TOPICS IN NETWORK ASSIGNMENT-2 REPORT

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18/04/2020

Programming Language Used:

C++

Software used for generating Report:

R Studio Markdown

Scheduling Algorithms Implemented :

INQ

In this scheduling Algorithm for each packet generated, if there is no contention for its desired output port, it is selected for transmission and placed in the corresponding output port's buffer. For packets contending for the same output port, one of the packets is randomly selected for transmission and placed in the corresponding output port's buffer; the other packets are queued at the corresponding input port.

KOUQ

In this scheduling Algorithm a maximum of K packets (per output port) that arrive in a given slot are queued (based on packet arrival time) at the corresponding output port. If two or more packets have the same arrival time, the packets can be queued in any order. If more than K packets arrive in a slot for a particular output port, then K packets are randomly selected for buffering, and the remaining packets are dropped. The default value is K = 0.6N.

iSlip

This scheduling Algorithm is implemented using a Virtual Output Queue (VOQ).

Inputs to the program

The command line will specify the following:

• Number of switch input and output ports

• Buffer size

• Packet generation probability

• queue scheduling technique being used

Outputs produced by the program

The following performance metrics will be produced by the program

• Average packet delay: The mean packet delay computed for all transmitted packets.

• Average link utilization: Link utilization for each link, is defined as the fraction of time a link has been used for transmitting a packet, with respect to the entire simulation duration. Average link utilization would be its mean value.

• KOUQ drop probability: The probability per slot that more than K packets were generated for an output port. The following output in give format will be stored in a output file :-

(p) (Queue type) (Avg PD) (Std Dev of PD) (Avg link utilization)

Data Visualization and Interpretation

Table Containing the required Performance Metric Values

```
##    algorithm avg_pd avg_link_util B  N K_value
## 1        INQ  2.650        48.000 2  4   0.6*N
## 2      iSLIP  2.460        49.300 2  4   0.6*N
## 3       KOUQ  2.240        48.675 2  4   0.6*N
## 4        INQ  2.890        49.300 3  4   0.6*N
## 5      iSLIP  2.520        50.150 3  4   0.6*N
## 6       KOUQ  2.240        48.675 3  4   0.6*N
## 7        INQ  3.033        49.890 4  4   0.6*N
## 8      iSLIP  2.536        50.200 4  4   0.6*N
```

```
## 9       KOUQ  2.240        48.675 4  4   0.6*N
## 10       INQ  3.780        39.200 2  8   0.6*N
## 11     iSLIP  2.550        48.900 2  8   0.6*N
## 12      KOUQ  2.420        50.000 2  8   0.6*N
## 13       INQ  5.190        39.190 3  8   0.6*N
## 14     iSLIP  2.610        49.900 3  8   0.6*N
## 15      KOUQ  2.420        50.000 3  8   0.6*N
## 16       INQ  6.820        38.900 4  8   0.6*N
## 17     iSLIP  2.630        50.000 4  8   0.6*N
## 18      KOUQ  2.420        50.000 4  8   0.6*N
## 19       INQ  7.460        22.970 2 16   0.6*N
## 20     iSLIP  2.590        48.000 2 16   0.6*N
## 21      KOUQ  2.470        49.990 2 16   0.6*N
## 22       INQ 11.000        22.680 3 16   0.6*N
## 23     iSLIP  2.660        49.800 3 16   0.6*N
## 24      KOUQ  2.470        49.990 3 16   0.6*N
## 25       INQ 14.750        22.500 4 16   0.6*N
## 26     iSLIP  2.680        49.990 4 16   0.6*N
## 27      KOUQ  2.470        49.990 4 16   0.6*N
## 28       INQ 13.370        13.560 2 32   0.6*N
## 29     iSLIP  2.620        48.590 2 32   0.6*N
## 30      KOUQ  2.480        49.940 2 32   0.6*N
## 31       INQ 19.710        13.580 3 32   0.6*N
## 32     iSLIP  2.700        49.700 3 32   0.6*N
## 33      KOUQ  2.480        49.940 3 32   0.6*N
## 34       INQ 26.560        13.400 4 32   0.6*N
## 35     iSLIP  2.710        49.920 4 32   0.6*N
## 36      KOUQ  2.480        49.940 4 32   0.6*N
```

The Table above contains the following data :-

Algorithm Name

Average Packet Delay

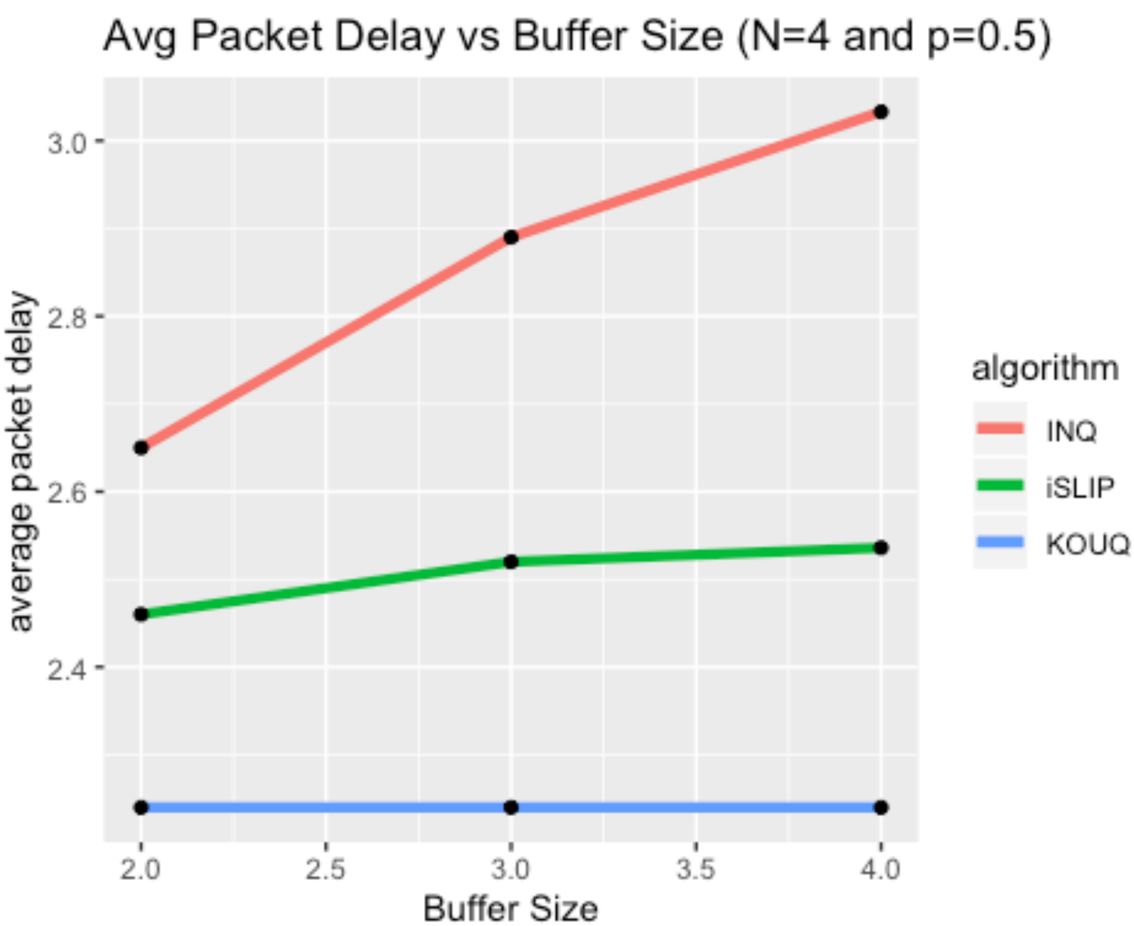
Average Link Utilization

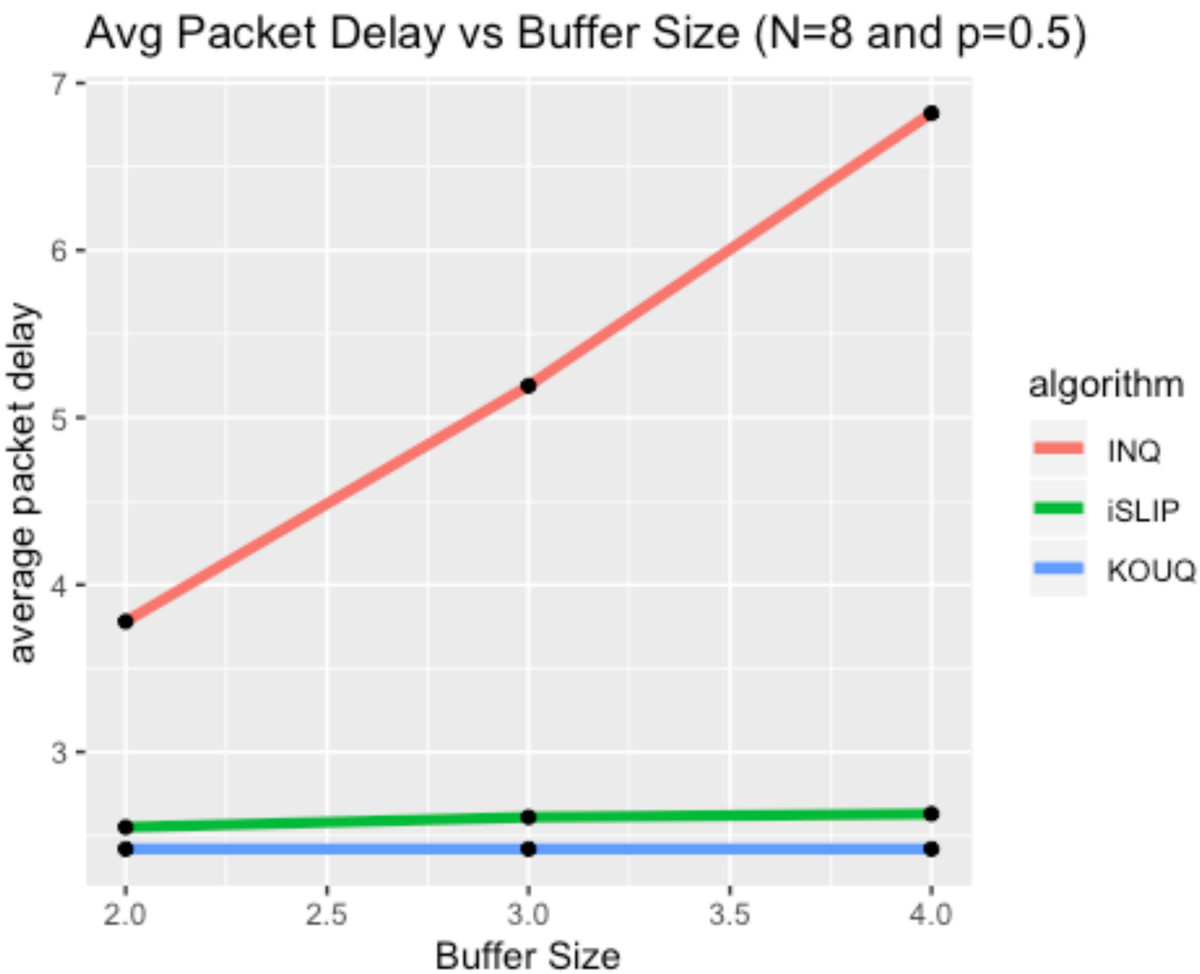
Buffer Size

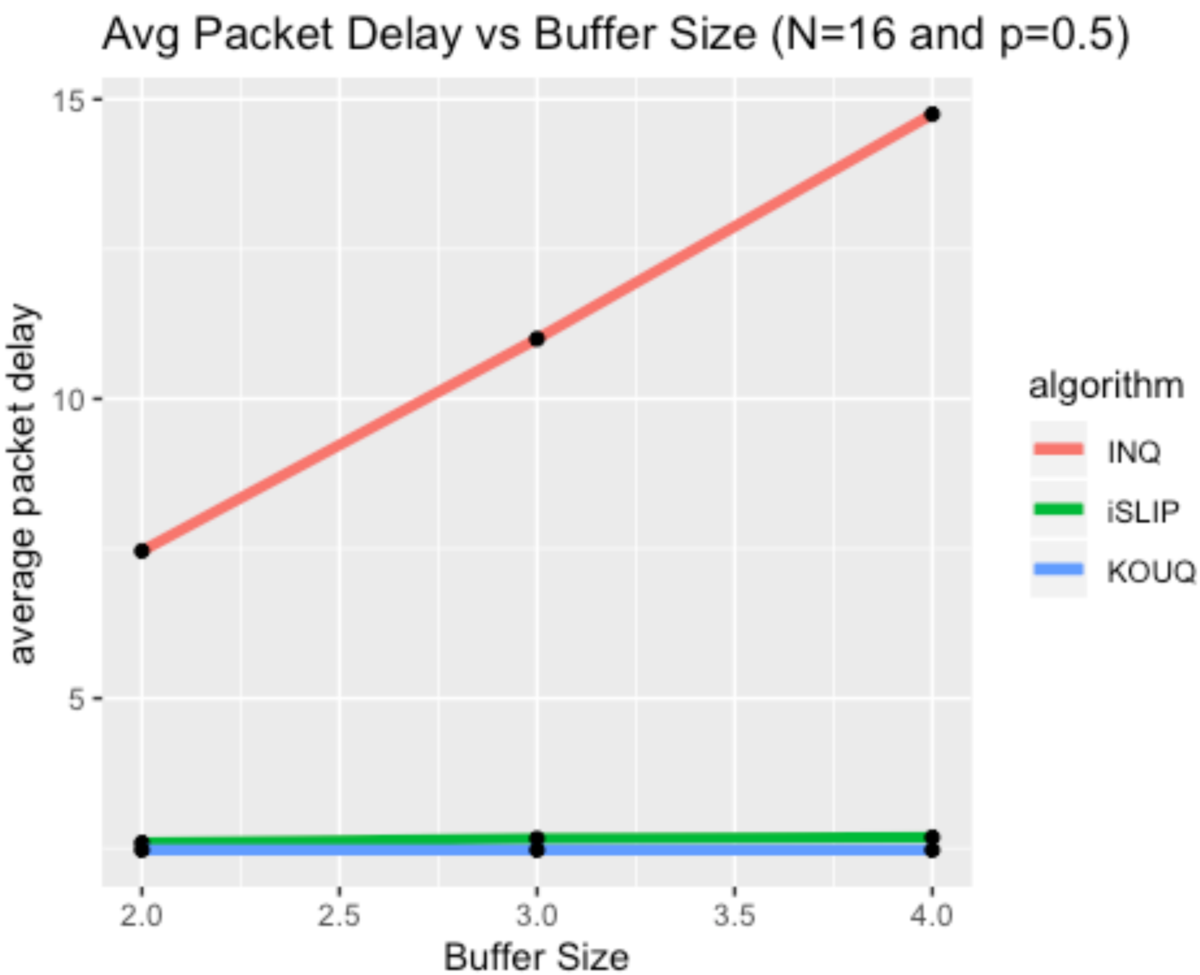
No of ports

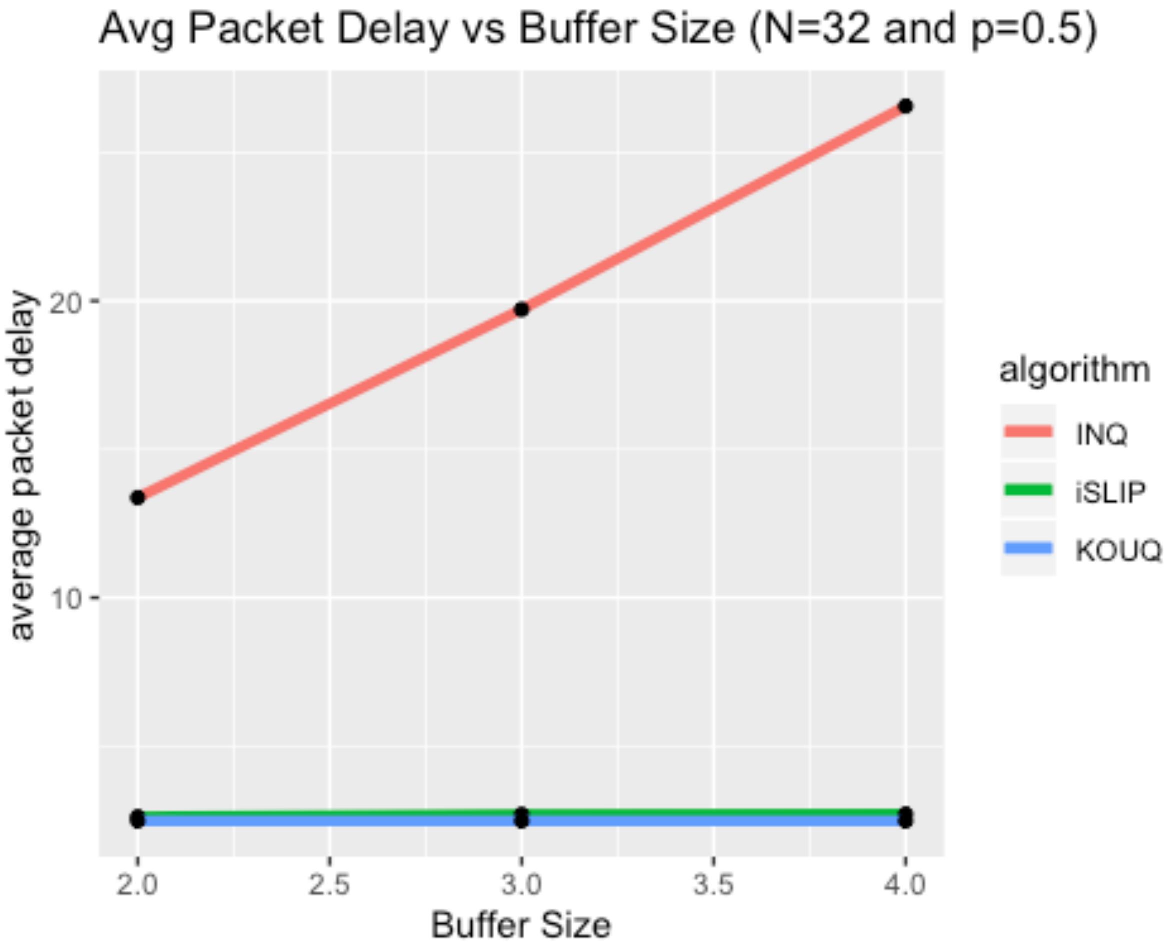
K value

Average Packet Delay Performance Metric




Avg Packet Delay vs Buffer Size (N=8 and p=0.5)
average packet delay
7
6
5
4
3
2.0
2.5
3.0
3.5
4.0
Buffer Size
algorithm
INQ
iSLIP
KOUQ


Avg Packet Delay vs Buffer Size (N=16 and p=0.5)
average packet delay
15
10
5
2.0
2.5
3.0
3.5
4.0
Buffer Size
algorithm
INQ
iSLIP
KOUQ



From the above plot we can observe the performance of the 3 scheduling algorithms with respect to average packet delay performance metric when we variate the N value and the Buffer Size value and here K value is fixed for KOUQ as K = 0.6*N.

N ={4,8,16,32}

B ={2,3,4}

p = 0.5

Knockout value = 0.6*N

The Observations we can make :-

1.) For the INQ Algorithm the averge packet delay is the highest as compared to the other algorithms. As the buffer size increases for fixed N value the average Packet Delay for the switch implemented using INQ algorithm increases almost at a linear rate specially for the case when N=8,N=16 and N=32.

Also as the N value increases the Average packet delay for INQ Algorithm also increases for constant value of Buffer Size and constant p value.

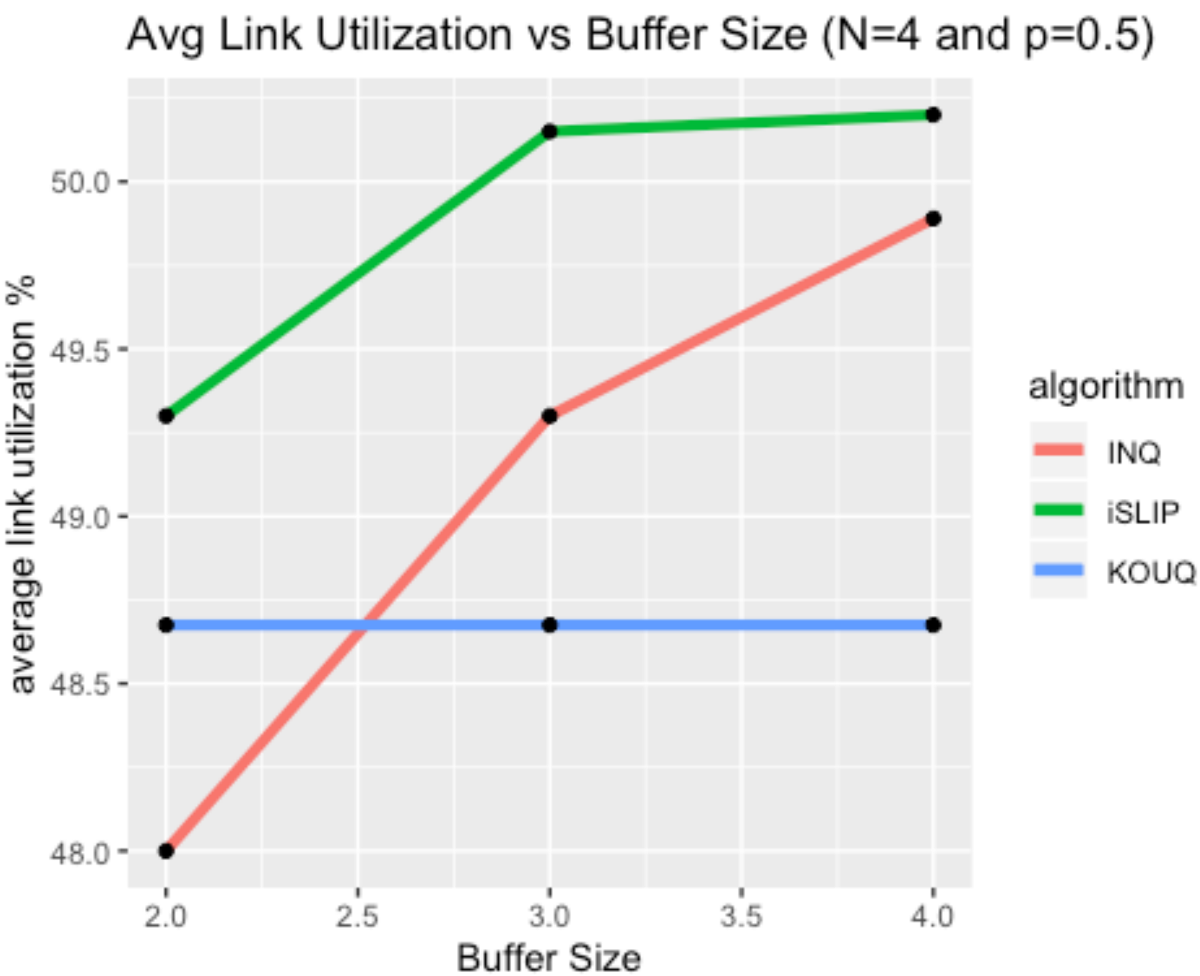
2.) For the iSLIP Algorithm the average packet delay if found to be in between the average packet delays for the INQ and KOUQ algorithms.On increasing the buffer size for fixed N value the average packet delay for the iSLIP Algorithm increases by a very small amount and then gets stablized to a value. Also we can observe that as for N=16 and N=32 the average packet delay for iSLIP algorithm gets close to that of KOUQ algorithm.

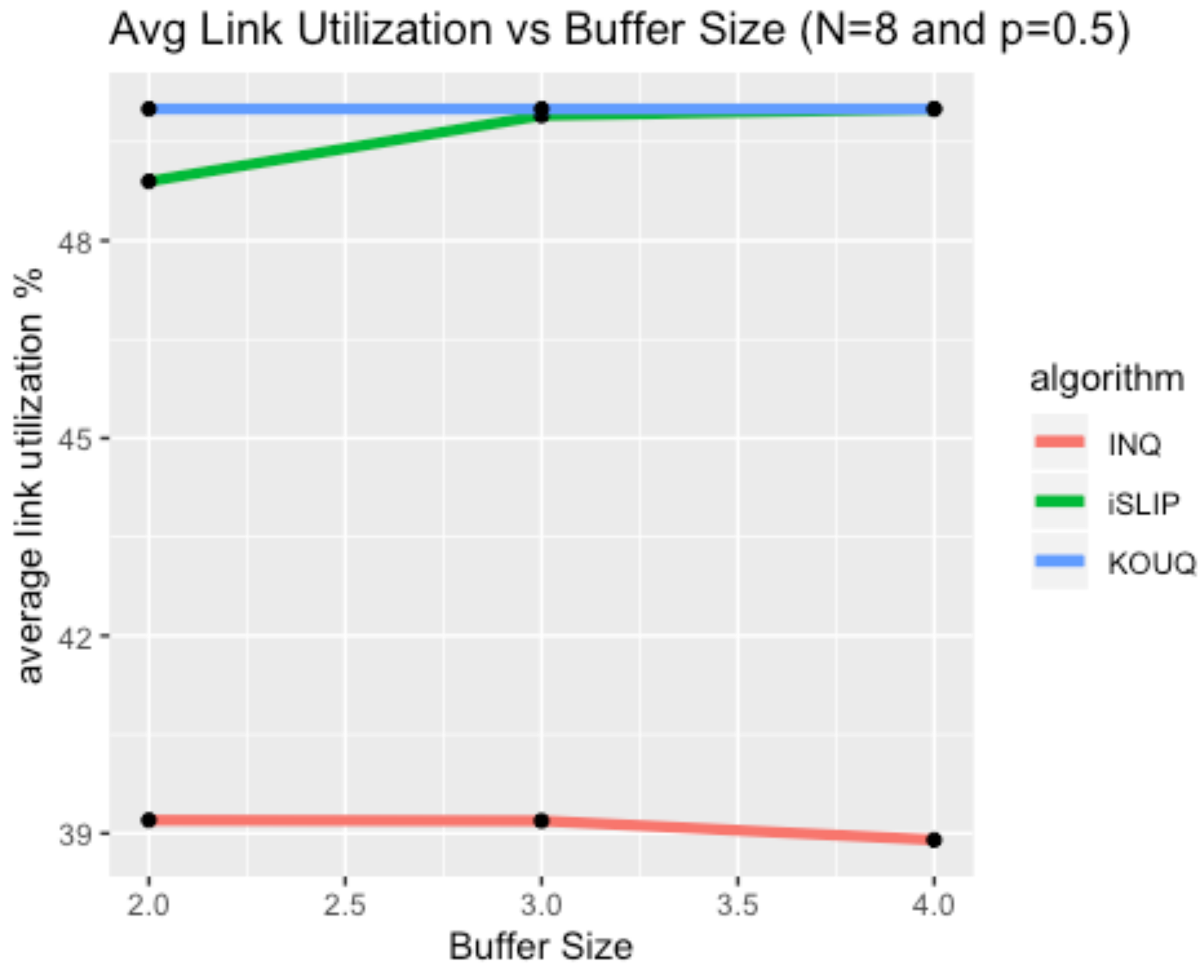
Also as the N value increases the Average packet delay for iSLIP Algorithm also increases for constant value of Buffer Size and constant p value.

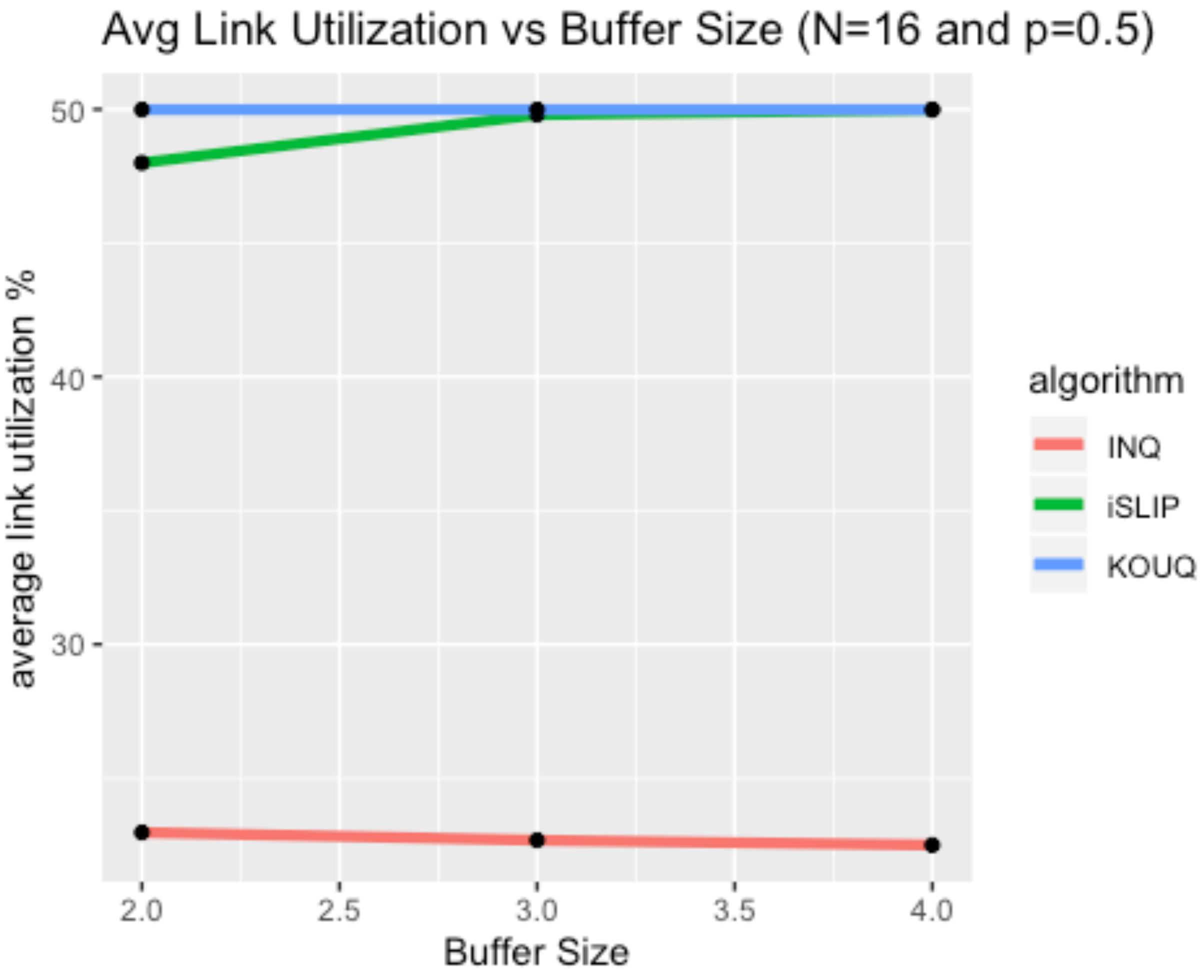
3.) For the KOUQ Algorithm the average packet delay is the least as compared to other implemented algorithms. The average packet delay in case of KOUQ remains constant with variation in the buffer size for fixed N value.We here have used a constant K Value which is = 0.6*N

Also as the N value increases the Average packet delay for KOUQ Algorithm also increases for constant value of Buffer Size,K= 0.6*N snd constant p value.

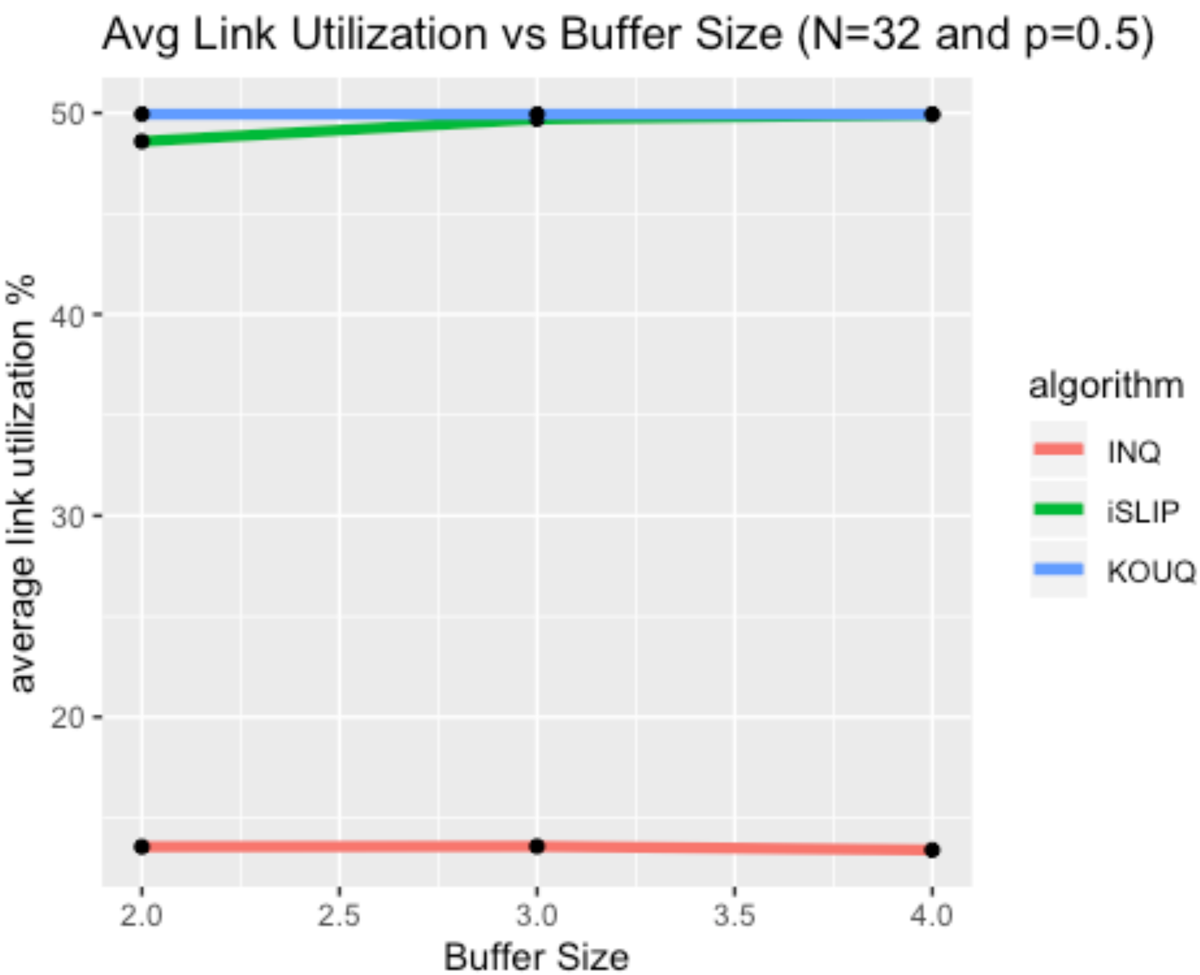
Average Link Utilization Performance Metric




Avg Link Utilization vs Buffer Size (N=8 and p=0.5)
average link utilization %
48
45
42
39
2.0
2.5
3.0
3.5
4.0
Buffer Size
algorithm
INQ
iSLIP
KOUQ



Avg Link Utilization vs Buffer Size (N=16 and p=0.5)
50
40
30
average link utilization %
2.0
2.5
3.0
3.5
4.0
Buffer Size
algorithm
INQ
iSLIP
KOUQ



From the above 3 plots we can observe the performance of the 3 scheduling algorithms with respect to average link utilization performance metric when we variate the N value and the Buffer Size value and here K value is fixed for KOUQ as K = 0.6*N.

N ={4,8,16,32}

B ={2,3,4}

p = 0.5

Knockout value = 0.6*N

The Observations we can make :-

1.) For the INQ Algorithm when N=4 we can observe that as the buffer size increases the average link utilization increases and we achieve a better link utilization than the KOUQ algorithm for B=3 and B=4.

Also we can observe that when the N=8 and N=16 the average link utilization metric value for INQ remains the least with respect to the other algorithms implemented in all the cases. We can also observe in case of INQ on increasing the buffer size for fixed N value the link utilization value shoots up from buffer size = 2 to buffer size = 3 but the link utilization degrades when the buffer size is changed for 3 to 4 specifically for the value N=8.The average link utilization fro INQ algorithm is found to be very poor as compared to other algorithms.

Also as the N value increases the Average link Utilizatiin for INQ Algorithm decreases substantially for constant value of Buffer Size and constant p value.

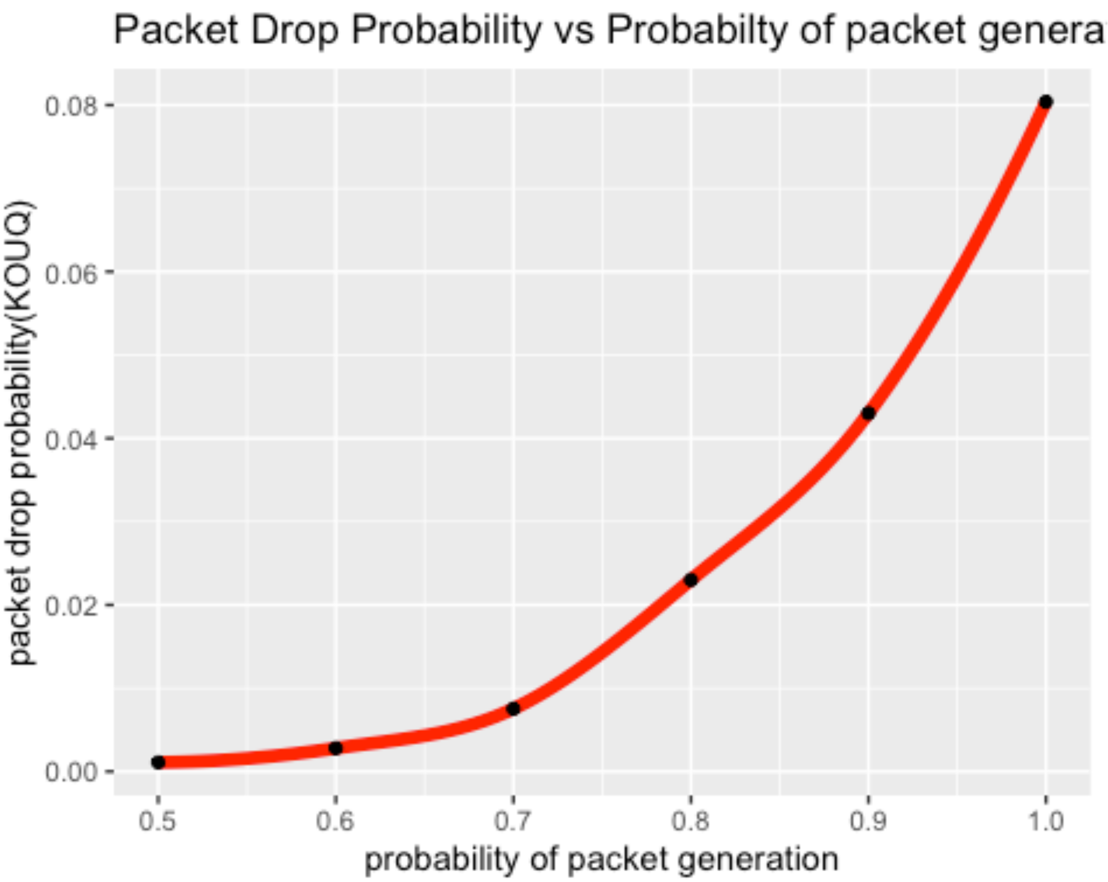
2.) For the iSLIP algorithm we can observe that the average link utilization increases with increase in the buffer size.The max averege link utilization is achieved by iSLIP is for the buffer size value = 4 and is also better than the average link utization provided by KOUQ Algorithm for K=0.6*N value.

Also as the N value increases the Average link Utilizatiin for INQ Algorithm remains almost equal for constant value of Buffer Size and constant p value.

3.) For the KOUQ Algorithm the average link utilization is the maximum as compared to other implemented algorithms when N=8,N=16 and N=32. The average link utilization in case of KOUQ remains constant with variation in the buffer size for fixed N value.We here have used a constant Knockout Value which is = 0.6*N.

Also as the N value increases the Average link Utilizatiin for INQ Algorithm remains almost equal for constant value of Buffer Size,constant p value and K value = 0.6*N.

KOUQ Packet drop Probability vs Probability of Packet Generation



Knockout value used = 0.6*N

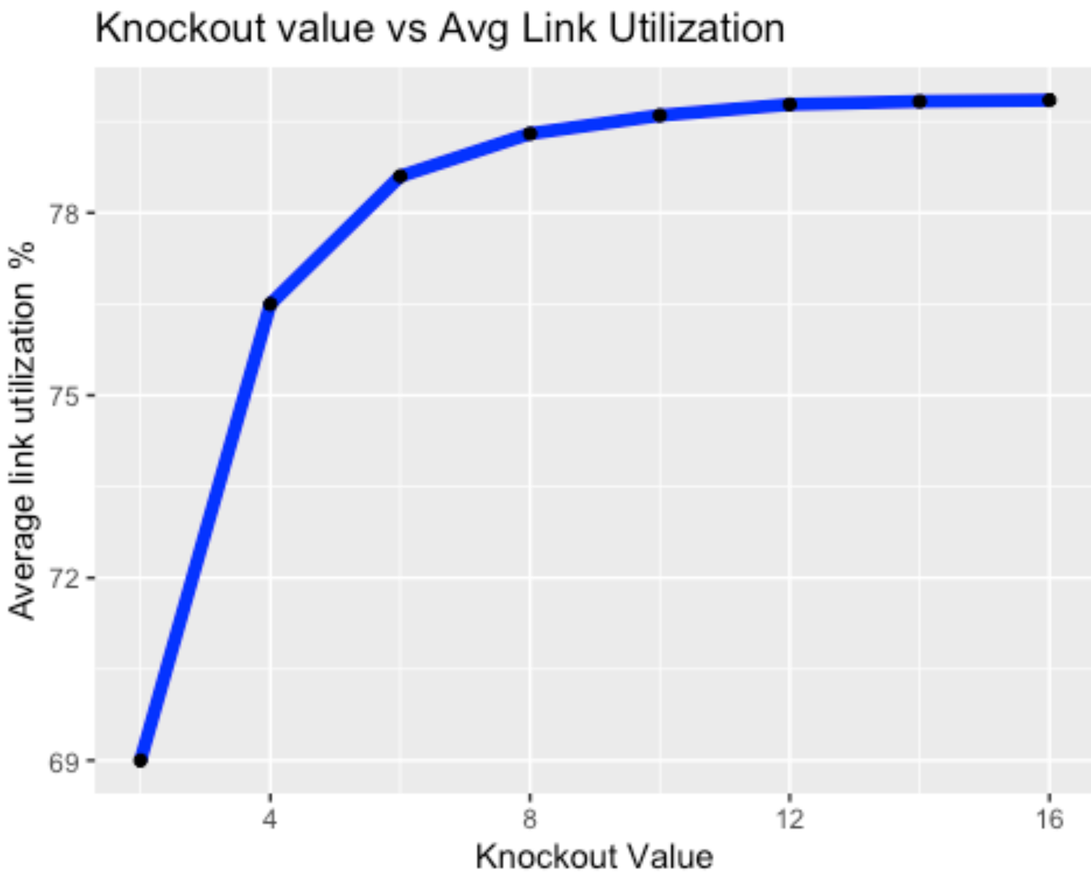
N=8

B=4

From the above plot we can easily observe that as we increase the p value (probability of packet generation) the packet drop probability value in KOUQ algorithm with K=0.6*N increases almost polynomially.

This shows as the p value is larger the KOUQ Algorithm is likely to drop more packets which is not a good sign for a scheduling algorithm.

Variating The Knockout Value in KOUQ



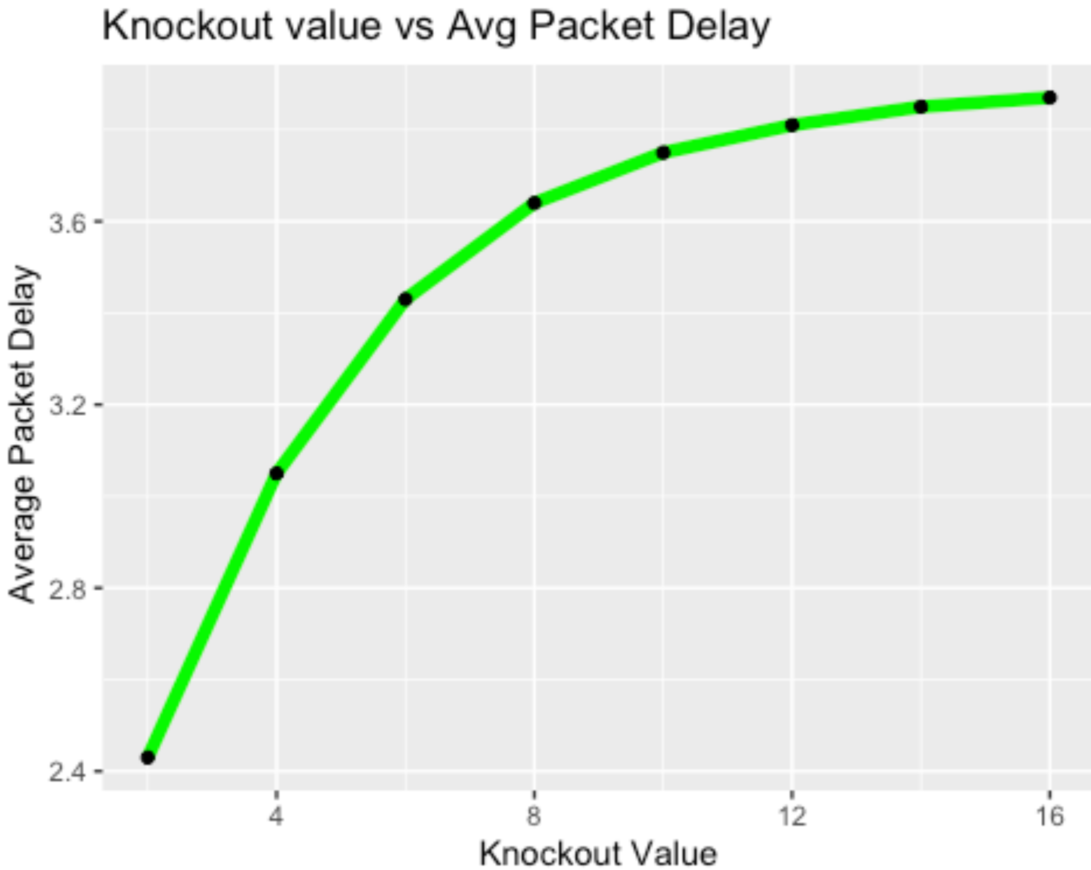
N = 16

B = 4

p=0.8

From the above plot we can observe that as the Knockout value increases the average Link utilization for KOUQ algorithm also increases.

As the knockout value gets closer to the N value the avaerge link utilization starts getting saturated to the maximum value possible.



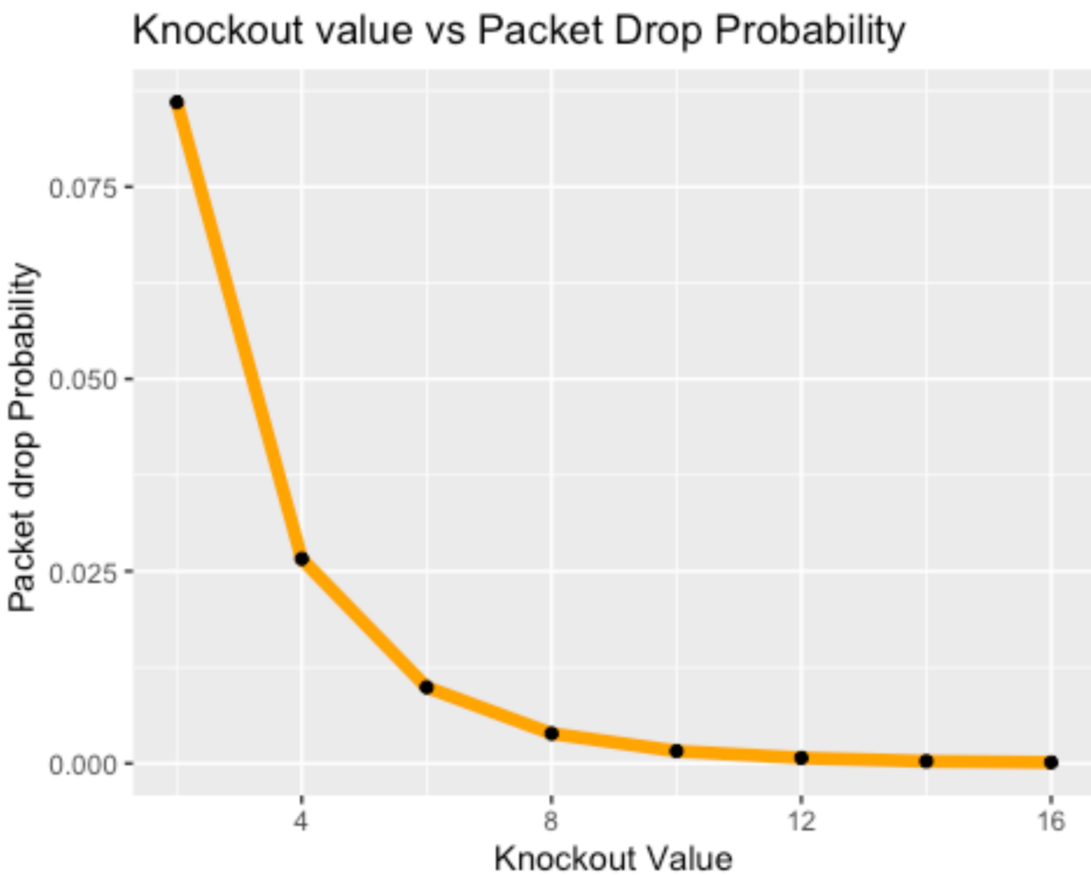
N = 16

B = 4

p= 0.8

From the above plot we can observe that as the Knockout value increases the average packet delay for KOUQ algorithm also increases.

As the knockout value gets closer to the N value the avaerge packet delay starts getting saturated which means it increases with very small factor for increasing Knockout value.



N = 16

B = 4

p= 0.8

From the above plot we can observe that as the Knockout value increases the packet drop probability for KOUQ algorithm decreases gradually.

As the knockout value gets closer to the N value the packet drop probability starts getting saturated which means it decreases with very small factor for increasing Knockout value and gets closer to 0.

CONCLUSION

1.) The INQ scheduling algorithm is a brute force algorithm with very poor performance for large values of N. The INQ algorithm has the least average link utilization and highest average packet delay value when compared to other 2 algorithms.

2.) The iSLIP algorithm is a good choice of scheduling algorithm in multiple situations. The iSLIP algorithm has a comparable high average link utilization and low average packet delay values compared to the INQ Algorithm.

When compared to KOUQ algorithm the iSlip algorithm performance is somewhat similar to KOUQ with oneadvantage.The iSlip algorithm drops the packets in between transmission are very less whereas in KOUQ Algorithm the packet drops are larger as the knockout value is smaller.

Also we observed from running the code for different parameter values that in given time frame iSLIP scheduling algorithm transmits the largest number of packets generated from the input ports to specific output ports.

Hence when there is a requirement such that maximum number of packets must be transmitted to the required output port from the given input port iSlip is the best algorithm to be used as in KOUQ chance of packet getting dropped are larger for smaller k values.

3.) The KOUQ Algorithm is a good choice to be used when we can bear to get good efficiency by trading off with packet dropping possibilities.

As the packet generation probability increases the packet dropping probability also increases in KOUQ.

The Knockout value (K) in KOUQ algorithm plays a very important role. As the Knockout value increases the KOUQ Algorithm average link utilization also increases substantially and on the other hand the average packet delay also increases substantially.

Also as the value of Knockout increases the packet drop probability decreases and as the the knockout value gets nearer to the N value the packet drop probability gets very close to zero.