Network Programming (IS F462)
Project List (2020-2021, Second semester)
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Multipath TCP (MPTCP) and Multipath QUIC (MPQUIC) are well-known known protocols for Multipath Networking. It enables the simultaneous use of several IP-addresses/interfaces by a modification of the regular TCP/UDP protocols. MPTCP and MPQUIC enable a much higher aggregated throughput.

A list of projects is given below where you have to implement either MPTCP or MPQUIC protocols. MPTCP requires the change in kernel whereas MPQUIC is in user-space and no kernel modification is required.

You can either use separate hardware (e.g., 2 different PCs/laptops to perform) to perform the experiments or you may launch MPTCP/MPQUIC inside a VirtualBox as well. The demonstration can be done using the following setups (Figure 2 or Figure 3).
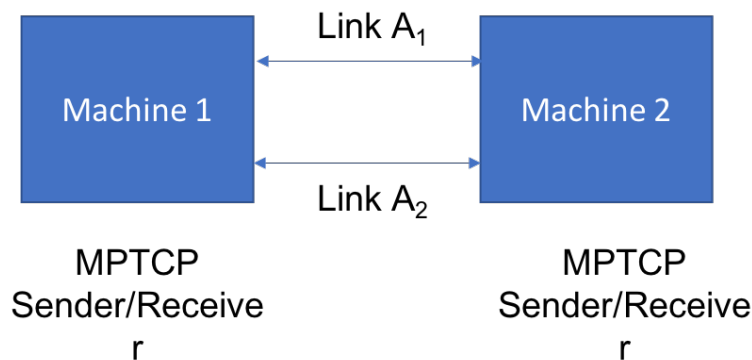

Figure 1 MPTCP Setup with two machines (Similar architecture exists for MPQUIC as well)
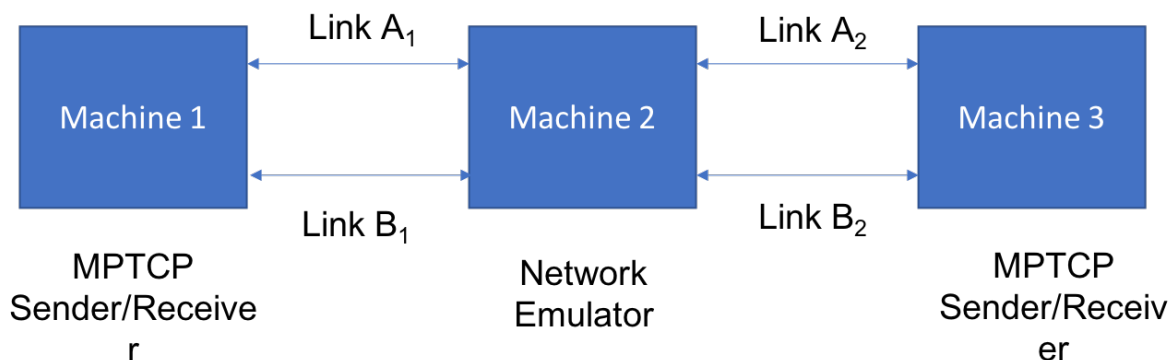

Figure 2 MPTCP Setup with Network Emulator (Similar architecture exists for MPQUIC as well)

In the project list given below, you will implement the MPTCP or MPQUIC protocol, and either:

- Transfer a file from machine 1 to machine 2 (if you use setup in Figure 2) or from machine 1 to machine 3 (if you use setup in Figure 3).
- Stream a video from machine 1 to machine 2 (if you use setup in Figure 2) or from machine 1 to machine 3 (if you use setup in Figure 3).

Figure 2 considers a scenario where machine 1 and machine 2 are connected with two networks, let's say through Cellular (Link A1) and WiFi (Link A2). You need to use MPTCP or MPQUIC such that both of these networks are used in parallel. You can demonstrate this by running a Wireshark or any other packet capturing tool. Note that you may need to limit the rate of the interfaces. For example, you can use network emulators (like Netem) to limit the rate of the Cellular or WIFI interface.

Figure 2 considers a scenario where your machine 2 acts as a network emulator between machine 1 and machine 3. You can consider two routes from machine 1 to machine 3: Link A1+Link A2 as one route and Link B1+Link B2 as another route. You can control the network parameters using the network emulator at Machine 2 using Netem.

There are two projects as listed below. Each project is either based on MPTCP or MPQUIC protocols. A list of the projects is as follows:

- **Project 1:** Performance analysis of Multipath TCP and Multipath QUIC protocols
  - **Application:** File Transmission
  - **Demonstration:** Demonstrate file transmission between two machines PCs/Laptops (real setups only, virtual setup can be used for study purposes) using both MPTCP and MPQUIC.
  - **Results:** Justification of network settings with real world scenario. Comparison of multipath QUIC and multipath TCP schedulers with different network settings.
  - **Innovation:** Your own MPTCP or MPQUIC scheduler
  - **Difficulty level:** 3/5

- **Project 2**: Video Streaming using Multipath TCP and Multipath QUIC protocols
  - **Application:** Video Streaming
  - **Demonstration:** Demonstrate video streaming between two machines PCs/Laptops (real setups only, virtual setup can be used for study purposes) using MPTCP and MPQUIC.
  - **Results:** Streaming and display of video in both machines. Wireshark traces that the data if streaming through both the networks.
  - **Innovation:** Devise your own video streaming algorithm such that the video data is transferred through both the links.
  - **Difficulty level:** 4/5

Some Relevant References:

1. ### MPTCP
   - http://progmp.net/
   - https://www.multipath-tcp.org/
   - https://github.com/multipath-tcp/mptcp
   - https://ieeexplore.ieee.org/document/8666496
   - https://ieeexplore.ieee.org/abstract/document/8121920
   - https://ieeexplore.ieee.org/document/7774599
   - https://tools.ietf.org/html/draft-samar-mptcp-socketapi-03

2. ### MPQUIC
   - https://tools.ietf.org/html/draft-ietf-quic-transport-23
   - https://ieeexplore.ieee.org/document/8422951
   - https://multipath-quic.org/conext17-deconinck.pdf
   - https://github.com/qdeconinck/mp-quic
   - https://github.com/lucas-clemente/quic-go/
   - https://golang.org/doc/install#install

3. ### Network and System Emulators
   - http://man7.org/linux/man-pages/man8/tc-netem.8.html
   - http://mininet.org/download/
   - https://github.com/multipath-tcp/mptcp
   - https://github.com/qdeconinck/mp-quic
   - https://www.ffmpeg.org/