PROJECT #2: Performance Evaluation of a Space Division Packet Switching

COURSE: ESE 546 Network Algorithms, Fall 2015, Prof. T. Robertazzi

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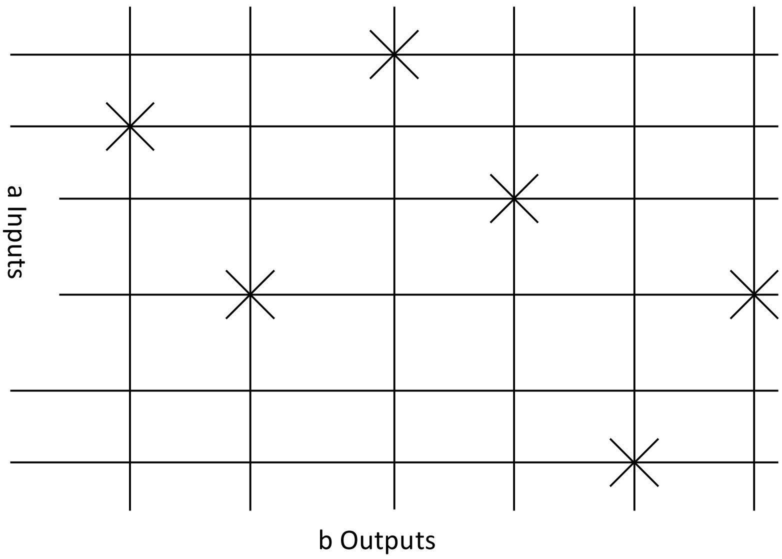
Description of Program

The project aims at producing a discrete event simulation of 3x4, 4x5, and 5x6 cross bar switches. The probability that an input has a single packet on it is p. One packet fills one slot. The input packet is equally likely to go on any output. If two or more than two packets from different inputs arrive at same output slot, only one is chosen randomly and the remaining are discarded.

The project is implemented in two phases namely, theoretical and simulation. In simulation part, discrete event simulation for the scenario is implemented. The program mimics the operation of the network and collects the statistics. That is, for each size crossbar, in each slot, packets are randomly generated for the crossbar inputs. Thereafter, amongst the packets available on input are randomly allowed to go to output. If there are multiple input packets on an output slot, only one is selected randomly and rest are dropped. The process is repeated for 5000 time slots to obtain smooth curves. The same procedure is followed for probability values ranging from p =0.02 to 1. Throughput is calculated for each value of p. Finally, a graph is plotted for throughput for each crossbar versus probability values.

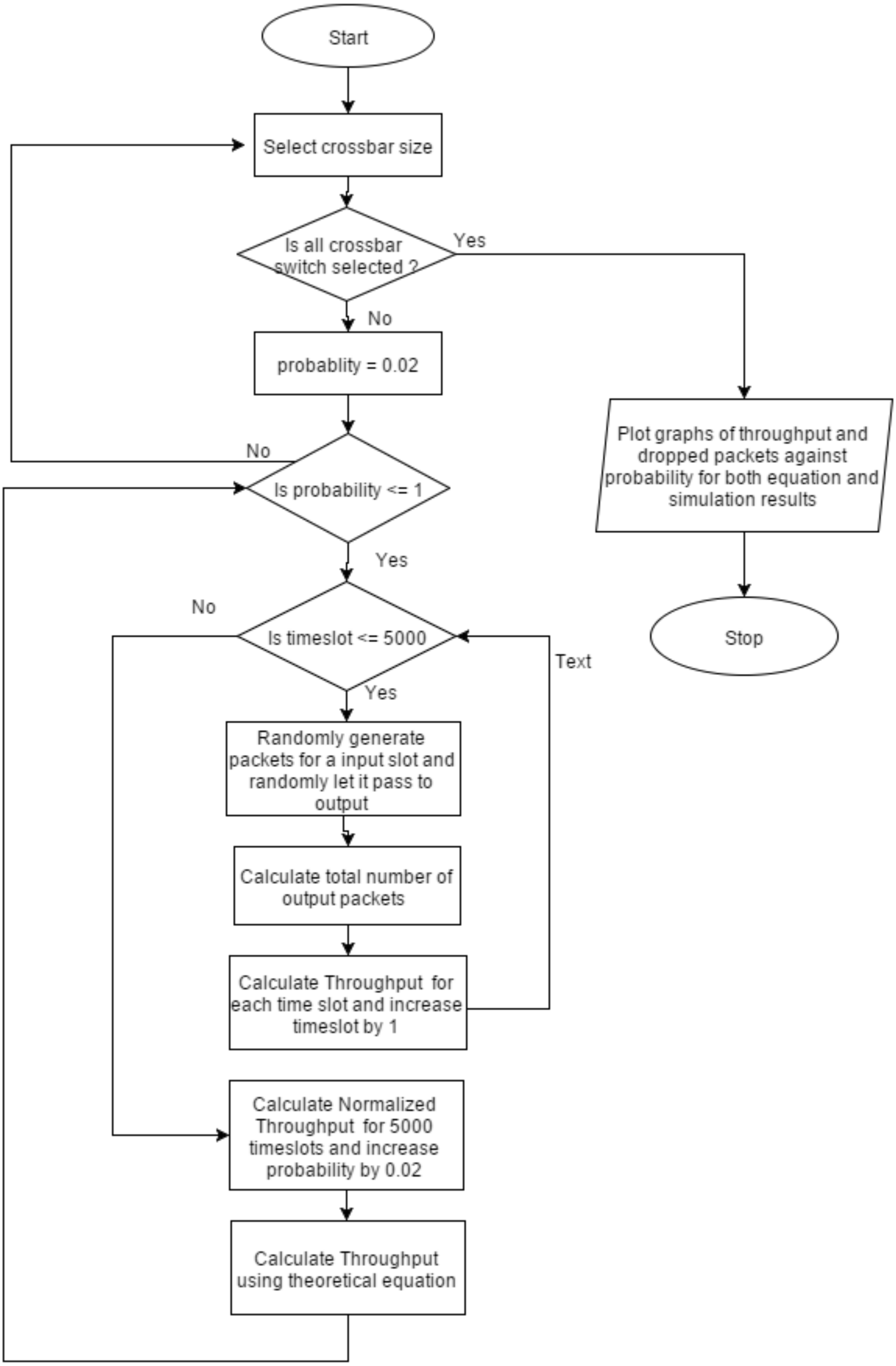


The next phase of project deals with obtaining theoretical values for each probability values ranging from 0.02 to 1. The equation used to calculate theoretical value of throughput is given below:

$$\text{Throughput}_{\text{output}} = \left(1 - \left(1 - \frac{p}{b}\right)^{a}\right)$$

Thereafter, a graph is plotted for this case too which is essentially same as that obtained for simulation case.

FLOWCHART


Start
Select crossbar size
Is all crossbar switch selected ?
Yes
No
probablity = 0.02
No
Is probability <= 1
Yes
No
Is timeslot <= 5000
Yes
Text
Randomly generate packets for a input slot and randomly let it pass to output
Calculate total number of output packets
Calculate Throughput for each time slot and increase timeslot by 1
Calculate Normalized Throughput for 5000 timeslots and increase probability by 0.02
Calculate Throughput using theoretical equation
Plot graphs of throughput and dropped packets against probability for both equation and simulation results
Stop

SOURCE CODE

Name of Language Used: MATLAB

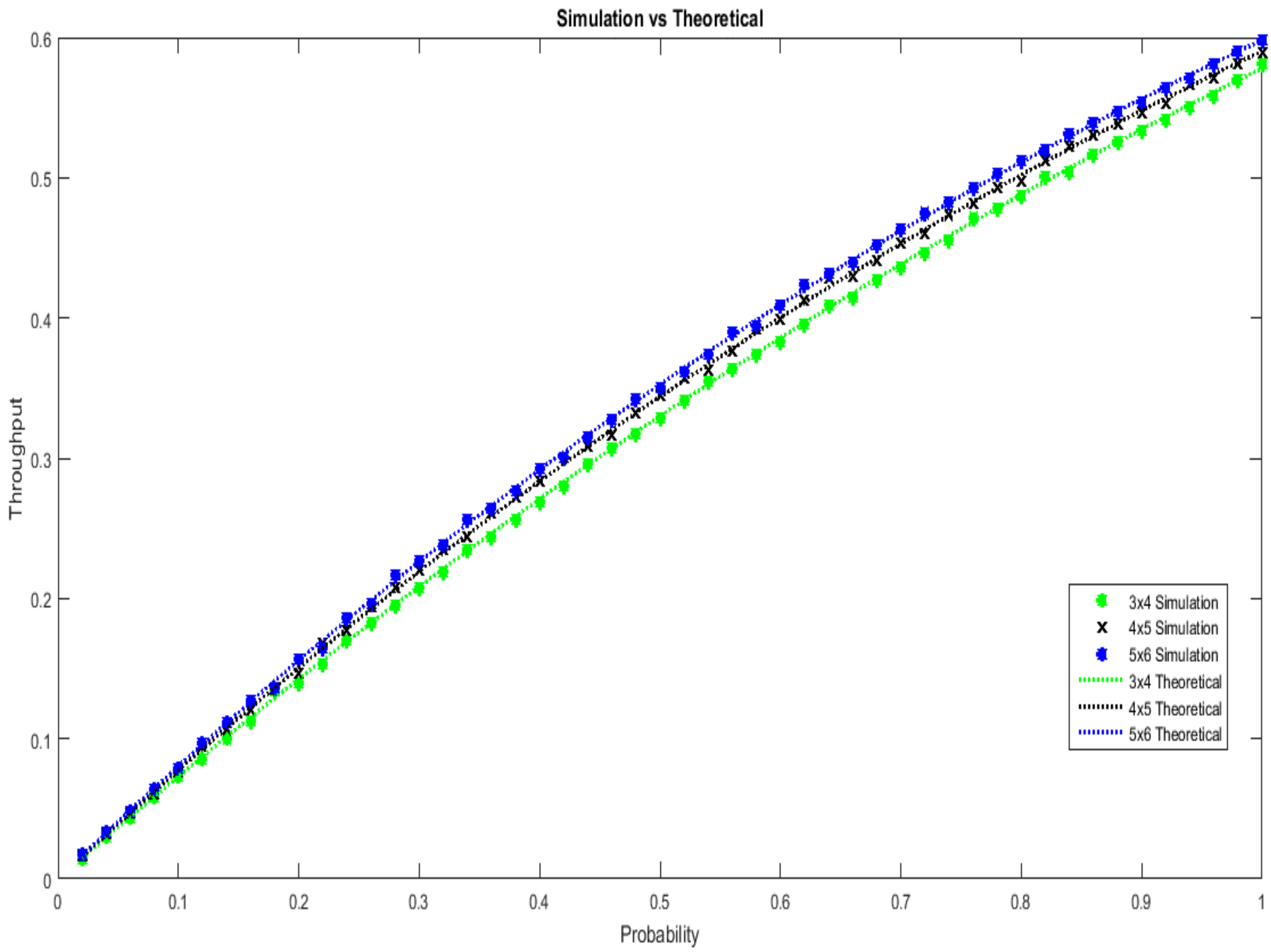
```
%% Theoretical Part
input = 3;
output = 4;
prob = 0.02:0.02:1;
throughput = zeros(3,50);
for i = 1:3
    for p = 1:50
        %Calculation of theoretical throughput
        throughput(i,p) = (1-(1-(prob(p)/output))^input);
    end
    input = input + 1;
    output = output + 1;
end
t1 = throughput(1,1:50);    %Throughput for 3x4
t2 = throughput(2,1:50);    %Throughput for 4x5
t3 = throughput(3,1:50);    %Throughput for 5x6

%% Simulation Part
input = 3;
output = 4;
throughput_sim = zeros(3,50);
for i = 1:3                 %For each of the crossbar
    l = 1;
    t = 0;
    for p = 0.02:0.02:1
        for j = 1:5000
            input_packet = (rand(1,input)) <= p ;   %Generate input packets
            o = zeros(1,output);
            for k = 1:input
                if(input_packet(k) == 1 )
                    o(randi([1 output],1,1)) = 1;   %Randomly select output
packet
                end
            end
            t = t + sum(o);
        end
        t = t/(5000 * output);       %Calculate throughput for each
probability
        throughput_sim(i,l) = t;
        l = l+1;
    end
    input = input + 1;
    output = output + 1;
end

%% Plot Graphs
figure
p1 =
plot(prob,throughput_sim(1,1:50),'*g',prob,throughput_sim(2,1:50),'xk',prob,
throughput_sim(3,1:50),'bo',prob,t1,':g',prob,t2,':k',prob,t3,':b');
title('Simulation vs Theoretical');
xlabel('Probability');
ylabel('Throughput');
p1(1).LineWidth = 2;
```

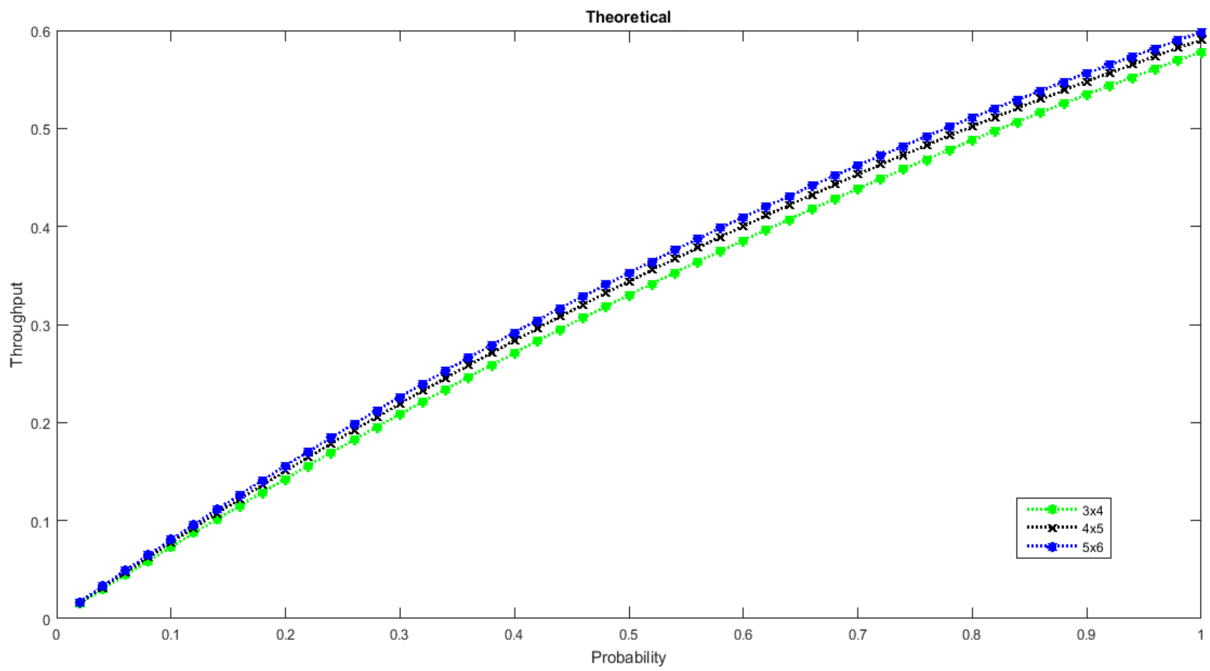
```
p1(2).LineWidth = 2;
p1(3).LineWidth = 2;
p1(4).LineWidth = 2;
p1(5).LineWidth = 2;
p1(6).LineWidth = 2;
```

GRAPH

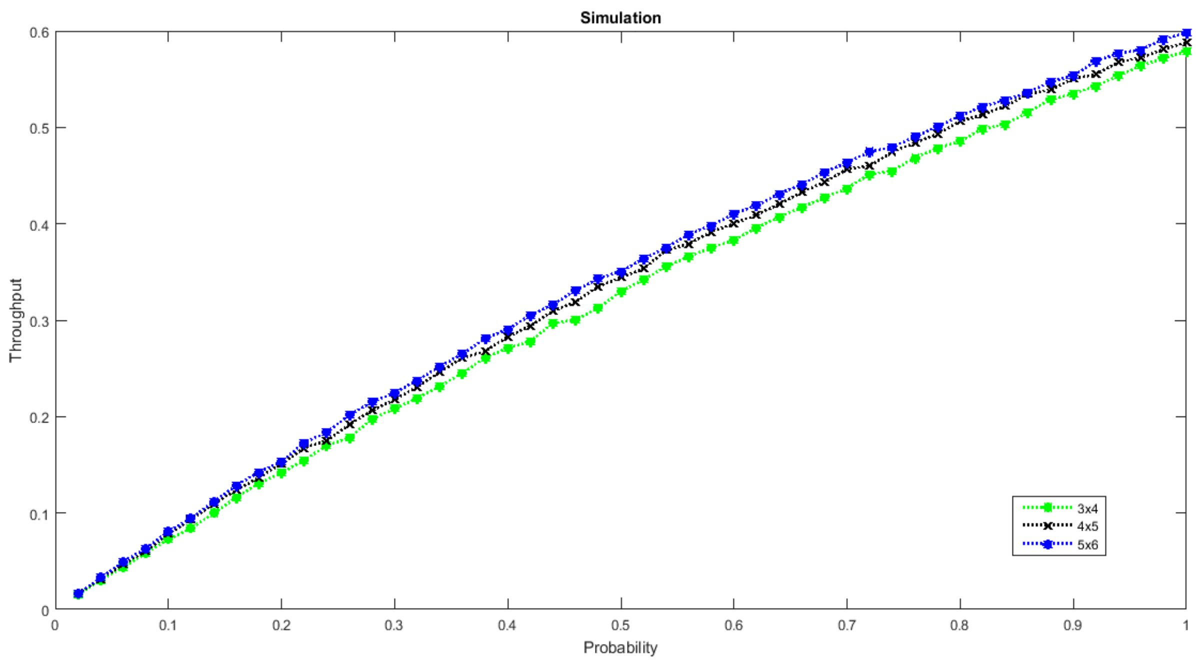


GRAPHS

1. Throughput VS Probability (Theoretical)



2. Throughput VS Probability (Simulation)



CONCLUSION

The performance of space division packet switching for a crossbar switch can be evaluated on the grounds of probability of arrival of packets on input as well as outputs. As the probability of packets arriving on input slot increases, throughput of the system increases. This can be well verified from the graphs we have obtained from simulation and theoretical results.

If more packets arrive at the same output slot, only one packet can be let through. Others are dropped. Therefore, the increase in dropped packets at output slot results in reduced throughput thereby decreasing the performance of the system.

The throughput of the crossbar switch also increases as the output slots increases as can be observed from the graph.