CN-Advanced
L42

Mobility in Cellular Networks

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Resources Acknowledgement

Chapter 6
Wireless and
Mobile Networks

Computer Networking: A Top Down Approach
6th edition
Jim Kurose, Keith Ross
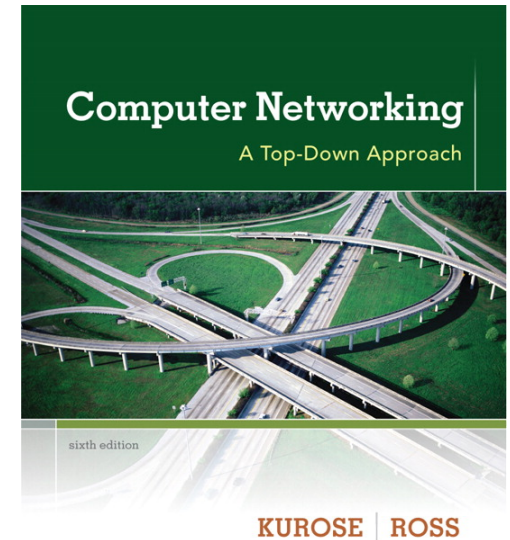Addison-Wesley
March 2012

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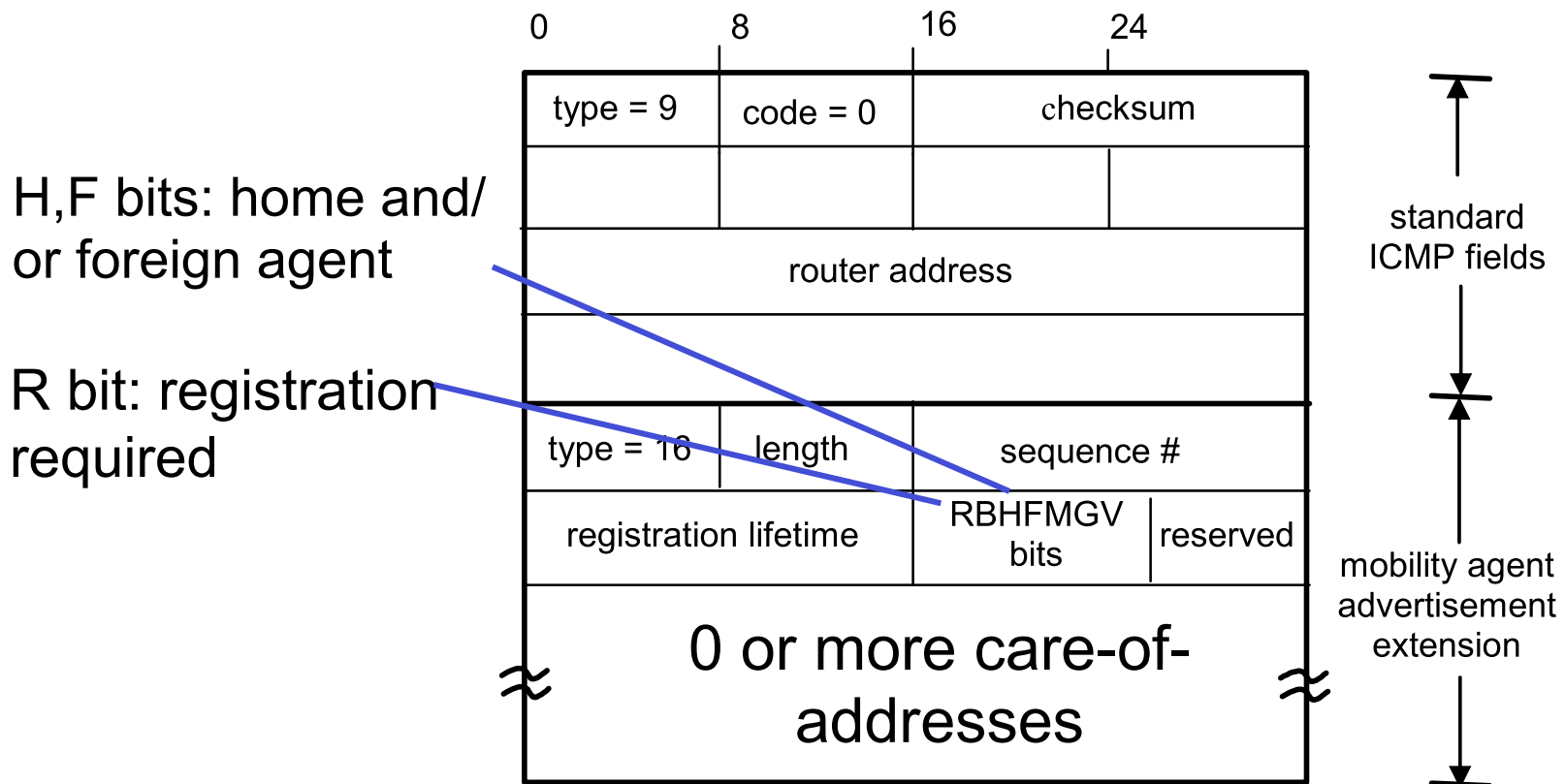
Thanks and enjoy! JFK/KWR

Mobile IP: agent discovery

- *Agent advertisement:* foreign/home agents advertise service by broadcasting ICMP messages (typefield = 9)

H,F bits: home and/or foreign agent

R bit: registration required

0	8	16	24
type = 9	code = 0	checksum	
router address			
type = 16	length	sequence #	
registration lifetime		RBHFMGV bits	reserved
0 or more care-of-addresses			

standard ICMP fields

mobility agent advertisement extension

Mobile IP: agent discovery

- Flag Bits
    - B - Agent is busy, can't take any more registrations
    - H - identifies agent as home agent
    - F - identifies agent as foreign agent
    - R - registration of mobile node required with FA
    - M - Minimal encapsulation supported
    - G - GRE Tunnel
    - r - reserved
    - T - foreign agent supports reverse tunneling
    - X - mobile node support registration revocation

Mobile IP: agent discovery

- Agent Solicitation
    - Mobile node does not want to wait for router advt.
    - TTL is set to 1
    - similar to ICMP Router solicitation
        - ICMP Type = 10
    - must be implemented by a mobile node
    - used when CoA can't be determined thru link layer
    - initial rate: max rate of 1 per sec up to 3 solicitations
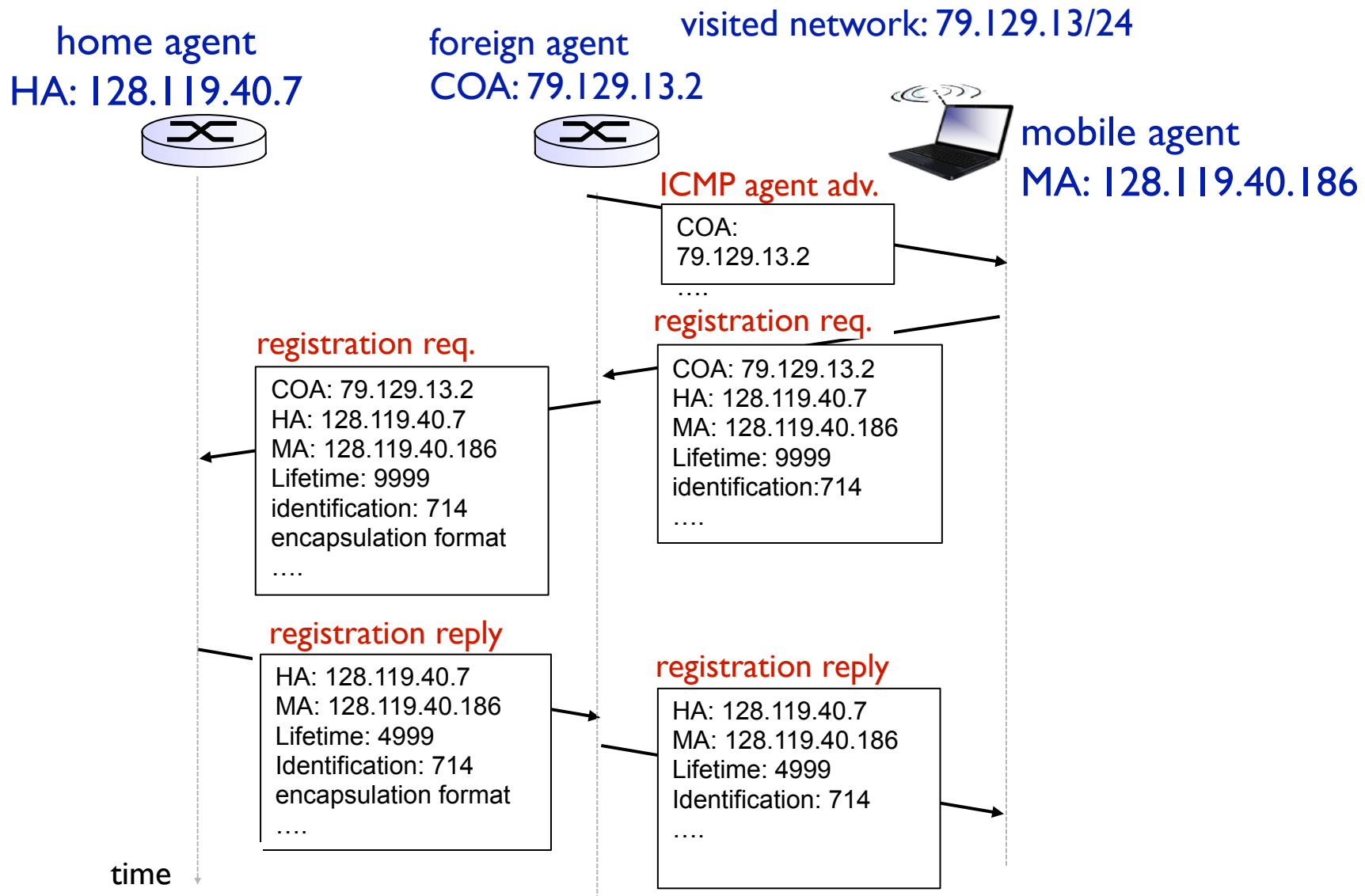   - rate reduced subsequently using exponential binary backoff

Mobile IP: Move Detection

- Move Detection by Mobile Agent
- Algo 1
    - makes use of lifetime value in registration msg.
    - time expires and no regisgration renewal
- Algo 2
    - makes use of network prefixes
    - when new agent advt. has different n/w prefixes
    - implies node movement
- Mobile node should do registration with new agent
- Returning home
    - when receive agent advertisement from home agent
    - de-registers with home agent

Mobile IP: Registration

- Registration overview
  - when using FA's CoA
    - register via that CoA (i.e. FA)
  - when using Co-located CoA, but receives agent advt. with R bit set
    - register via that FA
  - when using co-located CoA otherwise
    - register directly with HA
  - when returned to home network
    - deregister with HA
- Registration messages
  - registration request and registration reply
- Example: next slide

Mobile IP: registration example

home agent
HA: 128.119.40.7

foreign agent
COA: 79.129.13.2

visited network: 79.129.13/24

mobile agent
MA: 128.119.40.186

ICMP agent adv.

COA:
79.129.13.2
….

registration req.

COA: 79.129.13.2
HA: 128.119.40.7
MA: 128.119.40.186
Lifetime: 9999
identification:714
….

registration req.

COA: 79.129.13.2
HA: 128.119.40.7
MA: 128.119.40.186
Lifetime: 9999
identification: 714
encapsulation format
….

registration reply

HA: 128.119.40.7
MA: 128.119.40.186
Lifetime: 4999
Identification: 714
encapsulation format
….

registration reply

HA: 128.119.40.7
MA: 128.119.40.186
Lifetime: 4999
Identification: 714
….

time

Mobile IP: Routing

- Encapsulation
  - Must support
    - IP in IP (RFC 2003)
  - Alternative encapsulations
    - Minimal encapsulation within IP: RFC 2004
    - GRE tunnel: RFC 2784

Mobile IP: Routing at Mobile Node

- Receiving broadcasts
  - HA will send Broadcast when MN specifies so during registration
- Receiving Multicasts
  - MN joins the multicast group in foreign network
  - MN sets up bi-directional tunnel

Components of cellular network architecture

recall:

correspondent

wired public telephone network

MSC

MSC

MSC

MSC

MSC

MSC
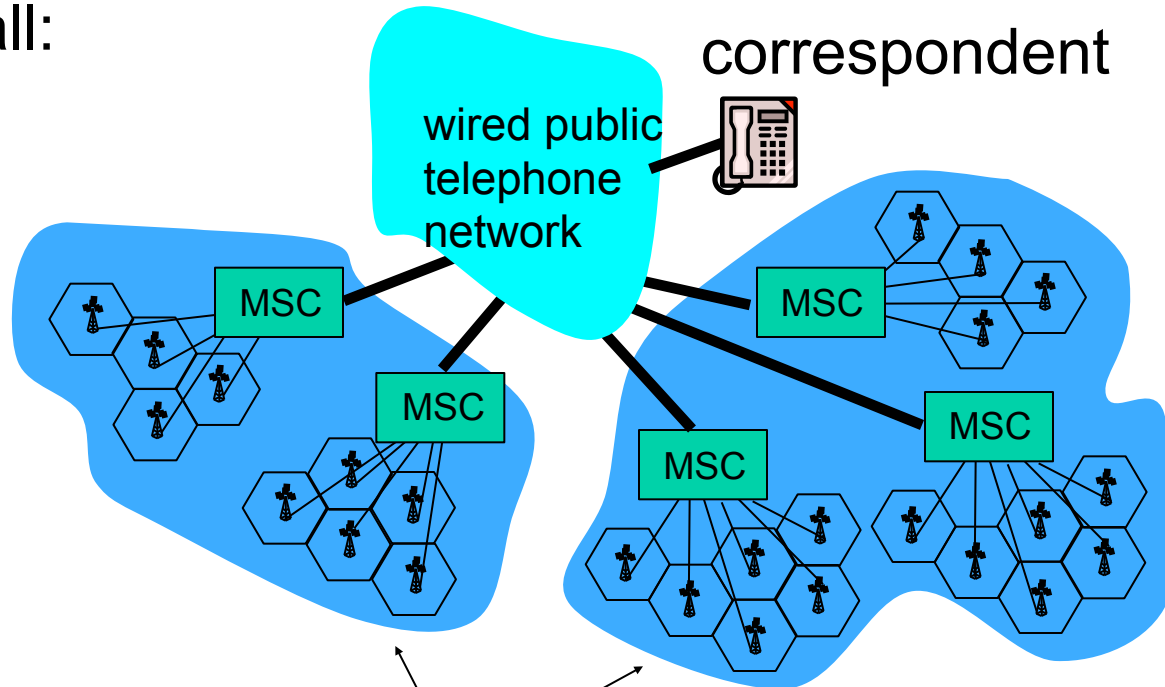
different cellular networks, operated by different providers
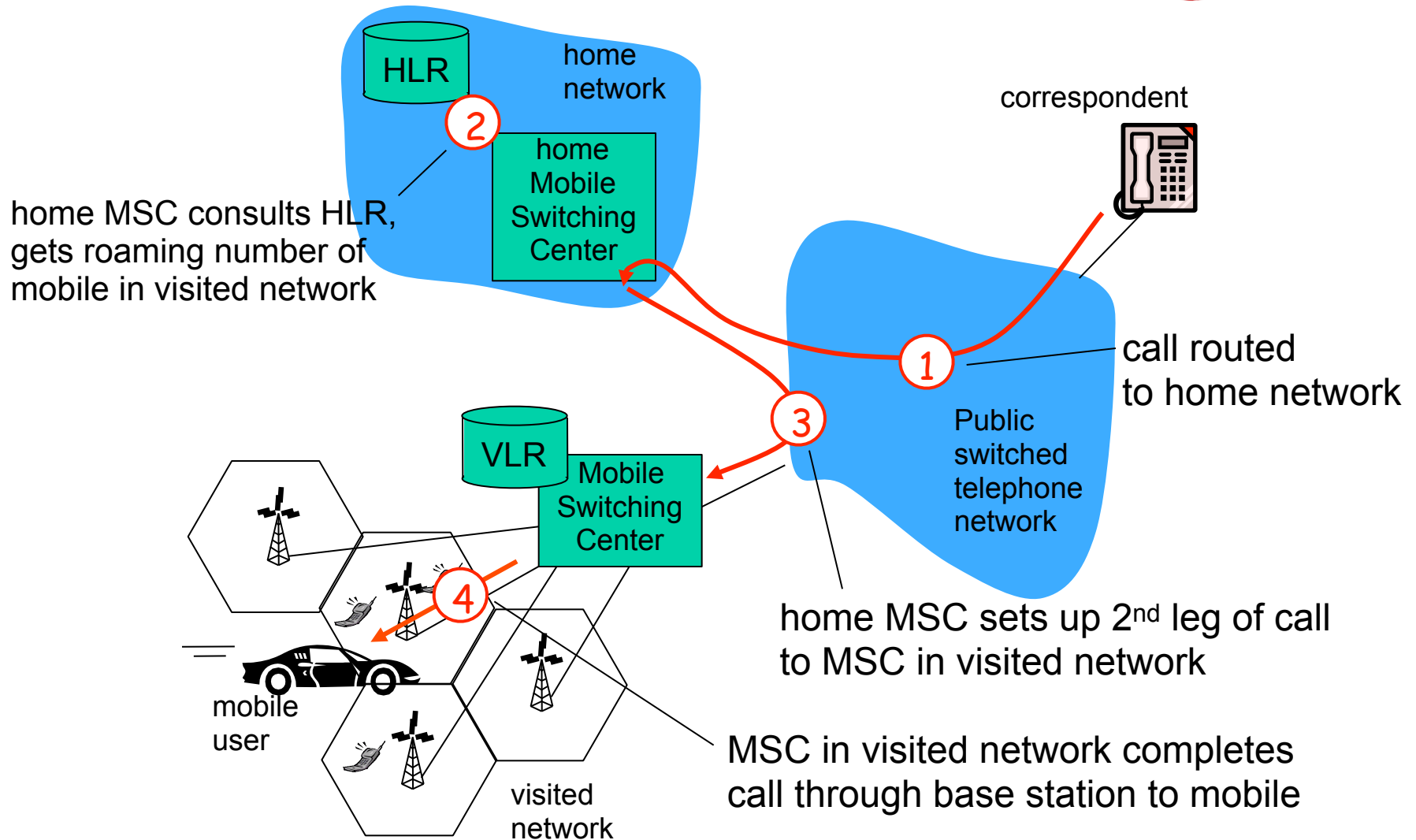
Handling mobility in cellular networks

- Similarities with Mobile IP?
- Call Routing?
  - Indirect or Direct
    - If indirect, is it triangular routing?
- Responsibilities of Home and Visited Networks
- Few Terms
  - PLMN: Public Land Mobile Network
    - home PLMN and visited PLMN
  - HLR
  - VLR

Handling mobility in cellular networks

- *home network:* network of cellular provider you subscribe to (e.g., Airtel, Vodafone, Idea Cellular)
  - *home location register (HLR):* database in home n/w
    - contains permanent cell phone #, profile information (services, preferences, billing), information about current location (could be in another network)
- *visited network:* network in which mobile currently resides
  - *visitor location register (VLR):* database with entry for each user currently in network
  - could be home network
    - contains info even when you are in home network
  - Generally, co-located with MSC
  - co-ordinates call setup - to/from visited network

GSM: indirect routing to mobile

home network — HLR

② home MSC consults HLR, gets roaming number of mobile in visited network

home Mobile Switching Center

correspondent

① call routed to home network

Public switched telephone network

③ VLR — Mobile Switching Center

home MSC sets up 2nd leg of call to MSC in visited network

④ mobile user

visited network

MSC in visited network completes call through base station to mobile

Q: Return path?

GSM: indirect routing to mobile

- How does HLR gets info about VLR
  - MS moves to visited network
  - MS registers itself with VLR
  - VLR sends LU (Location Update) msg to HLR
    - contains either routing number (MSRN)
    - or VLR address
      - used later to obtain MSRN
  - VLR also obtains the subscriber information
   - which services can be offered to MS

# GSM: handoff with common MSC

What is Handoff ?
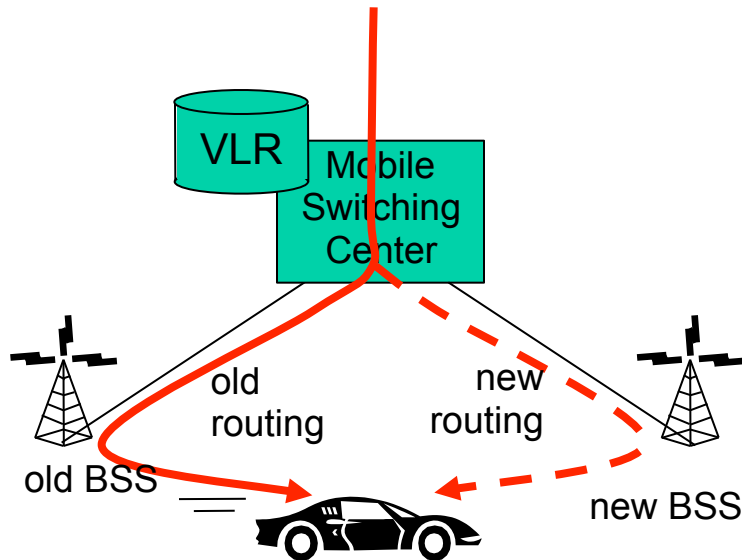
- *handoff goal:* route call via new base station (without interruption)

- reasons for handoff:
  - stronger signal to/from new BSS (continuing connectivity, less battery drain)
  - load balance: free up channel in current BSS
  - GSM doesn't mandate why to perform handoff (policy), only how (mechanism)

- handoff initiated by old BSS

GSM: handoff with common MSC
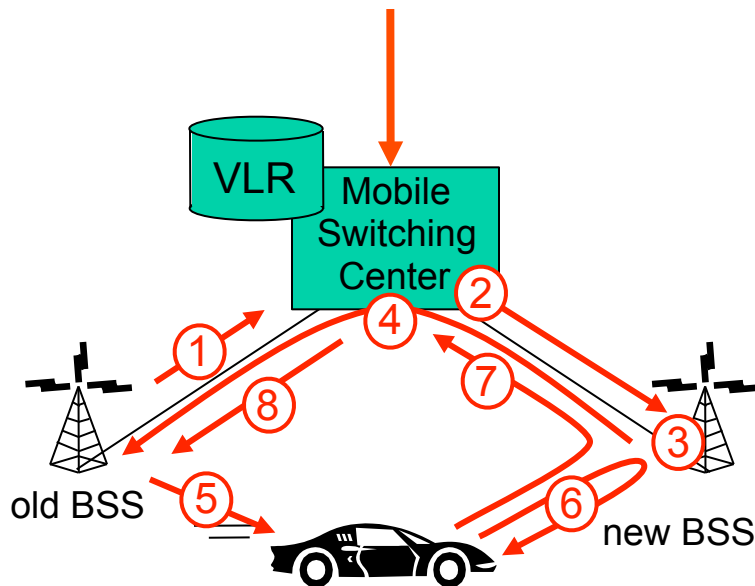
1. old BSS informs MSC of impending handoff, provides list of 1^+ new BSSs

2. MSC sets up path (allocates resources) to new BSS

3. new BSS allocates radio channel for use by mobile

4. new BSS signals MSC, old BSS: ready

5. old BSS tells mobile: perform handoff to new BSS

6. mobile, new BSS signal to activate new channel

7. mobile signals via new BSS to MSC: handoff complete. MSC reroutes call

8 MSC-old-BSS resources released

GSM: handoff between MSCs
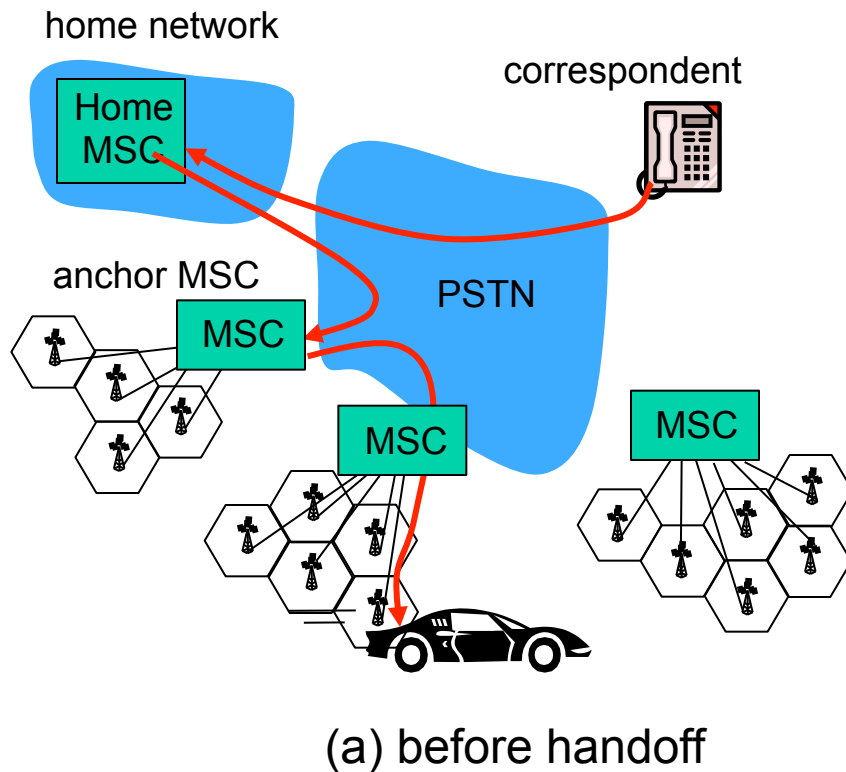
(a) before handoff

- *anchor MSC:* first MSC visited during call
    - call remains routed through anchor MSC
- new MSCs add on to end of MSC chain as mobile moves to new MSC
- optional path minimization step to shorten multi-MSC chain

GSM: handoff between MSCs
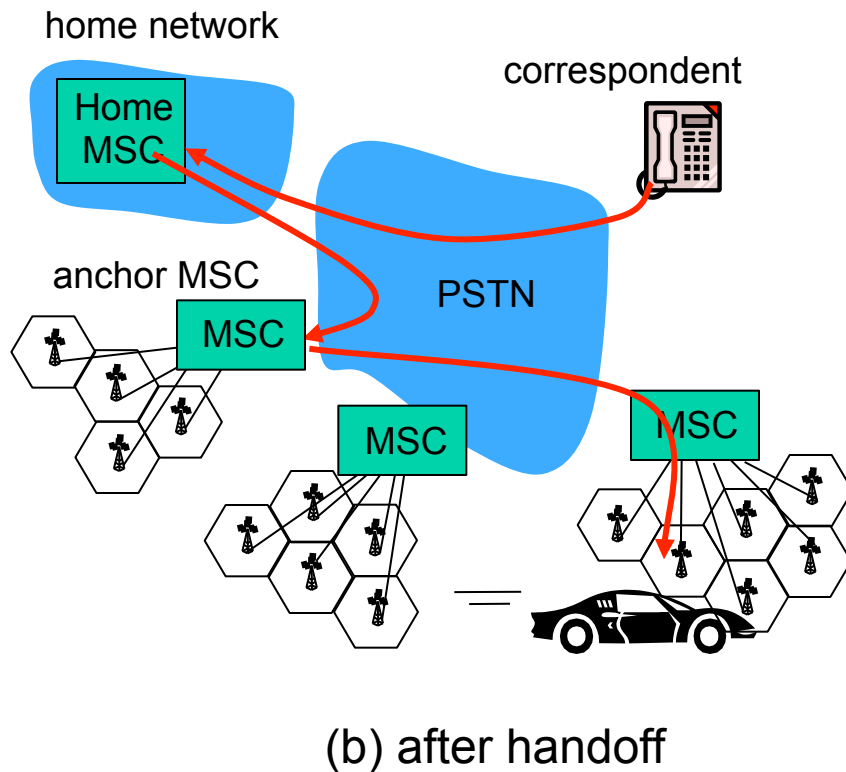
home network

correspondent

anchor MSC

Home MSC

PSTN

MSC

MSC

MSC

(b) after handoff

- *anchor MSC:* first MSC visited during call
  - call remains routed through anchor MSC
- new MSCs add on to end of MSC chain as mobile moves to new MSC
- optional path minimization step to shorten multi-MSC chain

Mobility: GSM versus Mobile IP

GSM element	Comment on GSM element	Mobile IP element
Home system	Network to which mobile user's permanent phone number belongs	**Home network**
Gateway Mobile Switching Center, or "home MSC". Home Location Register (HLR)	Home MSC: point of contact to obtain routable address of mobile user. HLR: database in home system containing permanent phone number, profile information, current location of mobile user, subscription information	**Home agent**
Visited System	Network other than home system where mobile user is currently residing	**Visited network**
Visited Mobile services Switching Center. **Visitor Location Record (VLR)**	Visited MSC: responsible for setting up calls to/from mobile nodes in cells associated with MSC. VLR: temporary database entry in visited system, containing subscription information for each visiting mobile user	**Foreign agent**
Mobile Station Roaming Number (MSRN), or "roaming number"	Routable address for telephone call segment between home MSC and visited MSC, visible to neither the mobile nor the correspondent.	**Care-of-address**

Wireless, mobility: impact on higher layer protocols

- logically, impact *should* be minimal …
  - Changes are only in link layer
  - best effort service model (IP layer) remains unchanged
  - TCP and UDP can (and do) run over wireless, mobile
- … but performance-wise:
  - packet loss/delay due to bit-errors (discarded packets, delays for link-layer retransmissions), and handoff
  - TCP interprets loss as congestion, will decrease congestion window un-necessarily
  - delay impairments for real-time traffic
  - limited bandwidth of wireless links

Wireless, mobility: impact on higher layer protocols

- **Approaches for dealing with TCP Congestion**
  - Local recovery
    - ARQ protocol, FEC for bit errors
  - TCP Sender aware of wireless links
    - invokes congestion control only when
      - loss is due to congestive wired network losses
  - Split connection approaches
    - end to end connection is split into two parts
      - Mobile to Access Point
      - Access point to other communication end point
    - e-to-e connection is catenation of wired & wireless part

Wireless, mobility: impact on higher layer protocols

- **Impact on application layer**
  - logically should have no impact
  - Reality: Consider a web server serving mobile on 3G
    - may not be able to provide content rich images
  - mobility however opens another opportunity
    - location aware services
  - Wireless n/w will play a key role in
    - ubiquitous computing environment of the future
  - We are at tip of the iceberg

Summary - Mobility

- *Mobility*
- principles: addressing, routing to mobile users
- home, visited networks
- direct, indirect routing
- care-of-addresses
- case studies
- mobile IP
- mobility in GSM
- impact on higher-layer protocols