

CS4222/CS5422 Semester 2, 2022/2023

Tutorial for Week 11 (March 20th 2023)

Question 1: A node running BMAC spends its time in the following 4 states (1) sleeping (consumes 1mW), (2) idle listening (consumes 10mW) (3) receiving (consumes 20mW) and (4) transmission (consumes 20mW). Note that in the idle listening state, a node detects channel activity but does not receive data. In the receiving state, there is actual packet reception.

By default, it wakes up every 250ms to sample the channel for a duration of 5ms. Every 5s, the node transmit or receive a packet with equal probability. Packet transmission or reception duration is always 5ms. On the average, what is the percentage of the energy spent on:

- sleeping,
- idle listening,
- receiving
- transmission?
- If the battery used provides 10KJ of energy, what is the lifetime of the node?

Answer 1:

In transmission cycle, 250ms + 5ms

2.5% (1/20 * 0.5) Active send = 0.255 x 20 mW (T)

2.5% (1/20 * 0.5) Active recv = 0.125 x 1mW (S) + 0.125 x 10mW (I) + 0.005 x 20mW (R)

95% Idle = 0.005 x 10mW (I) + 0.245 * 1mW (S)

sleeping (S) = 0.95 * 0.245 * 1 + 0.025 * 0.125 * 1 = 0.23275 + 0.003215 = 0.235875 mJ/cycle

idle listening (I) = 0.95 * 0.005 * 10 + 0.025 * 0.125 * 10 = 0.07875 mJ/cycle

recv (R) = 0.025 * 0.005 * 20 = 0.0025 mJ/cycle

transmit (T) = 0.025 * 0.255 * 20 = 0.1275 mJ/cycle

total = 0.4446 mJ

a) sleeping = (0.236/0.4446) = 53.1%

b) idle listening ~ 17.7%

c) receiving $\sim 0.56\%$

d) transmit $\sim 28.7\%$

e) Total Energy = 0.4446 mJ/cycle. Lifetime = $10 \text{ kJ} / (0.4446 \text{ mJ} * 20/5.005\text{s}) = 5.63 * 10^6 \text{ seconds} = 65 \text{ days}$

Answer 2:

(a) Path ETX = $1/(1-0.25) + 1/(1-0.1) + 1/(1-0.5) + 1/(1-0.2) = 4/3 + 10/9 + 2 + 5/4 = 5.69$

(b) No error = $(0.75) \times (0.9) \times (0.5) \times (0.8) = 0.27$

Answer 3:

(a) 2 hops, $5 \rightarrow 1 \rightarrow 0$

(b) $1/0.6 + 1/0.9 = 2.77$, also $5 \rightarrow 1 \rightarrow 0$

(c) $x/0.6 = 5x/3$

Answer 4:

Wireless Mesh Networks: Consists of static nodes. Network topology does not change except due to node failures. Routing protocols are designed to ensure the best quality and minimize interference. Eg: Wifi Networks

Mobile Ad Hoc Network: Nodes are mobile and end to end connectivity is ensured. Proactive/reactive routing protocols are designed to handle mobility. Eg: Wireless Sensor Networks, Vehicular Ad Hoc Network

Delay Tolerant Network: Nodes are mobile but end to end connectivity is not guaranteed. Store and forward protocols are designed. Eg: Apple Airtag, Space Networks, Military Ad Hoc Applications