Challenges of Sleeping Nodes

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What Are Sleeping Nodes?

- Small, low-cost, battery-powered nodes often “sleep” to extend battery life
  - Keep *just enough* of the system on to wake up on schedule
  - Radio **receiver** and transmitter are off
  - All high-power chips (radio chips, CPU) are off
- Wake up periodically to perform functions
  - Sensors: Take/report sensor readings
  - Actuators: Poll for events/messages, take appropriate actions
- Devices may sleep 99% of the time, or more

Protocol Challenges

- Sleeping nodes are not “always on”
  - Increasing number of IETF protocols expect nodes to be “always on”, including IPv6 ND & DAD.
  - Most multicast protocols don’t work well for sleeping nodes
- Costs of leaving and rejoining a network or application may be prohibitive
  - IP no longer provides best-effort delivery
  - Need to determine you are on the same network before using IP address(es) -- DNA, DHCP
  - Need to reestablish Neighbor Cache entries before sending packets
- Verbose Protocols
  - Every round trip requires receiver to stay on for another RTT
  - Congestion concerns are not the only reason to limit message size
    - Longer packets take more energy to transmit

Possible Solutions

- "Always On" assumption
  - Consider alternative paradigm for sleeping nodes
    - End-node polling vs. sending events/messages as they happen?
    - Gateways/Routers proxy for nodes that sleep (Proxy ND, etc.)
- High cost to rejoin network
  - Goal is to determine that a mobile node has not moved to another network
  - Why isn't detection of the same layer 2 network good enough?
    - Same SSID, L2 security credentials work, etc.
- Verbose Protocols
  - Minimize round trips and required messages
  - Consider compressed or succinct message formats
    - COAP, XML compression, etc.
  - Use UDP with one-way messages when appropriate

Which Protocols?

- At minimum, Internet Protocol (IPv4 & v6) should continue to work on these nodes
  - IPv4 & ARP work (minus some optional add-ons)
  - IPv6 has challenges, especially in ND
    - Essentially, many optional add-ons in IPv4 are now required in all IPv6 implementations
      - Address autoconfiguration, DNA, IGMP/Multicast, DAD, etc.
- Device-to-device, configuration, management, service discovery
  - DNS, DHCP, SNMP, NETCONF, DNS-SD, SDP, etc.
- Some applications assume a human at both ends, and won't be used on sleeping devices
  - Instant messaging, voice, multimedia, etc.
  - But, are we sure? (consider HTML & Jabber)

Wider Applicability

- Described as problem for low-cost, battery-powered, wireless sensors and actuators, but principals may apply to other nodes
  - Could extend laptop, touch pad or cell phone battery life
  - Could reduce energy consumption of wall-powered nodes

Just because the energy is available,

doesn't mean we should squander it!