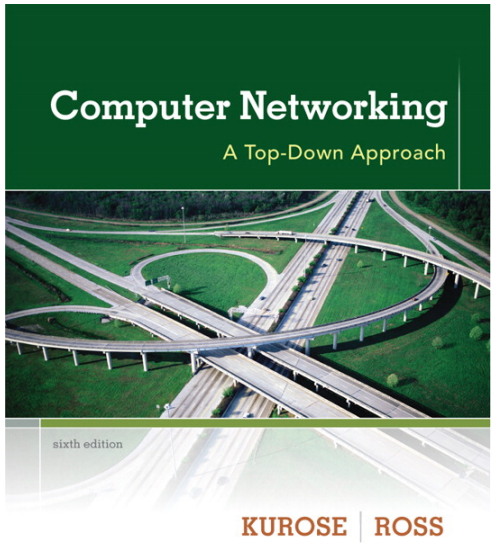
CN-Advanced
L43

Mobility in Cellular Networks

Dr. Ram P Rustagi
rprustagi@ksit.edu.in
http://www.rprustagi.com
https://www.youtube.com/rprustagi

Resources Acknowledgement

Chapter 6 Wireless and Mobile Networks



A note on the use of these ppt slides:
We're making these slides freely available to all (faculty, students, readers). They're in PowerPoint form so you see the animations; and can add, modify, and delete slides (including this one) and slide content to suit your needs. They obviously represent a *lot* of work on our part. In return for use, we only ask the following:

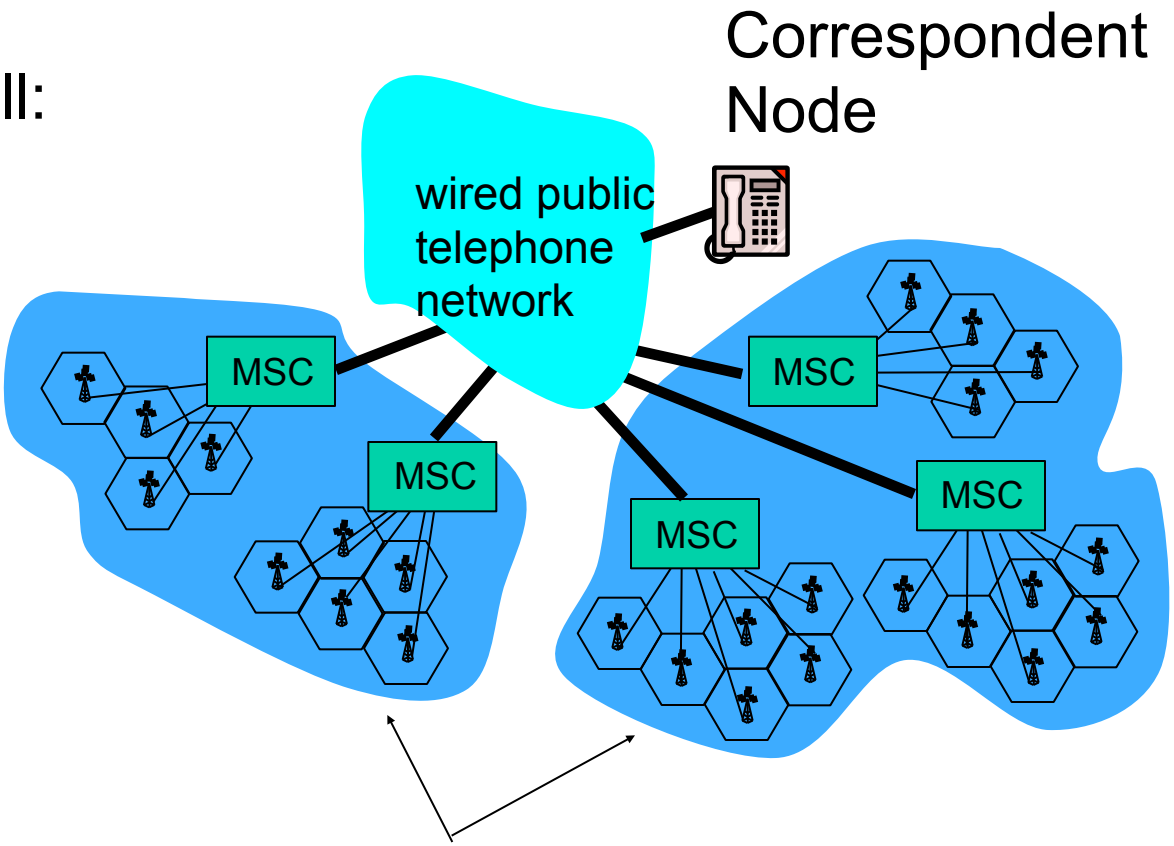
- If you use these slides (e.g., in a class) that you mention their source (after all, we'd like people to use our book!)
- If you post any slides on a www site, that you note that they are adapted from (or perhaps identical to) our slides, and note our copyright of this material.

Thanks and enjoy! JFK/KWR

Computer Networking: A Top Down Approach
6th edition
Jim Kurose, Keith Ross
Addison-Wesley
March 2012

Components of cellular network architecture

recall:



Different cellular networks,
Operated by different providers

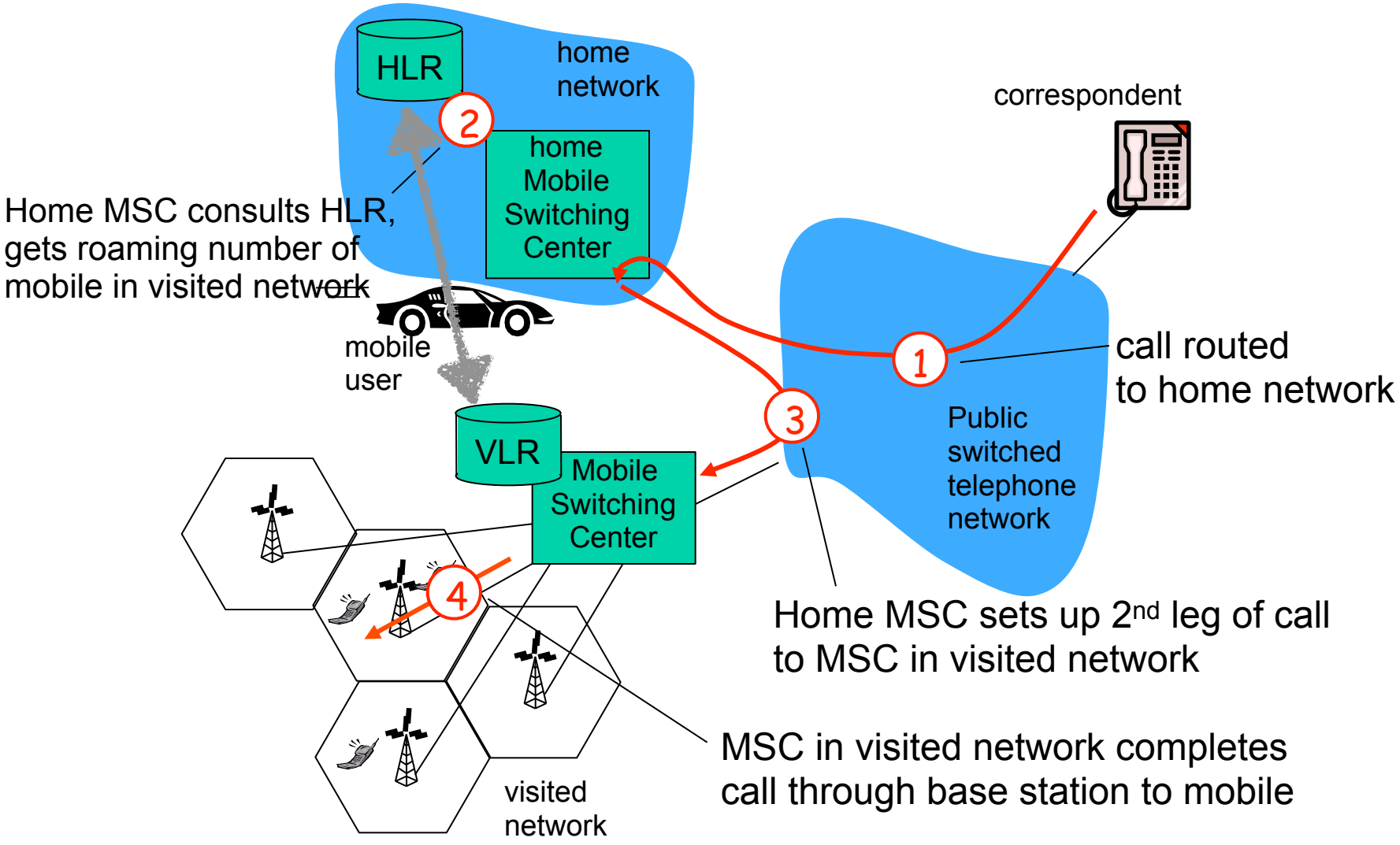
Handling mobility in cellular networks

- Similarities with Mobile IP?
- Call Routing?
  - Indirect or Direct
    - If indirect, is it triangular routing?
- Responsibilities of Home and Visited Networks
- Few Terms
  - PLMN: Public Land Mobile Network
    - Home PLMN and visited PLMN
  - HLR
  - VLR

Handling mobility in cellular networks

- *Home network:* network of cellular provider you subscribe to (e.g., Airtel, Vodafone, Idea Cellular)
  - *Home location register (HLR):* database in home n/w
    - Contains permanent cell phone #,
    - Profile info (services, preferences, billing),
    - Info about current location (could be in another network)
- *Visited network:* network in which MN currently resides
  - *Visitor location register (VLR):* database with entry for each user currently in network
  - Could be home network
    - Contains info even when you are in home network
  - Generally, co-located with MSC
  - Co-ordinates call setup - to/from visited network

GSM: indirect routing to mobile



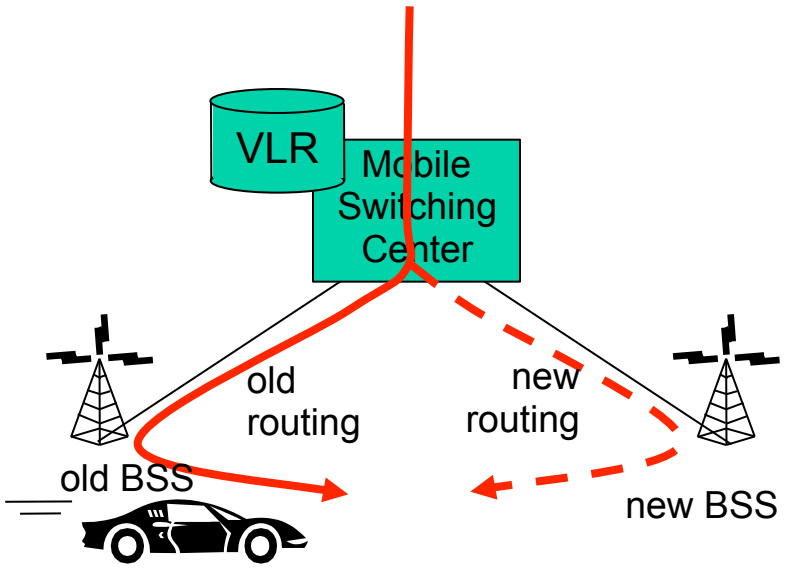
Q: Return path?

GSM: indirect routing to mobile

- How does HLR gets info about VLR
  - MS moves to visited network
  - MS registers itself with VLR
  - VLR sends LU (Location Update) msg to HLR
    - Contains either routing number (MSRN), or
    - VLR address
      - Used later to obtain MSRN
  - VLR also obtains the subscriber information
    - Which services can be offered to MS

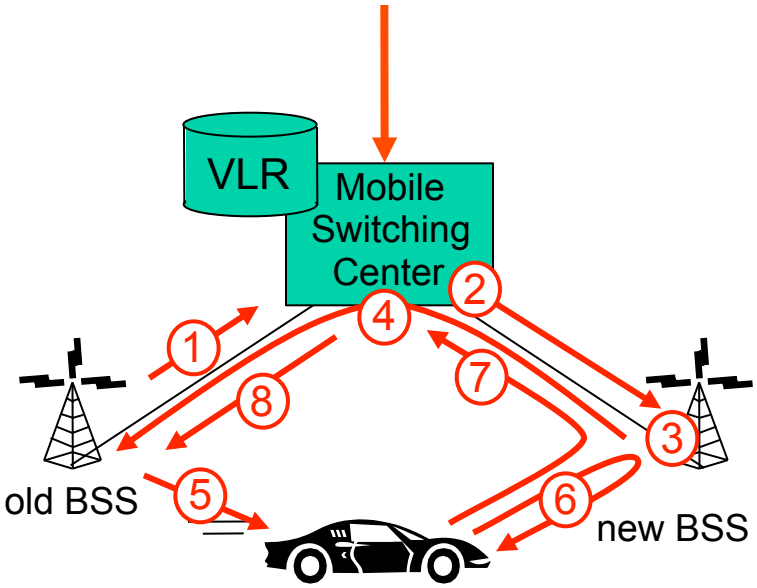
GSM: handoff with common MSC

What is Handoff ?



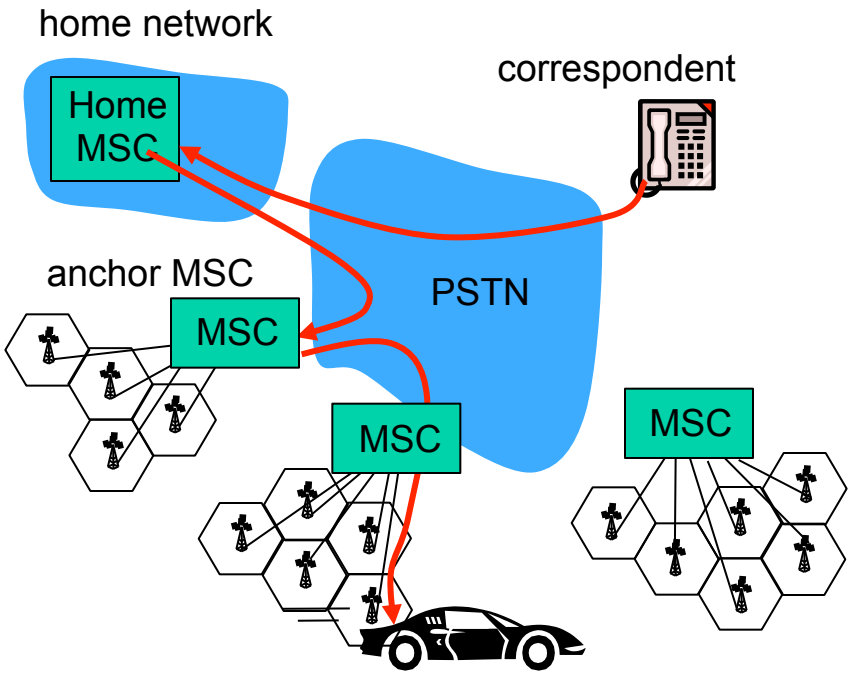
- *Handoff goal:* route call via new base station (without interruption)
- Reasons for handoff:
  - Stronger signal to/from new BSS (continuing connectivity, less battery drain)
  - Load balance: free up channel in current BSS
  - GSM doesn't mandate why to perform handoff (policy), only how (mechanism)
- 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

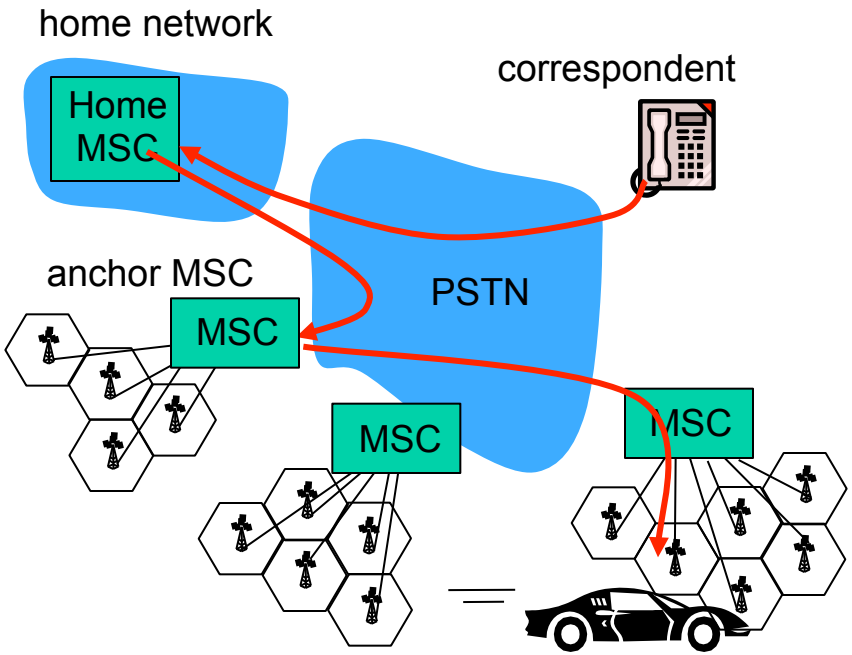
GSM: handoff between MSCs



(a) before handoff

- *Anchor MSC:* first MSC visited during 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

GSM: handoff between MSCs



(b) after 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
- Optional path minimization step to shorten multi-MSC chain

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**

Wireless, mobility: impact on higher layer protocols

- Logically, impact *should* be minimal …
  - Changes are only in link layer
  - Best effort service model (IP layer) remains unchanged
  - TCP and UDP can (and do) run over wireless, mobile
- … but performance-wise:
  - Packet loss/delay due to bit-errors (discarded packets, delays for link-layer retransmissions), and handoff
  - TCP interprets loss as congestion, will decrease congestion window un-necessarily
  - Delay impairments for real-time traffic
  - Limited bandwidth of wireless links

Wireless, mobility: impact on higher layer protocols

- Approaches for dealing with TCP Congestion
  - Local recovery
    - ARQ protocol, FEC for bit errors
  - TCP Sender aware of wireless links
    - Invokes congestion control only when
      - Loss is due to congestive wired network losses
  - Split connection approaches
    - End to end connection is split into two parts
      - Mobile to Access Point
      - Access point to other communication end point
    - E-to-e connection is catenation of wired & wireless part

Wireless, mobility: impact on higher layer protocols

- Impact on application layer
  - Logically should have no impact
  - Reality: Consider a web server serving mobile on 3G
    - May not be able to provide content rich images
  - Mobility however opens another opportunity
    - Location aware services
  - Wireless n/w will play a key role in
    - Ubiquitous computing environment of the future
  - We are at tip of the iceberg

Summary - Mobility

- *Mobility*
- Principles: addressing, routing to mobile users
- Home, visited networks
- Direct, indirect routing
- Care-of-addresses
- Mobile IP
- Mobility in GSM
- Impact on higher-layer protocols

VTU Questions (2015 scheme)

- July 2019 - Q7
  - Illustrate the two different approaches for routing to a mobile node (8 marks)
  - With a neat diagram, bring out the steps for mobile node registration to home agent. (8 marks)
- July 2019 - Q8
  - Bring out the components of 3G cellular network architecture (8)
  - State handoff? What are the steps involved in accomplishing handoff (5 marks)
  - Explain the three phses of mobile IP (3 marks)
- Jan 2019 - Q7
  - Explain components of cellular network architecture (8 marks)
  - Explain direct routing of a mobile node (8 marks)
- Jan 2019 - Q8
  - Explain steps of handoff a mobile user (8 marks)
  - Explain HLR, VLR, Home Address, Care of address (8 marks)

VTU Questions (2015 scheme)

- July 2018 - Q7
  - Define cellular network. Give the overview of GSM cellular network architecture (8 marks)
  - Explain the two different types of routing approaches to mobile node (8 marks)

– July 2018 - Q8
  - Explain the following concepts of mobile IP (8 marks)

    a. Agent discovery, b) Registration with home agent
  - Illustrate the steps involved when a base station does decide to hand-off a mobile user IP (8 marks)

VTU Questions (2015 scheme)

- Jan 2018 - Q7
  - Show the components of GSM 2G Cellular network architecture with a diagram (7 marks)
  - Illustrate the steps involved in mobile IP registration with home agent (5)
  - Write a note on mobile IP (4 marks)
- Jan 2018 - Q8
  - Define handoff. Explain the steps accomplishing a handoff. (7 marks)
  - Bring out the mechanism of direct routing to mobile node in mobility management. (6 marks)
  - Compare the 4G LTE standard to 3G systems. (3 marks)