School of
Applied Computing

Network Simulation

NetSim

Exercise 5

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5. Understand the impact of bit error rate on packet error and investigate the impact of error of a simple hub based CSMA/CD network

5.1 Theory:

Bit error rate (BER): The bit error rate or bit error ratio is the number of bit errors divided by the total number of transferred bits during a studied time interval i.e.

$$\text{BER} = \frac{\text{Bit errors}}{\text{Total number of bits}}$$

For example, a transmission might have a BER of 10^{-5}, meaning that on average, 1 out of every of 100,000 bits transmitted exhibits an error. The BER is an indication of how often a packet or other data unit has to be retransmitted because of an error.

Unlike many other forms of assessment, bit error rate, BER assesses the full end to end performance of a system including the transmitter, receiver and the medium between the two. In this way, bit error rate, BER enables the actual performance of a system in operation to be tested.

Bit error probability (p_e): The bit error probability is the expectation value of the BER. The BER can be considered as an approximate estimate of the bit error probability. This estimate is accurate for a long time interval and a high number of bit errors.

Packet Error Rate (PER):

The PER is the number of incorrectly received data packets divided by the total number of received packets. A packet is declared incorrect if at least one bit is erroneous.

The expectation of the PER is denoted as packet error probability p_p, which for a data packet length of N bits can be expressed as,

$$p_p = 1 - (1 - p_e)^N$$

It is based on the assumption that the bit errors are independent of each other.

Derivation of the packet error probability:

Suppose packet size is N bits.

p_e is the bit error probability then probability of no bit error=1-p_e

As packet size is N bits and it is the assumption that the bit errors are independent. Hence,

Probability of a packet with no errors = $(1-p_e)^N$

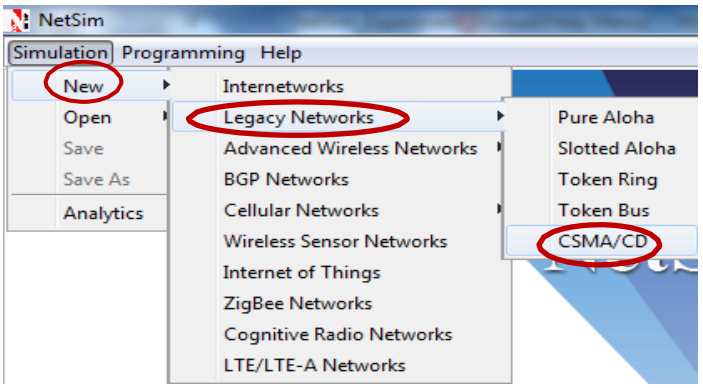
A packet is erroneous if at least there is one bit error, hence

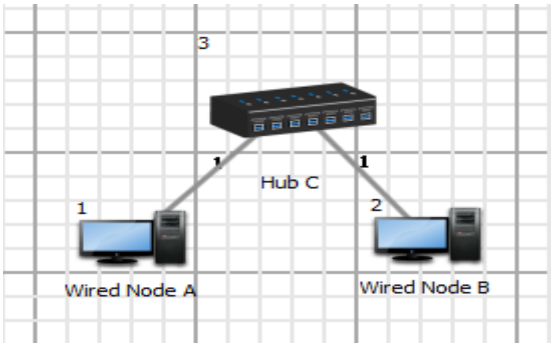
Probability of packet error=1-$(1-p_e)^N$

5.2 Procedure:

How to create a scenario and generate traffic:

- **Create Scenario:** –Simulation → New →Legacy Networks →CSMA/CD‖.





Example 1:

Create samples by varying the bit error rate (10^{-6}, 10^{-7}, 10^{-8}, 10^{-9}, No error) and check whether packet error output matches the PER formula.

Sample Inputs:

To perform this sample experiment, two nodes and one hub are considered.

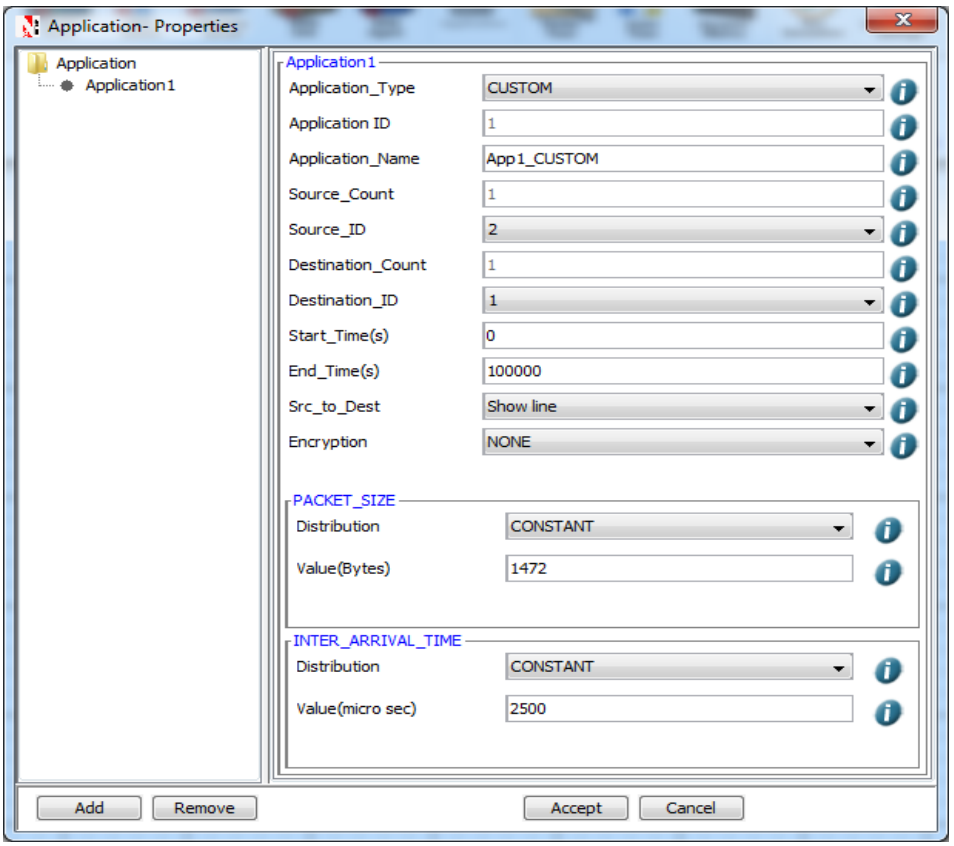
- Click and drop Hub on the environment builder.
- Click and drop Node1.
- Click and drop Node2.

The properties of Node 1 and Hub are as follows: (Node 2 has default properties)

Link Properties	**Sample 1**	**Sample 2**	**Sample 3**	**Sample 4**	**Sample 5**
Data rate (Mbps)	10	10	10	10	10
Error Rate (BER)	No Error	10^{-9}	10^{-8}	10^{-7}	10^{-6}

Wireless Node Properties: Disable TCP in transport layer

Application Properties: Click and drop the Application icon and set the following properties



Simulation Time - 10 Sec

*(**Note:** The Simulation Time can be selected only after the following two tasks,*

- *Set the properties for the Nodes& The Hub*
- *Click on the Simulate button**).***

Example 2:

Sample Inputs:

In this sample experiment, four nodes and one hub are considered.

- Click and drop Hub on the environment builder
- Click and drop Node1
- Click and drop Node2
- Click and drop Node3
- Click and drop Node4

Link Properties	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Data rate (Mbps)	10	10	10	10	10
Error Rate (BER)	No Error	10^{-9}	10^{-8}	10^{-7}	10^{-6}

The properties of Node 1 are same as in Example 1 and Node 2 properties are shown below:

(Node 3 and Node 4 have default properties)

Application Properties: Click and drop the Application icon and set the properties as in example 1.

Simulation Time - 10 Sec

*(**Note:** The Simulation Time can be selected only after the following two tasks,*

- *Set the properties for the Nodes& The Hub*
- *Click on the Simulate button)***.**

NetSim simulation output:

Example 1: One node transmission

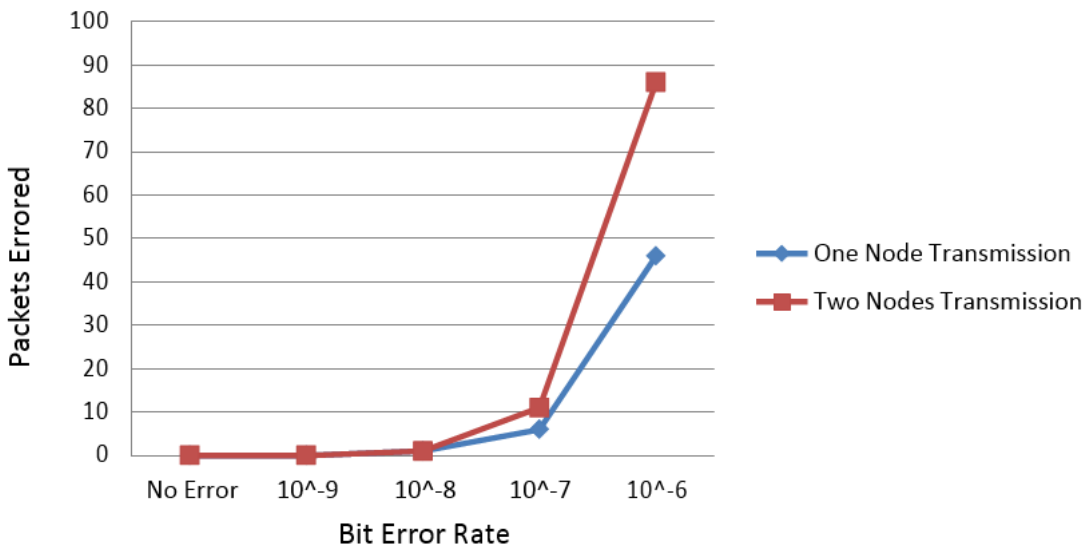
BER	Packets Errored	Packets Generated
0	0	3999
1E-09	0	3999
1E-08	1	3999
1E-07	6	3999
1E-06	46	3999

Example 2: Two nodes transmission

BER	Packets Errored	Packets Generated
0	0	7998
1E-09	0	7998
1E-08	1	7998
1E-07	11	7998
1E-06	86	7998

Packet size for the calculation of the output table=1500 bytes or 12000 bits

Comparing Packets errored with Bit error rate:



5.3 Inference:

From the Graph, we see that as the error rate is increased the number of errored packets increase. The increase is exponential since the error rate is increased in powers of 10.