Problem 1

In this problem, you will put together much of what you have learned about Internet protocols. Suppose you walk into a room, connect to Ethernet, and want to download a Web page. What are the protocol steps that take place, starting form powering on your PC to getting the Web page? Assume there is nothing in our DNS or browser caches when you power on your PC. Explicitly indicate in your steps how you obtain the IP and MAC addresses of a gateway router.

Write your solution to Problem 1 in this box

1. We initially connected to a network, but we don't have an IP address. Use DHCP to get an IP address.
   1a. DHCP discover - broadcast a discover message on network that eveyone can see
   1b. DHCP offer - the router running DHCP replies to the client, assigning an IP address, IP of DNS server, IP of first-hop router
   1c. DHCP accept - client accepts the provided IP addresses
   1d. DHCP ACK - server acknowledges that the client has accepted the IP addresses
2. We want to send requests, but we don't know the MAC address of the first-hop router, only its IP address. We can use ARP.
   2a. client broadcasts ARP query, with IP address of router.
   2b. router sends a reply to client with its MAC address, saves the interface to switching table
3. Encapsulate DNS query in IP datagram
   3a. if local DNS exists, it will find the IP of the requested server using iterative or recursive query, querying root DNS server, TLD servers, authoritative servers
   3b. if it doesn't exist, client will do it themselves
4. Now we must route to the desired web server
   4a. if the server is in the same AS network, use OSPF
   4b. if the server is in a different AS network, and we are moving in the same AS network use iBGP
   4c. if the server is in adifferent AS network, and we are moving between AS networks, use eBGP
5. Now we know the IP of the desired server. Create a HTTP request and encapsulate it in TCP packet and IP datagram
   5a. TCP handshake to initiate connection
   5b. server receives TCP packet with HTTP request, sends client HTTP response
   5c. client receives TCP packet with HTTP response, displays the webpage

Problem 2

Consider the hierarchical network in Slide 6-84 and suppose that the data center needs to support email and video distribution among other applications. Suppose four racks of servers are reserved for email and four racks are reserved for video. For each of the applications, all four racks must lie below a single tier-2 switch since the tier-2 to tier-1 links do not have sufficient bandwidth to support the intra-application traffic. For the email application, suppose that for 99.99 percent of the time only three racks are used, and that the video application has identical usage patterns.

(a) For what fraction of time does the email application need to use a fourth rack? How about for the video application?

(b) Assuming email usage and video usage are independent, for what fraction of time do (equivalently, what is the probability that) both applications need their fourth rack?

Write your solution to Problem 2 in this box

a) The email application needs to use the fourth rack 0.01/100 of the time or 0.0001% of time. The video application needs to use the fourth rack 0.01/100 of the time or 0.0001% of time.

b) The fraction of time in which both applications use the fourth rack is 0.0001/100 or 0.00000001% of the time.

Problem 3

Suppose there are two ISPs, providing WiFi access in a particular café, with each ISP operating its own AP and having its own IP address block.

(a) Further suppose that by accident, each ISP has configured its AP to operate over channel 11. Will the 802.11 protocol completely break down in this situation? Discuss what happens when two stations, each associated with a different ISP, attempt to transmit at the same time.

(b) Now suppose that one AP operates over Channel 1 and the other over Channel 11. How do your answers change?

Write your solution to Problem 3 in this box

a) No, the wifi protocol will not break down. However, we must distinguish at the access points which access point the frame is meant for. Suppose a host is in range of both AP's, but is only connected to one. When the host sends data to its desired AP, it is identified by its SSID and MAC address. The other AP will not process the data because it was not addressed to it. As a result, two AP's can operate over the same channel. However, the two ISPs are still sharing the same wireless bandwidth, and if the ISP's are different, there may be collisions.

b) There will be no collisions because the channel is different.

Problem 4

In Mobile IP, what effect will mobility have on end-to-end delays of datagrams between the source and destination?

Write your solution to Problem 4 in this box

The delay of datagrams between source and destination will be generally higher, because datagrams must be first forwarded to the home agent and then to the mobile device. There is, however, a small chance that the delay is shorter, and this occurs if the datagram is not routed through the home agent.

Problem 5

Answer the following questions:

(a) What are three important differences between the 3G and 4G cellular architectures?

(b) What is the role of the eNodeB, MME, P-GW, and S-GW in 4G architecture?

Write your solution to Problem 5 in this box

a)
1. In 4G, all IP datagrams are tunneled through the IP core, from base station to gateway.
   In 3G, IP datagrams are first tunneled through a radio access network.
2. In 4G, voice and data are not separated. All traffic is carried over the IP core
   In 3G, voice and data are separated, and they operate in parallel
3. In 4G, only packet switching is used
   In 3G, there is a circuit switched domain for voice and a packet switched domain for data.

b)
eNodeB is basically a base station that connected to end wireless devices.
The MME or mobility management entity keeps track of which end wiresless devices are connected and authorizes them.
The S-GW or serving gateway is responsible for holding idle devices information, ensuring quality of service and also for passing packets to the P-GW.
The P-GW or packet data network gateway transfers packets to the packet data network or the internet.