Virtual Private Network

19.1. What are the main differences between SSH tunnel and VPN tunnel?

19.2. To log into Syracuse University's network, Bob needs to use a TLS-based VPN. After he has established a VPN tunnel between his machine and Syracuse University's network (`128.230.0.0/16`), he checks the routing table on his computer. Here is what he says:

```
---------------------------------------------------------------
  Network
Destination    Netmask          Gateway         Interface
---------------------------------------------------------------
    0.0.0.0    0.0.0.0          192.168.0.1     192.168.0.13
  127.0.0.0    255.0.0.0        On-link         127.0.0.1
  127.0.0.1    255.255.255.255  On-link         127.0.0.1
128.230.0.0    255.255.0.0      128.230.153.48  128.230.153.80
128.230.153.12 255.255.255.255  192.168.0.1     192.168.0.13
128.230.153.80 255.255.255.255  On-link         128.230.153.80
192.168.0.0    255.255.255.0    On-link         192.168.0.13
192.168.0.13   255.255.255.255  On-link         192.168.0.13
192.168.0.255  255.255.255.255  On-link         192.168.0.13
```

From the above routing information, please answer the following questions (you need to explain your answer).

(a) What is the IP address of the TUN interface on Bob's machine?

(b) What is the IP address of Syracuse University's VPN server?

(c) What is the computer's real IP address, i.e., the IP address assigned to the machine's physical network interface card?

(d) Assume that Bob is behind a firewall that blocks him from accessing a web site (assume that the IP address of the web site is 8.8.8.8). Please describe how Bob can use Syracuse University's VPN to bypass the firewall. If changes need to be made to this routing table, please show exactly what changes Bob needs to make to achieve the goal.

19.3. In Figure 1, Machine X has established a VPN with Machine Y, which is a VPN server connected to the private network `10.0.20.0/24`. With the VPN, a user on Machine X can now access machines on the `10.0.20.0/24` network. The user runs the following command on Machine X: `"telnet 10.0.20.100"`. Figure 1 shows the packet flow triggered by this command. Please answer the following questions:

(a) What is the relationship between packets ❶ and ❷?

(b) What is the relationship between packets ❸ and ❹?

(c) What is the source IP and destination IP of packets ❶, ❷, ❸, and ❹?

(d) What routing entries are needed on Machine X?

(e) What routing entries are needed on Machine Y?

(f) What routing entries are needed on Machine `10.0.20.100`?

(g) If we break the VPN tunnel, what is going to happen to the `telnet` connection? Is it going to be broken? After a few seconds, we reconnect the VPN tunnel between X and Y, what is going to happen?

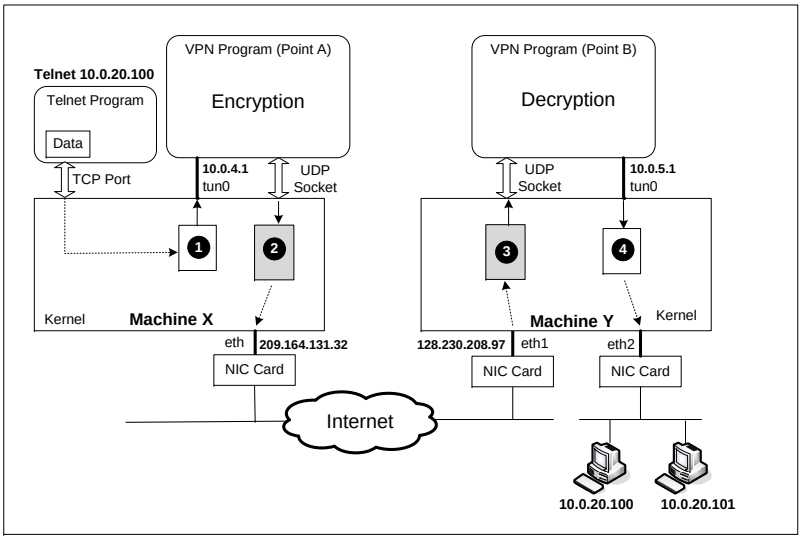

Figure 1: Packet flow over VPN (for Problem 19.3.)

19.4. A VPN allows Host U on a private network `192.168.60.0/24` to communicate with Host V on another private network `192.168.80.0/24`. See Figure 2 for the VPN setup. Please describe the following:

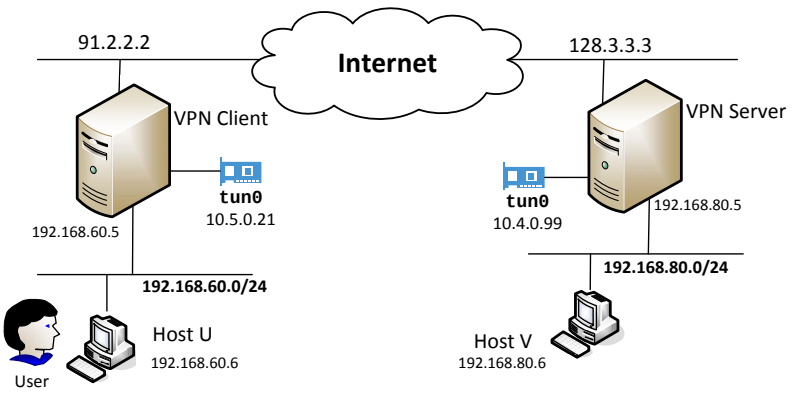

Figure 2: Figure for Problem 19.4.

(a) What routing entries need to be added to Host U, VPN Client, VPN server, and Host V? You don't need to write down the actual command, but you need to describe those routing entries.

(b) When Host V receives a packet from Host U, what is the source IP address of the packet?

(c) When VPN server receives a packet from Host U to Host V, via the VPN tunnel, what is the source and destination IP addresses of the packet?

(d) After the VPN tunnel is set up, when we ping Host V from Host U, please describe in details how the ICMP echo request packets get to Host V from Host U, and how the ICMP echo reply packets get back to Host U.

19.5. When we use VPN to reach Facebook, which is blocked by our firewall, we route our Facebook-bound packets towards the TUN interface to reach the VPN server via the tunnel. The VPN server will route our packets towards Facebook (via the Internet). When Facebook sends reply to us, will the packet be sent directly to us (i.e., without going through the tunnel), or to the VPN server (and then go through the tunnel)? Please explain why.

19.6. A website in California only allows machines in California to access it. The way how it enforces the rule is to check whether a visitors IP address is from California or not. You live in Syracuse, New York, and you desperately want to visit this website. Please describe how you can do it.