londonknowledgelab

Mobile and Ubiquitous Computing

Wireless Transmission and Mobility

Modulation, MAC and IPv6

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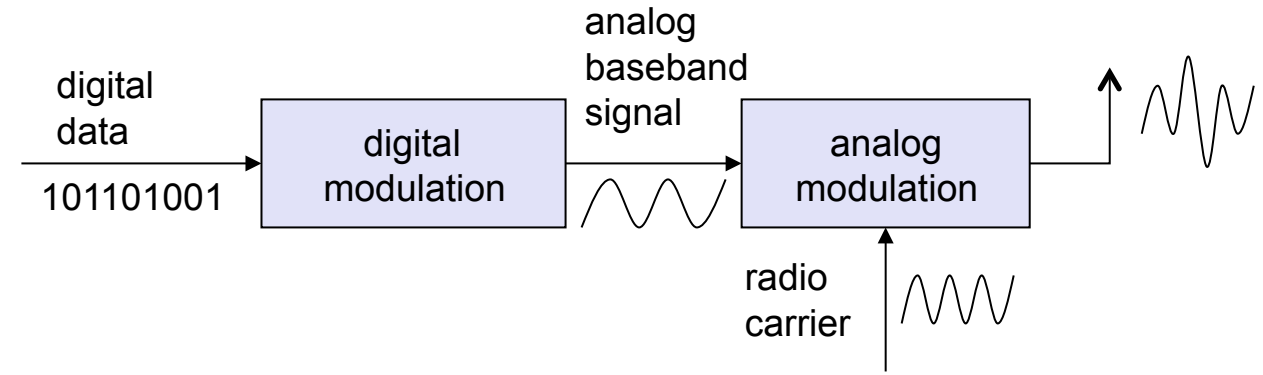
UIDCenter

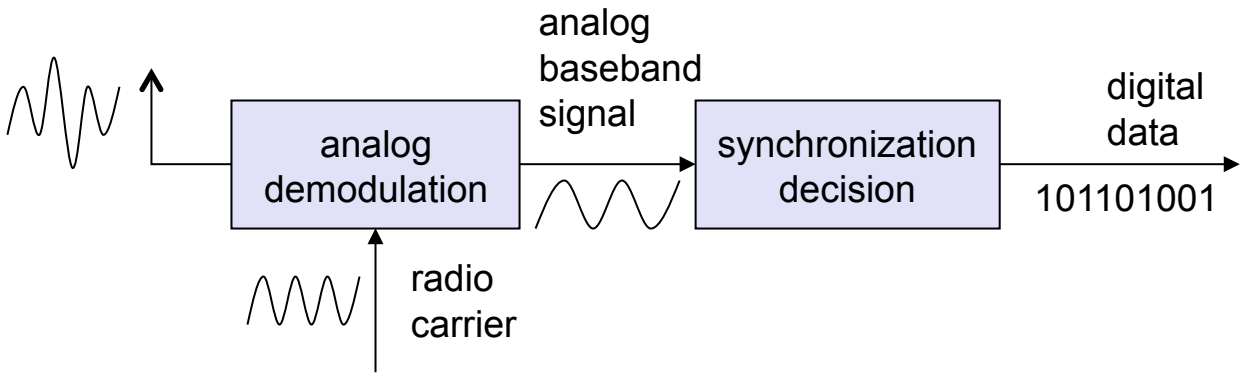
Modulation

- Digital modulation
  - digital data is translated into an analog signal (baseband)
  - ASK, FSK, PSK
  - differences in spectral efficiency, power efficiency, robustness

Modulation and demodulation



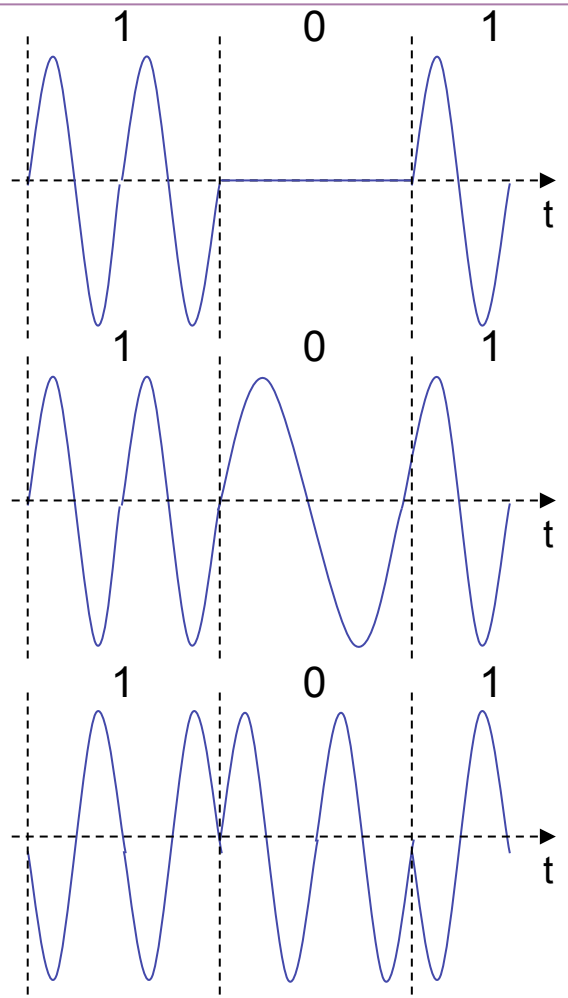
radio transmitter



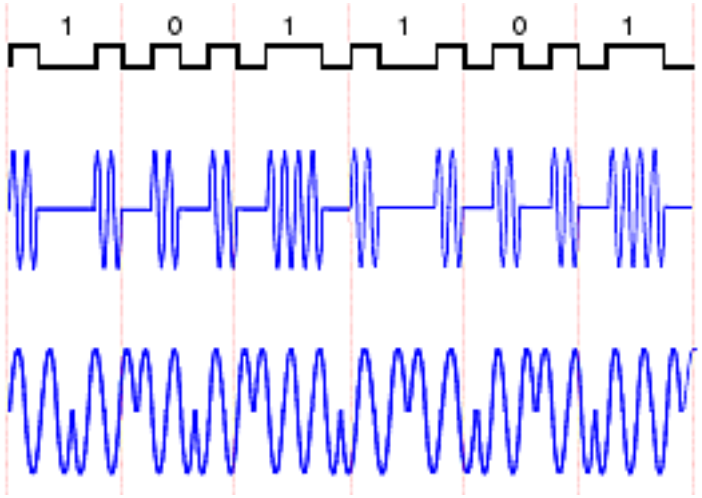
radio receiver

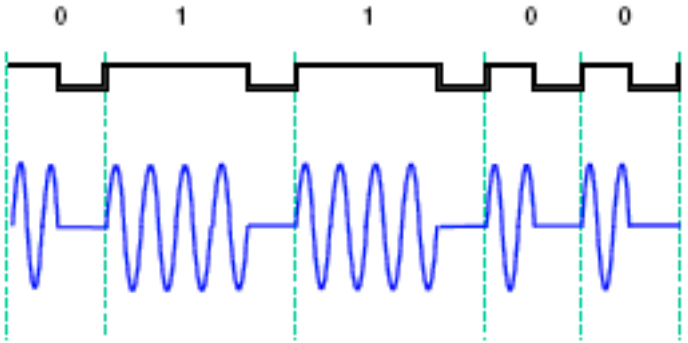
Digital modulation

- Modulation of digital signals known as Shift Keying
- Amplitude Shift Keying (ASK)
- Frequency Shift Keying (FSK)
- Phase Shift Keying (PSK)



Example (RFID)





Motivation

- Can we apply media access methods from fixed networks?

- Example CSMA/CD
  - **C**arrier **S**ense **M**ultiple **A**ccess with **C**ollision **D**etection
  - send as soon as the medium is free, listen into the medium if a collision occurs (original method in IEEE 802.3)
- Problems in wireless networks
  - signal strength decreases proportional to the square of the distance
  - the sender would apply CS and CD, but the collisions happen at the receiver
  - it might be the case that a sender cannot “hear” the collision, i.e., CD does not work
  - furthermore, CS might not work if, e.g., a terminal is “hidden”

Motivation - hidden and exposed terminals

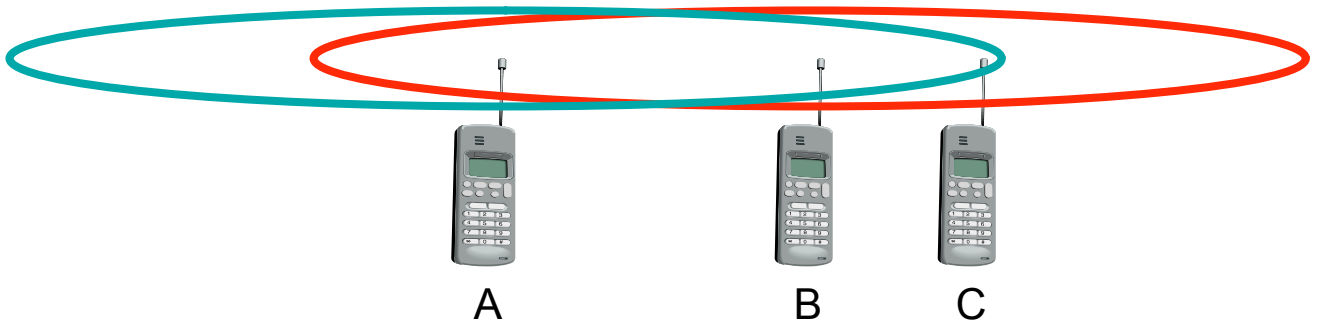
- Hidden terminals
  - A sends to B, C cannot receive A
  - C wants to send to B, C senses a “free” medium (CS fails)
  - collision at B, A cannot receive the collision (CD fails)
  - A is “hidden” for C

A B C

- Exposed terminals
  - B sends to A, C wants to send to another terminal (not A or B)
  - C has to wait, CS signals a medium in use
  - but A is outside the radio range of C, therefore waiting is not necessary
  - C is “exposed” to B

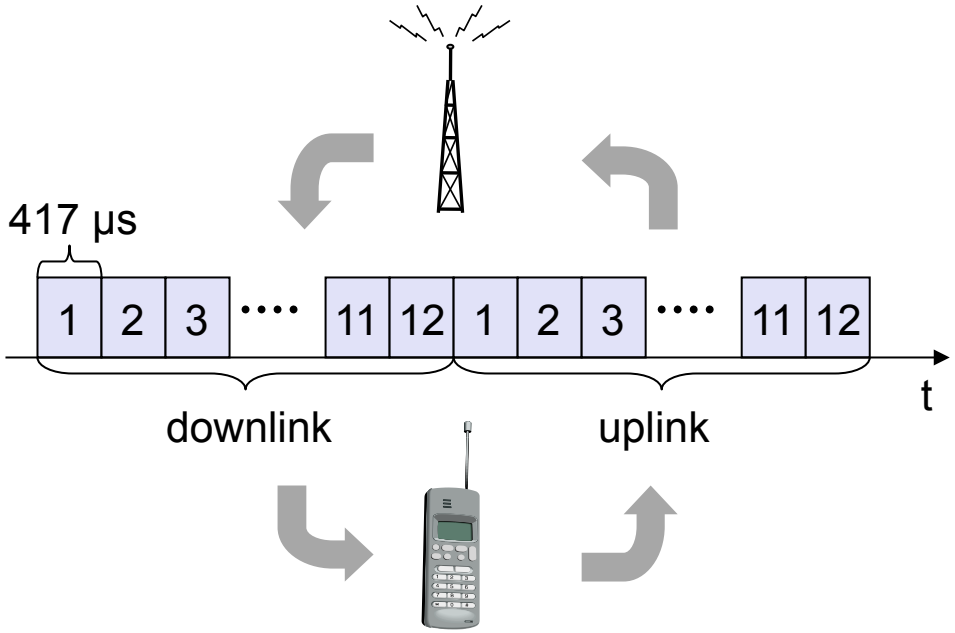
Motivation - near and far terminals

- Terminals A and B send, C receives
  - signal strength decreases proportional to the square of the distance
  - the signal of terminal B therefore drowns out A's signal
  - C cannot receive A



- If C for example was an arbiter for sending rights, terminal B would drown out terminal A already on the physical layer
- Also severe problem for CDMA-networks - precise power control needed!

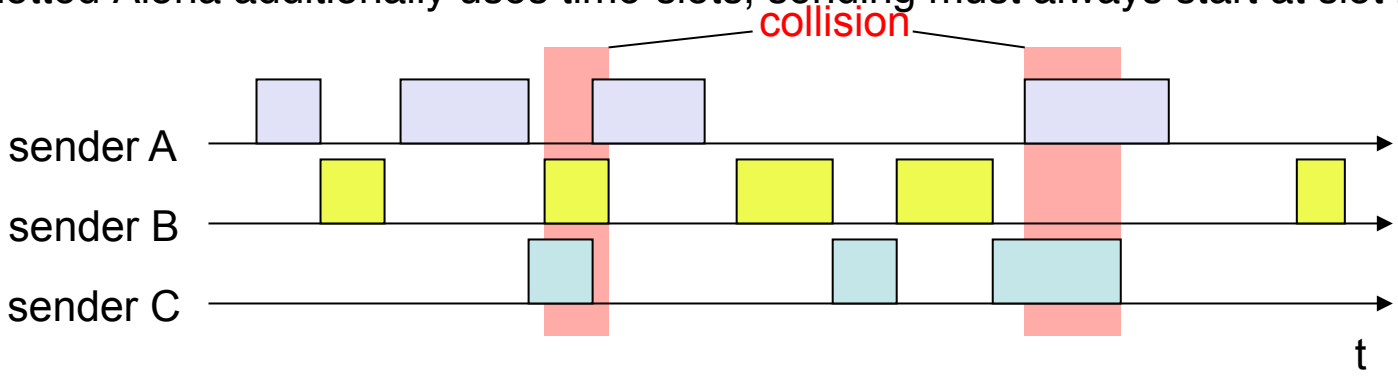
TDD/TDMA - general scheme



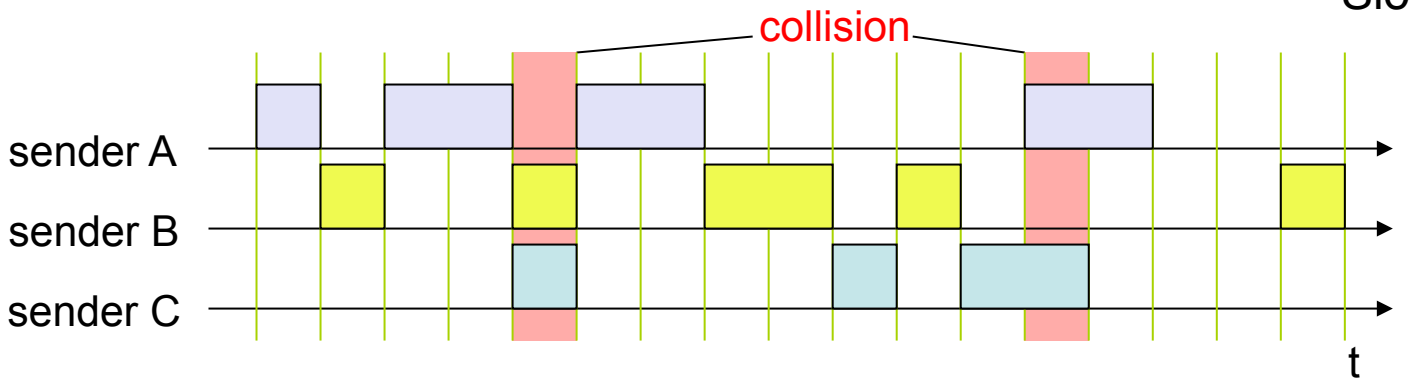
Aloha/slotted aloha

- Mechanism
  - random, distributed (no central arbiter), time-multiplex
  - Slotted Aloha additionally uses time-slots, sending must always start at slot boundaries

- Aloha



- Slotted Aloha

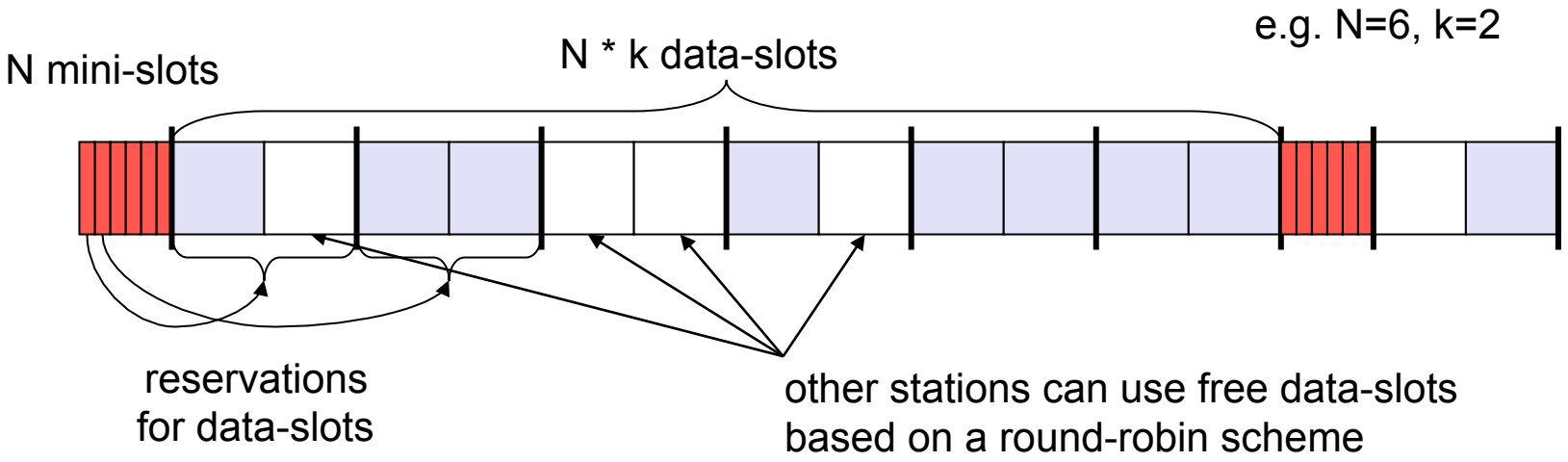


DAMA - Demand Assigned Multiple Access

- Channel efficiency only 18% for Aloha, 36% for Slotted Aloha (assuming Poisson distribution for packet arrival and packet length)
- Reservation can increase efficiency to 80%
  - a sender *reserves* a future time-slot
  - sending within this reserved time-slot is possible without collision
  - reservation also causes higher delays
  - typical scheme for satellite links
- Examples for reservation algorithms:
  - *Explicit Reservation*
  - *Implicit Reservation (PRMA)*
  - *Reservation-TDMA*

Access method DAMA: Reservation-TDMA

- Reservation Time Division Multiple Access
  - every frame consists of N mini-slots and x data-slots
  - every station has its own mini-slot and can reserve up to k data-slots using this mini-slot (i.e. x = N * k).
  - other stations can send data in unused data-slots according to a round-robin sending scheme (best-effort traffic)



Mobility: Location Based Computing

- How to take into account the location of the host and the user
  - to access resources nearest to you
    - more relevant, better performance
    - local restaurant, closer data servers
  - to modify the operation of software e.g. discover new services available localy
- Technology: many different depending on
  - wireless system used, indoor-outdoor, type of location needed
  - GPS, location tags, vision, triangulation etc
- A whole session will be on this!

Mobility: Migration

- Device
  - start work on a PDA and continue on a phone
  - processes, data, state
- Location
  - start work on the train and continue at home
  - security, resources, preferred attachement
- Context
  - use the same resource to work and then to entertain
  - cost, security, resources, identity

Motivation for Mobile IP

- Routing
  - based on IP destination address, network prefix (e.g. 129.13.42) determines physical subnet
  - change of physical subnet implies change of IP address to have a topological correct address (standard IP) or needs special entries in the routing tables
  - TCP connections break, security problems

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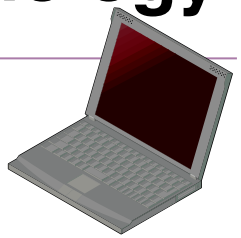
Motivation for Mobile IP

- Specific routes to end-systems?
  - change of all routing table entries to forward packets to the right destination
  - does not scale with the number of mobile hosts and frequent changes in the location, security problems
- Changing the IP-address?
  - adjust the host IP address depending on the current location
  - almost impossible to find a mobile system, DNS updates take to long time
  - TCP connections break, security problems

Requirements to Mobile IP

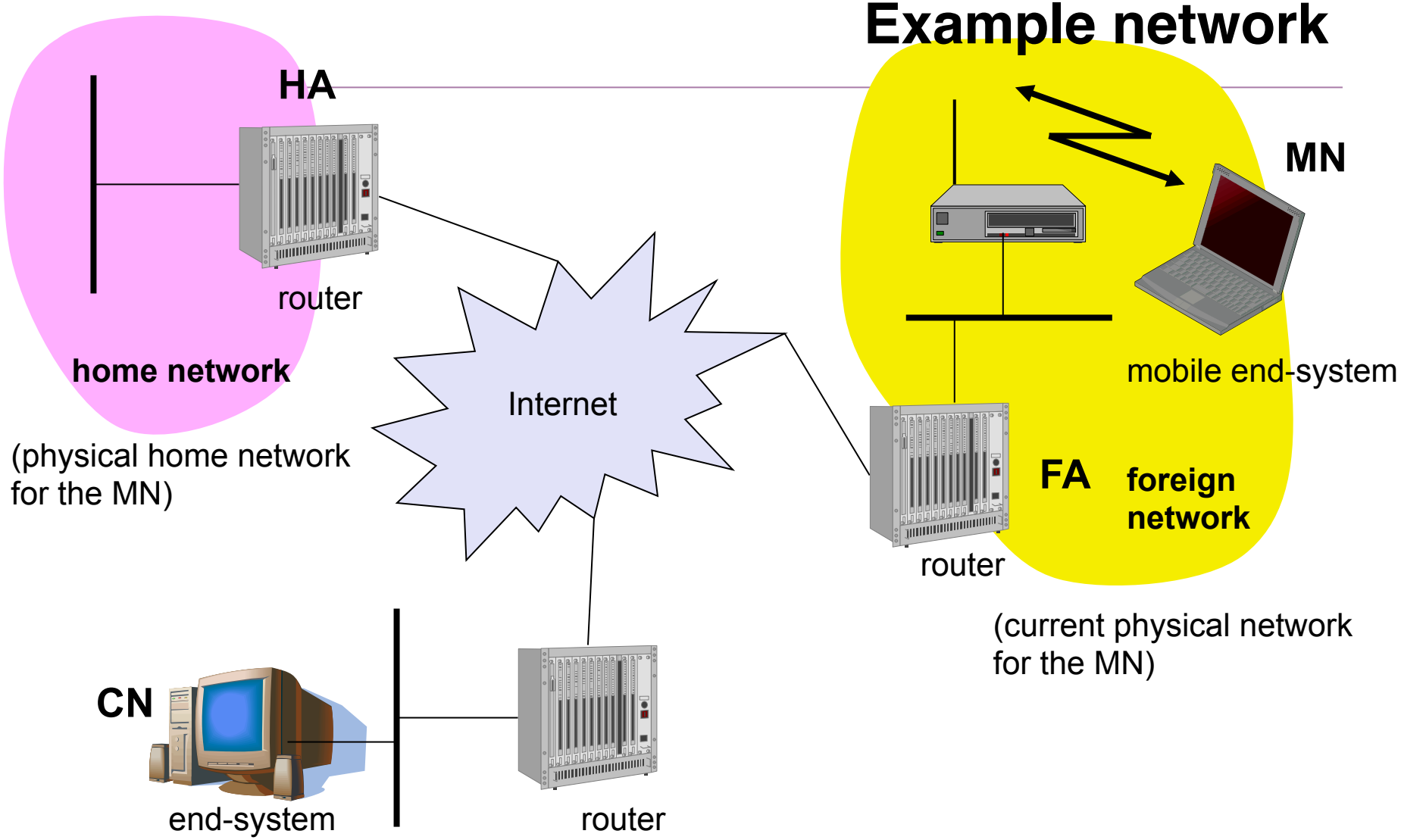
- Transparency
  - mobile end-systems keep their IP address
  - continuation of communication after interruption of link possible
  - point of connection to the fixed network can be changed
- Compatibility
  - support of the same layer 2 protocols as IP
  - no changes to current end-systems and routers required
  - mobile end-systems can communicate with fixed systems
- Security
  - authentication of all registration messages
- Efficiency and scalability
  - only little additional messages to the mobile system required (connection typically via a low bandwidth radio link)
  - world-wide support of a large number of mobile systems in the whole Internet

Terminology

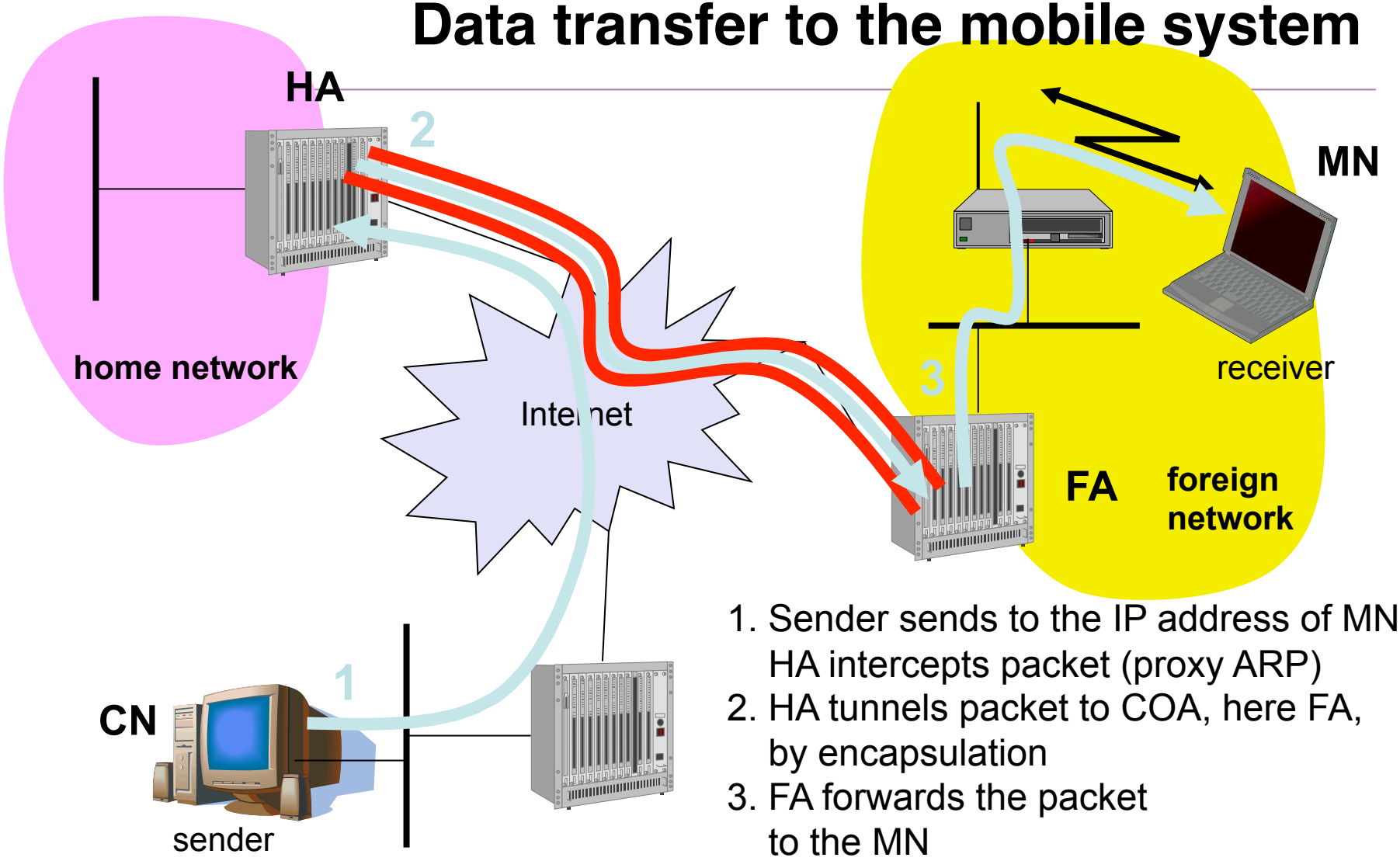


- Mobile Node (MN)
  - system (node) that can change the point of connection to the network without changing its IP address
- Home Agent (HA)
  - system in the home network of the MN, typically a router
  - registers the location of the MN, tunnels IP datagrams to the COA
- Foreign Agent (FA)
  - system in the current foreign network of the MN, typically a router
  - forwards the tunneled datagrams to the MN, typically also the default router for the MN
- Care-of Address (COA)
  - address of the current tunnel end-point for the MN (at FA or MN)
  - actual location of the MN from an IP point of view
  - can be chosen, e.g., via DHCP
- Correspondent Node (CN)
  - communication partner

Example network

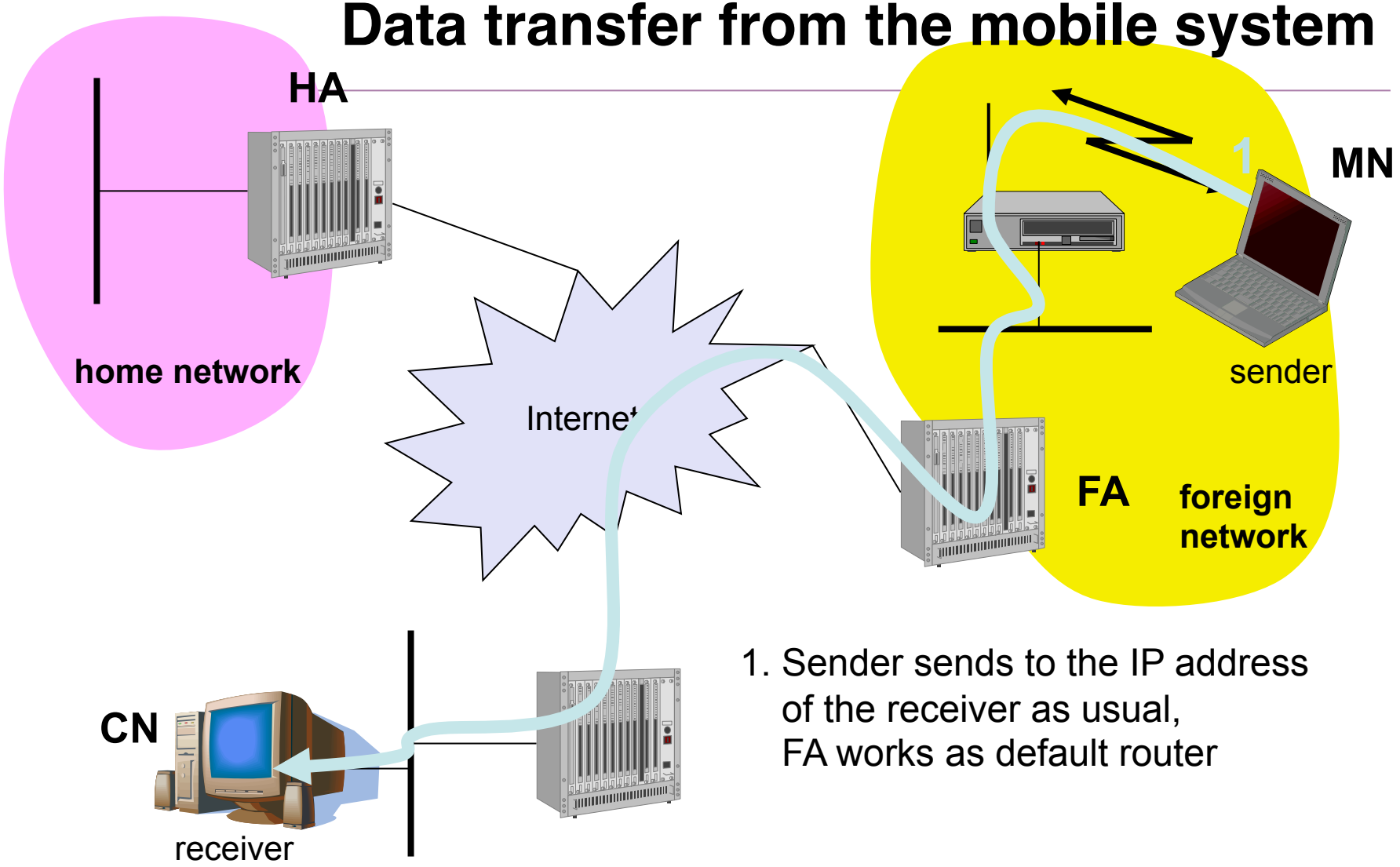


Data transfer to the mobile system



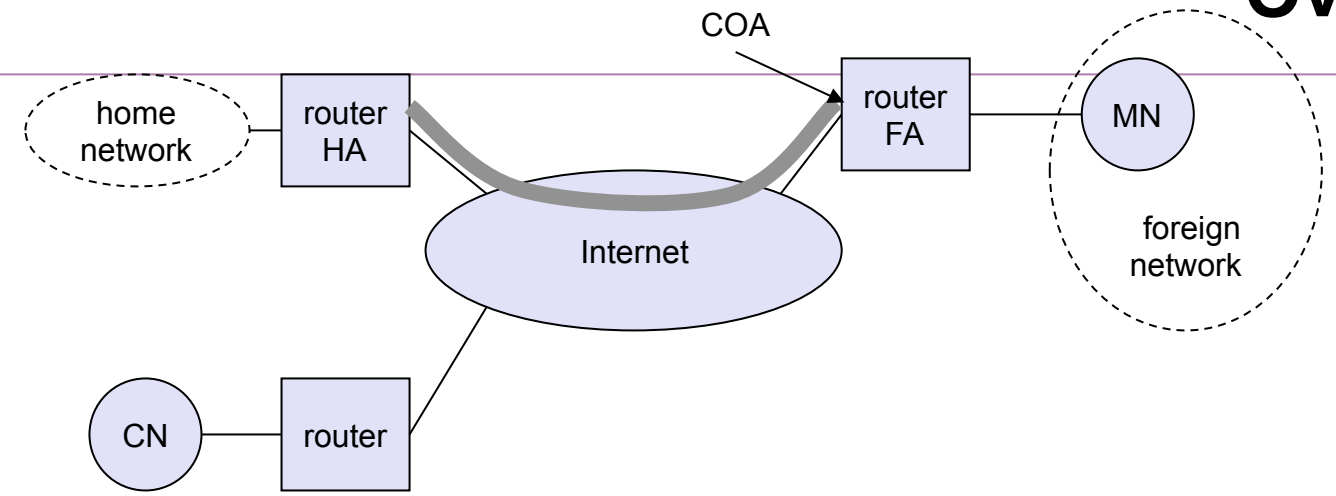
1. Sender sends to the IP address of MN, HA intercepts packet (proxy ARP)
2. HA tunnels packet to COA, here FA, by encapsulation
3. FA forwards the packet to the MN

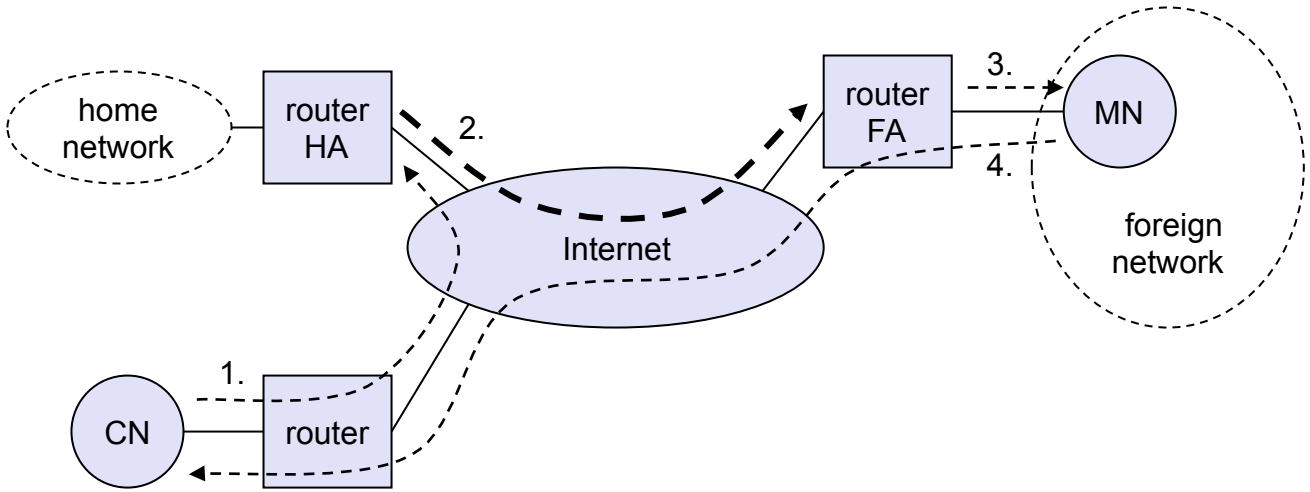
Data transfer from the mobile system



1. Sender sends to the IP address of the receiver as usual, FA works as default router

Overview


COA
home network
router HA
router FA
MN
Internet
foreign network
CN
router


home network
router HA
2.
router FA
3.
MN
4.
Internet
foreign network
1.
CN
router

Network integration

- Agent Advertisement
  - HA and FA periodically send advertisement messages into their physical subnets
  - MN listens to these messages and detects, if it is in the home or a foreign network (standard case for home network)
  - MN reads a COA from the FA advertisement messages
- Registration (always limited lifetime!)
  - MN signals COA to the HA via the FA, HA acknowledges via FA to MN
  - these actions have to be secured by authentication
- Advertisement
  - HA advertises the IP address of the MN (as for fixed systems), i.e. standard routing information
  - routers adjust their entries, these are stable for a longer time (HA responsible for a MN over a longer period of time)
  - packets to the MN are sent to the HA,
  - independent of changes in COA/FA