1. What are the main problems of signal propagation? Why do radio waves not always follow a straight line? Why is reflection both useful and harmful?

*Ans:* Problems: attenuation, scattering, diffraction, reflection, refraction. Except for attenuation all other effects can divert the waves from a straight line. Only in vacuum and without gravitational effects radio waves follow a straight line. Without reflection radio reception in towns would be almost impossible. A line-of-sight almost never exists. However, reflection is the main reason for multipath propagation causing ISI.

2. What limits the number of simultaneous users in a TDM/FDM system compared to a CDM system? What happens to the transmission quality of connections if the load gets higher in a cell, i.e., how does an additional user influence the other users in the cell?

*Ans:* TDM/FDM-systems have a hard upper limit of simultaneous users. The system assigns a certain time-slot at a certain frequency to a user. If all time-slots at all frequencies are occupied no more users can be accepted. Compared to this “hard capacity” a CDM system has a so-called “soft-capacity” (compare filling a box with bricks or tissues). For CDM systems the signal-to-noise-ratio typically limits the number of simultaneous users. The system can always accept an additional user. However, the noise level may then increase above a certain threshold where transmission is impossible. In TDM/FDM systems additional users, if accepted, do not influence other users as users are separated in time and frequency (well, there is some interference; however, this can be neglected in this context). In CDM systems each additional user decreases transmission quality of all other users (the space for the tissues in the box gets tighter).

3. Considering duplex channels, what are alternatives for implementation in wireless networks? What about typical wired networks?

*Ans:* Wireless networks can use different frequencies, different time slots or even different codes to implement duplex channels. Typical wired networks simply use different wires (however, more elaborated schemes such as echo cancellation are feasible, too).

4. What are benefits of reservation schemes? How are collisions avoided during data transmission, why is the probability of collisions lower compared to classical Aloha? What are disadvantages of reservation schemes?

*Ans:* After reservation of the medium succeeded no more collisions can occur (if the system is error free). Reservation schemes can also guarantee bandwidth, delay, and maximum jitter. Thus, during the transmission nothing can happen. Compared
to classical Aloha the collision probability is lower because the contention period is kept short compared to the contention-free period where transmission takes place. A disadvantage of reservation schemes is the latency for data transmission. Before terminals can start transmission they have to reserve the medium. This wastes time in case of a very lightly loaded medium.

5. How can MACA still fail in case of hidden/exposed terminals? Think of mobile stations and changing transmission characteristics.

Ans: Think of asymmetric transmission conditions and, for example, the hidden terminal scenario. What if station C in figure 3.10 transmits with a lot of power while it cannot receive anything from B? Then MACA fails because CTS is not received but C causes a collision at B.

6. Can a network be wireless but not mobile? Explain your answer carefully.

Ans:
Yes, for example, microwave backbone network, controlled robot, portable laptops with ethernet connections.

7. What are pros and cons of having different size cells for wireless networking?

Ans:
Smaller the cell size, low power consumption, low operating cost but increased infrastructure cost. Smaller the cell size, more users in a small area (user density) can be accommodated in the network.

8. If a total 33MHz of bandwidth is allocated to a particular cellular telephone system that uses two 25-kHz simplex channels to provide full duplex voice channels, compute the number of simultaneous calls that can be supported per cell if a system uses (a) FDMA, (b) TDMA with 8-way time multiplexing. Assume that additional bandwidth is reserved for control channels.

Ans:

(a) \[
\frac{33 \cdot 10^6}{25 \cdot 10^3 \cdot 2} = 660. \]

(b) \[
\frac{33 \cdot 10^6 \cdot 8}{25 \cdot 10^3 \cdot 2} = 5280. \]