Network Architecture I

**Project Document**

**Performance Evaluation: TCP vs. UDP-based Data Transfer Protocols using EMULAB**

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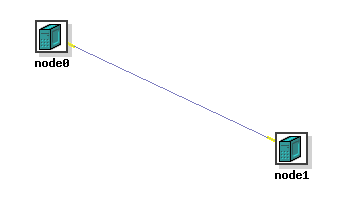
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**Introduction:**

In this project we have evaluated the performance of TCP by comparing it with UDT using the emulab. We have constructed a simple topology with two nodes and a link using the emulab testbed. We measured the throughput by changing other network performance parameters like delay, throughput and bandwidth of the link between the nodes. The differences between TCP and UDP based transfer protocols were observed using the results obtained under various network conditions.

**Approaches and Techniques:**

We have used a simple topology with two nodes and a link between the two nodes as shown below. We consider one of the nodes as the client nodes and the other as the server node while performing various operations on the nodes using the putty for measuring the throughput values.



We have performed all our experiments by variation of important network performance parameters of the link like delay, loss rate and bandwidth as shown in the below table:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Delay(ms)** | **Loss rate** | **Bandwidth** |
| **Experiment 1** | 5 | 10^-3 | 1 Gbps |
| **Experiment 2** | 5 | 10^-6 | 1 Gbps |
| **Experiment 3** | 50 | 10^-3 | 1 Gbps |
| **Experiment 4** | 50 | 10^-6 | 1 Gbps |
| **Experiment 5** | 5 | 10^-3 | 500Mbps |

**Tools/Languages Used:**

|  |  |
| --- | --- |
| **Tools** | **Functionalities used** |
| **emulab Testbed** | Creation of simple network topology, variation of the network performance parameters of the link like delay, loss rate and bandwidth |
| **iperf** | Measuring the throughput values for TCP |
| **putty** | Accessing and managing the network nodes created using the emulab testbed |
| **C++** | UDT source codes for measuring the throughput values for UDT |
| **Unix** | Operating system used in the client and the server nodes |

**Difficulties faced:**

As we were not familiar with emulab earlier it took some time for us to know how to use emulab. We faced difficulties in analyzing the UDT part particularly during the extraction of the file. Other than these we had minor problems in accessing the nodes using their IP addresses.

**Additional work:**

We were able to place our own file in the remote directory of the server and we tried to transfer that packet from server to client. In order to upload our file into remote directory we have used ‘put’ command and then we have set a path in order to access the file. The command used for this purpose is shown below:

$ /usr/bin/iperf -c node0.BandwidthCheck.UMKCNAI-Project2.emulab.net -t 20 -i 2 **–F <Path of the file on the node>**

**Tasks and Team Member Roles:**

|  |  |
| --- | --- |
| **Team Members** | **Tasks** |
| Jaswanth Krishna Aavula | * Creation of the Experiments in the emulab testbed * Measuring the performance of TCP * Analyzing the graphs and documentation |
| Krishnamurthy Gopisetty | * Creation of the Experiments in the emulab testbed * Measuring the performance of UDT * Analyzing the graphs and documentation |

**Results and Observations:**

**Graph1:** Delay = 5ms, Loss Rate = 10^-3, **Graph2:** Delay = 5ms, Loss Rate = 10^-6, Bandwidth = 1Gbps Bandwidth =1Gbps

**Graph3:** Delay = 50ms, Loss Rate = 10^-3, **Graph4:** Delay = 50ms, Loss Rate = 10^-6, Bandwidth = 1Gbps Bandwidth = 1Gbps

**Graph5:** Delay = 5ms, Loss Rate = 10^-3, Bandwidth = 500Mbps

**Graph7:** Delay= 5ms, Bandwidth = 1Gbps,

Loss Rate Variation= 10^-3 & 10^-6

**Graph6:** Delay= 5ms, Loss Rate= 10^-3, Bandwidth Variation = 500Mbps & 1Gbps

**Graph8:** Delay= 50ms, Bandwidth = 1Gbps,

Loss Rate Variation= 10^-3 & 10^-6

**Individual Graph Observations:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Delay** | **Loss rate** | **Bandwidth** | **Description** |
| **Graph 1** | 5ms | 10^-3 | 1 Gbps | **Throughput vs. Time** |
| **Graph1 Observation:** The throughput value is high in the beginning i.e. for the first time slot and then it gradually fluctuates for TCP (both Reno and Cubic) where as for UDT it is low on the beginning and then increases gradually remains almost constant though there are little fluctuations. | | | | |
| **Graph 2** | 5ms | 10^-6 | 1 Gbps | **Throughput vs. Time** |
| **Graph2 Observation:** The same observation as for Graph1 for the change in the throughput but with respect to the time. | | | | |
| **Graph 3** | 50ms | 10^-3 | 1 Gbps | **Throughput vs. Time** |
| **Graph3 Observation:** The same observation as for Graph1 for the change in the throughput but with respect to the time. | | | | |
| **Graph 4** | 50ms | 10^-6 | 1 Gbps | **Throughput vs. Time** |
| **Graph4 Observation:** The same observation as for Graph1 for the change in the throughput but with respect to the time. | | | | |
| **Graph 5** | 5ms | 10^-3 | 500Mbps | **Throughput vs. Time** |
| **Grap5 Observation:** Though we have changed the bandwidth instead of the delay and loss rate, we have seen the same observation as for Graph1 for the change in the throughput but with respect to the time. | | | | |
| **Graph 6** | 5ms | 10^-3 | 500Mbps & 1Gps | **Throughput vs. Bandwidth** |
| **Graph6 Observation:**  The throughput for the TCP (both Reno and cubic) has been significantly affected i.e. decreased with the increase in the bandwidth while compared to UDT which is not much affected with the increase in the bandwidth. | | | | |
| **Graph 7** | 5ms | 10^-3 & 10^-6 | 1 Gbps | **Throughput vs. Loss rate** |
| **Graph7 Observation:** There is increase in the throughput for all TCP (both Reno and Cubic) and UDT when there is less delay. | | | | |
| **Graph 8** | 50ms | 10^-3 & 10^-6 | 1Gbps | **Throughput vs. Loss rate** |
| **Graph8 Observation:** With the increase in the delay, the throughput has decreased for all TCP (both Reno and Cubic) and UDP. | | | | |

**Overall Observations:**

* We have also observed that throughput for the TCP (both Reno and cubic) have been significantly affected i.e. decreased with the increase in the bandwidth when compared to UDT which is not much affected with the increase in the bandwidth as observed from Graph1, Graph5 and Graph 6.
* The throughput values are high for UDT when there is low loss rate and the throughput values are low when there is high loss rate while for TCP (both Reno and cubic) they remained almost constant irrespective of the loss rate from Graph1-Graph2 and Graph3-Graph4.
* When there are low delays, the throughput values are high for TCP Cubic and UDT unlike TCP Reno whose throughput values are high even when there is high delay which can be observed from Graph1-Graph3 and Graph2-Graph4. Thus TCP Reno works better than others when there is more delay but there is no much negative effect on the others because of the delay when compared to affects because of the loss and bandwidth.
* We can conclude from the above observations that the throughput of the TCP (both Reno and Cubic) is much more significantly affected or suffered when there is increase in the bandwidth with high delay values when compared to the affect due to the loss rates. The UDT is affected or suffers more due to the high loss rates while compared to the affect due to the bandwidth or the delays under which the throughput values for UDT almost remain constant.