CS 455 - Computer Networks
Homework 6

Due: See class webpage.

- **Question 1 (Token ring) - 20 pts**
  - We consider a **token ring protocol** operating on a ring network with a **data rate** of **10 Mbps**.

    There are **N = 10 nodes** connected to the token ring network.

    A node is allowed to **transmit 1 packet** when it **receives** the **token**.

    When a node receives the **token** and transmits a **message**, the **message** must **return back** to the **sending node** and **then** the **node** will **pass** the **token** to the **next node** in the ring.

    We assume that **all messages** have the **same length** and each message is **1000 bytes** (= **8000 bits**) long.

    The **distance** between **any 2 nodes** is the **same** and it takes **1.0 msec (milli sec)** for a **message** to **travel** to the **next node** in the token ring.

    We define the **token rotation time** T_{rot} to be the **time** between **2 consecutive arrivals** of the **token** at the ***same node***.

    For example:

    - Suppose **node 1** received the **token** at time T_1

      Node 1 could now **transmit** a **message** or if **node 1** has **no message** to **transmit**, it will **pass** the **token** to the **next node**

    - Then **later**, at time T_2, **node 1** received the **token** again.

    - Then the **token rotation time** is **equal to:**

      $$T_{rot} = T_2 - T_1$$

Questions:

- What is the ***minimum*** **value** of the **token rotation time** in this token ring network ? (10 pts)

  ```
  T = actual time

  ---

  Min token passing time is achieve when all nodes has no message
  to transmit

  Let T = 0  when a node X passes the token

  The token will reach the next node at:      T = 1 msec
  The token will reach the next next node at: T = 2 msec
  and so on

  The token will return to the node X at:     T = 10 msec
  ```

```
Min token passing time = 10 msec
```

- What is the ***maximum*** **value** of the **token rotation time** in this token ring network ? (10 pts)

```
T = actual time
t = time taken to do a task
```

```
Max token passing time is achieve when all nodes transmits
1 message when it receives the token

Let T = 0  when a node X passes the token
```

```
The token will reach the next node at time  T = 1 msec

This node will transmit a message:          t = 8000/10,000,000 = 0.8 msec
Message need to come back to node:          t = 10 × 1 msec = 10 msec

Node will pass token to the next node at:   T = 1 + 10.8 msec = 11.8 msec
```

```
The token will reach the next next node at: T = 12.8 msec (11.8 + 1 msec)

This node will transmit a message:          t = 8000/10,000,000 = 0.8 msec
Message need to come back to node:          t = 10 × 1 msec = 10 msec

Node will send token at:                    T = 12.8 msec + 10.8 = 23.6
                                              = 2 × 11.8 msec
```

```
And so on
```

```
The 9th node will send token (to node X) at:  T = 9 × 11.8 = 106.2 sec

The token will return to the node X at:       T = 107.2 msec

Max token passing time = 107.2 msec
```

```
=========================================================================
```

```
In formula:

    1.  X pass token to next node:                1 msec

    2.  Each node (9 of them) will:

          1. send a message:                0.8 msec
          2. wait for message to return:  10  msec
          3. pass token to next node:      1  msec

        Total time for 1 node:   11.8 msec

 Answer:  1 msec + 9*(0.8 + 10 + 1)  =  107.2 msec
```

- **Question 2 (Token bus) - 30 pts**

- Consider the **variables** in a **node** in a **token bus network**:

```
ID           =  4444
predeccessor =  5678
successor    =  1234
```

Suppose the **node 4444** wish to **invite** other nodes to **join** the **token bus network**

Question:

- What **control message** will the **node 4444** transmit: (5 pts)

```
4444.Solicit_Successor1(1234)
```

- Give the **range** of **node IDs** that are **invited**: (5 pts)

```
      (4444 .. 1234)

Or    (1234 .. 4444)
```

Suppose this node **receives** the **token frame** from the **node 5555**

Questions:

- **Give** a **scenario** where the **node 4444** can receive a **token** from **node 5555** (that is ***not*** its **predecessor**) (5 pts)

```
Node 5555 has just inserted itself into the token bus
```

- Show the **values** of the **variables** of this **node** after it has **processed** the **token frame**: (5 pts)

```
ID           =  4444
predeccessor =  5555
successor    =  1234
```

Use the **original values** in the **node's variables** to answer this question

Suppose this node **receives** a `Who_follows(5678)` from **node 9999**

Questions:

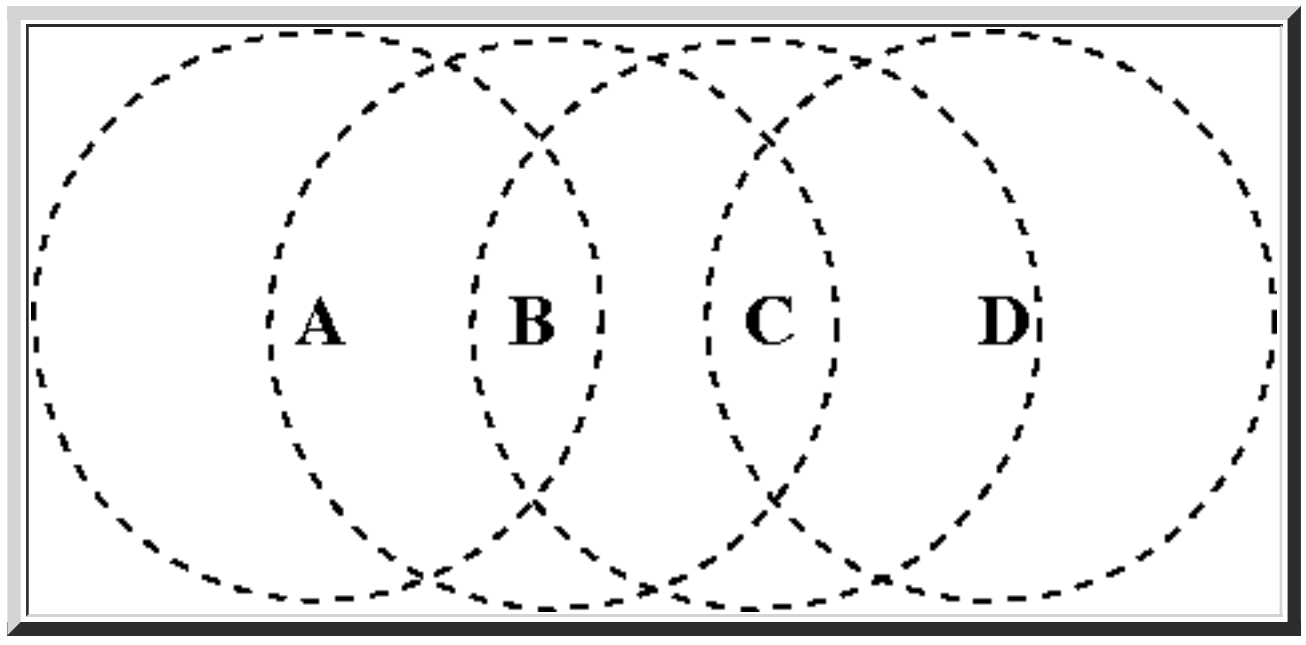
- **Give** a **scenario** where the **node 4444** can receive such a control frame (5 pts)

```
Node 5678  has failed
```

- What is the **response** of **node 4444** to this control message ? (5 pts)

```
Send  Set_successor( 4444 )     to node 9999
```

- **Question 3 - 20 pts**
  - **Consider** the following **wireless network** with **4 nodes** (**A, B, C and D**)



Questions:

- List the **hidden node(s)** of **each node** below: (10 pts)

```
Hidden node for A:  C
Hidden node for B:  D
Hidden node for C:  A
Hidden node for D:  B
```

- List the **exposed node(s)** of **each node** below: (10 pts)

```
Hidden node for A:  none
Hidden node for B:  A and C
Hidden node for C:  B and D
Hidden node for D:  none
```

- **Question 4 (10 pts)**
  - Suppose 2 wireless nodes **A and B** uses the following **chips**:

```
chip of A = 1010111
chip of B = 1101000
```

The **nodes** received the following **transmissions**:

```
                A                   B
      ------------------------------
```

1111111	1	0
1000000	0	1
0111111	1	0
0000000	0	1

Write in the table above the **bit value** that each **node** will **assign** to **each transmission** (10 pts)

- **Question 5 (20 pts)**
  - Let **A** and **B** be two **IEEE 802.11 hosts** attempting to transmit on an **wireless network**. Each host has a **steady queue of frames** ready to send.

    A's frames will be numbered as $\mathbf{A_1}$, $\mathbf{A_2}$ and so on, and **B's** frames will be numbered as $\mathbf{B_1}$, $\mathbf{B_2}$ and so on.

    Suppose the **IEEE 802.11 MAC algorithm** using this **value** for the **initial back off window size**:

    CW_{min} = 15 (i.e.: initial choice of random numbers from [0 .. 15])

    Suppose **A** and **B** ***simultaneously*** **(= at the same time)** attempt to send **frame 1** and the **transmissions** collide (= did **not receive** an **ACK frame**).

    Assumes that **A** chooses **backoff time 2×T** (i.e., **A** picked the **random number 2**) and **B** chooses **backoff time 14×T**.

    According to the **DCF protocol** (see: click here), **A** will **wins the race** and **transmits** its first frame $\mathbf{A_1}$ ***successfully***.

    Notice that when **A** starts **transmitting** its first frame $\mathbf{A_1}$, the **node B** will ***pause*** its **count down** (see the **DCF protocol**: click here) !!!

    When **node A** finishes transmitting the frame $\mathbf{A_1}$, the node **A first** perform a **back off** (while **B** will **resume** the **count down**)

    Therefore, **nodes A and B** will be **competing** compete to transmit their frames.

    Questions:

    - Find the **probability** that **A** will **win** the ***second*** **backoff race** (10 pts)

      A will choose from: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 (16 numbers)
      B will count down from: 12 (picked 14, has counted down 2 before)

      A wins if A picks: 0 1 2 3 4 5 6 7 8 9 10 11 (12 numbers)

      Probab(A wins) = 12/16

    - Find the **probability** that **B** will **win** the ***second*** **backoff race** (10 pts)

      A will choose from: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
      B will count down from: 12 (picked 14, has counted down 2 before)

      B wins if A picks: 13 14 15

      Probab(B wins) = 3/16