

Administrivia

- ❑ No lecture on Thurs.
- ❑ Last homework will be out this week (not due, covers wireless)
- ❑ Extra office hours for next week and the week after.

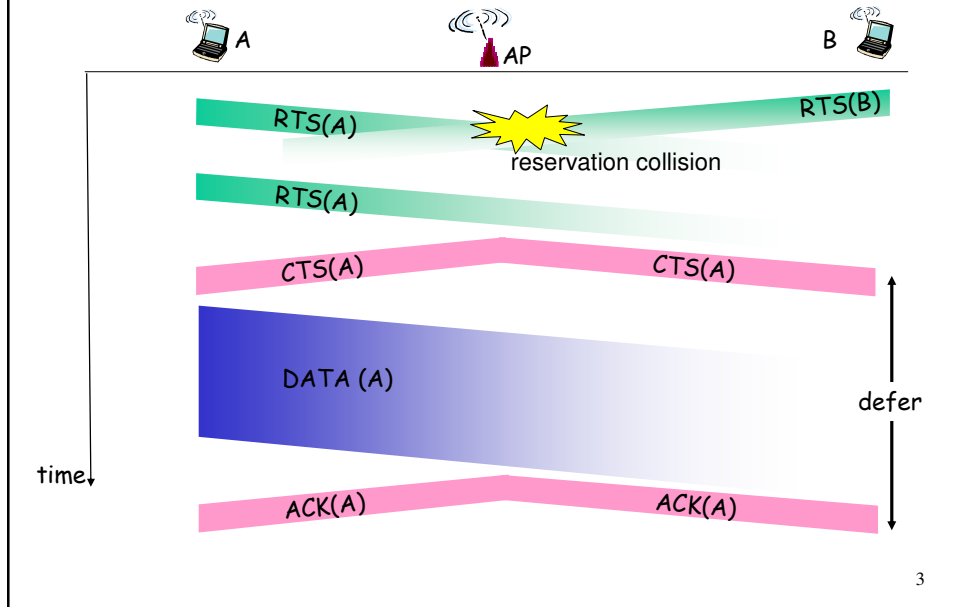
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CSMA/CA: Recap

- ❑ Sensing in wireless medium is limited by hidden terminal problem.
- ❑ Collision detection is limited by half-duplex nature of radios (cannot talk and listen at the same time)
- ❑ Collision avoidance is the key!
 - Random backoff after sensing busy slot
 - RTS/CTS reservation protocol

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Collision Avoidance: RTS-CTS exchange



Channel Partitioning, Random Access and Scheduling

- ❑ Channel partitioning (GSM, CDMA, etc) is inflexible in accomodating bursty traffic.
- ❑ Random access allows "on-demand" allocation, but has significant overhead due to collision or RTS/CTS.
- ❑ 4th generation cellular systems are shifting to explicit centralized scheduling of resources by the BS.

Mobility Management

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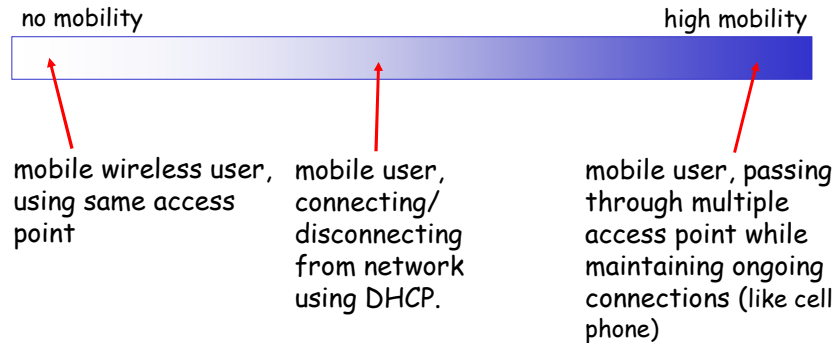
Mobility Management

- General principles
- Cellular network examples.

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What is mobility?

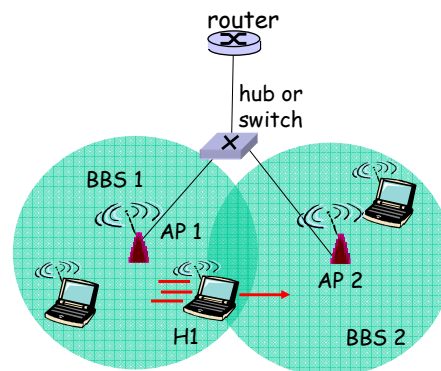
- spectrum of mobility, from the *network* perspective:



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Example (simple): mobility within same 802.11 subnet

- H1 remains in same IP subnet: IP address can remain same
- switch: which AP is associated with H1?
 - self-learning (Ch. 5): switch will see frame from H1 and "remember" which switch port can be used to reach H1



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Wide-Area Mobility Management

- ❑ In the 802.11 example, mobility is handled at the link layer.
- ❑ For wide-area roaming, it must be handled at the network layer.
- ❑ Issues:
 - How to find the destination?
 - How to route stuff to the destination?
 - How to update and keep track of its location?

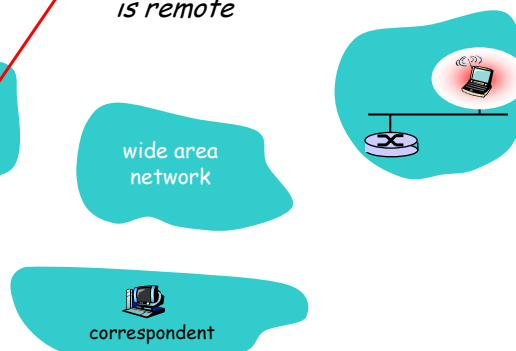
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Mobility: Vocabulary

home network: permanent "home" of mobile
(e.g., 128.119.40/24, Verizon)

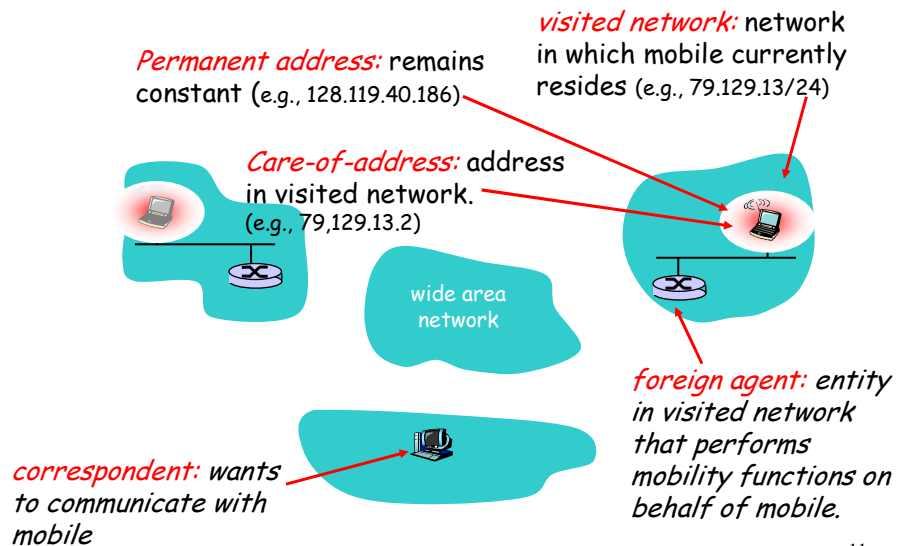
home agent: entity that will perform mobility functions on behalf of mobile, when mobile is remote

Permanent address: address in home network, *can always* be used to reach mobile
e.g., 128.119.40.186,
(510) 642-5807



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Mobility: more vocabulary



Mobility: approaches

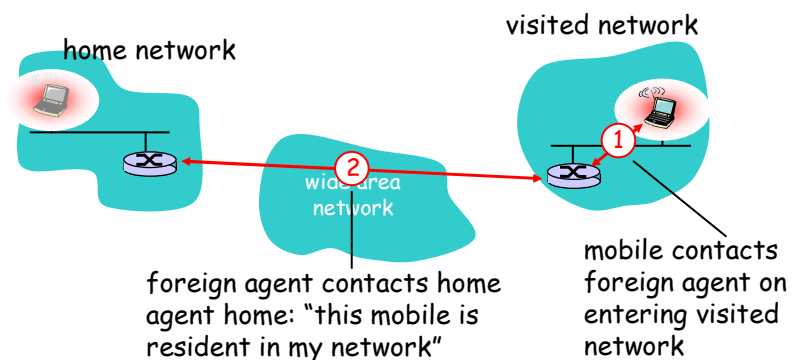
- *Let routing handle it:* routers advertise permanent address of mobile-nodes-in-residence via usual routing table exchange.
 - routing tables indicate where each mobile located
 - no changes to end-systems
- *Let end-systems handle it:*
 - *indirect routing:* communication from correspondent to mobile 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's residence via usual routing table entries
 - routing table entries for each mobile located
 - no changes to routing tables as mobiles move
- *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 from home agent, sends directly to mobile

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Mobility: registration

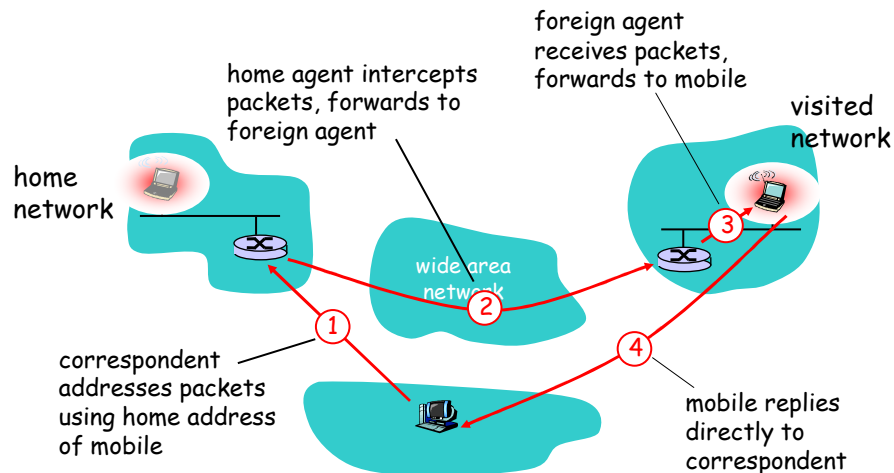


End result:

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

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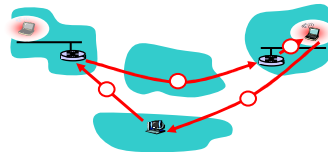
Mobility via Indirect Routing



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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
- triangle routing: correspondent-home-network-mobile
 - inefficient when correspondent, mobile are in same network



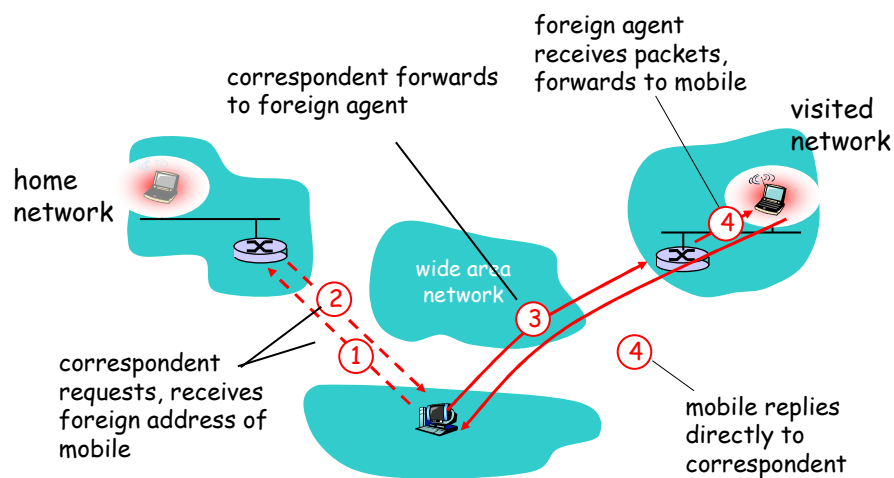
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Indirect Routing: moving between networks

- 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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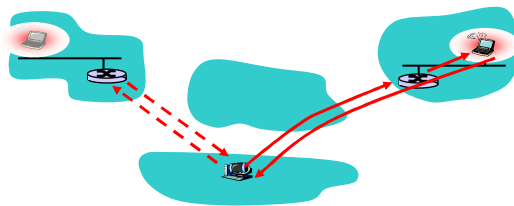
Mobility via Direct Routing



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Mobility via Direct Routing: comments

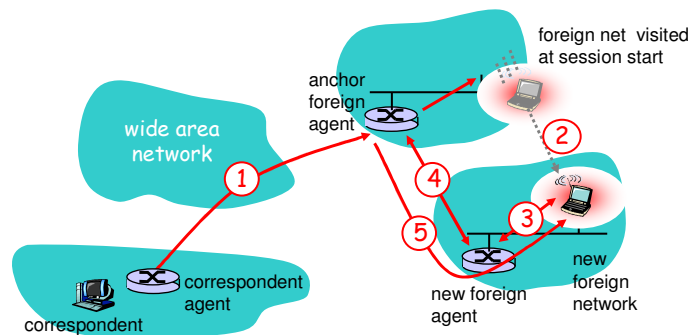
- ❑ overcome triangle routing problem
- ❑ **non-transparent to correspondent:**
correspondent must get care-of-address from home agent
- ❑ what if mobile changes visited network?



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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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Examples

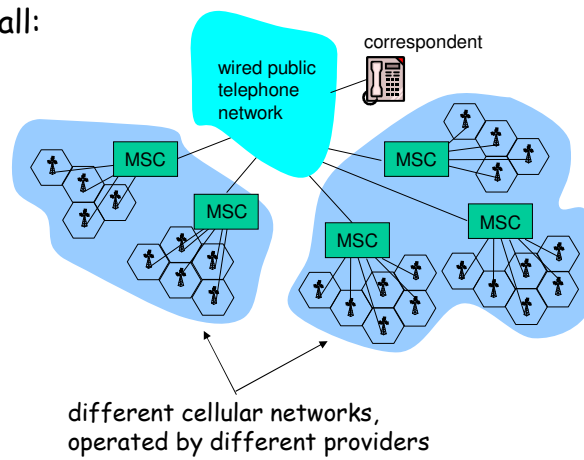
- Mobile IP
- Cellular networks

Will focus on latter.

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Components of cellular network architecture

recall:



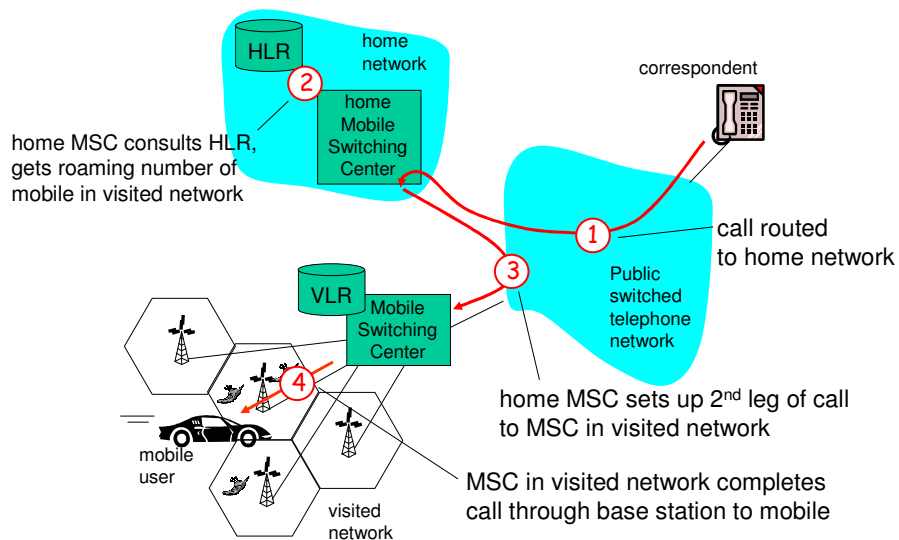
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Handling mobility in cellular networks

- **home network:** network of cellular provider you subscribe to (e.g., Sprint, 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

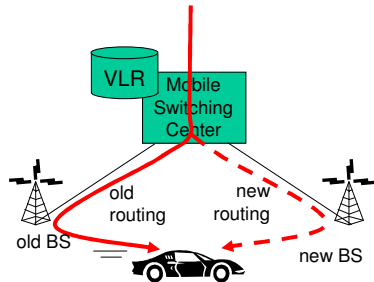
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GSM: indirect routing to mobile



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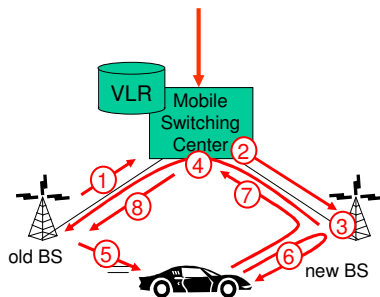
GSM: handoff with common MSC



- Handoff goal: route call via new base station (without interruption)
- reasons for handoff:
 - stronger signal to/from new BS (continuing connectivity, less battery drain)
 - load balance: free up channel in current BS
 - GSM doesn't mandate why to perform handoff (policy), only how (mechanism)
- handoff initiated by old BS

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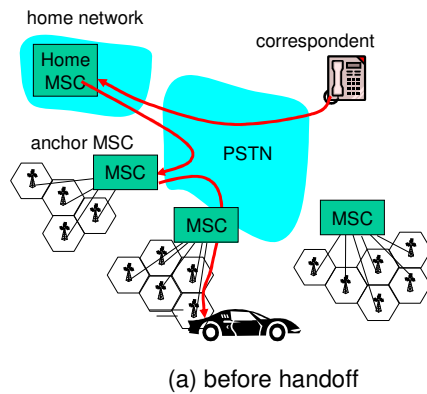
GSM: handoff with common MSC



0. Mobile measures signal strength from adjacent BS's based on beacons.
1. old BS informs MSC of impending handoff, provides list of 1+ new BS's
2. MSC sets up path (allocates resources) to new BS
3. new BS allocates radio channel for use by mobile
4. new BS signals MSC, old BS: ready
5. old BS tells mobile: perform handoff to new BS
6. mobile, new BS signal to activate new channel
7. mobile signals via new BS to MSC: handoff complete. MSC reroutes call
8. MSC-old-BS resources released

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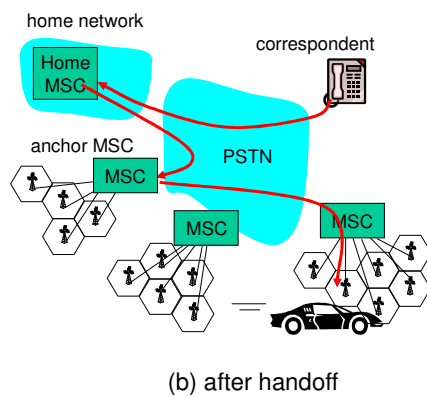
GSM: handoff between MSCs



- *anchor MSC*: first MSC visited during cal
 - call remains routed through anchor MSC
- new MSCs add on to end of MSC chain as mobile moves to new MSC

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Soft vs Hard Handoff

- ❑ In *GSM*, a mobile is connected to only one BSS at any one time.
- ❑ Handoff entails changing channels.
- ❑ In *CDMA*, all users occupy the entire bandwidth (1.25 MHz).
- ❑ Two BSS's can be simultaneously listening to the mobile and pass their decisions and their reliability to the MSC.
- ❑ The MSC decides based on the better decision at the moment.
- ❑ Soft handoff provides a form of **macrodiversity**.

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