CHECKPOINT-2

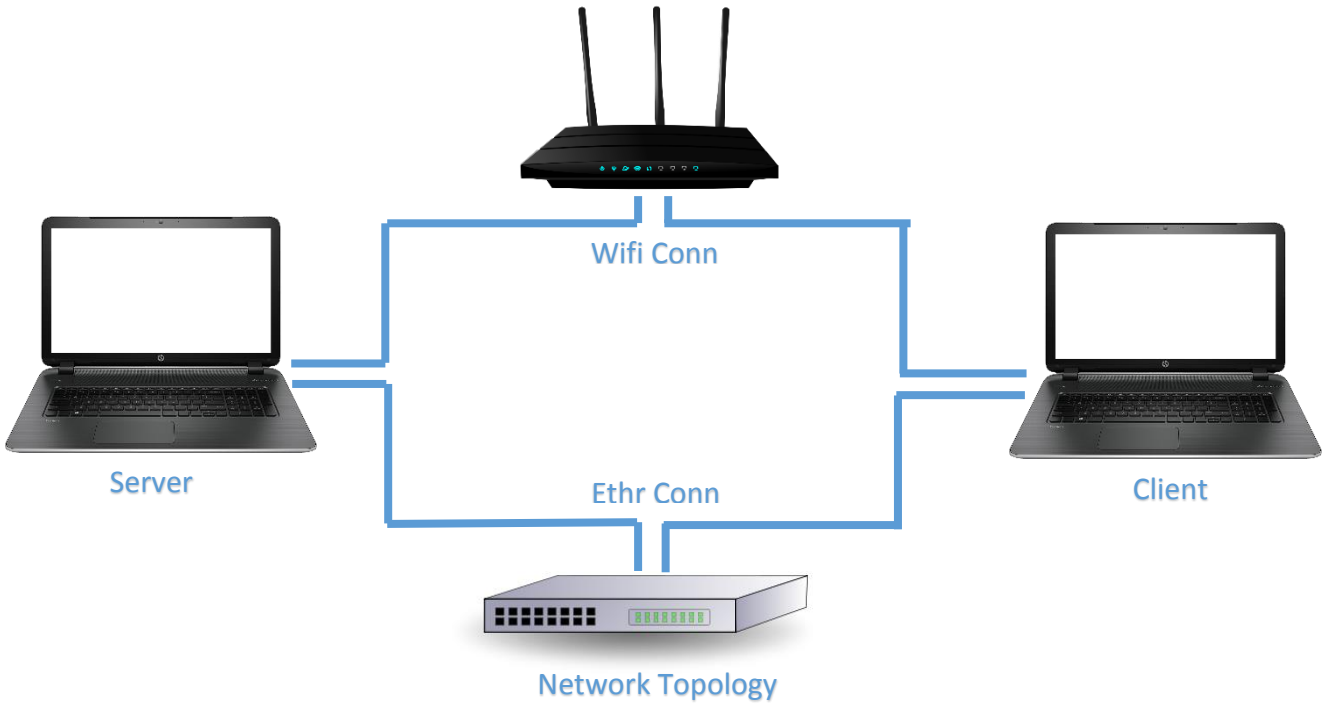
- **Team Number and Names:**

Team Number: #21

Team Members:
- Agneev Ghosh
- Jayant Malani
- Heli Utpal Modi

- **Accomplishment from Checkpoint 1:**

1. To begin with, we have succeeded at making two laptops capable of communicating through MPTCP. This provided us the opportunity to test the MPTCP protocol in a real environment. A point to note here is that as we were able to install MPTCP kernel in the laptop itself we modified our objective to verify the workability of MPTCP in real environment rather than simulating the protocol itself.
2. Next, we have developed and deployed a java code for file transfer between client and server (which are our two MPTCP enabled laptops) using MPTCP in real time.
3. Also, we have deployed TCP (over Ethernet & Wi-Fi), MPTCP (simultaneously on Ethernet & Wi-Fi having two separate networks) as well as various MPTCP congestion control protocols such as LIA, OLIA, BALIA & wVegas on actual hardware. Our n/w topology comprised of two MPTCP enabled laptops acting as client and server- connected to each other via Ethernet (using a switch) and through a separate Wi-Fi (AT&T apartment router).



Network Topology

4. Furthermore, we have used analysis tools such as iptraf, netstat and a self-developed bash scripts which logs the data transfer throughput in kB for every 'second' i.e. kB ps, at the server for every TCP connection

as well as for each MPTCP low. Using, these tools we have done comparative analysis of TCP, MPTCP and the 4 MPTCP congestion control protocols under ideal situation as well as under congestion. We introduced congestion into the network, by implementing a competing process which contests for the existing network bandwidth by utilizing the network resources and thus limiting the utilizable bandwidth for the MPTCP application.

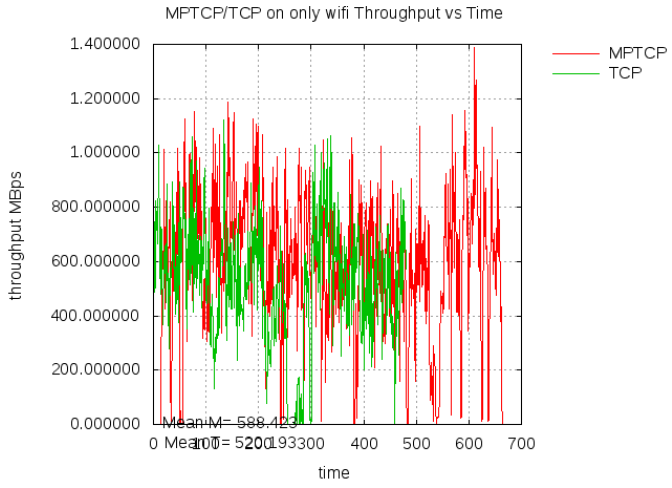
5. In addition to this, we have summarized the analyzed data and come up with ideas for several graphs that can describe our findings and analysis (described in the section- What we expect to present?). During this process we have successfully managed to show that MPTCP can work faster along with giving better throughput than TCP under favorable conditions!
6. We have also conducted a comparative analysis of MPTCP with UDP as well,
7. We will also analyze 'RTT delay Effect' and will be studying the sequencing of the packets that MPTCP implements at client and server.

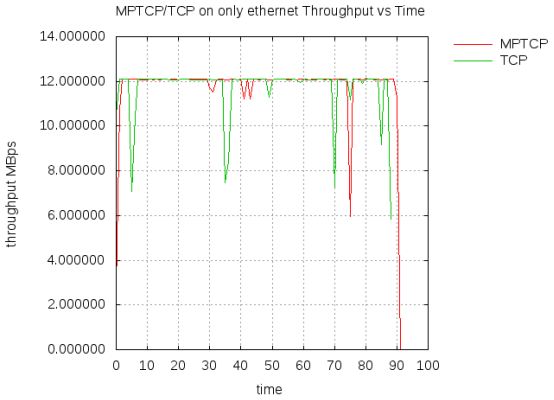
- **Deliverables completed**

1. We now have hardware implementation of a File Transfer Application, transferring files from client to server (both MPTCP enabled) creating desired sub-flows in real time.
2. Additionally, we have verified multiple congestion control algorithms and performed a comparative analysis to evaluate their competency.
3. We were able to find the threshold level of subflows (subflows = 10) which renders the most optimal bandwidth utilization in our environment and strengthened our claim by proving so in a comparative case study comprising an analysis between ‘5’ TCP connections and 5 MPTCP connection having 10 subflows.

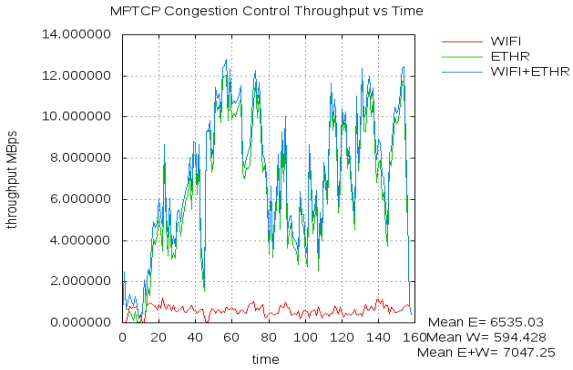
- **What we expect to present?**

Graphs.
MPTCP vs TCP Behavior

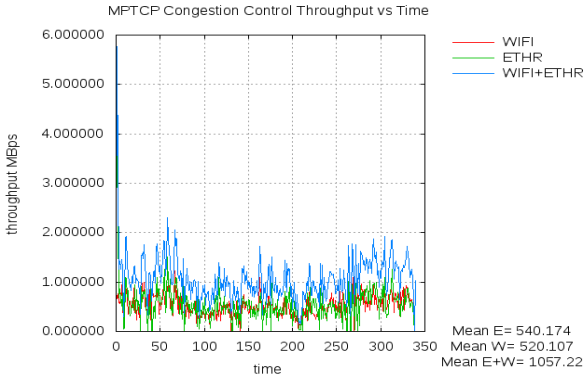




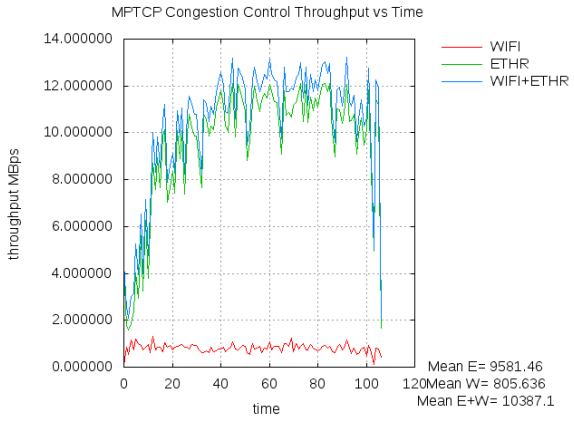
Comparative Analysis of Congestion Control Algorithms:



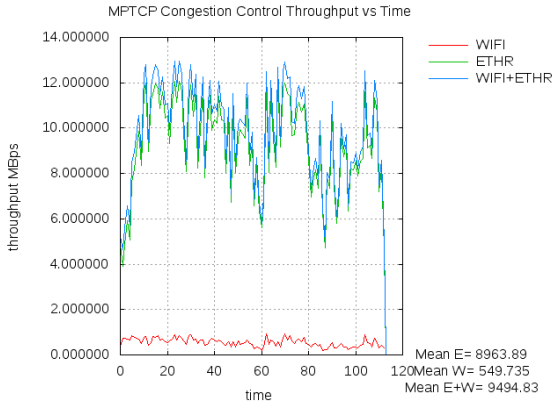
BALIA Congestion Control



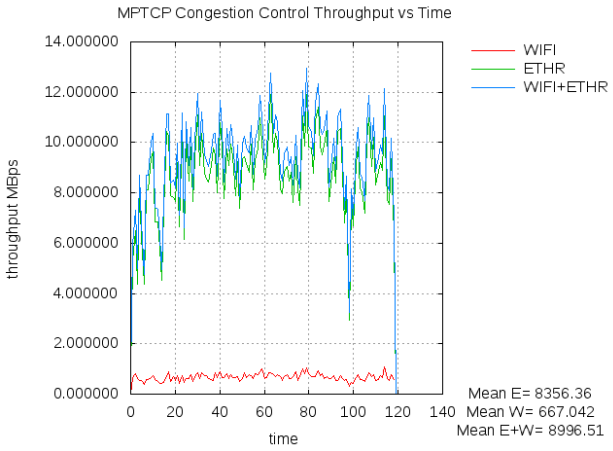
Cubic Congestion Control



LIA Congestion Control

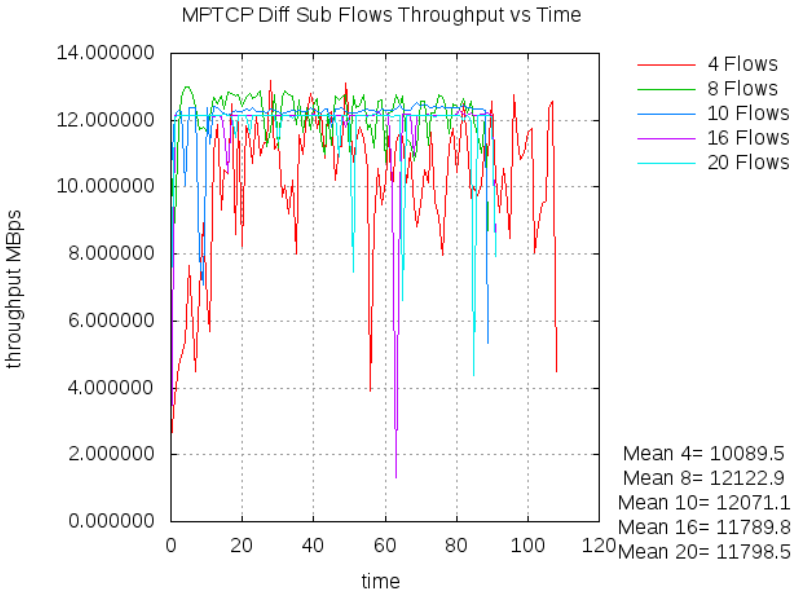


OLIA Congestion Control

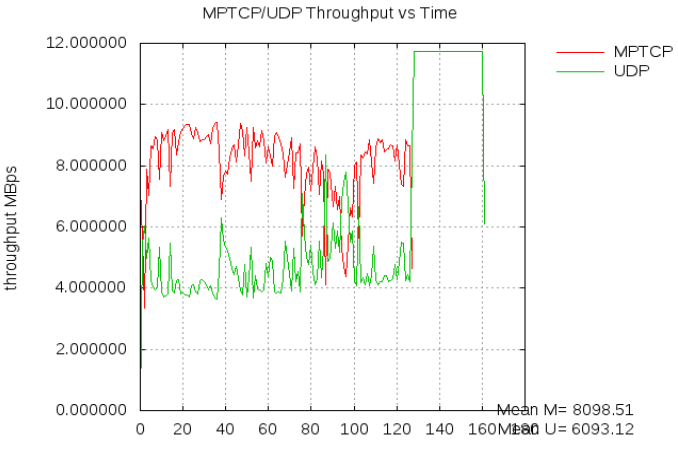


wVegas Congestion Control

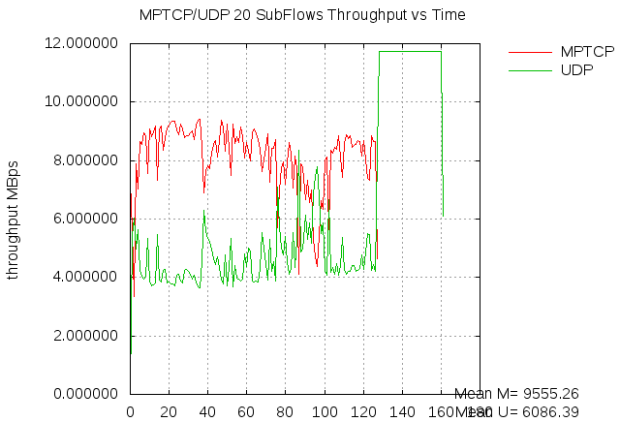
Comparison of different number of flows in MPTCP connection :



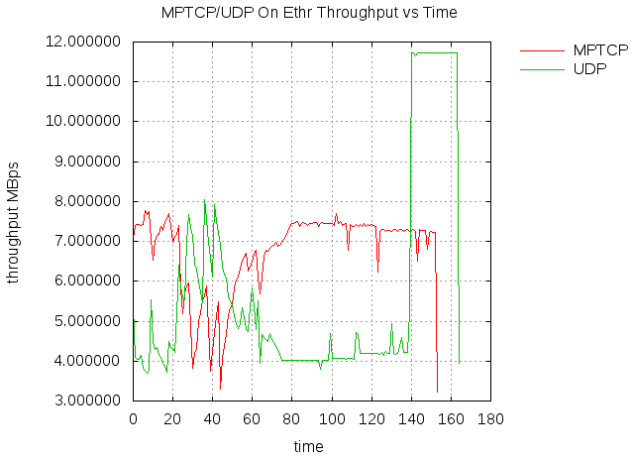
UDP – MPTCP Comparison –



Number of sub flows = 2



Number of Sub Flows = 20



Breaking of Connection :