Chapter 6 outline

6.1 Introduction

Wireless

6.2 Wireless links, characteristics
- CDMA

6.3 IEEE 802.11 wireless LANs ("Wi-Fi")
- Deploying

6.4 Cellular Internet access
- architecture
- standards (e.g., GSM)

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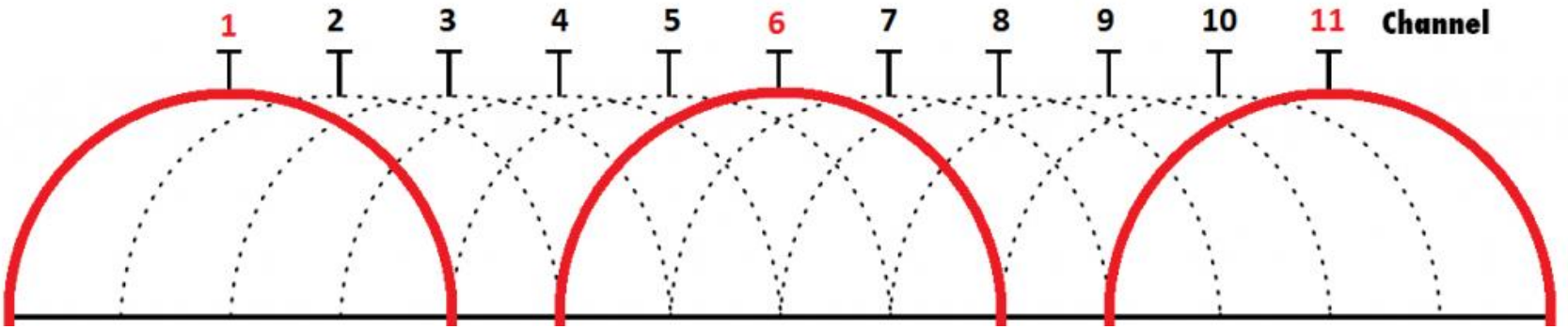
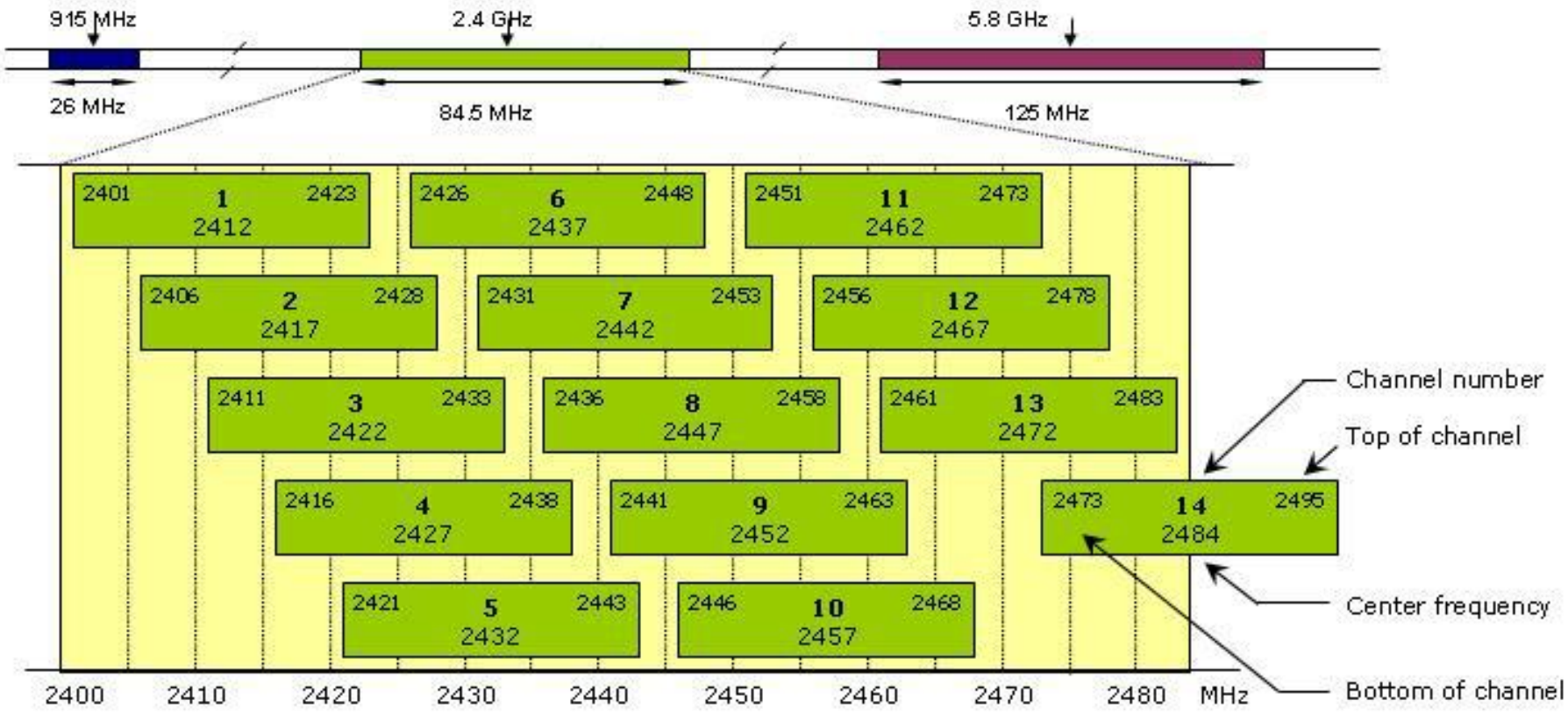
802.11: Channels

- 802.11b: 2.4GHz-2.485GHz spectrum divided into 11 channels at different frequencies
  - AP admin chooses frequency for AP, or they can auto-hop based on measured interference:
  - interference possible: channel can be same as that chosen by neighboring AP!



https://igscomputers.co.uk/how-to-choose-the-right-wi-fi-channel-and-avoid-interference/

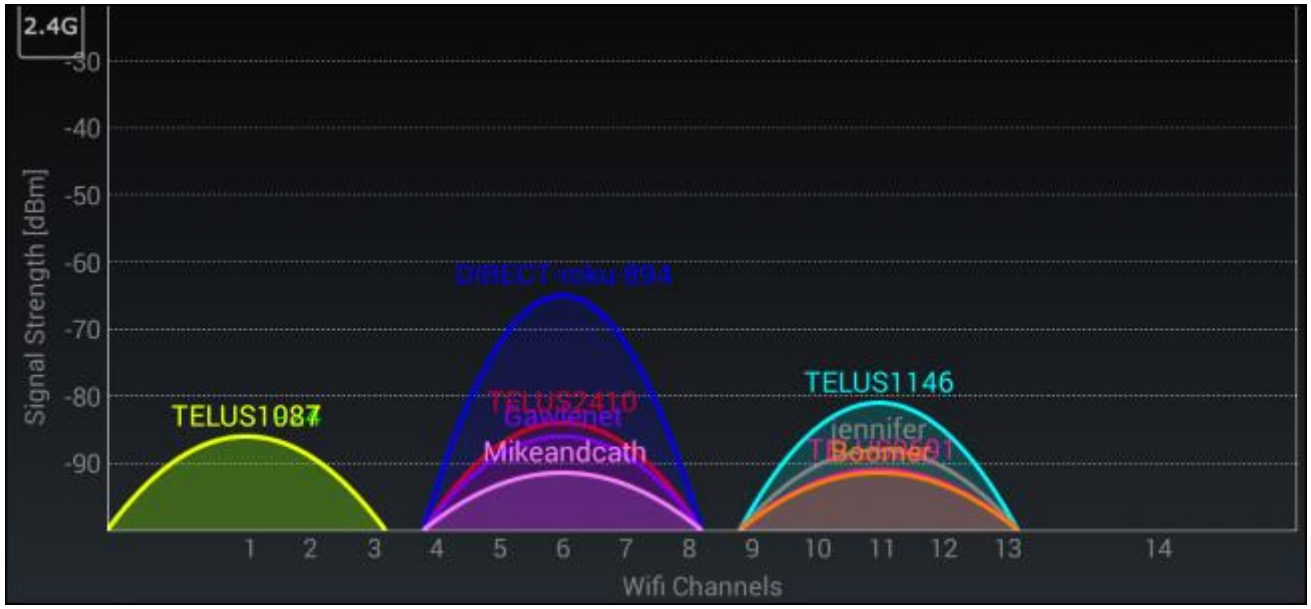
802.11: Channels



https://photosync-app.com

802.11: Channels

- It is worse to use the non-big three (1, 6, 11), even if they're full!
  - Collisions happen on BOTH ends, and the result is a lower transmission rate

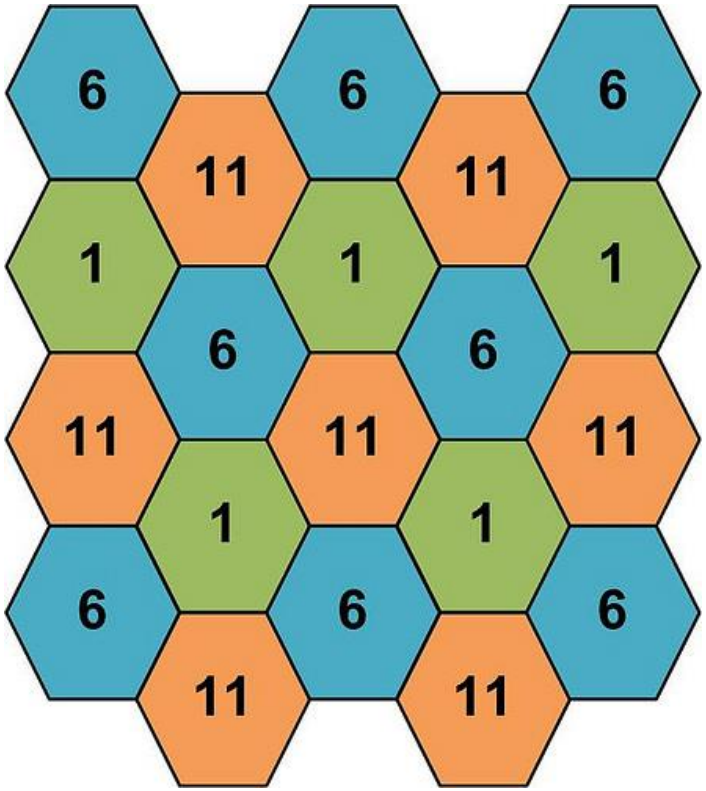


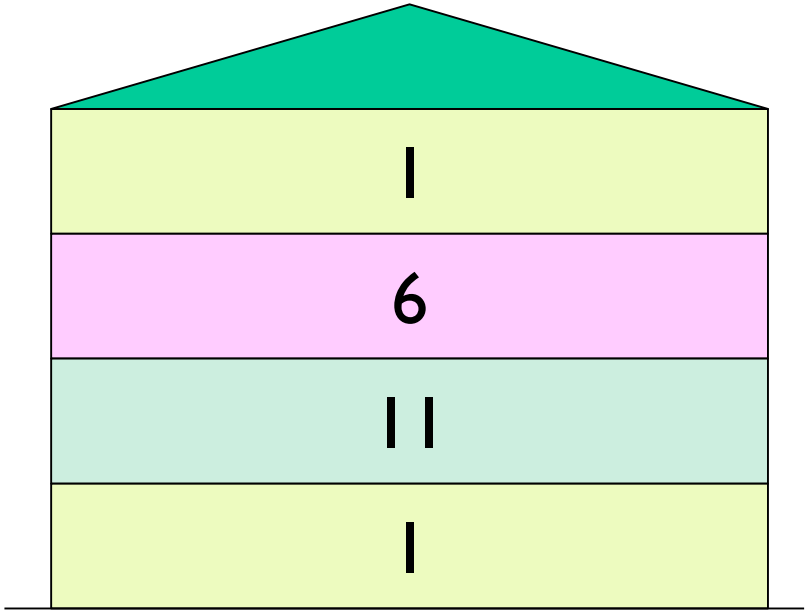
http://www.howtogeek.com/197268/how-to-find-the-best-wi-fi-channel-for-your-router-on-any-operating-system/

802.11: WAP Placement

- When placing wireless access points in a building, use a method that:
  - Centralizes the WAPs
  - Separates the channels from overlapping (as much as possible)
  - Uses the same SSID (network name) and password
  - Turn off low data rates if possible
    - Some WAPs offer low data rates, which makes devices "stick" to them as they move around, which prevents devices from associating with closer, better WAPs
    - In some cases, using different SSIDs will help the users to know which WAP they're connected to, if stickiness is a problem

802.11: Separation

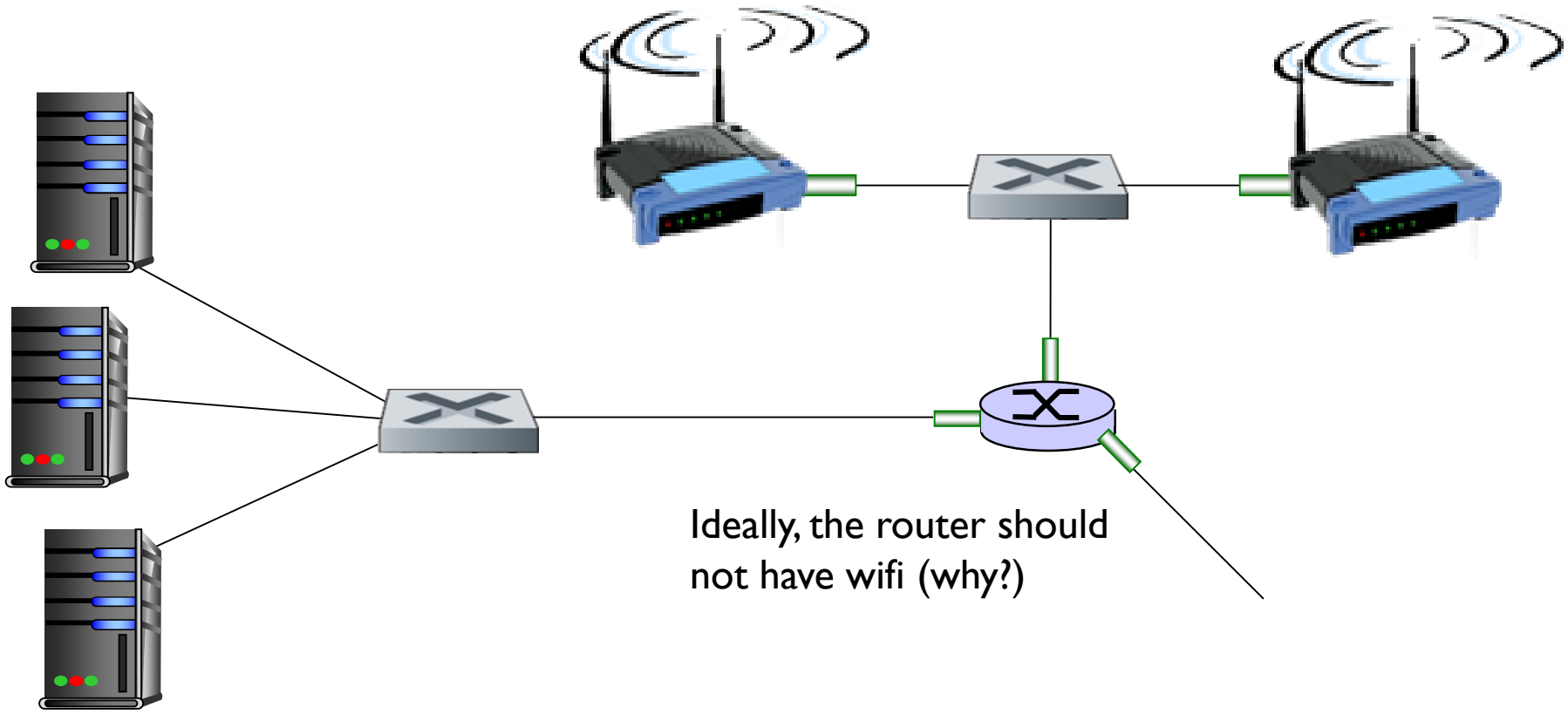




http://forum.projetoderedes.com.br/viewtopic.php?t=775

802.11: Deployment

- Deployment Diagram:



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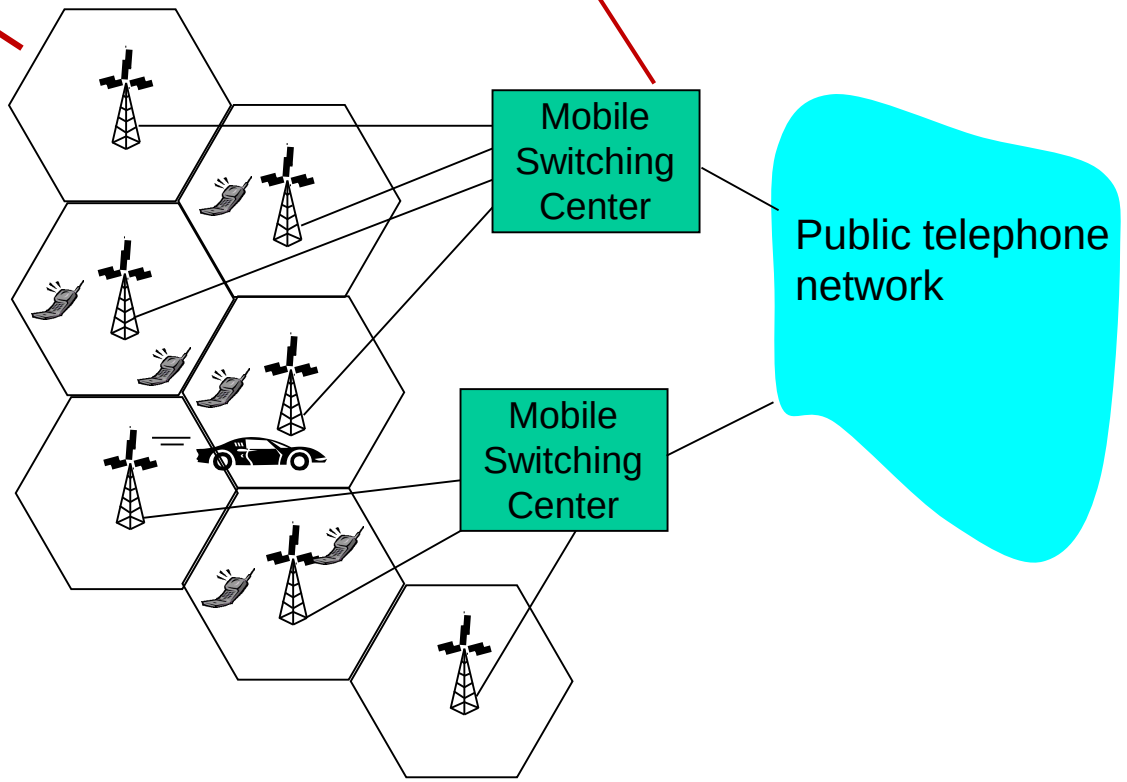
Components of cellular network architecture

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

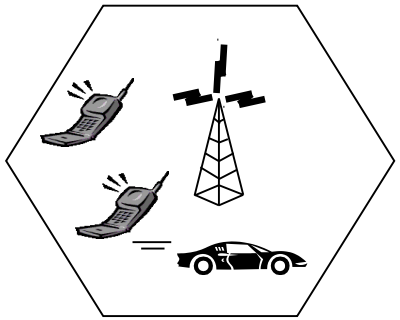
cell
- covers geographical region
- *base station* (BS) analogous to 802.11 AP
- *mobile users* attach to network through BS
- *air-interface:* physical and link layer protocol between mobile and BS

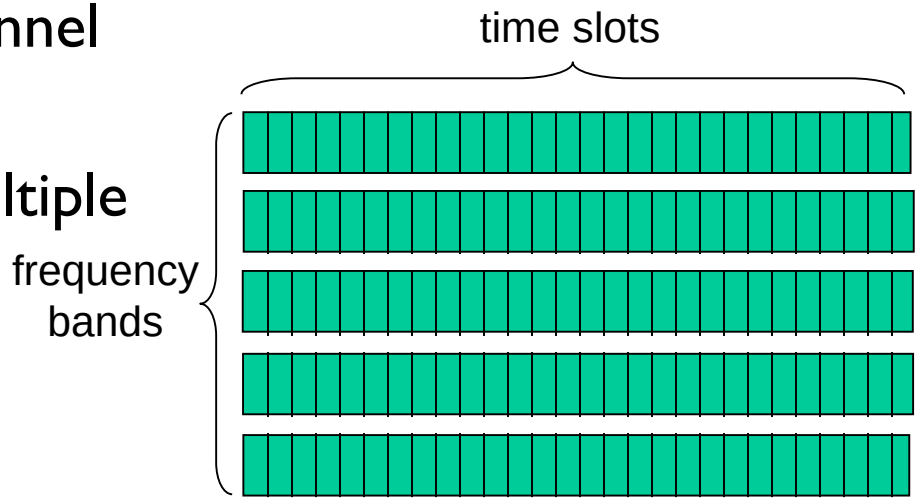


Cellular networks: the first hop

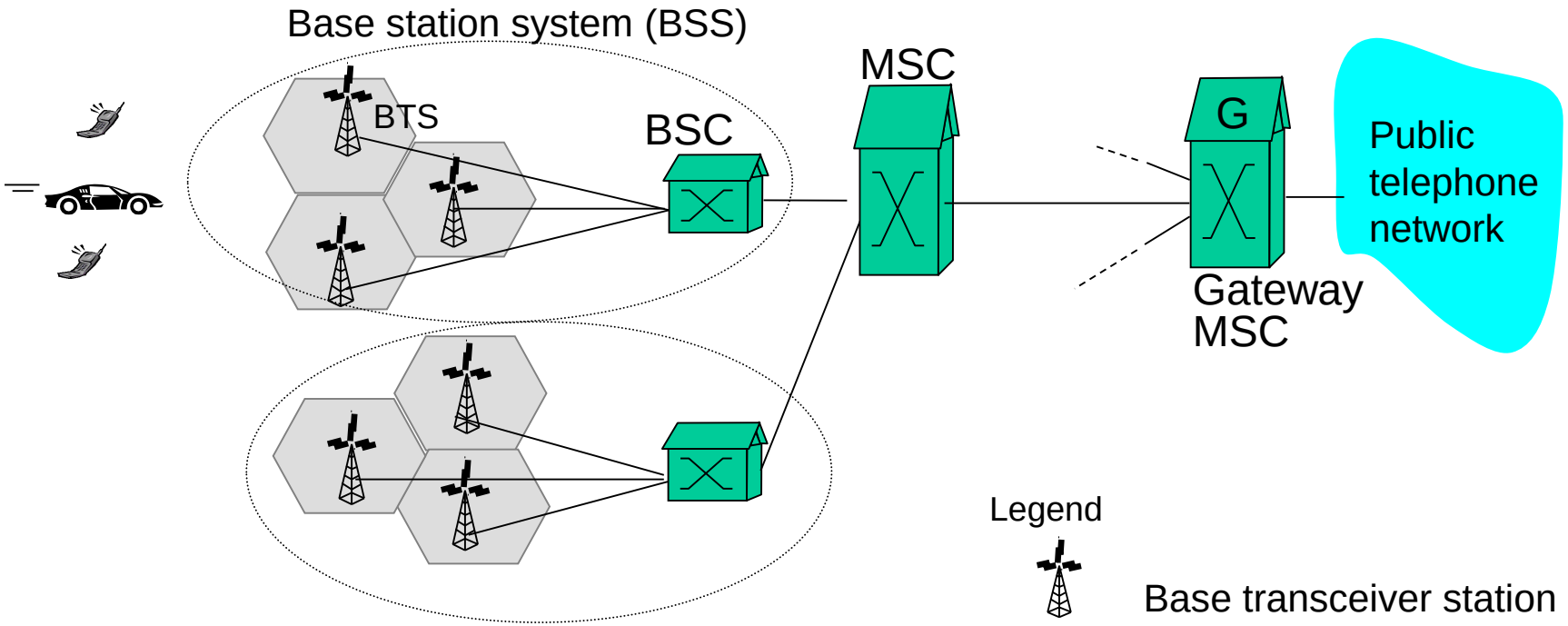
Two techniques for sharing mobile-to-BS radio spectrum

- combined FDM/TDM: divide spectrum in frequency channels, divide each channel into time slots
- CDMA: code division multiple access





2G (voice) network architecture



Legend

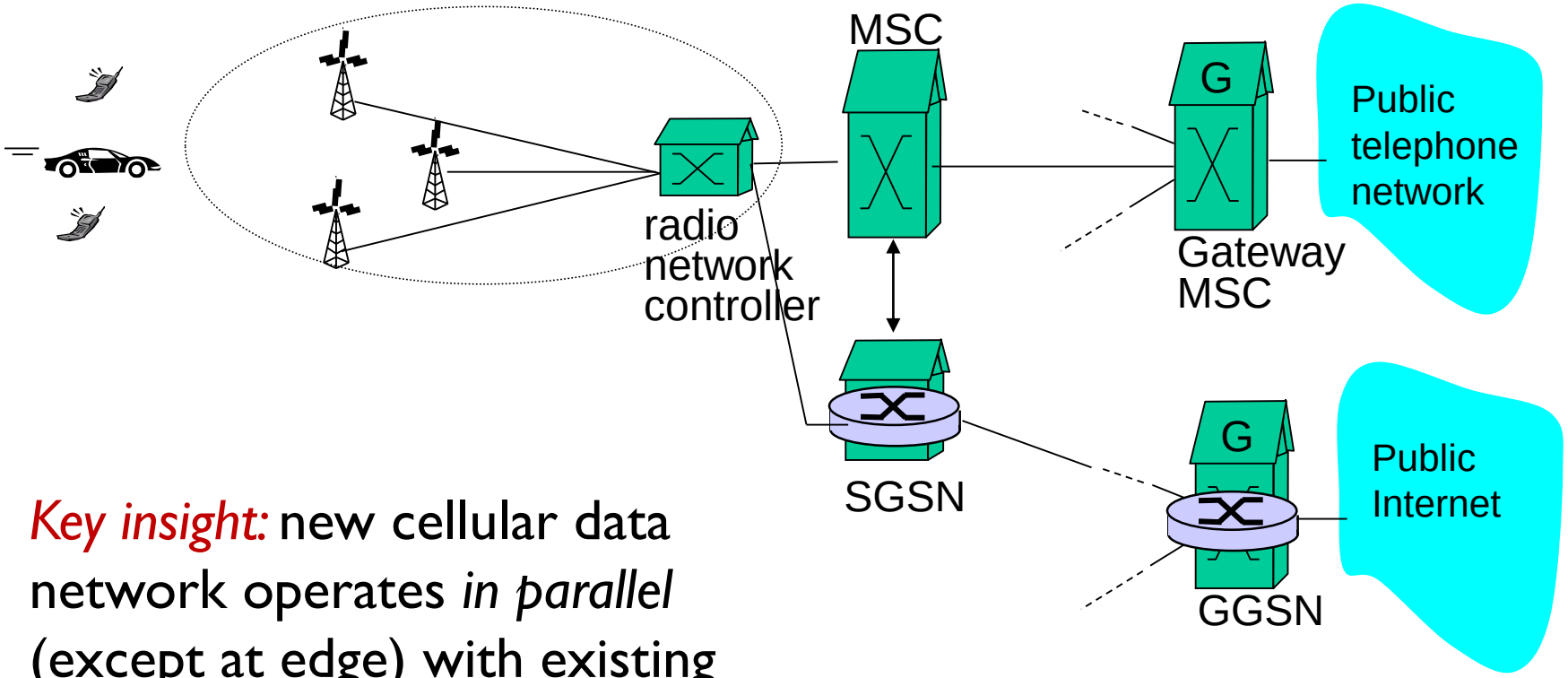
Base transceiver station (BTS)

Base station controller (BSC)

Mobile Switching Center (MSC)

Mobile subscribers

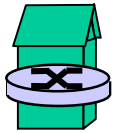
3G (voice+data) network architecture



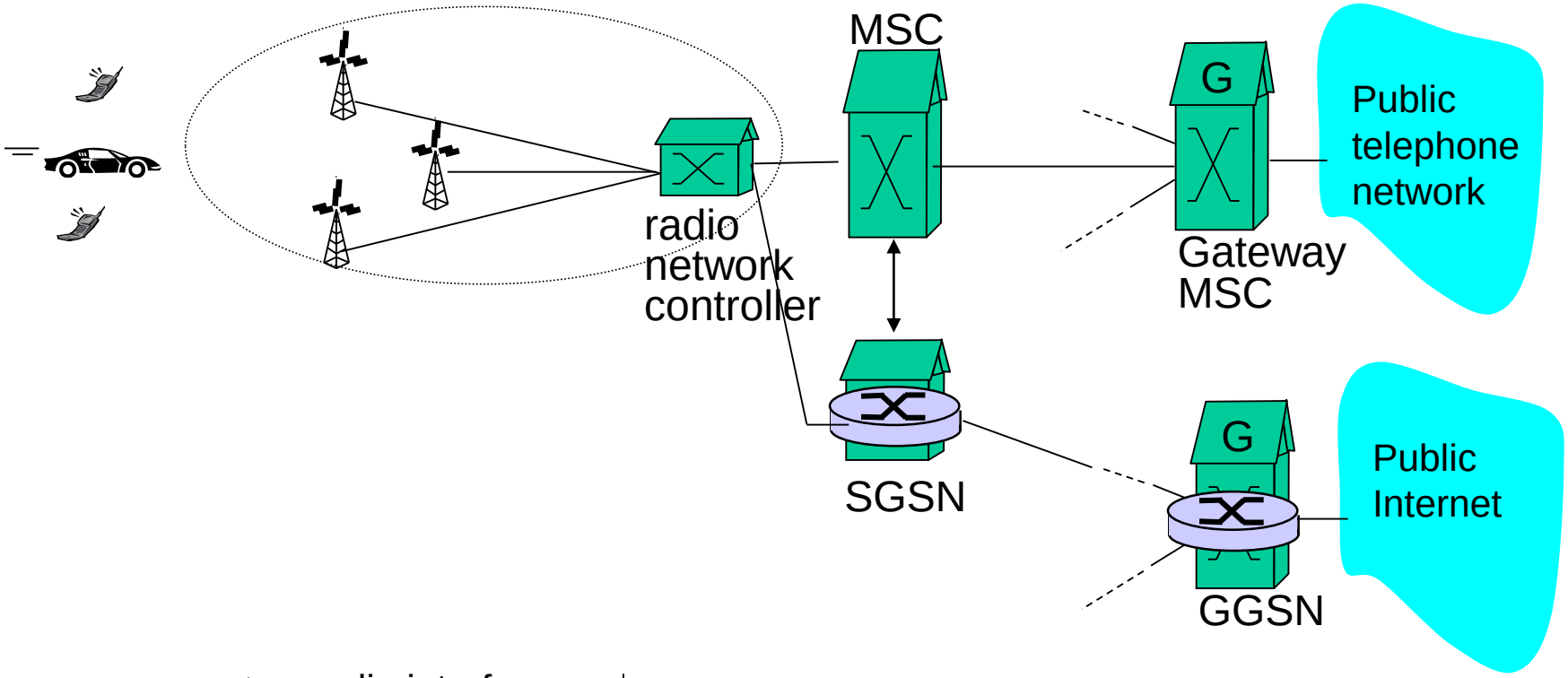
Key insight: new cellular data network operates *in parallel* (except at edge) with existing cellular voice network

- voice network unchanged in core
- data network operates in parallel


Serving GPRS Support Node (SGSN)


Gateway GPRS Support Node (GGSN)

3G (voice+data) network architecture



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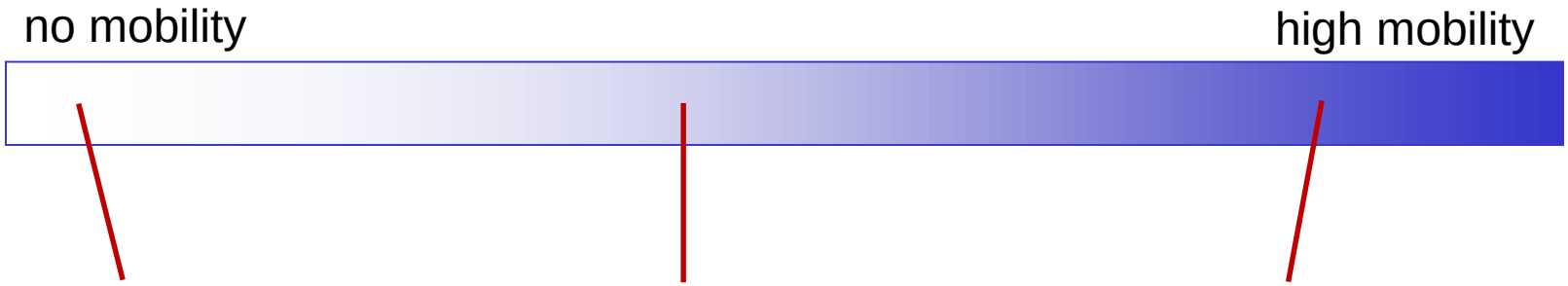
What is mobility?

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



mobile wireless user, using same access point

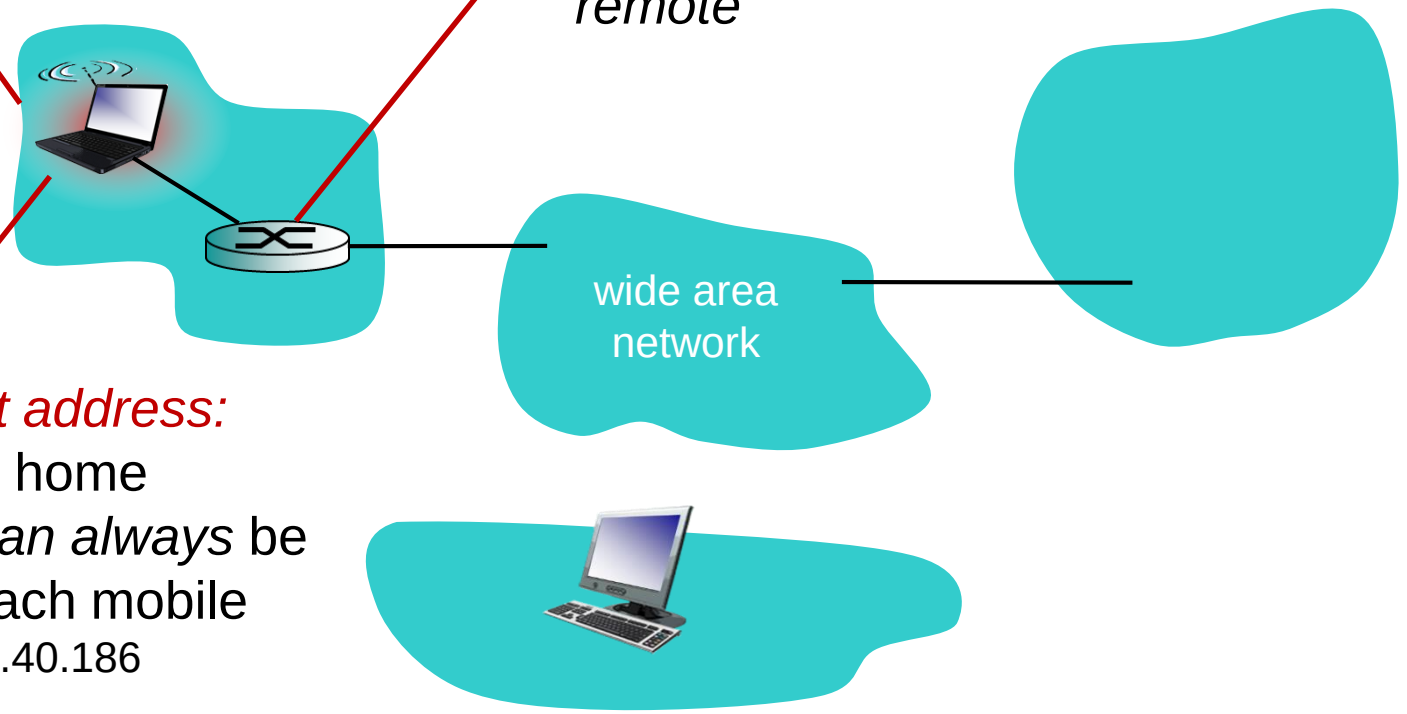
mobile user, connecting/ disconnecting from network using DHCP.

mobile user, passing through multiple access point while maintaining ongoing connections (like cell phone)

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



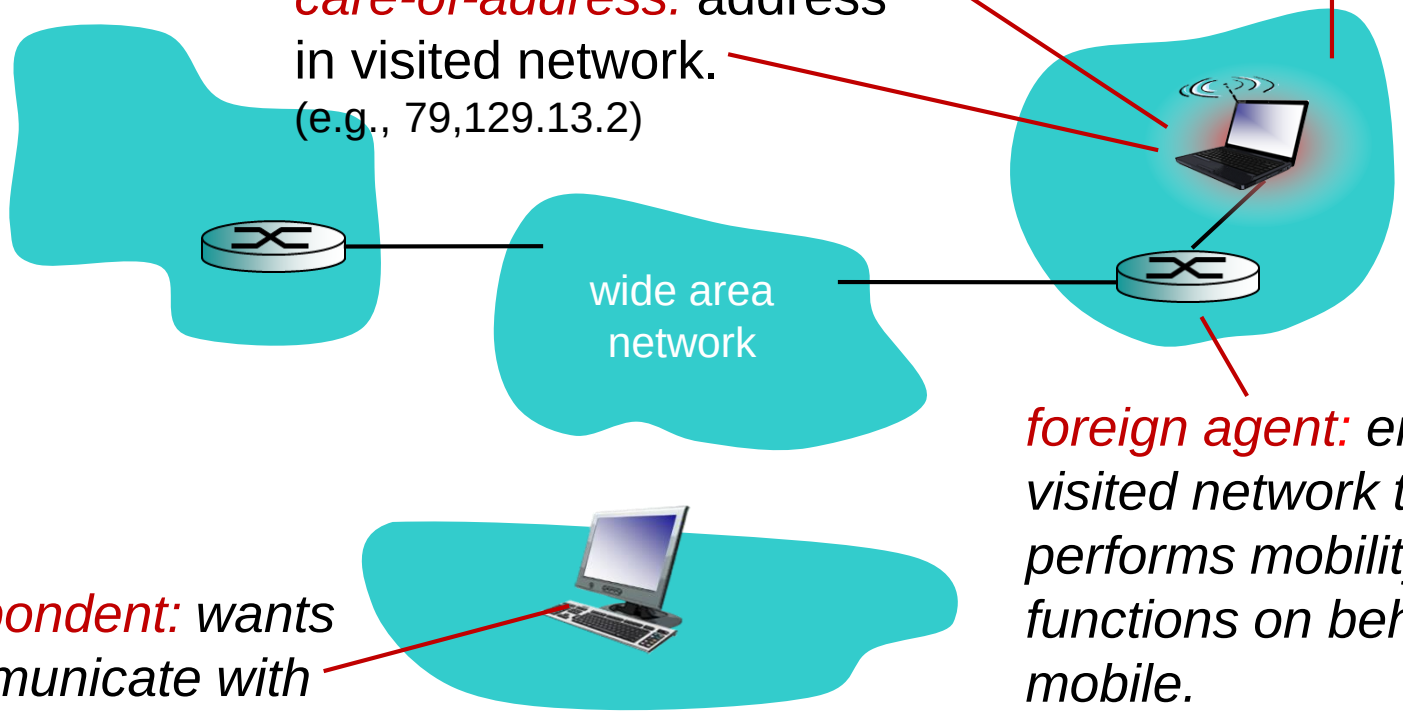
permanent address: address in home network, *can always* be used to reach mobile
e.g., 128.119.40.186

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)



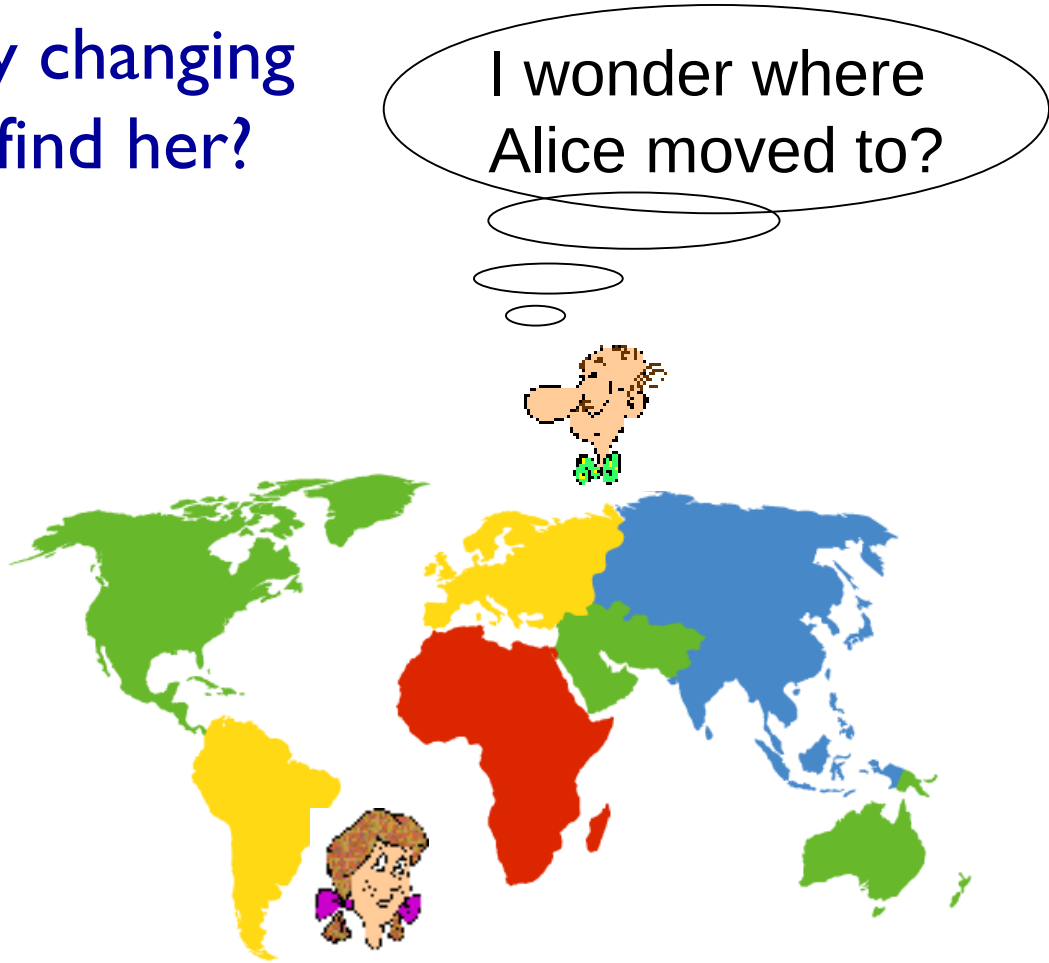
foreign agent: *entity in visited network that performs mobility functions on behalf of mobile.*

correspondent: *wants to communicate with mobile*

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 he/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

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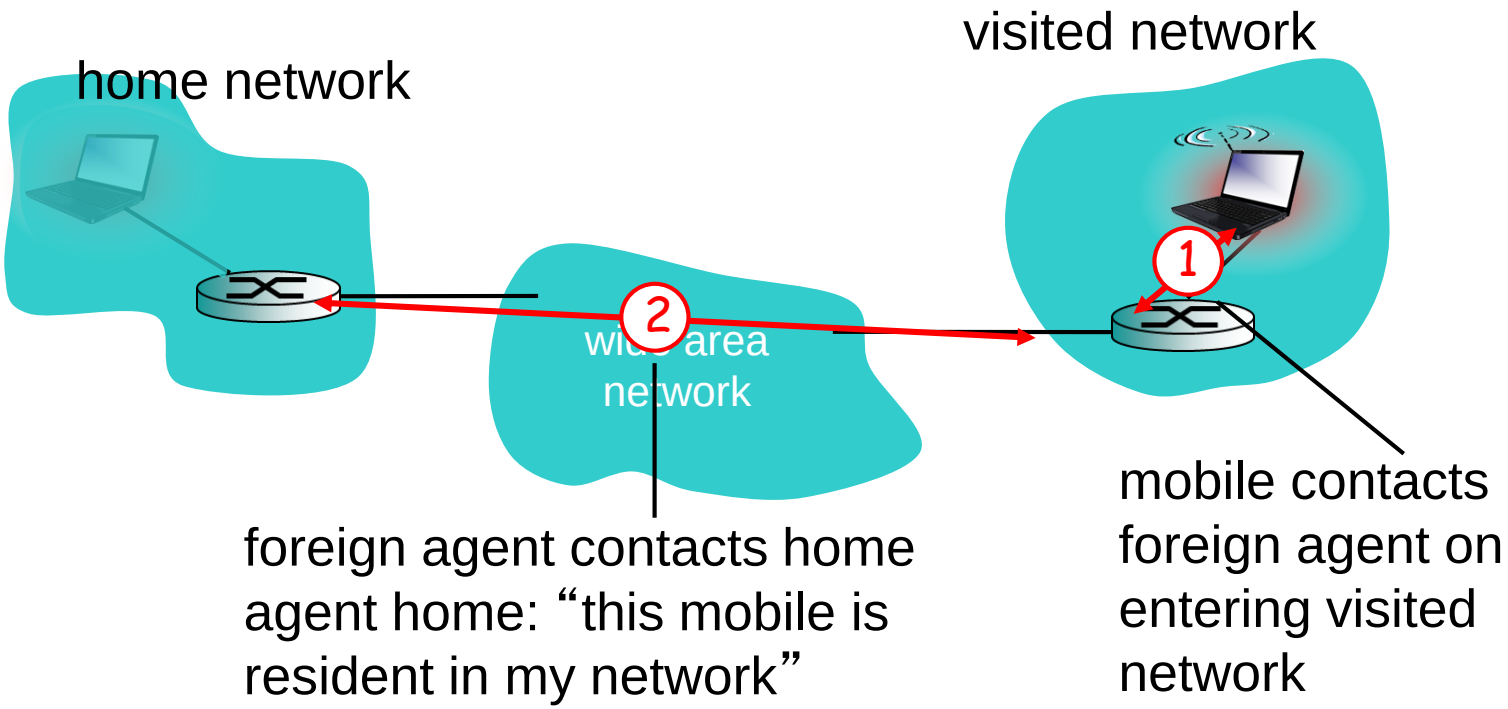
not scalable to millions of mobiles

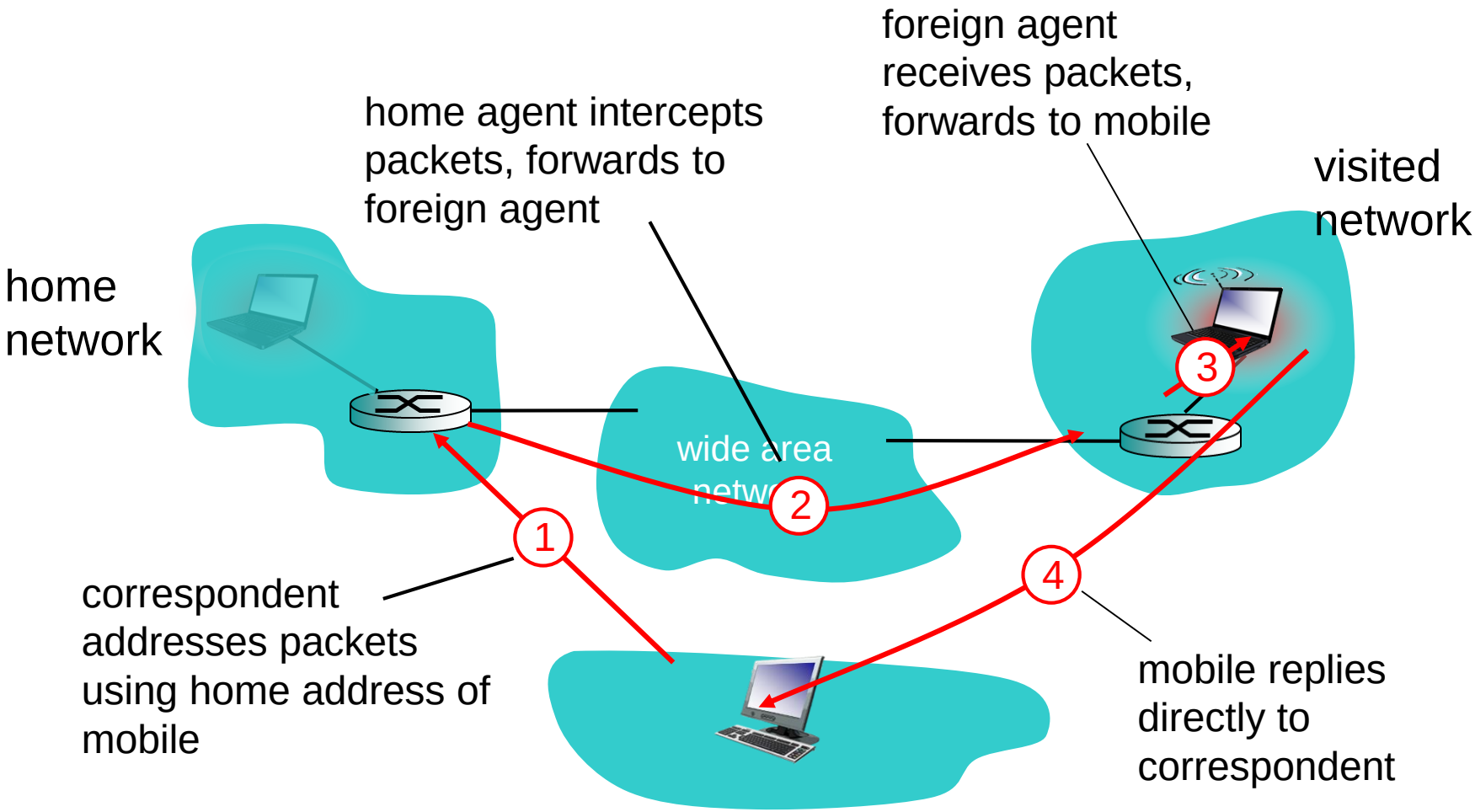
Mobility: registration



end result:

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

Mobility via indirect routing



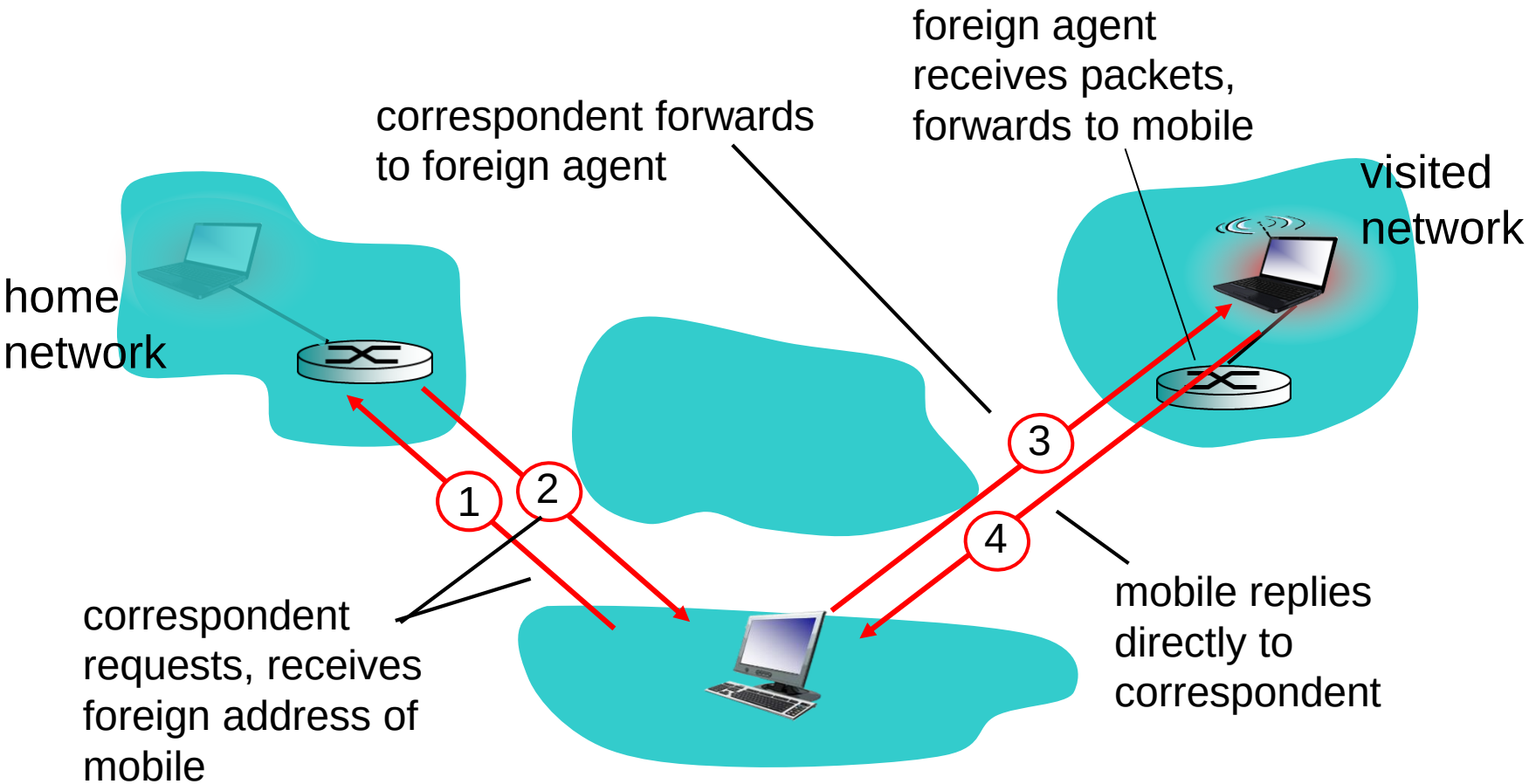
Indirect Routing: comments

- 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
- foreign agent functions may be done by mobile itself
- triangle routing: correspondent-home-network-mobile
  - inefficient when correspondent, mobile are in same network

Indirect routing: moving between networks

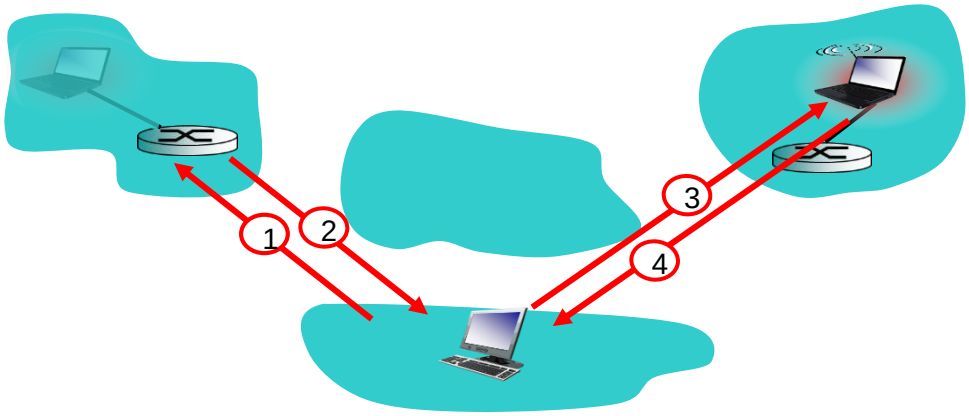
- suppose mobile user moves to another network
  - registers with new foreign agent
  - new foreign agent registers with home agent
  - home agent update care-of-address for mobile
  - packets continue to be forwarded to mobile (but with new care-of-address)
- mobility, changing foreign networks transparent: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

Mobility via direct routing



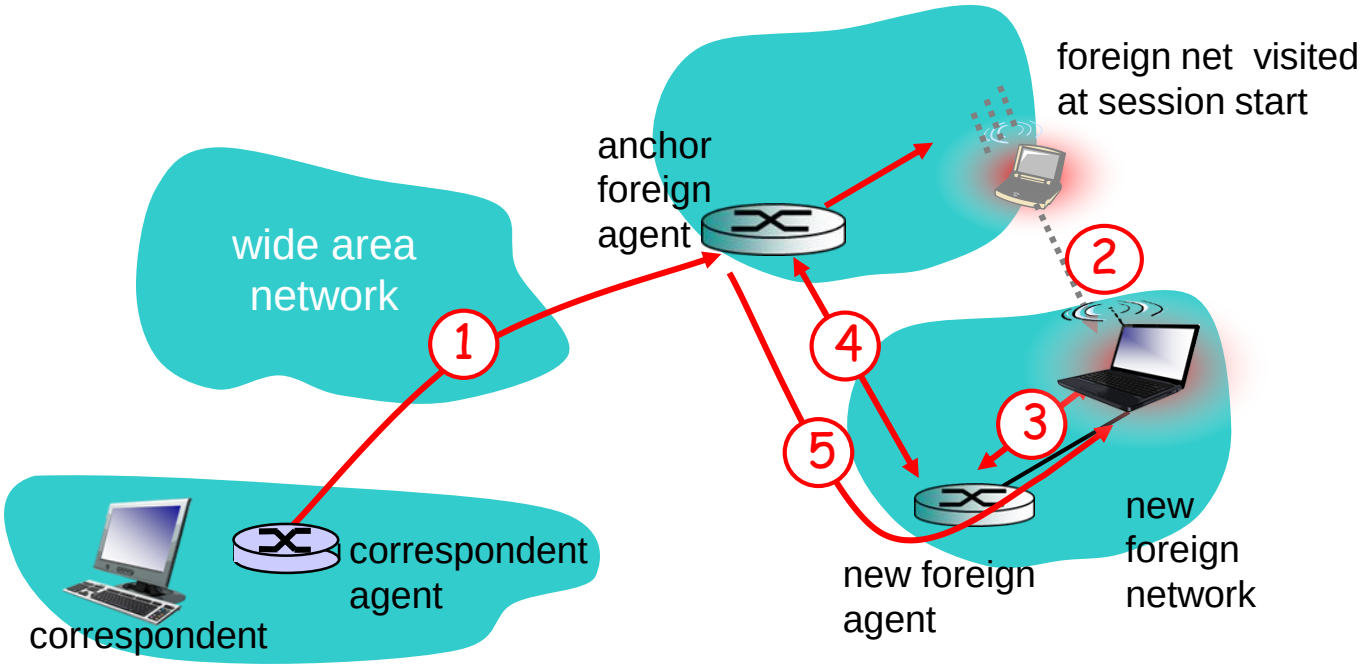
Mobility via direct routing: comments

- 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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