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Exercises of lecture

Wireless Sensor Networks

Winter 2006/2007

Sheet 4

SECTION 1:
Wireless Sensor Transceiver, Energy

1. Energy is limited in wireless sensor network. Therefore, the energy supply and consumption scheme has to be designed as efficient as possible. State the requirements for the energy module of wireless sensor network.
   Answers:

   (a) Low self-discharge

   (b) Long shelf live

   (c) Capacity under load

   (d) Efficient recharging at low current

   (e) Good relaxation properties (seeming self-recharging)

   (f) Voltage stability (to avoid DC-DC conversion)

2. Consider a wireless sensor network with the energy consumption for each sensor node stated as follows:

   Idle mode: 0,05mA
   CPU computation (e.g. doing calculations): 9mA
   Sending of wireless data: 10mA
   Receiving of wireless data: 5mA

   Based on the following scenario:

   - Each sensor node is equipped with the battery that provides an amount of energy of 1500 mAh. Assume that every node is driven with the same voltage supplied by the battery.
   - A measurement has to be taken every 200ms. For each measurement, sending is required only once per second, and each attempt to send a packet requires the node to receive one packet. Assume that a node knows exactly when a foreign packet will arrive.
   - Every packet length is 250 bytes and the radio bandwidth is 9600 bits/s.
   - A single measurement takes 5ms.

   (a) What is the lifetime of each node?

(b) There are several influences that are not taken into account in this example. State the influences and briefly explain whether and how they reduce or extend the lifetime of the sensor node.

Answers:

(a) Energy for CPU processing and computation

5 samples/second x 0,005 seconds (for each measurement) x 9mA = 0,225mAs

Energy for radio transmission (involves both sending and receiving)

(250 bytes x 8 bit)/(9600 bits/s) x (9mA (basic consumption) + 10 mA (for sending)) + (250 bytes x 8 bit)/(9600 bits/s) x (9mA (basic consumption) + 5mA (for receiving)) = 5/24s x19mA + 5/24s x 14mA = 6,875 mAs

Energy consumption in idle mode

First, find out the idle time within 1 second.
Active time includes 0,025s for computation and processing, and 0,4167s for radio transmission within 1 second.
Therefore, idle time is (1-0,025-0,4167) = 0,5583.
Idle energy consumption is: 0,5583s x 0,05 mA = 0,027915 mAs

Total energy consumption per second

0,225mAs + 6,875mAs + 0,027915 mAs = ca. 7,127915 mAs
Battery provides 1500mAh = 1500x60x60 mAs / 7,127915 = ca. 757.584s / (60x60x24) = 8,768 days

(b) Influences extending the node lifetime:

- Compression of redundant data was not taken into account

Influences reducing the node lifetime:

- Temperature has impacts on the energy supply
- Control packets caused by routing protocol and accumulation of data were not considered
- In general, the lifetime of the network is not equal to the lifetime of an average node
- Network partition happens if sensor nodes fail and in certain cases, communications cannot be achieved
- Battery does not provide 1.5V of capacity all the time
- Retransmission may happen due to packet collisions/channel noise that will cause transmission errors

SECTION 2:
MAC Layer

Provide short answers for the following questions.

1. Write four major sources of energy wastage and explain them very briefly.
   Answer:

   (a) Collision: A collision is followed by backoff or/and retransmission which result in wasting energy

   (b) Overhearing: A node hear the data distin to some other node

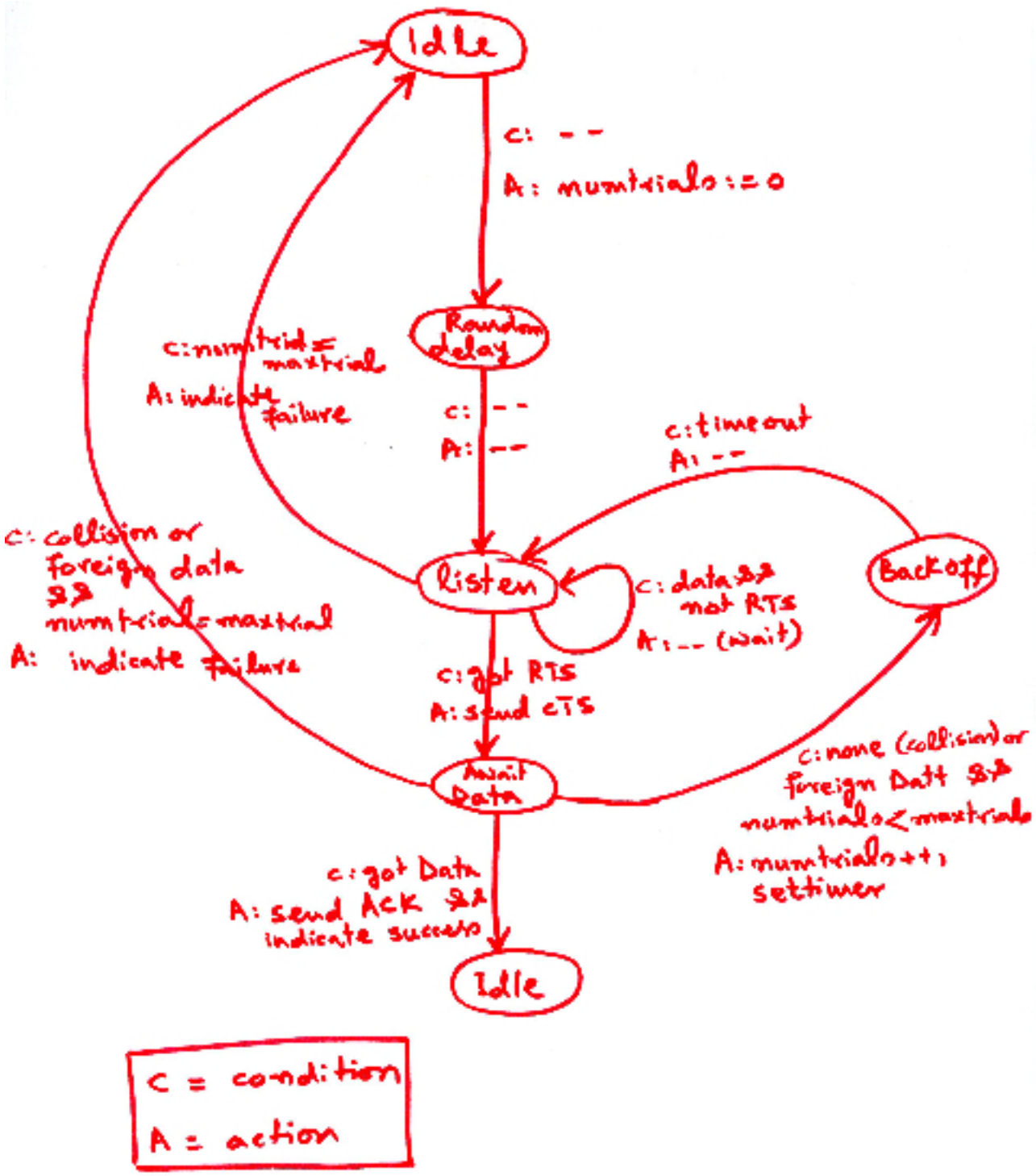
   (c) Control overhead (Protocol overhead): Protocol overhead is induced by MAC-related control frames like RTS/CTS and furthermore by per packet overhead like packet headers and trailers.

   (d) Idle listening: A node being in idel state (listening medium) but is not currently receiving anything.

2. Explain briefly (not more than three sentences) that why busy tone should not be stronger or weaker than data signal?
   Answer:

   If the busy tone is too strong, more nodes than necessary suppress their transmissions. If the busy tone is too week, a node within radio range of the reciever might start data transmission and destroy the reciever's signal.

3. Following figure shows steps a CSMA protocol follow at the sender side. Draw a similar diagram for the reciever side.



Choose between true and false for the following questions.

1. MAC protocols provides medium access control mechanism when a number of nodes compete for a shared communication medium? (**True**/False)

2. In WSN, if a sender sense that medium is free (and suppose that condition will hold) then is that means receiver will get its transmission without facing any collisions? (True/**False**)

3. In Ethernet, if a sender sense that medium is free (and suppose that condition will hold) then is that means receiver will get its transmission without facing any collisions? (**True**/False)

4. In pure ALOHA a sender after sensing the medium immediately sends the data packet. ? (True/**False**)

5. In slotted ALOHA a sender can send only at the beginning of a time slot and wait otherwise? (**True**/False)

6. In persistent CSMA, a node wait for random amount of time after last collision before sensing the channel again? (True/**False**)

7. In p-persistent CSMA, a node decide to transfer with probability p on current time slot? (**True**/False)