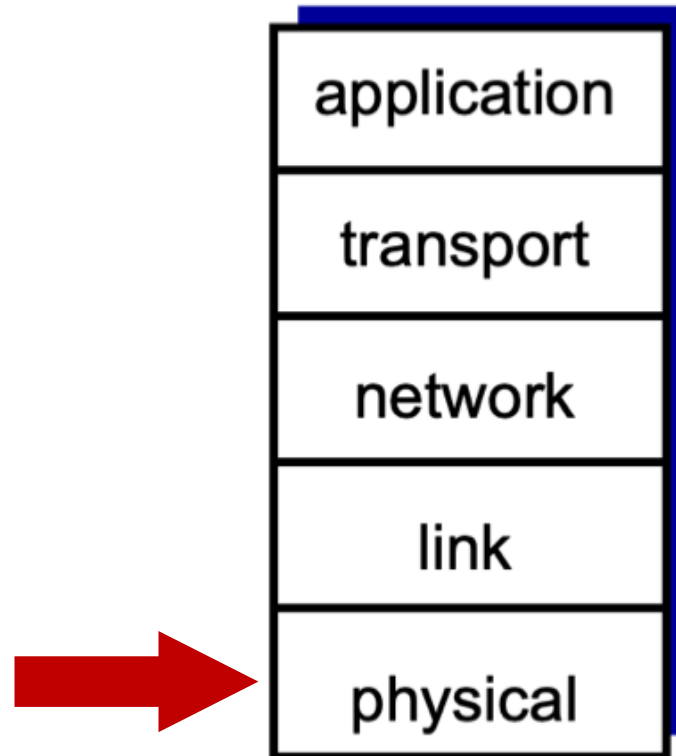


CSC358 Week 12

Logistics

- Exam Instructions posted on Discussion Board
- Mock Exam for Practice on Quercus
- Vote on Quercus to change marking scheme
- Today:
 - Finishing "wireless and mobile" and Exam review
- This Friday
 - Tutorial
- Pre-exam office hours next week
 - Michael: April 8th, 2-3:30 PM
 - Larry: April 9th, 2–3:30 PM

We are here



Outline

7.1 Introduction

Wireless

7.2 Wireless links, characteristics

- CDMA

7.3 IEEE 802.11 wireless LANs (“Wi-Fi”)

7.4 Cellular Internet access

- **architecture**
- **standards (e.g., 3G, LTE)**

Mobility

7.5 Principles: addressing and routing to mobile users

7.6 Mobile IP

7.7 Handling mobility in cellular networks

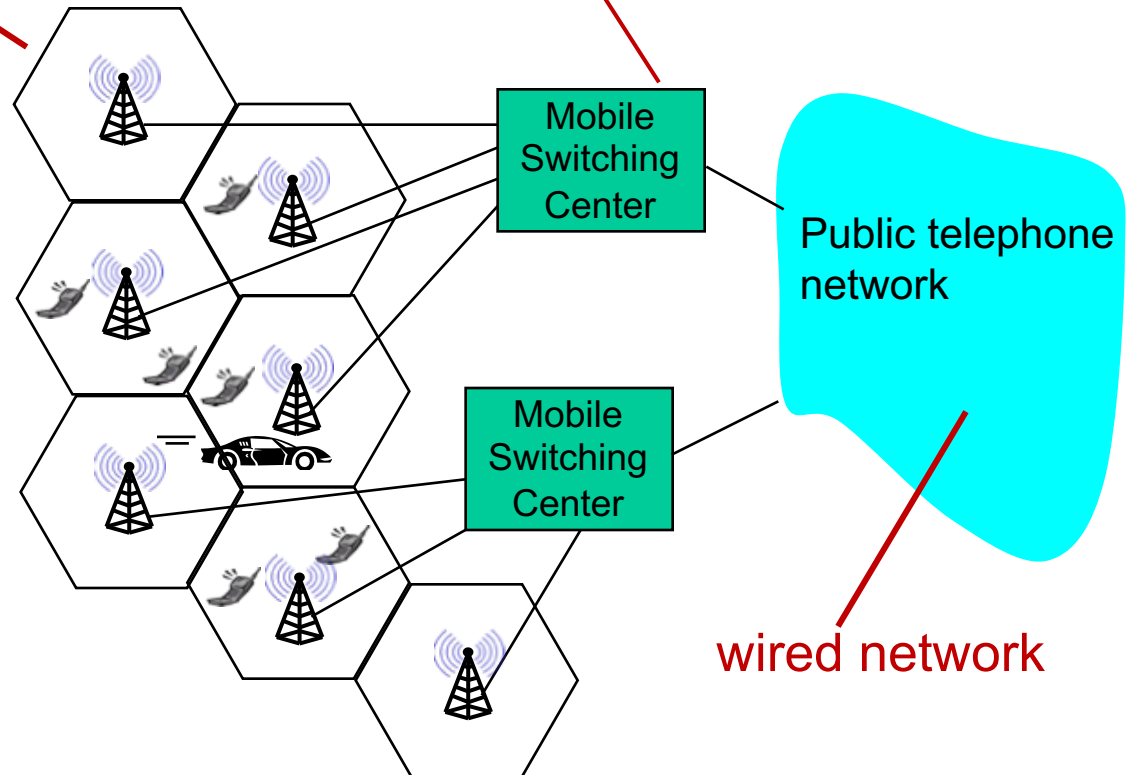
Components of cellular network architecture

cell

- ❖ covers geographical region
- ❖ *base station* (BS) analogous to 802.11 AP
- ❖ *mobile users* attach to network through BS
- ❖ *air-interface*: physical and link layer protocol between mobile and BS

MSC

- ❖ connects cells to wired tel. net.
- ❖ manages call setup (more later!)
- ❖ handles mobility (more later!)



2G, 3G, 4G (LTE)

- 2G: voice
- 3G: voice + data
 - data network operates in parallel with voice network
- 4G (LTE):
 - all-IP core: no separation between voice and data

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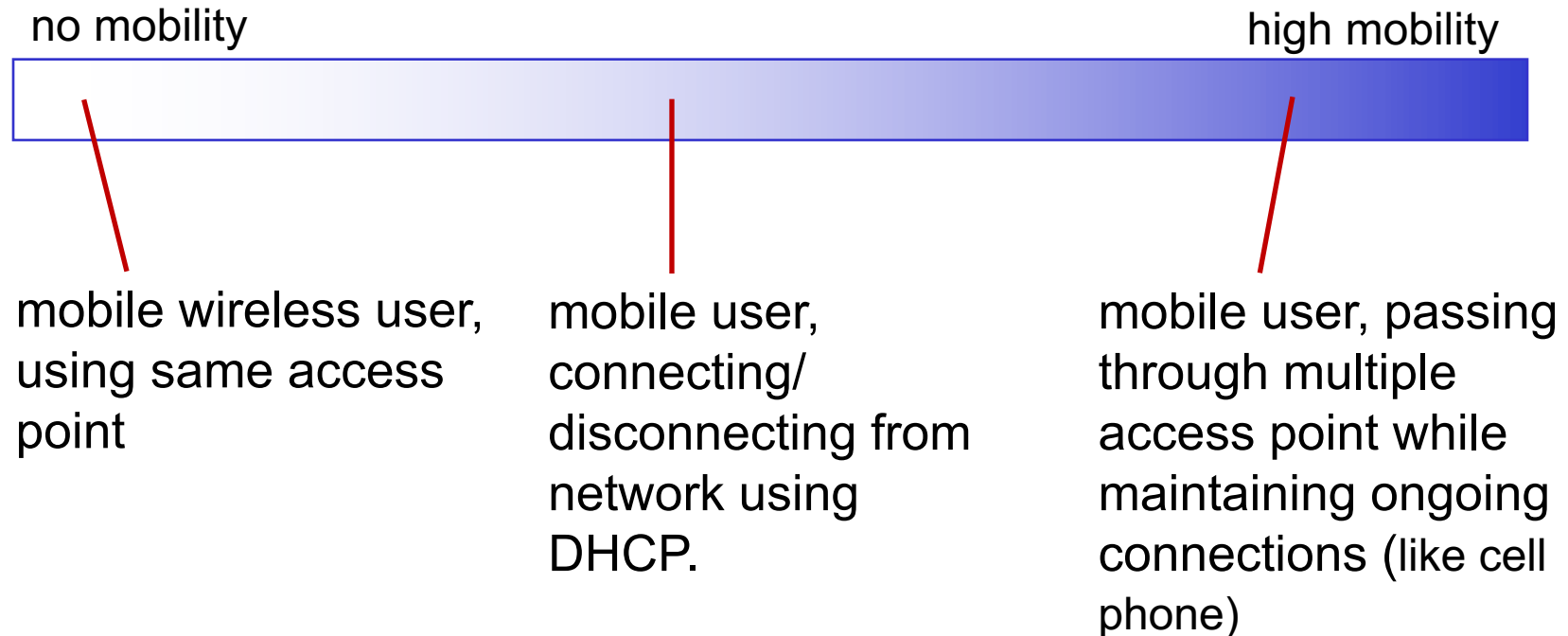
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What is mobility?

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

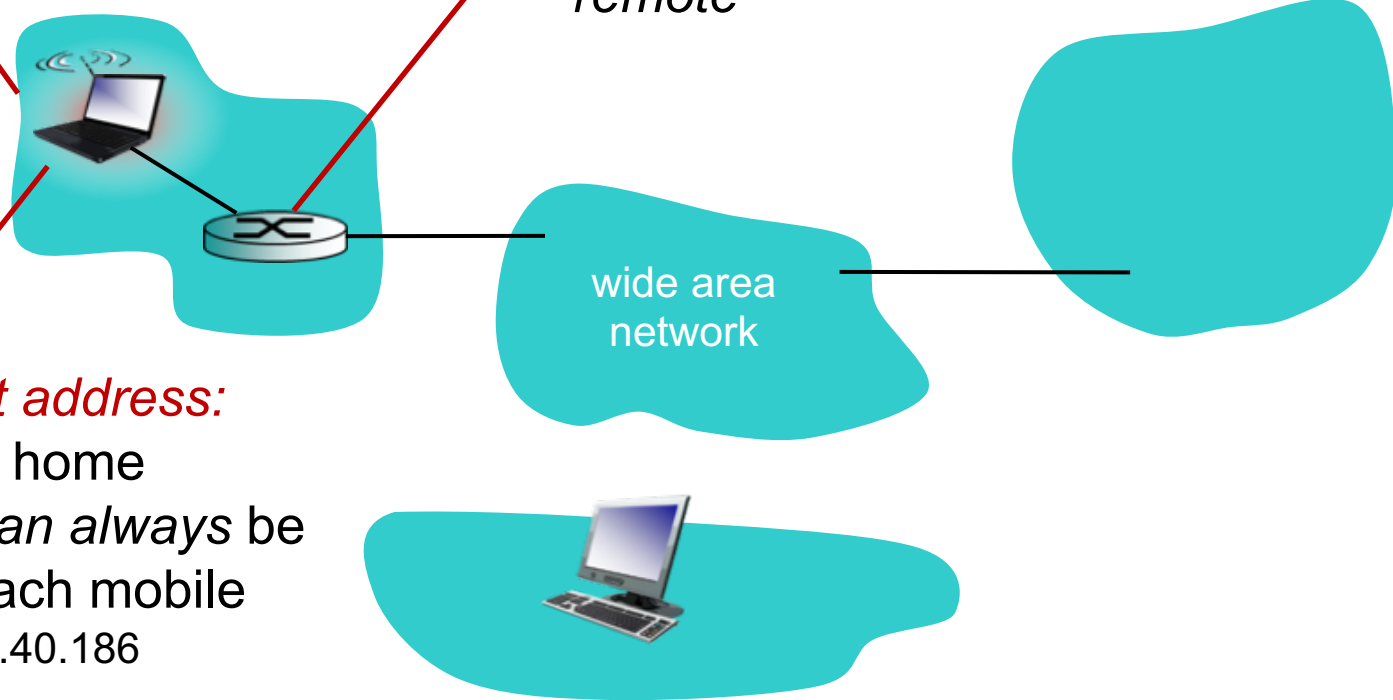


Mobility: vocabulary

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

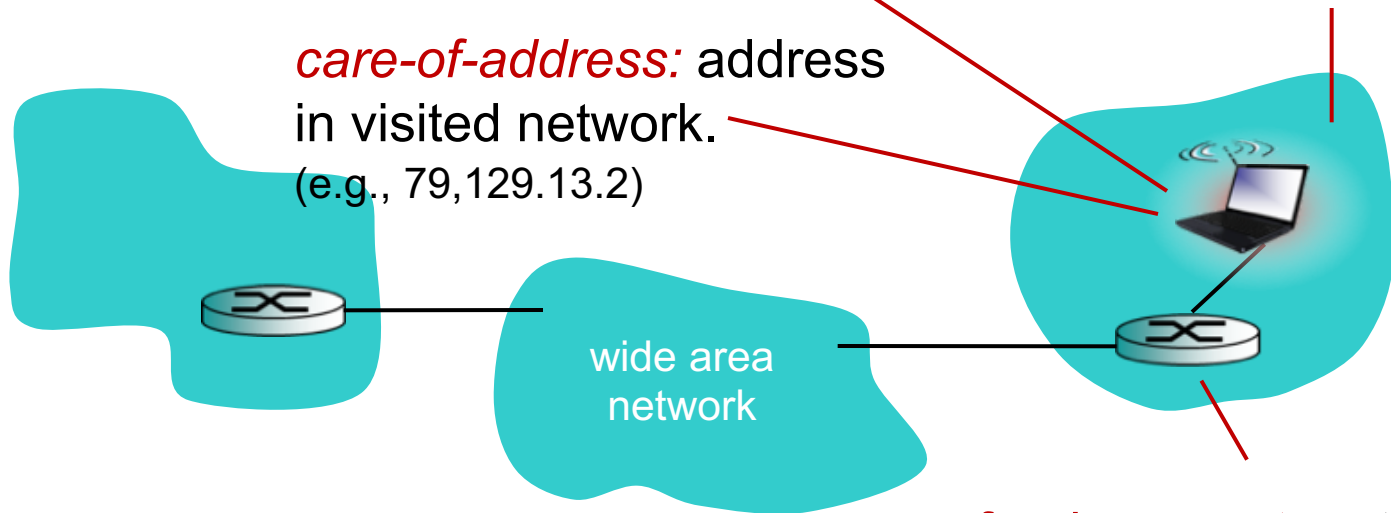


Mobility: more vocabulary

permanent address: remains constant (e.g., 128.119.40.186)

visited network: network in which mobile currently resides (e.g., 79.129.13/24)

care-of-address: address in visited network. (e.g., 79.129.13.2)



correspondent: wants to communicate with mobile

foreign agent: entity in visited network that performs mobility functions on behalf of mobile.

How do *you* contact a mobile friend:

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

I wonder where Alice moved to?



Mobility: approaches

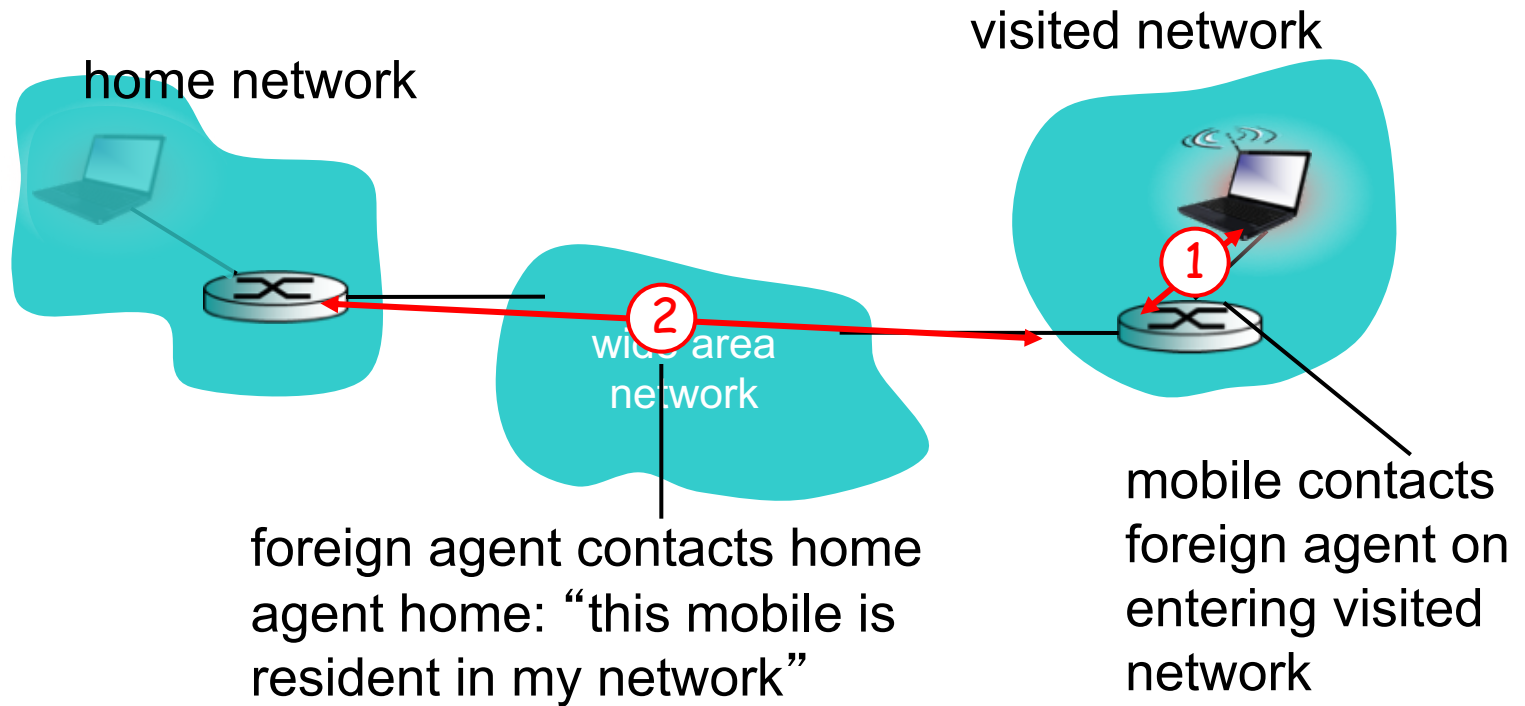
- *let routing handle it:* routers advertise permanent address of mobile-nodes-in-residence via usual routing table exchange.
 - routing tables indicate where each mobile located
 - no changes to end-systems
- *let end-systems handle it:*
 - *indirect routing:* communication from correspondent to mobile 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, mobile advertises current residence via usual routing table exchange
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not
scalable
to millions of
mobiles

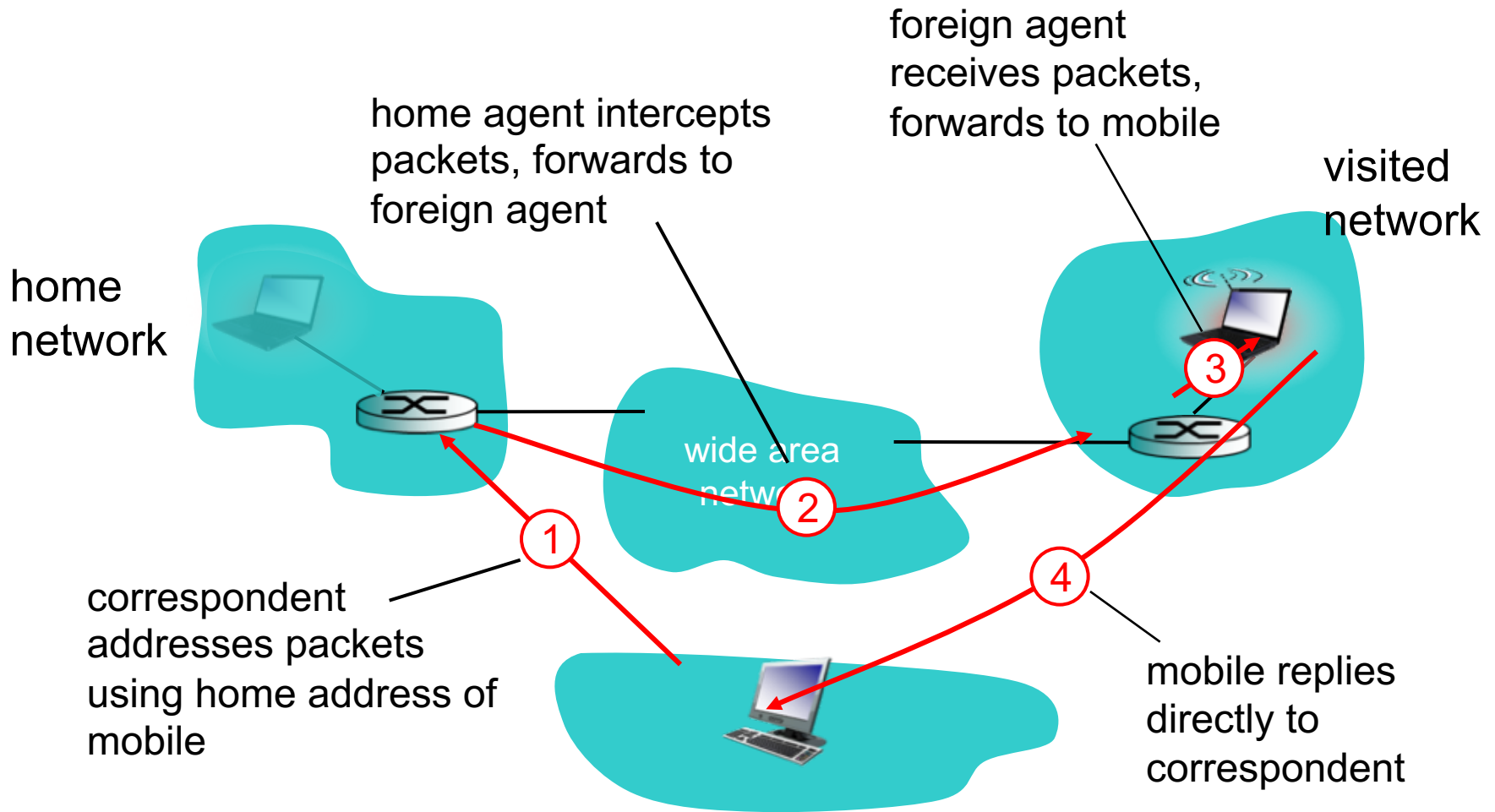
Mobility: registration



end result:

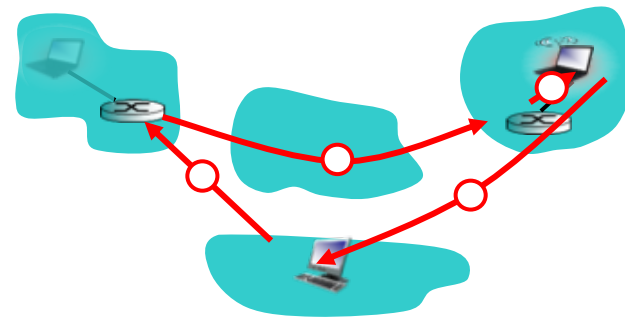
- foreign agent knows about mobile
- home agent knows location of mobile

Mobility via indirect routing



Indirect Routing: comments

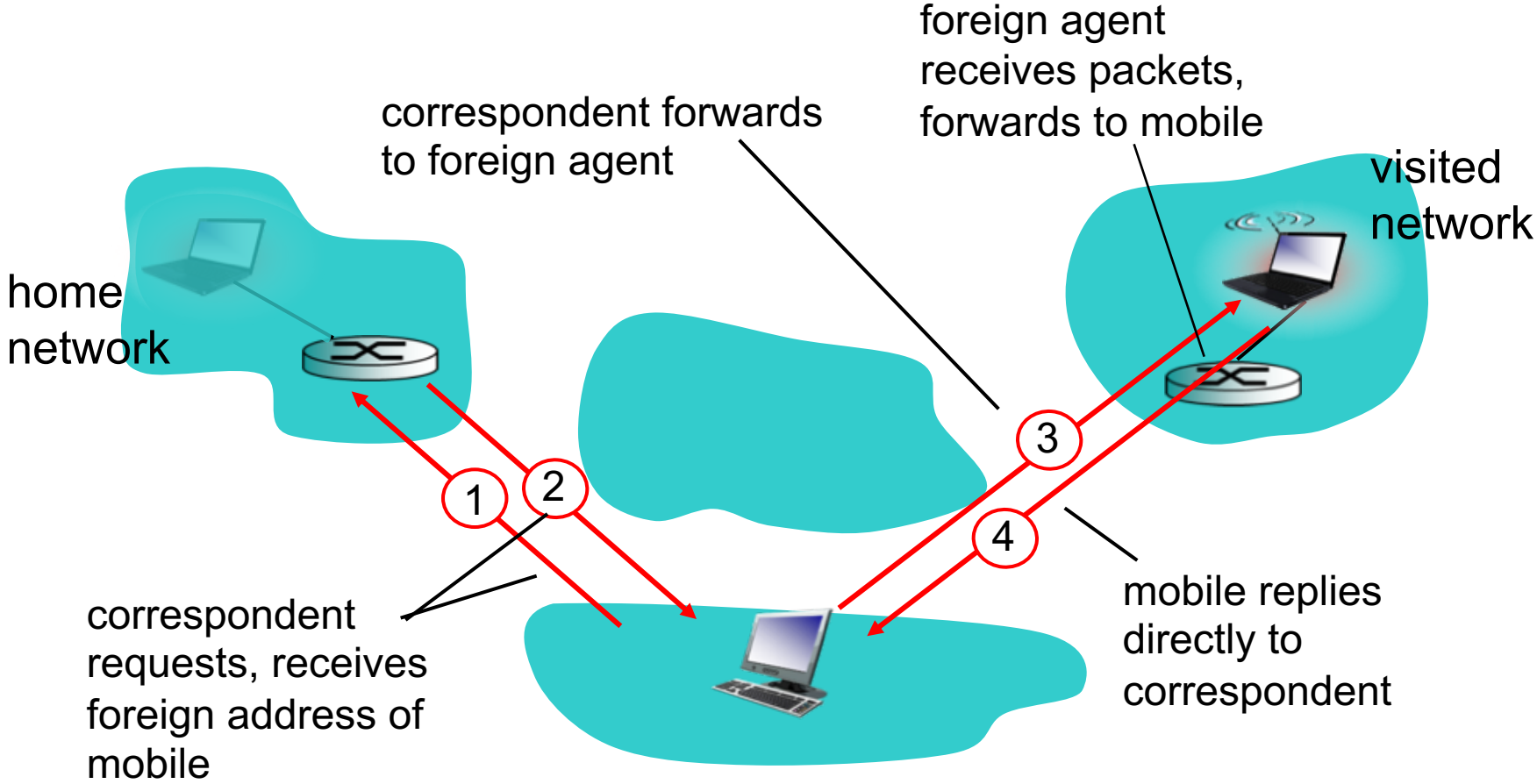
- mobile uses two addresses:
 - **permanent address:** used by correspondent (hence mobile location is *transparent* to correspondent)
 - **care-of-address:** used by home agent to forward datagrams to mobile
- **triangle routing:** correspondent-home-network-mobile
 - inefficient when correspondent, mobile are in same network



Indirect routing: moving between networks

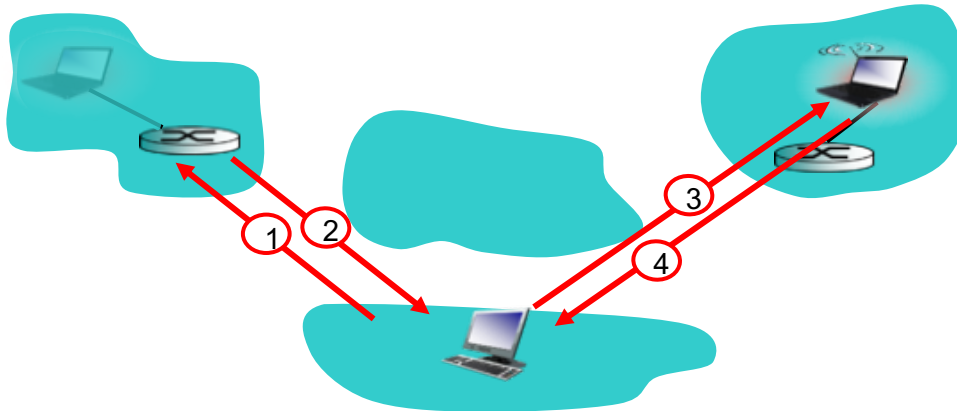
- suppose mobile user moves to another network
 - registers with new foreign agent
 - new foreign agent registers with home agent
 - home agent update care-of-address for mobile
 - packets continue to be forwarded to mobile (but with new care-of-address)
- mobility, changing foreign networks transparent to end hosts: *on going connections can be maintained!*

Mobility via direct routing



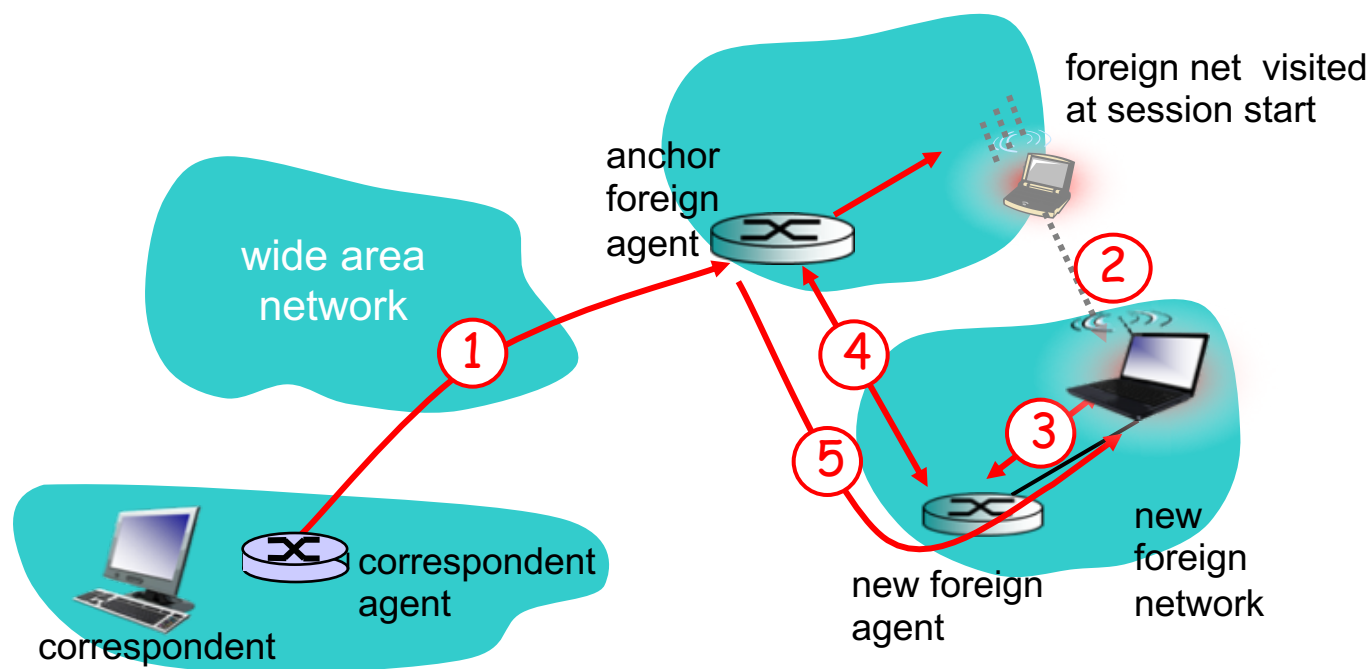
Mobility via direct routing: comments

- 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)



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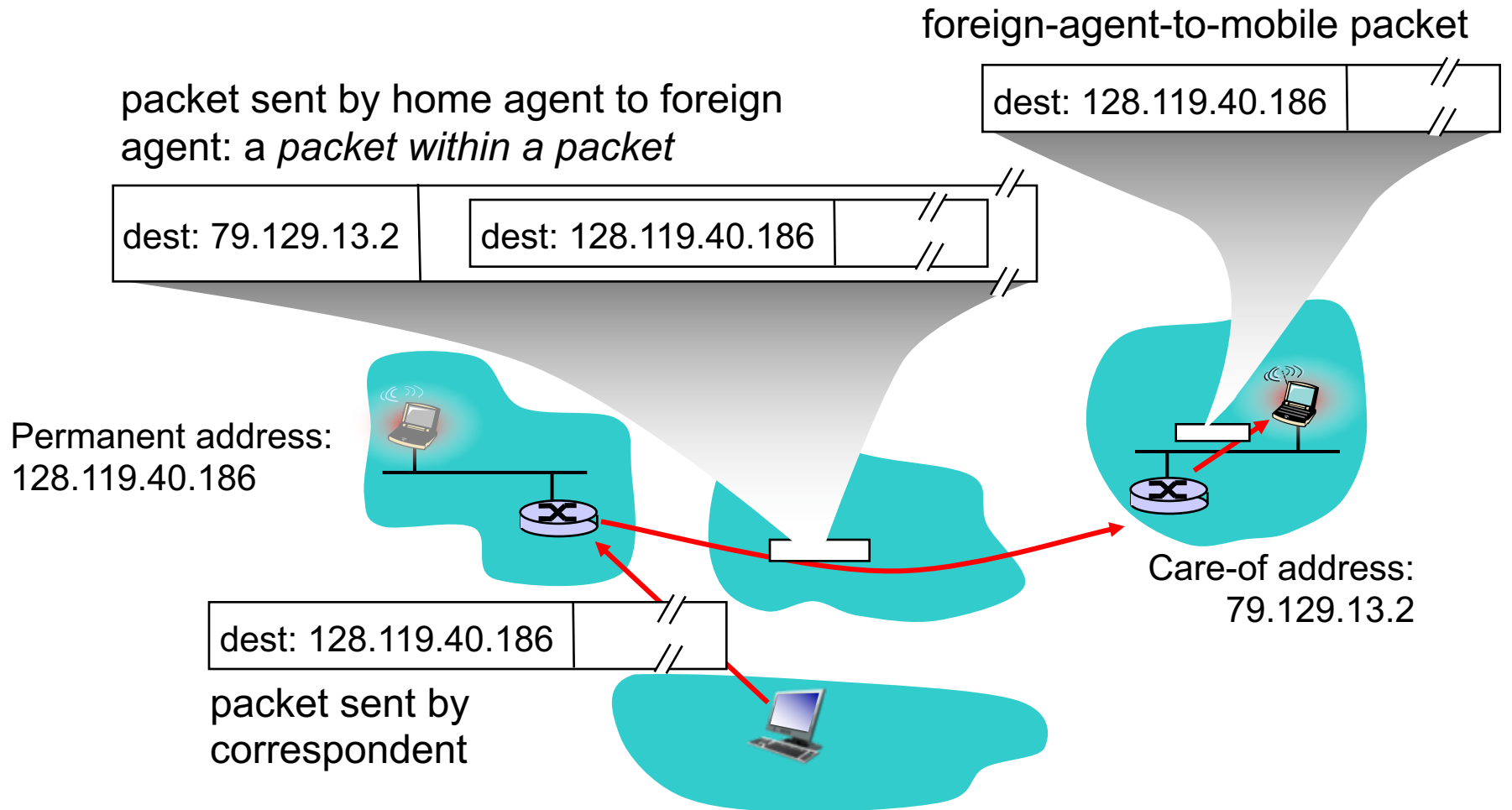
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Mobile Internet Protocol

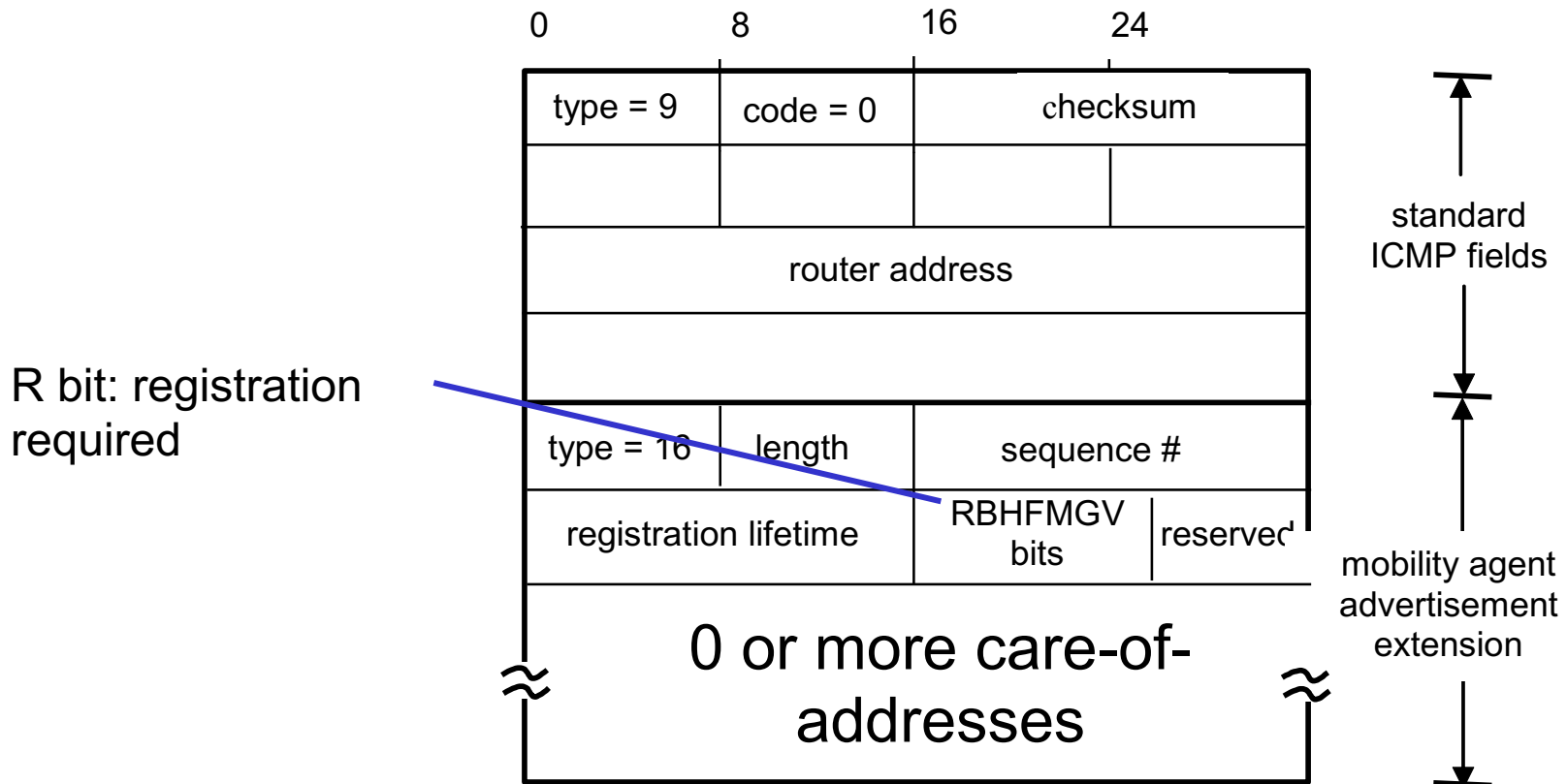
- RFC 3344
- has many features we've seen:
 - home agents, foreign agents, foreign-agent registration, care-of-addresses, encapsulation (packet-within-a-packet)
- three components to standard:
 - indirect routing of datagrams
 - agent discovery
 - registration with home agent

Mobile IP: indirect routing

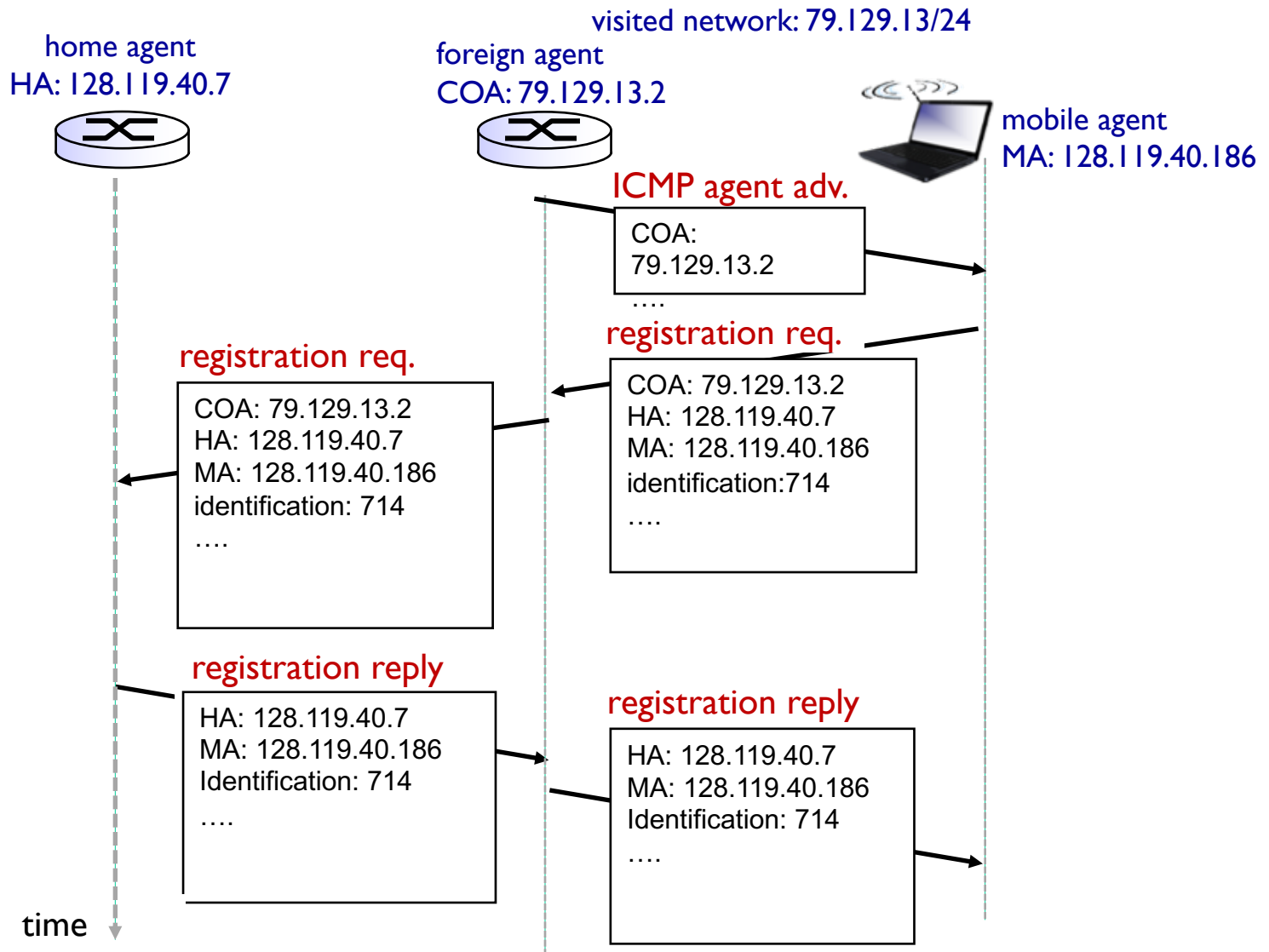


Mobile IP: agent discovery

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



Mobile IP: registration example



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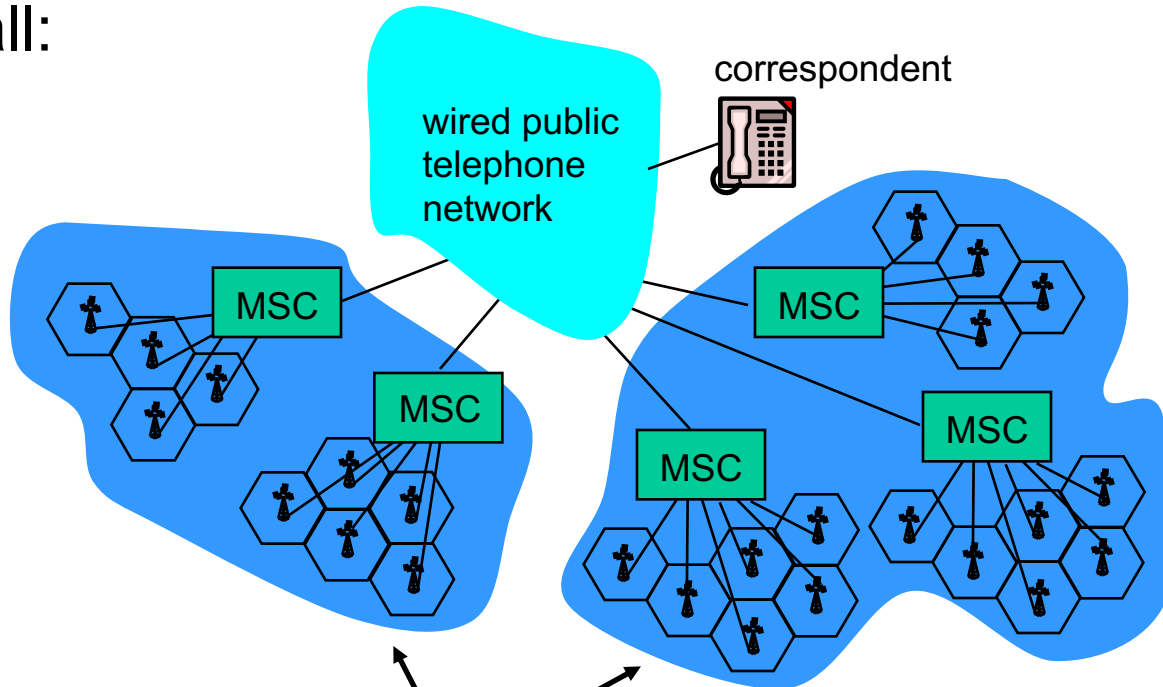
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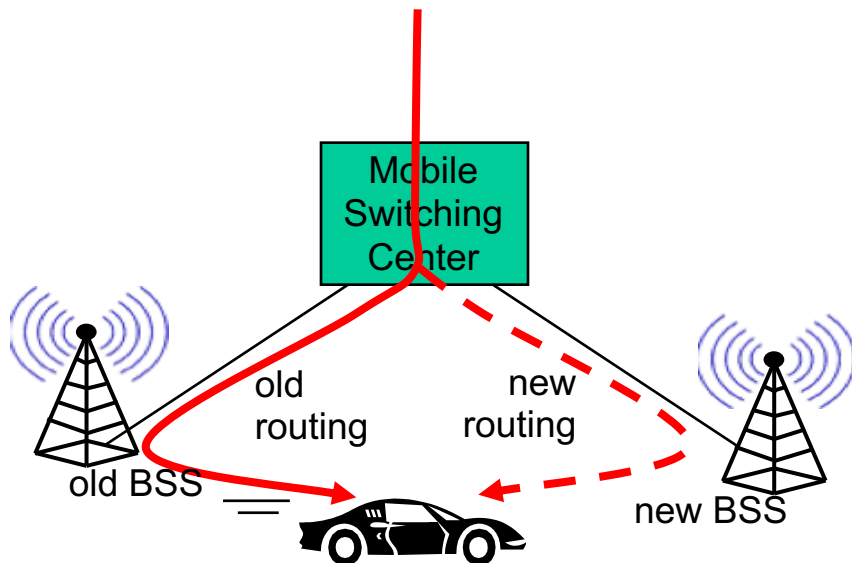
Components of cellular network architecture

recall:



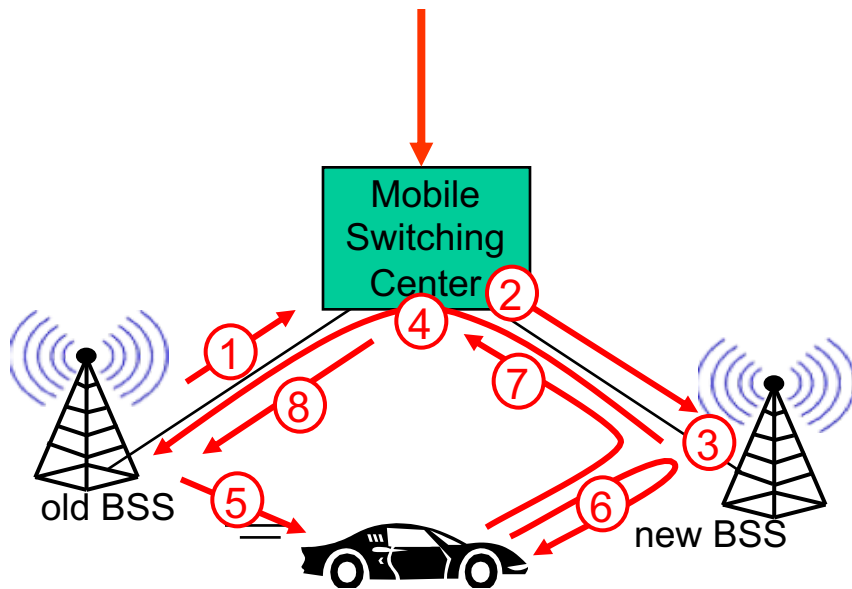
different cellular networks,
operated by different providers

GSM: handoff with common MSC



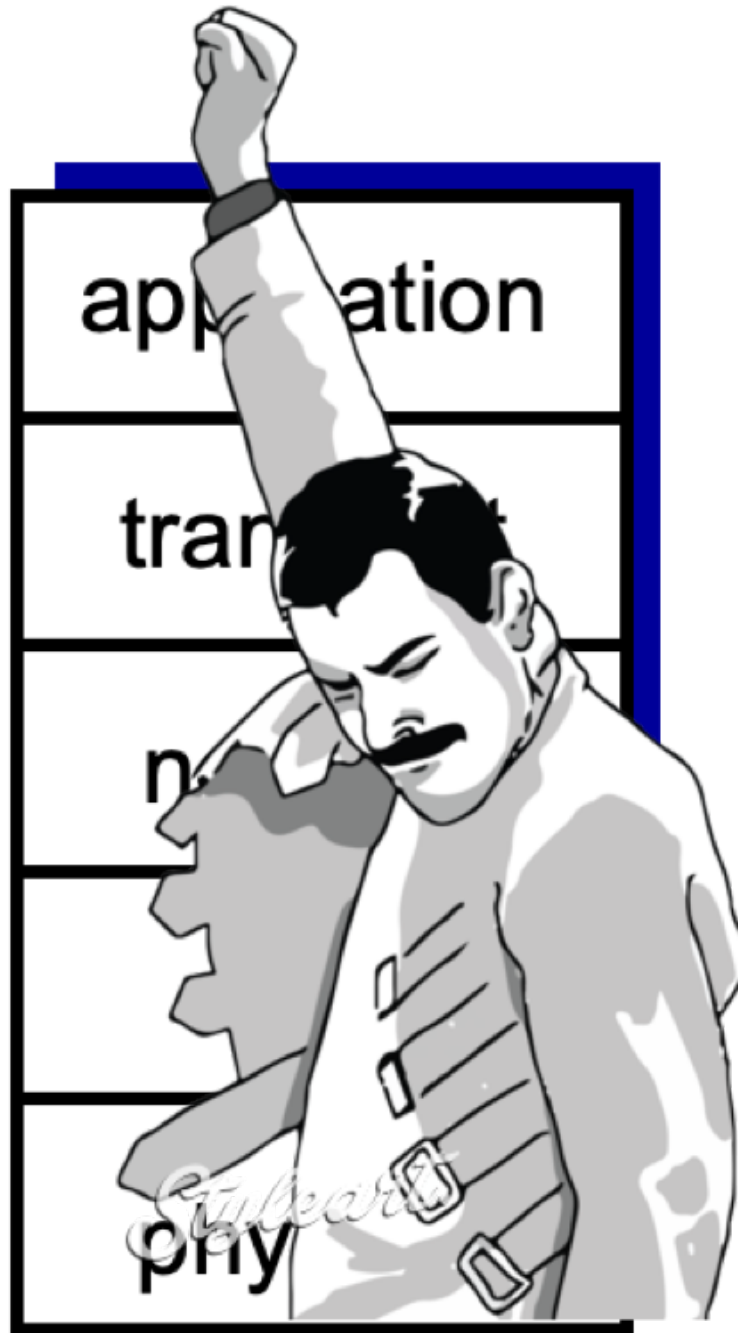
- *handoff goal*: route call via new base station (without interruption)
- reasons for handoff:
 - stronger signal to/from new BSS (continuing connectivity, less battery drain)
 - load balance: free up channel in current BSS
- handoff initiated by old BSS

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

We are done!



That was a lot

- Now we know how the Internet works, at all layers, in detail.
- We learned an excellent example of “how to design a system”. Many useful ideas for any future system design problems you might encounter.
- And there is still a lot more, if you want to go even deeper.

Final Exam Review

Exam Format

- Online, as a Quercus Quiz
- On April 13th, log in before 9 a.m. (Toronto time) and navigate to the quiz page.
- At 9:00 a.m., refresh your page and the exam should be available.
- At 12:00 p.m., your responses will be submitted. You can submit earlier; if you do, you cannot modify your answers

Resources

- We ask that you restrict yourself to:
 - Materials linked from the course website (slides, tutorial notes, the textbook)
 - A non-programmable calculator
 - Our BB Collaborate chat (for clarifications or if you have technical problems)
- In particular, please don't:
 - Frantically google or search stack overflow (that won't help much anyway)
 - Discuss the exam with anyone

Types of Questions

- Short answer
 - Explain some concepts concisely
 - Simple calculation
 - Identify the name of a concept based on its description
- Longer answers
 - calculations
 - analyze protocol
 - design protocol
 - tracing algorithm / procedure
 - mathematical proof
 - Write a short essay on a given topic.

Review notes

- Posted on the course website.
- Review so that you can answer all the questions in the notes.
- Particularly important concepts that require deeper and detailed understanding are highlighted (boldface and larger fonts)
- Ideas of possible exam questions to be asked.

Review Tips

- **Understand, don't memorize.**
- How to review
 - Go through the review notes while going through lecture slides
 - Go through tutorials carefully.
 - Review what you did in assignments.
 - More exercises:
 - past UTM exams (most questions are relevant)
 - exercises from the textbook.
 - Whenever in doubt, ask on the discussion board or come to office hours!

A bit more motivation

- Sticker if get A or A+.



See you in office hours!