CS 558: Computer Systems Lab

Assignment – 3:
Network Simulation Using NS-3

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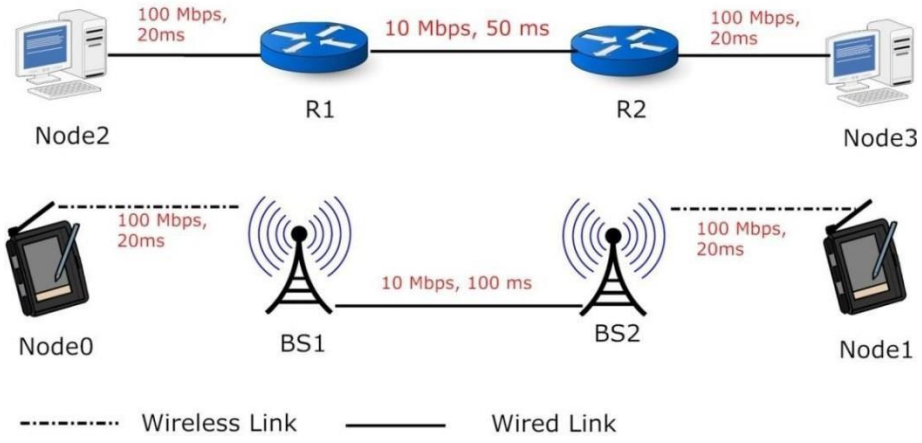
Application 2

Compare the performance of TCP over wired and wireless networks. Consider a topology as described below. The network consists of two TCP sources Node0 and Node2, corresponding to two TCP destinations Node1 and Node3 respectively. Node2 and Node3 come in wired domain with two routers R1 and R2 (connected by a {10 Mbps, 50 ms} wired link) between them. Both the routers use drop-tail queues with queue size set according to bandwidth-delay product. Node0 comes in domain of Base Station 1 (BS1) and Node1 comes in domain of Base Station 2 (BS2). BS1 and BS2 are connected by a (10 Mbps, 100 ms) wired link. The hosts, i.e. Node0, Node1, Node2, Node3 are attached with (100 Mbps, 20ms) links to routers or base stations (as shown in the figure below). The sources (Node0 and Node2)) use three TCP agents (i.e. TCP Westwood, TCP Veno and TCP Vegas) to generate three different TCP flows. Study and plot the fairness index (Jain's fairness index) and throughput change when the TCP packet size is varied; all the other parameter values are kept constant. You should use the following TCP packet size values (in Bytes): 50, 54, 58, 62, 70, 652, 676, 728, 1520 and 1600 for your experiments. The throughput (in Kbps) and fairness index must be calculated at steady-state. Make appropriate assumptions wherever necessary.



Running the program

./ns3 run wired_TCP.cc

./ns3 run wireless_TCP.cc

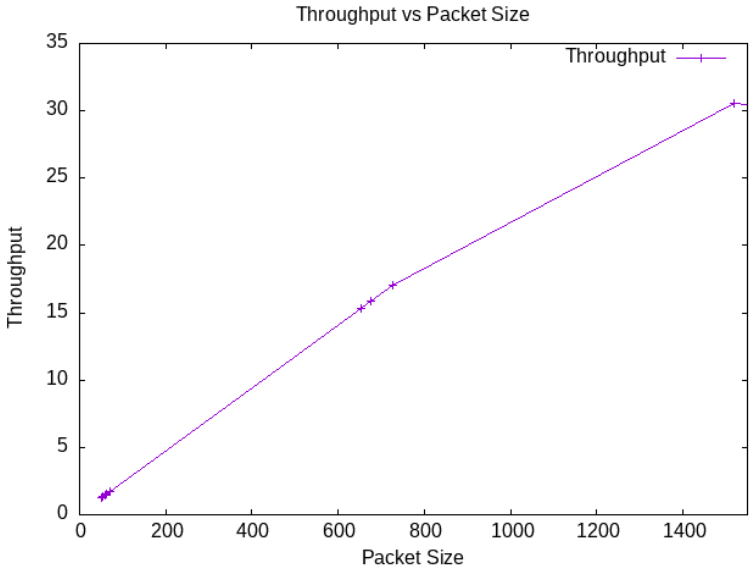
Formulae:

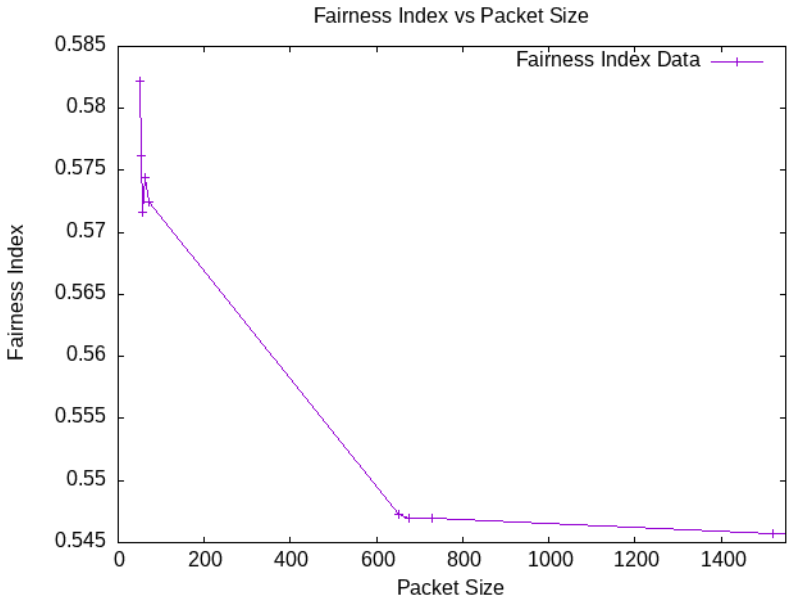
1. Average Throughput = (Sum of throughputs) / number of flows

2. Fairness Index = ((Sum of throughputs) ^2) / (number of flows) * (sum of squares of throughputs)

Wired

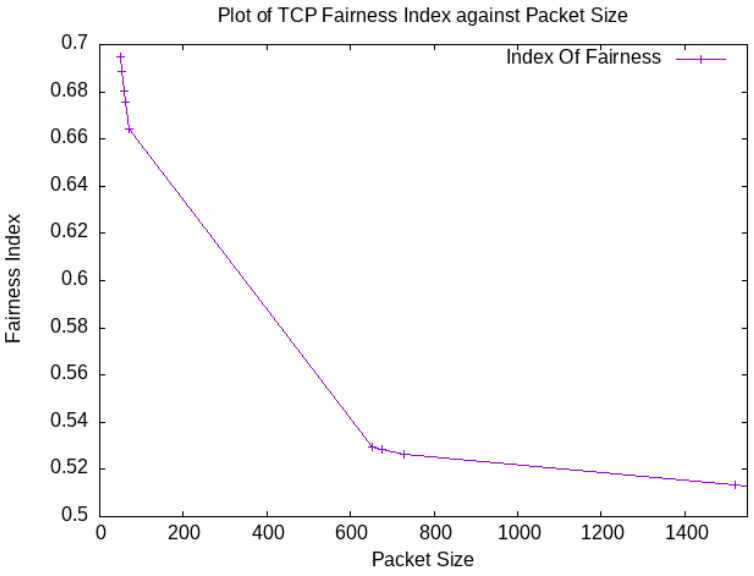
Packet size	Throughput	Fairness Index
50	1.26397	0.582171
54	1.35602	0.576238
58	1.43749	0.571655
62	1.54018	0.5714409
70	1.73494	0.572501
652	15.3064	0.547276
676	15.8694	0.546989
728	17.077	0.546918
1520	30.5914	0.545767
1600	30.3315	0.545794

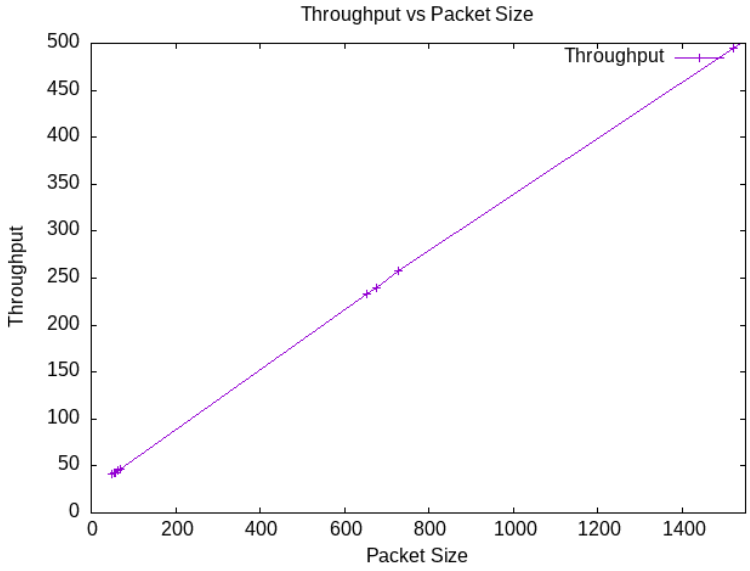




Wireless

Packet size	Throughput	Fairness Index
50	41.3506	0.694642
54	42.8166	0.688442
58	43.3063	0.680198
62	45.6784	0.675694
70	46.7307	0.664
652	233.004	0.52967
676	239.791	0.528659
728	257.294	0.526488
1520	495.164	0.513282
1600	518.303	0.512725





Observations:

1. Throughput vs Packet Size: It can be observed that, in most cases, initially as the packet size is increased, the throughput increases. As the size of the transmitted packet is increased beyond some limit, the throughput starts to degrade.
2. Wired vs Wireless TCP: Some factors like installing a wireless link requires less physical preparation, physical cables have the advantage of stability, wireless signals are greatly affected by EMI and weather, which do not come to play in our experiments since a simulation is used.
3. Vegas vs Veno vs Westwood:
    a. Vegas: One of the smoothest TCP algorithms, it increases the timeout delay for packets, which allows more to be received, but at a higher rate.
    b. Veno: Veno is closely related to Vegas, it is a combination of Vegas and Reno in order to enhance TCP performance over Wireless networks.
    c. Westwood: A newer version of Reno.