# Problem Set 4 of Mobile Computing

Due Date: Dec. 29, 2005

1. Explain how tunneling works in general and especially for Mobile IP using IP-in-IP, minimal, and generic routing encapsulation, respectively. Discuss advantages and disadvantages of these three methods.

Sol:

Tunnelling simply means that a packet is encapsulated at tunnel entry and decapsulated at tunnel exit. The packet is thus payload of the outer packet inside the tunnel. IP-in-IP encapsulation is the simple case of using IP for encapsulating other IP packets. This is simple because all devices already know how to insert payload into an IP packet. Bandwidth is wasted by transferring the same field several times. Minimal encapsulation tries to avoid this waste of bandwidth, however, it cannot be used in case of fragmentation. GRE is a more general scheme, not only for IP traffic but also, e.g., encapsulation of Ethernet packets into IP packets. Additionally, it may control the level of encapsulation. Several versions exist.

2. What is the basic purpose of DHCP? Name entities of DHCP.

Sol:

DHCP is a mechanism for configuring nodes. Parameters acquired via DHCP are, e.g., IP address, default gateway, DNS server, subnet mask etc. Without DHCP all parameters must be configured manually. A DHCP server provides DHCP information, a relay can forward data into different LANs.

3. In a hypothetical wireless system, five adjacent frequency bands ($f_1$, $f_2$, $f_3$, $f_4$, $f_5$) are allowed for frequency hopping sequences. Enumerate how many different frequency hopping sequences are possible?

Sol:

If we have 5 bands we can have $5! = 120$ hopping sequences.

4. In the previous problem, it was decided to add five additional channels ($f_6$, $f_7$, $f_8$, $f_9$, $f_{10}$) while keeping the frequency hopping sequence to five bands. Is it advisable to maintain frequency hopping within each of the channels ($f_1$, $f_2$, $f_3$, $f_4$, $f_5$) and ($f_6$, $f_7$, $f_8$, $f_9$, $f_{10}$) or it is better to select five channels among the bands ($f_1$, $f_2$, $f_3$, $f_4$, $f_5$, $f_6$, $f_7$, $f_8$, $f_9$, $f_{10}$)? Explain your answer with quantitative measures.

Sol:

In the first case the number of hopping sequences we get will be: $2 * 5! = 240$.

In the second case the number of hopping sequences we get will be $\binom{10}{5} * 5! = \frac{10!}{(10-5)!5!} * 120 = 37240$. Hence the second scheme is better.

5. Describe the wireless solutions that you would recommend for the following situations. Some situations may need multiple standards. Explain clearly.

（1） A person carries a PDA, laptop, biosensors, and wrist watch with applications that are collaborative in nature and communicate with the Internet.

（2） A salesman on the road needs to keep track of product inventories.

（3） A group of executives meet in a conference room and want to digitally exchange their business cards.

（4） A group of conference organizations need to take “conflict of interest” into account while discussing conference submissions and making acceptable decisions.

Sol:

(a) Use WPAN technology to communicate between the devices, and access the Internet using the WLAN or WMAN technology.

(b) Use WMAN technology, such as Ricochet to connect to the online product inventories.

(c) WLAN technology. By using IEEE 802.11 standard, we can build up the communication between their laptops or PDAs.

(d) We can try to integrate WLAN, WPAN, and cellular system, to set up a heterogeneous wireless network to satisfy the different requirement of different groups or persons

6. Do Bluetooth devices and household microwave ovens interfere? Explain.

Sol:

Bluetooth, which works in ISM band, typically hops faster (220 micro seconds) and employs shorter packets as compared to other systems operating in same frequency band. It limits the impact of microwave ovens and other sources of indoor disturbances on Bluetooth enabled devices by using fast frequency hopping technique.