

Networks Lecture 12

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Source of the material

- This lecture is based on the following resources
 - Chapter 7 of Computer Networking: A Top Down Approach (8th edition) by Jim Kurose and Keith Ross
 - The material is aligned and add/deleted according to the need of the students.

Topic of the lecture

- Mobility
- Principles: addressing and routing to mobile users
- Mobile IP
- Handling mobility in cellular networks
- Mobility and higher-layer protocols
- Summary

Topic of the tutorial

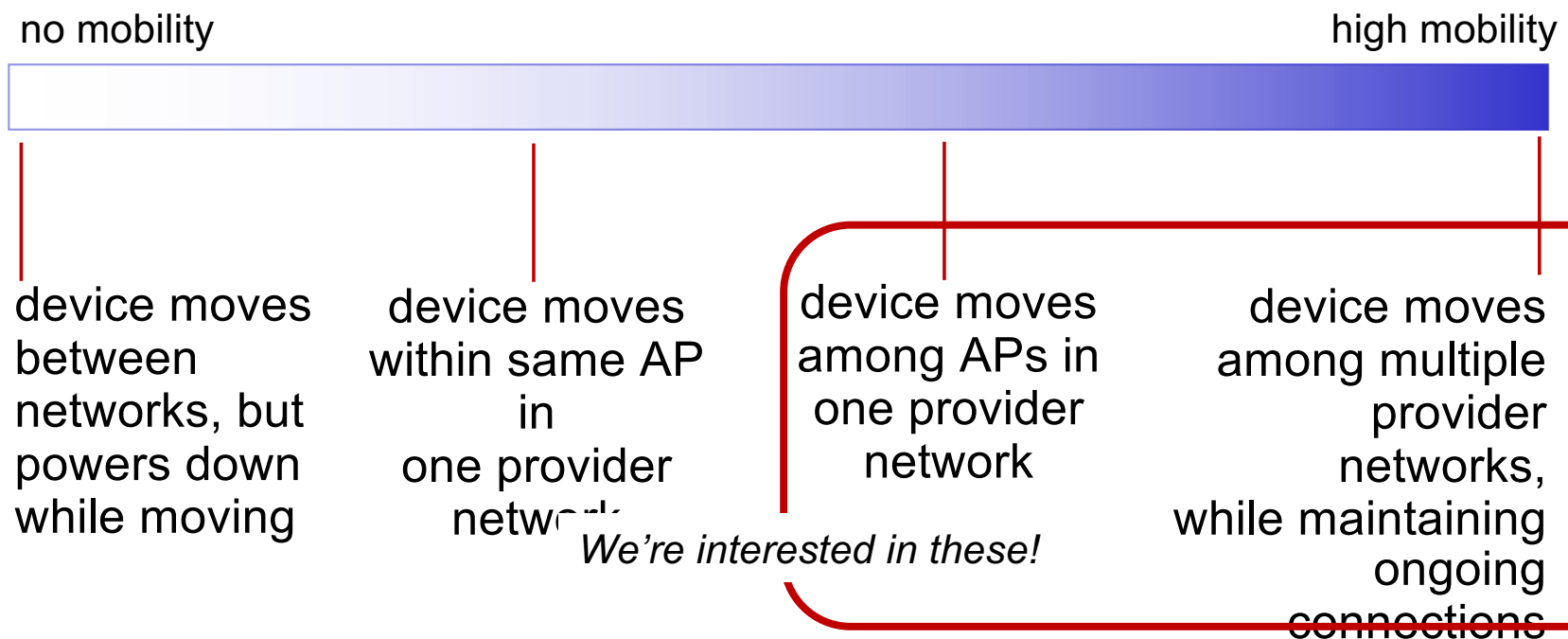
- Recap of the Wireless and Mobile Networks
- Questions & Answers

Topic of the lab

- Continuation of the labs

What is mobility?

- spectrum of mobility, from the **network** perspective:

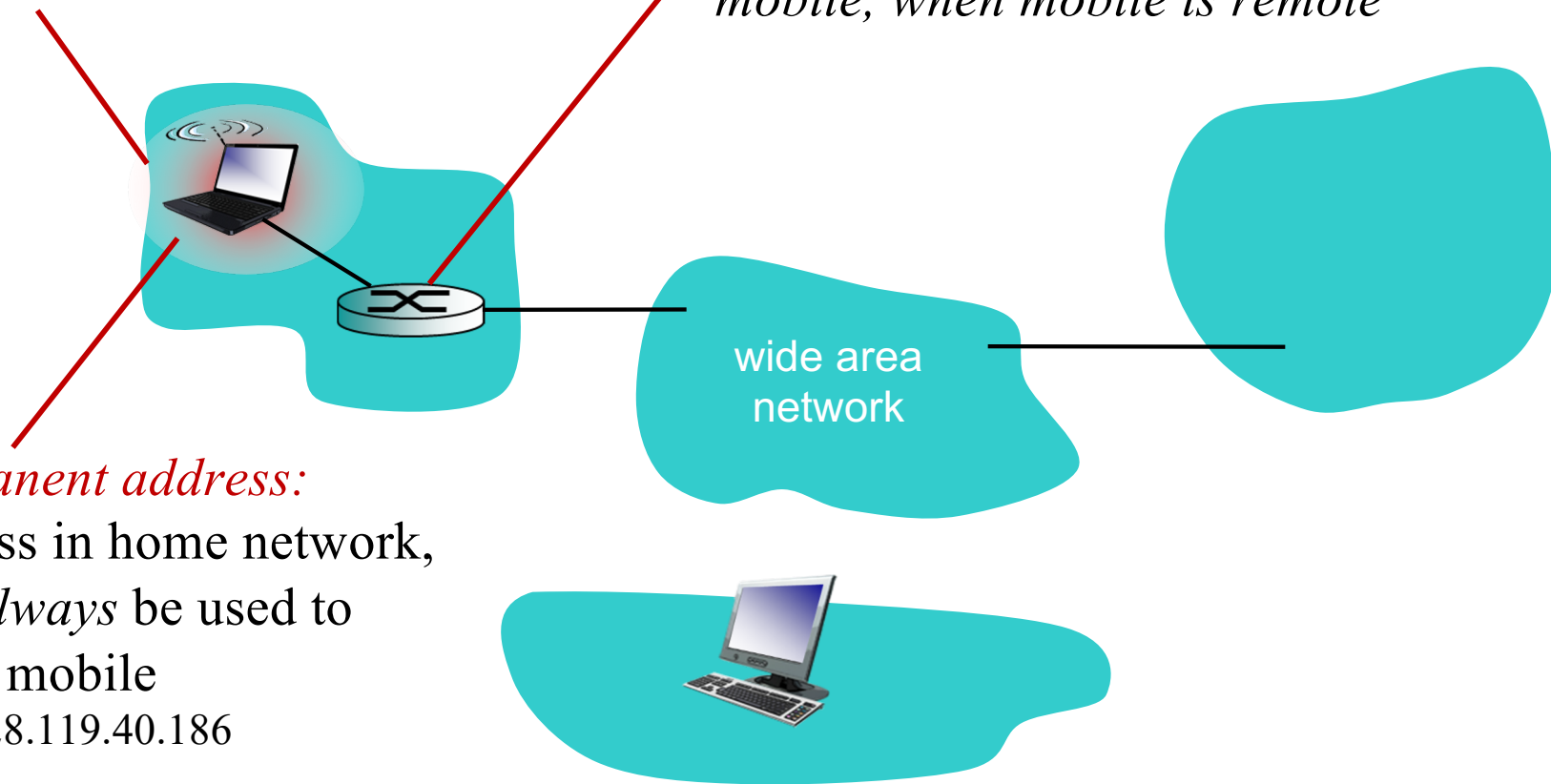


Mobility: Vocabulary

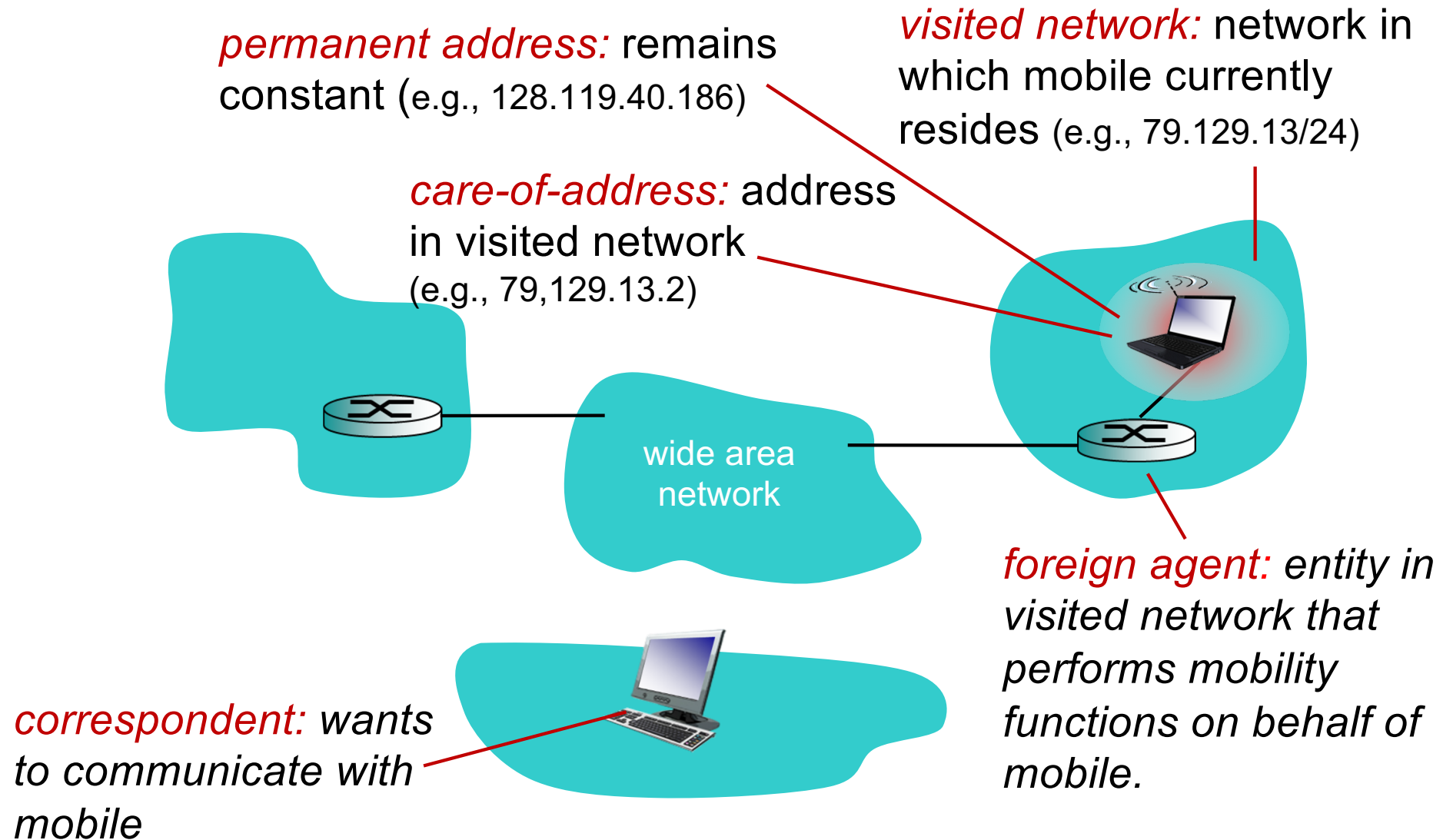
home network: permanent
“home” of mobile
(e.g., 128.119.40/24)

home agent: entity that will perform
mobility functions on behalf of
mobile, when mobile is remote

permanent address:
address in home network,
can always be used to
reach mobile
e.g., 128.119.40.186



Mobility: more vocabulary



How do *you* contact a mobile friend?

Consider friend frequently changing addresses, how do you find her?

- search all phone books?
- call her parents?
- expect her to let you know where she is?



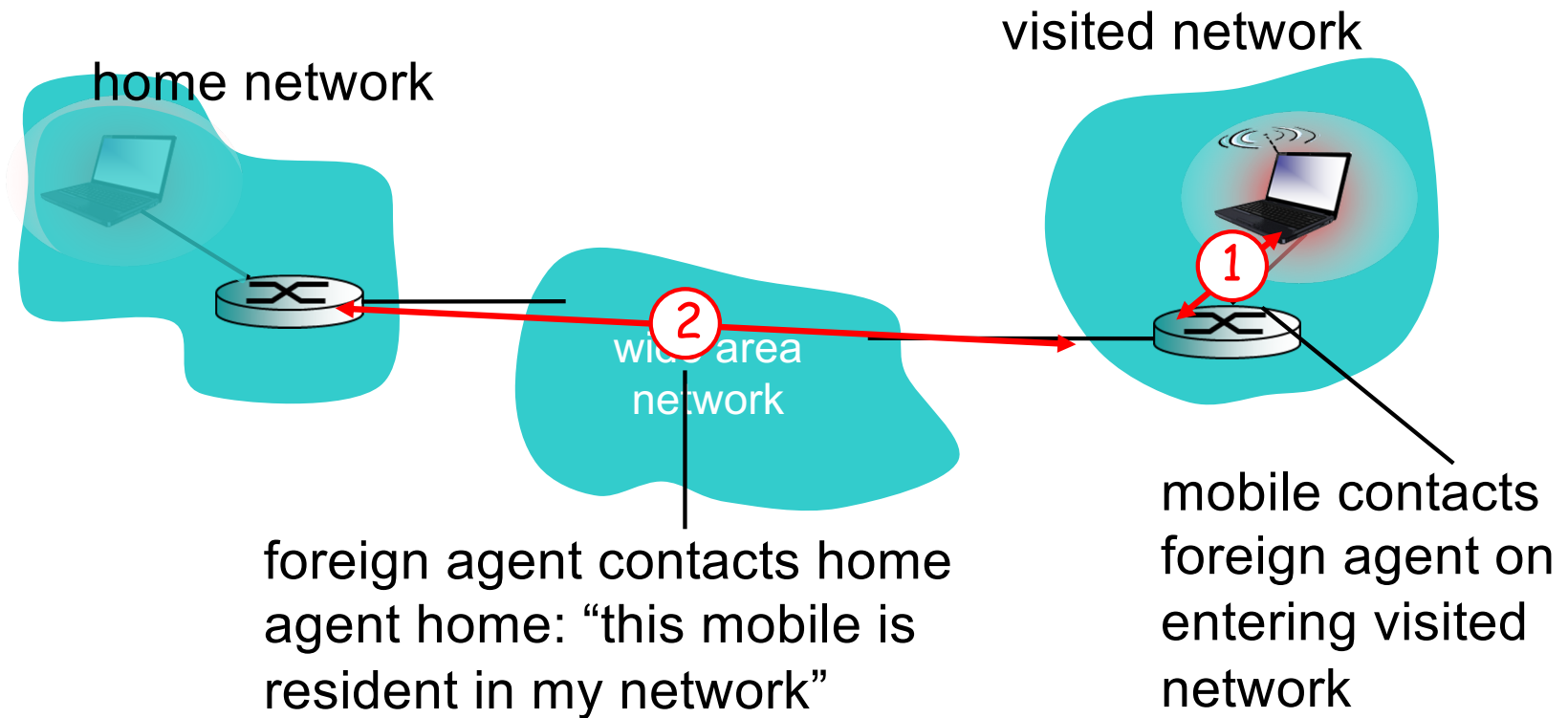
Mobility: Approaches

- *Let routing handle it:* routers advertise permanent address of mobile-nodes-in-residence via usual routing table exchange.
 - routing tables indicate where each mobile located
 - no changes to end-systems
- *Let end-systems handle it:*
 - *indirect routing:* communication from correspondent to mobile goes through home agent, then forwarded to remote
 - *direct routing:* correspondent gets foreign address of mobile, sends directly to mobile

Mobility: Approaches

- *Let routing handle it:* routers advertise permanent address of mobile-nodes-in-residence, equal routing table exchange.
 - routing tables indicate mobile located
 - no changes to end-systems
- not
scalable
to millions of
mobiles
- *Let end-systems handle it:*
 - *indirect routing:* communication from correspondent to mobile goes through home agent, then forwarded to remote
 - *direct routing:* correspondent gets foreign address of mobile, sends directly to mobile

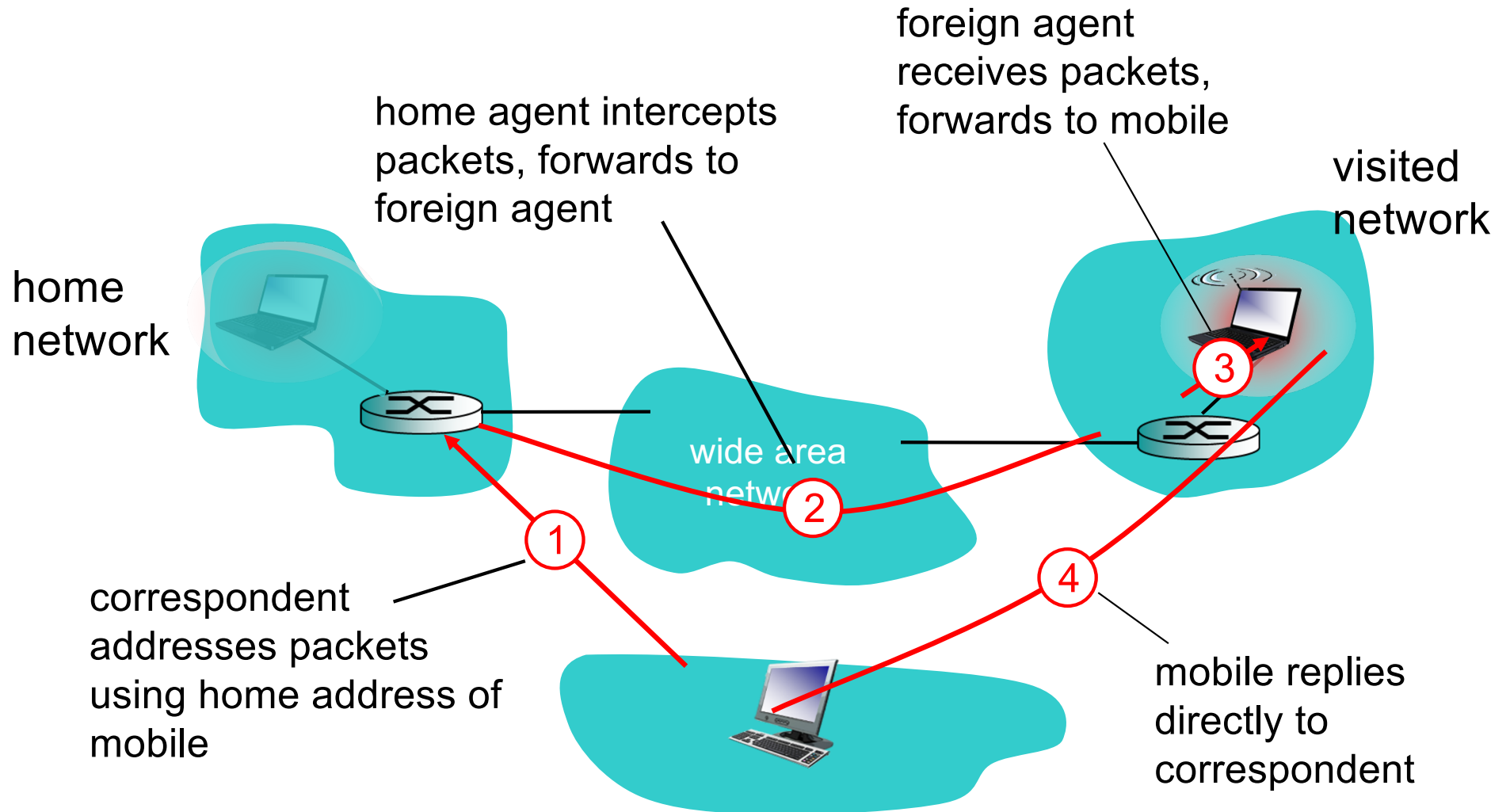
Mobility: Registration



End result:

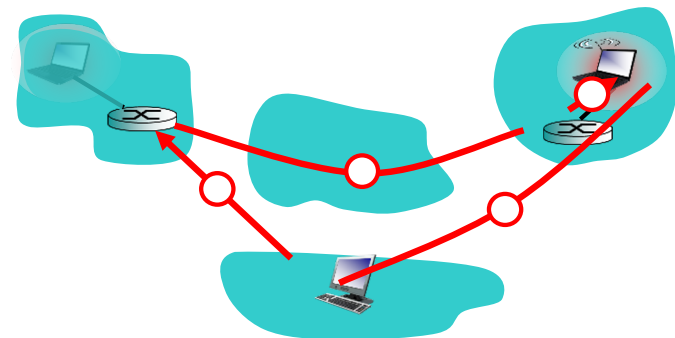
- Foreign agent knows about mobile
- Home agent knows location of mobile

Mobility via Indirect Routing



Indirect Routing: Comments

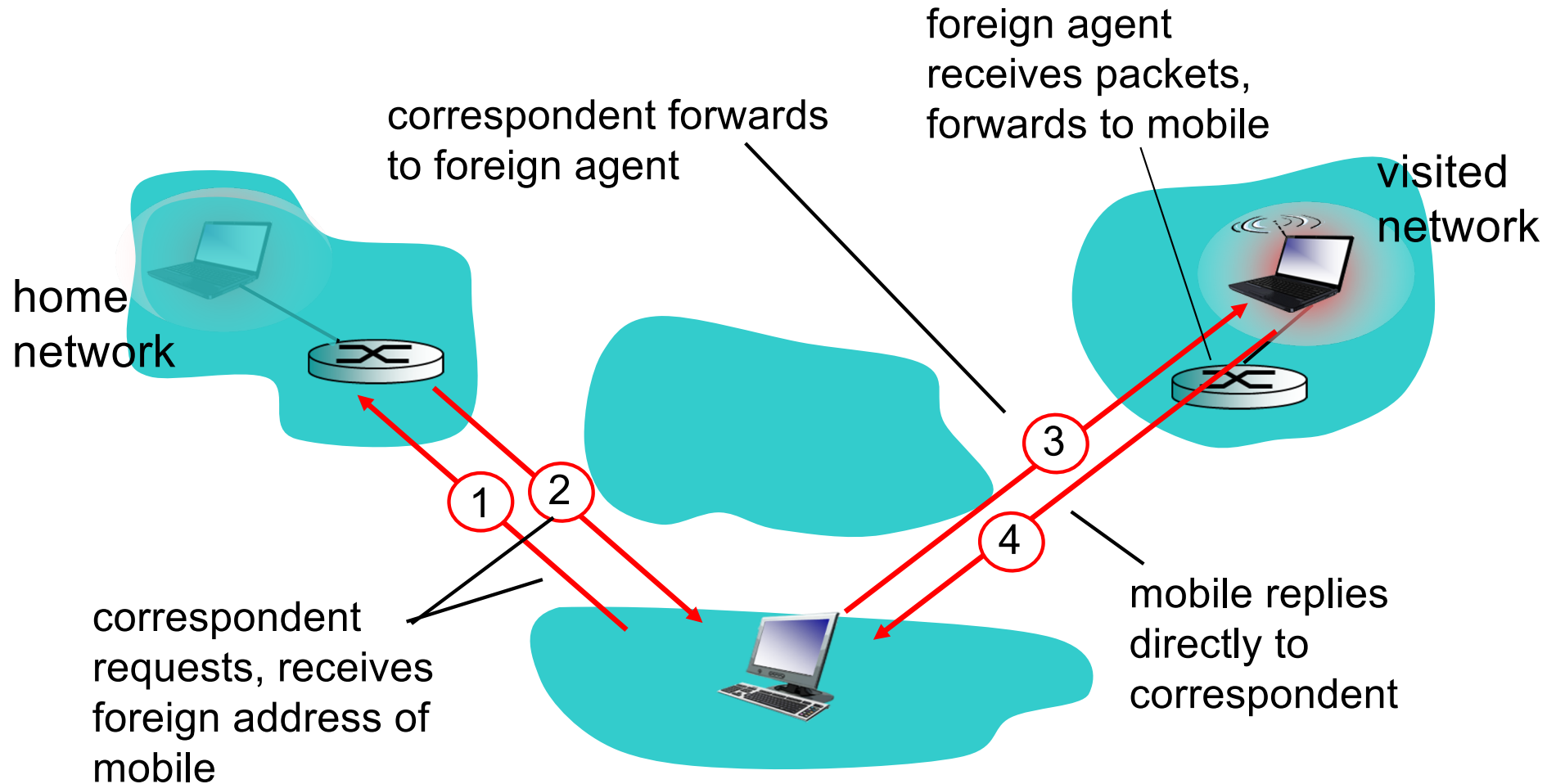
- Mobile uses two addresses:
 - **Permanent address:** used by correspondent (hence mobile location is *transparent* to correspondent)
 - **Care-of-address:** used by home agent to forward datagrams to mobile
- Foreign agent functions may be done by mobile itself
- **Triangle routing problem:** The problem in communication between a fixed host and a mobile host



Indirect Routing: moving between networks

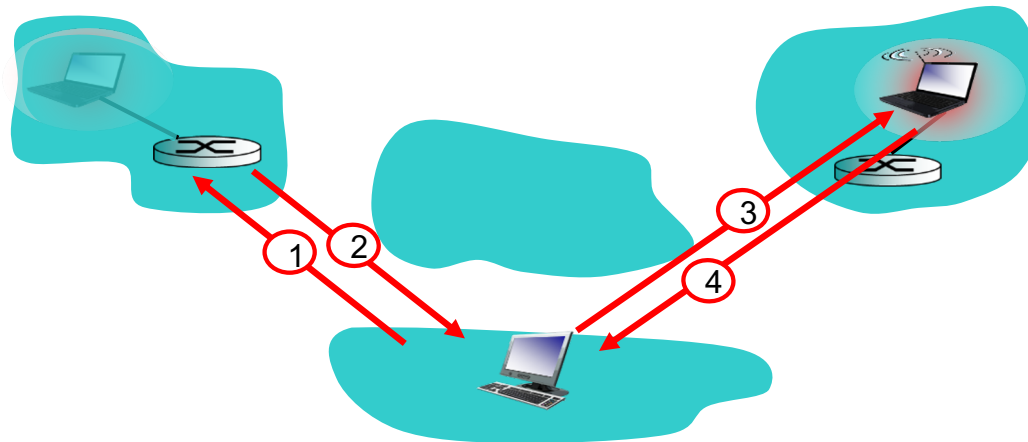
- Suppose a mobile user moves to another network
 - registers with a new foreign agent
 - new foreign agent registers with home agent
 - home agent updates care-of-address for mobile
 - packets continue to be forwarded to mobile (but with new care-of-address)
- Mobility, changing foreign networks transparent:
on going connections can be maintained!

Mobility via Direct Routing



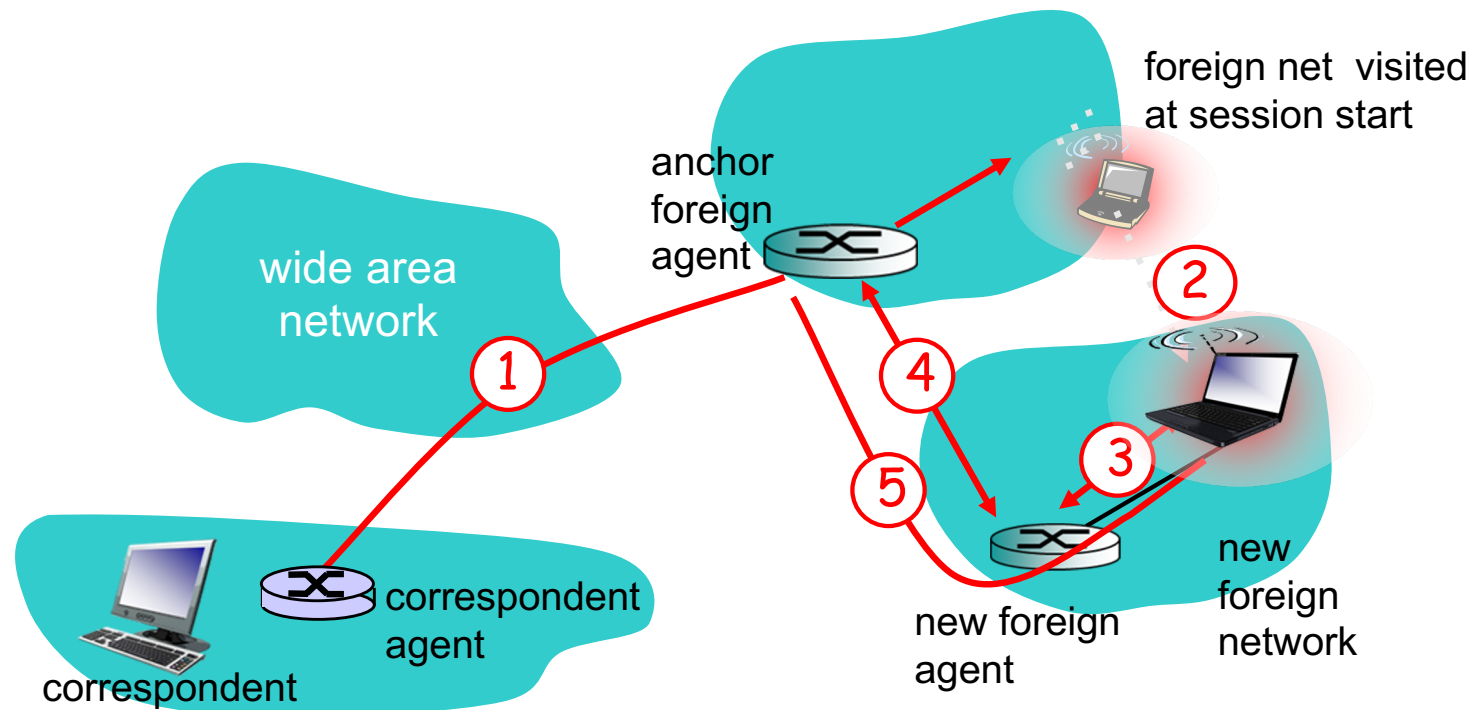
Mobility via Direct Routing: Comments

- Overcome triangle routing problem
- *Non-transparent to correspondent*: correspondent must get care-of-address from home agent
 - What if mobile changes visited network?



Accommodating Mobility with Direct Routing

- Anchor foreign agent: FA in first visited network
- Data always routed first to anchor FA
- When mobile moves: new FA arranges to have data forwarded from old FA (chaining)



FA: Foreign
Agent

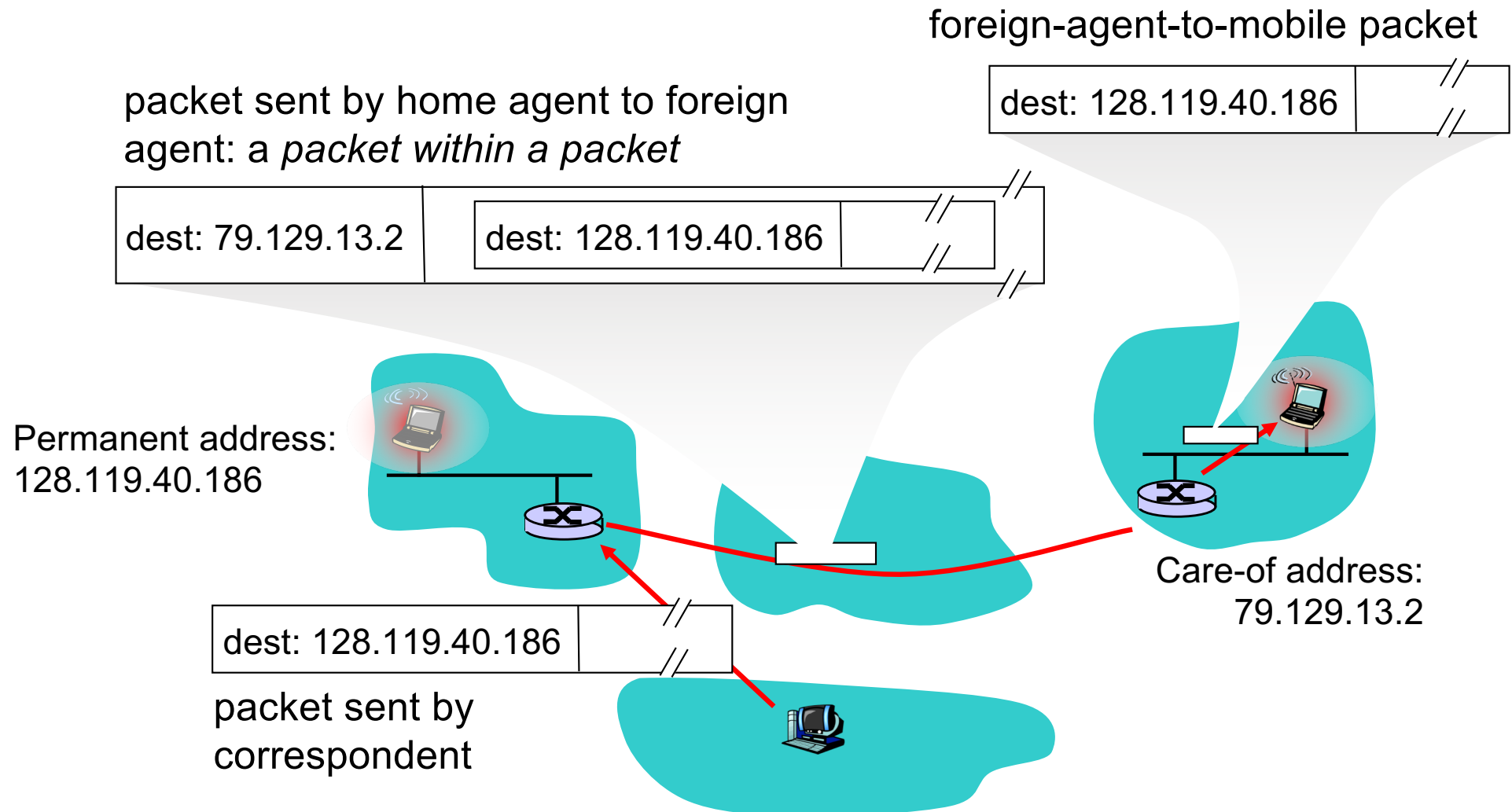
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Mobile IP

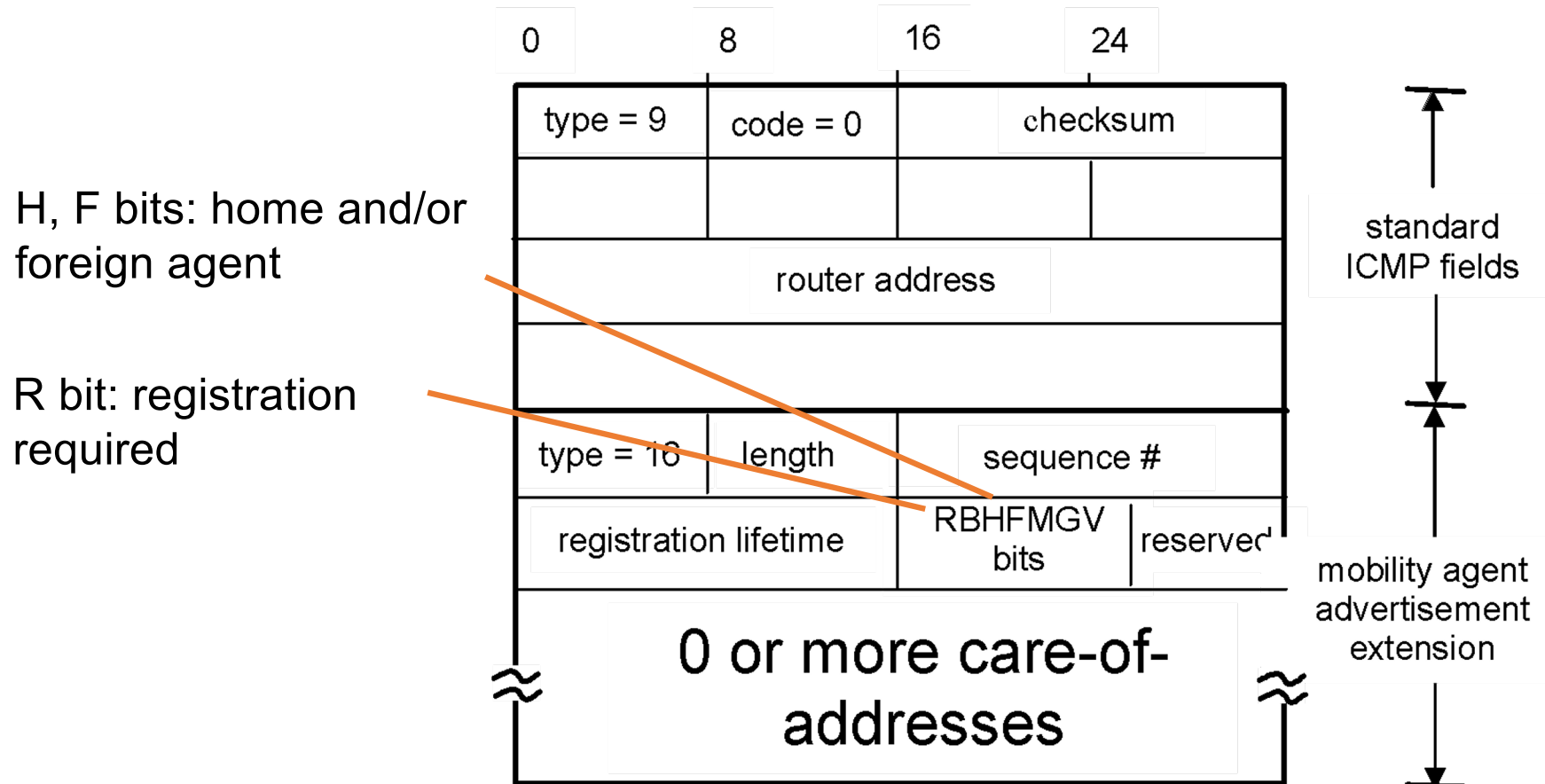
- Mobile IP is an Internet Engineering Task Force (IETF) standard communications protocol that is designed to allow mobile device users to move from one network to another while maintaining a permanent IP address (RFC 5944)
- It has many features we have seen:
 - Home agents, foreign agents, foreign-agent registration, care-of-addresses, encapsulation (packet-within-a-packet)
- The three components to standard:
 - Indirect routing of datagrams
 - Agent discovery
 - Registration with home agent

Mobile IP: Indirect Routing

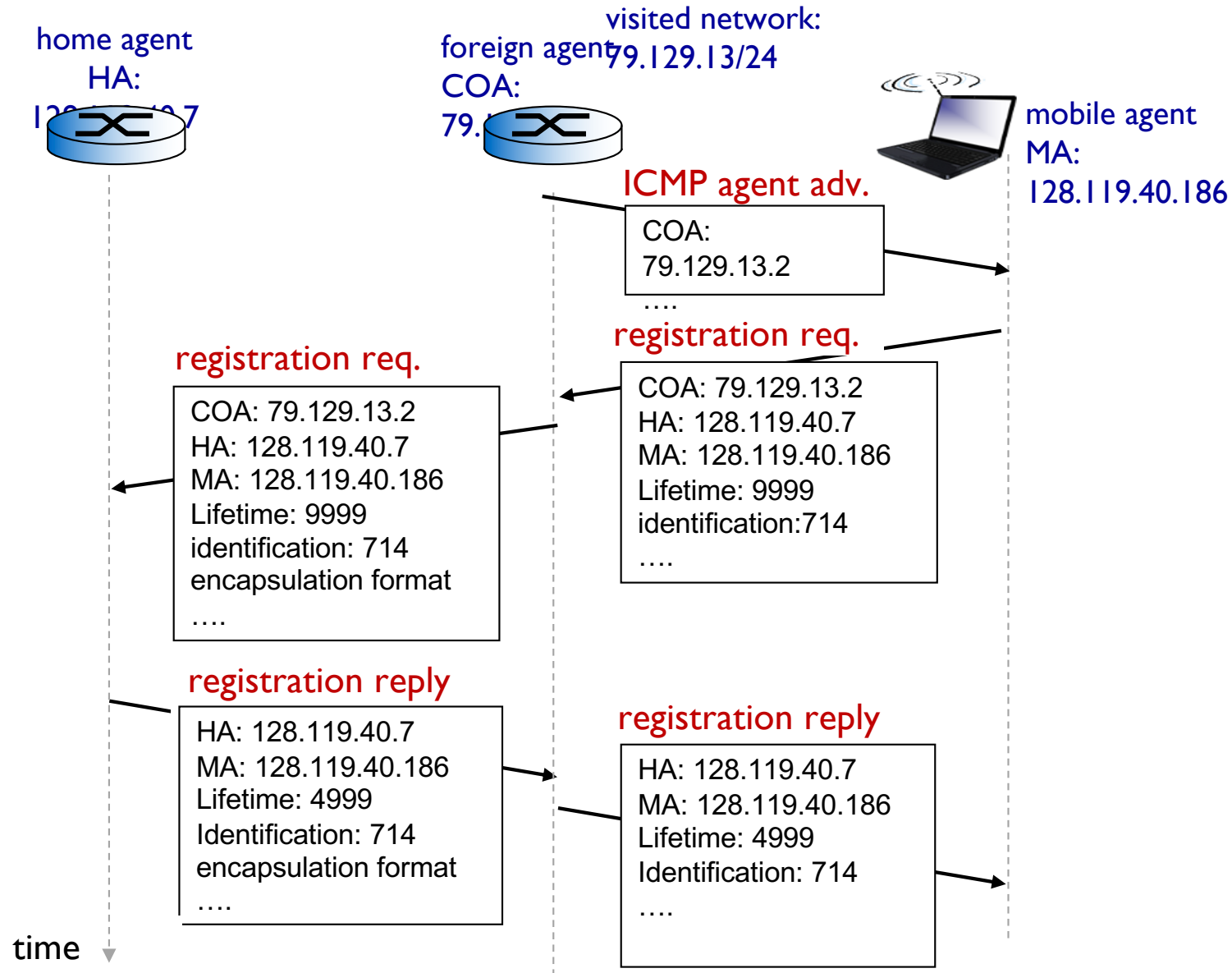


Mobile IP: Agent Discovery

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

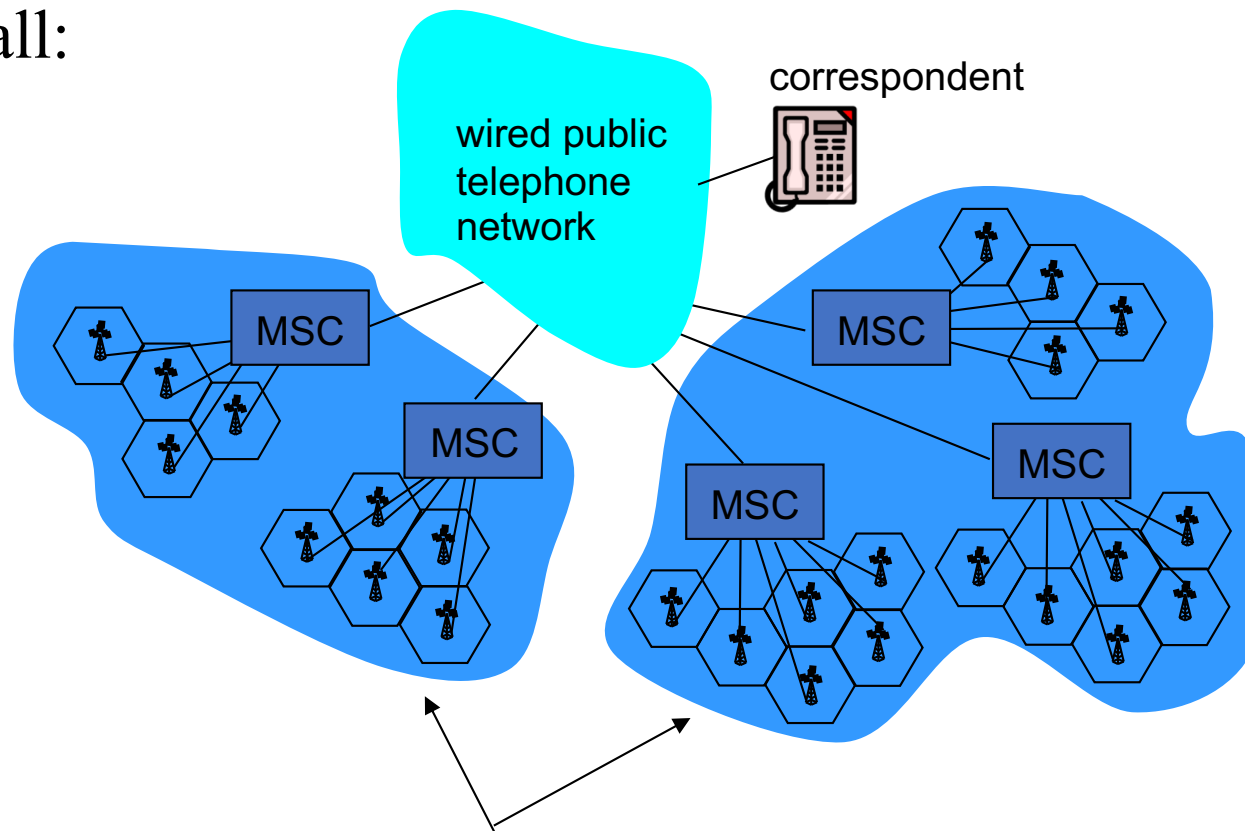


Mobile IP: Registration Example



Components of Cellular Network Architecture

Recall:

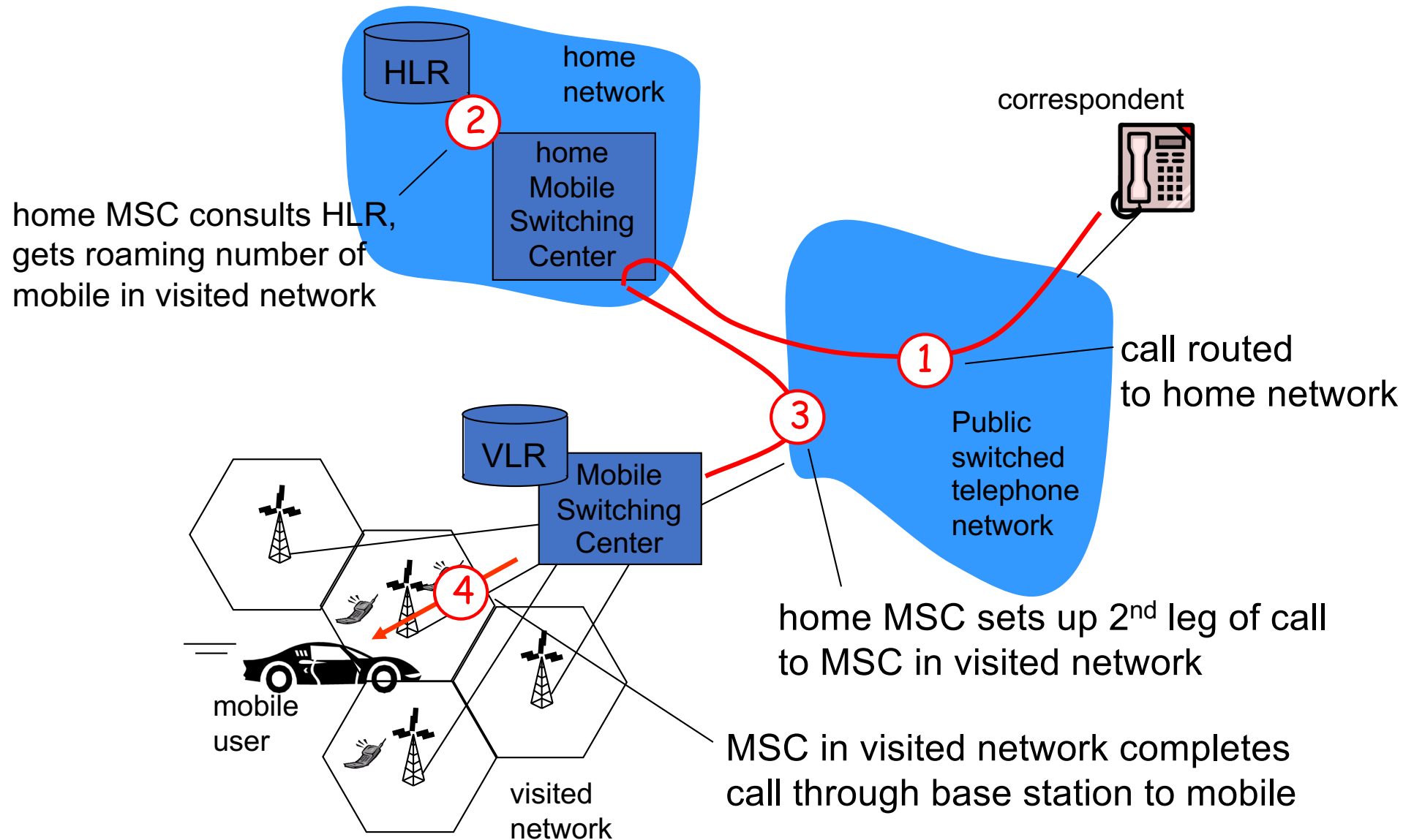


Different cellular networks,
operated by different providers

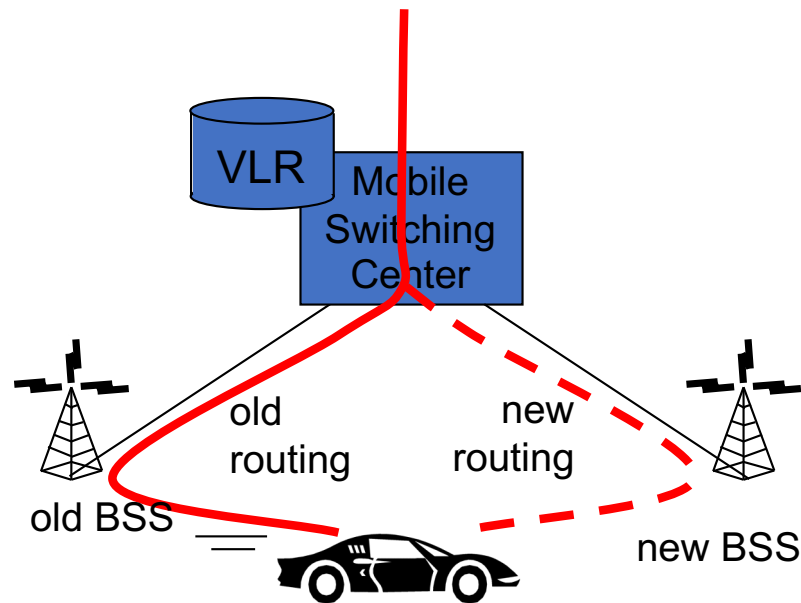
Handling Mobility in Cellular Networks

- *Home network*: network of cellular provider you subscribe to (e.g., Vodafone, MTC etc.)
 - *Home location register (HLR)*: database in home network containing 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
 - It could be home network

GSM: Indirect Routing to Mobile

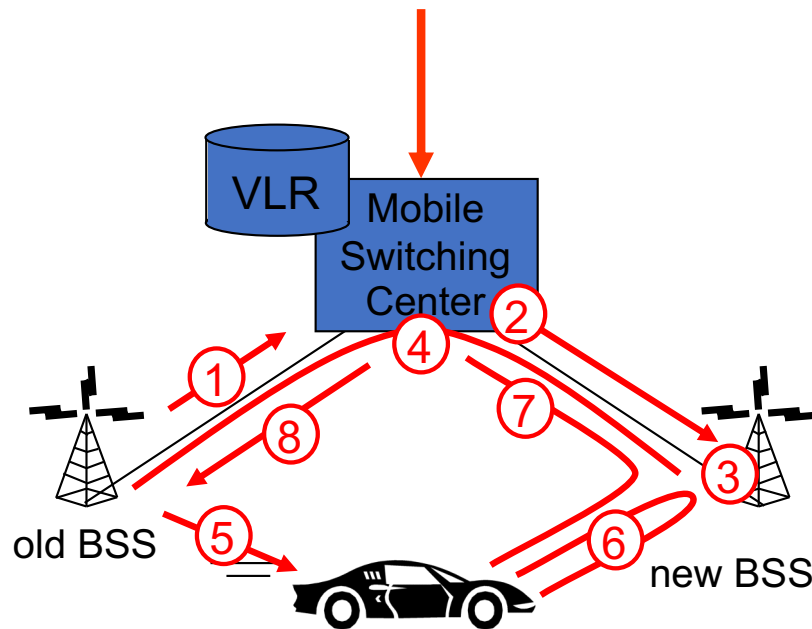


GSM: Handoff with Common MSC



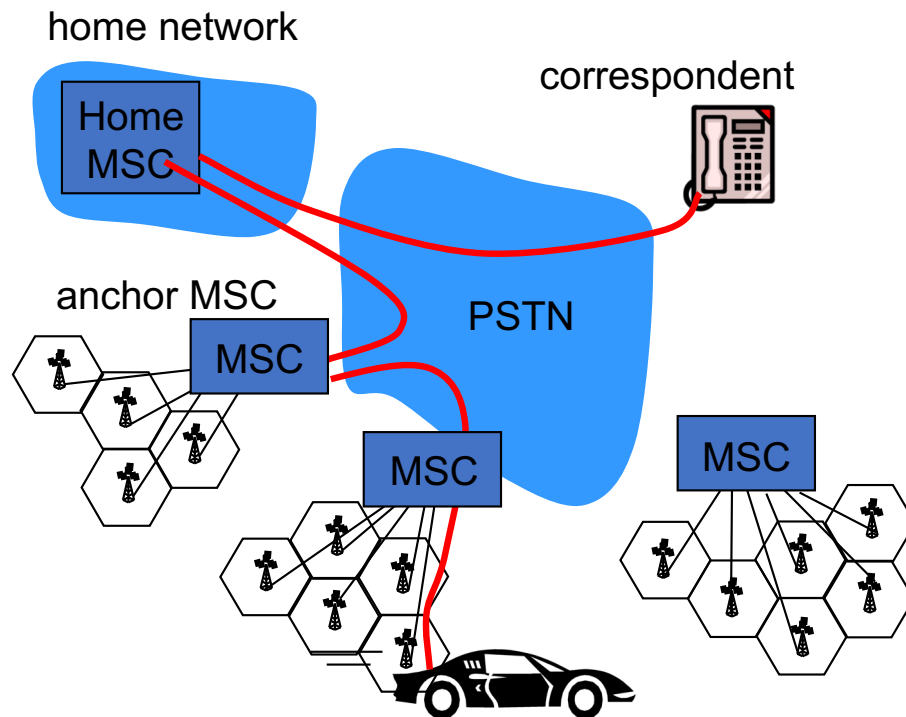
- *Handoff goal:* route call via new base station (without interruption)
- Reasons for handoff:
 - Stronger signal to/from new BSS (continuing connectivity, less battery drain)
 - Load balance: free up channel in current BSS
 - GSM doesn't mandate why to perform handoff (policy), only how (mechanism)
- 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

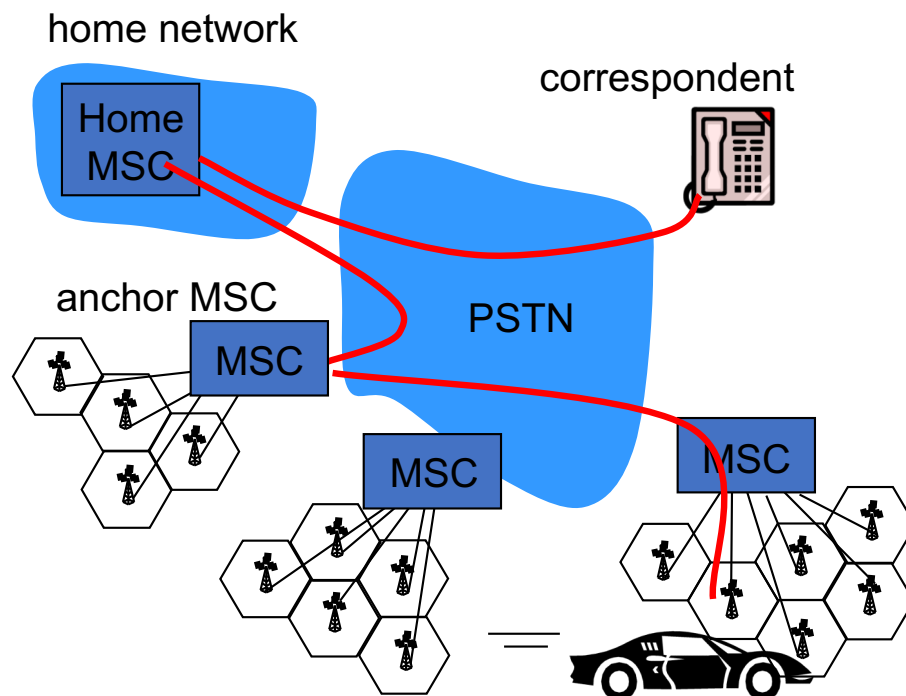
GSM: Handoff between MSC



(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 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 ...
 - best effort service model 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 unnecessarily
 - delay impairments for real-time traffic
 - limited bandwidth of wireless links

Summary

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