

High-Function, Long-Range Passive Wireless Sensor Tags

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Powercast Overview

RF-based power for low power applications

- uW to mW

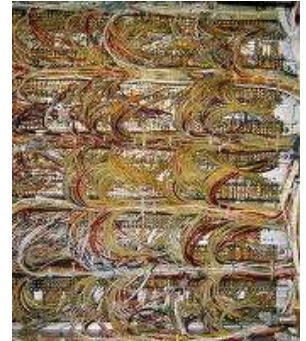
Range of solutions

- OEM Powerharvester[®] modules
- RF transmitters
- Systems (PWST)
- Custom engineering



Why Wireless Power?

- **Wiring is expensive**
 - \$100s per device to \$100s per foot
 - Wiring requires bulky termination panels
 - Wiring changes are disruptive / costly
- **Batteries can be liabilities**
 - Hazardous material handling and disposal
 - Repeated maintenance cost
 - Impact of early failure
 - Limitations of scale
- **Wireless enables mobility**



Why RF vs. Energy Harvesting?

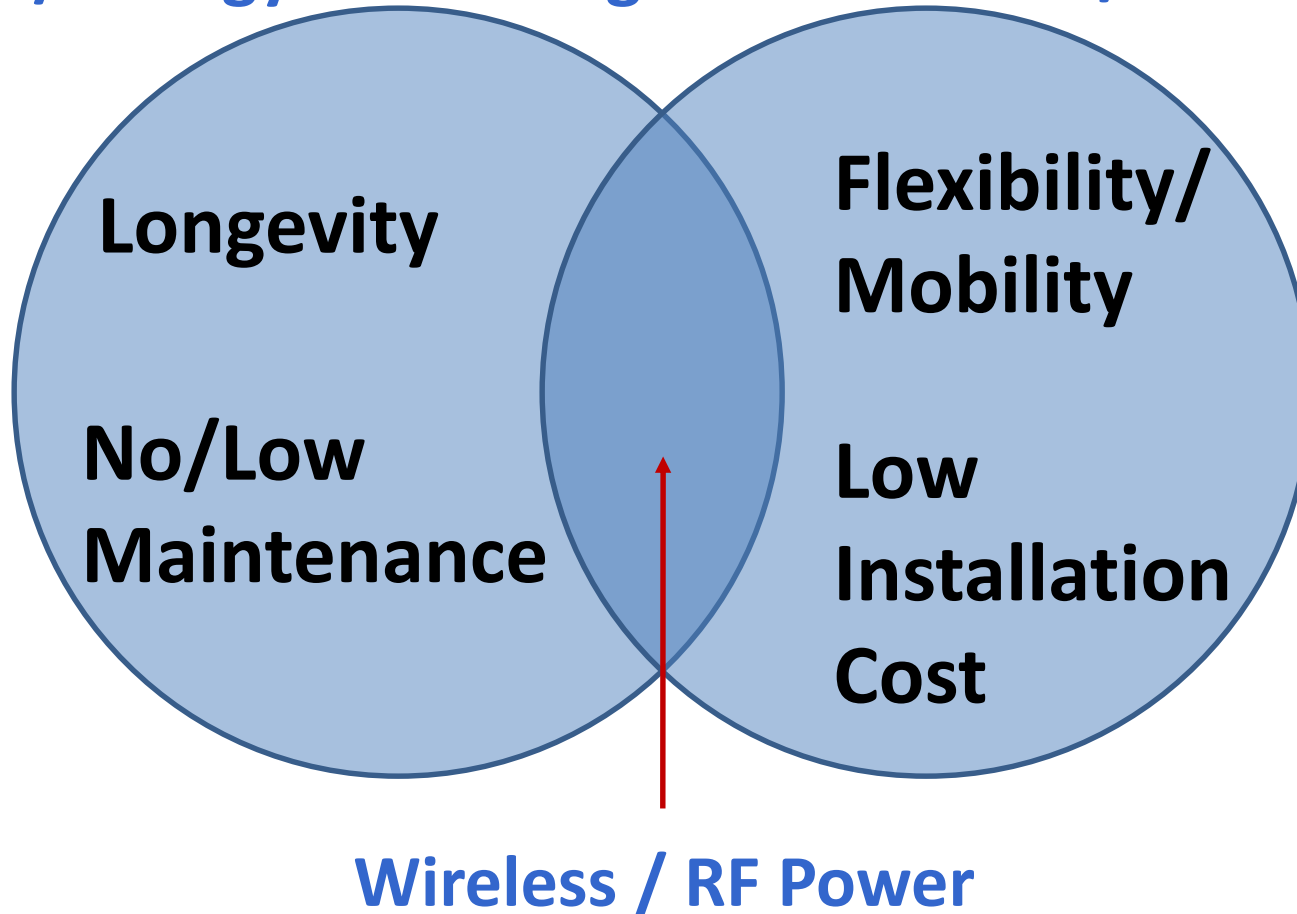
- Light / solar energy not always sufficient and rechargeable batteries are required
- Temperature requires large ΔT
- Vibration has narrow bandwidth, moving parts
- RF-based wireless power
 - Send power over distance - μW , low mW
 - One-to-many, any-to-any topologies
 - Overcomes lack of light, temp diff., or vibration
 - Controllable: continuous, scheduled, on-demand



RF-power enables benefits of wired and battery-based systems

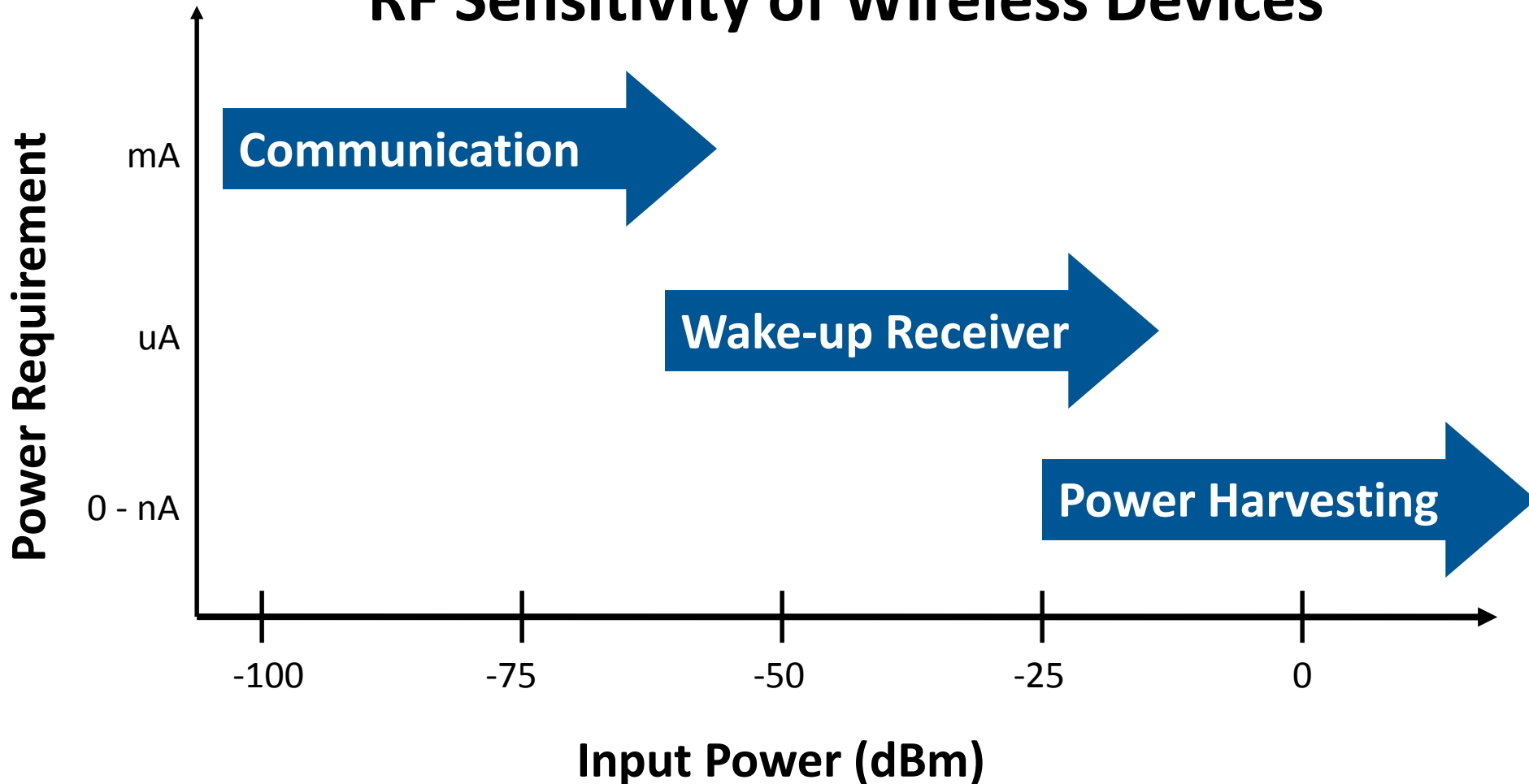
Wired / Energy Harvesting

Wireless / Batteries



Perspective: Communication vs. Power

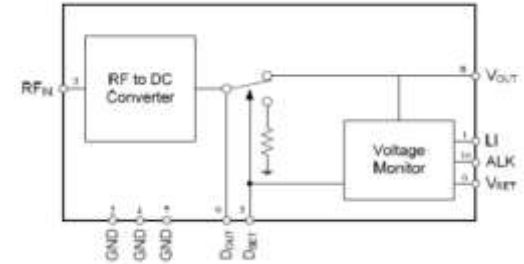
RF Sensitivity of Wireless Devices



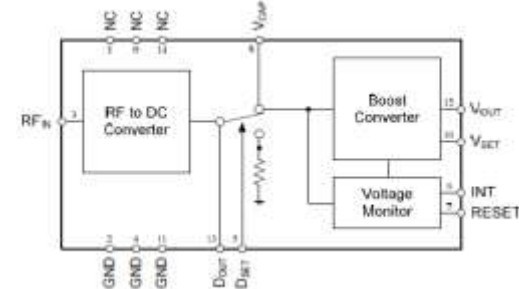
Powerharvester[®] Receivers

- Convert RF input to DC current
- Provide power management
- Frequency range: 850-950MHz
- RSSI and Data output
- Designed for standard 50Ω antennas

P1110



P2110



P1110

Continuous Power Output

- RF range: -5.0dBm to 20dBm
- Output voltage: 1.8V to 4.2V (configurable)
- Range of at least 3 meters



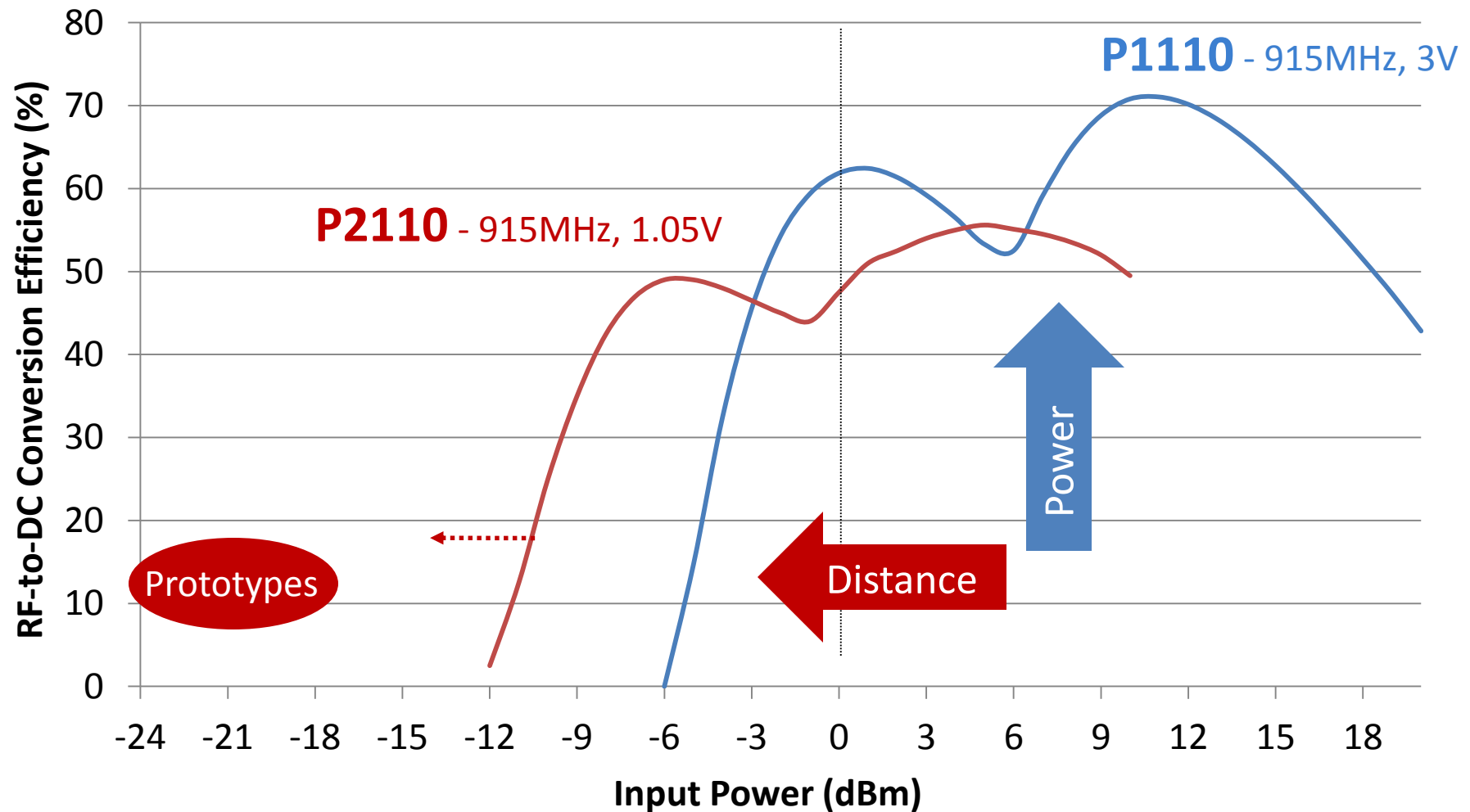
P2110

Pulsed Power Output

- RF range: -11.5dBm to 15dBm
- Output voltage: 1.8V to 5.25V (configurable and regulated)
- Range of at least 10 meters

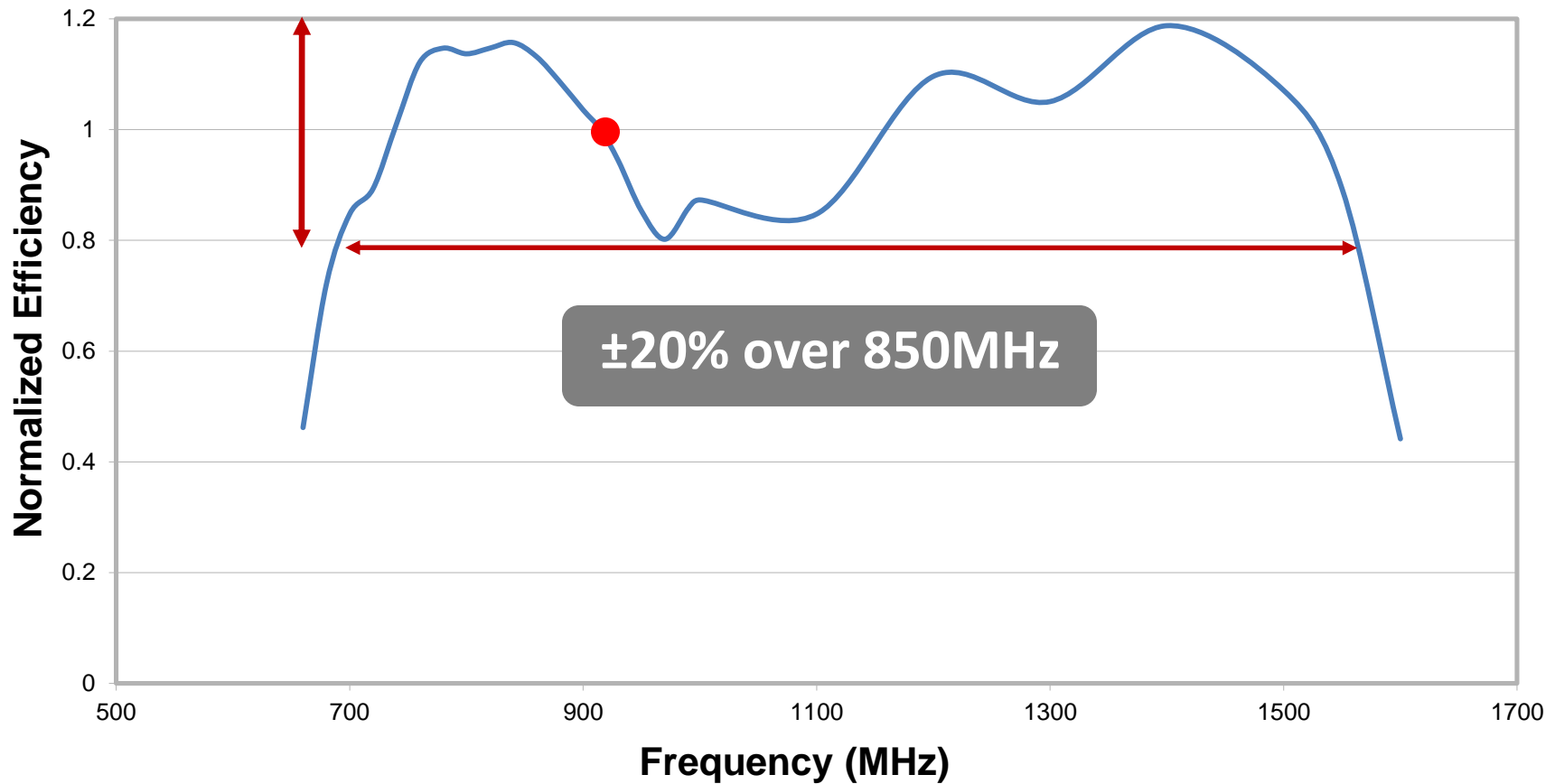


Powerharvester[®] Efficiency Maintained Over Wide Range of Input Power

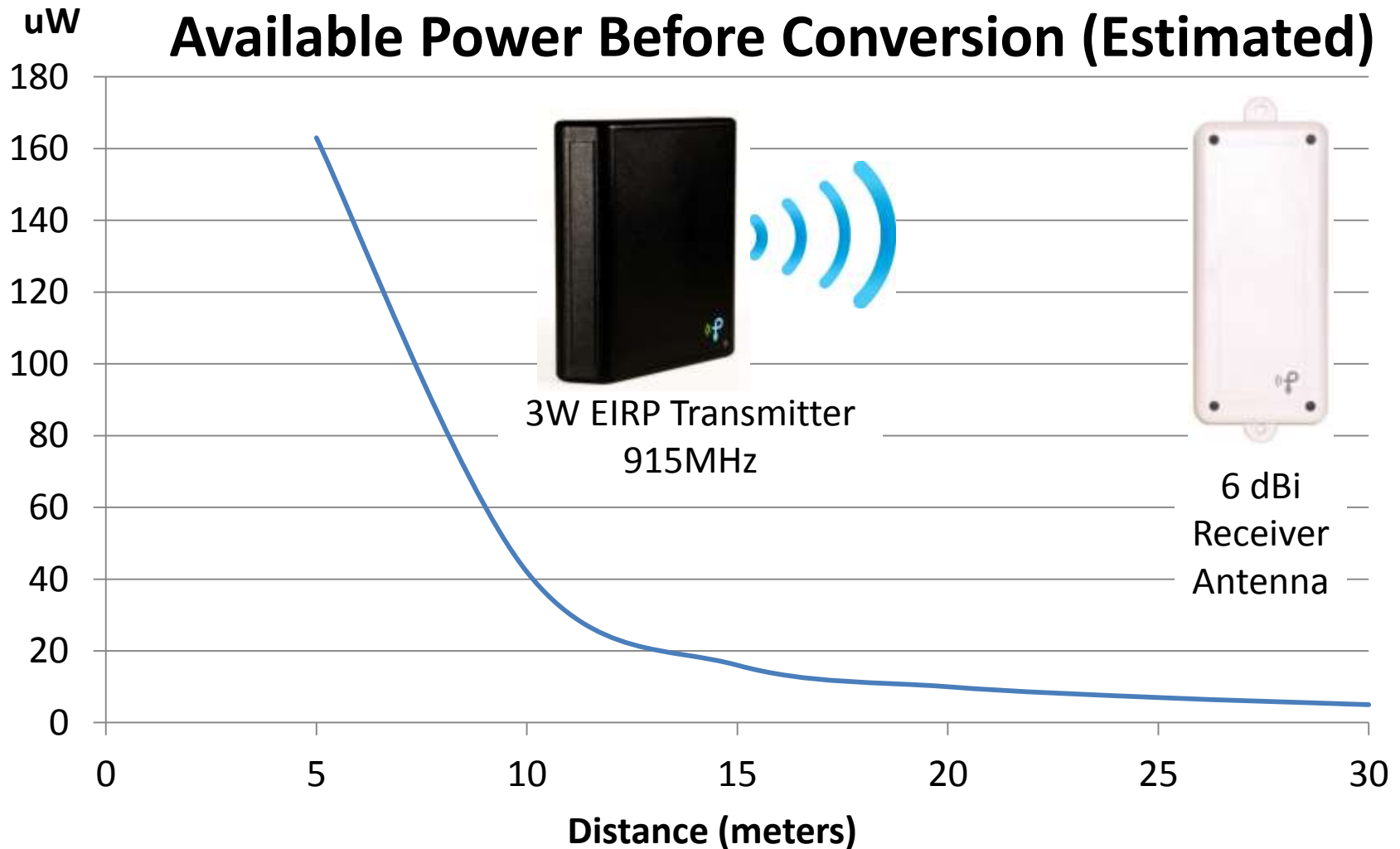


Powerharvester[®] Efficiency Maintained Over Frequency

-3dBm (500uW) Input, 1V Load



Available Power vs. Distance



Powercast vs. Traditional RFID



Access Point



Powercaster

Various frequencies & protocols (e.g. 2.4GHz, ZigBee)



915MHz



Battery-less Device



- Longer range
- Higher function



- Battery recharge

Remote Battery/Device

Power Transfer = Energy Accumulation



RFID Reader



RFID Protocol



RFID Tag

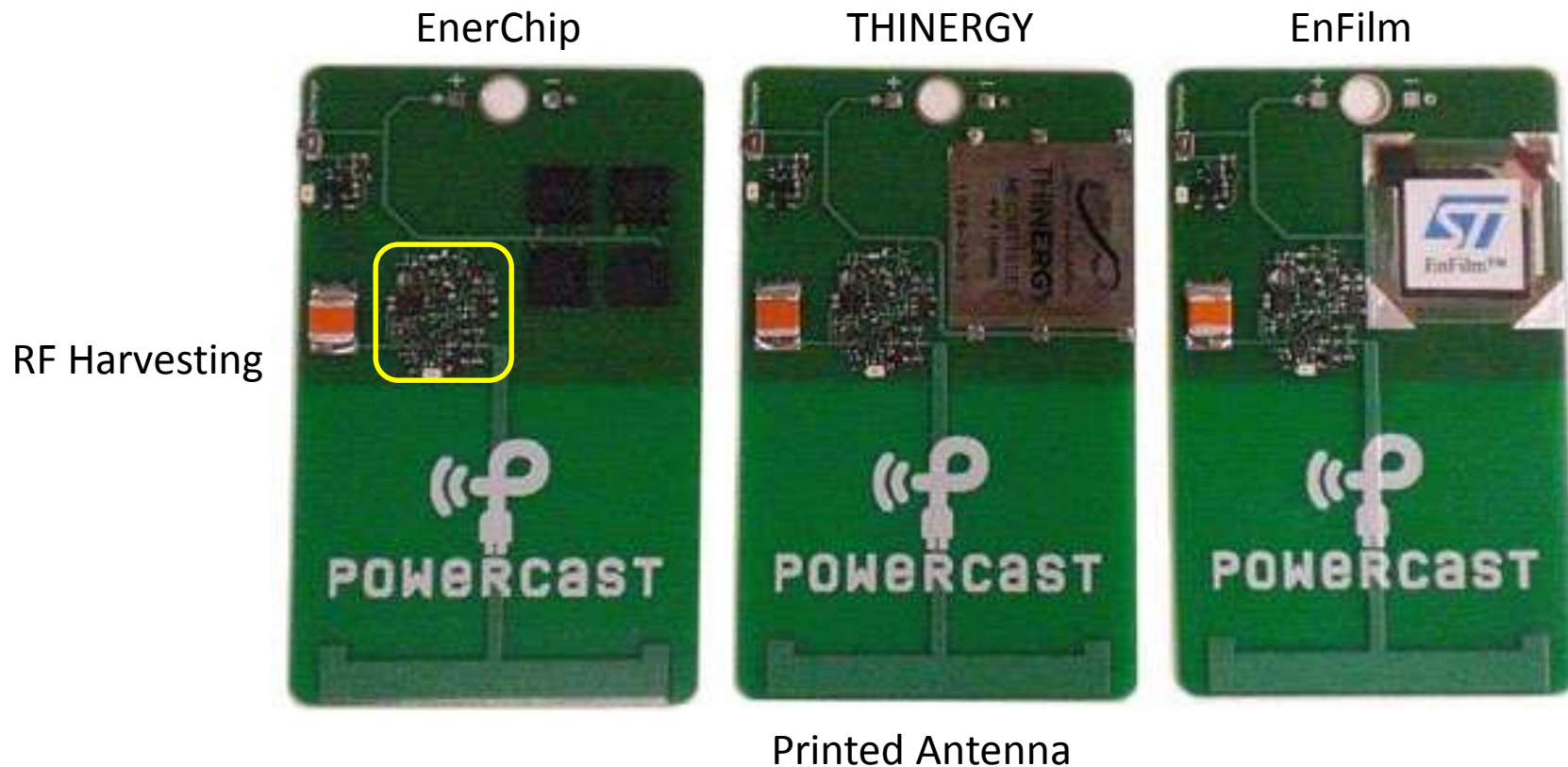


- Low cost
- Low function
- Short range

Identification = Real-Time Operation

Prototypes for Rechargeable Active Tags

Rechargeable thin-film batteries enables thin form factor



Battery-Less Sensor Demo (2010)

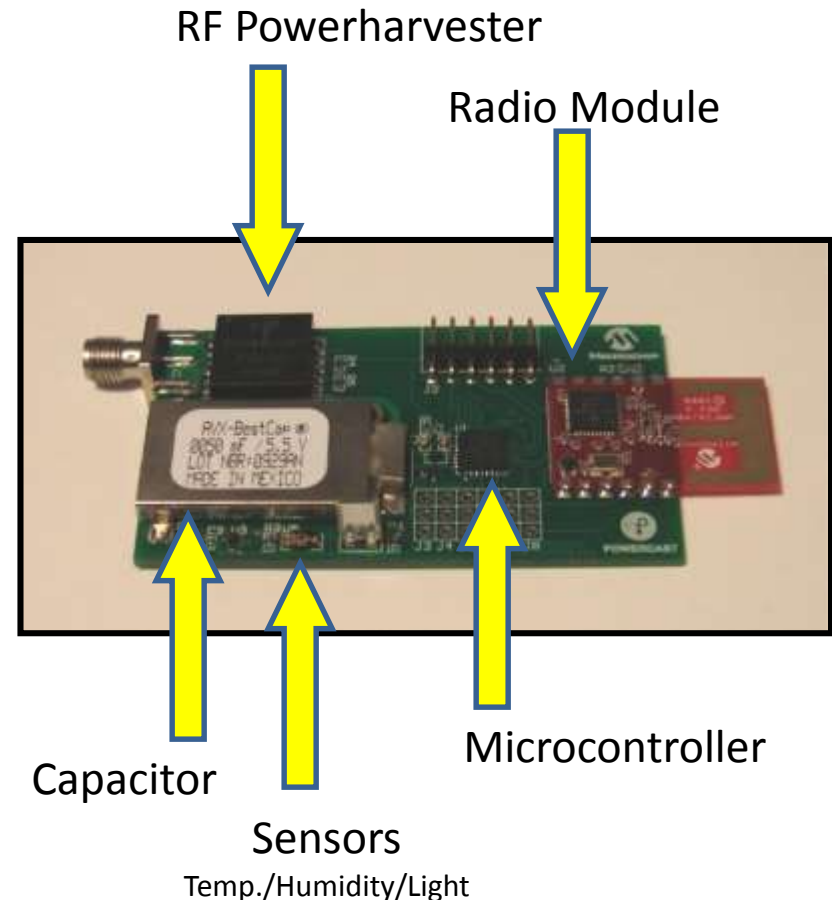
Module Components & Features

- Powercast P2110 Powerharvester[®] Receiver
- MCU: Microchip PIC24F16KA102 XLP MCU
- Radio module: Microchip MRF24J40 (2.4 GHz)
- System power: 3.3V
- Capacitor: 50 mF (as low as 3300 μ F)
- Discrete sensors: Temp., Humidity, Light
- Wireless protocol: MiWi[™] P2P
- Data packet: Node ID, T/H/L data, RSSI

Power Source: 3W, 915 MHz, DSSS transmitter

Access Point: XLP 16-bit Development Board

- output to PC via USB



Lifetime Power® Sensor System

Powercaster® Transmitter

One-to-Many
Power Source



TX91501

915 MHz



Gateway

Network

Ethernet or Serial



WSG-101

Wireless Access Point
(for up to 100 devices)

RF-Powered Wireless Sensors

2.4 GHz



Temperature
Humidity



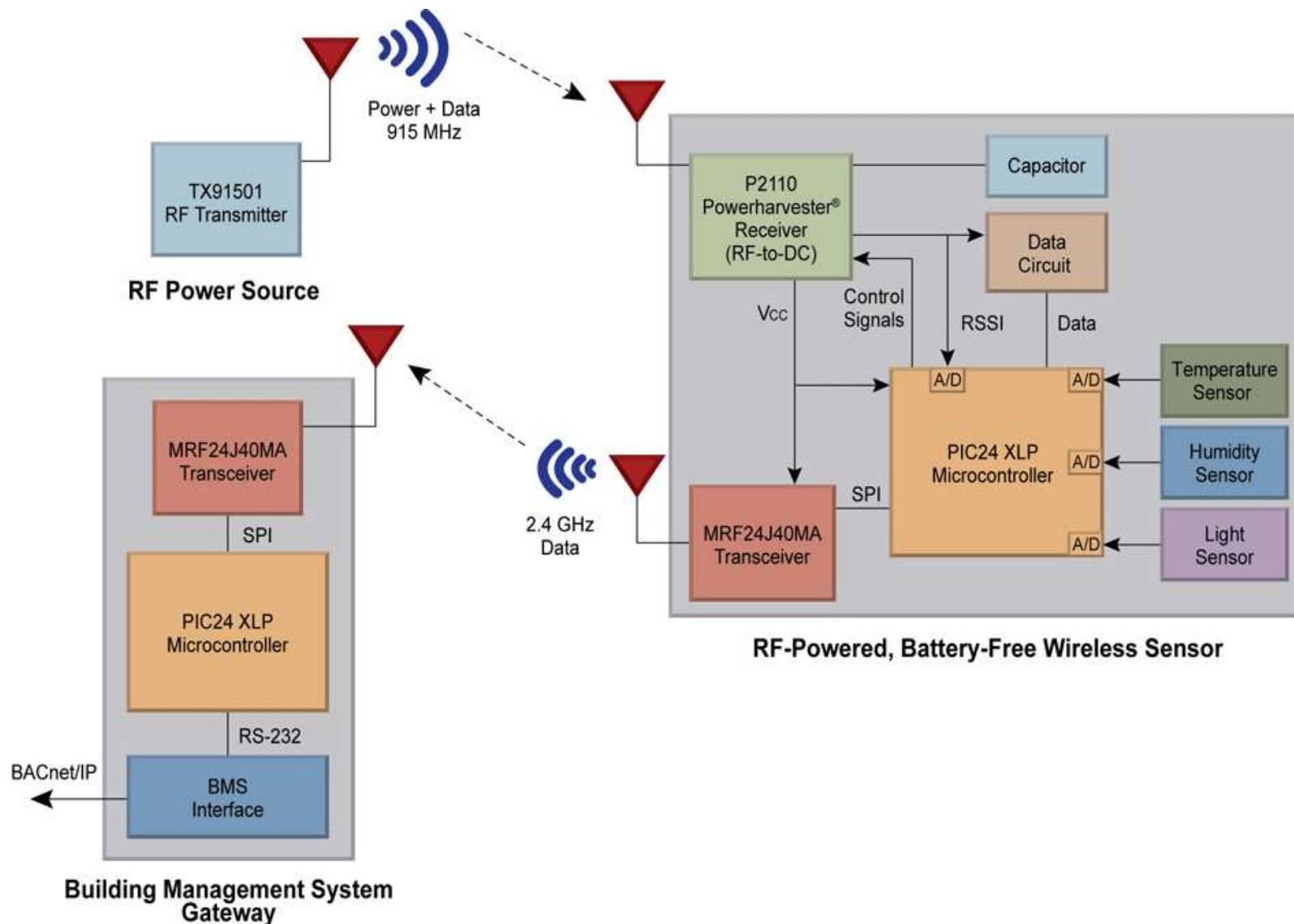
Light



Pressure

Battery-less Sensors (PWST)

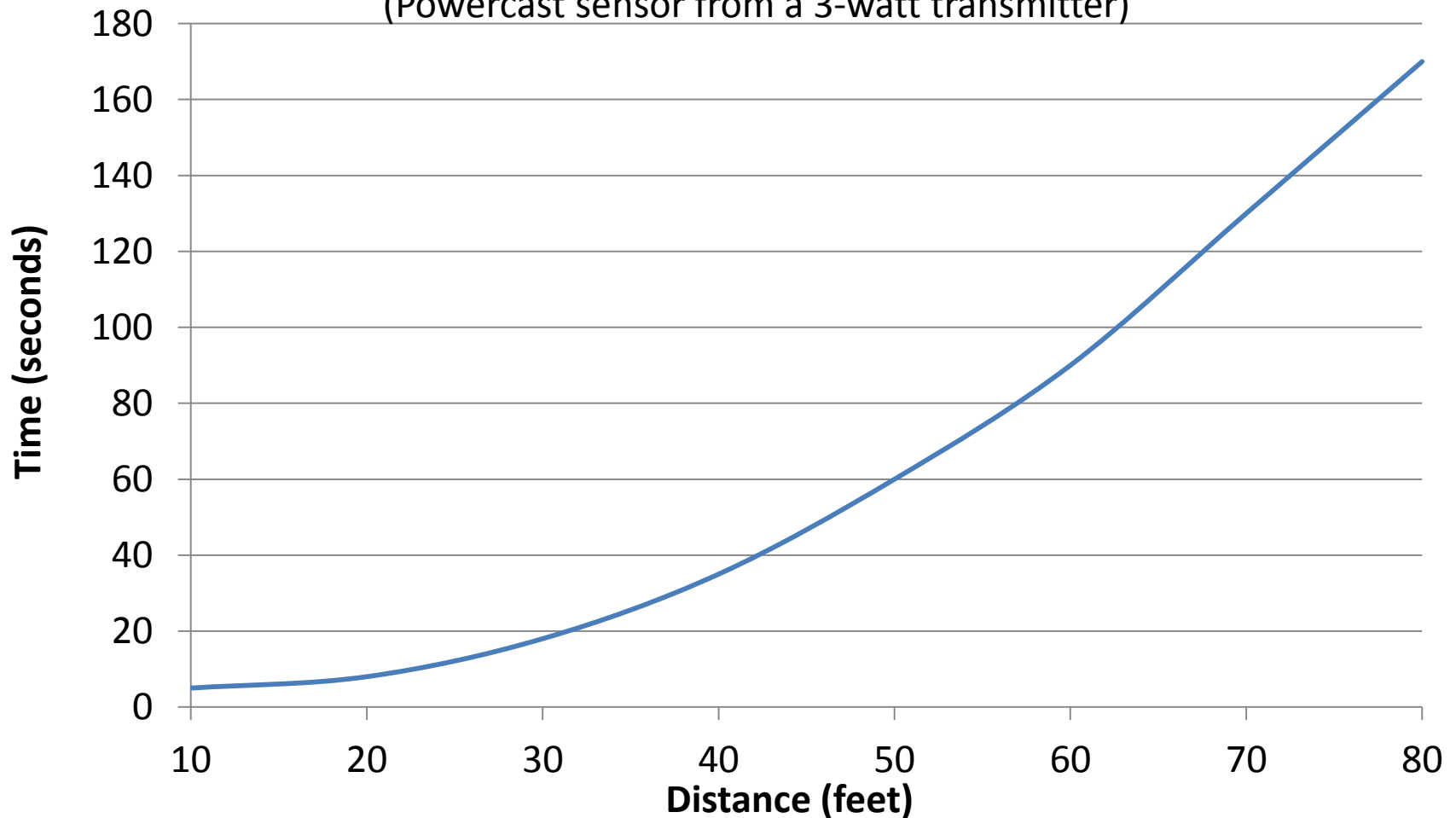
System Block Diagram



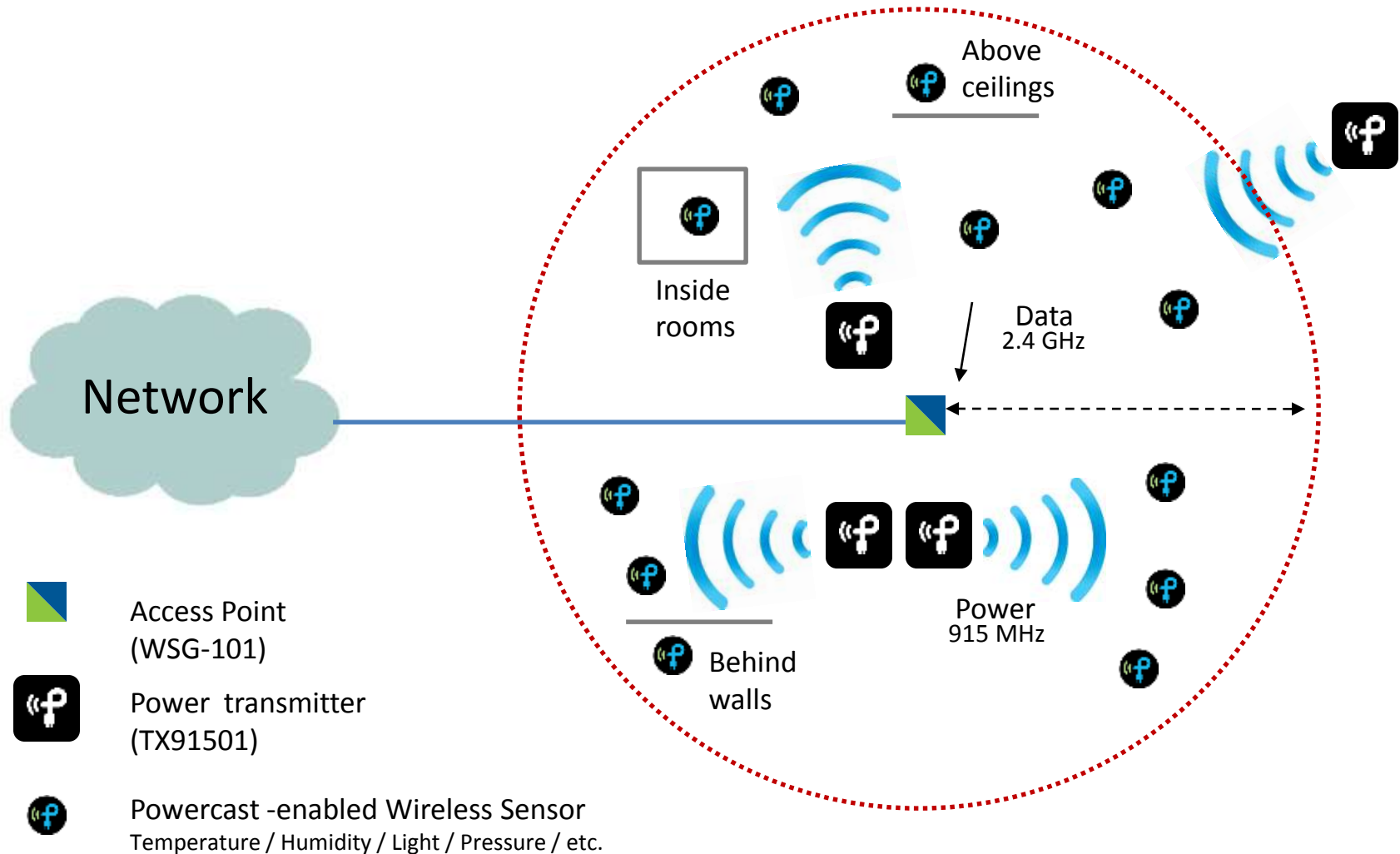
System Performance

Typical time between packets

(Powercast sensor from a 3-watt transmitter)



Scalable System Deployment



Lifetime Power® Wireless Sensors



- Powered wirelessly (915MHz)
 - No batteries, no wires
 - Power range of 60-90 feet line of sight
- Range of sensor types
 - Temp / Humidity
 - Light
 - Pressure
- Data transmit range of ~120ft
 - 2.4GHz, 802.15.4 radios
- Serial Interface (USB)
 - Configuration from Gateway
- Both antennas internal

Broadcasted Power Coverage Area

Coverage Area – 3W transmitter (TX91501)

@ 60 feet $\approx 1900 \text{ ft}^2$

@ 80 feet $\approx 3300 \text{ ft}^2$

Average $\approx 2500 \text{ ft}^2$



60 ft

80 ft

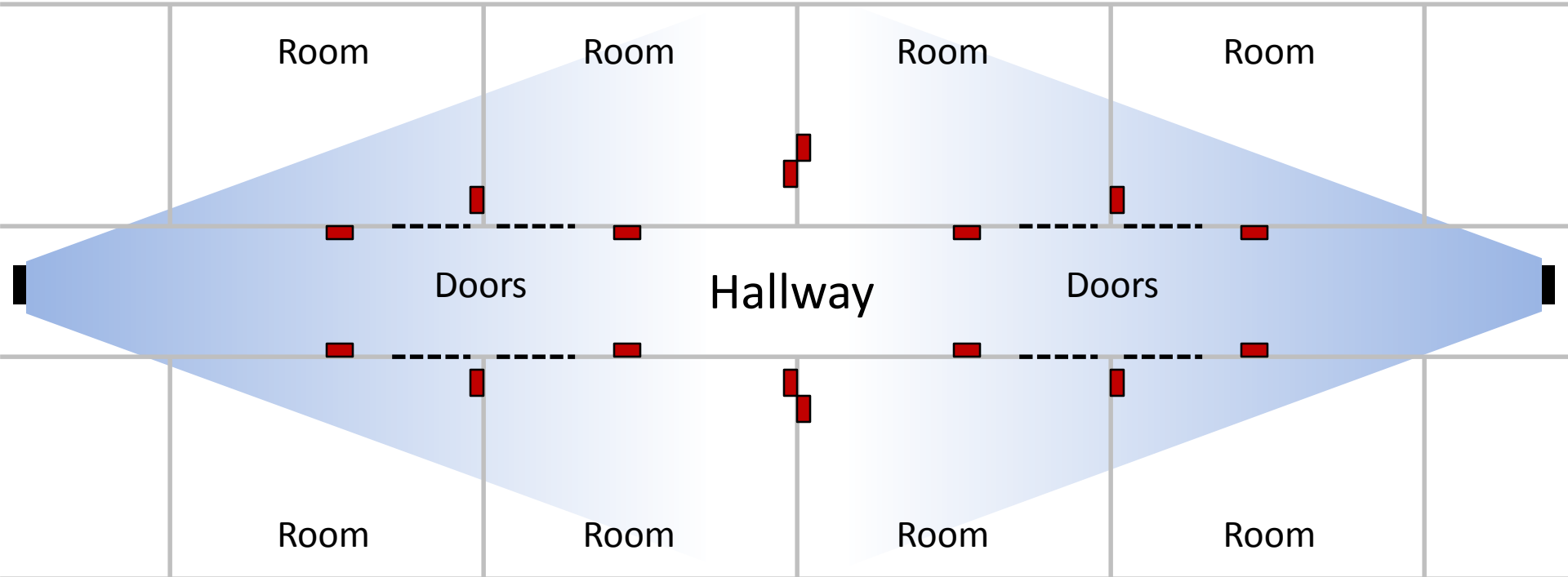
Effective range
increases with
improved RF
sensitivity of
the receiver

Cost per $\text{ft}^2 \approx \$0.10$ to $\$0.15$

Wireless Sensor Deployment

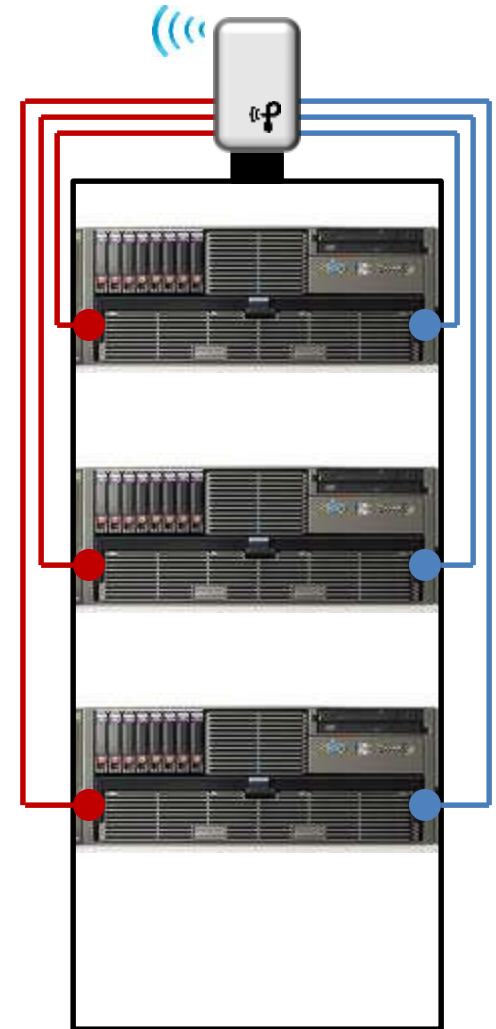
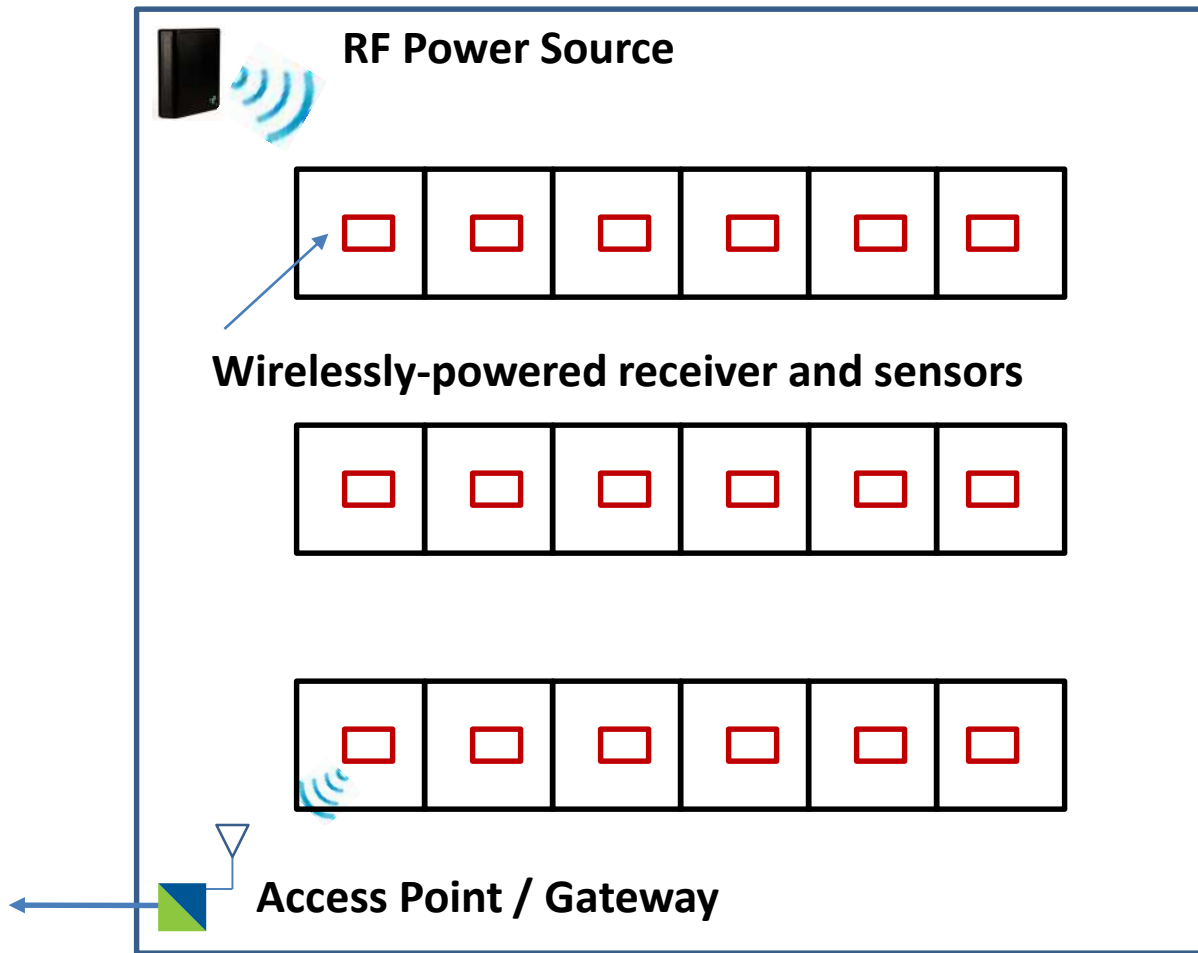
- Sensor locations
- RF transmitter (ceiling mount)

Offices, Hospitals, Hotels, Apartments, etc.

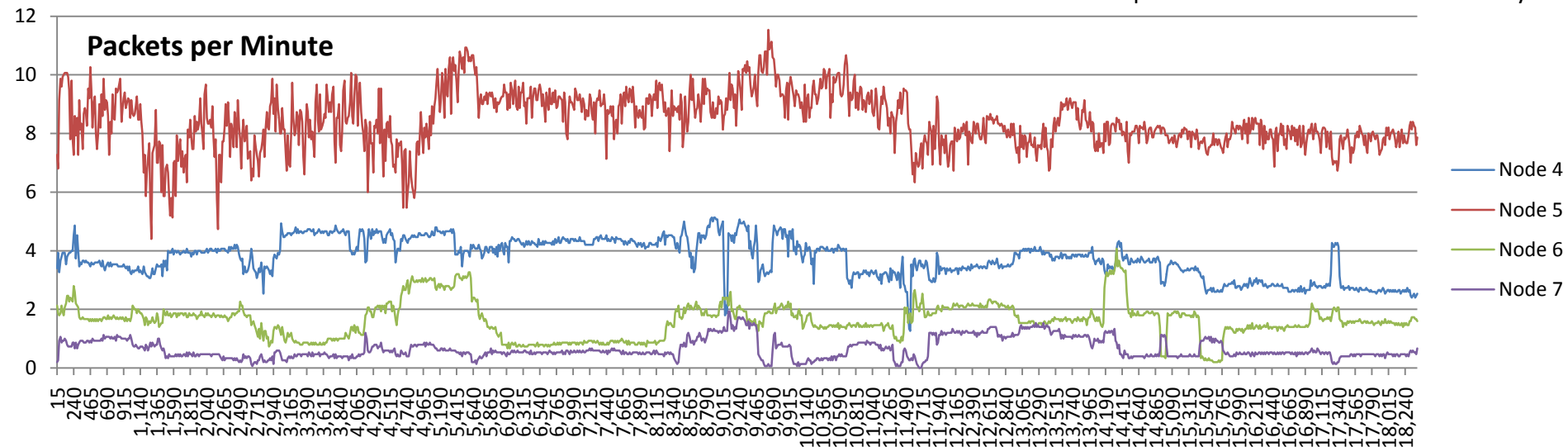
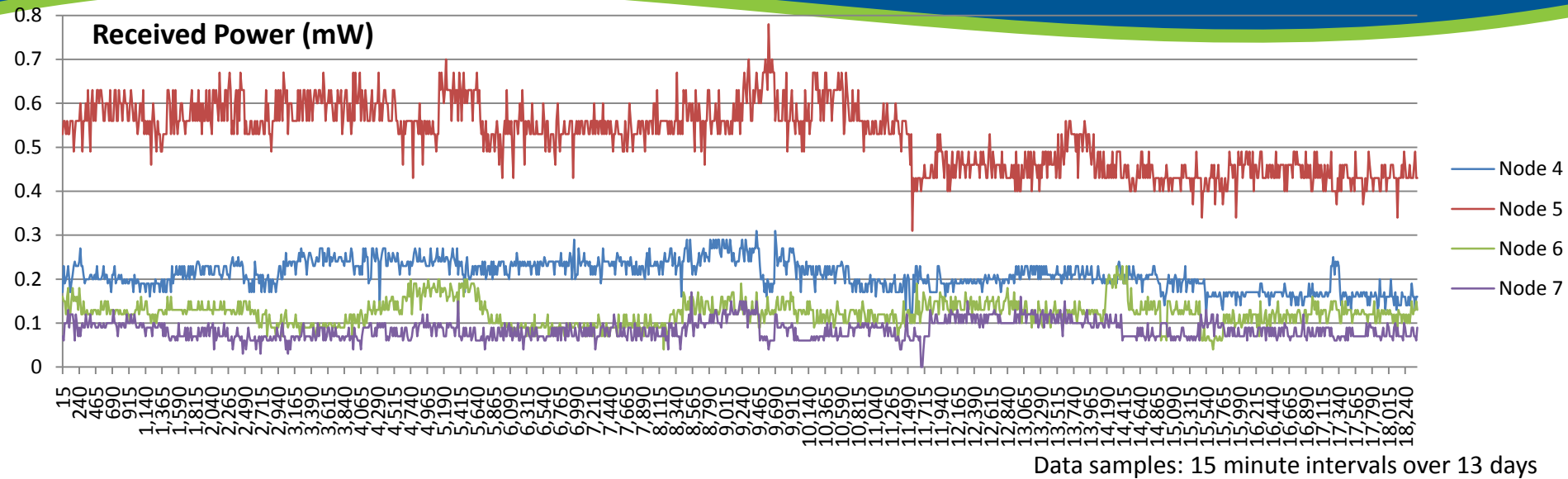


- Using multiple transmitters creates a wireless, micro-power grid.
- Unlimited receivers can be used within range of a power transmitter.

Equipment Rack Monitoring



Trial Deployment: Data Center



RF-Power for Substation Monitoring



- One-to-Many scenario
- Relatively short range
- 24 x 7 x 365 power
- Minimal weather issues

Future: Low Frequency for Range/Power

- Longer range
- Acceptability of antenna size
- Lower transmitter power
- Higher received power
- Omni-directional Tx/Rx
- Freedom of placement



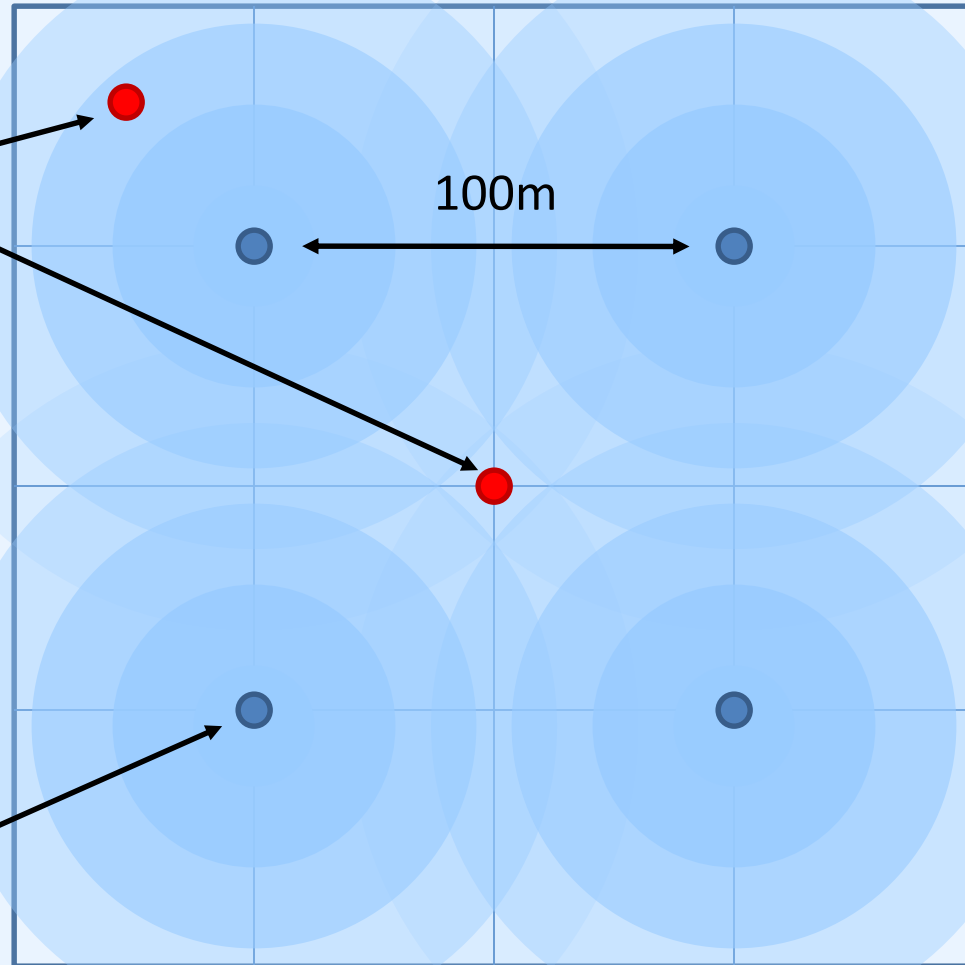
Low Frequency Example

200m x 200m area

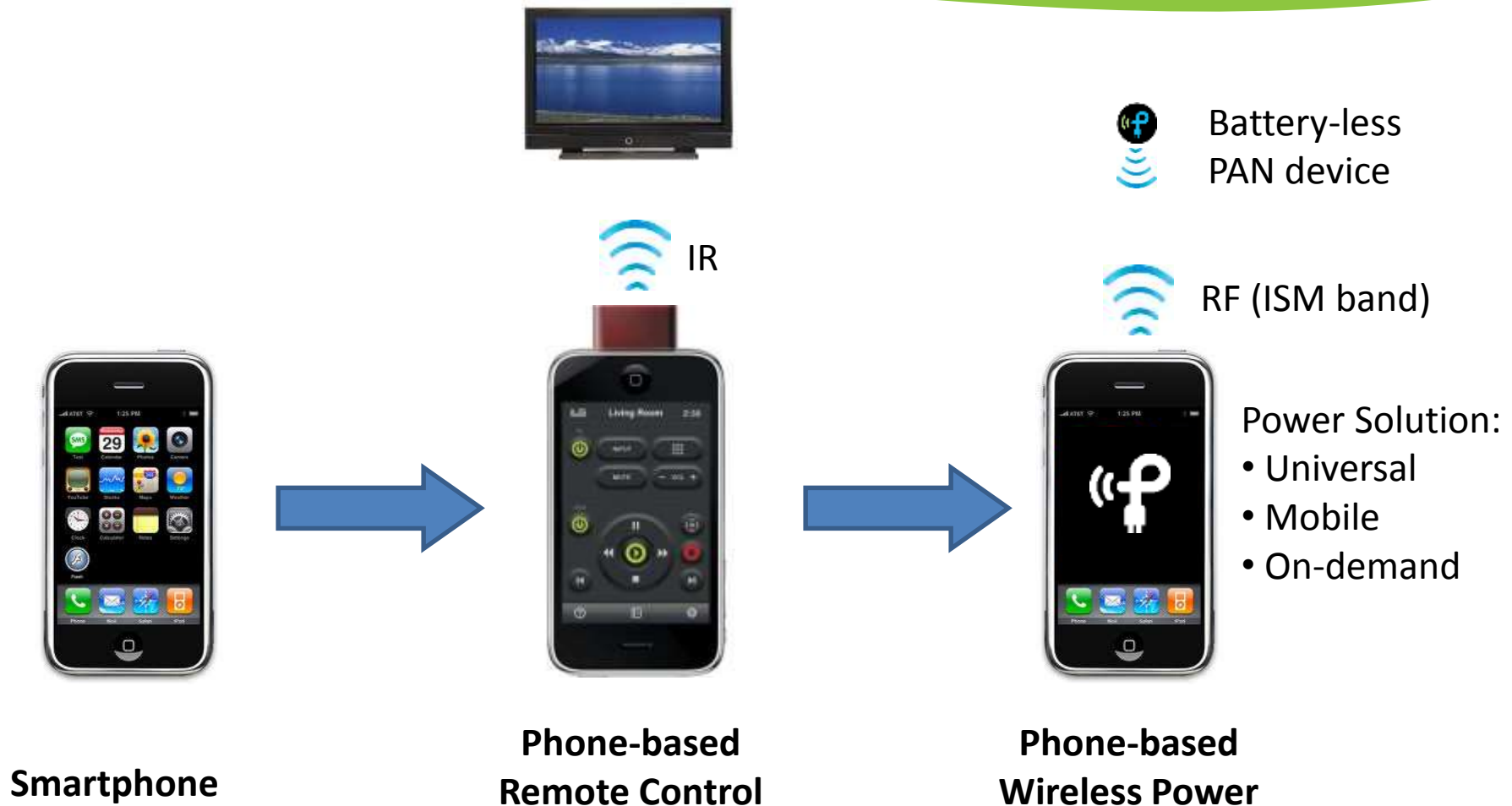
Equivalent Power
Available

Transmitter Power	Available Power
1 watt	290 μ W
4 watts	1.16mW

Transmitter



Future: Smartphone “Power App”



Demo at <http://www.youtube.com/powercastco>

Summary

- RF-powered systems for remote monitoring are available, practical, and deployable.
- RF-power combines benefits of wires, energy harvesting, and batteries.
- Battery-less tags can be placed in hard to service areas
- Packet rates of several minutes or less are sufficient for many control applications

Questions

Thank You!

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Emerging
Technology



P2100
Powerharvester®



TX91501
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