

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.

1

Channel Partitioning, Random Access and Scheduling

- Channel partitioning (GSM, CDMA, etc) is inflexible in accomdating 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.

4

CSMA/CA: Recap

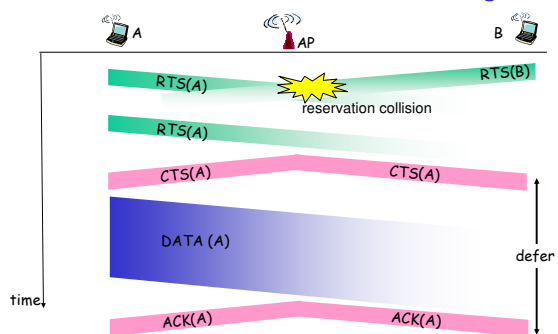
- Sensing in wireless medium is limited by hidden terminal problem.
- Collision detection is limited by half-duplex nature of radios (cannot talk and listen at the same time)
- Collision avoidance is the key!
 - Random backoff after sensing busy slot
 - RTS/CTS reservation protocol

2

Mobility Management

5

Collision Avoidance: RTS-CTS exchange



3

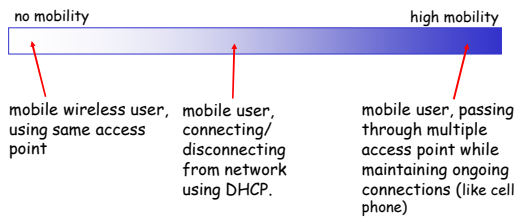
Mobility Management

- General principles
- Cellular network examples.

6

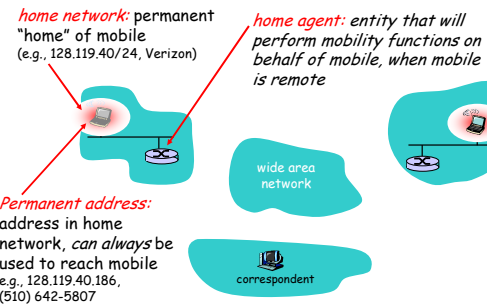
What is mobility?

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



7

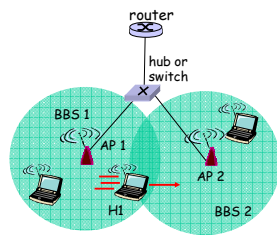
Mobility: Vocabulary



10

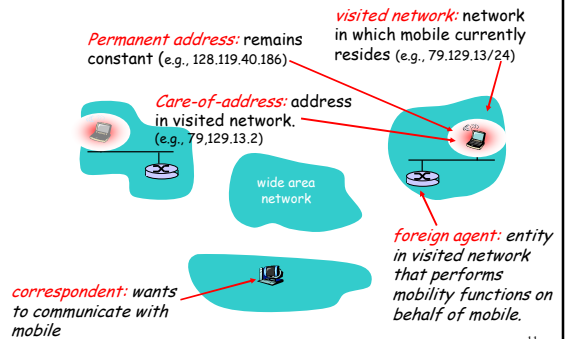
Example (simple): mobility within same 802.11 subnet

- 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



8

Mobility: more vocabulary



11

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?

9

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

12

Mobility: approaches

- Let routing handle routers advertise permanent address of mobile, router residence via usual routing table ex:
 - routing table not scalable to millions of mobiles
 - 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

13

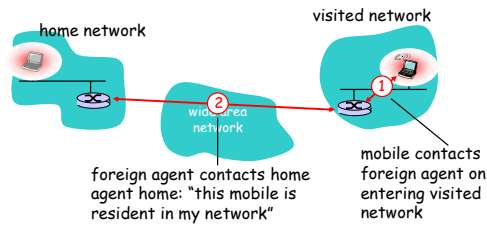
Indirect Routing: comments

- 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



16

Mobility: registration



End result:

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

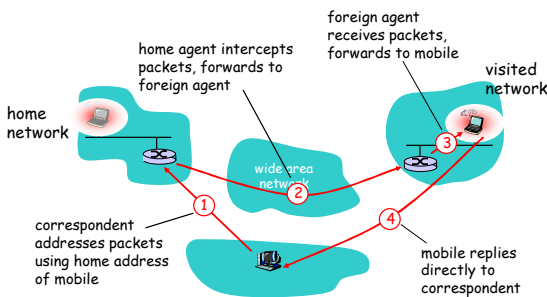
14

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!*

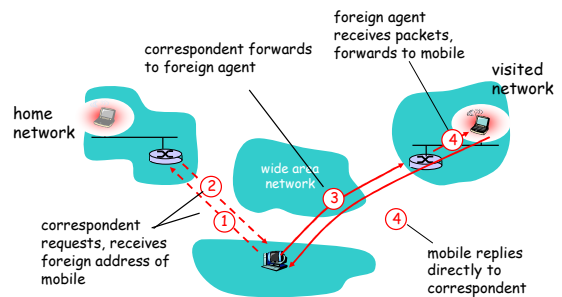
17

Mobility via Indirect Routing



15

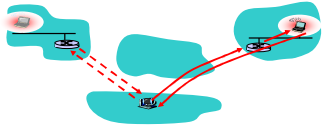
Mobility via Direct Routing



18

Mobility via Direct Routing: comments

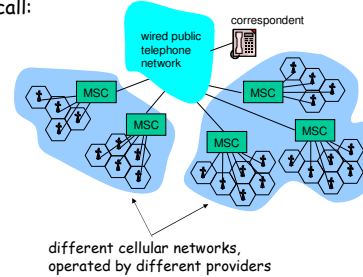
- overcome triangle routing problem
- **non-transparent to correspondent:** correspondent must get care-of-address from home agent
- what if mobile changes visited network?



19

Components of cellular network architecture

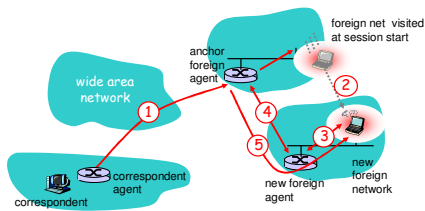
recall:



22

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)



20

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

23

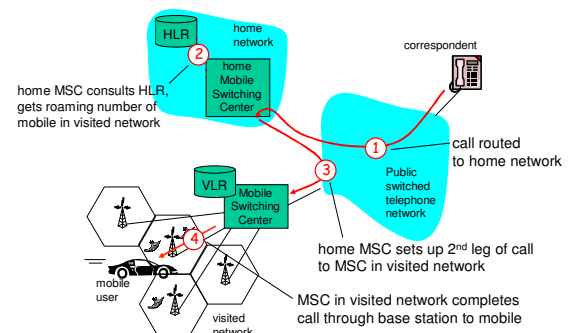
Examples

- Mobile IP
- Cellular networks

Will focus on latter.

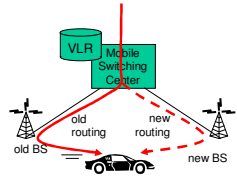
21

GSM: indirect routing to mobile



24

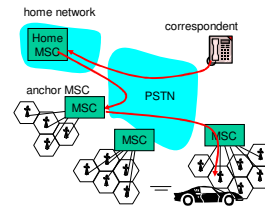
GSM: handoff with common MSC



- 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

25

GSM: handoff between MSCs

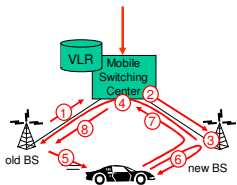


- **anchor MSC**: first MSC visited during call
 - call remains routed through anchor MSC
- new MSCs add on to end of MSC chain as mobile moves to new MSC

(b) after handoff

28

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 BSS: 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

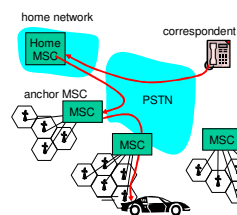
26

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**.

29

GSM: handoff between MSCs



(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

27