

Mobile Communication

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Assignment Sheet #7

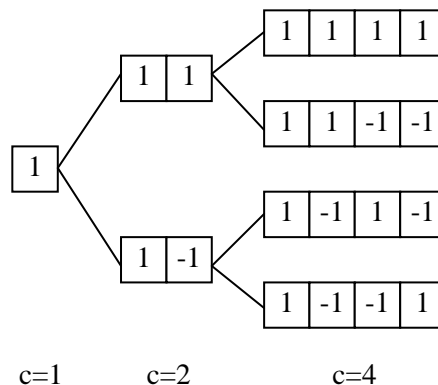
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Exercise 18: (UMTS WCDMA)

As also discussed in the last assignment sheet, GSM uses Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA) to differentiate the available channels on the radio-interface. In contrast to this, UMTS uses Code Division Multiple Access (CDMA) for this purpose. For the following considerations, bit 0 is to be encoded as symbol 1 and bit 1 is to be encoded as symbol -1.

In case of Wideband Code Division Multiple Access (WCDMA), which is used by UMTS, different orthogonal codes are used to spread the signal over time. As a result, all transmissions can be sent on the same frequency at the same time. These codes are denoted as spreading-codes in the following. Two spreading-codes \vec{x} and \vec{y} are orthogonal, if $\vec{x} \cdot \vec{y} = 0$. Consider the following spreading-code tree:



- a) Which pairs of spreading-codes depicted in the spreading-code tree can be used in parallel?

If a user equipment uses the spreading-code \vec{x} with a length of c bits, it sends $a\vec{x}$ on the medium to transmit the symbol a . As different user equipments send at the same time in general, the base station receives $(a\vec{x} + \vec{n})$. As the base station also knows the spreading-code \vec{x} , it can determine $(a\vec{x} + \vec{n}) \cdot \vec{x} = ca$. So, a symbol is successfully transmitted, if $\pm c$ is received.

Assume that there are three user equipments A, B, and C, using orthogonal spreading-codes and an error-free channel. User equipment A uses the spreading-code $[1:-1:1:-1]$ and transmits the bit-sequence (0,1,0,0), B uses the spreading-code $[1:-1:-1:1]$ and transmits the bit-

sequence (1,0,0,0), and C uses the spreading-code [1:1] and transmits the sequence (1,1,0,0,1,0).

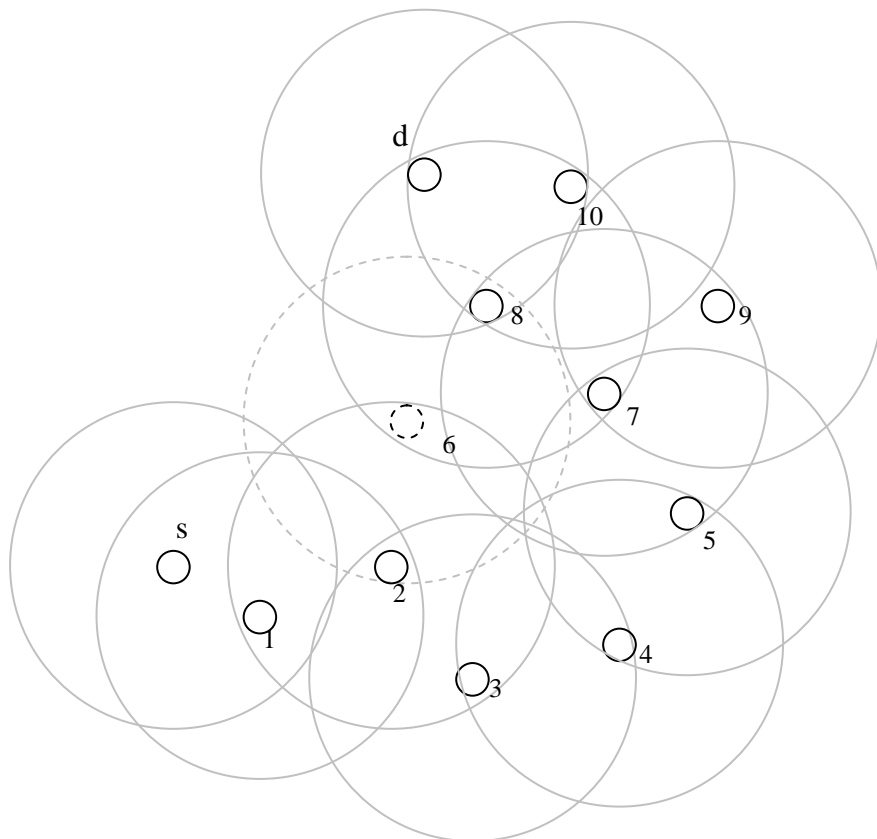
- b) Determine the chip-sequences which are sent by the user equipments A, B, and C.
- c) What is observed on the medium, if the user equipments A, B, and C are the only devices sending their chip-sequences on the medium?
- d) Determine what is received by the base station for the different user equipments A, B, and C.
- e) Why does WCDMA work correctly? You can argument with the scalar product.

Exercise 19: (Ad-hoc networks)

Ad-hoc On-Demand Distance Vector (AODV) and Optimized Link State Routing (OLSR) are two examples for flat ad-hoc routing protocols. An important feature of AODV is that its route discovery acts reactive, as routes are discovered at the point in time a route has to be established. In contrast to this approach, OLSR acts as a proactive protocol, as routing tables are set up for any traffic that would require routing functionality.

- a) Discuss the advantages and the disadvantages of proactive and reactive routing protocols.

The following figure shows a set of mobile devices and their transmission-coverage. Assume that mobile device s wants to transmit some data to mobile device d.



- b) Explain the route discovery process for a route from s to d in case of AODV.

- c) What happened if the mobile device, marked with the dotted line (ID 6), is switched off?

Exercise 20: (Short and Sweets)

Which of the following statements are true, which are false? Explain your answers!

Mobile IP

- a) The home IP address of a mobile station depends on the location of the mobile device.
- b) The care-of IP address of a mobile station is assigned by the home agent and communicated to the foreign agent.
- c) The care-of IP address is communicated to the DNS.
- d) A foreign agent care-of address can be used for several mobile devices, while a co-located care-of address is only used by one mobile device.
- e) Packets for a mobile device are sent to its home agent. The home agent tunnels the packets to the care-of IP address.
- f) The care-of IP address is generally used as source address by the mobile device.
- g) A home link of a mobile device which is never at home is denoted as virtual.
- h) What are possible problems of Triangle Routing?

Wireless Communication

- a) The signal strength at the receiver decreases quadratically with the distance from the transmitter.
- b) A signal can be detected within its entire interference range.
- c) Explain Attenuation, Shadowing, Reflection, Scattering, Diffraction, and Refraction.
- d) If frequency is modulated to encode the transmitted data, “0” and “1” are represented by different signal levels.
- e) Time Division Multiple Access requires different frequencies for the transmissions of the mobile devices.
- f) Code Division Multiple Access requires only one frequency band for several devices.
- g) Explain the Hidden Station Problem.

Bluetooth

- a) Bluetooth uses the same frequency band as Wireless LAN IEEE 802.11b / IEEE 802.11g.
- b) A Bluetooth Piconet can have several masters, up to seven active slaves and up to 255 inactive (parked) slaves.
- c) All devices of a Piconet use the same frequency hopping sequence.
- d) Several Bluetooth Piconets can operate at the same location, as TDMA is used.
- e) The frequency which is used by a sender can be switched during the transmission of a single packet.
- f) Packets can only span an even number of slots.
- g) Within a Bluetooth Scatternet, a mobile station can be master and slave at the same time.
- h) When a mobile device saves power using the HOLD-Mode, it has to check the packet header at the beginning of every even slot.
- i) The encryption key is also used to authenticate a Bluetooth device.

Wireless LAN

- a) Data Frames (Class 3) can be transmitted if a mobile station is authenticated but unassociated.
- b) A movement to another Access Point within the same Extended Service Set requires a new association and a new authentication.
- c) Wireless LAN IEEE 802.11b / IEEE 802.11g implements priority by using different Inter Frame Spaces.
- d) Maximum access delays and minimum bandwidth can be guaranteed when PCF is used by an access point.
- e) The hidden station problem can be solved if the medium is virtually allocated by RTS / CTS.

GSM

- a) The Mobile Switching center is located in the Radio Sub-System.
- b) GSM uses Frequency Division Multiple Access and Time Division Multiple Access in parallel.
- c) The diameter of a GSM-cell can be up to 35km.
- d) GSM, HSCSD, and GPRS use a packet-oriented allocation of resources.
- e) The Timing Advance parameter is updated every 550m.
- f) Edge encodes two bits on a symbol.

UMTS

- a) UMTS uses Code Division Multiple Access for data transmission.
- b) The spreading-codes used by the user equipments have to be orthogonal.
- c) The user equipments have to know all spreading-codes which are used within a cell.
- d) In the downlink, the base-station uses different power levels for the transmission depending on the distance of the user equipment.

Ad-Hoc Networks

- a) Flooding finds a route from a source to the destination, if a connection between source and destination exists.
- b) AODV is a proactive routing protocol without periodic updates.
- c) AODV prefers the path with the minimum hop count.
- d) OLSR executes the route discovery before a route is requested.
- e) OLSR floods link state information periodically across the network.