Mobility …

Slides used in TDDE48 (Mobile Networks) @ LiU, Sweden, Fall 2025

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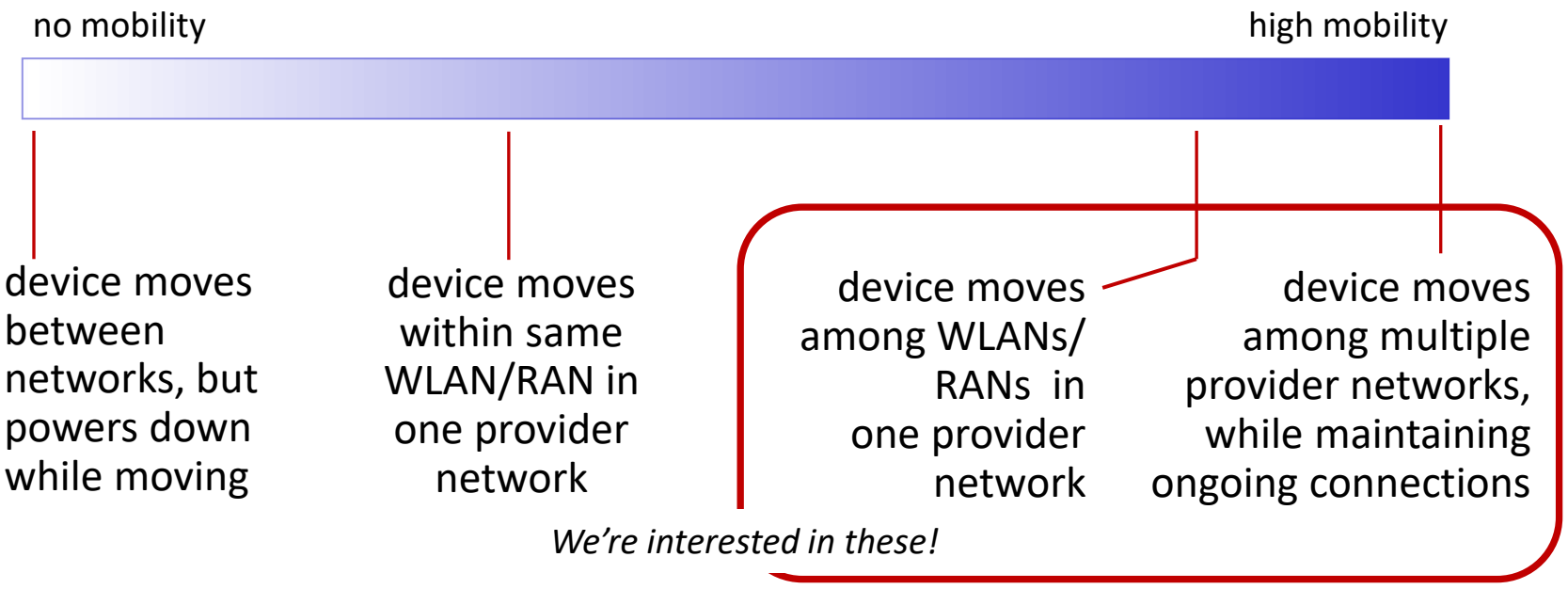
Slides for this lecture are adapted or based on various on-line resources, including lectures notes by Jim Kurose and Keith Ross for the recommended book "Computer Networking: A Top-Down Approach")

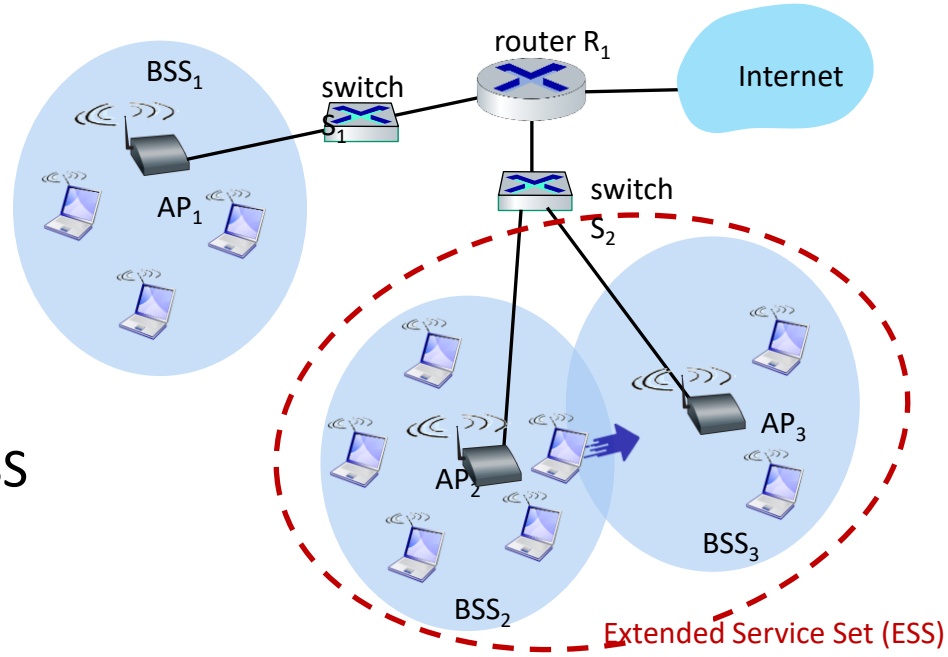
What is mobility?

- spectrum of mobility, from the network perspective:



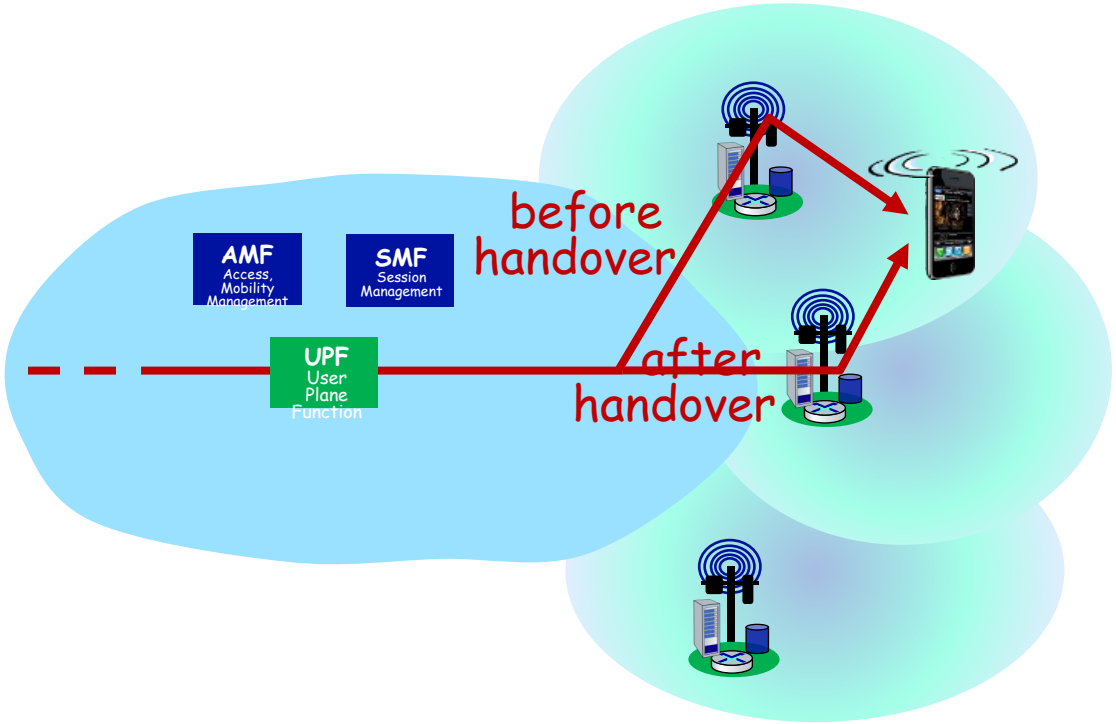
Mobility in a WiFi network

- 802.11: a link-layer standard, takes a link-layer approach towards mobility
- Extended Service Set (ESS): multiple BSS's, in same layer-3 subnet, each with same SSID



- mobility between BSSs in same ESS
  - Fast re-authentication
  - AP can suggest new APs to device
- proprietary (vendor) solutions for enhanced mobility

Mobility in 5G networks: handover

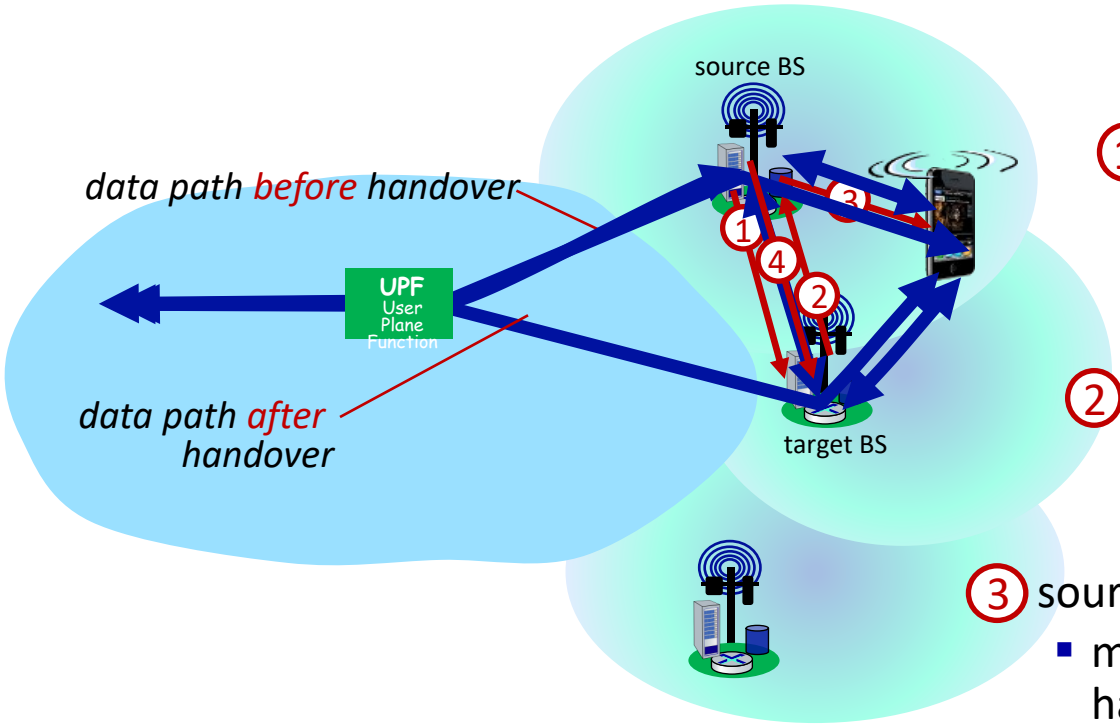


Handover:

- mobile device changes is point of attachment to the network
- data flow to device changes from *source* base station to *target* base station

Why perform handover?

- stronger signal from target base station
- target base station has less devices, less traffic

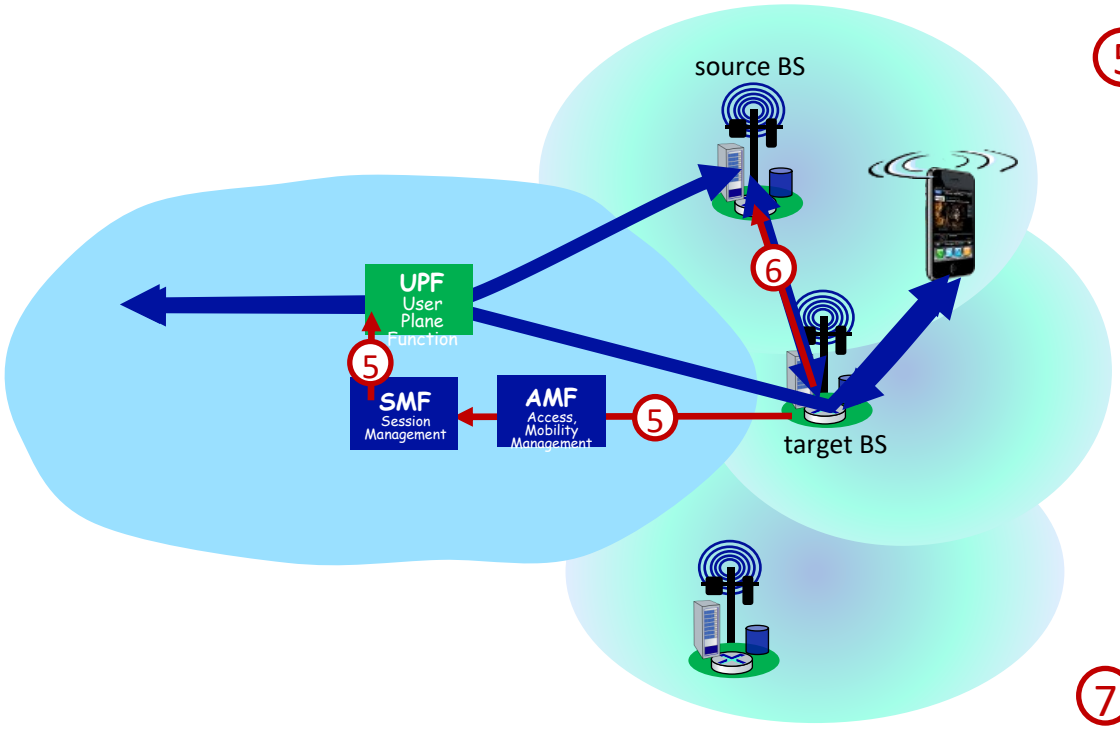


1. current (source) BS selects target BS, sends *Handover Request message* to target BS

2. target BS pre-allocates radio time slots, responds with HR ACK with info for mobile

3. source BS informs mobile of new BS
   - mobile can now send via new BS - handover *looks* complete to mobile

4. source BS stops sending datagrams to mobile, instead forwards to new BS (who forwards to mobile over radio channel)



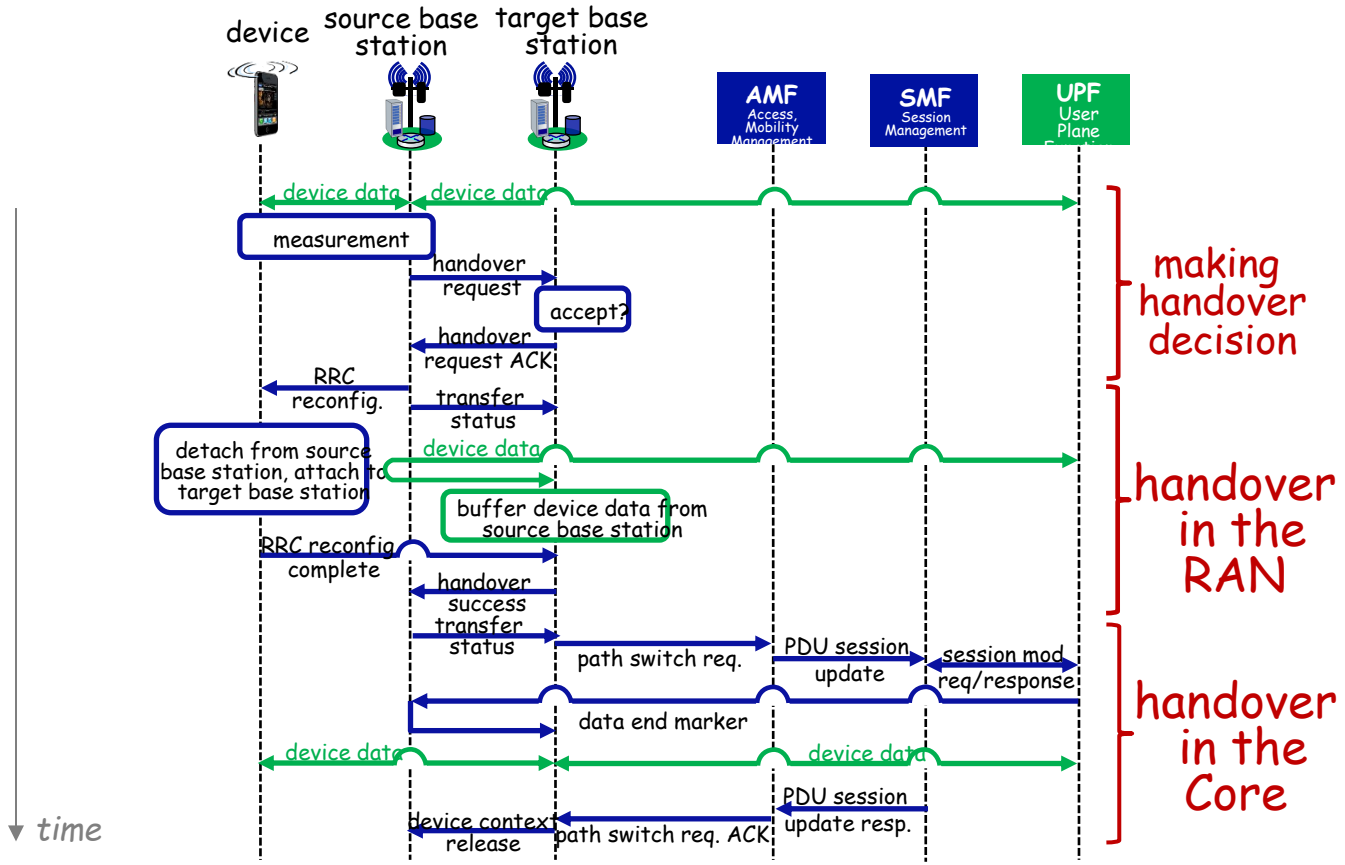
5 target BS informs AMF, SMF that it is new BS for mobile

- SMF instructs UPF to change tunnel endpoint to be (new) target BS

6 target BS ACKs back to source BS: handover complete, source BS can release resources

7 mobile's datagrams now flow through new tunnel from target BS to UPF

Handover: timeline, signaling



More slides …

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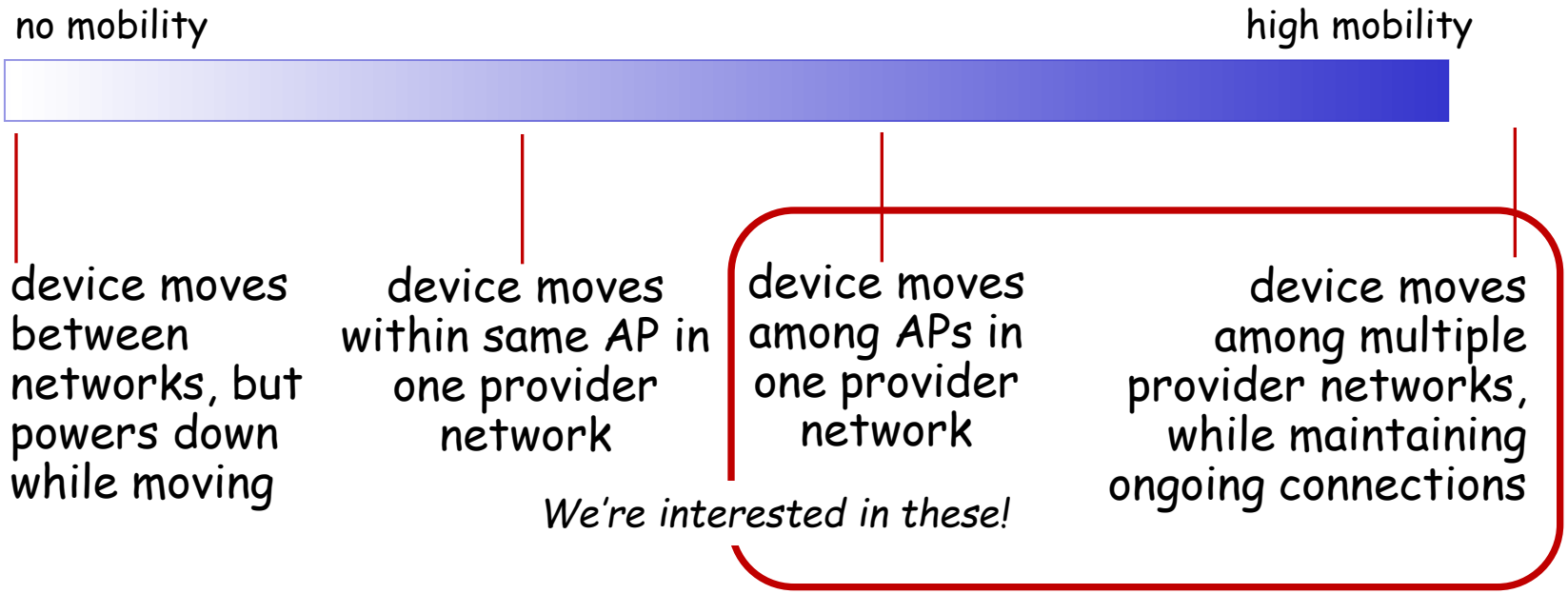
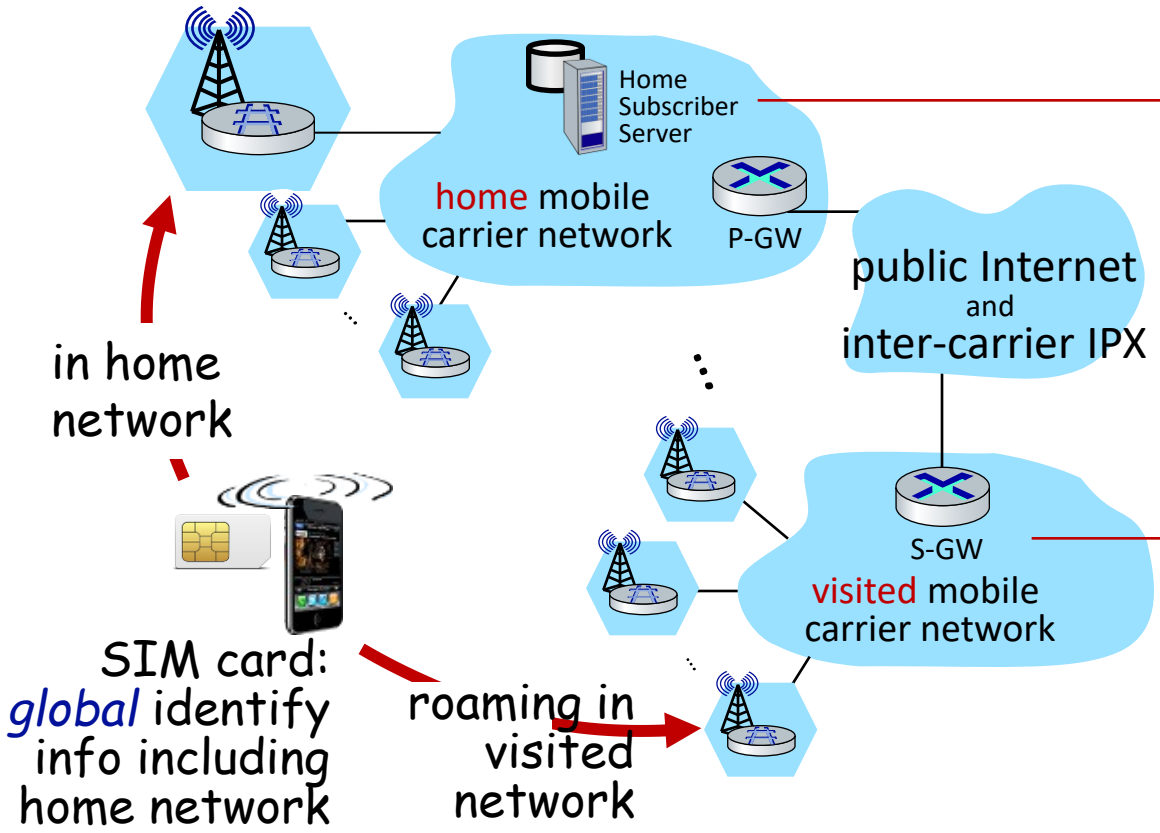


Home network, visited network: 4G/5G



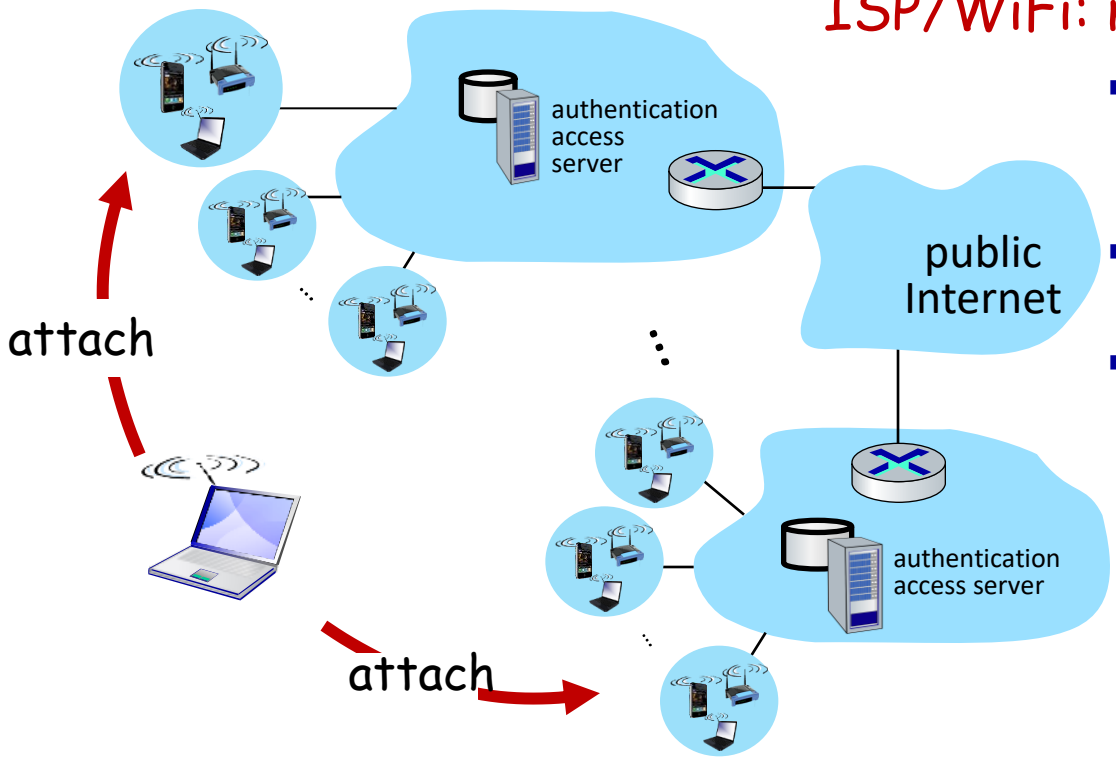
home network:

- (paid) service plan with cellular provider, e.g., Verizon, Orange
- home network HSS stores identify & services info

visited network:

- any network other than your home network
- service agreement with other networks: to provide access to visiting mobile

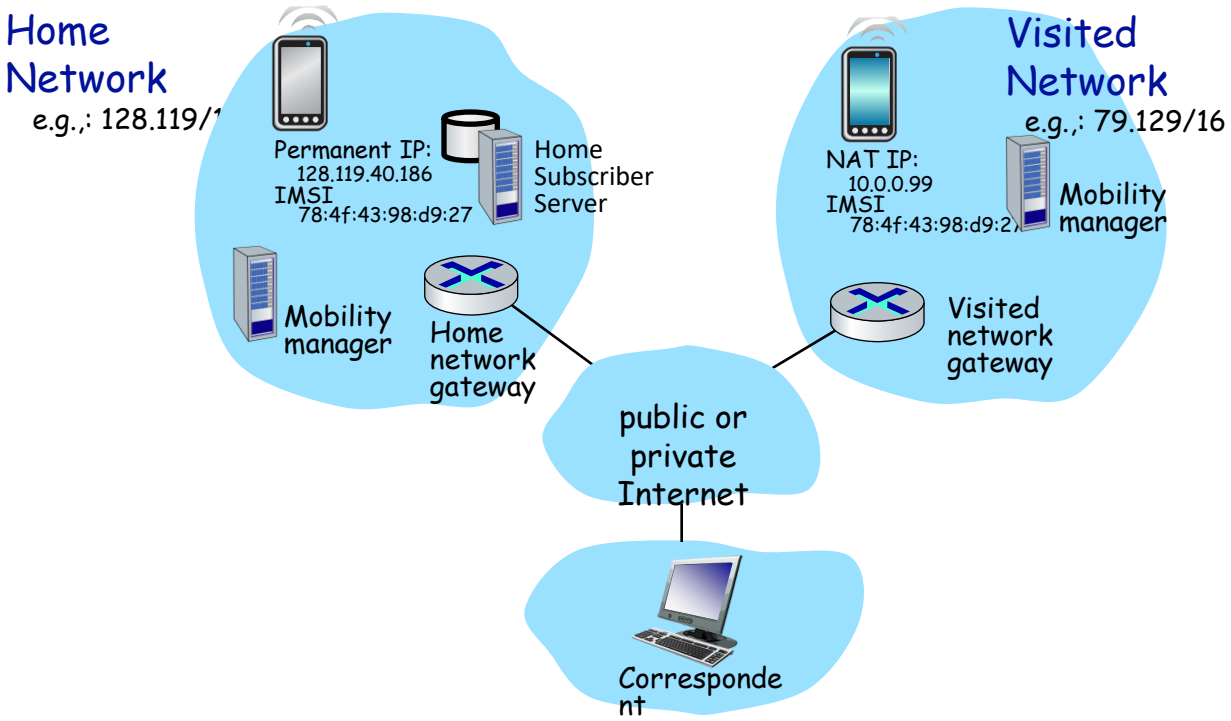
Home network, visited network: ISP/WiFi



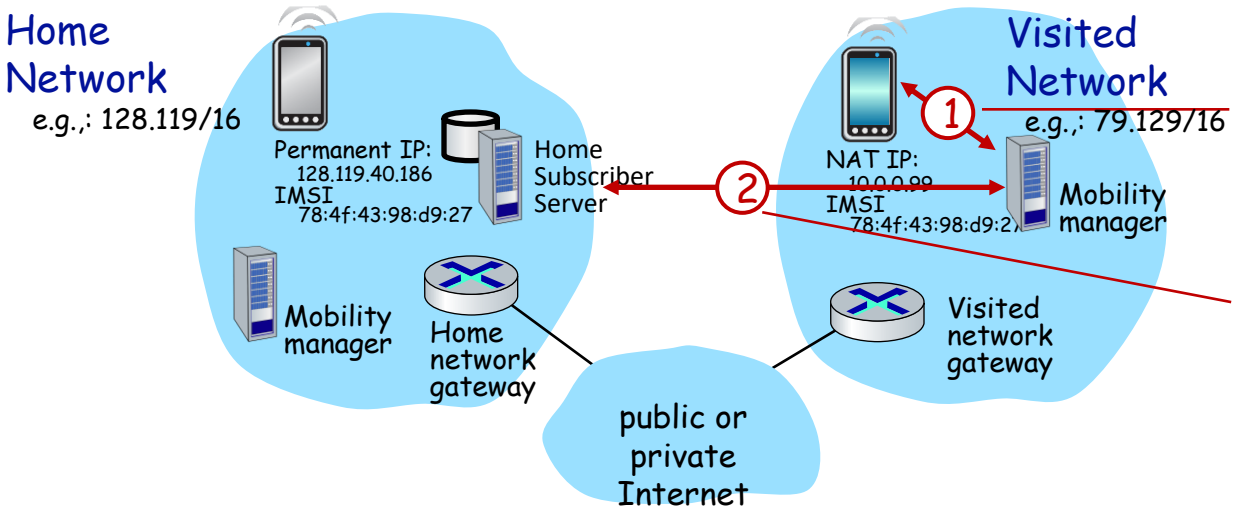
ISP/WiFi: no notion of global "home"

- credentials from ISP (e.g., username, password) stored on device or with user
- ISPs may have national, international presence
- different networks: different credentials
  - some exceptions (e.g., eduroam)
  - architectures exist (mobile IP) for 4G-like mobility, but not used

Home network, visited network: generic



Registration: home needs to know where you are!



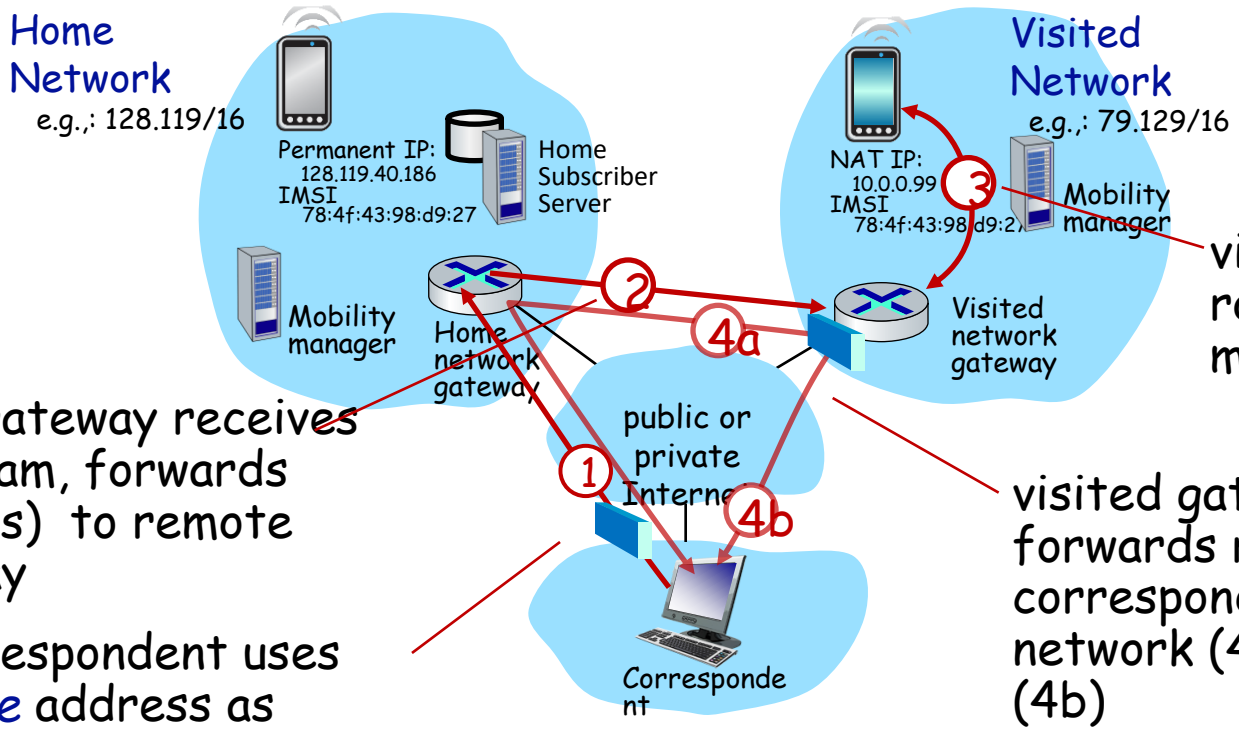
mobile *associates* with visited mobility manager

visited mobility manager *registers* mobile's location with home HSS

end result:

- visited mobility manager knows about mobile
- home HSS knows location of mobile

Mobility with indirect routing



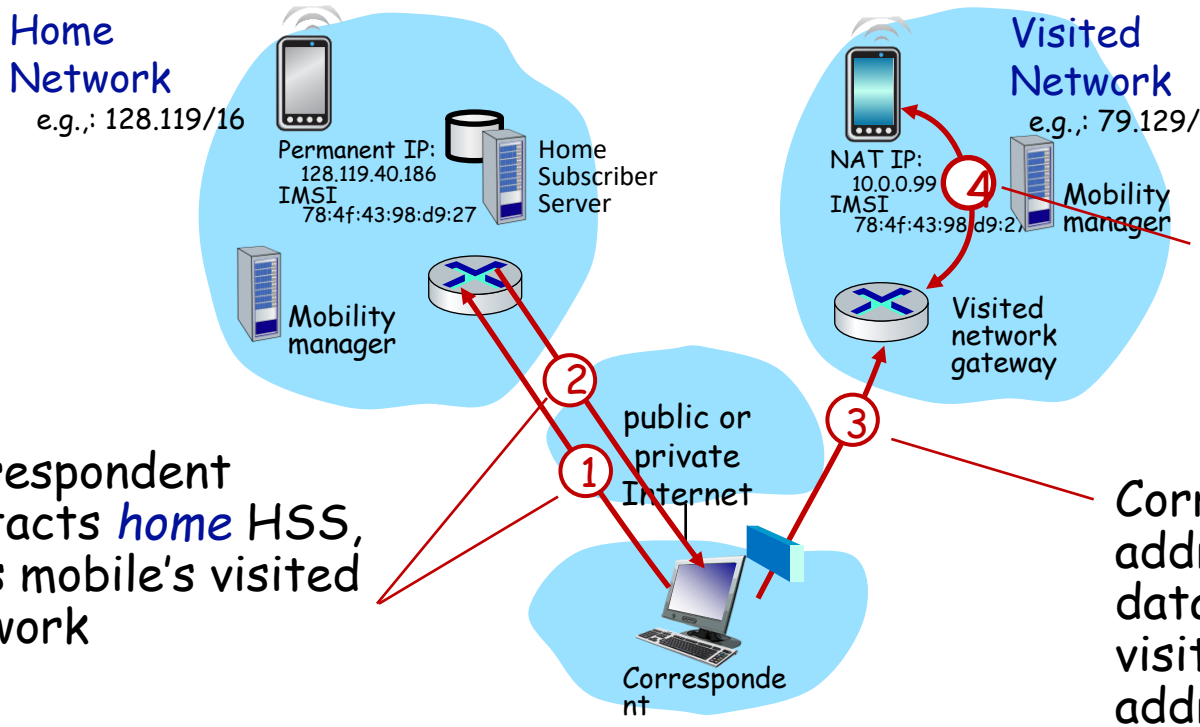
home gateway receives datagram, forwards (tunnels) to remote gateway

correspondent uses *home* address as datagram destination address

visited gateway router forwards to mobile

visited gateway router forwards reply to correspondent via home network (4a) or directly (4b)

Mobility with direct routing

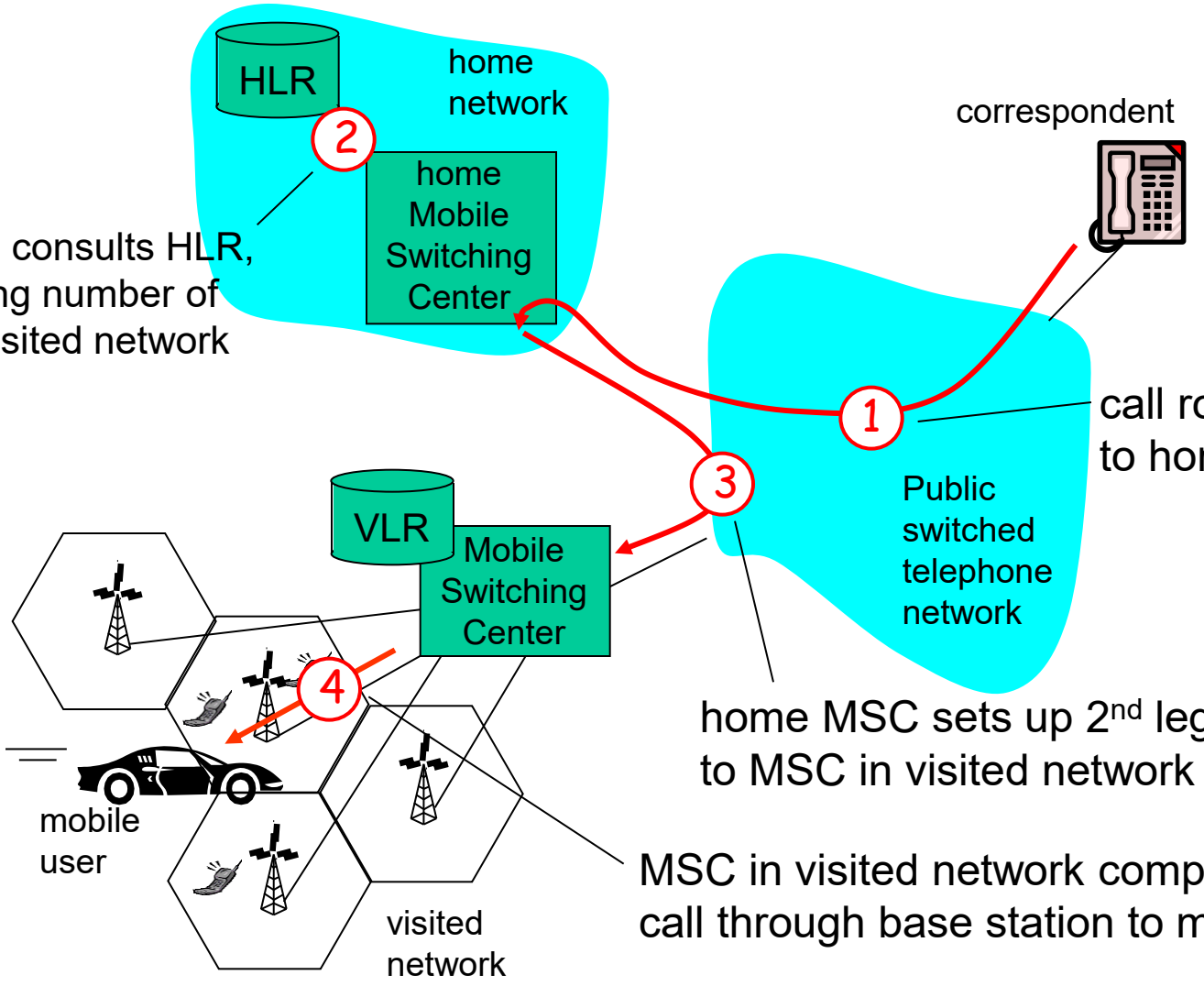


correspondent contacts *home* HSS, gets mobile's visited network

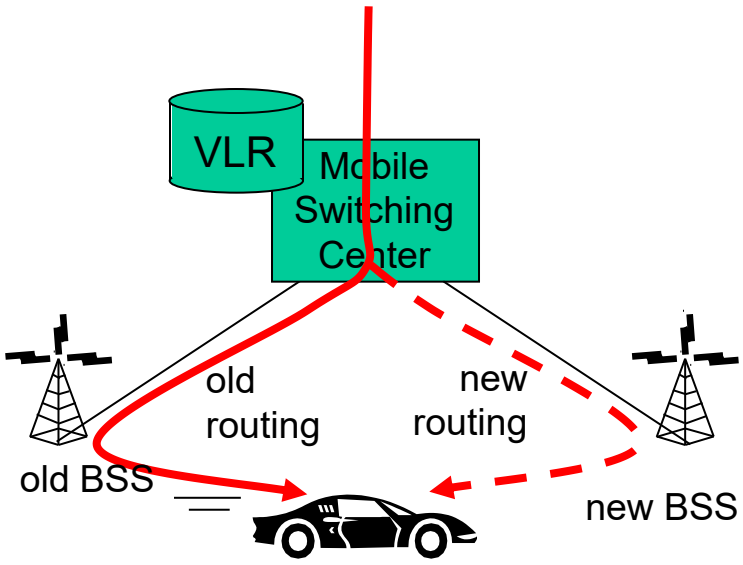
visited gateway router forwards to mobile

Correspondent addresses datagram to visited network address

GSM: indirect routing to mobile

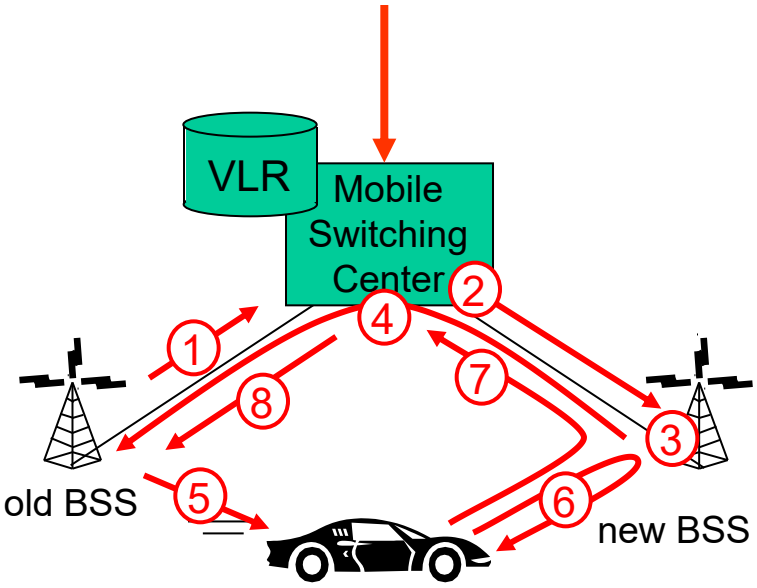


GSM: handoff with common MSC



- 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

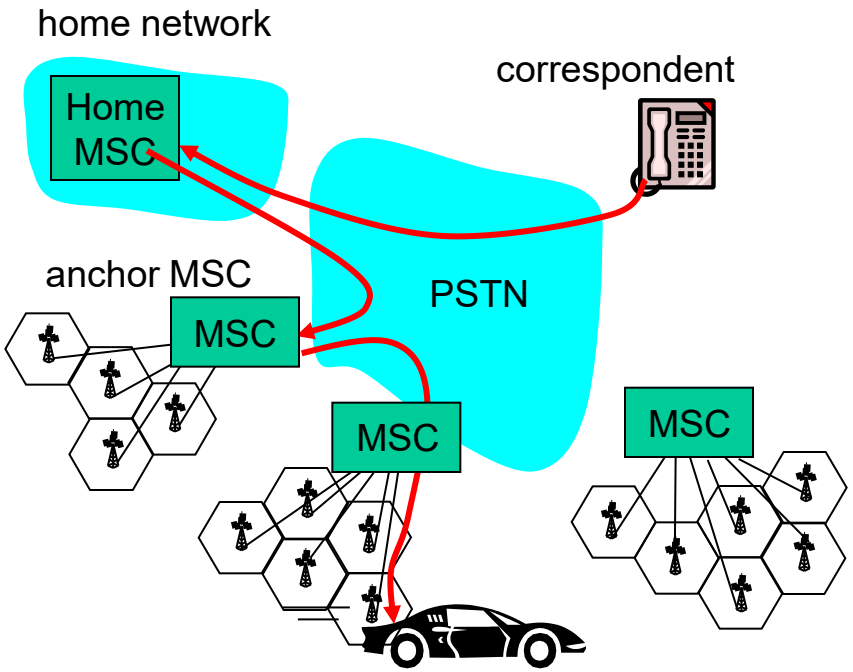
GSM: handoff with common MSC



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

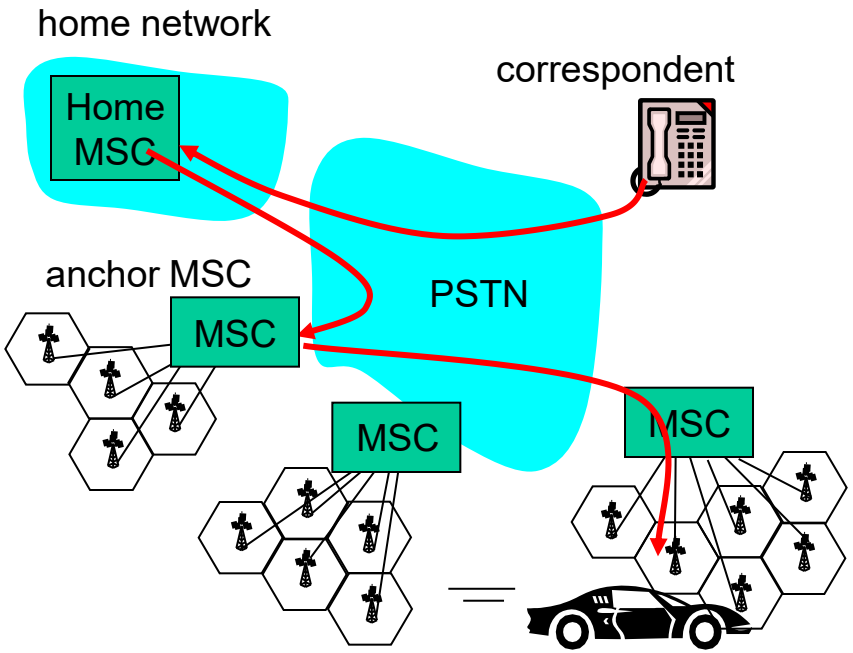
GSM: handoff between MSCs



(a) before handoff

- *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
- IS-41 allows optional path minimization step to shorten multi-MSC chain

GSM: handoff between MSCs



(b) after handoff

- *anchor MSC:* first MSC visited during cal
  - call remains routed through anchor MSC
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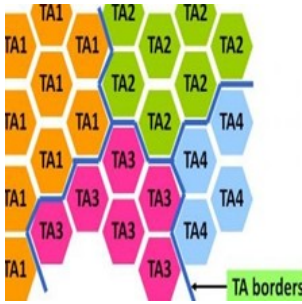
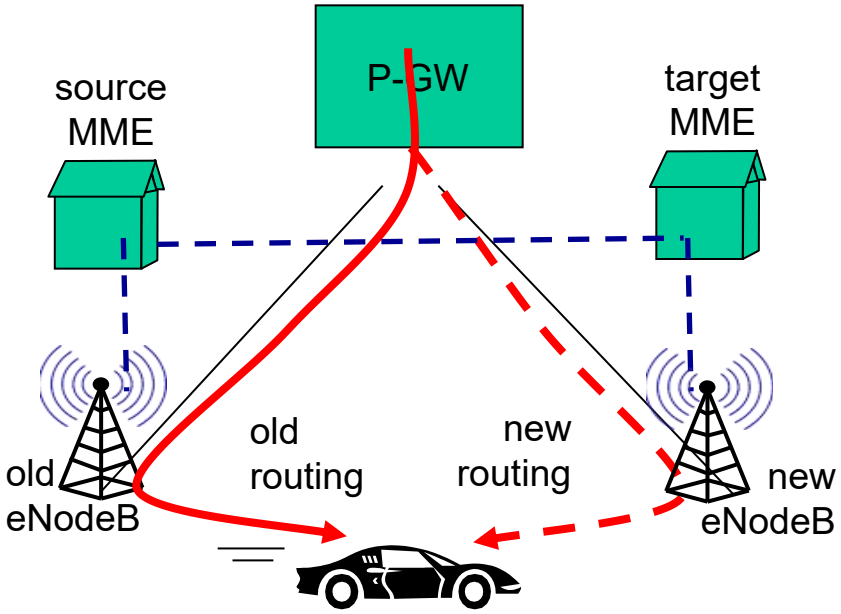
- IS-41 allows optional path minimization step to shorten multi-MSC chain

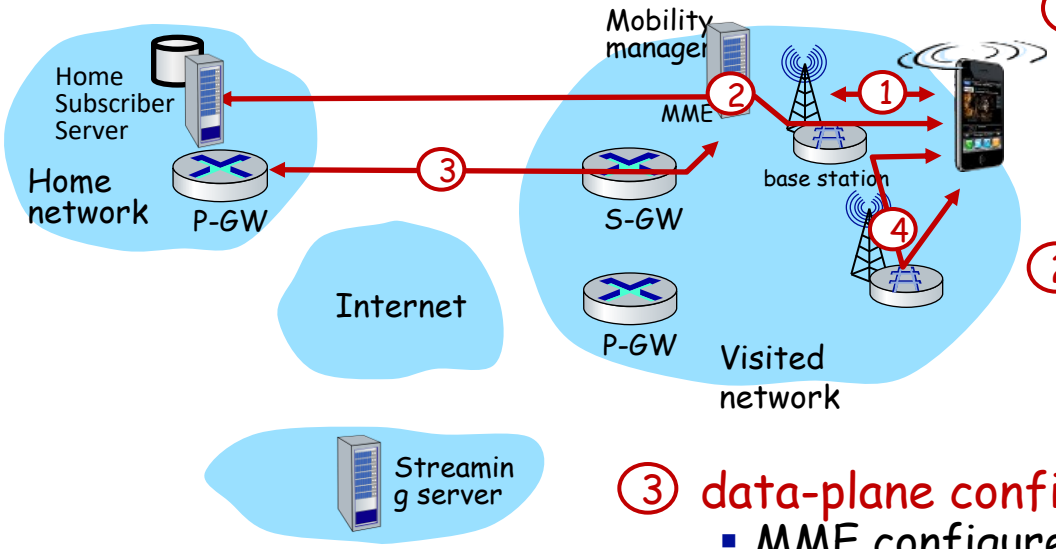
Handling Mobility in LTE



- Paging: idle UE may move from cell to cell: network does not know where the idle UE is resident
  - paging message from MME broadcast by all eNodeB to locate UE
- handoff: similar to 3G:
  - preparation phase
  - execution phase
  - completion phase
- But hard handover



Mobility in 4G networks: major mobility tasks



① base station association:
- covered earlier
- mobile provides IMSI - identifying itself, home network

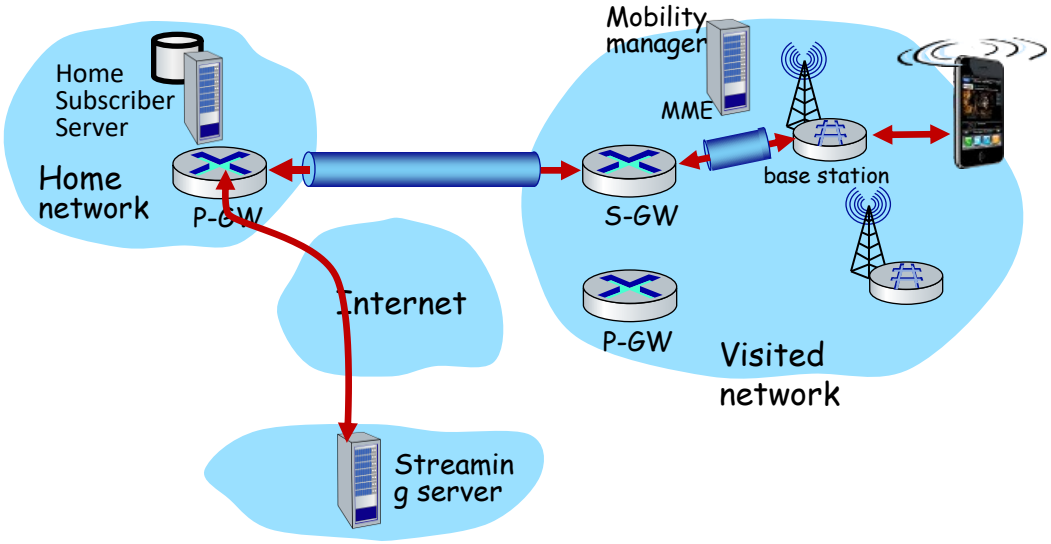
② control-plane configuration:
- MME, home HSS establish control-plane state - mobile is in visited network

③ data-plane configuration:
- MME configures forwarding tunnels for mobile
- visited, home network establish tunnels from home P-GW to mobile

④ mobile handover:
- mobile device changes its point of attachment to visited network

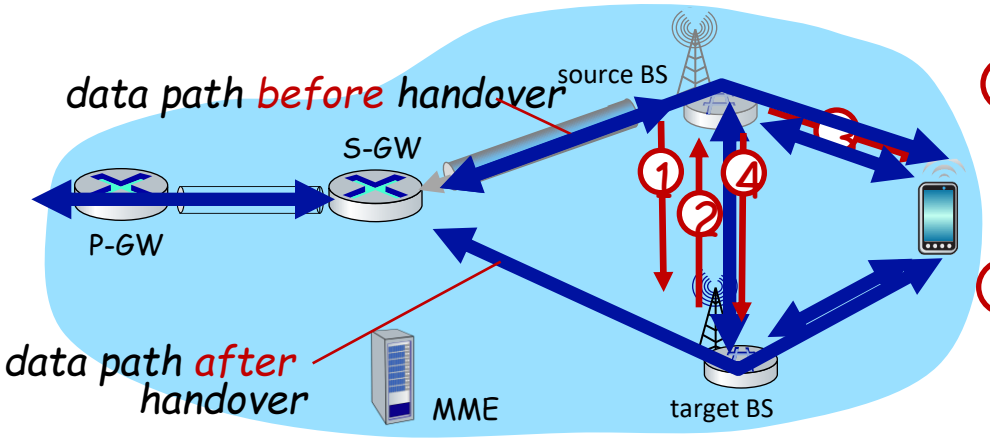
Configuring data-plane tunnels for mobile

- S-GW to BS tunnel: when mobile changes base stations, simply change endpoint IP address of tunnel
- S-GW to home P-GW tunnel: implementation of indirect routing



- tunneling via GTP (GPRS tunneling protocol): mobile's datagram to streaming server encapsulated using GTP inside UDP, inside datagram

Handover between BSs in same cellular network



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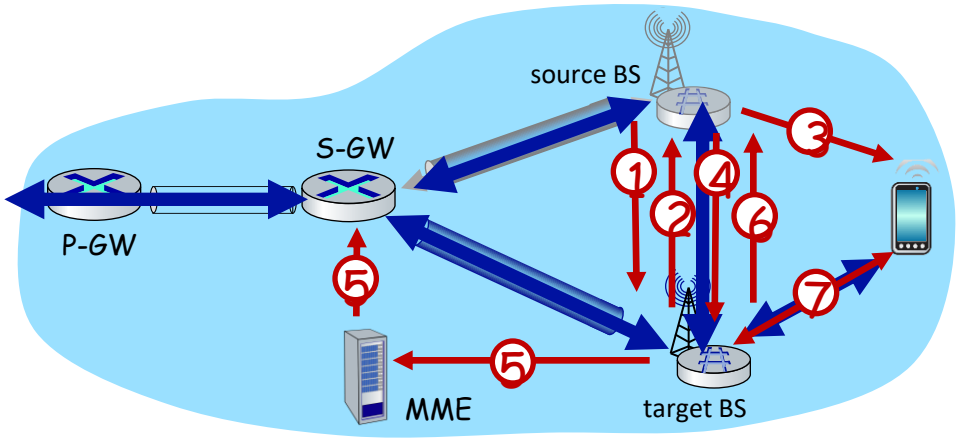

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⑦ mobile's datagrams now flow through new tunnel from target BS to S-GW

Image: http://www.lteandbeyond.com/2012/03/s1-interface-based-handover.html

LTE Handover