CS120: Computer Networks

Lecture 14. Mobile Routing

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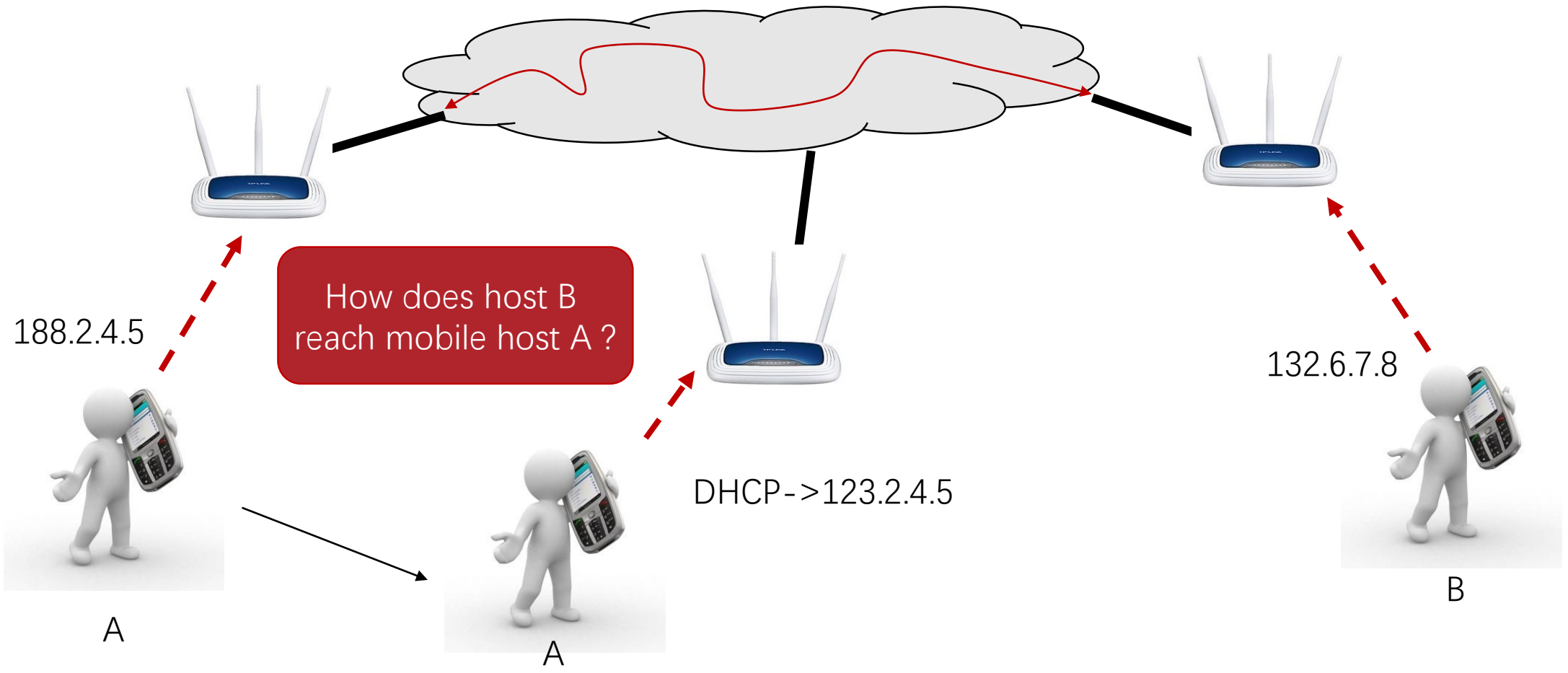
Outline

- Mobile Routing
  - Mobile IP
  - Mobility Handling in Cellular Network
  - Routing in Mobile Ad Hoc Network (MANET)
    - OLSR

Mobility Challenge in IP Network

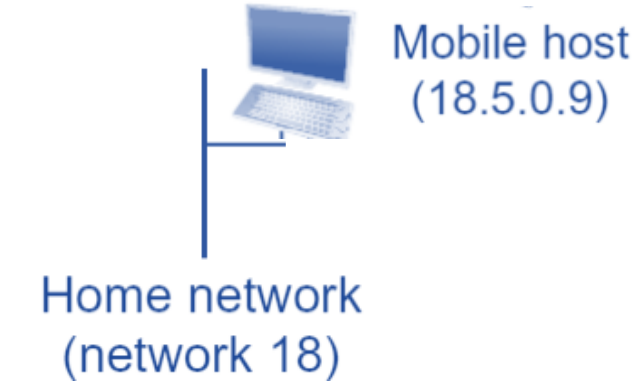


Mobile IP

- Goal
  - Mobile IP is designed to provide seamless network connectivity under mobile situation where subnetwork changes may occur.
    - e.g., From one WLAN to another WLAN
- Standard by IETF in 2002
  - Long before ubiquitous smartphones, 4G support for Internet protocols
  - Did not see wide deployment/use (in China)

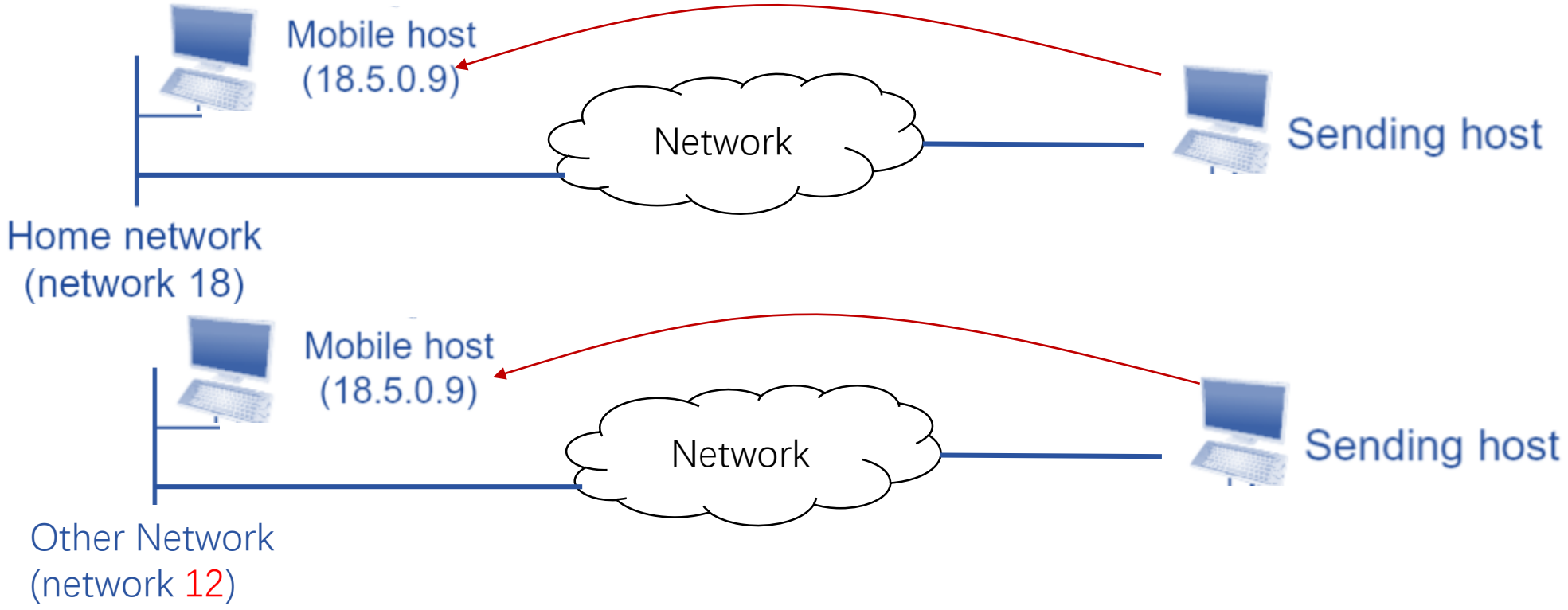
Mobile IP

- Home Address
  - Permanent IP address of the mobile host
    - e.g.,18.5.0.9
  - Other host uses it to contact the mobile host
- Home Network
  - The network that the home address resides
    - e.g., 18.5.0.0/24
  - “Home” of the mobile host



Mobile IP

- Goal
  - A sending host can find the mobile host through its home address

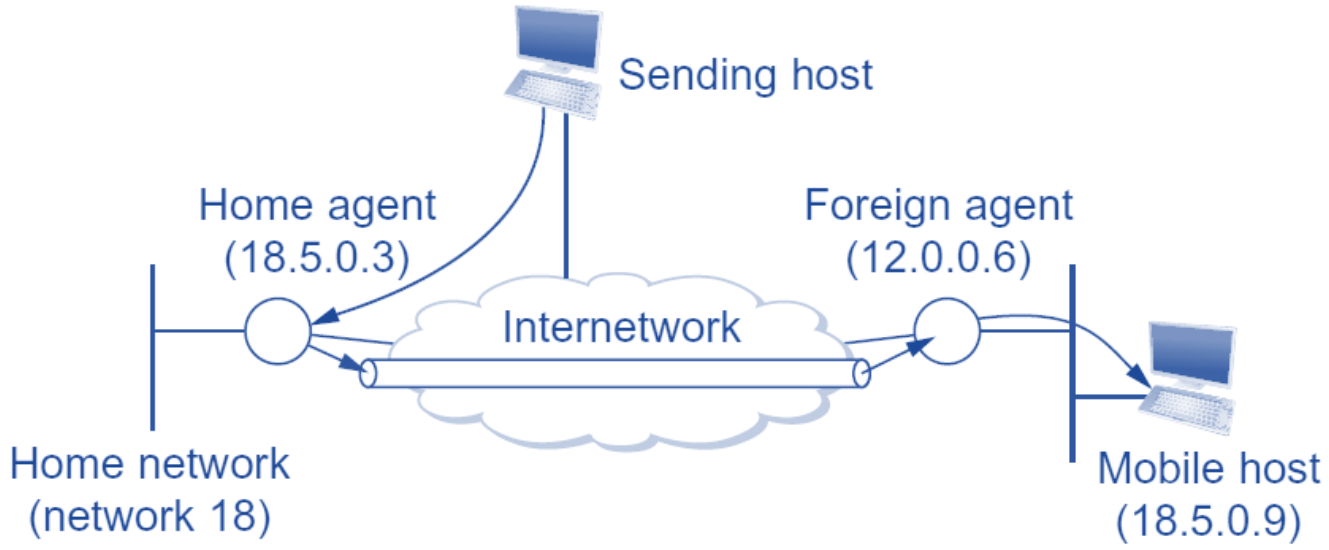


Mobile IP

- Home Agent
  - The router in the home network to support mobile IP
    - e.g., 18.5.0.3
- Foreign Agent
  - The router out of the home network to support mobile IP
    - e.g., 12.0.0.6

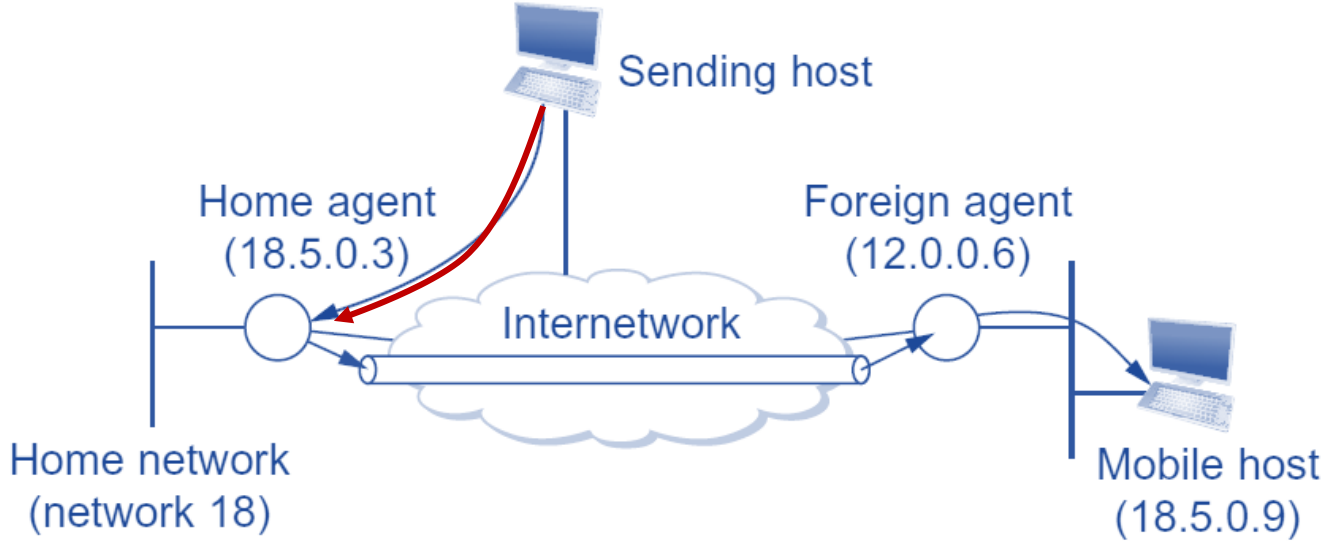
Mobile IP

- From mobile host to sending host: direct send packets
  - src IP: home address
- From sending host to mobile host: following steps
  - Packets from sending host to mobile host are routed to home network
  - Home agent redirects packets for mobile host to the foreign agent
  - Foreign agent recognizes and delivers packets for the mobile host (directly via layer-2)



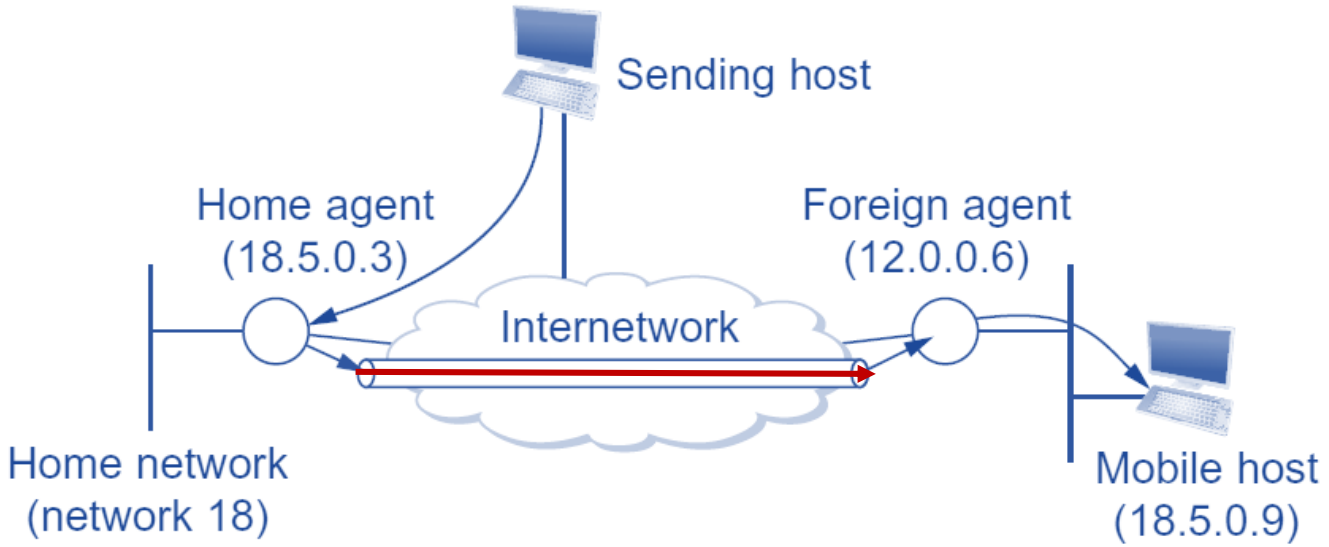
Mobile IP

- Step 1
  - Packets from sending host to mobile host are routed to home network
    - Problem: route of sending host to mobile host dost not go through home agent
      - Case1: Sending host is in the home network
      - Case2: Sending host's path does not go through the home agent (Network 18 is connected to multiple routers)
    - Solution: Proxy ARP
      - Home agent broadcasts ARP to bind mobile host's MAC with home agent's IP

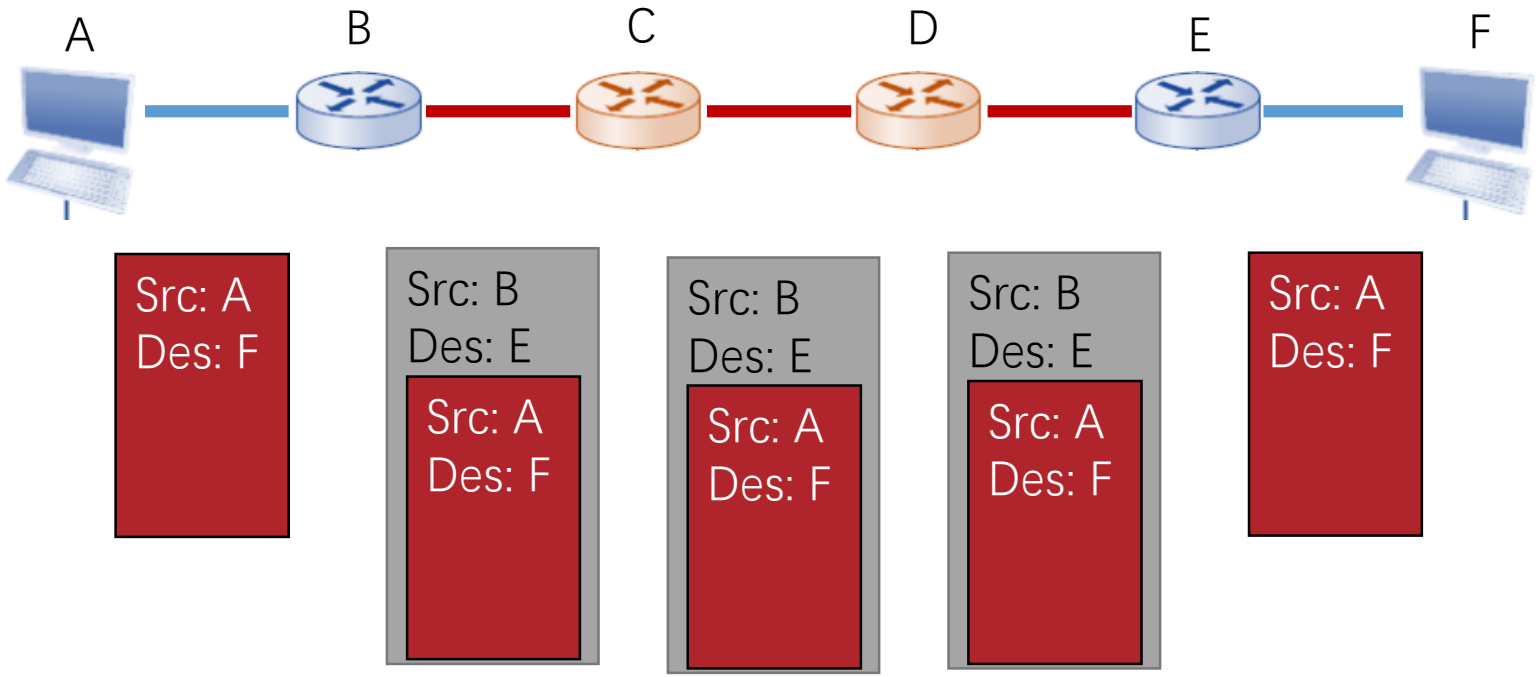


Mobile IP

- Step 2
  - Home agent redirects packets for mobile host to the foreign agent
    - Problem: routers in the network cannot correctly forward according to mobile host's home address
    - Solution: tunneling
      - Home agent and foreign agent are connected through IP tunnel

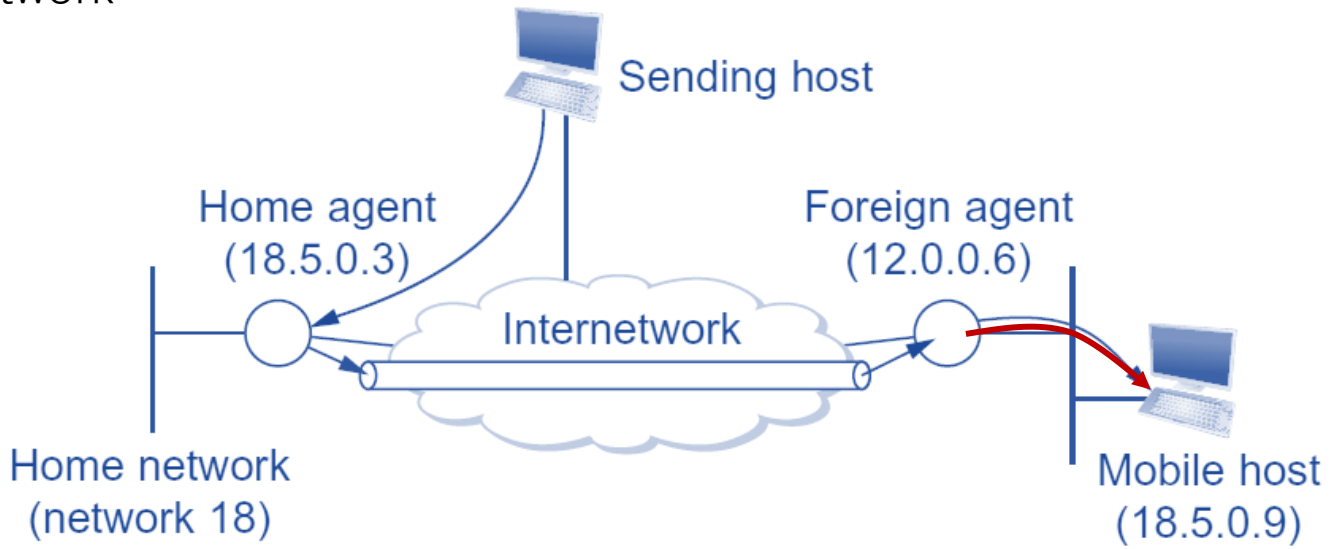


IP Tunnel Between Host A and Host F



Mobile IP

- Step 3
  - Foreign agent recognizes and delivers packets for the mobile host
    - Problem:
      - Why there is a foreign agent
    - Solution: combine foreign agent and mobile host
      - A software in mobile host acts as the foreign agent and obtain DHCP IP from foreign network



Outline

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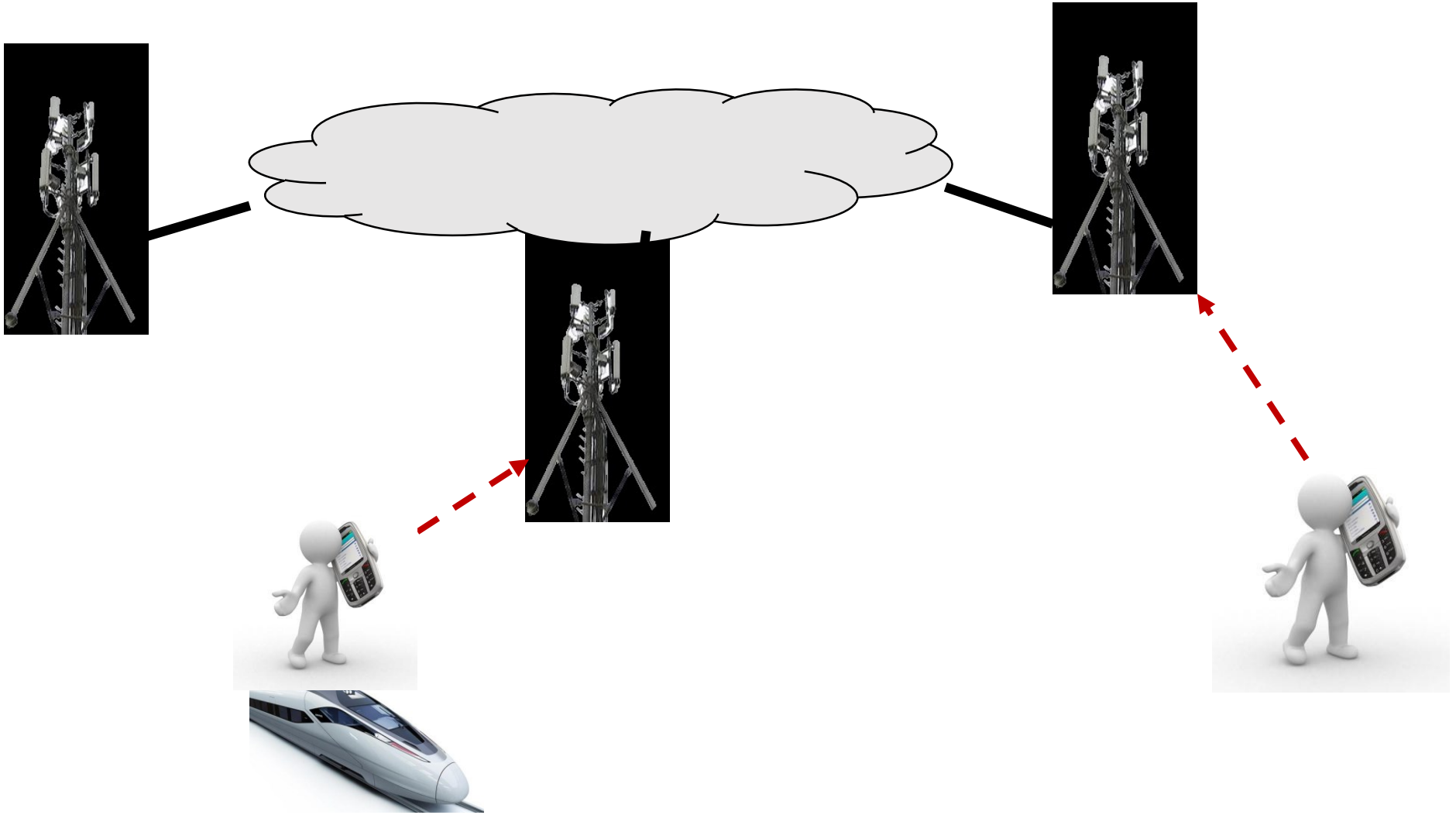
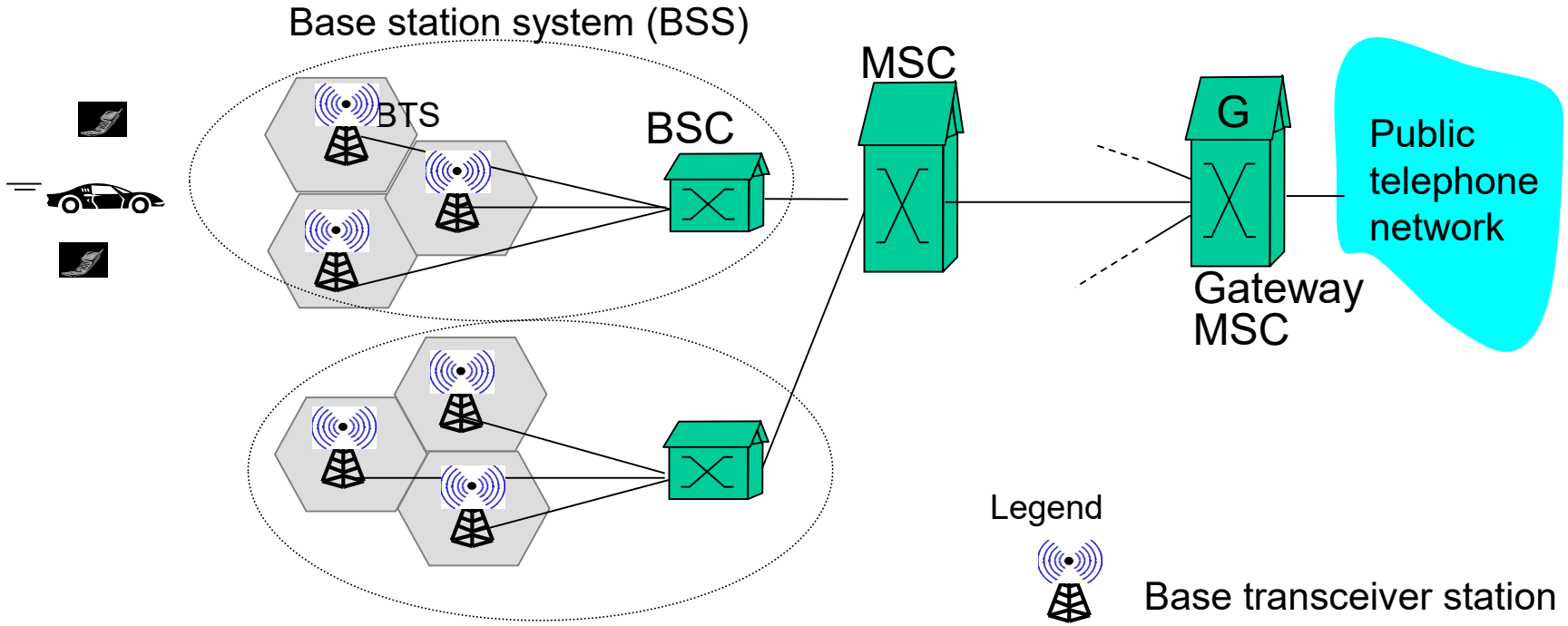
Mobility in Cellular Network



2G (GSM) Network Architecture



Legend

Base transceiver station (BTS)

Base station controller (BSC)

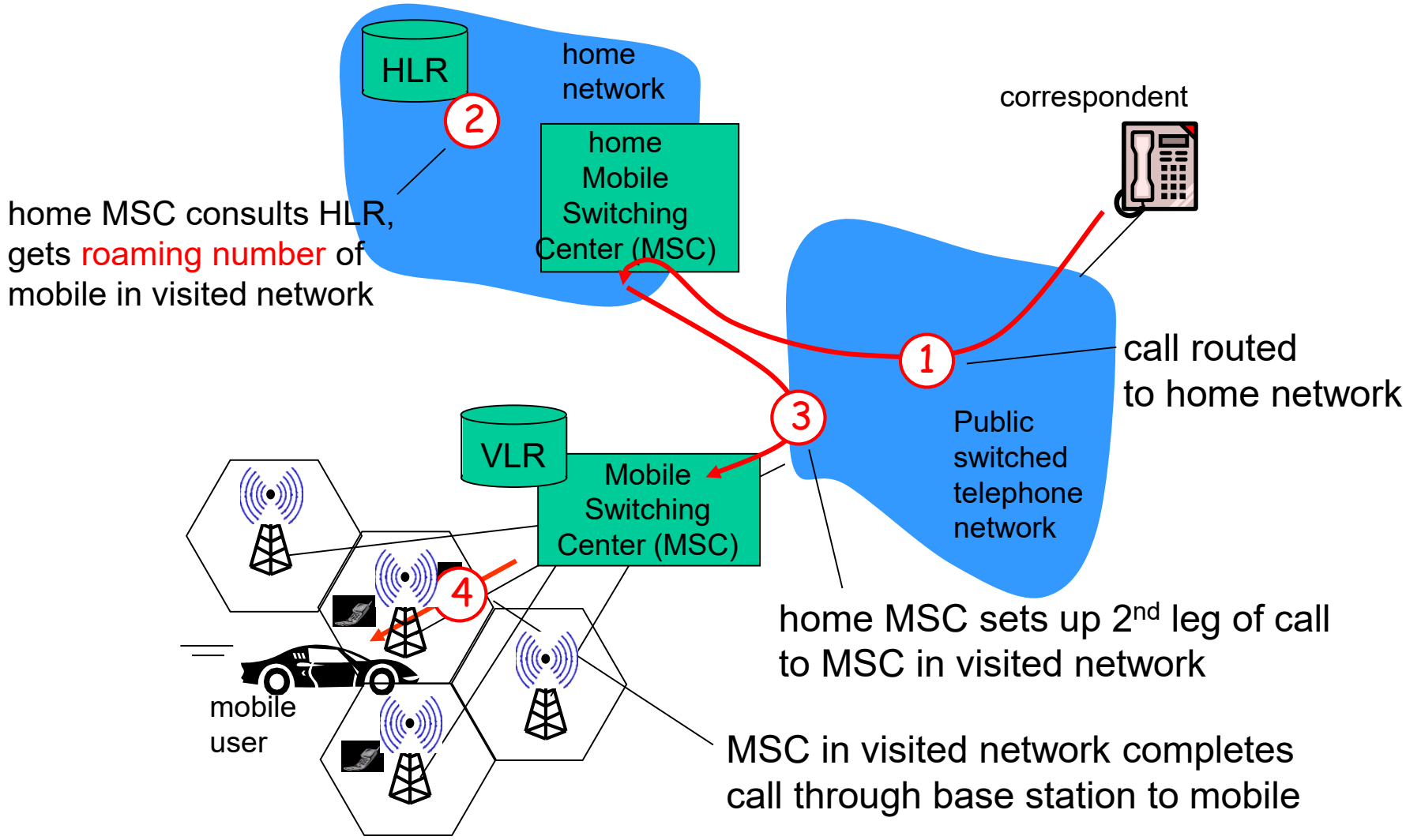
Mobile Switching Center (MSC)

Mobile subscribers

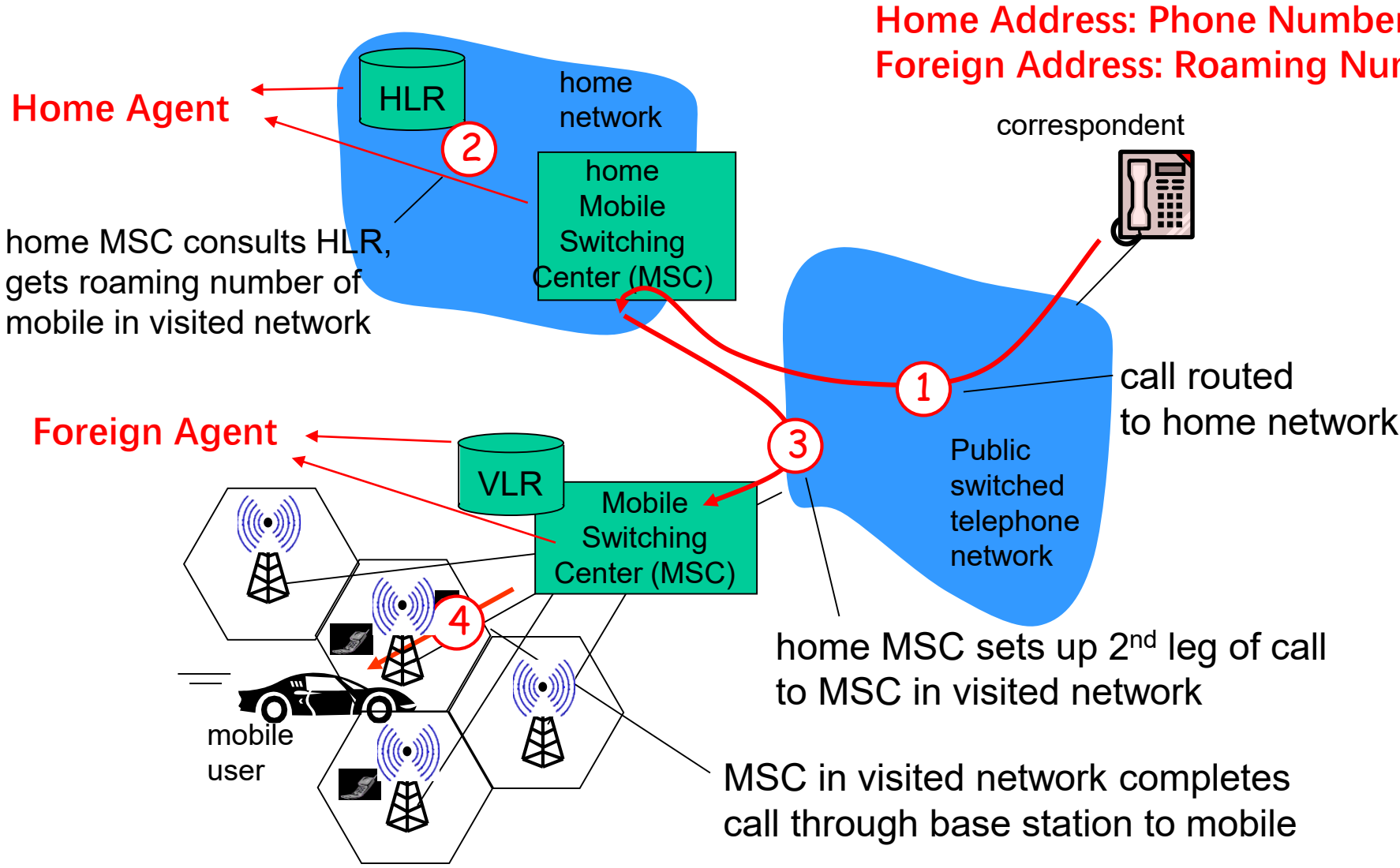
Mobility Handling In Cellular Networks

- *Home network*: network of cellular provider you subscribe to (e.g., China Mobile)
  - *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)
- *Foreign network (Visited):* network in which mobile currently resides (provider of other cities, or different provider)
  - *visitor location register (VLR):* database with entry for each user currently in network
  - could be home network

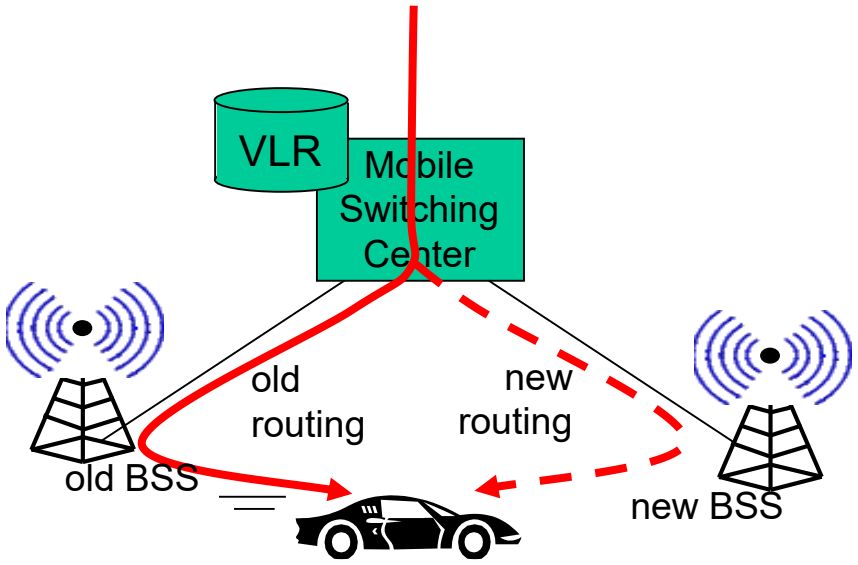
GSM: Indirect Routing to Mobile Host



Cellular versus Mobile IP

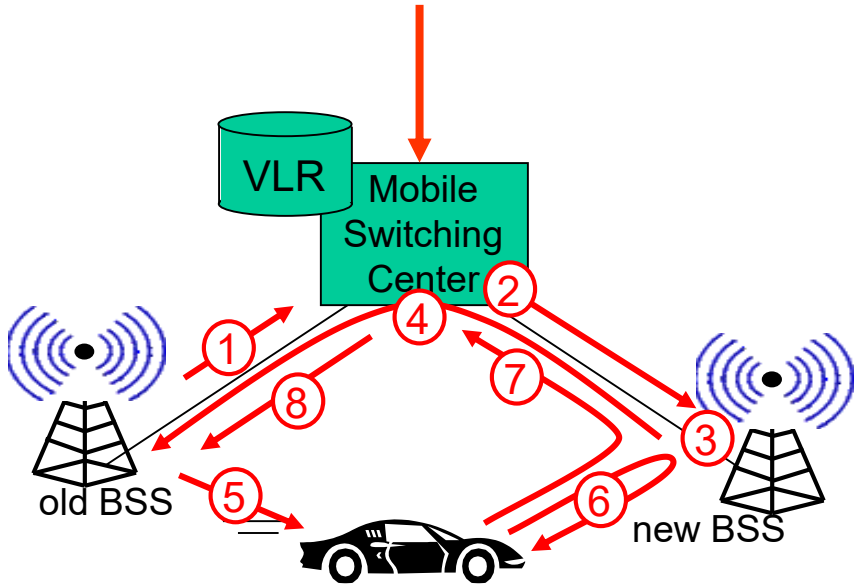


GSM: Handoff with Common MSC



- *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

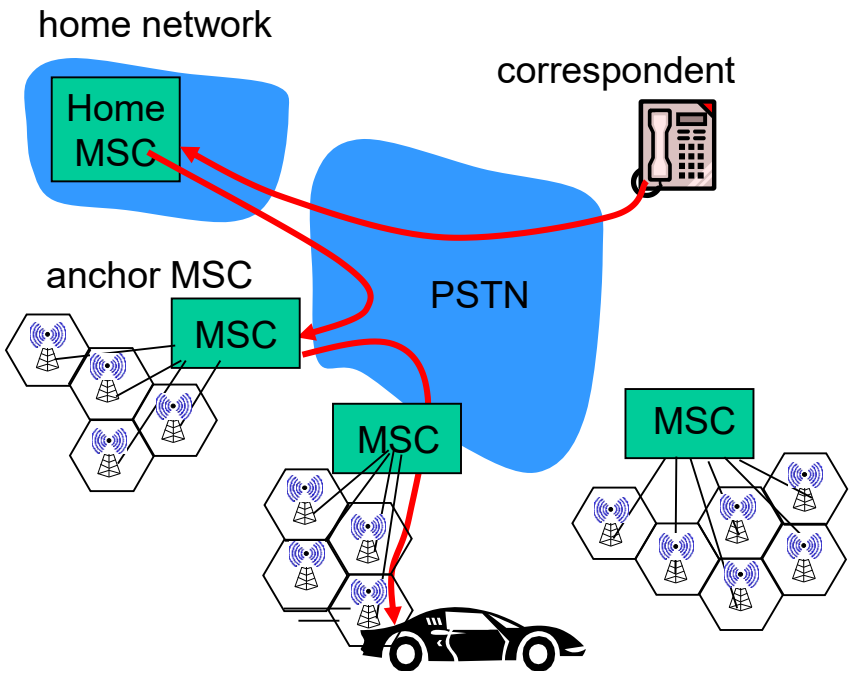
GSM: Handoff with Common MSC (Steps)



1. old BSS informs MSC of impending handoff, provides list of 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

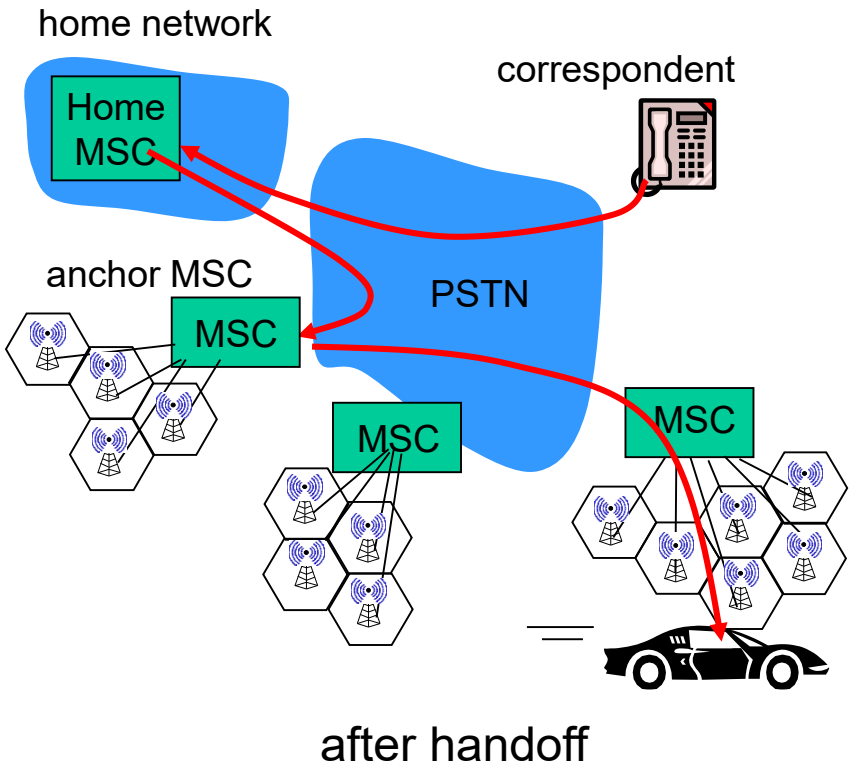
GSM: Handoff between MSCs



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



- *anchor MSC:* first MSC visited during call
  - call remains routed through anchor MSC
- Anchor MSC connects to new MSC

Outline

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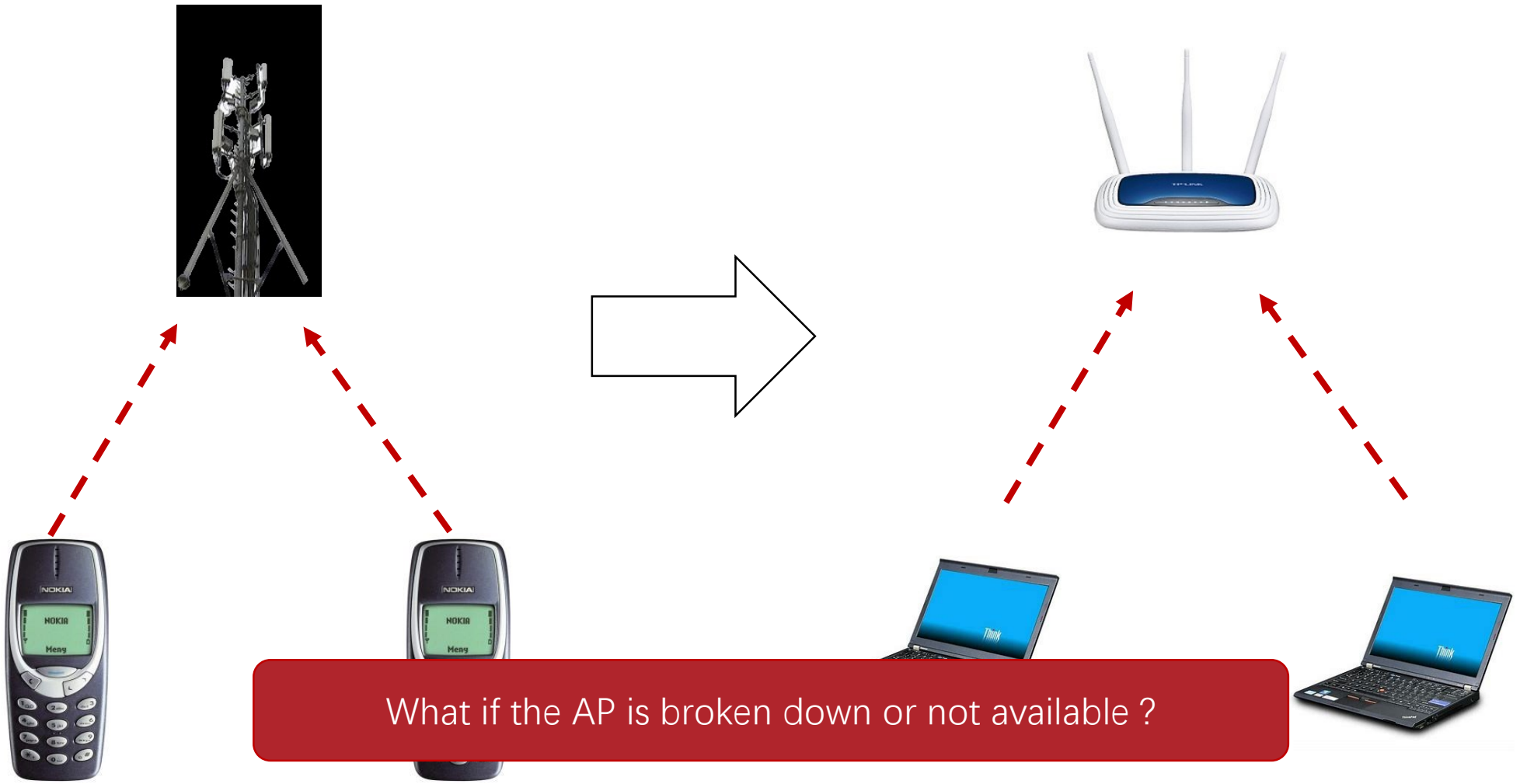
Wireless Network with Infrastructure



Mobile Ad Hoc Networks

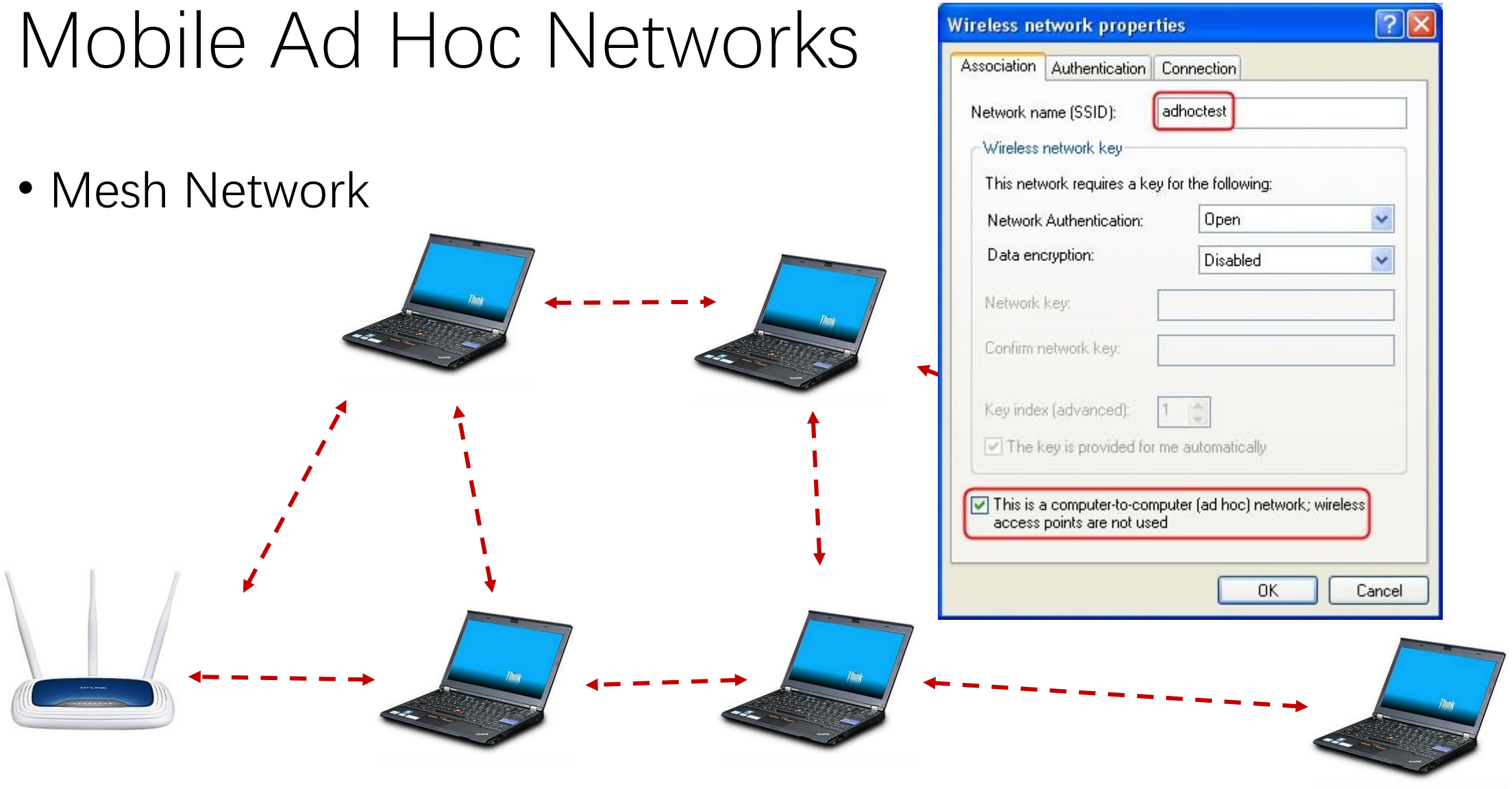
- Wireless
- Rapidly deployable, self configuring
- No Infrastructure

Emergency

Military

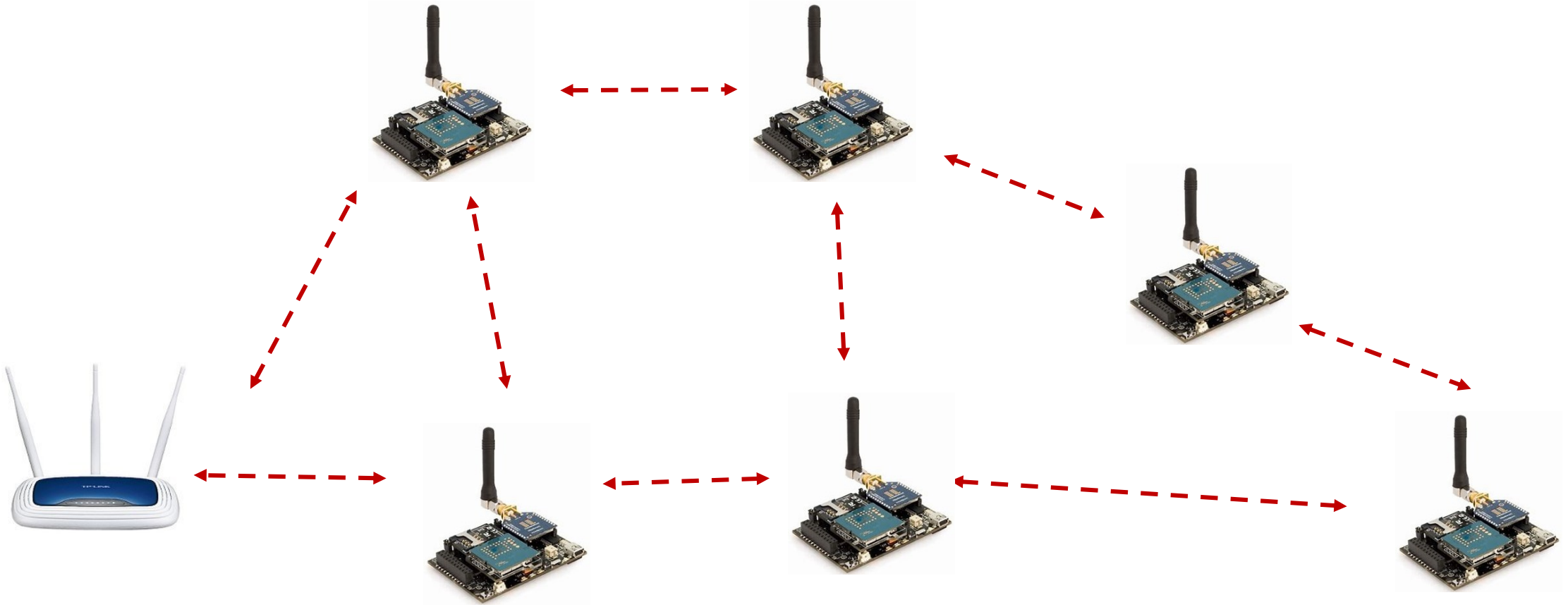
Mobile Ad Hoc Networks

- Mesh Network



Mobile Ad Hoc Networks

- Wireless Sensor Network

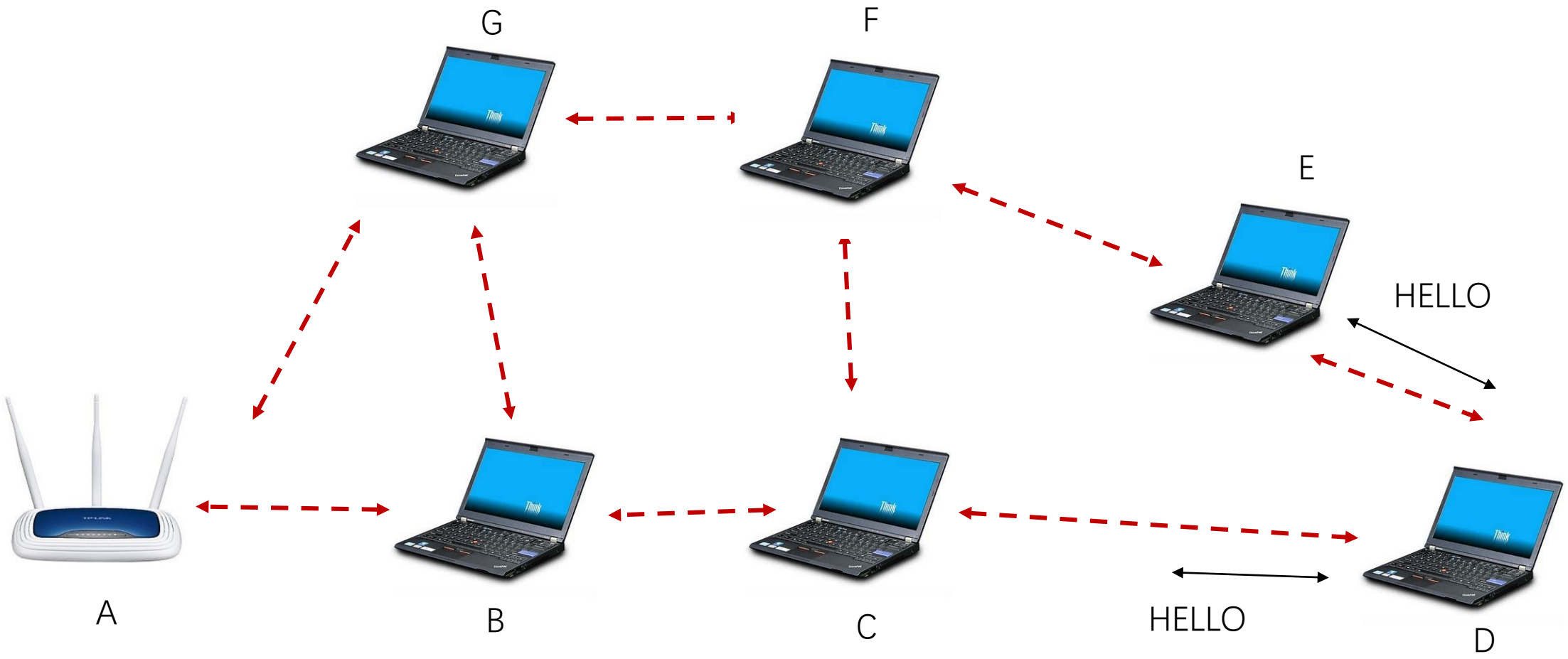


Routing in Ad Hoc Networks

- Problem:
  - Multi-hop operation requires a routing mechanism designed for mobile nodes
- Challenges:
  - Network topology is highly dynamic
    - Connection quality, Mobility of Participant, etc.
  - Resource of mobile devices is very limited
    - Bandwidth, Power, Computing Ability, Storage, etc.
  - Network connections can be asymmetric
    - e.g., A can reach B but B cannot reach A

Optimized Link State Routing (OLSR)

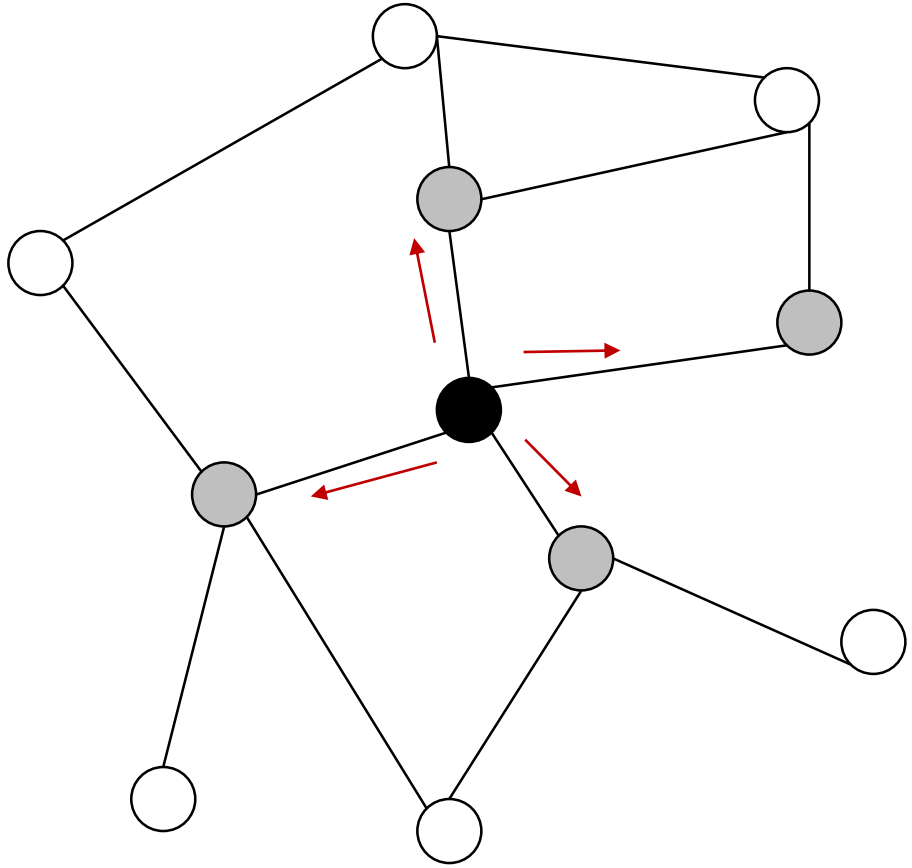
- RFC 3626
- Pro-Active
  - Routes are set up based on continuous control traffic
- Routing Method
  - Link sensing
  - “Selective” flooding
  - Link-State messaging


G
F
E
HELLO
A
B
C
HELLO
D

Neighbor Discovery and Link Sensing

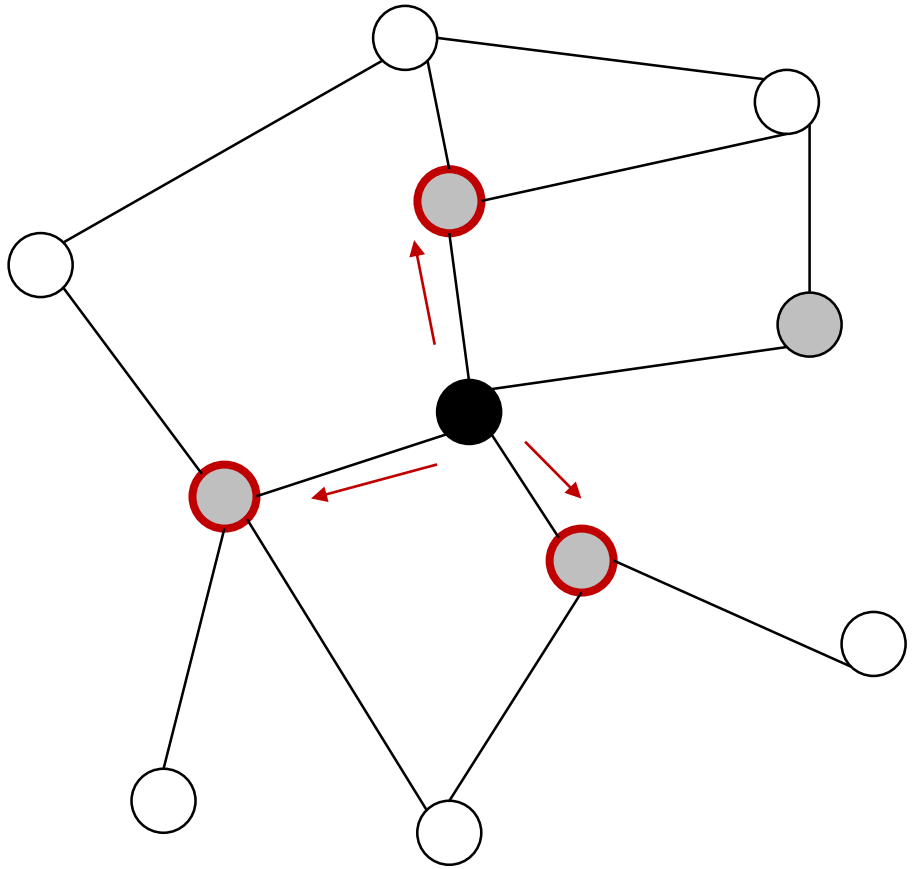
- HELLO messages are used to find symmetric links
- HELLO messages contains all 1-hop neighbors
  - Using HELLO messages each node knows not only its 1-hop neighborhood but its 2-hop neighborhood

Normal Flooding



“Selective” Flooding

- Select MultiPoint Relay (MPR)
  - to reduce broadcasting overhead
  - For all 2 hop neighbors there must exist a MPR set so that these 2 hop neighbors can be connected through nodes in MPR



Link-State Messaging

- Flood Link State
  - Similar to OSPF
  - Reduce overhead with MPR

Optimized Link State Routing (OLSR)

- Pro-Active
  - Routes are set up based on continuous control traffic
- Routing Method
  - Link sensing
  - “Selective” flooding
  - Link state messaging
- Pros and Cons
  - Constant routing overhead
  - Routes are always available

Reference

- Textbook 4.4