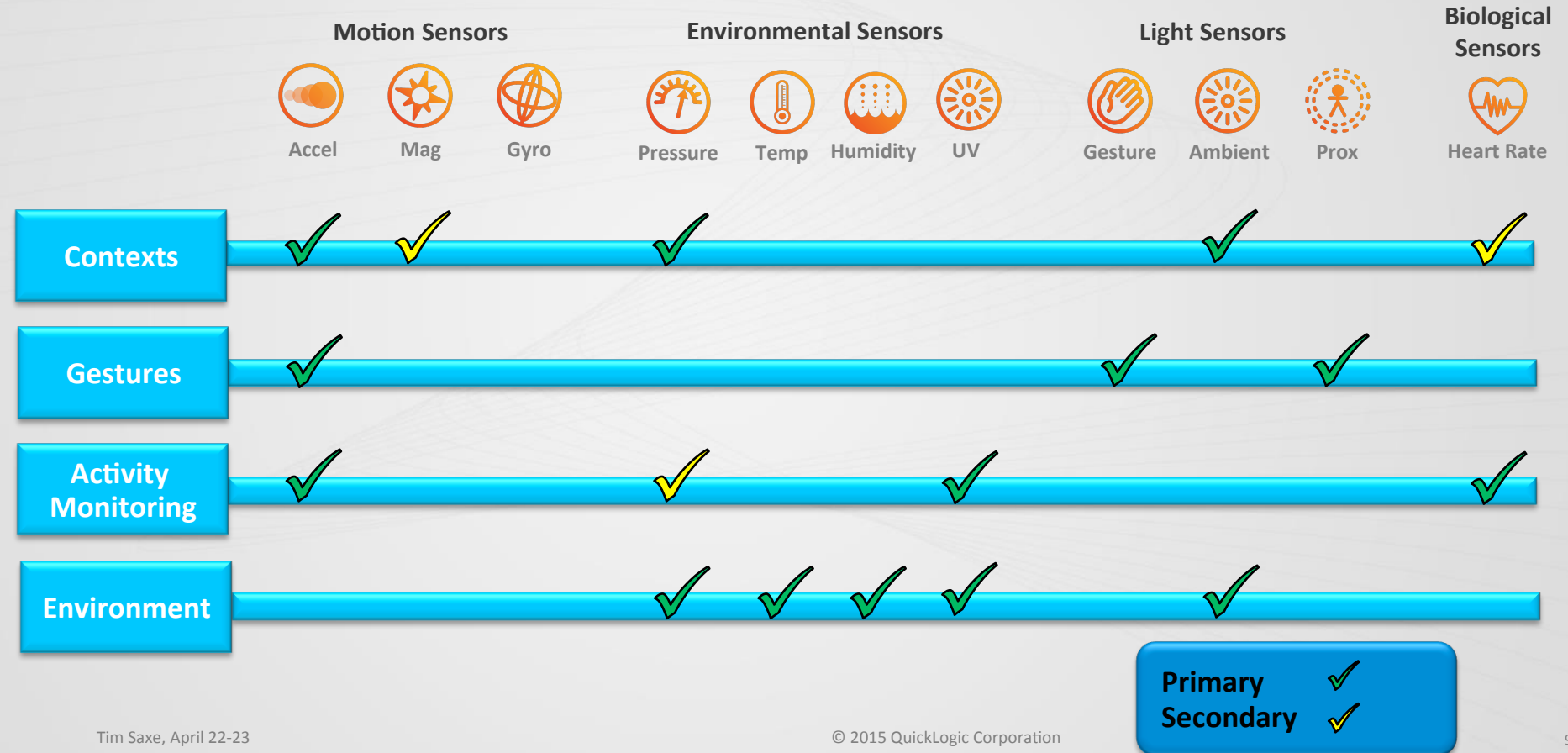
IoT need is 6x lower than wearables – but who wouldn't want their wearable to last a year?

THE PARTS



CURRENTLY DEPLOYED SENSORS AND APPLICATIONS

MOBILE MARKETS



CURRENTLY DEPLOYED SENSORS

MOBILE MARKET

Motion Sensors



Environmental Sensors



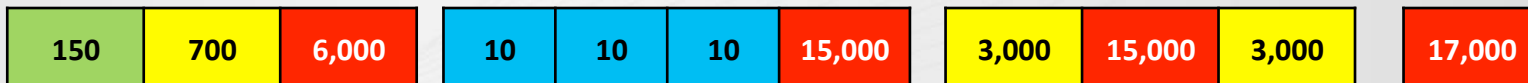
Light Sensors



Biological Sensors



Active Power* (μ W)



Relative Usage

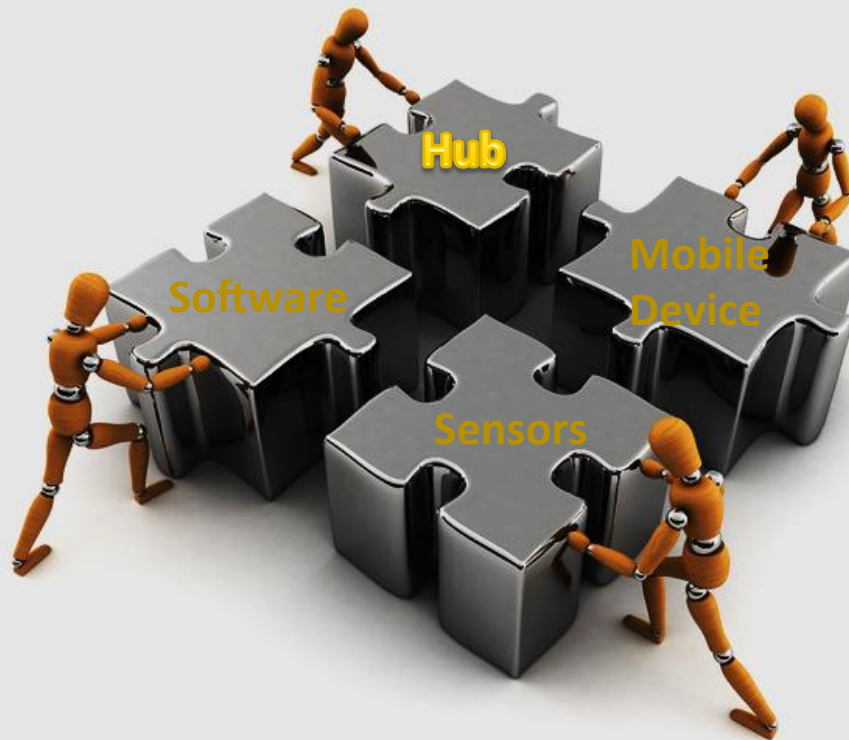


High power consumption devices will require special consideration for pervasive deployment

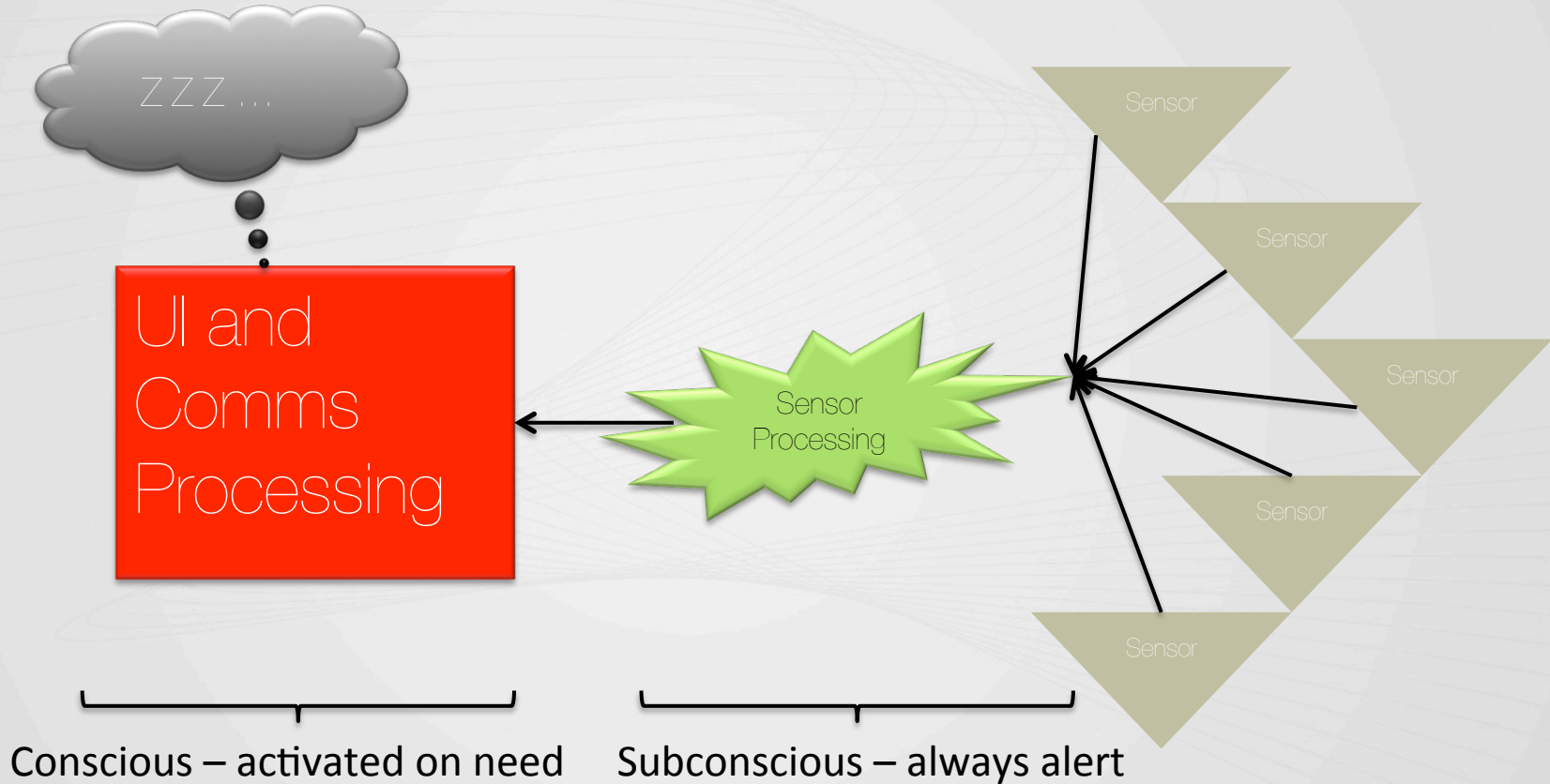
■ Meet IoT
 ■ Meet Wearable
 ■ Meet Phone
 ■ Exceed All

*Sampling Frequency Dependent

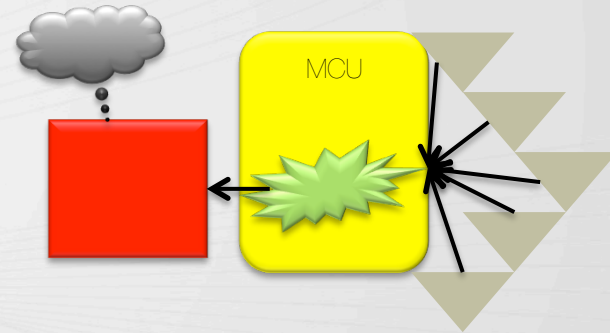
THE PARTS



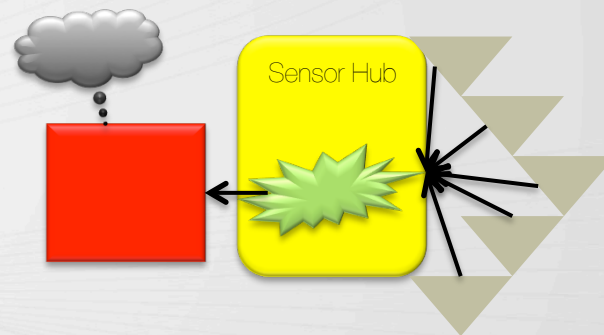
LOGICAL SYSTEM

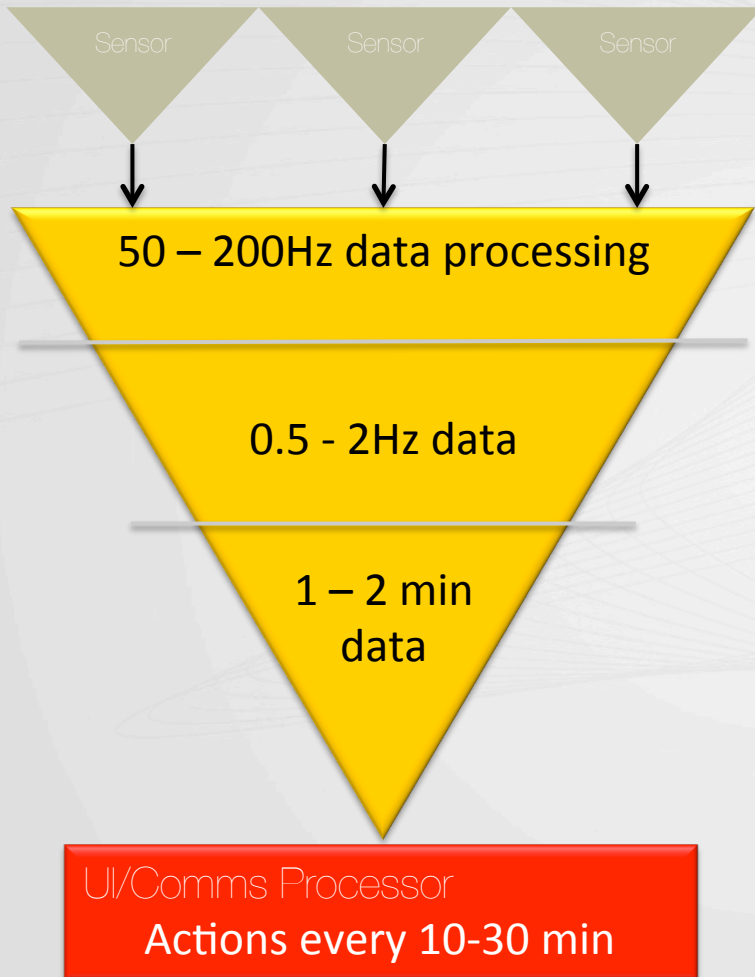


- Adding a small MCU just for the sensor processing
 - + Many options
 - + Good availability
 - + Access to all sensors
 - + Programmed in C
 - + Available third-party algorithms
 - + Works with sensors from any vendor
 - Higher than desired power



- Use a true sensor hub
 - + *Custom hardware* for sensor management
 - + *Custom hardware* for critical algorithms
 - + C programming for non-critical algorithms
 - + Sensor power management designed-in
 - + Access to all sensors
 - + Works with sensors from any vendor

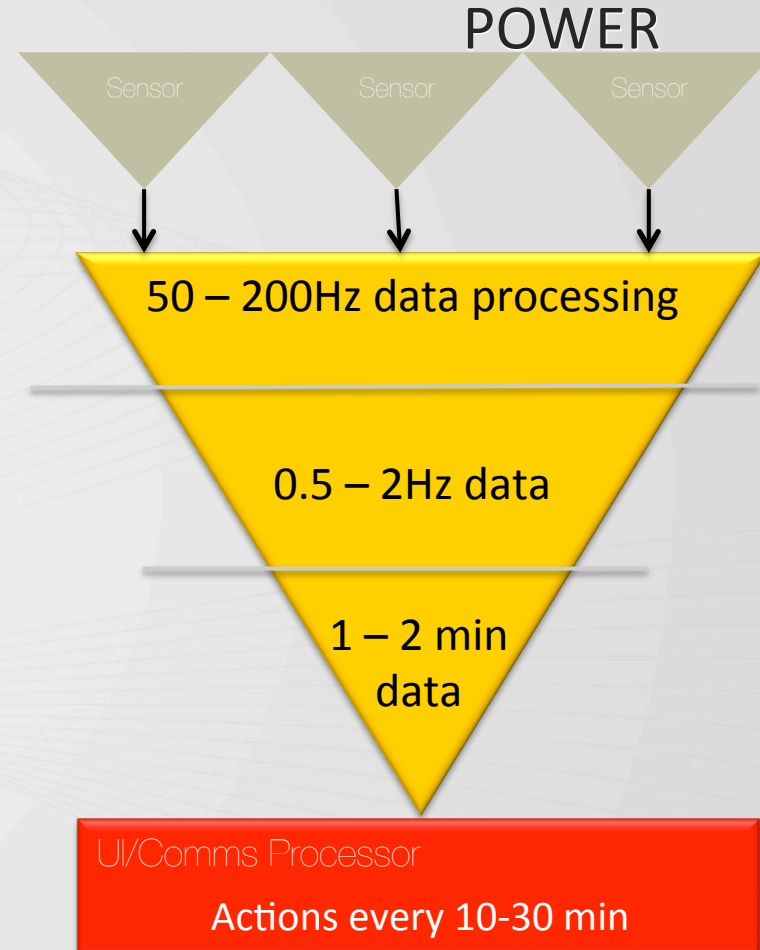




PARTITIONING

- Use dedicated hardware to reduce raw sensor data that arrives 50 – 200 times per second by 2 orders of magnitude into information at $\frac{1}{2}$ to 2 times per second (steps/heartbeats)
- Use software to reduce the $\sim 1\text{Hz}$ information by 2 orders of magnitude into decision points (stopped walking, got into car)
- Use abstract decision software to convert 1/minute decision points into actions every 10-30 minutes

- Dedicated hardware reduces power to 10's of microwatts
- Optimized software at low duty cycle turns sensors on/off to keep power low while maintaining accuracy
- Generic software provides ease of development and very low duty cycle results in low power



- A long battery life ***smartband*** with the following features:
 - Minimum of 1 month of battery life
 - Pedometer + Activity Monitor
 - Sleep monitoring



Stationary



Walking



Running



Cycling



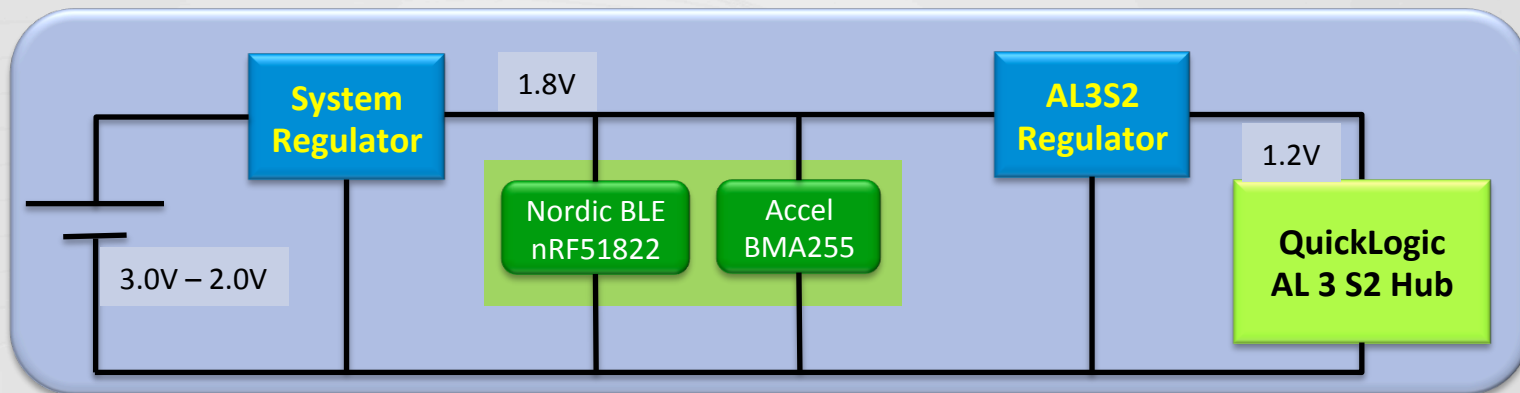
Sleeping



Device Not on Person

FEASIBILITY STUDY

CONSIDERED SYSTEM BASIC HIGH LEVEL BLOCK DIAGRAM



Component Type	Model	Notes
Sensor Hub	QL AL 3 S2	QuickLogic Ultra-Low Power Sensor Hub
Bluetooth Low Energy Device	Nordic nRF51822	BLE Device with M0 Host MCU
Accelerometer	Bosch BMA255	Low Power Mode, Supporting Inertial Wake
System Regulator	LTC3330	79% Efficiency @ 3.0 V _{in} Output Feeds AL 3 S2 LDO
Hub Regulator	LTC3330	75% Efficiency & 90% in Quiescent Mode
Battery	CR2030	250 mAh

AL 3 S2 USE-CASES AND ASSUMPTIONS

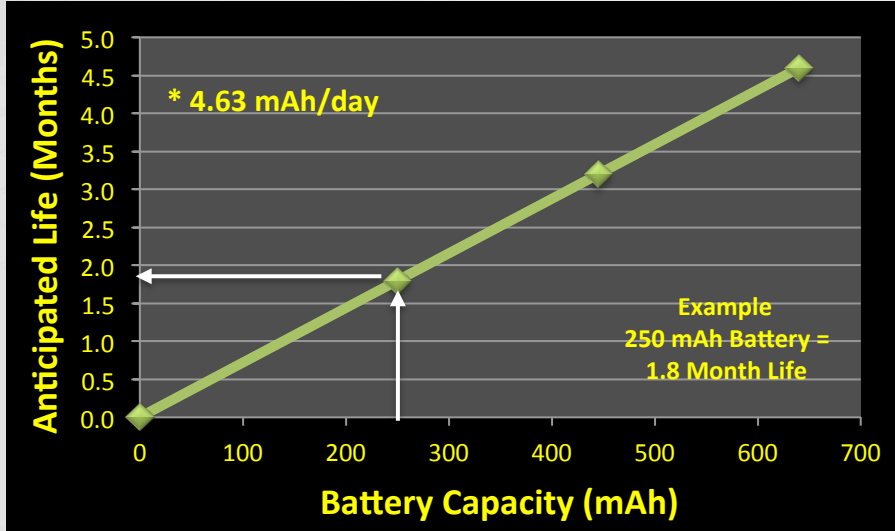
- Smartband Use-Cases Modeled
 - Vigorous Activity → Exercising (running, biking, ...)
 - Moderate Activity → Walking
 - Sedentary Activity → Stationary, Sleep

Activity Level	Regular Day		Active Day		Restful Day	
	Hours	Percent	Hours	Percent	Hours	Percent
Vigorous	1.0	4.0	2.5	10	0.0	0.0
Moderate	15	63	14.5	60	16	67
Sedentary	8.0	33	7.0	30	8.0	33

- BLE synchronization initiated by the paired smartphone *once per hour*

BATTERY LIFE ESTIMATIONS

Anticipated Battery Life



Coin Cell Battery	Battery Life
CR2025 (250 mAh)	1.8 months
CR2032 (450 mAh)	3.2 months
CR2045 (650 mAh)	4.5 months

- Use a sensor hub to:
 - Convert data into actionable information
 - Consolidate sensor processing in one low power device
 - Fuse data from multiple sensors
 - Partition repetitive, always-on processing into hardware
- When it comes to battery life, “bigger, better, faster” is not your friend