Wireless Sensor Networks: The Protocol Stack

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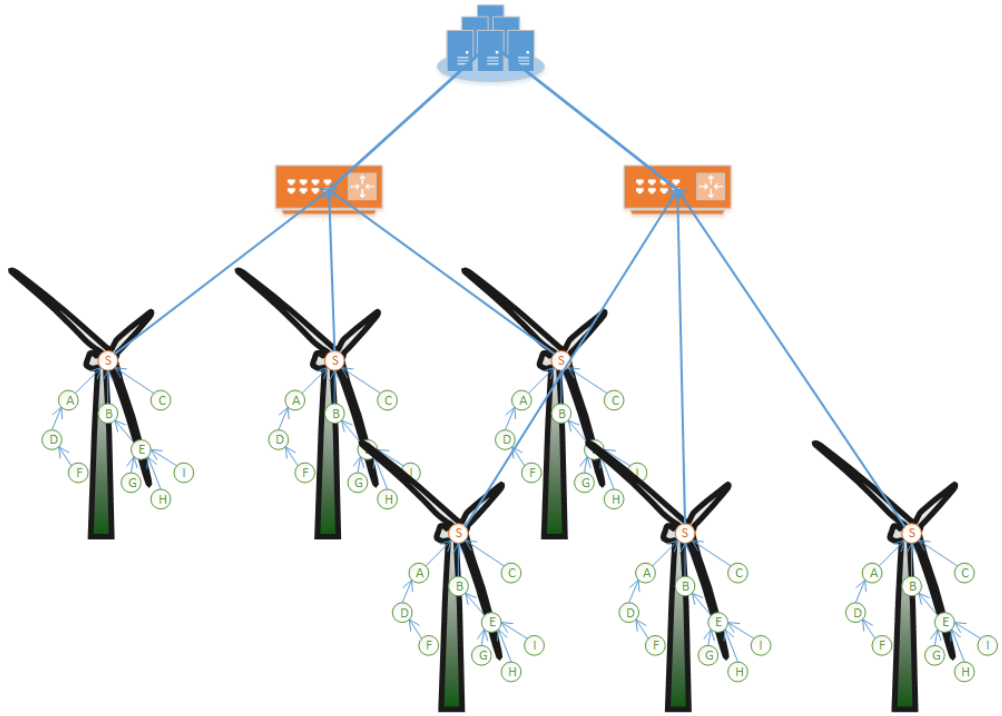
One-Slide Refresher

Wireless Sensor Networks (WSNs)

- Could be used for turbine structural health monitoring
- Are composed of sensor nodes
- Are very resource constrained
- Are a developing technology
- Are not your mama's WiFi



Possible WSN system architecture for wind energy

Protocol Stack

Computer networks have layers

- Upper layers - application specific
- Network - subject of research
- Data link - subject of research
- Physical - IEEE 802.15.4/ZigBee

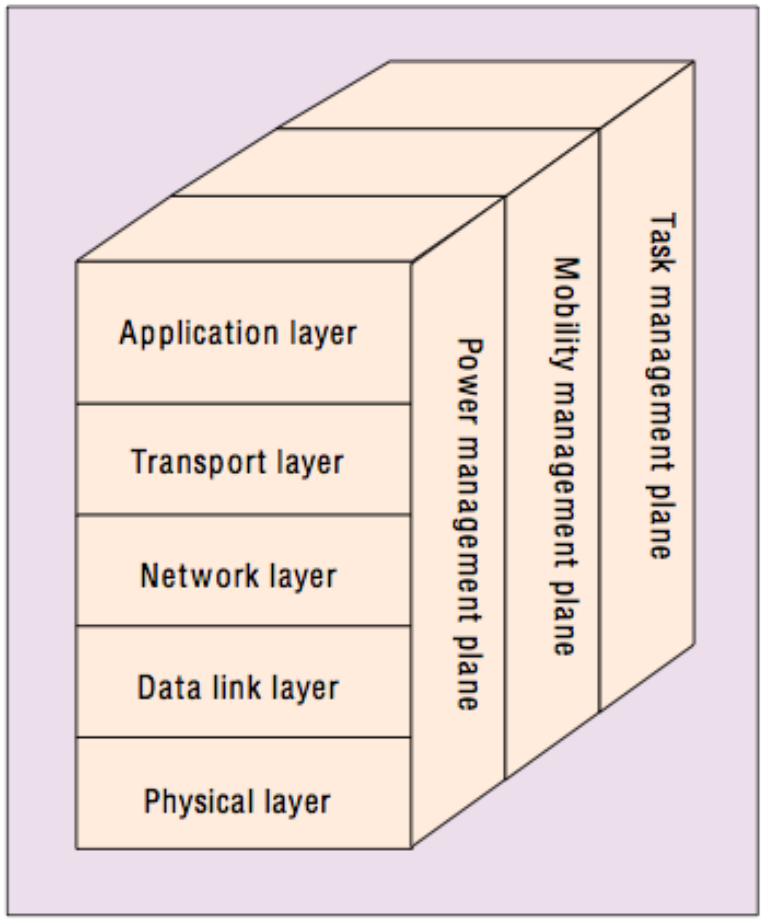


Figure 3. *The sensor networks protocol stack.*

Typical WSN protocol stack (Akyildiz et al., 2002)

Wired network

Layers	
Application	Google Chrome
Transport	Transmission Control Protocol (TCP)
Network	Internet Protocol (IP)
Data Link	Ethernet (IEEE 802.3)
Physical	Wired Ethernet (IEEE 802.3)

Wireless access point network

Layers	
Application	Google Chrome
Transport	Transmission Control Protocol (TCP)
Network	Internet Protocol (IP)
Data Link	WiFi (IEEE 802.11)
Physical	WiFi (IEEE 802.11)

Ad hoc wireless network

Layers	
Application	Real-Time Research and Candy Sharing System
Routing	Optimized Link State Routing (OLSR)
Data Link	IEEE 802.11
Physical	IEEE 802.11

Synchronously duty-cycled WSN

Layers	
Application	Structural health monitoring system
Routing	Collection Tree Protocol (CTP)
MAC	T-MAC
Physical	ZigBee (IEEE 802.15.4)

Asynchronously duty-cycled WSN

Layers	
Application	Structural health monitoring system
Routing	Collection Tree Protocol (CTP)
MAC	B-MAC
Physical	ZigBee (IEEE 802.15.4)

Asynchronously duty-cycled WSN

Layers	
Application	Structural health monitoring system
Routing	Collection Tree Protocol (CTP)
MAC	X-MAC
Physical	ZigBee (IEEE 802.15.4)

Asynchronously duty-cycled WSN

Layers	
Application	Structural health monitoring system
Routing	Collection Tree Protocol (CTP)
MAC	BoX-MAC-2
Physical	ZigBee (IEEE 802.15.4)

Asynchronously duty-cycled WSN with anycast

Layers	
Application	Structural health monitoring system
Routing	Opportunistic Routing for WSN (ORW)
MAC	BoX-MAC-2 with anycast
Physical	ZigBee (IEEE 802.15.4)

Project goals

Design an anycast WSN for a wind turbine SHM application that

- is very energy efficient.
- meets reliability targets.
- meets latency targets.
- is optimized for the unique characteristics of the application.

Note: this project is focused on the network and the communication, not about the methods used for SHM.

Proposed project method, part 1

1. Review existing literature on anycast
   - Anycast in wireless ad hoc networks
   - Anycast at the routing layer
   - Anycast routing metrics
2. Analyze anycast on existing MAC protocols
   - X-MAC/BoX-MAC
   - RI-MAC
3. Obtain and verify MAC optimized for anycast
   - Find what would optimize MAC for anycast
   - Extend existing MAC if possible
   - Simulate, implement and run reliability/latency/energy tests

Proposed project method, part 2

1. Design a reference sensor network for SHM of a wind turbine
   - Make best-guess assumptions about SHM methods
   - Place nodes for coverage first
   - Place nodes for connectivity second
2. Develop network operation specifications for the reference network
   - Maximum latency from sensor to sink
   - Minimum packet delivery rate
   - Target energy efficiency
3. Obtain and verify routing protocol optimized for reference network
   - Find what would optimize routing for network
   - Extend existing routing protocol if possible
   - Simulate, implement and run reliability/latency/energy tests

Questions?