# Simulation Report for Network Simulation Assignment 2

November 22, 2015

## Simulation Setup

ns2.tcl file construct two different buffer management strategies of Droptail and Red. There two scenarios, one has two TCP-Reno connection while the other has two TCP-Reno connection and one UDP connection. Both scenarios have a queue limit of 20 packets.

## Simulation Procedure

Open terminal in the folder where contains ns2.tcl file. Input [ns ns2.tcl (queue-machanism) (scenario No.)] in command line. For each scenario, type the corresponding queue-machanism and case number. In ns2.tcl, set the time 1.0s. So every 1 second, terminal will display [Input node: time: (current time) throughput: (average throughput of this 1 second)]. When go through 150 seconds, then automatically calculate the average throughput from time 30 to time 180, then display on terminal the average throughput for each link. Then program stop.

## Simulation Result

Scenario 1, Droptail Strategy:
This is a plot showing time(x-axis in seconds) and instantaneous throughput per time(y-axis in Kbps) with two connection TCP1 and TCP2

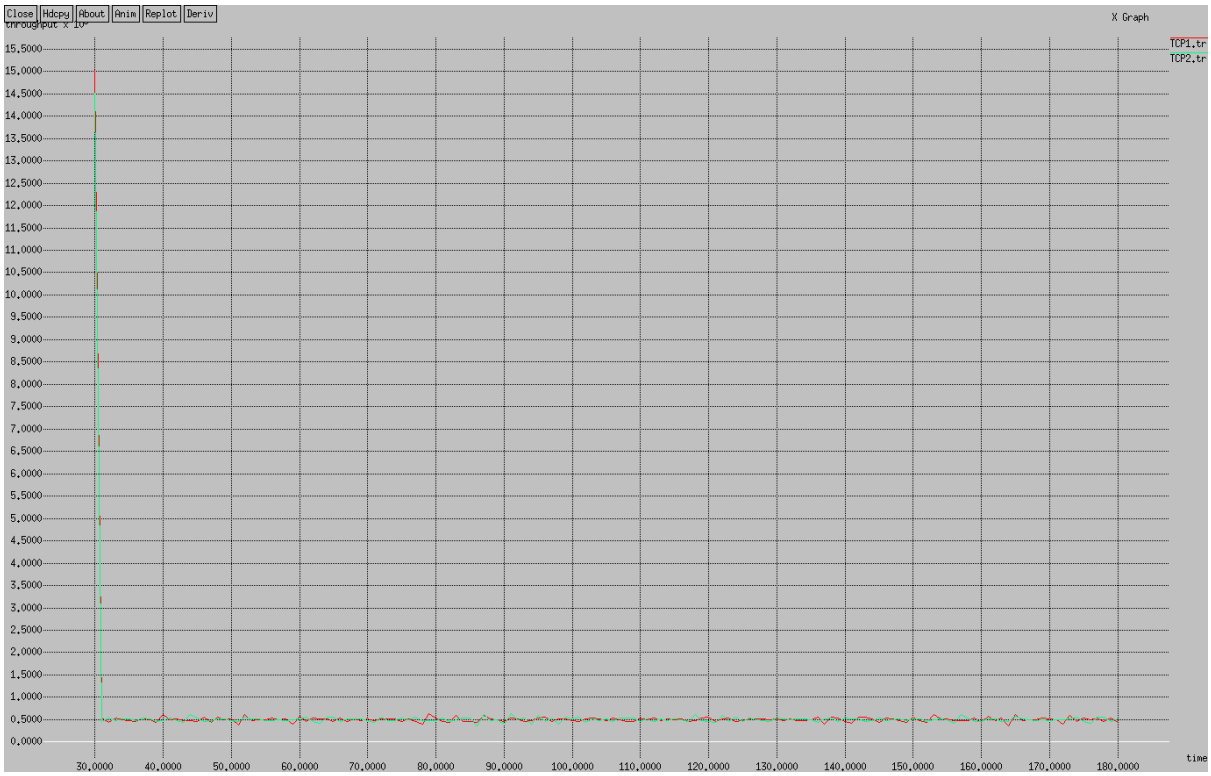

Table for Droptail Strategy and Scenario 1

| **Current_time(sec)** | **Throughput_of_TCP1(Kbps)** | **Throughput_of_TCP2(Kbps)** |
|---|---|---|
| 30 | 15017.92 | 14510.4 |
| 31 | 540.79999999999995 | 457.60000000000002 |
| 32 | 440.95999999999998 | 532.48000000000002 |
| 33 | 540.79999999999995 | 482.56 |
| 34 | 499.19999999999999 | 507.51999999999998 |
| 35 | 474.24000000000001 | 524.15999999999997 |
| 36 | 457.60000000000002 | 474.24000000000001 |
| 37 | 532.48000000000002 | 532.48000000000002 |
| 38 | 490.88 | 507.51999999999998 |
| 39 | 432.63999999999999 | 457.60000000000002 |
| 40 | 607.36000000000001 | 482.56 |
| 41 | 490.88 | 532.48000000000002 |
| 42 | 524.15999999999997 | 474.24000000000001 |
| 43 | 474.24000000000001 | 432.63999999999999 |
| 44 | 482.56 | 615.67999999999995 |
| 45 | 465.92000000000002 | 532.48000000000002 |
| 46 | 549.12 | 449.27999999999997 |
| 47 | 440.95999999999998 | 474.24000000000001 |
| 48 | 557.44000000000005 | 524.15999999999997 |
| 49 | 499.19999999999999 | 507.51999999999998 |
| 50 | 524.15999999999997 | 474.24000000000001 |
| 51 | 374.39999999999998 | 457.60000000000002 |
| 52 | 607.36000000000001 | 557.44000000000005 |
| 53 | 474.24000000000001 | 524.15999999999997 |
| 54 | 499.19999999999999 | 507.51999999999998 |
| 55 | 499.19999999999999 | 482.56 |
| 56 | 540.79999999999995 | 474.24000000000001 |
| 57 | 499.19999999999999 | 499.19999999999999 |
| 58 | 515.84000000000003 | 482.56 |
| 59 | 399.36000000000001 | 499.19999999999999 |
| 60 | 582.39999999999998 | 524.15999999999997 |
| 61 | 449.27999999999997 | 549.12 |
| 62 | 532.48000000000002 | 465.92000000000002 |
| 63 | 507.51999999999998 | 416.0 |
| 64 | 524.15999999999997 | 549.12 |
| 65 | 457.60000000000002 | 549.12 |
| 66 | 532.48000000000002 | 465.92000000000002 |
| 67 | 449.27999999999997 | 515.84000000000003 |
| 68 | 515.84000000000003 | 515.84000000000003 |
| 69 | 482.56 | 515.84000000000003 |
| 70 | 524.15999999999997 | 482.56 |
| 71 | 482.56 | 440.95999999999998 |
| 72 | 524.15999999999997 | 549.12 |
| 73 | 524.15999999999997 | 474.24000000000001 |
| 74 | 515.84000000000003 | 482.56 |
| 75 | 465.92000000000002 | 532.48000000000002 |
| 76 | 515.84000000000003 | 490.88 |
| 77 | 449.27999999999997 | 549.12 |
| 78 | 399.36000000000001 | 482.56 |
| 79 | 632.32000000000005 | 474.24000000000001 |
| 80 | 532.48000000000002 | 482.56 |
| 81 | 457.60000000000002 | 540.79999999999995 |
| 82 | 440.95999999999998 | 457.60000000000002 |

| | | |
|---|---|---|
| 83 | 599.03999999999996 | 499.19999999999999 |
| 84 | 465.92000000000002 | 532.48000000000002 |
| 85 | 465.92000000000002 | 532.48000000000002 |
| 86 | 440.95999999999998 | 366.07999999999998 |
| 87 | 590.72000000000003 | 607.36000000000001 |
| 88 | 524.15999999999997 | 474.24000000000001 |
| 89 | 499.19999999999999 | 499.19999999999999 |
| 90 | 449.27999999999997 | 391.04000000000002 |
| 91 | 532.48000000000002 | 632.32000000000005 |
| 92 | 507.51999999999998 | 490.88 |
| 93 | 457.60000000000002 | 540.79999999999995 |
| 94 | 474.24000000000001 | 399.36000000000001 |
| 95 | 532.48000000000002 | 590.72000000000003 |
| 96 | 549.12 | 457.60000000000002 |
| 97 | 465.92000000000002 | 532.48000000000002 |
| 98 | 515.84000000000003 | 391.04000000000002 |
| 99 | 524.15999999999997 | 565.75999999999999 |
| 100 | 482.56 | 515.84000000000003 |
| 101 | 457.60000000000002 | 549.12 |
| 102 | 507.51999999999998 | 432.63999999999999 |
| 103 | 532.48000000000002 | 524.15999999999997 |
| 104 | 524.15999999999997 | 474.24000000000001 |
| 105 | 474.24000000000001 | 524.15999999999997 |
| 106 | 532.48000000000002 | 449.27999999999997 |
| 107 | 490.88 | 532.48000000000002 |
| 108 | 465.92000000000002 | 532.48000000000002 |
| 109 | 457.60000000000002 | 540.79999999999995 |
| 110 | 532.48000000000002 | 457.60000000000002 |
| 111 | 490.88 | 515.84000000000003 |
| 112 | 540.79999999999995 | 465.92000000000002 |
| 113 | 482.56 | 515.84000000000003 |
| 114 | 507.51999999999998 | 474.24000000000001 |
| 115 | 499.19999999999999 | 515.84000000000003 |
| 116 | 507.51999999999998 | 490.88 |
| 117 | 457.60000000000002 | 449.27999999999997 |
| 118 | 482.56 | 607.36000000000001 |
| 119 | 532.48000000000002 | 474.24000000000001 |
| 120 | 549.12 | 449.27999999999997 |
| 121 | 449.27999999999997 | 440.95999999999998 |
| 122 | 524.15999999999997 | 590.72000000000003 |
| 123 | 532.48000000000002 | 465.92000000000002 |
| 124 | 449.27999999999997 | 549.12 |
| 125 | 474.24000000000001 | 457.60000000000002 |
| 126 | 524.15999999999997 | 540.79999999999995 |
| 127 | 507.51999999999998 | 499.19999999999999 |
| 128 | 524.15999999999997 | 474.24000000000001 |
| 129 | 499.19999999999999 | 457.60000000000002 |
| 130 | 507.51999999999998 | 532.48000000000002 |
| 131 | 482.56 | 515.84000000000003 |
| 132 | 507.51999999999998 | 499.19999999999999 |
| 133 | 482.56 | 515.84000000000003 |
| 134 | 474.24000000000001 | 524.15999999999997 |
| 135 | 499.19999999999999 | 499.19999999999999 |
| 136 | 557.44000000000005 | 440.95999999999998 |
| 137 | 407.68000000000001 | 507.51999999999998 |

| | | |
|---|---|---|
| 138 | 557.44000000000005 | 532.48000000000002 |
| 139 | 532.48000000000002 | 465.92000000000002 |
| 140 | 465.92000000000002 | 532.48000000000002 |
| 141 | 416.0 | 507.51999999999998 |
| 142 | 549.12 | 524.15999999999997 |
| 143 | 549.12 | 457.60000000000002 |
| 144 | 524.15999999999997 | 474.24000000000001 |
| 145 | 440.95999999999998 | 532.48000000000002 |
| 146 | 540.79999999999995 | 482.56 |
| 147 | 507.51999999999998 | 490.88 |
| 148 | 482.56 | 524.15999999999997 |
| 149 | 440.95999999999998 | 482.56 |
| 150 | 549.12 | 524.15999999999997 |
| 151 | 474.24000000000001 | 524.15999999999997 |
| 152 | 432.63999999999999 | 449.27999999999997 |
| 153 | 607.36000000000001 | 490.88 |
| 154 | 507.51999999999998 | 515.84000000000003 |
| 155 | 507.51999999999998 | 490.88 |
| 156 | 482.56 | 416.0 |
| 157 | 474.24000000000001 | 615.67999999999995 |
| 158 | 482.56 | 532.48000000000002 |
| 159 | 540.79999999999995 | 457.60000000000002 |
| 160 | 432.63999999999999 | 465.92000000000002 |
| 161 | 574.08000000000004 | 524.15999999999997 |
| 162 | 482.56 | 515.84000000000003 |
| 163 | 532.48000000000002 | 465.92000000000002 |
| 164 | 366.07999999999998 | 457.60000000000002 |
| 165 | 607.36000000000001 | 574.08000000000004 |
| 166 | 474.24000000000001 | 524.15999999999997 |
| 167 | 499.19999999999999 | 499.19999999999999 |
| 168 | 499.19999999999999 | 474.24000000000001 |
| 169 | 540.79999999999995 | 490.88 |
| 170 | 515.84000000000003 | 482.56 |
| 171 | 499.19999999999999 | 499.19999999999999 |
| 172 | 399.36000000000001 | 490.88 |
| 173 | 590.72000000000003 | 515.84000000000003 |
| 174 | 457.60000000000002 | 549.12 |
| 175 | 532.48000000000002 | 465.92000000000002 |
| 176 | 499.19999999999999 | 416.0 |
| 177 | 532.48000000000002 | 549.12 |
| 178 | 449.27999999999997 | 549.12 |
| 179 | 540.79999999999995 | 465.92000000000002 |
| 180 | 432.63999999999999 | 515.84000000000003 |

1. Average Throughput for TCP1 link is 599.8741 Kbps
2. Average Throughput for TCP2 link is 596.6571 Kbps

Scenario 1, Red Strategy:
This is a plot showing time(x-axis in seconds) and instantaneous throughput per time(y-axis in Kbps) with two connection TCP1 and TCP2

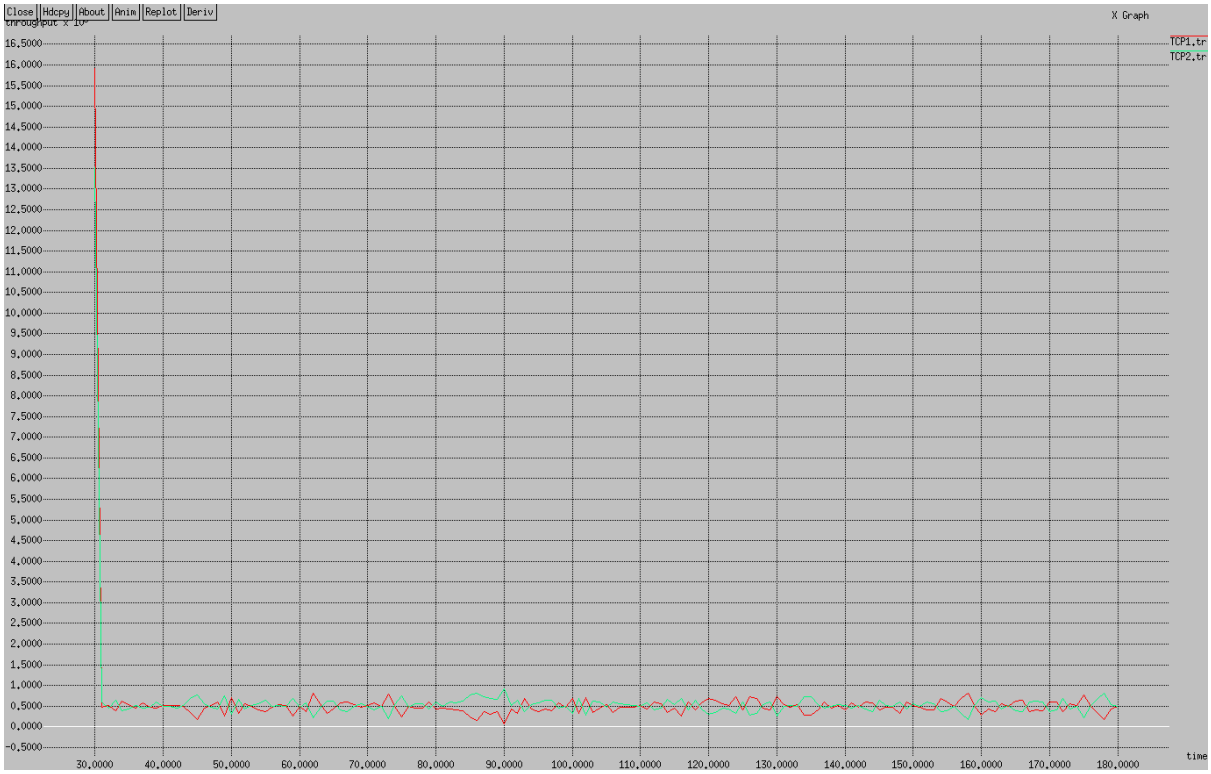


Table for Red Strategy and Scenario 1

| Current_time(sec) | Throughput_of_TCP1(Kbps) | Throughput_of_TCP2(Kbps) |
|---|---|---|
| 30 | 15908.16 | 13512.0 |
| 31 | 465.92000000000002 | 607.36000000000001 |
| 32 | 515.84000000000003 | 457.60000000000002 |
| 33 | 391.04000000000002 | 640.63999999999999 |
| 34 | 615.67999999999995 | 382.72000000000003 |
| 35 | 532.48000000000002 | 432.63999999999999 |
| 36 | 440.95999999999998 | 515.84000000000003 |
| 37 | 582.39999999999998 | 457.60000000000002 |
| 38 | 474.24000000000001 | 474.24000000000001 |
| 39 | 449.27999999999997 | 607.36000000000001 |
| 40 | 507.51999999999998 | 490.88 |
| 41 | 507.51999999999998 | 490.88 |
| 42 | 507.51999999999998 | 457.60000000000002 |
| 43 | 490.88 | 515.84000000000003 |
| 44 | 341.12 | 690.55999999999995 |
| 45 | 166.40000000000001 | 773.75999999999999 |
| 46 | 457.60000000000002 | 549.12 |
| 47 | 524.15999999999997 | 474.24000000000001 |
| 48 | 599.03999999999996 | 432.63999999999999 |
| 49 | 257.92000000000002 | 740.48000000000002 |
| 50 | 707.20000000000005 | 291.19999999999999 |
| 51 | 332.80000000000001 | 665.60000000000002 |
| 52 | 565.75999999999999 | 432.63999999999999 |
| 53 | 490.88 | 507.51999999999998 |
| 54 | 416.0 | 549.12 |
| 55 | 357.75999999999999 | 632.32000000000005 |
| 56 | 474.24000000000001 | 490.88 |
| 57 | 540.79999999999995 | 524.15999999999997 |
| 58 | 515.84000000000003 | 482.56 |

| | | |
|---|---|---|
| 59 | 257.92000000000002 | 682.24000000000001 |
| 60 | 499.19999999999999 | 474.24000000000001 |
| 61 | 366.07999999999998 | 574.08000000000004 |
| 62 | 807.03999999999996 | 216.31999999999999 |
| 63 | 565.75999999999999 | 449.27999999999997 |
| 64 | 332.80000000000001 | 615.67999999999995 |
| 65 | 432.63999999999999 | 624.0 |
| 66 | 582.39999999999998 | 399.36000000000001 |
| 67 | 590.72000000000003 | 374.39999999999998 |
| 68 | 532.48000000000002 | 482.56 |
| 69 | 465.92000000000002 | 557.44000000000005 |
| 70 | 524.15999999999997 | 482.56 |
| 71 | 574.08000000000004 | 399.36000000000001 |
| 72 | 490.88 | 482.56 |
| 73 | 782.08000000000004 | 191.36000000000001 |
| 74 | 490.88 | 540.79999999999995 |
| 75 | 241.28 | 757.12 |
| 76 | 482.56 | 474.24000000000001 |
| 77 | 440.95999999999998 | 557.44000000000005 |
| 78 | 440.95999999999998 | 557.44000000000005 |
| 79 | 607.36000000000001 | 424.31999999999999 |
| 80 | 424.31999999999999 | 590.72000000000003 |
| 81 | 457.60000000000002 | 482.56 |
| 82 | 424.31999999999999 | 599.03999999999996 |
| 83 | 407.68000000000001 | 582.39999999999998 |
| 84 | 382.72000000000003 | 624.0 |
| 85 | 232.96000000000001 | 765.44000000000005 |
| 86 | 149.75999999999999 | 807.03999999999996 |
| 87 | 357.75999999999999 | 715.51999999999998 |
| 88 | 299.51999999999998 | 673.91999999999996 |
| 89 | 366.07999999999998 | 665.60000000000002 |
| 90 | 74.879999999999995 | 906.88 |
| 91 | 424.31999999999999 | 524.15999999999997 |
| 92 | 324.48000000000002 | 640.63999999999999 |
| 93 | 690.55999999999995 | 374.39999999999998 |
| 94 | 424.31999999999999 | 540.79999999999995 |
| 95 | 357.75999999999999 | 574.08000000000004 |
| 96 | 432.63999999999999 | 632.32000000000005 |
| 97 | 382.72000000000003 | 632.32000000000005 |
| 98 | 574.08000000000004 | 440.95999999999998 |
| 99 | 474.24000000000001 | 490.88 |
| 100 | 673.91999999999996 | 332.80000000000001 |
| 101 | 324.48000000000002 | 673.91999999999996 |
| 102 | 707.20000000000005 | 282.88 |
| 103 | 349.44 | 624.0 |
| 104 | 440.95999999999998 | 590.72000000000003 |
| 105 | 532.48000000000002 | 465.92000000000002 |
| 106 | 349.44 | 607.36000000000001 |
| 107 | 474.24000000000001 | 557.44000000000005 |
| 108 | 465.92000000000002 | 540.79999999999995 |
| 109 | 474.24000000000001 | 524.15999999999997 |
| 110 | 515.84000000000003 | 482.56 |
| 111 | 424.31999999999999 | 574.08000000000004 |
| 112 | 599.03999999999996 | 399.36000000000001 |
| 113 | 557.44000000000005 | 440.95999999999998 |

| | | |
|---|---|---|
| 114 | 341.12 | 665.60000000000002 |
| 115 | 457.60000000000002 | 540.79999999999995 |
| 116 | 257.92000000000002 | 690.55999999999995 |
| 117 | 599.03999999999996 | 399.36000000000001 |
| 118 | 399.36000000000001 | 640.63999999999999 |
| 119 | 574.08000000000004 | 432.63999999999999 |
| 120 | 690.55999999999995 | 299.51999999999998 |
| 121 | 648.96000000000004 | 349.44 |
| 122 | 549.12 | 457.60000000000002 |
| 123 | 524.15999999999997 | 424.31999999999999 |
| 124 | 723.84000000000003 | 316.16000000000003 |
| 125 | 416.0 | 590.72000000000003 |
| 126 | 723.84000000000003 | 274.56 |
| 127 | 673.91999999999996 | 324.48000000000002 |
| 128 | 449.27999999999997 | 532.48000000000002 |
| 129 | 399.36000000000001 | 599.03999999999996 |
| 130 | 715.51999999999998 | 266.24000000000001 |
| 131 | 532.48000000000002 | 490.88 |
| 132 | 465.92000000000002 | 507.51999999999998 |
| 133 | 540.79999999999995 | 482.56 |
| 134 | 282.88 | 723.84000000000003 |
| 135 | 274.56 | 715.51999999999998 |
| 136 | 407.68000000000001 | 532.48000000000002 |
| 137 | 607.36000000000001 | 440.95999999999998 |
| 138 | 449.27999999999997 | 499.19999999999999 |
| 139 | 524.15999999999997 | 540.79999999999995 |
| 140 | 416.0 | 515.84000000000003 |
| 141 | 574.08000000000004 | 457.60000000000002 |
| 142 | 474.24000000000001 | 515.84000000000003 |
| 143 | 590.72000000000003 | 432.63999999999999 |
| 144 | 582.39999999999998 | 374.39999999999998 |
| 145 | 416.0 | 648.96000000000004 |
| 146 | 474.24000000000001 | 524.15999999999997 |
| 147 | 474.24000000000001 | 490.88 |
| 148 | 324.48000000000002 | 590.72000000000003 |
| 149 | 607.36000000000001 | 432.63999999999999 |
| 150 | 515.84000000000003 | 557.44000000000005 |
| 151 | 474.24000000000001 | 490.88 |
| 152 | 416.0 | 607.36000000000001 |
| 153 | 416.0 | 565.75999999999999 |
| 154 | 673.91999999999996 | 357.75999999999999 |
| 155 | 599.03999999999996 | 382.72000000000003 |
| 156 | 490.88 | 499.19999999999999 |
| 157 | 682.24000000000001 | 332.80000000000001 |
| 158 | 807.03999999999996 | 174.72 |
| 159 | 507.51999999999998 | 515.84000000000003 |
| 160 | 274.56 | 698.88 |
| 161 | 424.31999999999999 | 599.03999999999996 |
| 162 | 374.39999999999998 | 624.0 |
| 163 | 549.12 | 432.63999999999999 |
| 164 | 490.88 | 524.15999999999997 |
| 165 | 615.67999999999995 | 391.04000000000002 |
| 166 | 640.63999999999999 | 357.75999999999999 |
| 167 | 366.07999999999998 | 590.72000000000003 |
| 168 | 416.0 | 624.0 |

| | | |
|---|---|---|
| 169 | 391.04000000000002 | 590.72000000000003 |
| 170 | 599.03999999999996 | 374.39999999999998 |
| 171 | 590.72000000000003 | 407.68000000000001 |
| 172 | 357.75999999999999 | 682.24000000000001 |
| 173 | 549.12 | 424.31999999999999 |
| 174 | 524.15999999999997 | 499.19999999999999 |
| 175 | 773.75999999999999 | 216.31999999999999 |
| 176 | 499.19999999999999 | 507.51999999999998 |
| 177 | 341.12 | 657.27999999999997 |
| 178 | 183.03999999999999 | 815.36000000000001 |
| 179 | 424.31999999999999 | 540.79999999999995 |
| 180 | 482.56 | 499.19999999999999 |

1. Average Throughput for TCP1 link is 585.3973 Kbps
2. Average Throughput for TCP2 link is 608.1387 Kbps

Scenario 2, Droptail Strategy:
This is a plot showing time(x-axis in seconds) and instantaneous throughput per time(y-axis in Kbps) with two connection TCP1, TCP2 and UDP

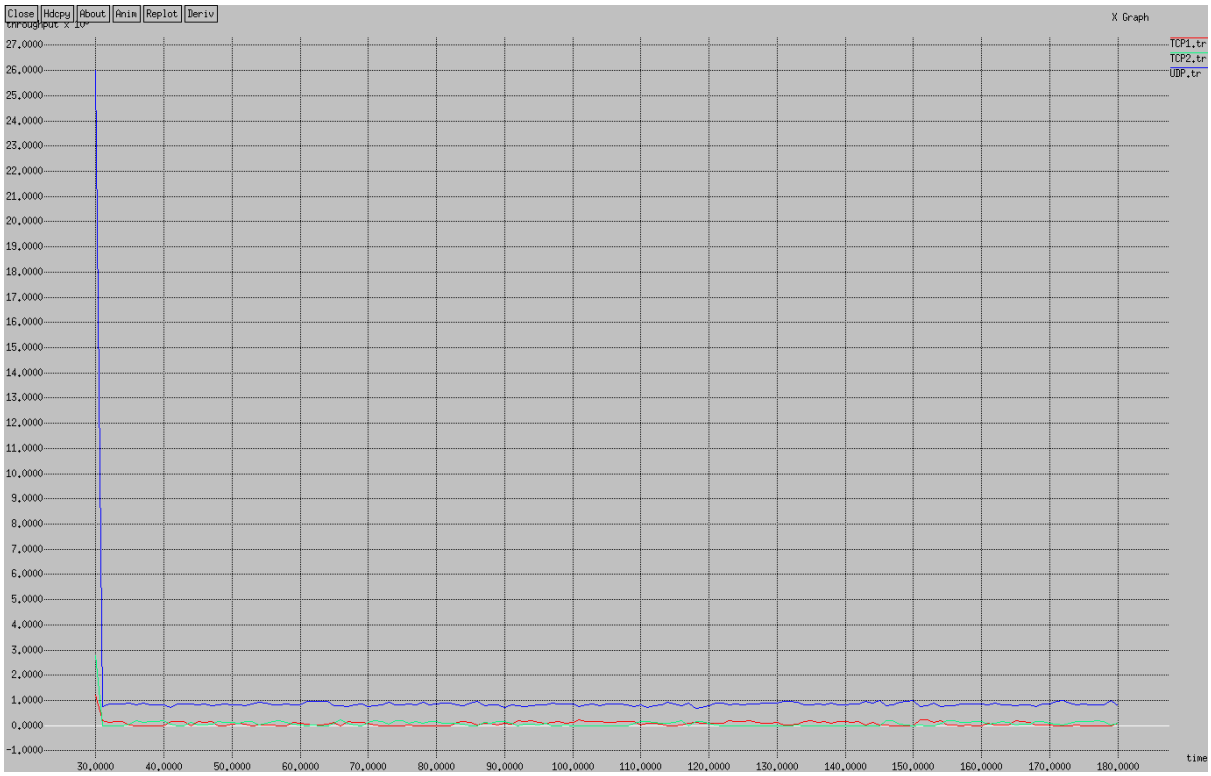


Table for Droptail Strategy and Scenario 2

| **Time(sec)** | **ThroughputTCP1(Kbps)** | **ThroughputTCP2(Kbps)** | **ThroughputUDP(Kbps)** |
|---|---|---|---|
| 30 | 1206.72 | 2762.5599999999999 | 25993.599999999999 |
| 31 | 199.68000000000001 | 0.0 | 770.39999999999998 |
| 32 | 141.44 | 0.0 | 863.20000000000005 |
| 33 | 149.75999999999999 | 0.0 | 850.39999999999998 |
| 34 | 149.75999999999999 | 0.0 | 866.39999999999998 |
| 35 | 24.960000000000001 | 58.240000000000002 | 900.79999999999995 |
| 36 | 0.0 | 183.03999999999999 | 835.20000000000005 |
| 37 | 0.0 | 124.8 | 881.60000000000002 |

| | | | |
|---|---|---|---|
| 38 | 0.0 | 158.08000000000001 | 839.20000000000005 |
| 39 | 0.0 | 158.08000000000001 | 836.0 |
| 40 | 0.0 | 183.03999999999999 | 817.60000000000002 |
| 41 | 158.08000000000001 | 66.560000000000002 | 723.20000000000005 |
| 42 | 149.75999999999999 | 0.0 | 861.60000000000002 |
| 43 | 149.75999999999999 | 0.0 | 857.60000000000002 |
| 44 | 0.0 | 133.12 | 866.39999999999998 |
| 45 | 158.08000000000001 | 16.640000000000001 | 825.60000000000002 |
| 46 | 116.48 | 16.640000000000001 | 867.20000000000005 |
| 47 | 166.40000000000001 | 74.879999999999995 | 775.20000000000005 |
| 48 | 0.0 | 158.08000000000001 | 833.60000000000002 |
| 49 | 0.0 | 133.12 | 866.39999999999998 |
| 50 | 58.240000000000002 | 124.8 | 808.0 |
| 51 | 91.519999999999996 | 91.519999999999996 | 814.39999999999998 |
| 52 | 66.560000000000002 | 174.72 | 779.20000000000005 |
| 53 | 0.0 | 149.75999999999999 | 858.39999999999998 |
| 54 | 16.640000000000001 | 24.960000000000001 | 933.60000000000002 |
| 55 | 8.3200000000000003 | 108.16 | 900.0 |
| 56 | 8.3200000000000003 | 174.72 | 816.79999999999995 |
| 57 | 0.0 | 183.03999999999999 | 816.79999999999995 |
| 58 | 0.0 | 124.8 | 867.20000000000005 |
| 59 | 133.12 | 41.600000000000001 | 824.79999999999995 |
| 60 | 108.16 | 8.3200000000000003 | 825.60000000000002 |
| 61 | 58.240000000000002 | 0.0 | 958.39999999999998 |
| 62 | 33.280000000000001 | 33.280000000000001 | 966.39999999999998 |
| 63 | 8.3200000000000003 | 0.0 | 967.20000000000005 |
| 64 | 49.920000000000002 | 0.0 | 970.39999999999998 |
| 65 | 116.48 | 83.200000000000003 | 796.79999999999995 |
| 66 | 0.0 | 216.31999999999999 | 783.20000000000005 |
| 67 | 166.40000000000001 | 83.200000000000003 | 759.20000000000005 |
| 68 | 141.44 | 16.640000000000001 | 809.60000000000002 |
| 69 | 124.8 | 0.0 | 865.60000000000002 |
| 70 | 99.840000000000003 | 124.8 | 767.20000000000005 |
| 71 | 33.280000000000001 | 199.68000000000001 | 792.0 |
| 72 | 0.0 | 149.75999999999999 | 841.60000000000002 |
| 73 | 0.0 | 58.240000000000002 | 925.60000000000002 |
| 74 | 0.0 | 183.03999999999999 | 841.60000000000002 |
| 75 | 0.0 | 183.03999999999999 | 816.79999999999995 |
| 76 | 33.280000000000001 | 108.16 | 858.39999999999998 |
| 77 | 0.0 | 166.40000000000001 | 808.79999999999995 |
| 78 | 0.0 | 83.200000000000003 | 933.60000000000002 |
| 79 | 0.0 | 149.75999999999999 | 841.60000000000002 |
| 80 | 0.0 | 158.08000000000001 | 842.39999999999998 |
| 81 | 0.0 | 99.840000000000003 | 908.0 |
| 82 | 0.0 | 83.200000000000003 | 884.0 |
| 83 | 124.8 | 99.840000000000003 | 808.79999999999995 |
| 84 | 149.75999999999999 | 41.600000000000001 | 800.0 |
| 85 | 141.44 | 0.0 | 883.20000000000005 |
| 86 | 16.640000000000001 | 0.0 | 958.39999999999998 |
| 87 | 99.840000000000003 | 124.8 | 786.39999999999998 |
| 88 | 83.200000000000003 | 99.840000000000003 | 823.20000000000005 |
| 89 | 33.280000000000001 | 149.75999999999999 | 816.79999999999995 |
| 90 | 99.840000000000003 | 166.40000000000001 | 725.60000000000002 |
| 91 | 49.920000000000002 | 108.16 | 816.79999999999995 |
| 92 | 191.36000000000001 | 0.0 | 792.0 |

| | | | |
|---|---|---|---|
| 93 | 174.72 | 58.240000000000002 | 741.60000000000002 |
| 94 | 199.68000000000001 | 49.920000000000002 | 800.79999999999995 |
| 95 | 124.8 | 16.640000000000001 | 808.79999999999995 |
| 96 | 91.519999999999996 | 99.840000000000003 | 841.60000000000002 |
| 97 | 116.48 | 0.0 | 881.60000000000002 |
| 98 | 158.08000000000001 | 0.0 | 842.39999999999998 |
| 99 | 91.519999999999996 | 33.280000000000001 | 868.0 |
| 100 | 133.12 | 0.0 | 859.20000000000005 |
| 101 | 249.59999999999999 | 0.0 | 741.60000000000002 |
| 102 | 149.75999999999999 | 0.0 | 817.60000000000002 |
| 103 | 174.72 | 0.0 | 858.39999999999998 |
| 104 | 174.72 | 0.0 | 800.0 |
| 105 | 141.44 | 0.0 | 858.39999999999998 |
| 106 | 133.12 | 0.0 | 867.20000000000005 |
| 107 | 166.40000000000001 | 0.0 | 858.39999999999998 |
| 108 | 166.40000000000001 | 0.0 | 825.60000000000002 |
| 109 | 149.75999999999999 | 99.840000000000003 | 744.79999999999995 |
| 110 | 8.3200000000000003 | 149.75999999999999 | 839.20000000000005 |
| 111 | 108.16 | 158.08000000000001 | 733.60000000000002 |
| 112 | 91.519999999999996 | 116.48 | 800.0 |
| 113 | 66.560000000000002 | 91.519999999999996 | 808.79999999999995 |
| 114 | 0.0 | 108.16 | 916.79999999999995 |
| 115 | 0.0 | 141.44 | 858.39999999999998 |
| 116 | 33.280000000000001 | 191.36000000000001 | 775.20000000000005 |
| 117 | 99.840000000000003 | 0.0 | 900.79999999999995 |
| 118 | 116.48 | 149.75999999999999 | 674.39999999999998 |
| 119 | 91.519999999999996 | 174.72 | 734.39999999999998 |
| 120 | 108.16 | 99.840000000000003 | 784.0 |
| 121 | 83.200000000000003 | 24.960000000000001 | 908.0 |
| 122 | 91.519999999999996 | 0.0 | 884.0 |
| 123 | 183.03999999999999 | 0.0 | 824.79999999999995 |
| 124 | 158.08000000000001 | 0.0 | 859.20000000000005 |
| 125 | 158.08000000000001 | 0.0 | 808.0 |
| 126 | 183.03999999999999 | 0.0 | 850.39999999999998 |
| 127 | 141.44 | 0.0 | 858.39999999999998 |
| 128 | 99.840000000000003 | 0.0 | 884.0 |
| 129 | 108.16 | 0.0 | 900.0 |
| 130 | 124.8 | 0.0 | 883.20000000000005 |
| 131 | 33.280000000000001 | 0.0 | 967.20000000000005 |
| 132 | 16.640000000000001 | 0.0 | 958.39999999999998 |
| 133 | 41.600000000000001 | 24.960000000000001 | 941.60000000000002 |
| 134 | 149.75999999999999 | 0.0 | 816.79999999999995 |
| 135 | 199.68000000000001 | 0.0 | 824.0 |
| 136 | 133.12 | 0.0 | 876.79999999999995 |
| 137 | 149.75999999999999 | 0.0 | 833.60000000000002 |
| 138 | 108.16 | 0.0 | 908.0 |
| 139 | 174.72 | 0.0 | 817.60000000000002 |
| 140 | 149.75999999999999 | 0.0 | 808.0 |
| 141 | 141.44 | 0.0 | 850.39999999999998 |
| 142 | 149.75999999999999 | 0.0 | 867.20000000000005 |
| 143 | 8.3200000000000003 | 0.0 | 966.39999999999998 |
| 144 | 133.12 | 0.0 | 883.20000000000005 |
| 145 | 24.960000000000001 | 0.0 | 984.0 |
| 146 | 8.3200000000000003 | 191.36000000000001 | 772.79999999999995 |
| 147 | 0.0 | 208.0 | 811.20000000000005 |

| | | | |
|---|---|---|---|
| 148 | 0.0 | 58.240000000000002 | 941.60000000000002 |
| 149 | 0.0 | 16.640000000000001 | 966.39999999999998 |
| 150 | 0.0 | 0.0 | 995.20000000000005 |
| 151 | 216.31999999999999 | 33.280000000000001 | 750.39999999999998 |
| 152 | 224.63999999999999 | 0.0 | 784.0 |
| 153 | 116.48 | 0.0 | 891.20000000000005 |
| 154 | 183.03999999999999 | 99.840000000000003 | 741.60000000000002 |
| 155 | 16.640000000000001 | 208.0 | 776.0 |
| 156 | 8.3200000000000003 | 183.03999999999999 | 800.79999999999995 |
| 157 | 0.0 | 124.8 | 866.39999999999998 |
| 158 | 8.3200000000000003 | 116.48 | 875.20000000000005 |
| 159 | 0.0 | 158.08000000000001 | 850.39999999999998 |
| 160 | 0.0 | 149.75999999999999 | 850.39999999999998 |
| 161 | 83.200000000000003 | 66.560000000000002 | 816.79999999999995 |
| 162 | 33.280000000000001 | 83.200000000000003 | 900.0 |
| 163 | 8.3200000000000003 | 158.08000000000001 | 834.39999999999998 |
| 164 | 24.960000000000001 | 141.44 | 832.79999999999995 |
| 165 | 183.03999999999999 | 33.280000000000001 | 775.20000000000005 |
| 166 | 149.75999999999999 | 41.600000000000001 | 817.60000000000002 |
| 167 | 116.48 | 41.600000000000001 | 841.60000000000002 |
| 168 | 24.960000000000001 | 166.40000000000001 | 758.39999999999998 |
| 169 | 33.280000000000001 | 166.40000000000001 | 850.39999999999998 |
| 170 | 16.640000000000001 | 91.519999999999996 | 850.39999999999998 |
| 171 | 0.0 | 41.600000000000001 | 966.39999999999998 |
| 172 | 0.0 | 8.3200000000000003 | 992.0 |
| 173 | 0.0 | 83.200000000000003 | 908.79999999999995 |
| 174 | 33.280000000000001 | 149.75999999999999 | 824.79999999999995 |
| 175 | 0.0 | 149.75999999999999 | 858.39999999999998 |
| 176 | 0.0 | 158.08000000000001 | 836.79999999999995 |
| 177 | 0.0 | 183.03999999999999 | 822.39999999999998 |
| 178 | 0.0 | 149.75999999999999 | 825.60000000000002 |
| 179 | 0.0 | 33.280000000000001 | 991.20000000000005 |
| 180 | 108.16 | 91.519999999999996 | 784.0 |

1. Average Throughput for TCP1 link is 86.5301 Kbps
2. Average Throughput for TCP2 link is 91.8549 Kbps
3. Average Throughput for UDP link is 1019.2800 Kbps

Scenario 2, Red Strategy:
This is a plot showing time(x-axis in seconds) and instantaneous throughput per time(y-axis in Kbps) with two connection TCP1, TCP2 and UDP

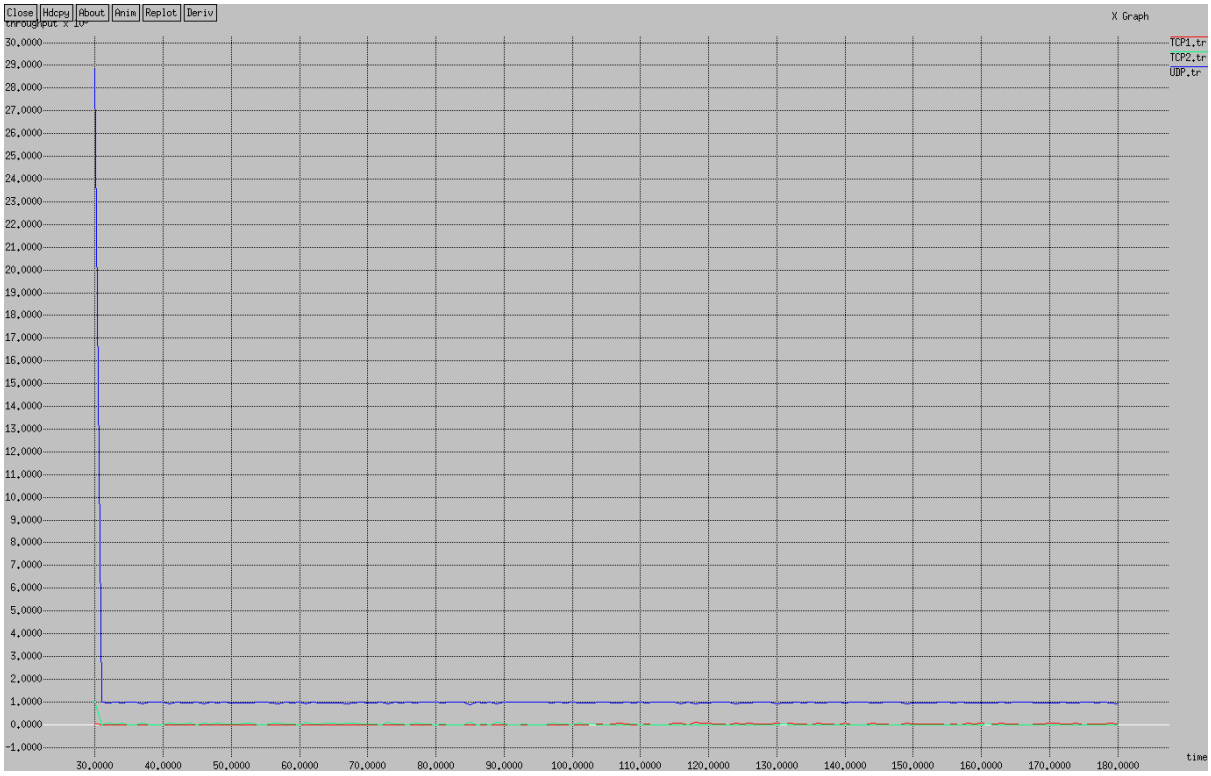


Table for Red Strategy and Scenario 2

| Time(sec) | ThroughputTCP1(Kbps) | ThroughputTCP2(Kbps) | ThroughputUDP(Kbps) |
|---|---|---|---|
| 30 | 75.200000000000003 | 1015.36 | 28813.599999999999 |
| 31 | 0.0 | 0.0 | 1000.0 |
| 32 | 0.0 | 58.240000000000002 | 941.60000000000002 |
| 33 | 0.0 | 24.960000000000001 | 975.20000000000005 |
| 34 | 0.0 | 49.920000000000002 | 933.60000000000002 |
| 35 | 0.0 | 0.0 | 1000.0 |
| 36 | 0.0 | 0.0 | 1000.0 |
| 37 | 0.0 | 83.200000000000003 | 916.79999999999995 |
| 38 | 0.0 | 0.0 | 992.0 |
| 39 | 0.0 | 0.0 | 1000.0 |
| 40 | 0.0 | 0.0 | 1000.0 |
| 41 | 0.0 | 74.879999999999995 | 908.0 |
| 42 | 0.0 | 24.960000000000001 | 983.20000000000005 |
| 43 | 0.0 | 41.600000000000001 | 966.39999999999998 |
| 44 | 0.0 | 66.560000000000002 | 934.39999999999998 |
| 45 | 0.0 | 0.0 | 1000.0 |
| 46 | 0.0 | 66.560000000000002 | 908.0 |
| 47 | 0.0 | 16.640000000000001 | 983.20000000000005 |
| 48 | 0.0 | 66.560000000000002 | 950.39999999999998 |
| 49 | 0.0 | 24.960000000000001 | 975.20000000000005 |
| 50 | 0.0 | 41.600000000000001 | 949.60000000000002 |
| 51 | 0.0 | 41.600000000000001 | 958.39999999999998 |
| 52 | 0.0 | 49.920000000000002 | 942.39999999999998 |
| 53 | 0.0 | 49.920000000000002 | 958.39999999999998 |
| 54 | 0.0 | 0.0 | 1000.0 |
| 55 | 0.0 | 0.0 | 1000.0 |
| 56 | 0.0 | 58.240000000000002 | 941.60000000000002 |
| 57 | 0.0 | 66.560000000000002 | 924.79999999999995 |
| 58 | 0.0 | 24.960000000000001 | 975.20000000000005 |

| | | | |
|---|---|---|---|
| 59 | 0.0 | 24.960000000000001 | 966.39999999999998 |
| 60 | 0.0 | 0.0 | 1000.0 |
| 61 | 0.0 | 91.519999999999996 | 925.60000000000002 |
| 62 | 0.0 | 24.960000000000001 | 983.20000000000005 |
| 63 | 0.0 | 24.960000000000001 | 958.39999999999998 |
| 64 | 0.0 | 58.240000000000002 | 941.60000000000002 |
| 65 | 0.0 | 58.240000000000002 | 941.60000000000002 |
| 66 | 0.0 | 33.280000000000001 | 967.20000000000005 |
| 67 | 0.0 | 58.240000000000002 | 924.0 |
| 68 | 0.0 | 74.879999999999995 | 942.39999999999998 |
| 69 | 0.0 | 16.640000000000001 | 992.0 |
| 70 | 0.0 | 41.600000000000001 | 933.60000000000002 |
| 71 | 0.0 | 24.960000000000001 | 966.39999999999998 |
| 72 | 0.0 | 0.0 | 1000.0 |
| 73 | 0.0 | 99.840000000000003 | 925.60000000000002 |
| 74 | 0.0 | 8.3200000000000003 | 983.20000000000005 |
| 75 | 0.0 | 24.960000000000001 | 958.39999999999998 |
| 76 | 0.0 | 0.0 | 1000.0 |
| 77 | 0.0 | 74.879999999999995 | 941.60000000000002 |
| 78 | 0.0 | 16.640000000000001 | 983.20000000000005 |
| 79 | 0.0 | 24.960000000000001 | 975.20000000000005 |
| 80 | 0.0 | 0.0 | 1000.0 |
| 81 | 0.0 | 16.640000000000001 | 966.39999999999998 |
| 82 | 0.0 | 0.0 | 1000.0 |
| 83 | 0.0 | 0.0 | 1000.0 |
| 84 | 0.0 | 0.0 | 1000.0 |
| 85 | 0.0 | 108.16 | 892.0 |
| 86 | 0.0 | 0.0 | 1000.0 |
| 87 | 0.0 | 33.280000000000001 | 967.20000000000005 |
| 88 | 0.0 | 0.0 | 1000.0 |
| 89 | 0.0 | 116.48 | 908.0 |
| 90 | 0.0 | 16.640000000000001 | 975.20000000000005 |
| 91 | 0.0 | 0.0 | 1000.0 |
| 92 | 0.0 | 0.0 | 1000.0 |
| 93 | 0.0 | 16.640000000000001 | 975.20000000000005 |
| 94 | 0.0 | 0.0 | 1000.0 |
| 95 | 0.0 | 0.0 | 1000.0 |
| 96 | 0.0 | 0.0 | 1000.0 |
| 97 | 0.0 | 58.240000000000002 | 941.60000000000002 |
| 98 | 0.0 | 24.960000000000001 | 983.20000000000005 |
| 99 | 0.0 | 24.960000000000001 | 958.39999999999998 |
| 100 | 0.0 | 0.0 | 1000.0 |
| 101 | 0.0 | 74.879999999999995 | 933.60000000000002 |
| 102 | 0.0 | 41.600000000000001 | 966.39999999999998 |
| 103 | 41.600000000000001 | 8.3200000000000003 | 950.39999999999998 |
| 104 | 16.640000000000001 | 0.0 | 983.20000000000005 |
| 105 | 0.0 | 0.0 | 983.20000000000005 |
| 106 | 41.600000000000001 | 0.0 | 967.20000000000005 |
| 107 | 66.560000000000002 | 0.0 | 933.60000000000002 |
| 108 | 24.960000000000001 | 0.0 | 974.39999999999998 |
| 109 | 0.0 | 24.960000000000001 | 958.39999999999998 |
| 110 | 0.0 | 0.0 | 1000.0 |
| 111 | 33.280000000000001 | 0.0 | 958.39999999999998 |
| 112 | 0.0 | 0.0 | 1000.0 |
| 113 | 0.0 | 0.0 | 1000.0 |

| | | | |
|---|---|---|---|
| 114 | 0.0 | 0.0 | 1000.0 |
| 115 | 49.920000000000002 | 0.0 | 975.20000000000005 |
| 116 | 83.200000000000003 | 0.0 | 908.79999999999995 |
| 117 | 0.0 | 0.0 | 1000.0 |
| 118 | 91.519999999999996 | 0.0 | 916.79999999999995 |
| 119 | 49.920000000000002 | 0.0 | 949.60000000000002 |
| 120 | 49.920000000000002 | 0.0 | 950.39999999999998 |
| 121 | 8.3200000000000003 | 0.0 | 975.20000000000005 |
| 122 | 33.280000000000001 | 0.0 | 975.20000000000005 |
| 123 | 0.0 | 0.0 | 1000.0 |
| 124 | 83.200000000000003 | 0.0 | 916.79999999999995 |
| 125 | 33.280000000000001 | 0.0 | 958.39999999999998 |
| 126 | 58.240000000000002 | 0.0 | 949.60000000000002 |
| 127 | 8.3200000000000003 | 0.0 | 975.20000000000005 |
| 128 | 24.960000000000001 | 0.0 | 983.20000000000005 |
| 129 | 24.960000000000001 | 0.0 | 977.60000000000002 |
| 130 | 74.879999999999995 | 0.0 | 922.39999999999998 |
| 131 | 41.600000000000001 | 33.280000000000001 | 933.60000000000002 |
| 132 | 66.560000000000002 | 0.0 | 950.39999999999998 |
| 133 | 24.960000000000001 | 0.0 | 975.20000000000005 |
| 134 | 24.960000000000001 | 0.0 | 966.39999999999998 |
| 135 | 0.0 | 0.0 | 1000.0 |
| 136 | 58.240000000000002 | 0.0 | 933.60000000000002 |
| 137 | 33.280000000000001 | 0.0 | 966.39999999999998 |
| 138 | 33.280000000000001 | 0.0 | 983.20000000000005 |
| 139 | 0.0 | 0.0 | 1000.0 |
| 140 | 58.240000000000002 | 0.0 | 942.39999999999998 |
| 141 | 0.0 | 0.0 | 1000.0 |
| 142 | 0.0 | 0.0 | 1000.0 |
| 143 | 0.0 | 0.0 | 1000.0 |
| 144 | 58.240000000000002 | 0.0 | 949.60000000000002 |
| 145 | 24.960000000000001 | 0.0 | 950.39999999999998 |
| 146 | 33.280000000000001 | 0.0 | 975.20000000000005 |
| 147 | 0.0 | 0.0 | 1000.0 |
| 148 | 0.0 | 0.0 | 1000.0 |
| 149 | 74.879999999999995 | 0.0 | 916.79999999999995 |
| 150 | 41.600000000000001 | 0.0 | 972.0 |
| 151 | 24.960000000000001 | 0.0 | 960.79999999999995 |
| 152 | 41.600000000000001 | 0.0 | 967.20000000000005 |
| 153 | 8.3200000000000003 | 0.0 | 966.39999999999998 |
| 154 | 33.280000000000001 | 0.0 | 983.20000000000005 |
| 155 | 0.0 | 0.0 | 1000.0 |
| 156 | 41.600000000000001 | 0.0 | 950.39999999999998 |
| 157 | 0.0 | 0.0 | 992.0 |
| 158 | 58.240000000000002 | 0.0 | 958.39999999999998 |
| 159 | 33.280000000000001 | 0.0 | 966.39999999999998 |
| 160 | 49.920000000000002 | 0.0 | 941.60000000000002 |
| 161 | 16.640000000000001 | 8.3200000000000003 | 950.39999999999998 |
| 162 | 16.640000000000001 | 0.0 | 966.39999999999998 |
| 163 | 49.920000000000002 | 0.0 | 975.20000000000005 |
| 164 | 33.280000000000001 | 0.0 | 950.39999999999998 |
| 165 | 33.280000000000001 | 0.0 | 974.39999999999998 |
| 166 | 0.0 | 0.0 | 1000.0 |
| 167 | 0.0 | 0.0 | 1000.0 |
| 168 | 41.600000000000001 | 0.0 | 958.39999999999998 |

| | | | |
|---|---|---|---|
| 169 | 41.600000000000001 | 0.0 | 933.60000000000002 |
| 170 | 66.560000000000002 | 0.0 | 958.39999999999998 |
| 171 | 58.240000000000002 | 0.0 | 933.60000000000002 |
| 172 | 24.960000000000001 | 0.0 | 983.20000000000005 |
| 173 | 8.3200000000000003 | 0.0 | 958.39999999999998 |
| 174 | 74.879999999999995 | 0.0 | 941.60000000000002 |
| 175 | 0.0 | 0.0 | 984.0 |
| 176 | 41.600000000000001 | 0.0 | 974.39999999999998 |
| 177 | 41.600000000000001 | 0.0 | 942.39999999999998 |
| 178 | 33.280000000000001 | 0.0 | 983.20000000000005 |
| 179 | 66.560000000000002 | 0.0 | 933.60000000000002 |
| 180 | 41.600000000000001 | 0.0 | 932.79999999999995 |

1. Average Throughput for TCP1 link is 16.8640 Kbps
2. Average Throughput for TCP2 link is 22.2443 Kbps
3. Average Throughput for UDP link is 1159.2533 Kbps

## Analysis of Simulation Result

1. In this simulation, queue size limit is added with 20 packets. At first, different sources will send a large number of packets which corresponds to the very high throughput in the first one second. Then as the queue is full and a lot of packets are dropped, the throughput of each connection decrease dramatically.
2. In droptail strategy, as long as the queue is filled up, it will drop subsequent packets arrived. In other words, drop the tail of sequence of packets. However, It doesn't distribute buffer space fairly. Because Drop Tail doesn't differentiate traffic from different sources, sources with higher traffic volume will take more buffer space. And If multiple TCP connections exist in the system and a buffer overflow will cause TCP global synchronization, which reduce the network throughput and utility significantly. In RED strategy, it monitors the average queue size and take actions on packet (either drop or mark) based on statistical probabilities. And RED is designed with the following goals, providing connection avoidance by controlling the average queue size, avoiding TCP global synchronization, avoiding bias against bursty traffic and maintaining an upper bound on average queue size even the transport-layer protocols doesn't cooperate.
3. In scenario 1, two link TCP1 and TCP2 have almost the same throughput. As the packets number is really large and the queue size is only 20, queue is full at the beginning. So the two different strategies perform almost the same.
4. In scenario 2, two link TCP1 and TCP2 still have almost the same throughput while UDP link has a very large throughput. This is because UDP is connectionless link and it's normal to lose packets which will not affect its transmission rate. As a result, UDP link still can maintain a high throughtput. The plots in RED graph go very smoothly while in Droptail graph go up and down, which means RED properly handle the bias of different sources against bursty traffic.