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) Your laptop needs to obtain an IP address so you send a DHCP request. The DHCP request is encapsulated in UDP, which is in turn encapsulated in IP, which is then encapsulated in 802.3 Ethernet.
2) The Ethernet frame is broadcasted on LAN and received by the DHCP server, which decapsulates the datagram to yield a DHCP request
3) DHCP server sends back a DHCP ACK containing the client's IP address, the IP address of the first hop router of the client, and the IP address of the DNS server. This is also encapsulated and sent.
4) The client receives the DHCP ACK, containing the above information.
5) The client creates a DNS query to obtain the IP address of the webpage. The client needs the MAC address of the router so it begins the ARP protocol.
6) An ARP query is broadcasted and received by the router with the destination address. The router sends an ARP reply w/ the MAC address
7) The client can send the DNS query now with the MAC address. The query is also encapsulated.
8) The DNS query is eventually sent to the DNS server which de-multiplexes it and replies with the IP address of the site
9) The client initiates a TCP 3-way handshake with the web server to establish a connection.
10) Once a connection is established, the client can send the HTTP request.

Problem 2

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 2 in this box

(a) No. Each AP should have its own SSID and MAC address. Wireless stations associated with different ISPs will each be associated to AP1 & AP2, respectively. If the stations begin to transmit, their transmissions will be sent to both AP1 and AP2 but they will be addressed to the corresponding APs using the MAC address. Thus, if a transmission addressed to AP1's MAC address arrives at AP2, AP2 will discard it. The two stations can thus share the same channel. However, the bandwidth is also shared so there may be collisions.

(b). There will be no collisions and both can transmit simultaneously.

Problem 3

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 3 in this box

Since in mobile IP, indirect routing is used, datagrams must be first forwarded to the home agent. Thus, delays will be longer, depending on the path taken, than direct routing. There is a chance that direct routing may result in more delay if the path to the direct mobile node from the correspondent is longer than the sum of the delay from the correspondent to the home agent and from the home agent to the mobile node. However, this is unlikely. Moreover, there is overhead incurred by having the home agent process and forward the datagram.

Problem 4

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 99.9 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 4 in this box

(a) The email application uses the fourth rack 0.001% of the time.

The video application also uses the fourth rack 0.001% of the time.

(b) The probability that both are using the fourth rack is:

0.001 * 0.001 = $\boxed{\text{0.000001 \% of the time}}$

Problem 5

Answer the following questions:

(a) What is the role of the "core network" in the 3G cellular data architecture?

(b) What is the role of the RNC in the 3G cellular data network architecture?

(c) What role does the RNC play in the cellular voice network?

Write your solution to Problem 5 in this box

(a) The "core network" in the 3G cellular data architecture [illegible] access networks to the public Internet.

(b) The Radio Network Controller (RNC) controls cell base transceiver stations. The RNC connects to the cellular data network architecture via an SGSN, or a Serving GPRS Support Node

(c) The Radio Network Controller (RNC) connects to the switched cellular voice network via an MSC, or a mobile switching center