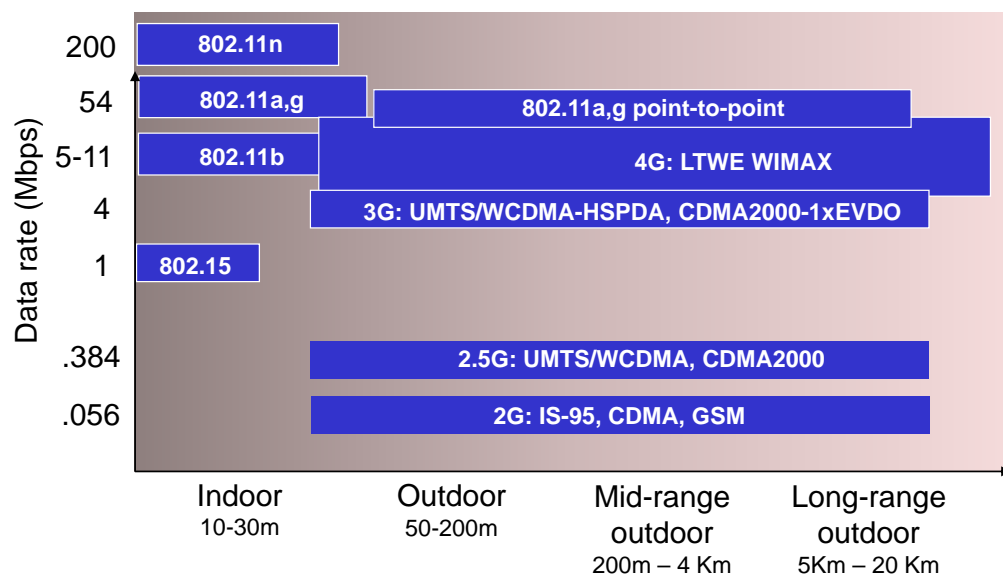


Wireless and Mobile Networks

- Reference
 - Chapter 06, *Computer Networking: A Top Down Approach*, 6/E, Jim Kurose, Keith Ross, Addison-Wesley
 - Adapted from part of the slides provided by the authors

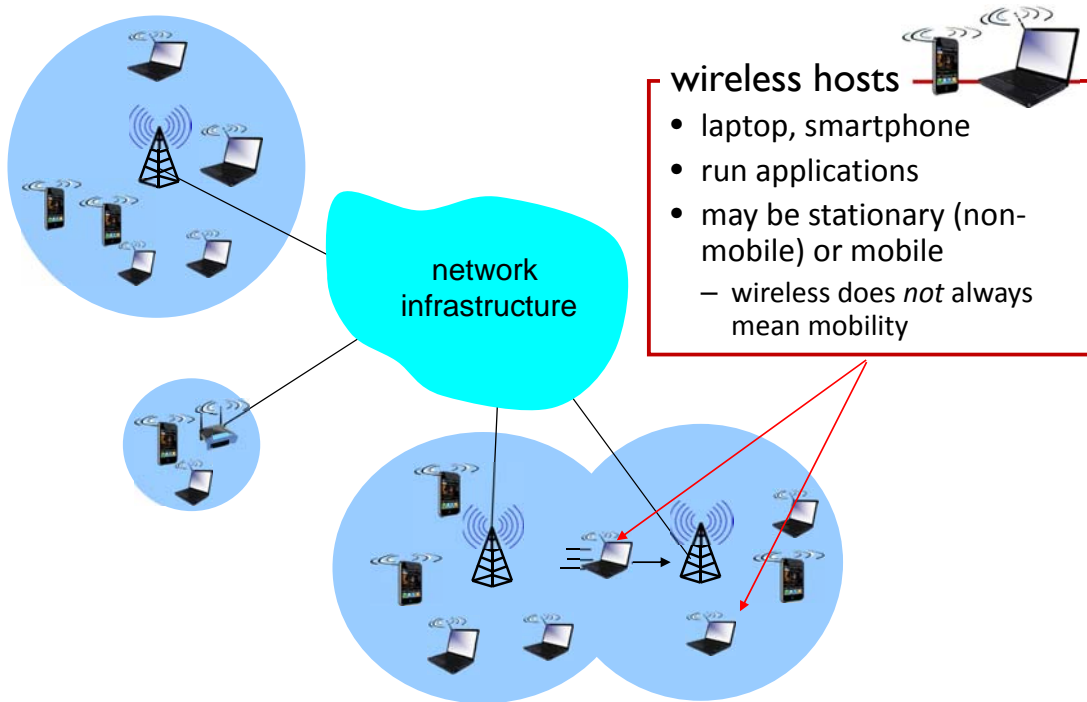
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Characteristics of selected wireless links



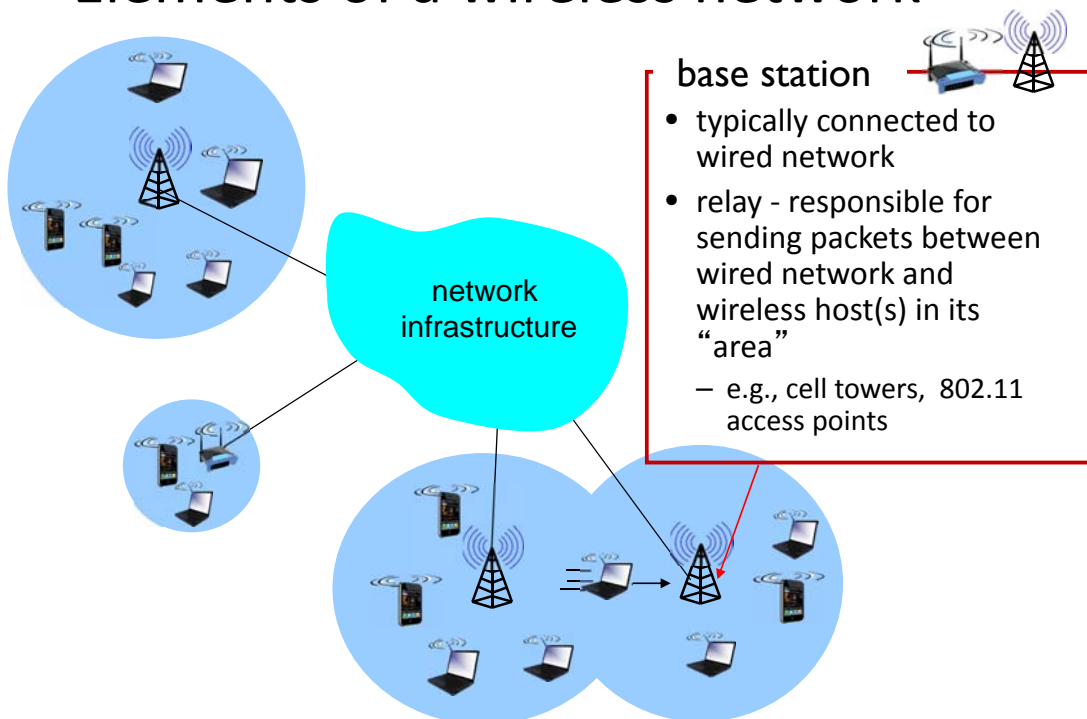
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Elements of a wireless network



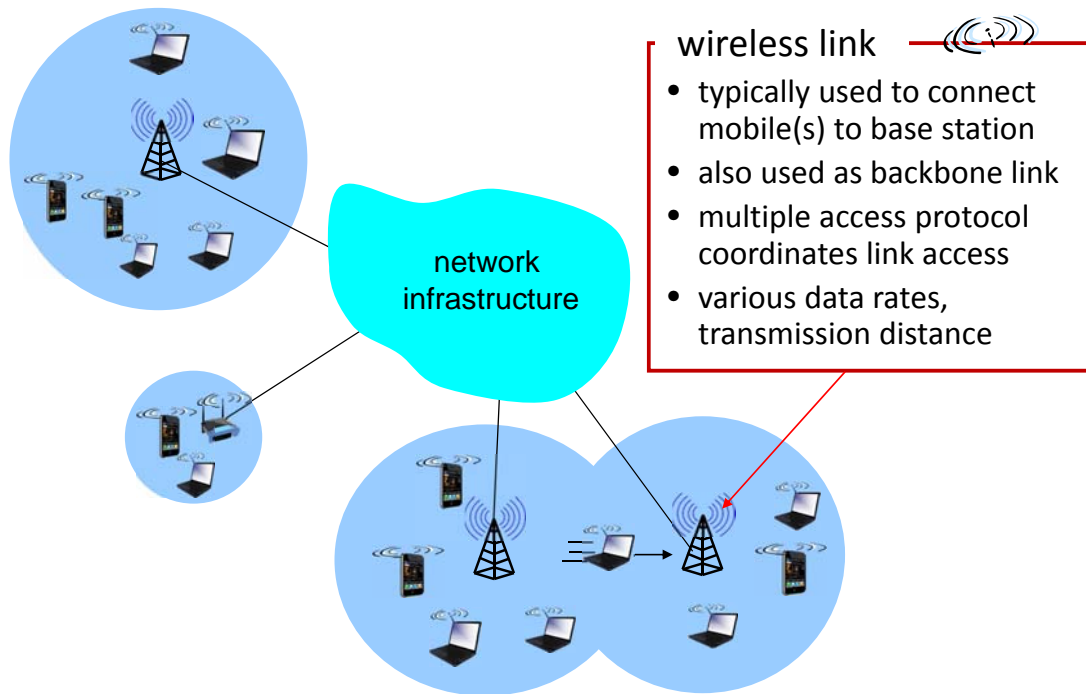
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Elements of a wireless network



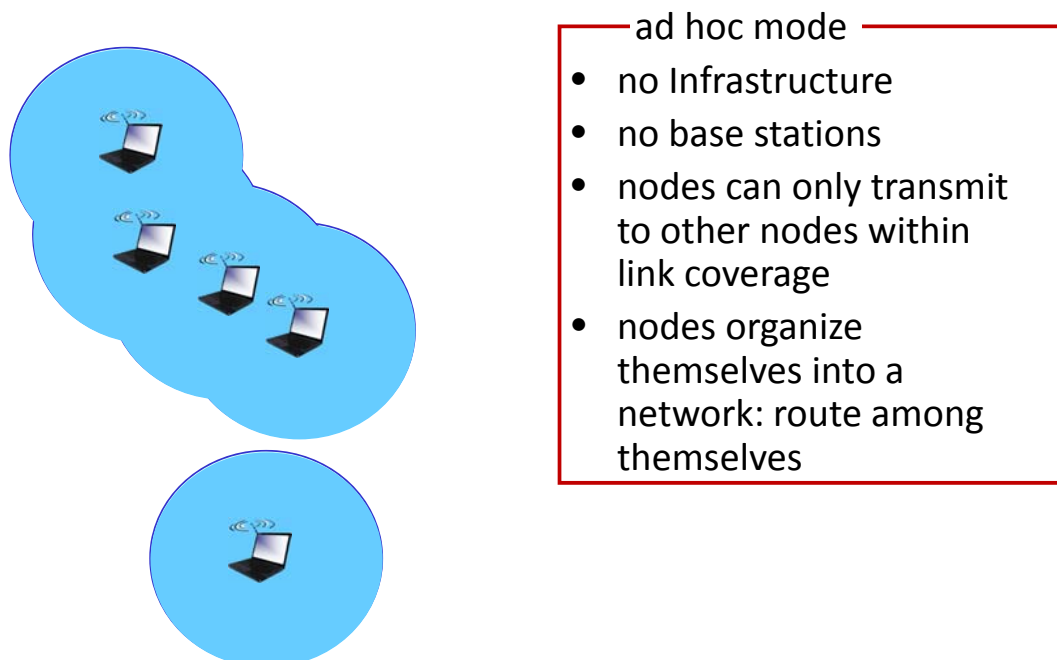
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Elements of a wireless network



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Elements of a wireless network



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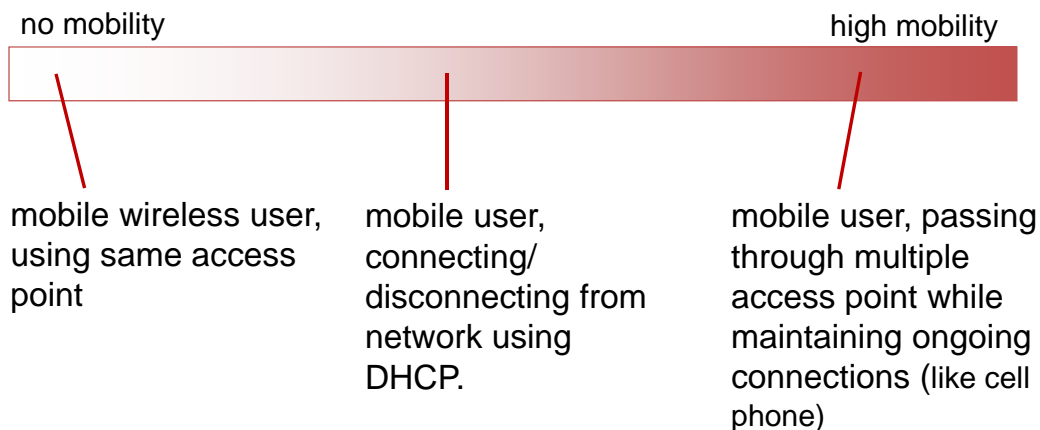
Wireless network taxonomy

	single hop	multiple hops
infrastructure (e.g., APs)	host connects to base station (WiFi, WiMAX, cellular) which connects to larger Internet	host may have to relay through several wireless nodes to connect to larger Internet: <i>mesh net</i>
no infrastructure	no base station, no connection to larger Internet (Bluetooth, ad hoc nets)	no base station, no connection to larger Internet. May have to relay to reach other a given wireless node MANET, VANET

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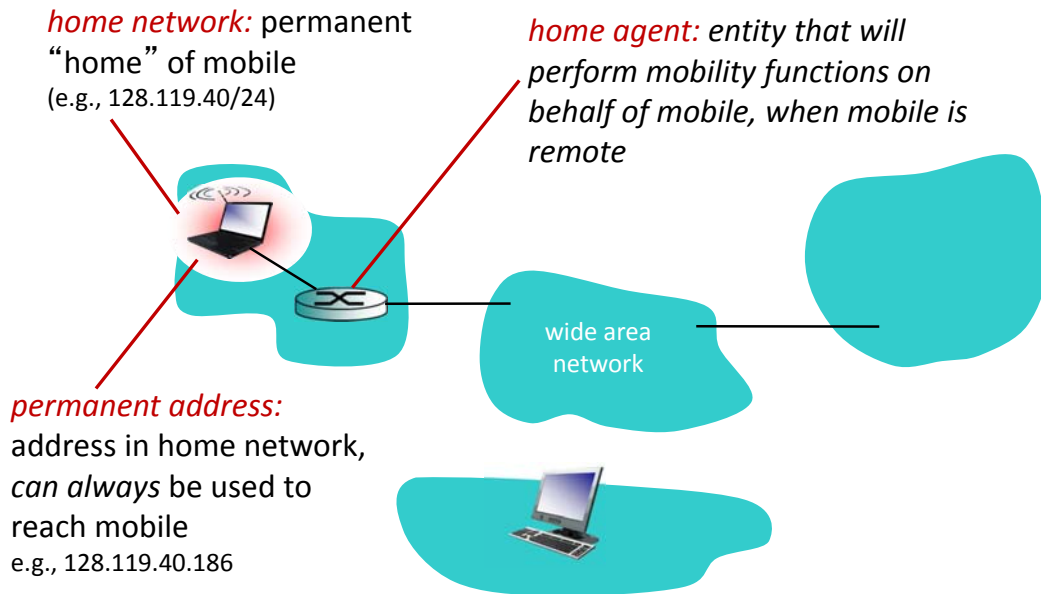
Mobility

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



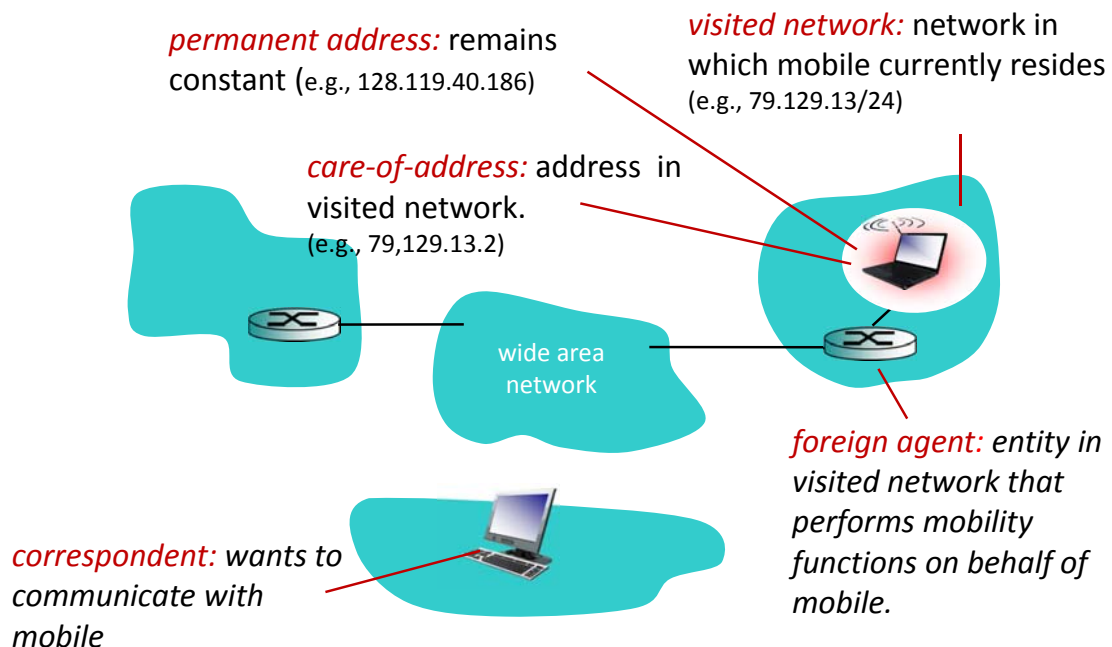
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Mobility: vocabulary



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Mobility: more vocabulary



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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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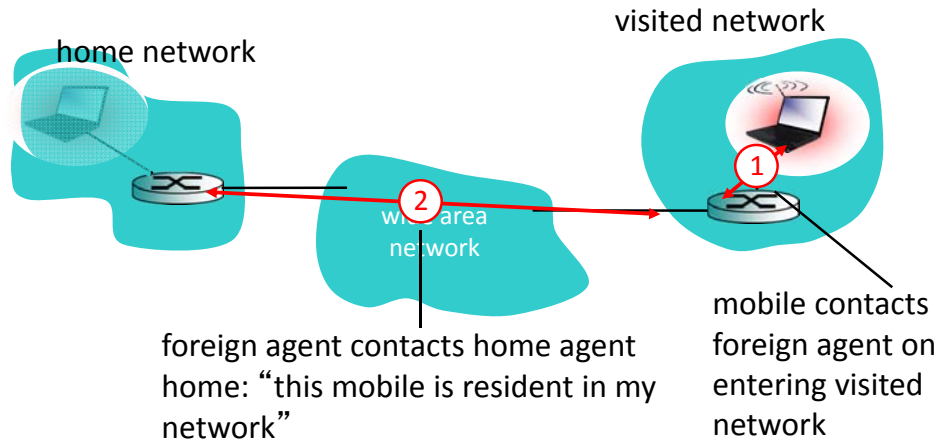
Mobility: approaches

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not
scalable
to millions of
mobiles

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Mobility: registration

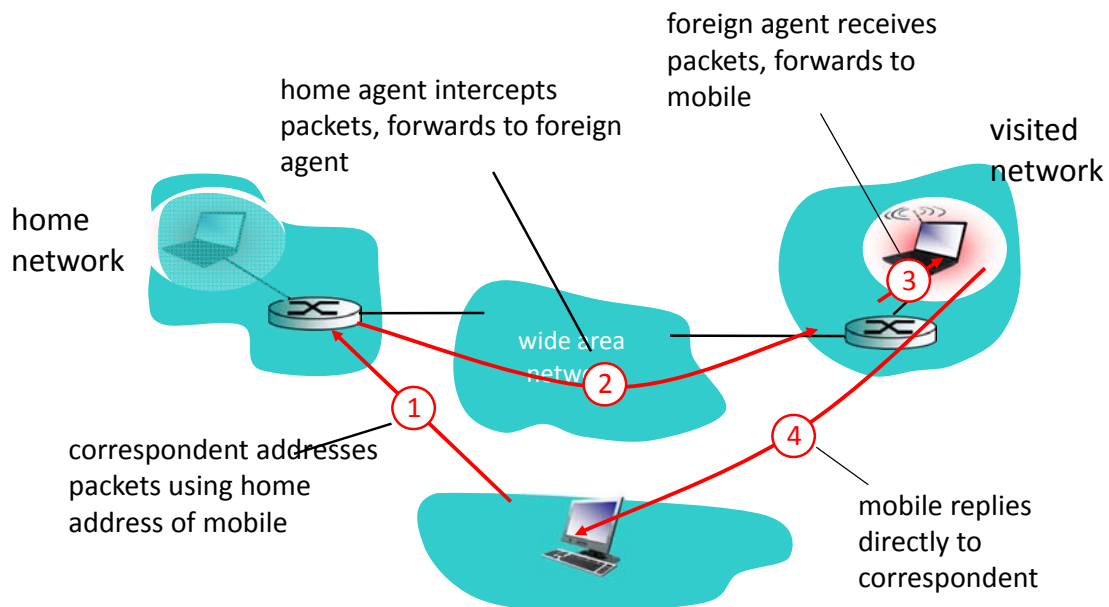


end result:

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

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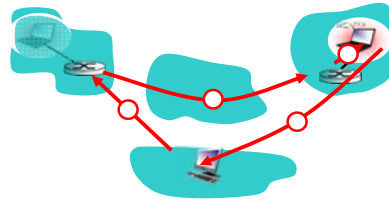
Mobility via indirect routing



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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



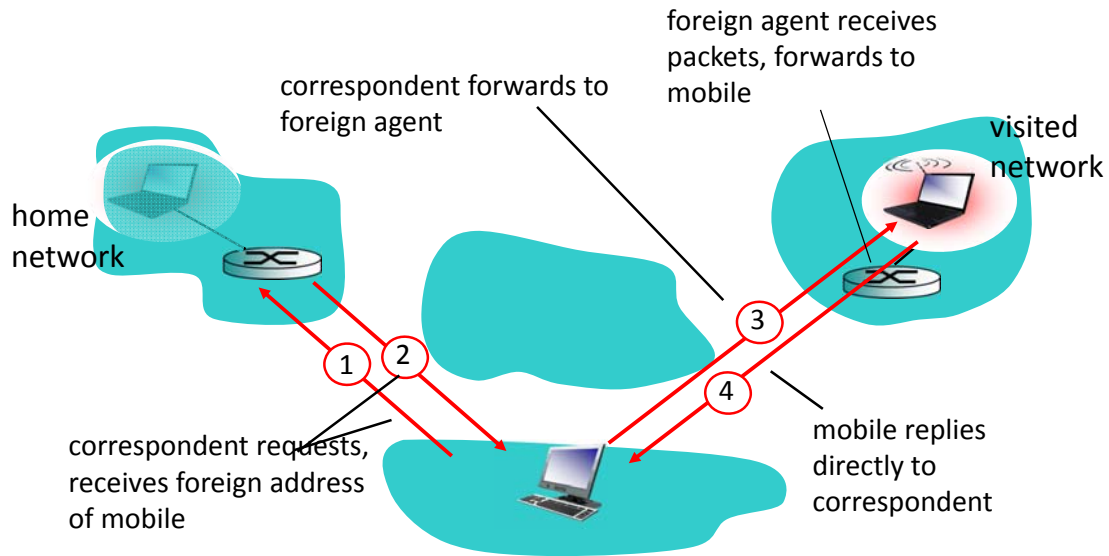
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Indirect routing: moving between networks

- 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!*

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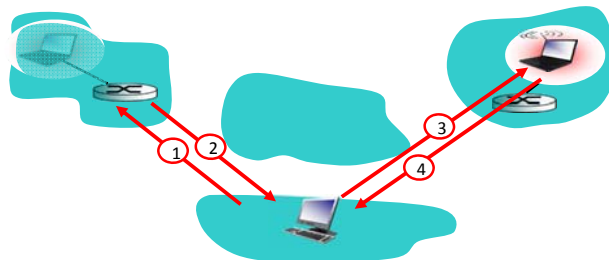
Mobility via direct routing



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Mobility via direct routing: comments

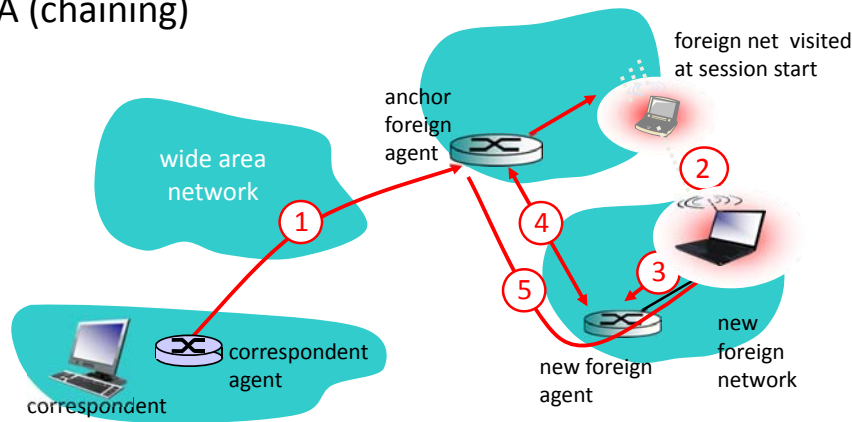
- overcome triangle routing problem
- *non-transparent to correspondent*: correspondent must get care-of-address from home agent
 - what if mobile changes visited network?



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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)



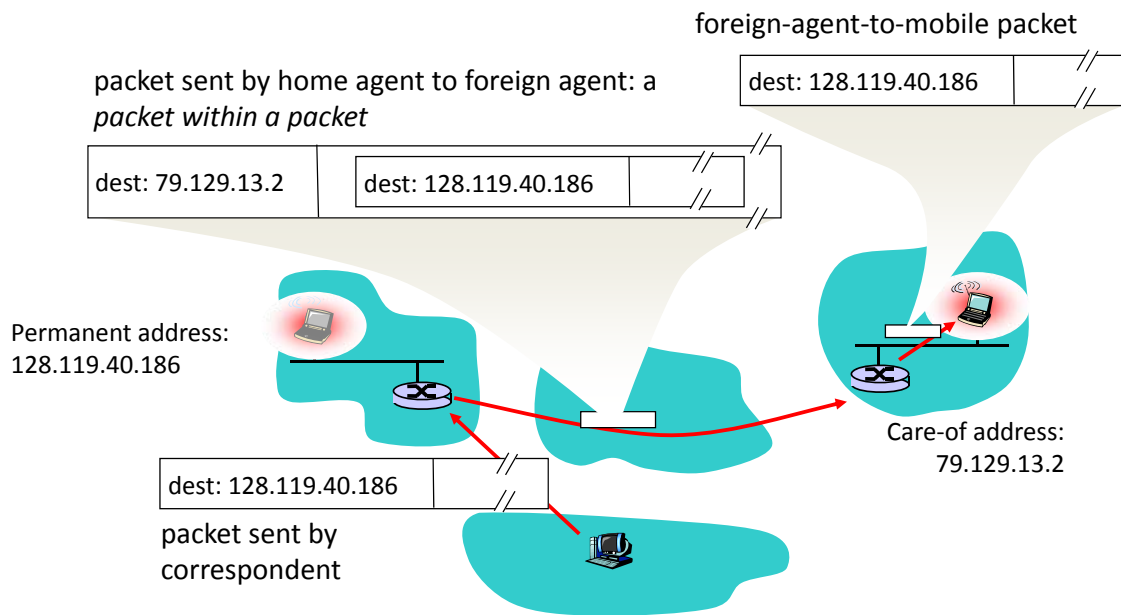
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Mobile IP

- 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

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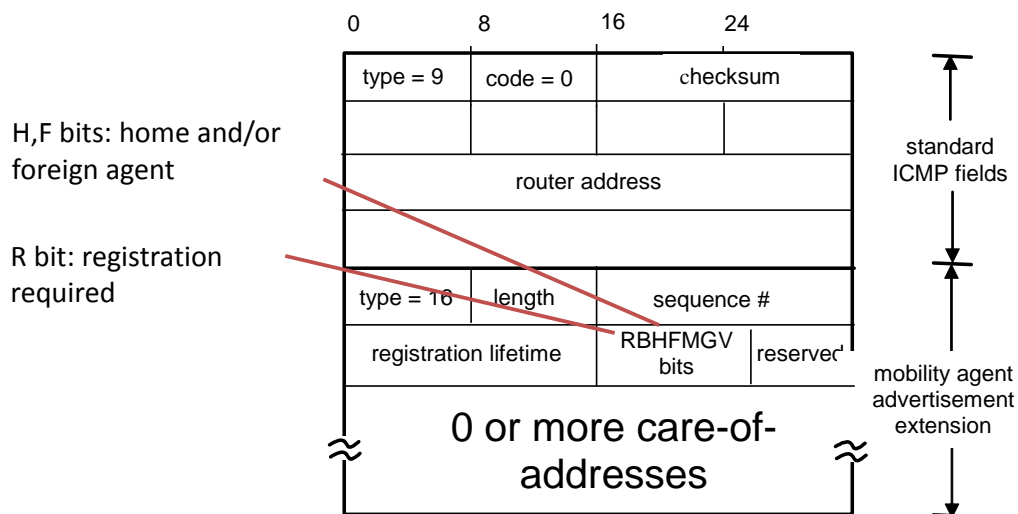
Mobile IP: indirect routing



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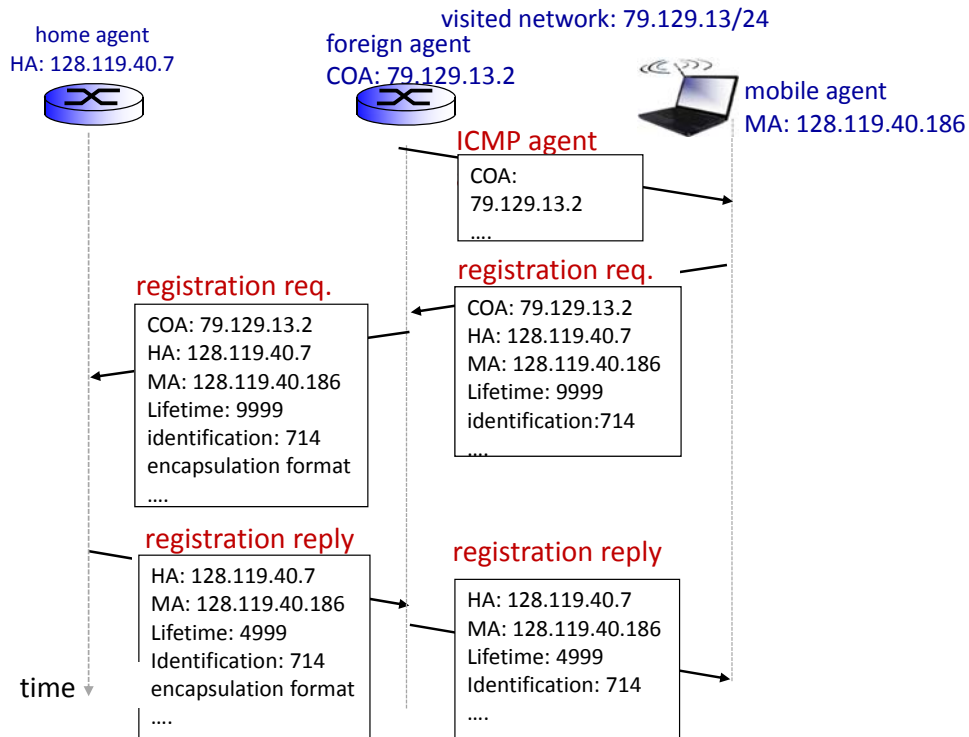
Mobile IP: agent discovery

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



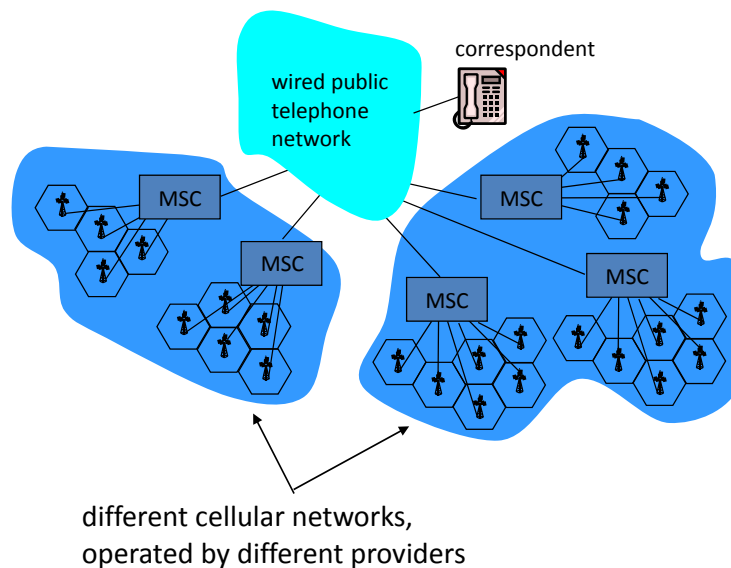
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Mobile IP: registration example



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Components of cellular network architecture



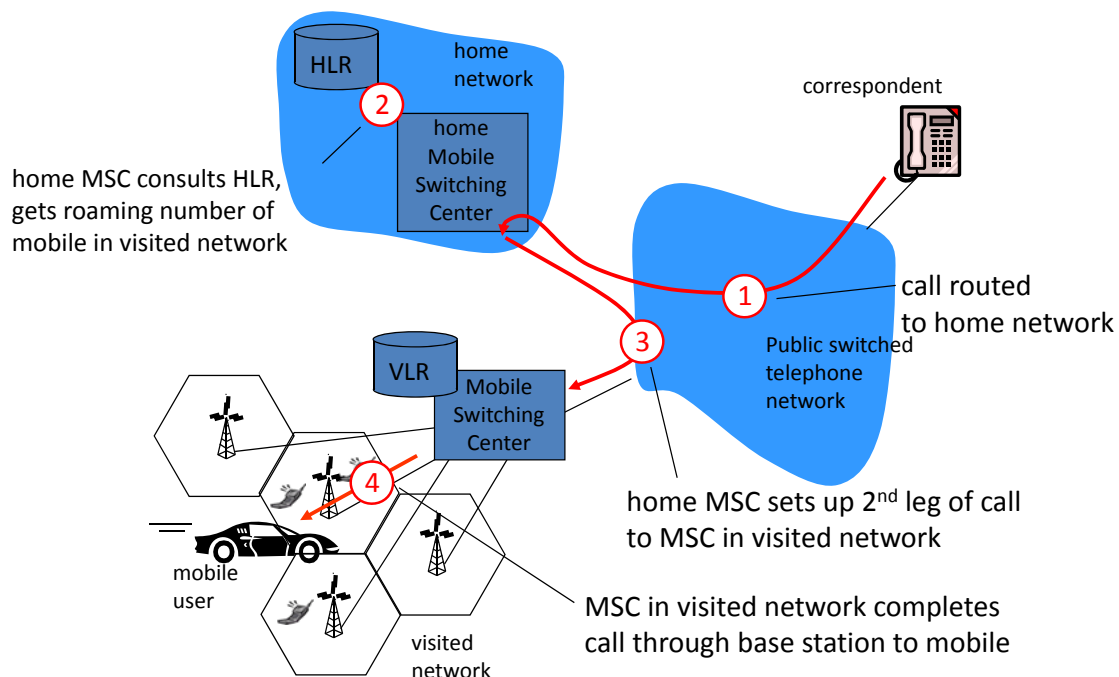
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Handling mobility in cellular networks

- **home network:** network of cellular provider you subscribe to (e.g., Sprint PCS, Verizon)
 - **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
 - could be home network

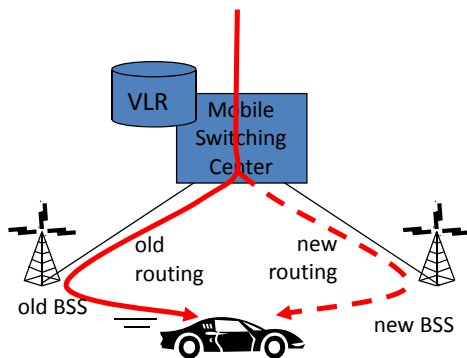
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GSM: indirect routing to mobile



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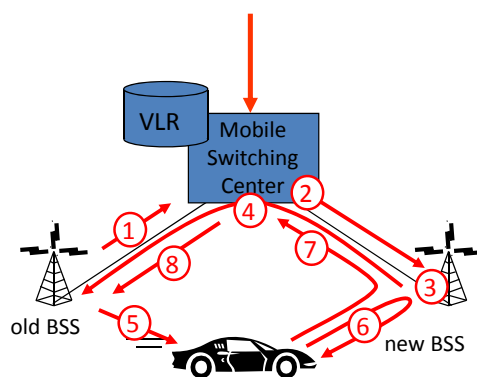
GSM: handoff with common MSC



- *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

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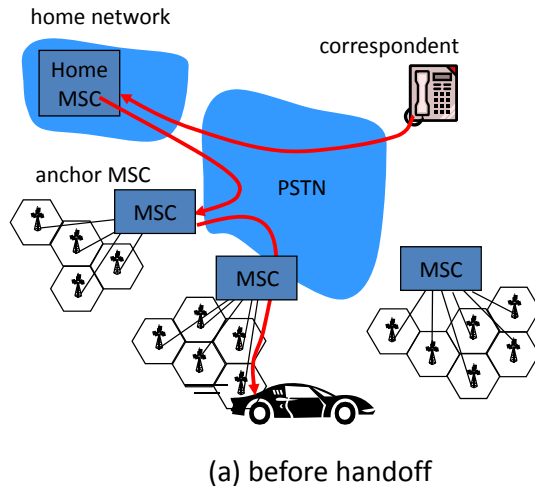
GSM: handoff with common MSC



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

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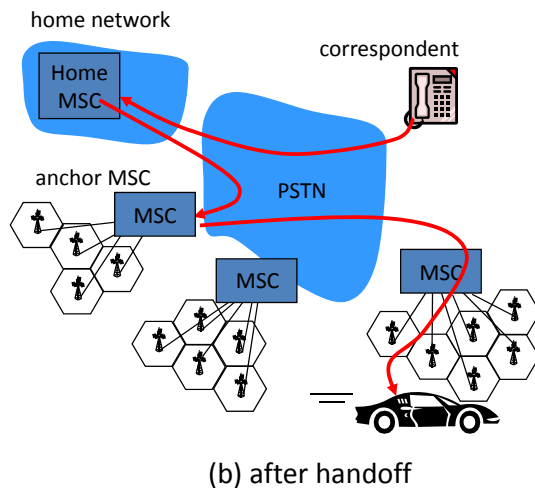
GSM: handoff between MSCs



- *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

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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