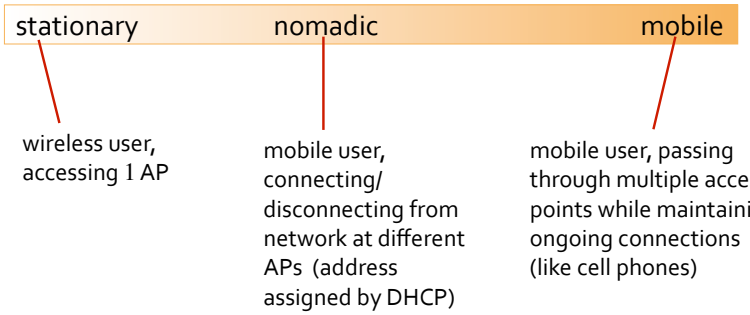
eecs 489 COMPUTER NETWORKS

Lecture 40:
Mobility

Degrees of Mobility

Spectrum of mobility, from the network perspective:



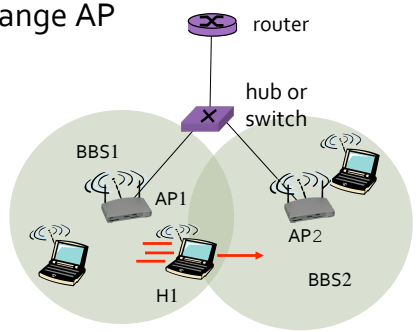
Mobility Within the Same Subnet

H1 remains in the same IP subnet
- IP address of the host can remain the same
- ongoing data transfers can continue uninterrupted

H1 recognizes the need to change AP
- H1 detects a weakening signal
- starts scanning for stronger one

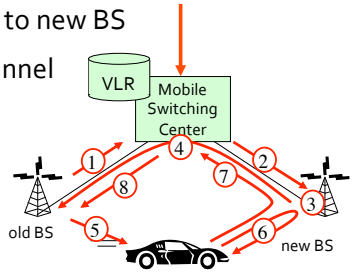
Changes APs
- H1 disassociates from one
- and associates with another AP

Switch learns of new location
- self-learning mechanism



Handoff within Common MSC

1. Handoff initiated by old BS: old BS informs MSC of impending handoff, provides list of ≥ 1 new BSs
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 and old BS: ready
5. old BS tells mobile: perform handoff to new BS
6. mobile and new BS activate new channel
7. mobile signals via new BS to MSC: handoff complete; MSC reroutes call
8. MSC and old-BS resources released



Mobility Across Subnets/MSCs

Let routing handle it: routers advertise the permanent address of mobile-nodes-in-residence via usual routing table exchange

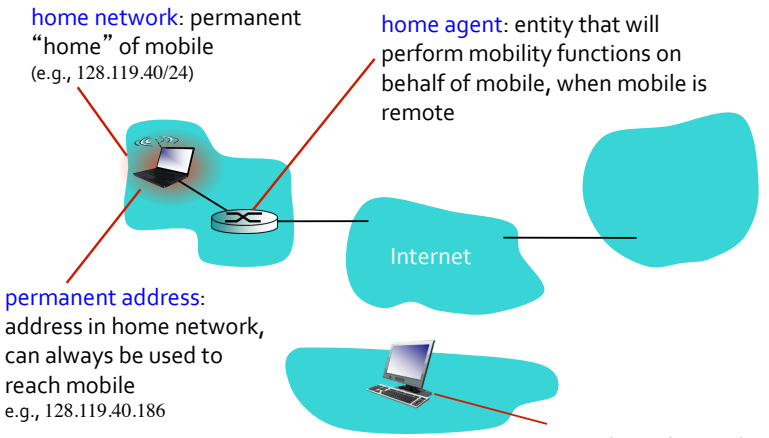
- routing tables indicate where each mobile is located
- no changes to end-systems

not scalable to millions of mobiles

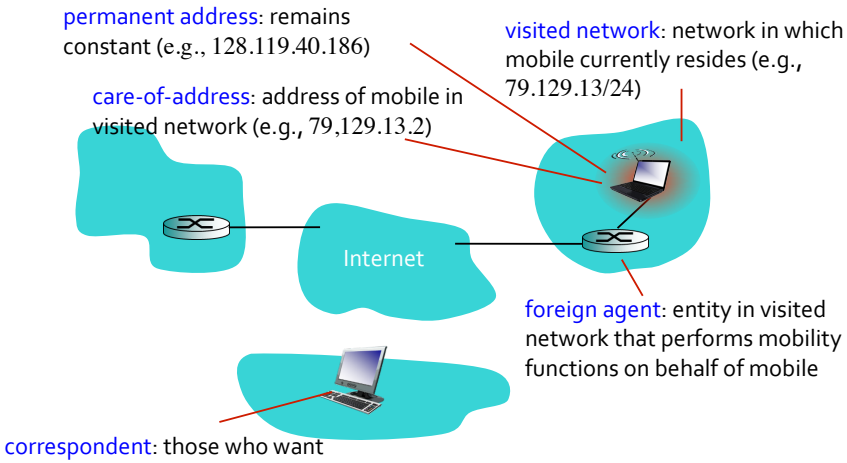
Let end-systems handle it:

- indirect routing: communication from correspondent to mobile goes through home agent, then forwarded to foreign agent
- direct routing: correspondent gets foreign address of mobile, sends directly to mobile

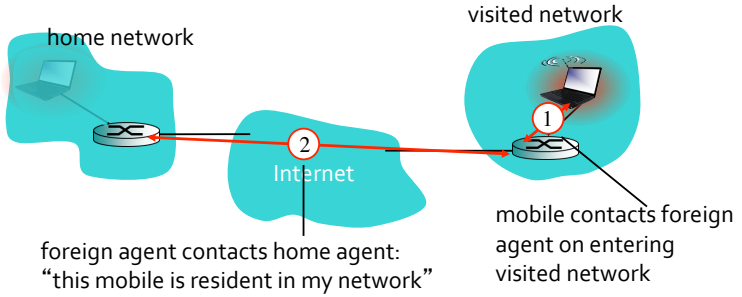
Mobility: Vocabulary



Mobility: More Vocabulary



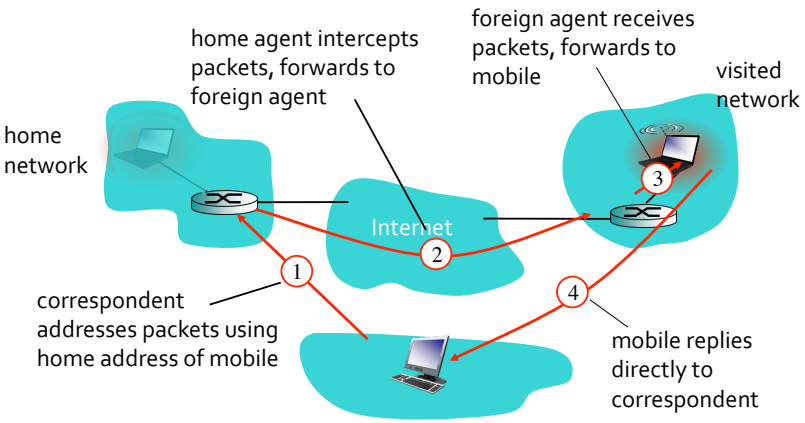
Mobility: Registration



End result:

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

Mobility via Indirect Routing



Indirect Routing

Mobile uses two addresses:

- permanent address: used by correspondent (mobile location is transparent to correspondent)
- care-of-address: used by home agent to forward datagrams to mobile

Foreign agent functions may be assumed by mobile itself

Used in Mobile IP

Triangle routing: correspondent-homenet-mobile

- inefficient when correspondent and mobile are in the same network

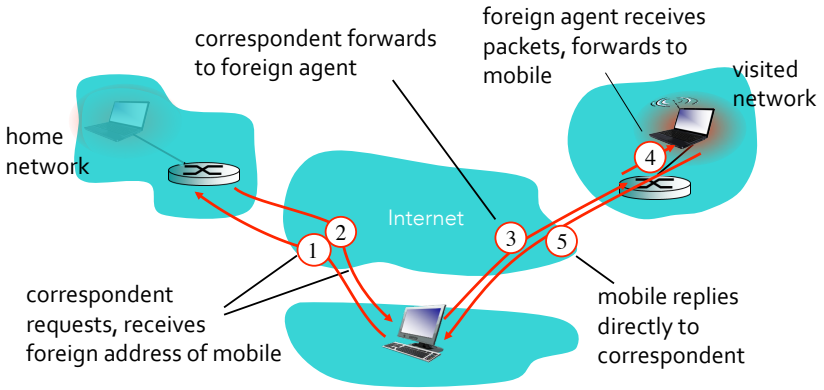
Advantage of Indirect Routing

Mobility transparent to correspondent:

- mobile registers with new foreign agent
- new foreign agent registers with home agent
- home agent updates care-of-address for mobile
- home agent continues to forward packets to mobile (but with new care-of-address)

On-going connections can be maintained!

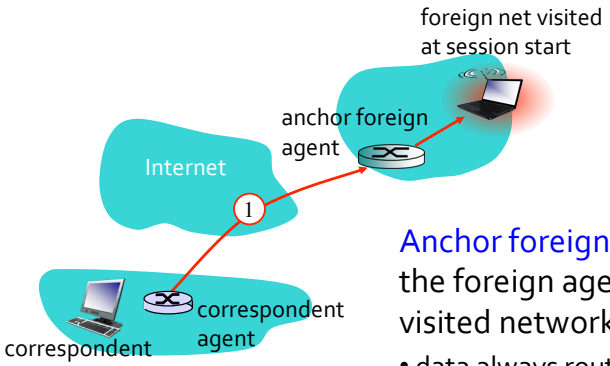
Mobility via Direct Routing



Overcome triangle routing inefficiency, however, mobility no longer transparent to correspondent

- what if mobile changes visited network?

Mobility with Direct Routing



Anchor foreign agent: the foreign agent in first visited network

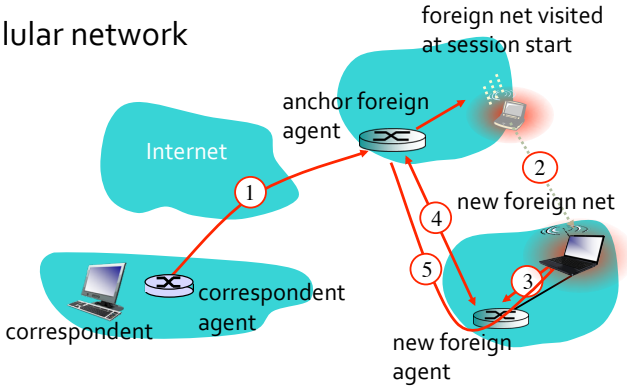
- data always routed first to anchor foreign agent

Mobility with Direct Routing

When mobile moves, new foreign agent arranges to have data forwarded from old foreign agent (chaining)

- optional path minimization step shortens chain

Used in cellular network



Mobile IP [RFC3220]

Has many features we've seen:

- home agent, foreign agent, foreign-agent registration, care-of-address, encapsulation (packet-within-a-packet)

Standard specifies:

- indirect routing of datagrams
- how to do agent discovery
- how to register with home agent

Mobility in 3GPP Networks

Home system: network of cellular provider (e.g., Sprint, Verizon) a user subscribes to

- 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 system: network mobile currently resides

- Visitor Location Register (VLR): database with entry for each user currently in network (could be home network, so not exactly equivalent to foreign agent)

Uses direct routing with optional forwarding chain shortening

Mobility: 3GPP versus Mobile IP

3GPP element	Comment on 3GPP element	Mobile IP
Home system	Network to which the mobile user's permanent phone number belongs	Home network
Gateway Mobile-service Switching Controller, 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-service Switching Controller; Visitor Location Register (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

Impact on Higher-Layer Protocols

Wireless and mobility change path properties

- wireless breaks the abstraction of a link (there's a base station in between, at least)
- wireless breaks the assumption that packet loss implies congestion
- mobility causes transient disruptions, and changes in RTT
- mobility also breaks the association of address and location

Impact on Higher-Layer Protocols

Ideally, impact should be minimal

- best-effort service model remains unchanged
- TCP and UDP can (and do) run over wireless, mobile

But, performance definitely is affected

- TCP treats packet loss as a sign of congestion
- TCP drives retransmissions by RTT estimates
- TCP does not perform well with out-of-order packets

Session Initiation Protocol (SIP)

Goals:

- all telephone and video conference calls should be placed over the Internet
- people are identified by names or e-mail addresses, not by phone numbers
- you can reach your parties no matter where they are, no matter what IP device they are currently using

Included as part of 3GPP's IP Multimedia Subsystem (IMS)

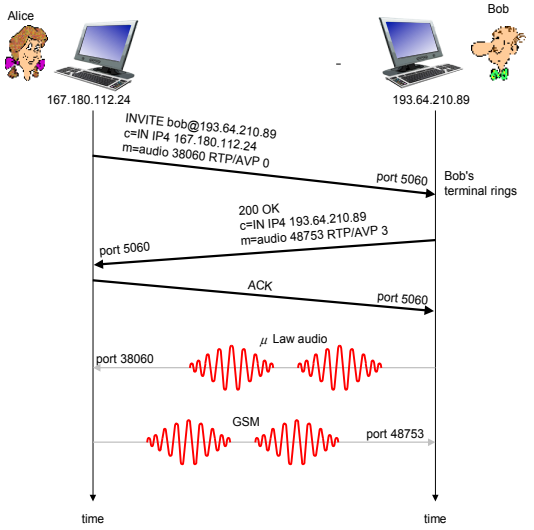
SIP Services

Setting up a call
- Alice can ring up Bob
- Alice and Bob can negotiate media type and encoding
- Alice or Bob can end call

Alice can resolve Bob's current IP address

Call management
- add new media streams during call
- change encoding during call
- invite others
- transfer and hold calls

Call Setup to Known IP address



- Alice's SIP invite message indicates her port number, IP address, encoding she prefers to receive (PCM μlaw)
- Bob's `200 OK` message indicates his port number, IP address, preferred encoding (GSM)
- SIP messages can be sent over TCP or UDP
- default SIP port number is 5060

Call Setup

Codec negotiation:
- suppose Bob doesn't have PCM μlaw decoder
- Bob will instead reply with `606 Not Acceptable` reply, listing his encoders
- Alice can then send a new `INVITE` with a different encoder

Rejecting a call
- Bob can reject with replies "busy," "gone," "payment required," "forbidden"

Name Resolution and User Location

Issues in name to current IP resolution:
- user moves around
- dynamic IP address allocation by DHCP protocol
- user has multiple IP devices (PC, tablet, smartphone, car)

Result can be based on:
- time of day (work, home)
- caller (don't want your boss to call you at home)
- status of callee (calls sent to voicemail when callee is otherwise engaged)

Name Resolution and User Location

Services provided by SIP servers:

- user registration:
  - when Bob starts SIP client, client sends `SIP REGISTER` message to Bob's registrar server
  - analogous to DNS authoritative name server
- proxy:
  - Alice sends invite message to her proxy server
  - proxy responsible for routing SIP messages to callee, possibly through multiple proxies
  - Bob sends response back through same set of SIP proxies
  - proxy returns Bob's SIP response message to Alice with Bob's IP address
  - analogous to local DNS server, but with recursive query all the way to callee

Example: `jim@umass.edu` Calls `keith@poly.edu`