Virtual IP Network with Dynamic Neighbor Discovery and TCP Tahoe Congestion Control

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In traditional computer networking, the link layer, IP forwarding, and routing are implemented by the OS and hardware in the hosts as well as the routers. However, in order to witness the working of these basic protocols firsthand and to gain experience in implementing the various layers into networking, I wrote an entire Virtual IP Network using only userspace programs with UDP sockets. Work on this project includes creating a virtual networking stack in userspace that implements a link layer and an IP forwarding mechanism using its routing protocol. One fascinating feature about this project is that it implemented something known as Neighbor Discovery, meaning that information on neighbors would be automatically discovered by nodes within a local network. I implemented this feature as my capstone work, where I developed and tested a dynamic discovery mechanism to hold neighbor information, boosting the capability and effectiveness of the network. In order to support hosting an efficient TCP implementation, for my capstone project, I implemented the Tahoe congestion control algorithm built on the aforementioned IP project. This improves performance in congested networks by implementing slow start, congestion avoidance, and fast retransmit heuristics. To enhance flexibility and robustness in performance, my TCP design allows for selectively enabling or disabling any available congestion control module. The performance of this solution was tested in different virtual network topologies and configurations that checked the efficiency of the congestion control algorithm and general robustness of the virtual IP stack.