Software/Hardware Integration

Medium Access Control for Wireless Sensor Networks

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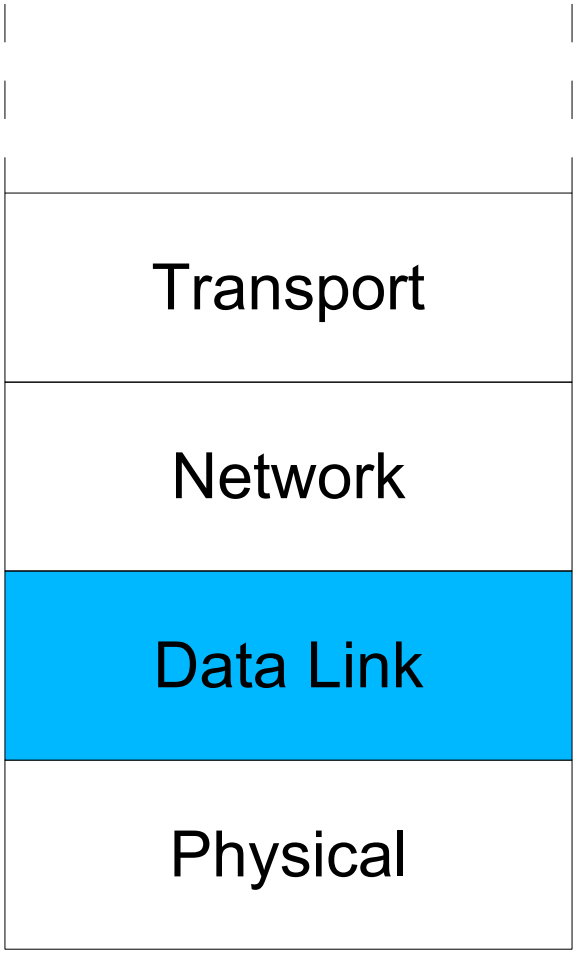
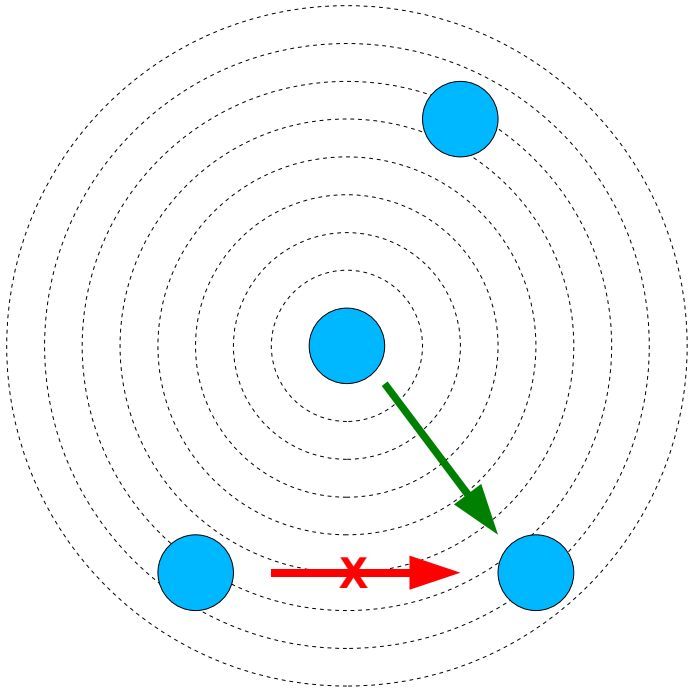
Data Link Layer

- Logical Link Control
  - Flow Control
- MAC
  - Control access to the shared medium
  - Avoid interferences between transmissions
  - Basic Mechanisms
    - Carrier Sense (Contention)
    - Time Division (Schedule)

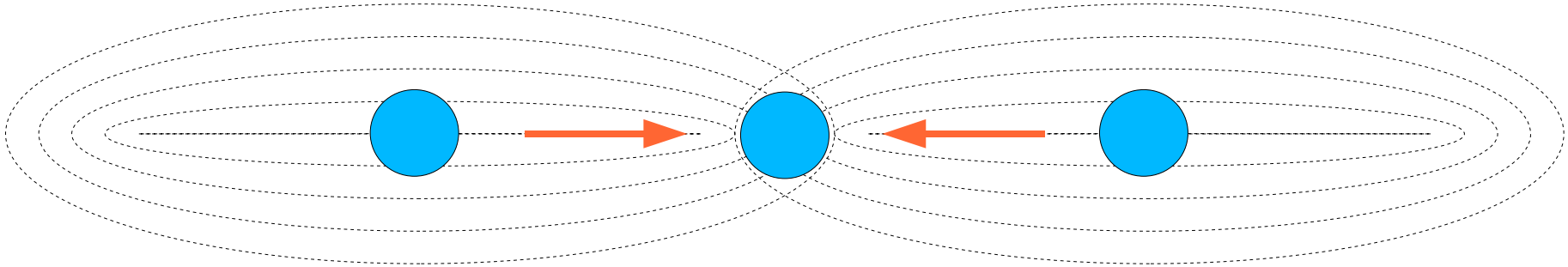


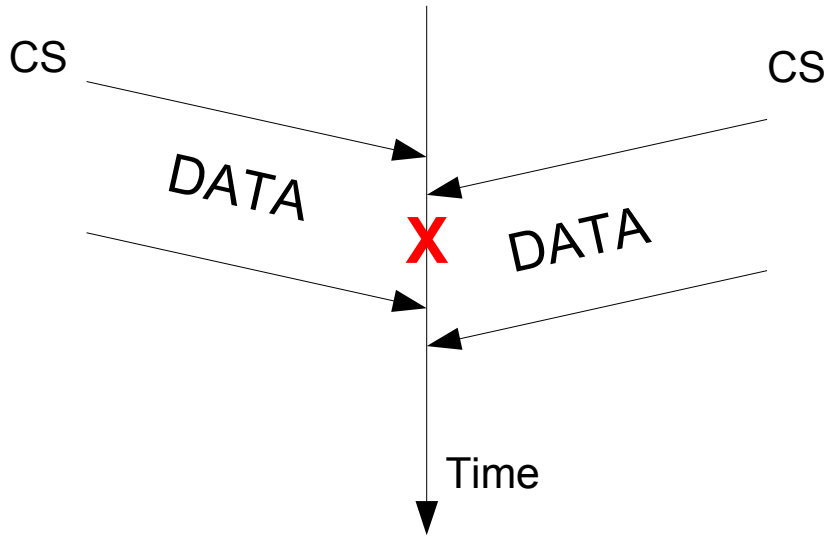
Contention-Based MAC Protocols

- ALOHA (1970, Un. Hawaii)
  - Send when ready
  - If message collides, retransmit
  - Sub-optimal channel utilization
- CSMA (Carrier Sense Multiple Access)
  - “Listen before talk”

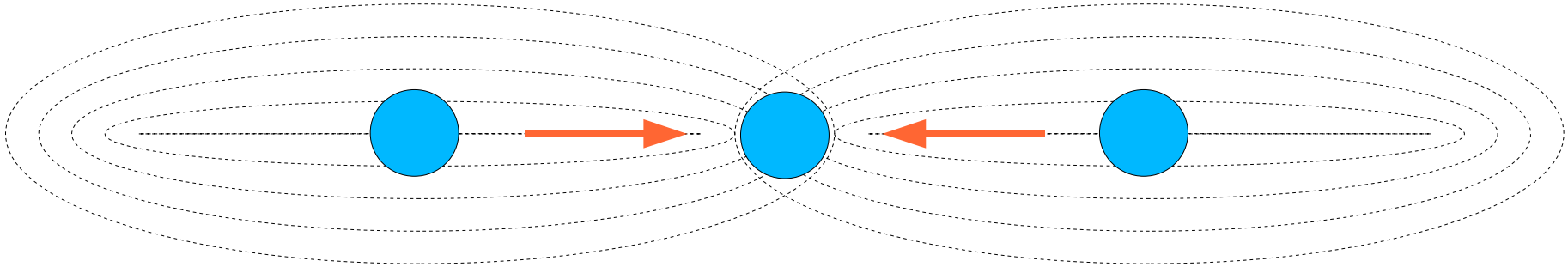


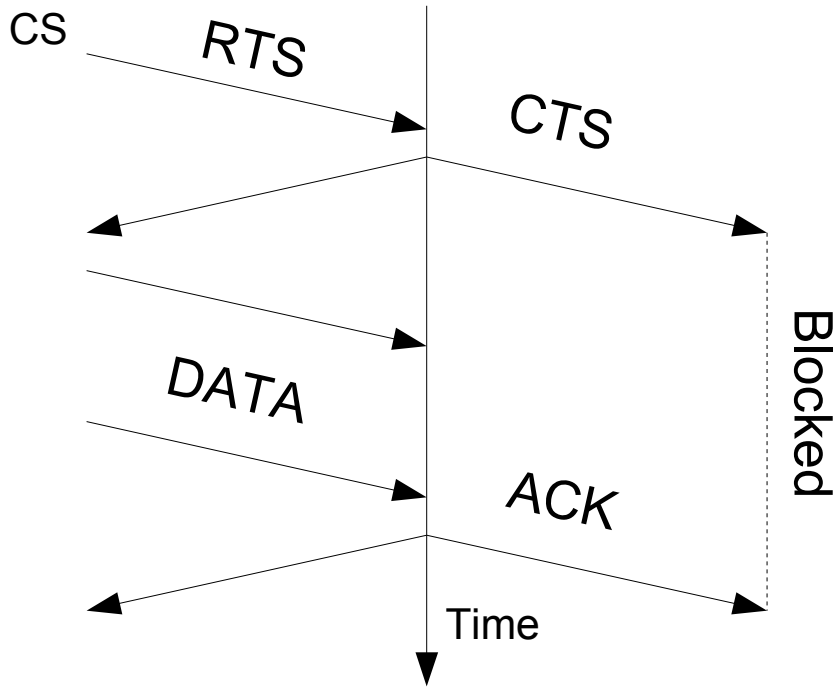
Hidden Terminal Problem





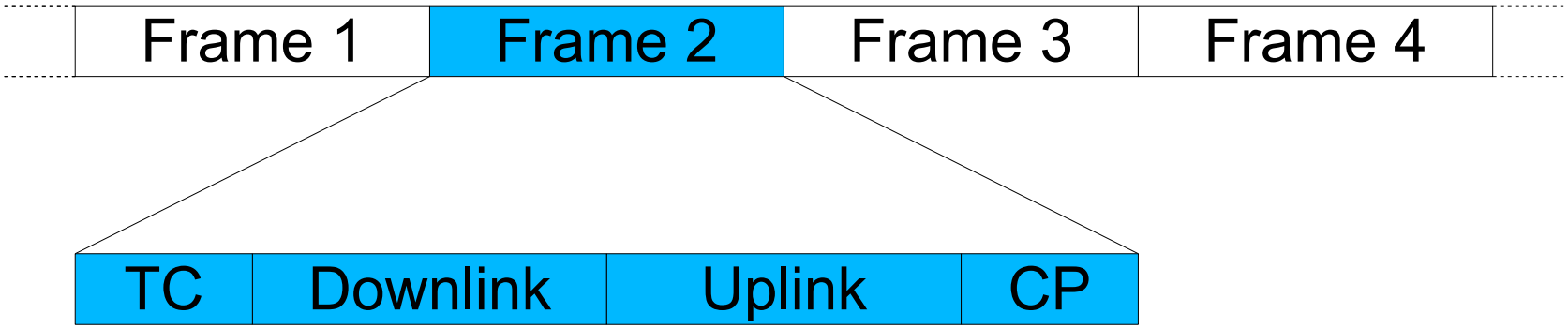
CSMA/CA





Schedule-Based MAC Protocols

- Time-Division Multiplexing
  - Communication is scheduled by a central authority (Access Point)
  - No contention, no overhearing

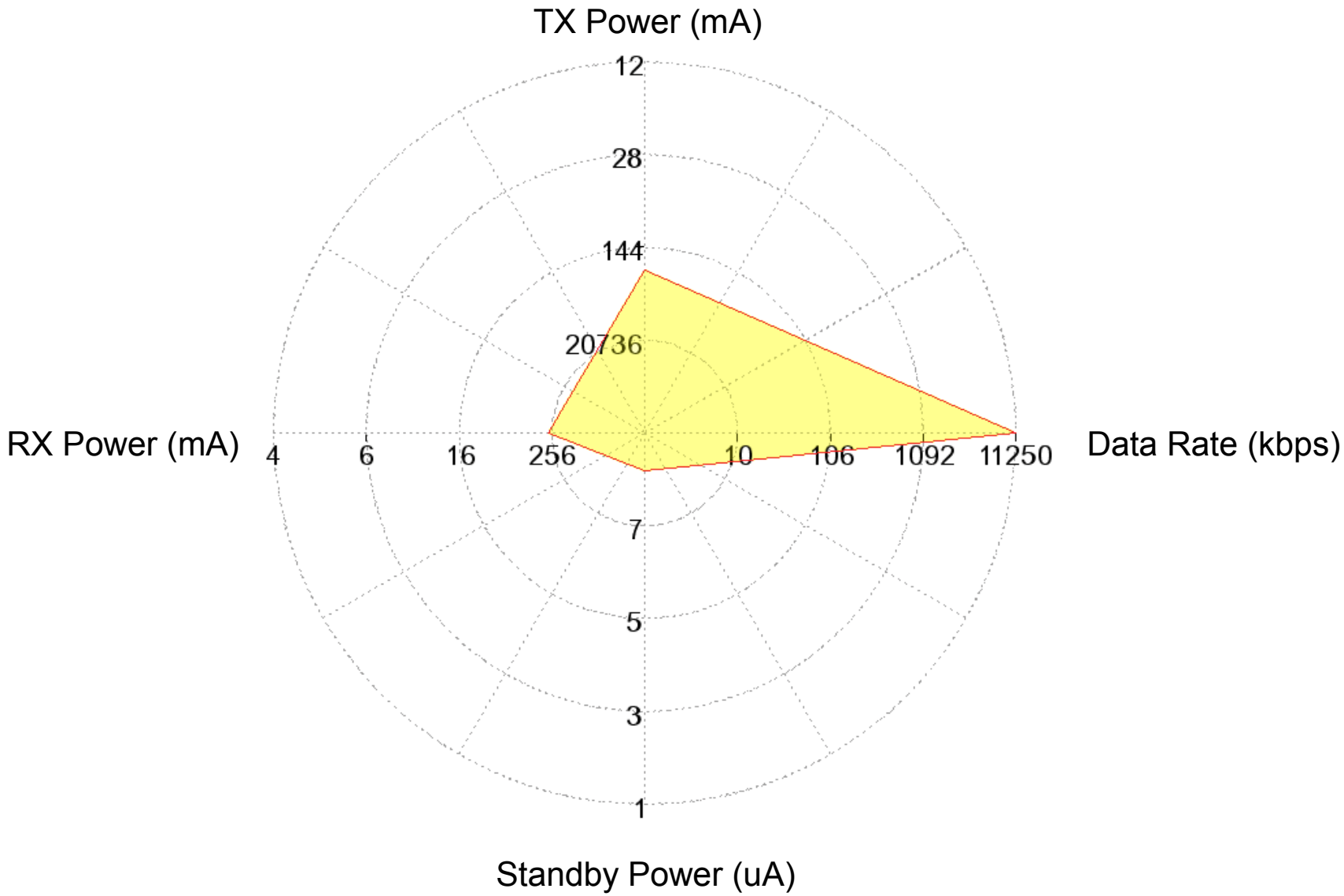


  - No direct communication between nodes
  - Access point broadcasts Traffic Control map
  - New nodes request frames in Contention Period

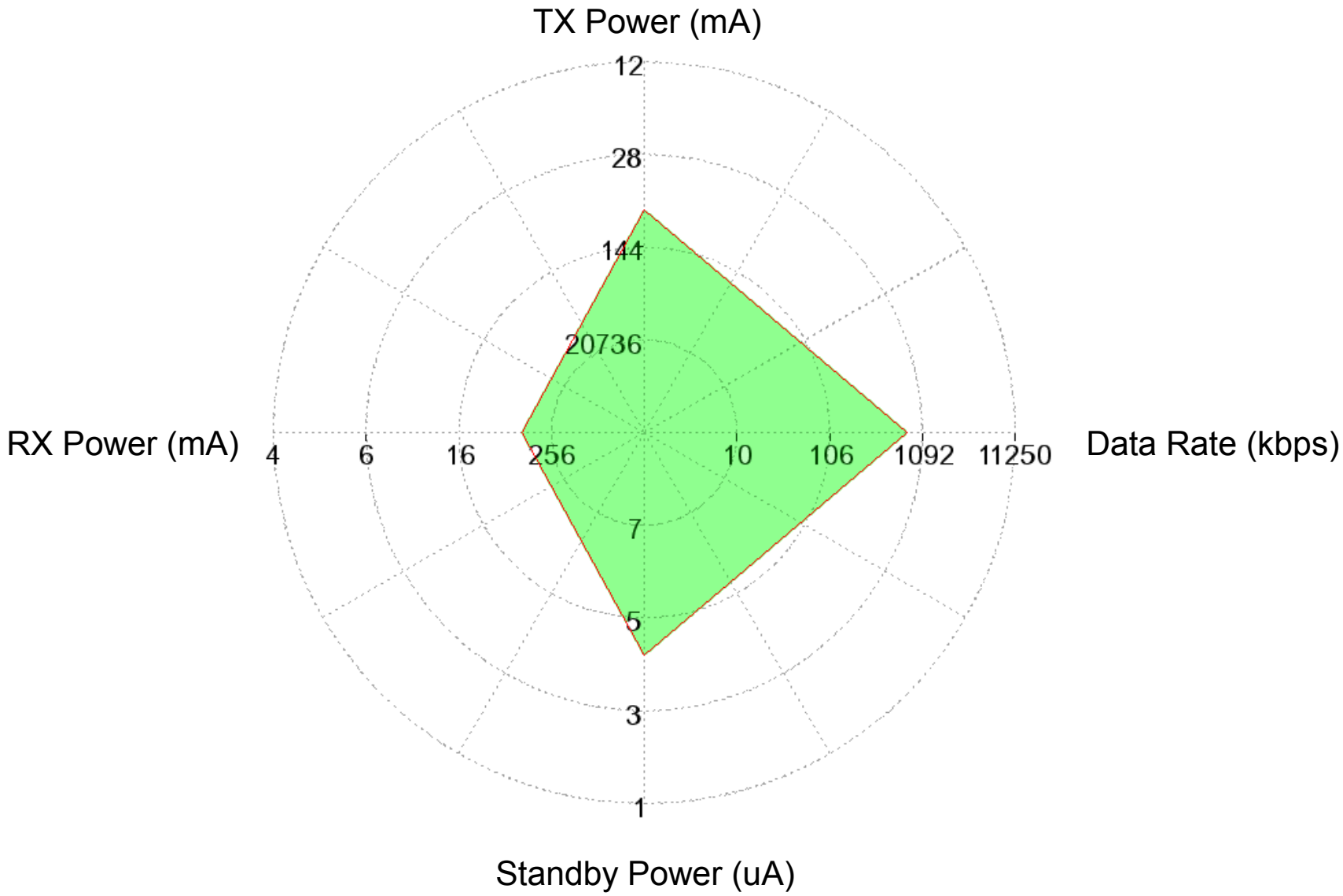
MACs for Sensor Networks

- Nodes
  - Limited hardware resources
  - Powered by batteries
  - Energy efficiency is the main objective
    - Turn off the radio whenever possible!
- Main sources of overhead
  - Idle listening
  - Collisions
  - Overhearing
  - Protocol overhead
  - Traffic fluctuations

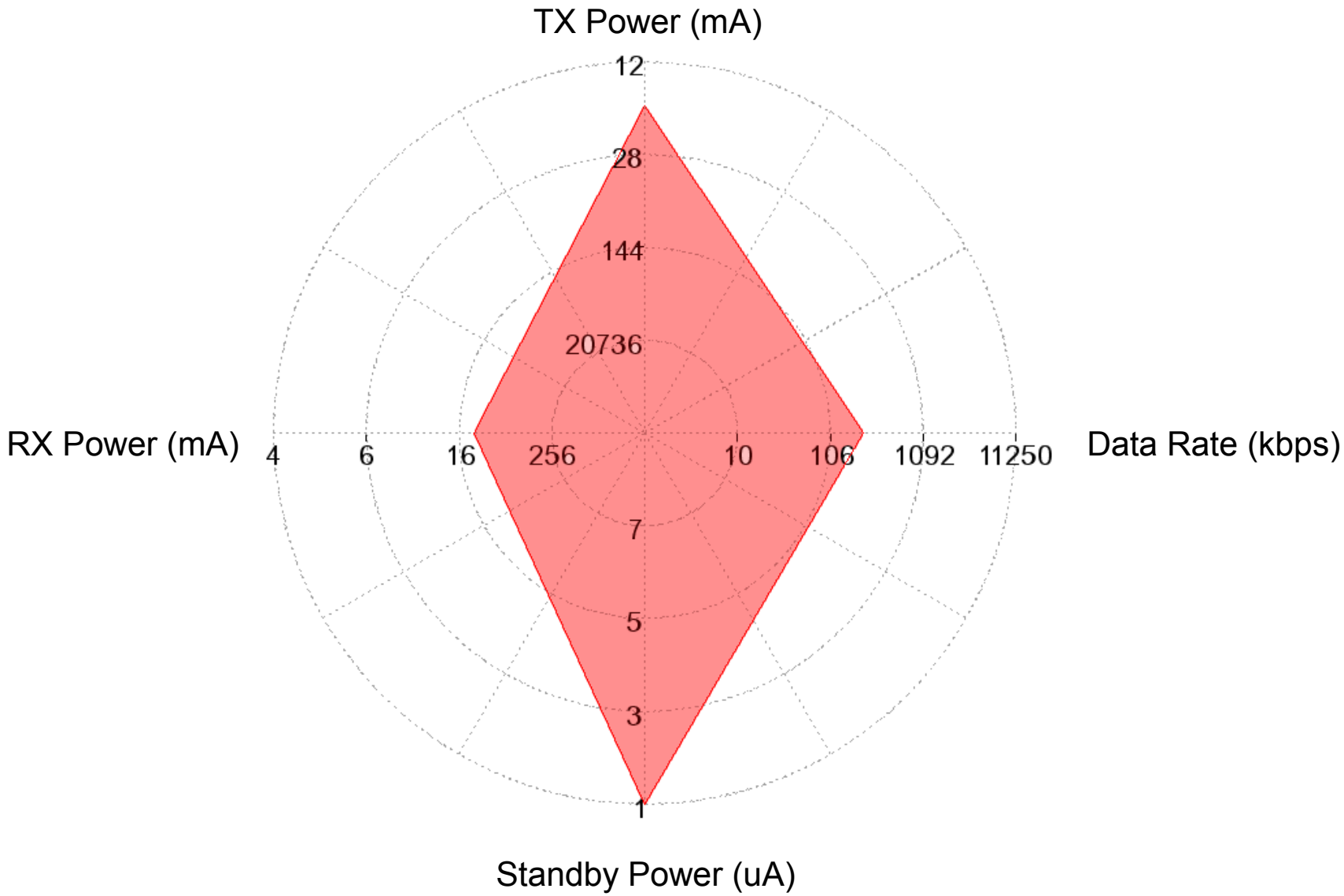
Comm. Hardware: Orinoco S (802.11)



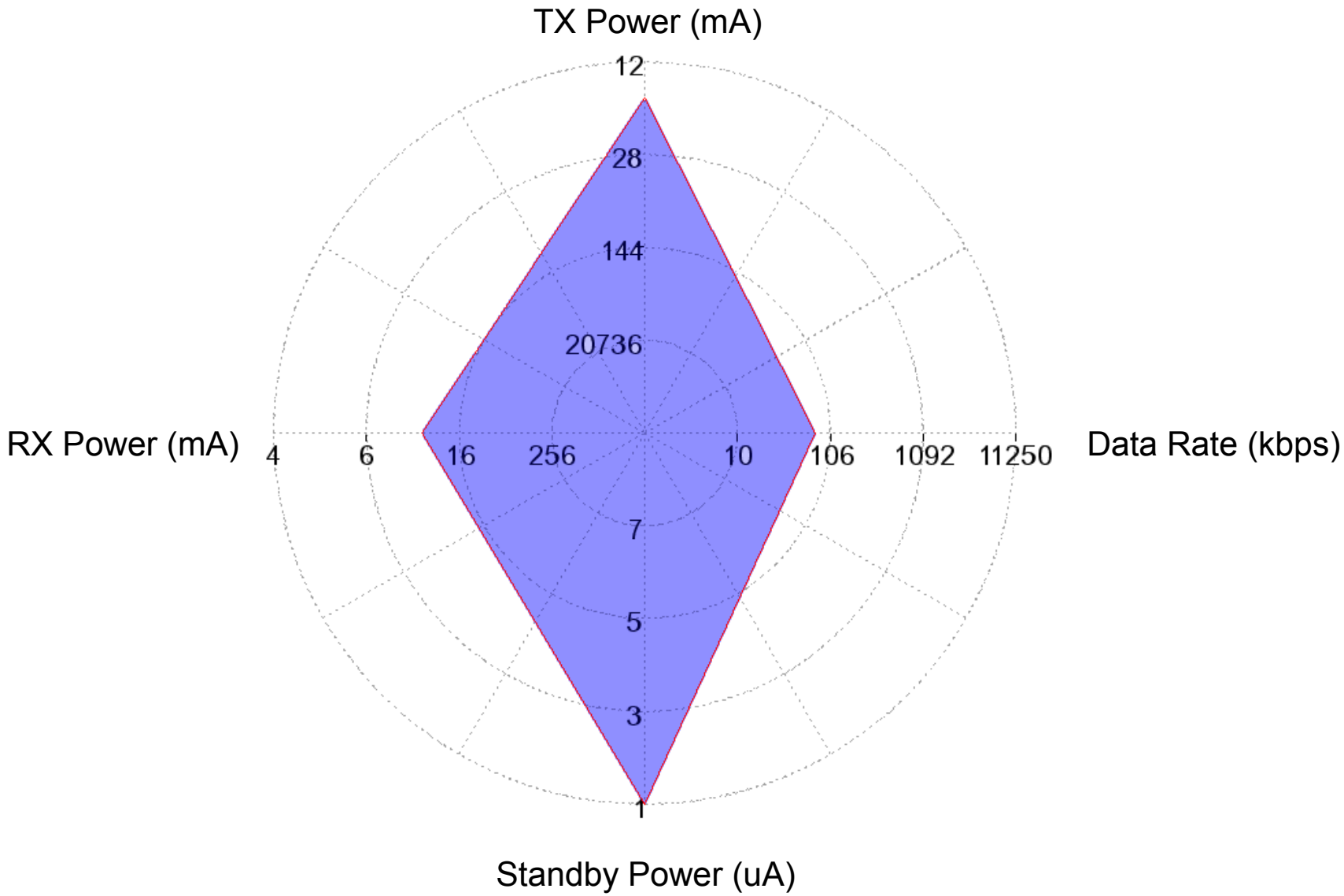
Comm. Hardware: ZV4002 (802.15.1)



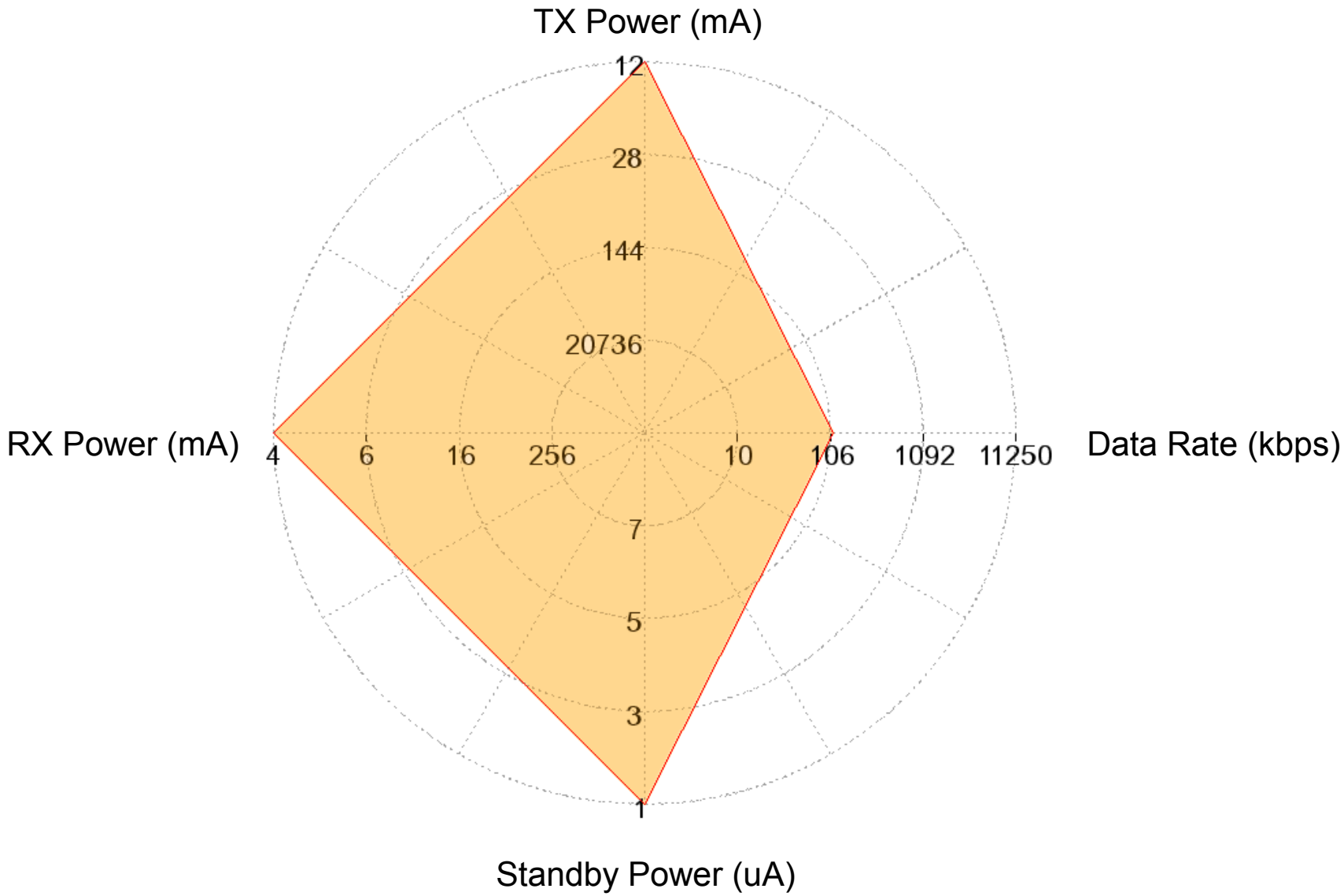
Comm. Hardware: CC2420 (802.15.4)



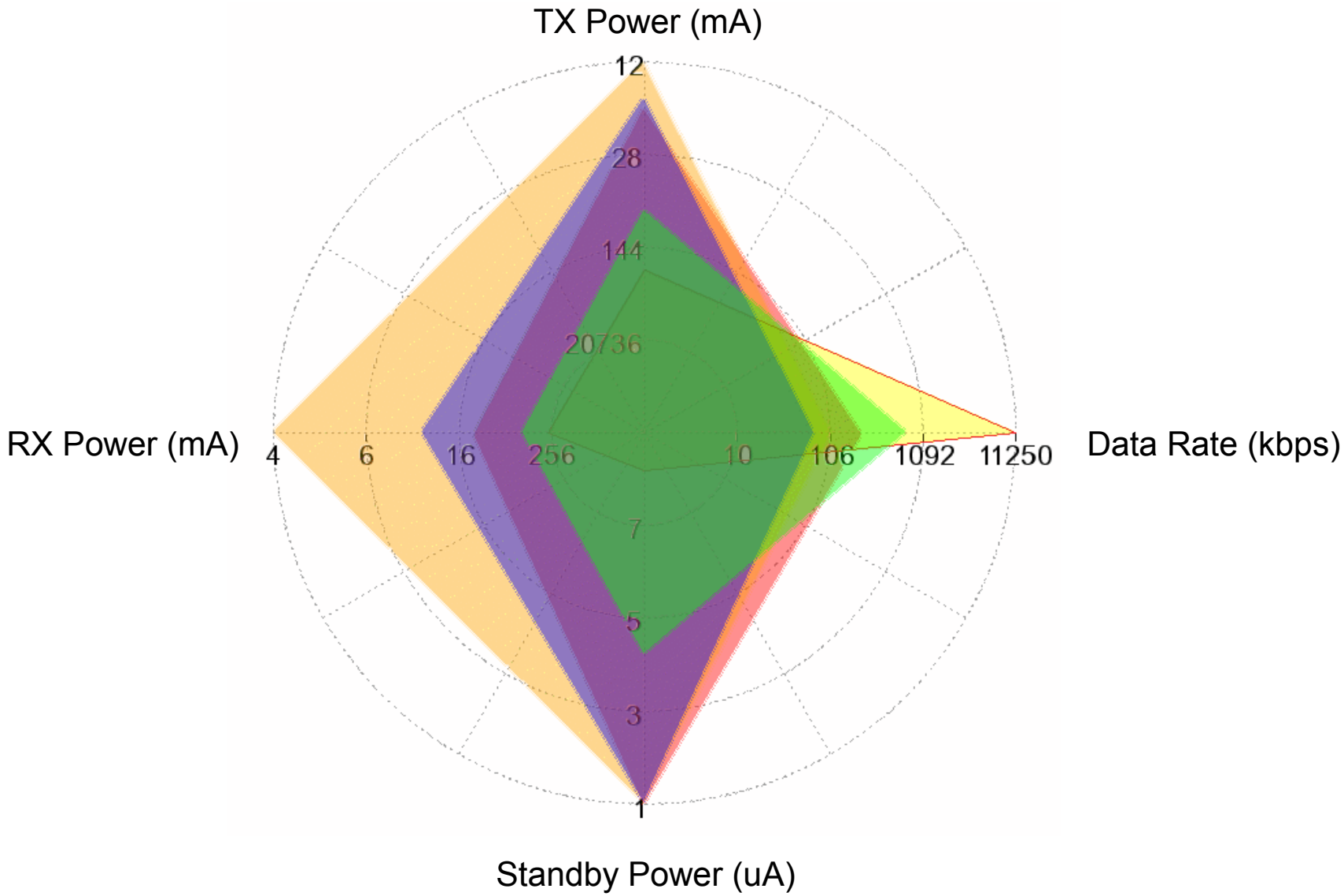
Comm. Hardware: CC1000



Comm. Hardware: TR1000



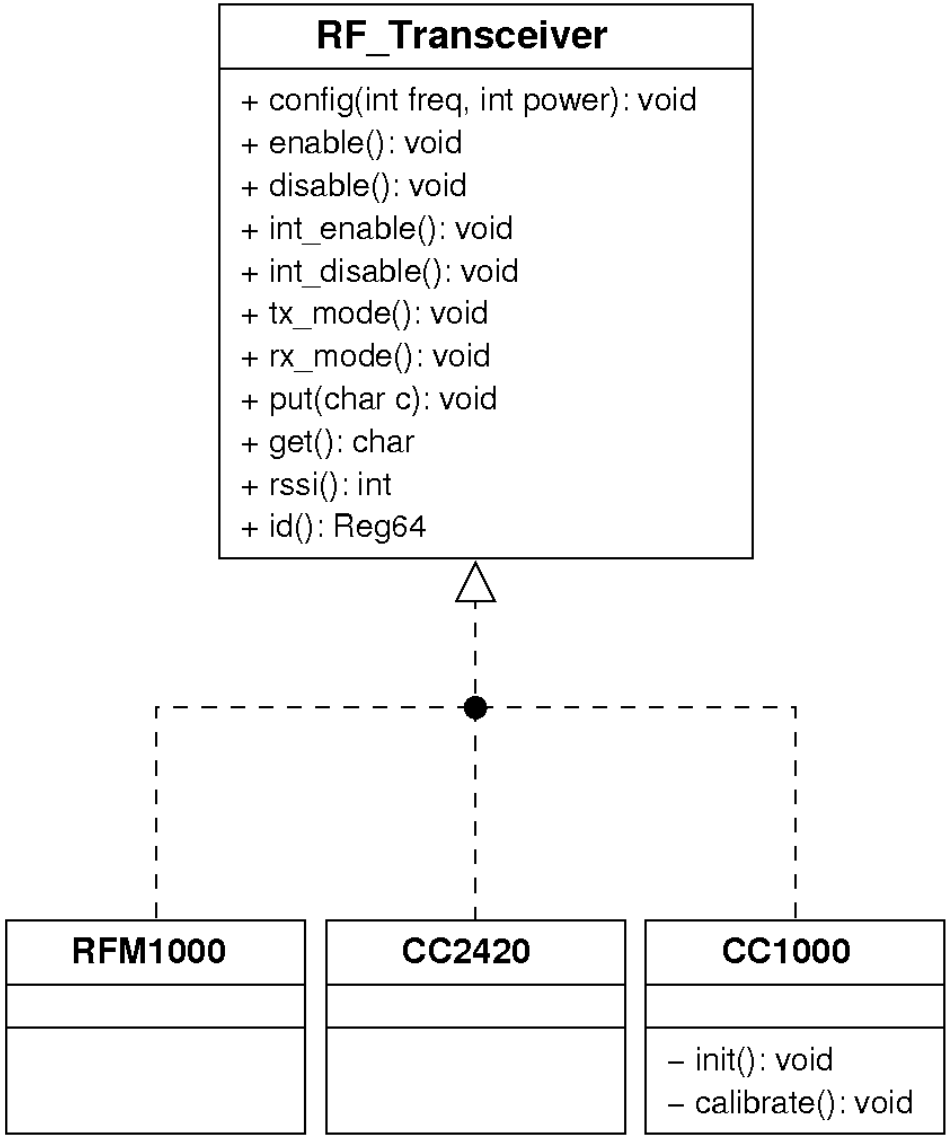
Communication Hardware



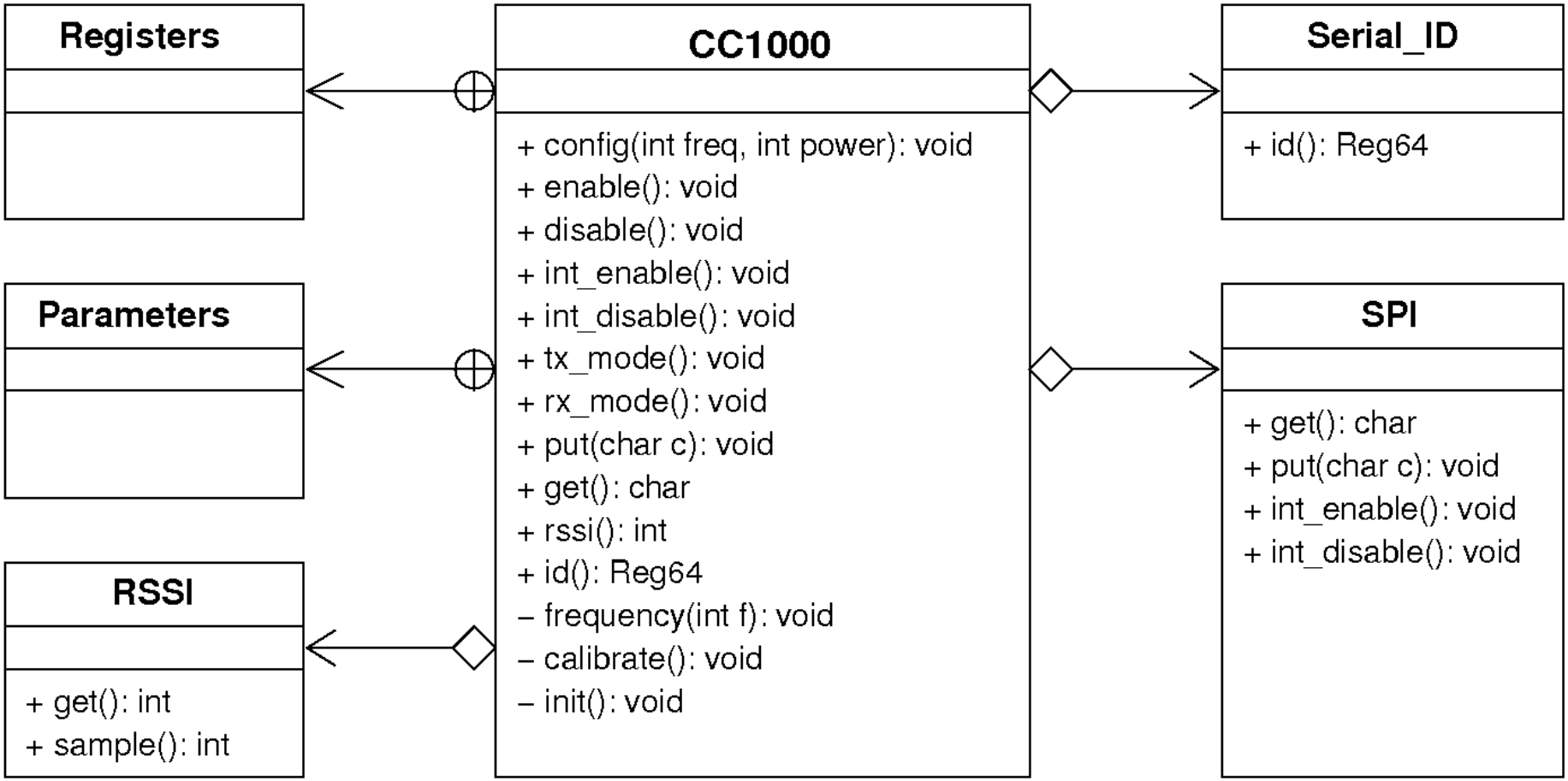
Communication Hardware: CC1000

- UHF FM Transceiver
  - Variable Frequency
  - Frequency-Shif Keying modulation (FSK)
  - Manchester of NRZ (Non-Return to Zero) encoding
  - Received Signal Strength Indicator (RSSI)
  - Programmable TX Power

EPOS: RF Transceiver Family

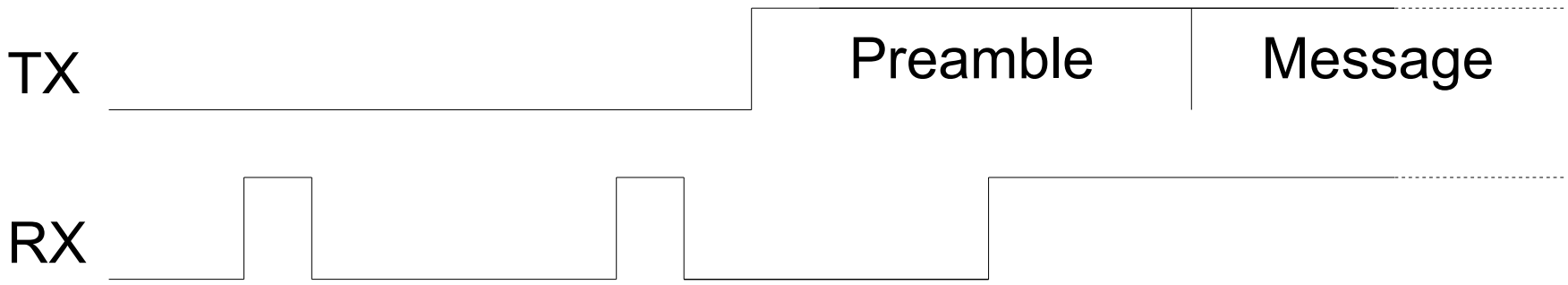


EPOS: CC1000 Mediator

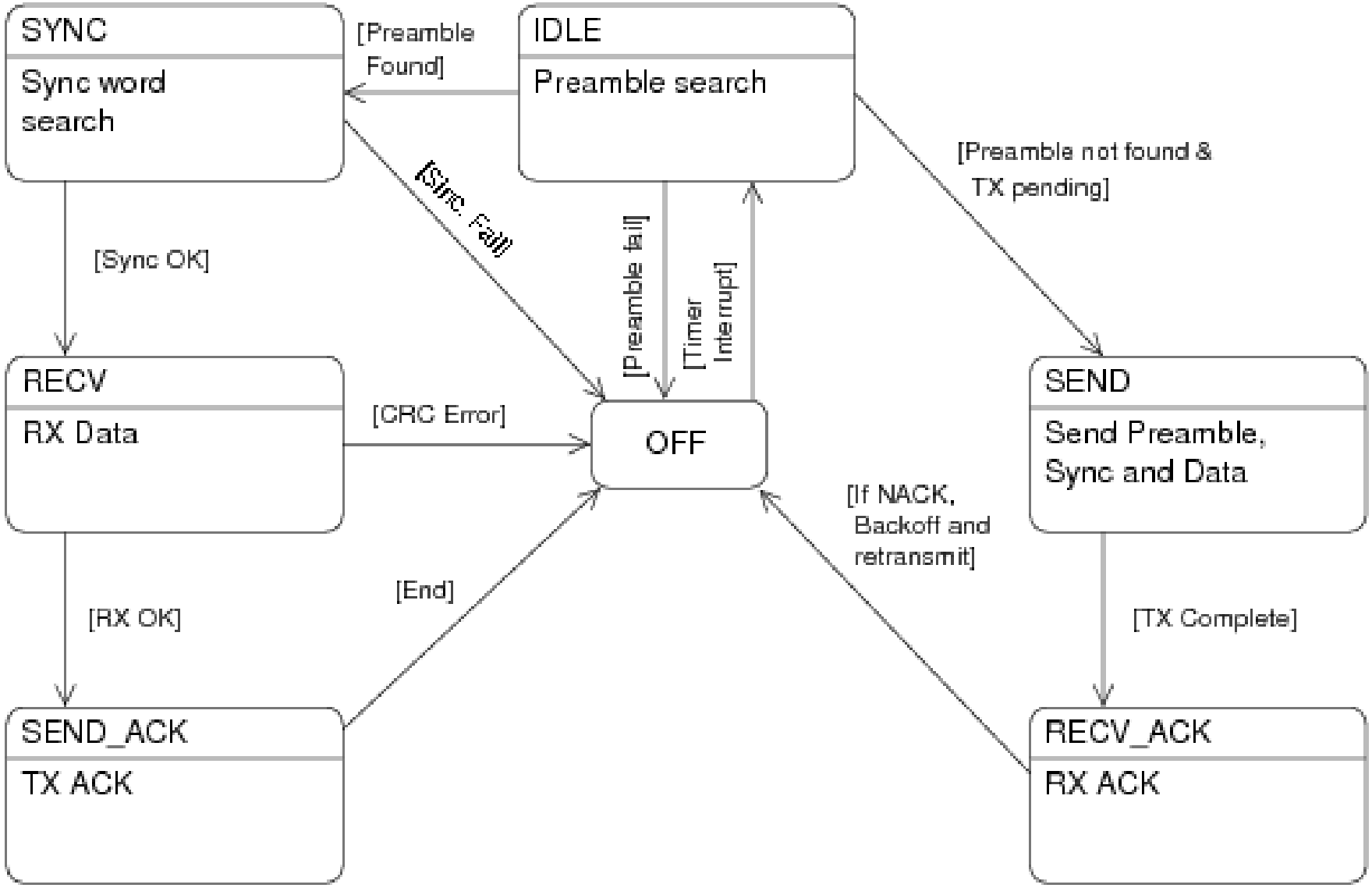


MACs for Sensor Networks: LPL

- Low Power Listening
  - Long preamble
  - Short sample



Low Power Listening: State Machine



EPOS: Low Power Radio