Network Optimization Project

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Contents

1 PART A

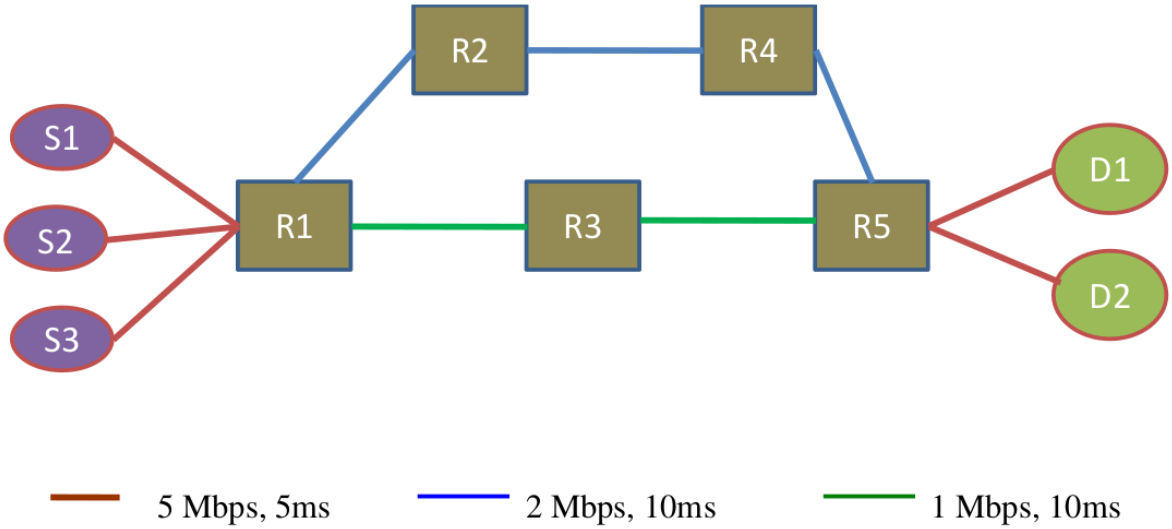

Figure 1: Shows the Topology of Experiment.

1.1 Trace-file Analysis

1.1.1 Packets Dropped

Packets Dropped per Flow are calculated by the following script:

```
BEGIN {
    FS = " ";
}

{
    eventType = $1;
    flowID = $8;

    if(eventType == "d"){
        packets[flowID]++;
    }
}

END{
    for (flowID in packets){
        print("Flow ID :" flowID " Packets Dropped : " packets[flowID]);
    }
}
```

To run the above script so you can take the results I run the following command:

awk -f dropped.awk out.tr >filename

The Results for Packets Dropped per Flow are shown in the following Table:
So Total Number of Packets Dropped in the Simulation are 341.

Flow ID	Packets Dropped
Flow 1	29 packets
Flow 2	37 packets
Flow 3	254 packets
Flow 4	7 packets

Table 1: Experiment Results Table.

1.1.2 Packets Delays

The following script chooses 1 random Packet of each Flow and calculates the time taken to arrive at its Destination.

```
    BEGIN {
    FS = " ";
    srand();  # Seed the random number generator
}

/^r/ {
    eventType = $1;
    time = $2;
    sourceNode = $3;
    destinationNode = $4;
    packetType = $5;
    packetSize = $6;
    flags = $7;
    flowID = $8;
    sequenceNumber = $9;
    eventID = $10;

    if (sourceNode != destinationNode && !(flowID in flowTimes)) {
        flowTimes[flowID] = time;
    }
    if (sourceNode != destinationNode && eventID < flowSequence[flowID]) {
        flowTimes[flowID] = time - flowTimes[flowID];
        flowSequence[flowID] = eventID;
    }
}

END {
    print "Time taken for a packet from each different flow to arrive at destination:";
    for (flow in flowTimes) {
        print "Flow", flow, ":", flowTimes[flow], "seconds";
    }
}
```

To run the above script so you can take the results I run the following command:

awk -f scriptA_1_b.awk out.tr >filename

The Results for Time Taken for a Packet per Flow to Arrive at its Destination are shown in the following Table:

Flow ID	Time Taken
Flow 1	2.005064 seconds
Flow 2	2.005064 seconds
Flow 3	2.0058 seconds
Flow 4	2.0058 seconds

Table 2: Experiment Results Table.

So the average time taken of Packets is around 2.005 seconds. Time taken for TCP handshake is 0.005186 seconds.

1.1.3 TCP & UDP Packets Dropped

The following Script Calculates the Percentage of TCP / UDP Packets Dropped in Blue and Green Path.

```
   BEGIN {
    FS = " ";
    dropped_tcp_green = 0;
    dropped_tcp_blue = 0;
    dropped_udp_green = 0;
    dropped_udp_blue = 0;
    total = 0;

}

/^d/{
    packetType = $5;
    sourceNode = $3;
    destinationNode = $4;

    if (packetType == "tcp" && sourceNode == 3 && destinationNode == 4)
    {
        dropped_tcp_green++;
        total++;

    }
    else if (packetType == "tcp" && sourceNode == 3 && destinationNode == 5)
    {
        dropped_tcp_blue++;
        total++;

    }
    else if (packetType == "cbr"  && sourceNode == 3 && destinationNode == 4)
    {
        dropped_udp_green++;
        total++;

    }
```

```
    else if (packetType == "cbr"  && sourceNode == 3 && destinationNode == 5)
    {
        dropped_udp_blue++;
        total++;

    }

}

END {
    tcp_green = (dropped_tcp_green/total) * 100;
    print "Percentage of TCP Packets Dropped in Green Flow is %d", tcp_green;

    tcp_blue = (dropped_tcp_blue/total) * 100;
    print "Percentage of TCP Packets Dropped in Blue Flow is %d", tcp_blue;

    udp_green = (dropped_udp_green/total) * 100;
    print "Percentage of UDP Packets Dropped in Green Flow is %d", udp_green;

    udp_blue = (dropped_udp_blue/total) * 100;
    print "Percentage of UDP Packets Dropped in Blue Flow is %d", udp_blue;

}
```

To run the above script so you can take the results I run the following command:

awk -f tcp_udp_dropped.awk out.tr >filename

The Results of Dropped TCP / UDP Packets are shown Below:

```
Percentage of TCP Packets Dropped in Green Flow is 2,91262%
Percentage of TCP Packets Dropped in Blue Flow is 18,4466%
Percentage of UDP Packets Dropped in Green Flow is 17,1521%
Percentage of UDP Packets Dropped in Blue Flow is 61,4887%
```

1.2 Experiment Results

1.2.1 Plotted Results

In the following Plot we can see the Throughput of each Flow.

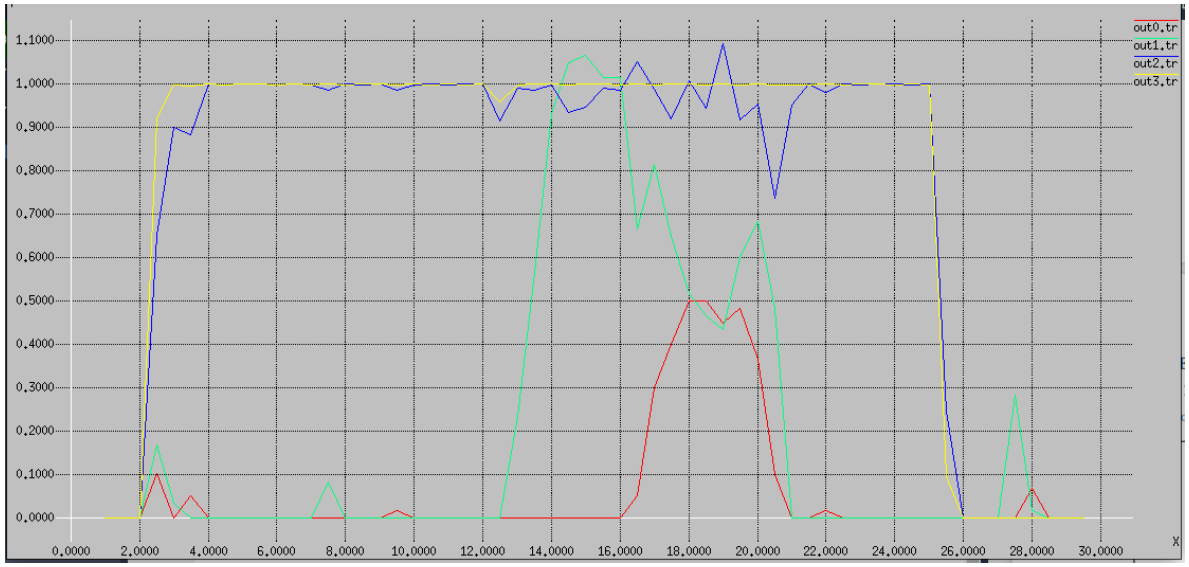

Figure 2: Shows the Throughput.

In the following Plot we can see the Congestion Window for each TCP Source.

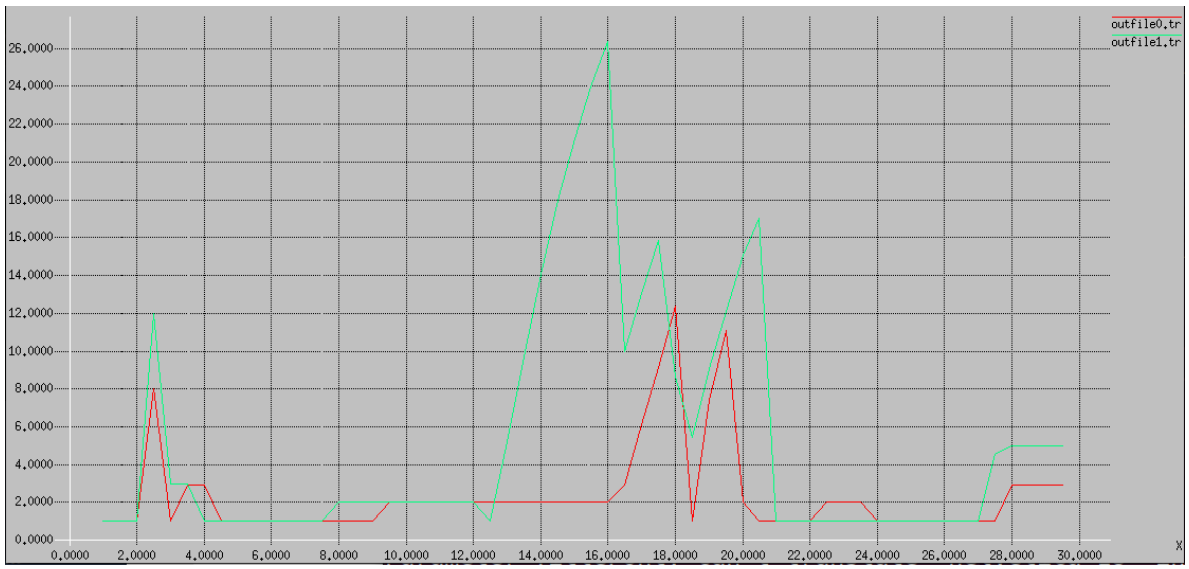

Figure 3: Shows the Congestion Window of TCP Flows.

1.2.2 Average Throughput

The following Script Calculates the Average Throughput per Flow.

```
BEGIN {
    FS = " ";
    startTime = 0;
    endTime = 0;
    flag[$8] = 0;
}

{
    event = $1;
    time = $2;
    flowID = $8;
    packetSize = $6;
    destinationNode = $4;
    sourceNode = $3;


    if (event == "r" && !(flowID == 0) && destinationNode == 9) {
        totalBytes[flowID] += packetSize;

        if(flag[flowID] == 0){
            startTime = time;
            flag[flowID] = 1;
        }
        endTime = time;

    }
    else if (event == "r" && !(flowID == 0) && destinationNode == 8) {
        totalBytes[flowID] += packetSize;
        if(flag[flowID] == 0){
            startTime = time;
            flag[flowID] = 1;
        }
        endTime = time;
    }
    else if (event == "r" && !(flowID == 0) && destinationNode == 3){
        totalBytes[flowID] += packetSize;
        if(flag[flowID] == 0){
            startTime = time;
            flag[flowID] = 1;
        }
        endTime = time;
    }

    if(event == "+"){
        totalPackets[flowID]++;
    }
}

END {
    totalDuration = endTime - startTime;

    for (flowID in totalPackets) {
        throughput = (totalBytes[flowID] * 8) / (totalDuration * 1000);  # in kbps
```

```
        print "Flow ID", flowID, ": ", throughput, " kbps";
        averagePacketRate = totalPackets[flowID] / totalDuration;
        print "Average Transfer Packet Rate to Sources: ", averagePacketRate, "packets/sec";
    }
}
```

To run the above script so you can take the results I run the following command:

awk -f avg_throughput.awk out.tr >filename

The Results of Average Throughput are shown Below:

```
Flow ID 1 :  151,475  kbps
Flow ID 2 :  498,765  kbps
Flow ID 3 :  1818,84  kbps
Flow ID 4 :  919,094  kbps
```

1.2.3 Average Rate of Sending Packets to Sources

The following Script Calculates the Average Packet Transfer Rate.

```
BEGIN {
 FS = " ";
 startTime = 0;
 endTime = 0;
 flag[$8] = 0;
}

{
    event = $1;
    time = $2;
    flowID = $8;
    packetSize = $6;
    destinationNode = $4;
    sourceNode = $3;


    if (event == "r" && !(flowID == 0) && destinationNode == 9) {
        totalBytes[flowID] += packetSize;

        if(flag[flowID] == 0){
            startTime = time;
            flag[flowID] = 1;
        }
        endTime = time;

    }
    else if (event == "r" && !(flowID == 0) && destinationNode == 8) {
        totalBytes[flowID] += packetSize;
        if(flag[flowID] == 0){
            startTime = time;
            flag[flowID] = 1;
        }
        endTime = time;
    }
    else if (event == "r" && !(flowID == 0) && destinationNode == 3){
```

```
        totalBytes[flowID] += packetSize;
        if(flag[flowID] == 0){
            startTime = time;
            flag[flowID] = 1;
        }
        endTime = time;
    }

    if(event == "+"){
        totalPackets[flowID]++;
    }
}

END {
    totalDuration = endTime - startTime;

    for (flowID in totalPackets) {
        throughput = (totalBytes[flowID] * 8) / (totalDuration * 1000);  # in kbps
        print "Flow ID", flowID, ": ", throughput, " kbps";
        averagePacketRate = totalPackets[flowID] / totalDuration;
        print "Average Transfer Packet Rate to Sources: ", averagePacketRate, "packets/sec";
    }
}
```

To run the above script so you can take the results I run the following command:

awk -f avg_throughput.awk out.tr >filename

The Results of Average Transfer Packet Rate per flow is shown Below:

```
Flow ID 1:
Average Transfer Packet Rate to Sources:  84,64 packets/sec
Flow ID 2:
Average Transfer Packet Rate to Sources:  284,92 packets/sec
Flow ID 3:
Average Transfer Packet Rate to Sources:  2355,08 packets/sec
Flow ID 4:
Average Transfer Packet Rate to Sources:  2381,16 packets/sec
```