

Wireless Sensor Node Design Considerations

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Overview

- Introduction
- Applications
- Wireless Sensor Network standards
- Block Diagram of Wireless Sensor Node
 - General specifications for Wireless Sensor Node
- Blocks in detail
 - Microcontroller
 - Sensor and Sensor interfaces
 - RFIC(RF Transceiver)
 - Antenna
 - Balun
- Components
- Materials
- Conclusion

Introduction

- A wireless sensor node (WSN) is a node in a wireless network that is able to collect the information from sensors, process it and communicate wirelessly with other nodes in the network
- Applications
 - Industrial automation
 - Home Automation
 - Medical Monitoring
 - Asset tracking
 - Agriculture

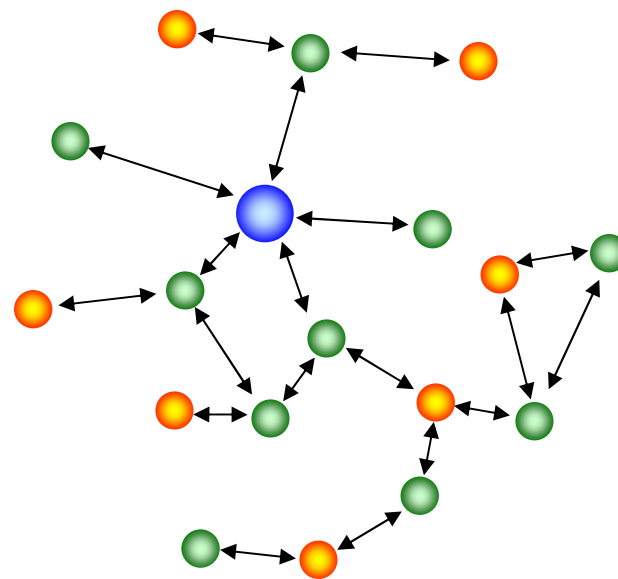


Some of the standards for Wireless Sensor Networks

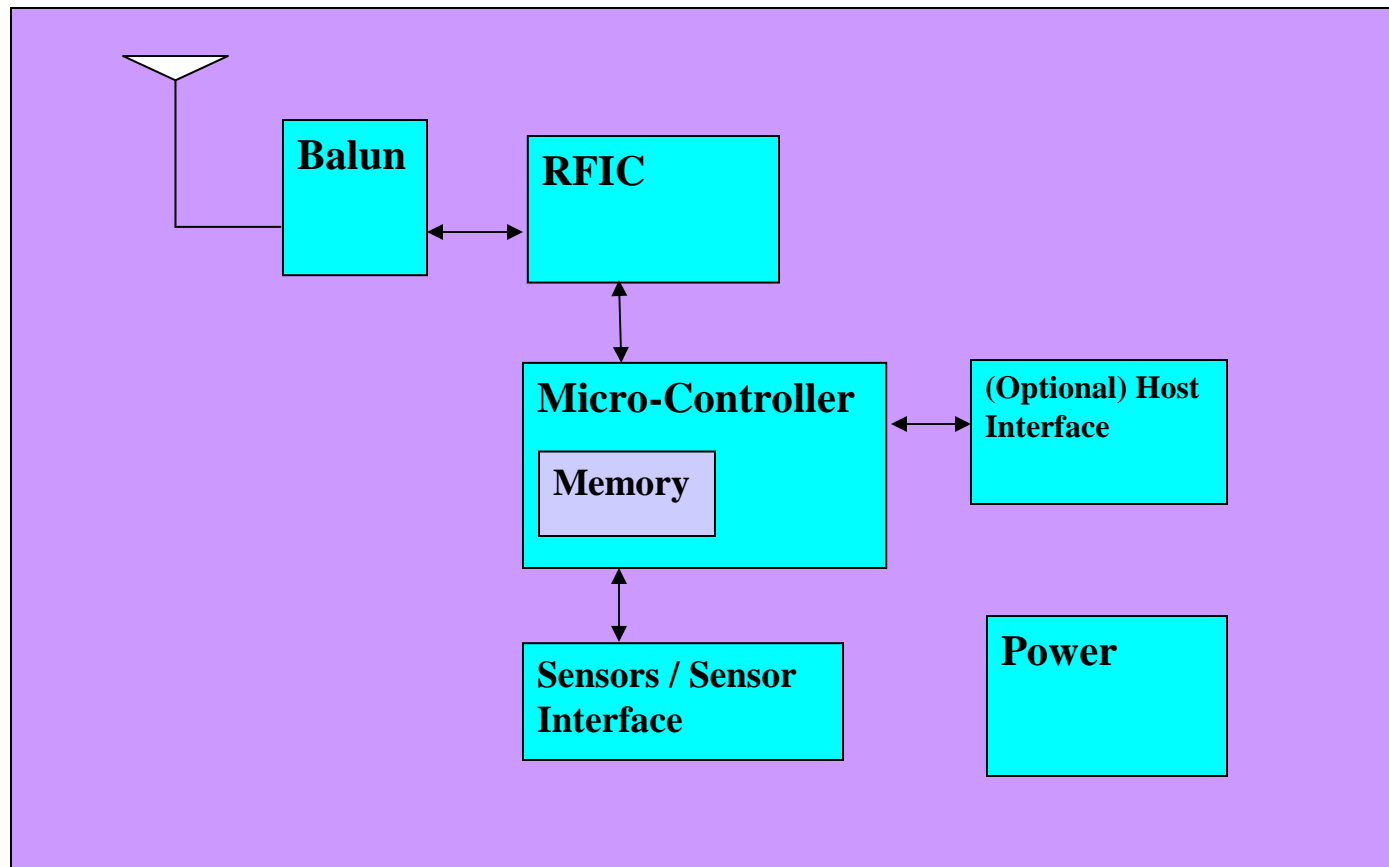
- IEEE 802.15.4/Zigbee
- HomeRF
- UWB
- Or any other proprietary protocols

Types of Devices in a typical Wireless Sensor Network

- Gateway
 - Interfaces wired and wireless domains
- Router
- End Device



Block diagram of a Wireless Sensor Node (WSN)



- Blocks
 - Microcontroller
 - Sensor & Sensor Interface
 - Radio Transceiver
 - Power
 - Host Interface (optional)

General specifications of WSN

- Operating Frequency
- Power output
- Range
- RF data rate
- Receiver sensitivity
- Interface data rate

Factors in Design of Wireless Sensor Nodes

- Power Management
 - Battery life
 - Power Consumption in sleep mode
- RF Power and Range
 - Power Amplifier Stage 1mw / 100 mw depending on operating range of 10m to 100m
- Cost
- Size/ weight
- S/W Foot print
 - Network Stack
- Functionality/ application
- Sensor Interface
 - Sensors / Actuators/ / MEMS / Vibration

Microcontroller

- Desired Features
 - Low Power
 - Small Profile
 - Built in peripherals
 - On chip RAM and Flash memory
- Typical Examples of WSN Microcontrollers
 - MSP430
 - ATmega
 - Any 8051 based low power microcontrollers ...

Sensor and Sensor Interface

- Onboard sensors
 - MEMS based sensors like
 - Temperature sensors
 - Voltage sensors
 - Photo sensors
 - Humidity sensors
 - Vibration sensors
 - Accelerometer...
- External sensors
 - Requires the node to have a sensor interface.
 - SPI
 - I2C
 - Serial
 - Analog

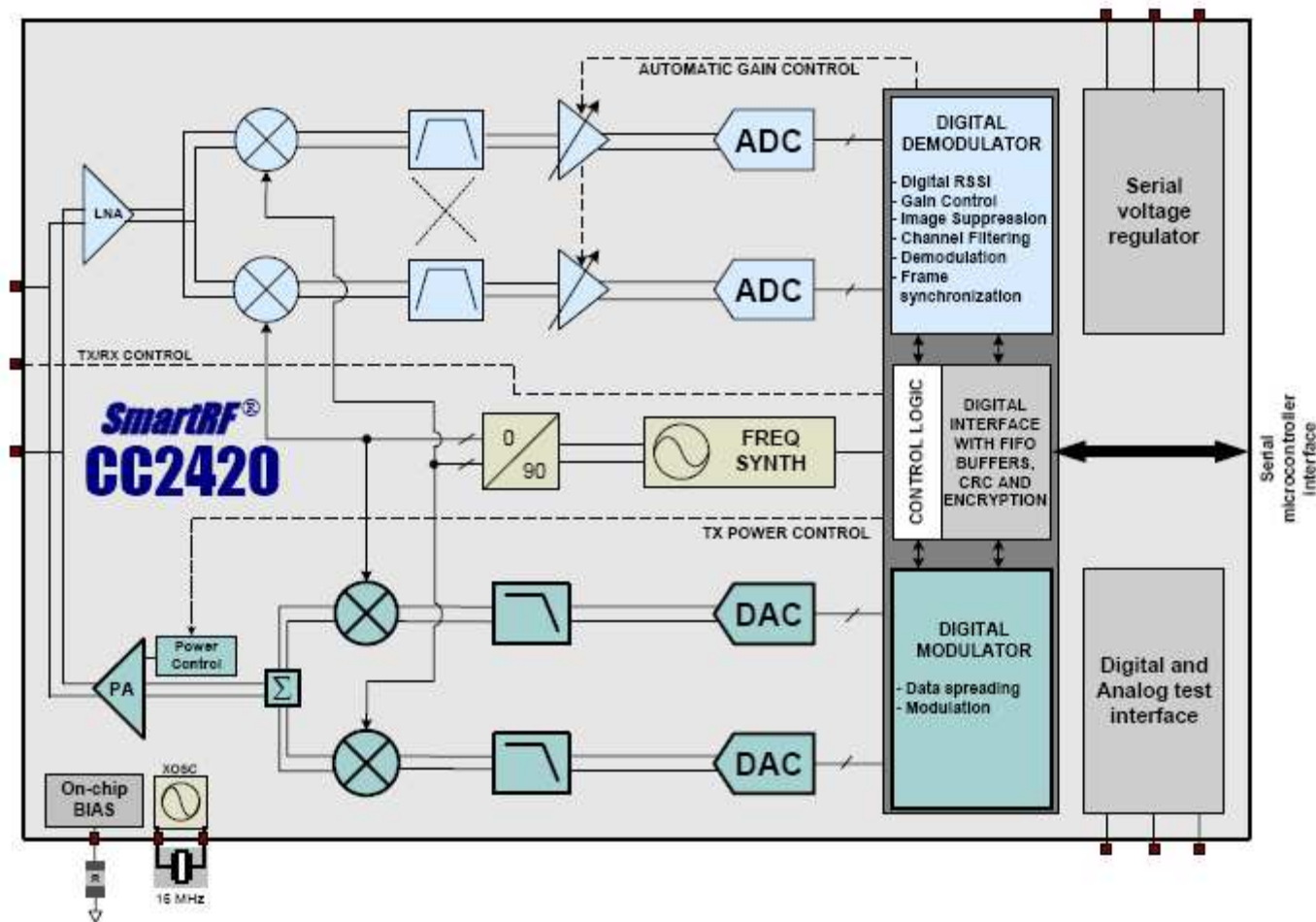
Power

- The power in a WSN is mainly dissipated by
 - Sensors
 - Transceivers (RFIC) while either transmitting or receiving
- Power Options
 - Battery operated
 - Solar power
 - DC power

RF Blocks

- RF Transceiver
 - Can be interfaced to Microcontroller using SPI, I2C, or UART interfaces
 - Low Noise Amplifier (LNA), Mixer, Variable Gain Amplifier (VGA), ADC, Demodulator,
 - Modulator, DAC, Filters, Mixer, Power Amplifier (PA),
- Balun
- Antenna

RFIC or RF Transceiver



Antenna

- Key parameters
 - Radiation pattern
 - Antenna gain
- Proper impedance (50ohm) match has to be maintained while feeding the antenna to minimize the return losses

Antenna

- External Antenna
 - Provides good gain and radiation pattern
 - Long ranges possible
 - monopoles

- PCB Antenna
 - Designing the PCB antenna is challenging
 - Requires good simulation while designing
 - Cost effective
 - Dipole, monopole, inverted F antenna...

- Chip Antenna
 - Small Range
 - Small profile



PCB Antenna



Chip Antenna

Balun

- A typical RFIC has a Differential output for antenna
- External antennas and monopoles are single ended
- Balancing and Unbalancing Network (Balun) will be needed when single ended antenna has to interface with differential drive of RFIC
 - Its a network of RLC which can also provide good matching in addition to from providing balancing
 - Can be also implemented using transmission lines on a PCB
 - Chip baluns can also be used with minimum external components

Passive components

- Resistor
 - Precision resistors with very low tolerances
 - Chip resistors
- Capacitor
 - NPO capacitors
- Inductor
 - (Self Resonance Frequency) SRF must be above the circuit operating range
 - Monolithic or Multilayer chip Inductors

Materials

- Parameters of the materials that has to be considered for RF
 - Dielectric Constant
 - Loss Tangent
 - Tg (Glass Transition Temperature)
- Some Materials
 - PTFE
 - Rogers
 - Nelco
 - FR4

Thank You