Lecture 12 (DHCP, ARP, IPv6, SDNs)

1 DHCP

1. Host broadcasts `DHCP discover` message (optional)
   - destination MAC = FF:FF:FF:FF:FF:FF
   - source IP = 0.0.0.0
   - destination IP = 255.255.255.255
2. DHCP server responds with address in `DHCP offer` message (optional)
3. Host sends `DHCP request` (source IP is still 0.0.0.0)
4. DHCP confirms the IP via `DHCP ack` (it also sends address of first-hop router, DNS server, network mask)
5. After the lease timeout, host requests for renewal (skipping the optional steps)

2 Access Networks

1. Layer 2 communication can be done using MAC (Media Access Control) address
2. It is built-in for each device
3. IP to MAC conversion is done using Address Resolution Protocol (ARP)
   - Router sends a broadcast query asking the MAC address
   - Corresponding host responds

3 IP Address

1. ICANN - Internet Corporation for Assigned Names and Numbers assigns the IP addresses through 5 Regional Registries (RRs)
2. Not enough IP addresses exist
   - The last chunks of IP addresses were allocated in 2011
   - Network Address Translation (NAT) exists
   - IPv6 has been introduced which uses a 128-bit space

3.1 NAT

1. Public IP is different from local IP address
2. Identifying the internal IP is done by using different port numbers for the local hosts

3. Translation is: (source IP, port) → (NAT IP, new port)
4. Router maintains a NAT table for reverse translation
5. Drawbacks:
    - router should process only till layer 3
    - inherent property of functioning of IP is violated since TCP modified

4 IPv6

1. IPv0 to IPv3 wasn't very widely used, similarly IPv5 was deprecated
2. IPv6 has 128 bit addressing
3. The protocol has a different treatment of "flows" and thus has a fixed length header of 40 bytes
4. No need of DHCP
5. It is more secure since communication is encrypted

4.1 Header

1. Version - 4 bits
2. Traffic class - 8 bits
3. Flow label - 20 bits
4. Payload length - 16 bits
5. Next header - 8 bits
6. Hop limit - 8 bits
7. Source address - 128 bits
8. Destination address - 128 bits

4.2 IPv6 Address

It is of three parts:

1. Global Routing (48 bits) -
    i. first three bits are 001 for global unicast
    ii. 45 bits for global routing prefix
2. Subnet ID (16 bits)
3. Interface ID (64 bits)

4.2.1 Address Scope

1. Link-local - nodes on same subnet
2. Unique-local - private side addressing
3. Global (001)

4.2.2 Representation

1. x:x:x:x:x:x:x:x where x is 16-bit hexadecimal field

2. Successive fields of 0 can be represented as :: (only once per address)

4.3 Transition from IPv4 to IPv6

1. Not all routers have IPv6
2. IPv6 packet is *tunneled* as payload in an IPv4 datagram
3. Transition to IPv6 has been really slow

5 SDN

5.1 Generalised Forwarding

1. Match of data in flow is done and then action is taken
2. Flow is given by in-link, network header, transport header

5.2 OpenFlow

1. It is a communication protocol which determines the flow table entries
2. Match (ingress port, link layer, network layer, transport layer) $\rightarrow$ Action (forward, drop, modify, encapsulate + send to controller) $\rightarrow$ Stats (packet + byte counters)
3. Router is a subset of OpenFlow in a way hence
4. Similarly switch, NAT and firewall are also subsets