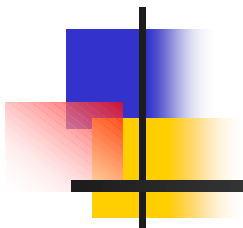


# Wireless Network and Mobility



**Dept. of Computer Science, University of Rochester**



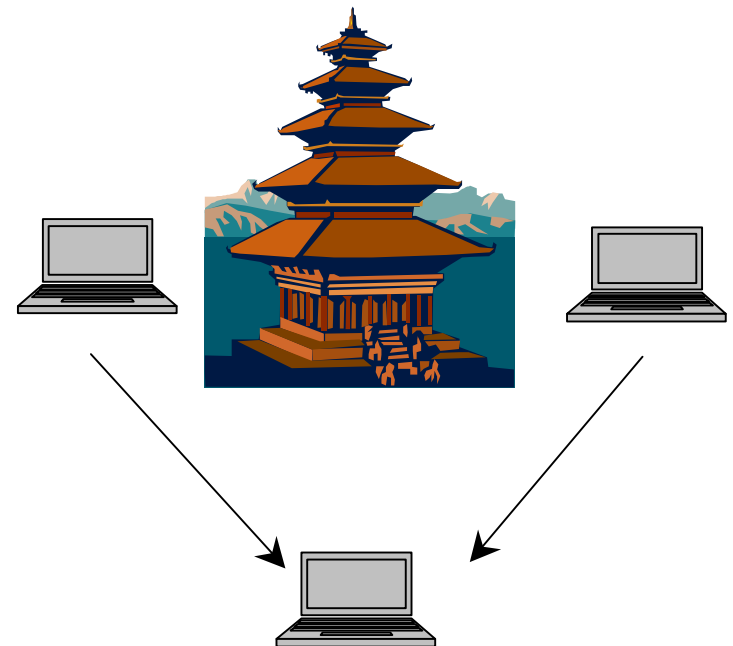
# Wireless Networks and Mobility

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- Wireless networking in the data link layer
  - Short range: IEEE 802.15 Bluetooth
  - Medium range: IEEE 802.11 wireless LAN (WiFi)
  - Long range: Cellular Internet access and long range WiFi
- Mobility in the network layer
  - Infrastructured wireless mobile networks
  - Ad hoc wireless mobile networks

# Media Access Control for Wireless Networks

- Collision if 2 or more nodes transmit at same time
- Efficiency goal of media access control:
  - get all the bandwidth if you're the only one transmitting
  - share the bandwidth fairly if multiple nodes transmit
- CSMA/CD (what is CSMA/CD??)
- **Hidden terminal problem**
  - the sender doesn't know if a transmission is successful
  - collision detection doesn't work



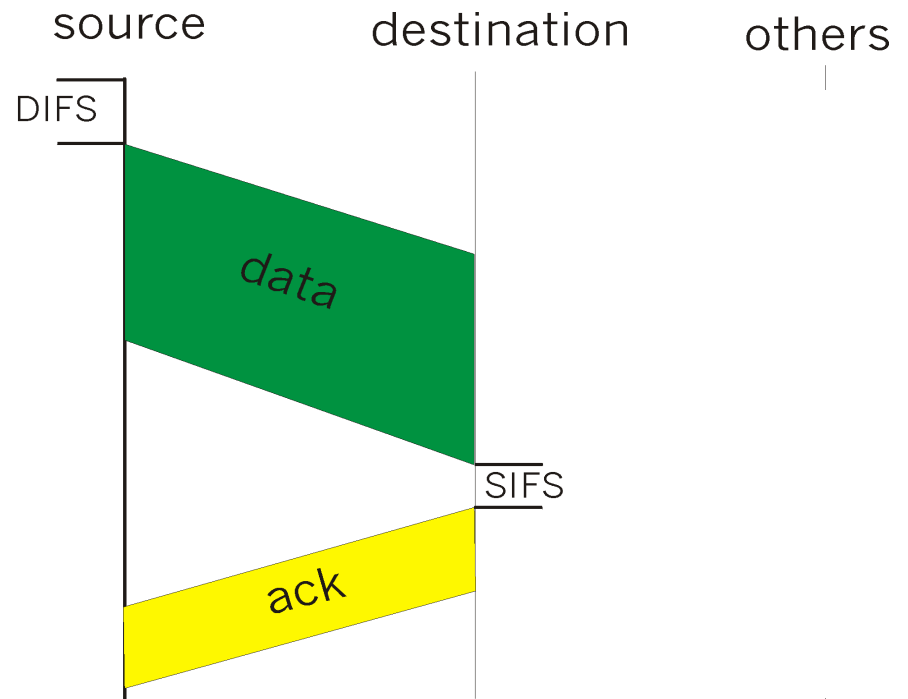
# IEEE 802.11 MAC Protocol: CSMA/CA

## 802.11 CSMA sender

- if sense channel idle for **DIFS** sec; then transmit entire frame (no collision detection)
- if sense channel busy; then backoff

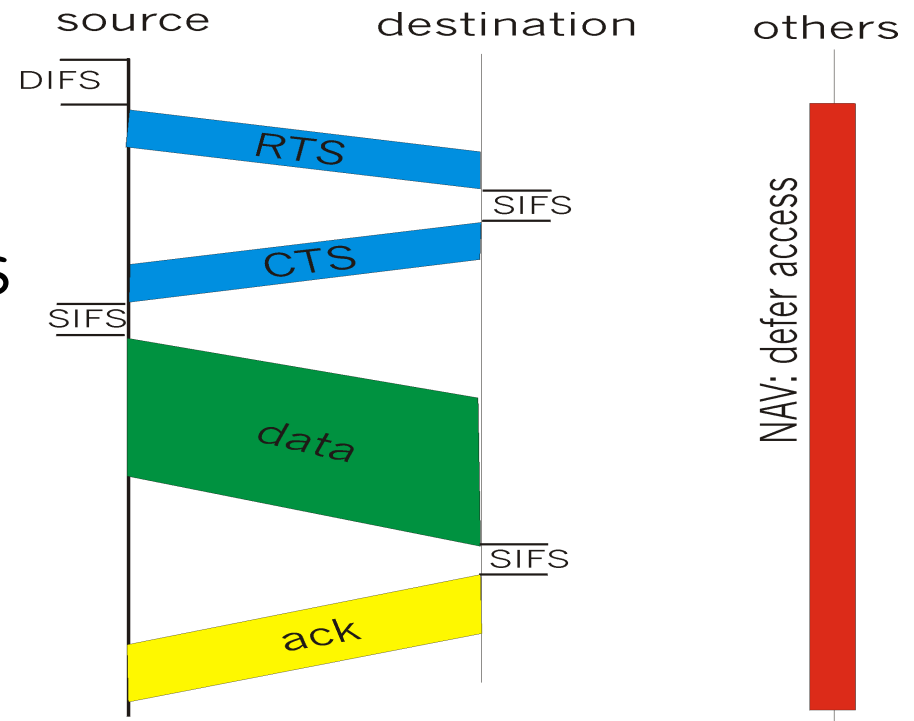
## 802.11 CSMA receiver

- if received OK; return ACK after **SIFS** (ACK is needed due to hidden terminal problem)



# Better Collision Avoidance through RTS-CTS Exchange

- sender transmits short RTS (request to send) packet: indicates duration of transmission
- receiver replies with short CTS (clear to send) packet
  - notifying (possibly hidden) nodes
- nodes hearing either RTS or CTS will not transmit for specified duration: NAV
- Collision is unlikely because RTS/CTS are short.



IEEE 802.11 MAC Protocol: **CSMA/CA**



# Wireless Networks and Mobility

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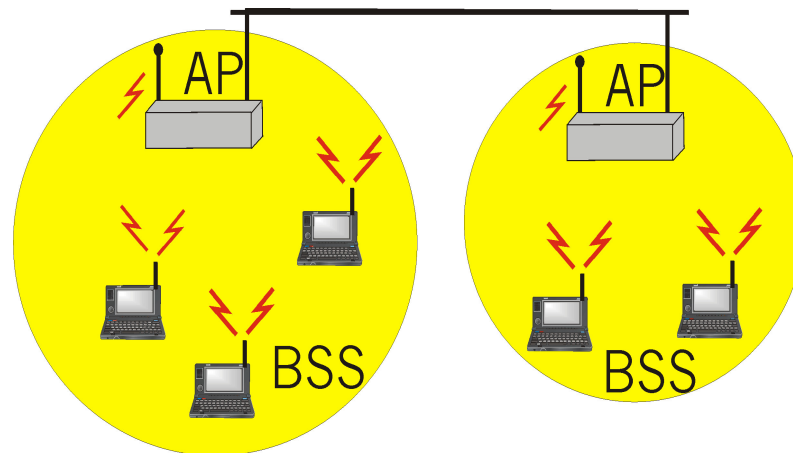
# Mobility issues

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- The desire for mobility abounds
  - Phone number portability
  - Cell phone handoffs among towers
  - Are there Internet handoffs among access points?
- “Any problem in computer science can be solved with another layer of indirection.”  
— David Wheeler, chief programmer for the EDSAC project in the early 1950s.
- Locations and End-point Identifiers are separate concepts
- But not in TCP or UDP
- Mobility offers opportunities for interception and redirection, so there are security considerations

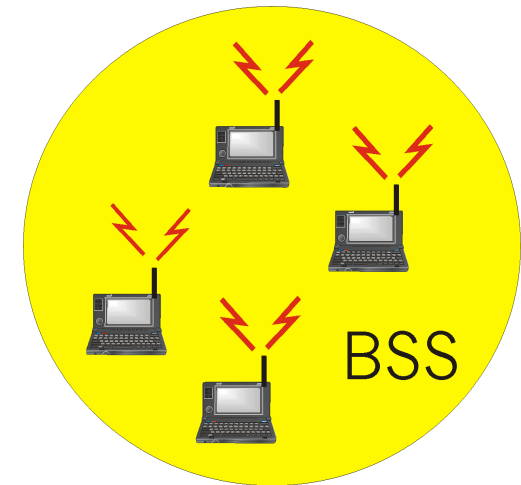
# Mobility: Base Station Model

- Wireless host communicates with a **base station** or **access point (AP)**.
- **Basic Service Set (BSS)** contains:
  - a base station;
  - wireless hosts reachable from the base station.
- Base stations are connected to each other and wide-area network through wired links.



# Mobility: Ad Hoc Network Model

- No base stations or access points
- Wireless hosts communicate with each other directly
  - to get packet from wireless host A to B may need to route through wireless hosts X, Y, Z
- Compared with based station model
  - more flexible
  - require complex support
- Applications:
  - "laptop" meeting in conference room, car
  - interconnection of "personal" devices
  - battlefield



# Addressing: when mobile is at home

**home network:** permanent "home" of mobile  
e.g., 128.119.40/24

**home agent:** entity that will perform mobility functions on behalf of mobile, when mobile is remote

**permanent address:** address in home network, can always be used to reach mobile  
e.g., 128.119.40.186

wide area network

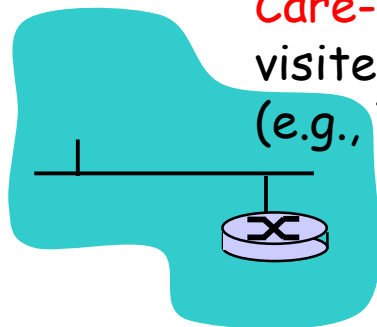
**correspondent:** wants to communicate with mobile

# Addressing: when mobile is moving around

**Permanent address:** remains constant (e.g., 128.119.40.186)

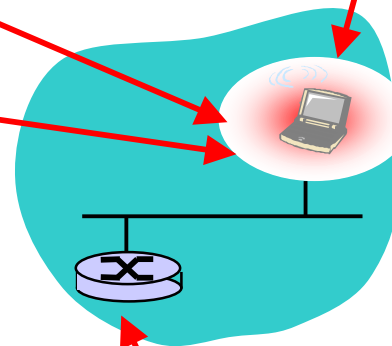
**visited network:** network in which mobile currently resides (e.g., 79.129.13/24)

**Care-of-address:** address in visited network. (e.g., 79.129.13.2)



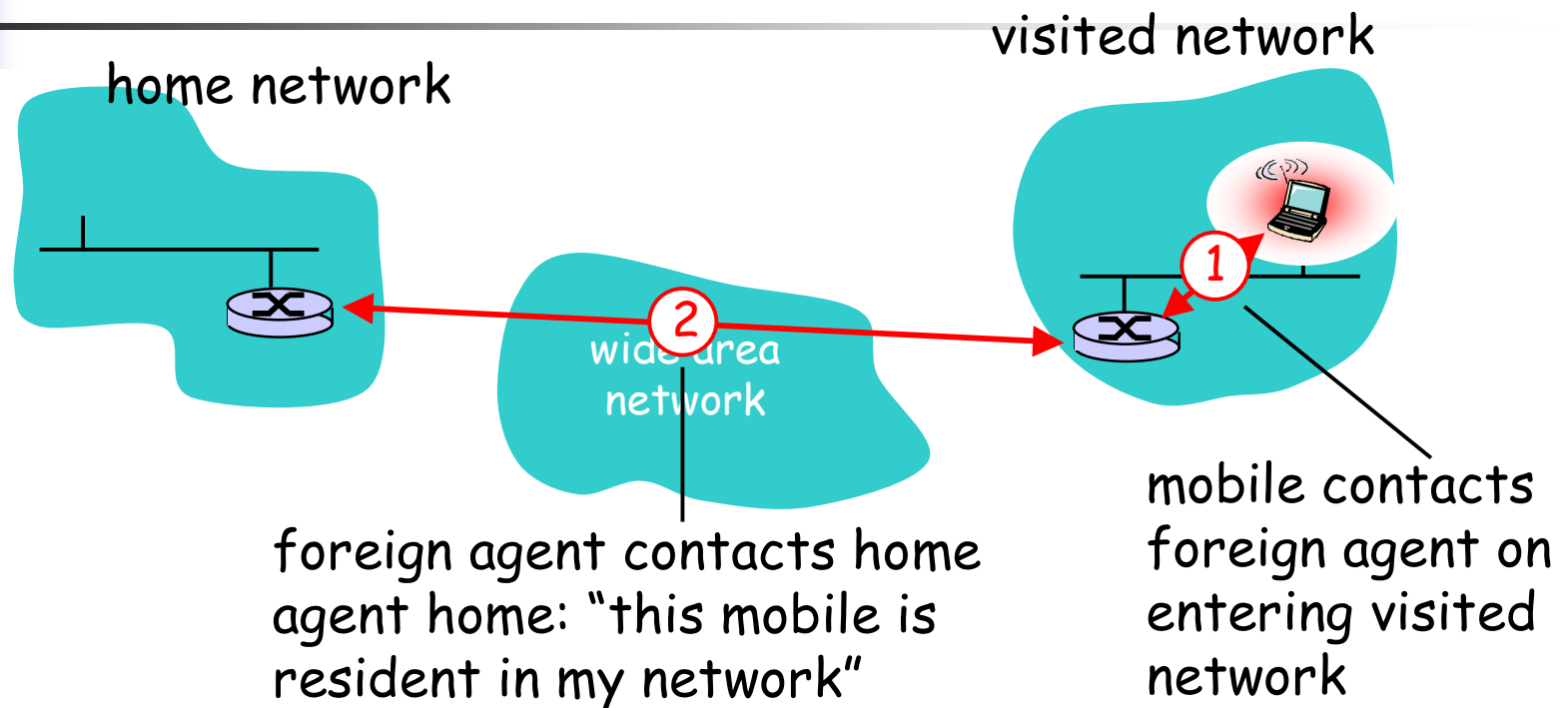
wide area network

correspondent



**foreign agent:** entity in visited network that performs mobility functions on behalf of mobile.

# Mobile Registration



End result:

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

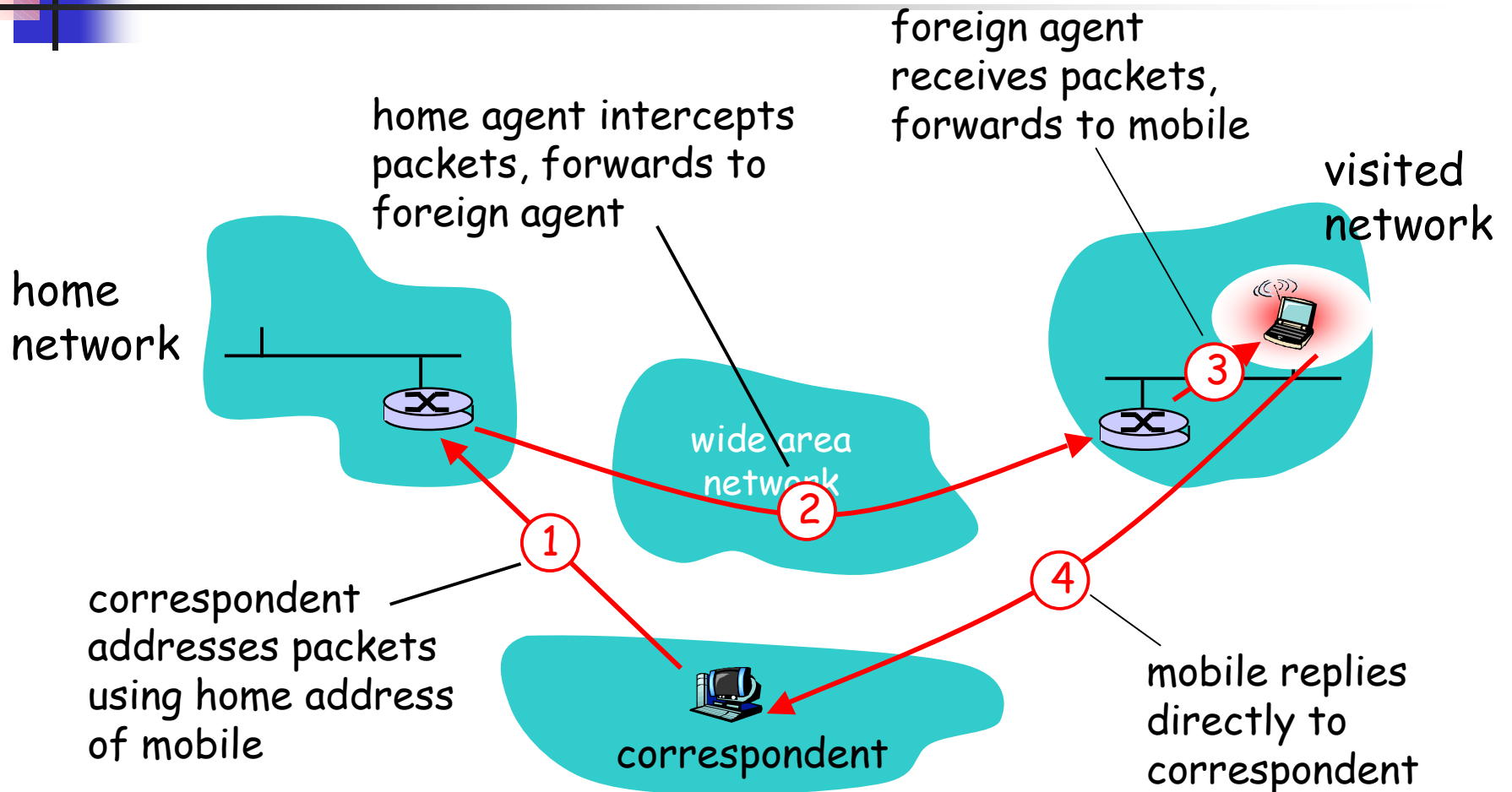


# Principles of Mobile Routing

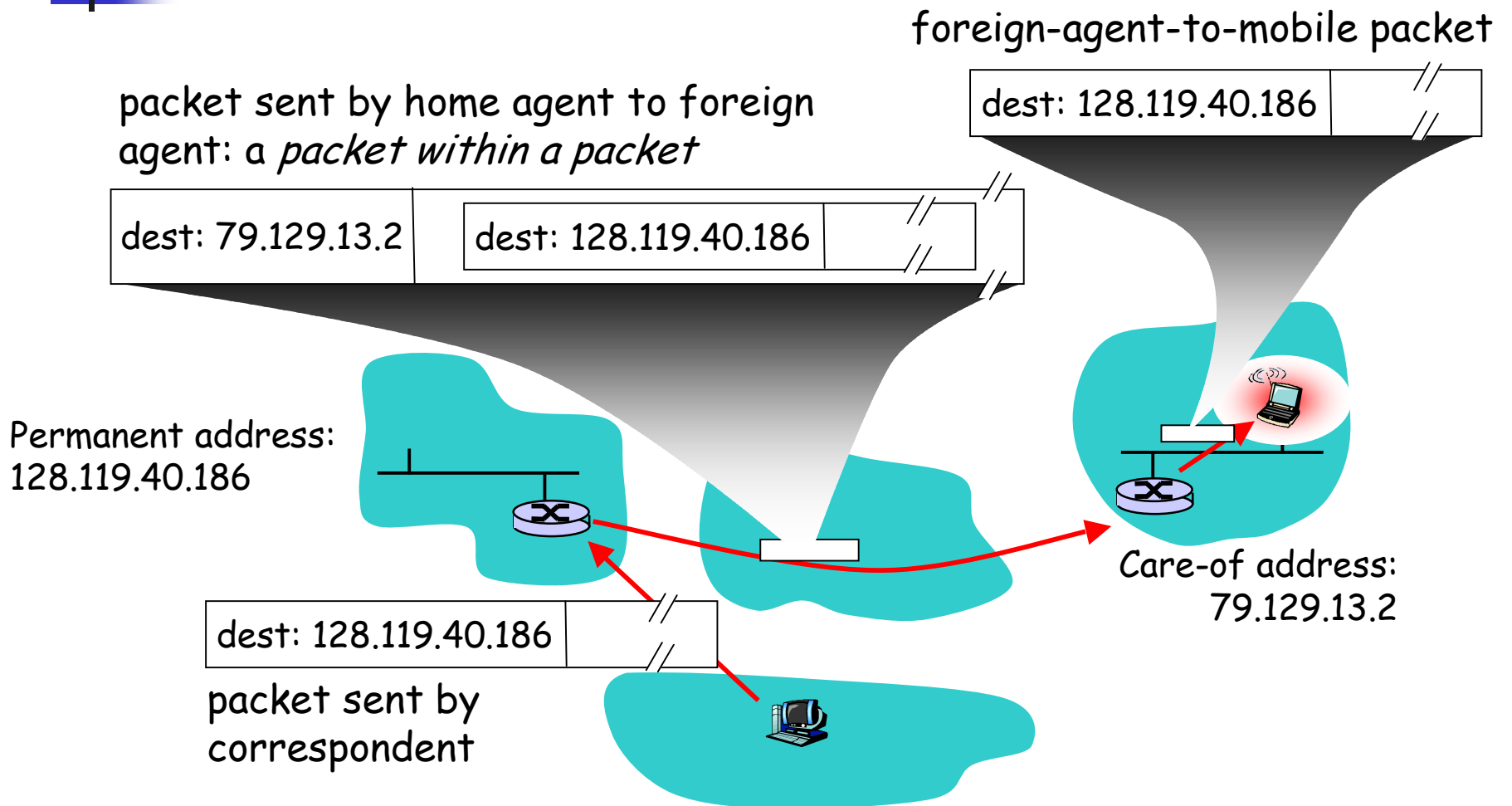
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- **Indirect routing**
  - communication from correspondent to mobile goes through home agent, then forwarded to remote
- **Direct routing**
  - correspondent gets foreign address of mobile, sends directly to mobile

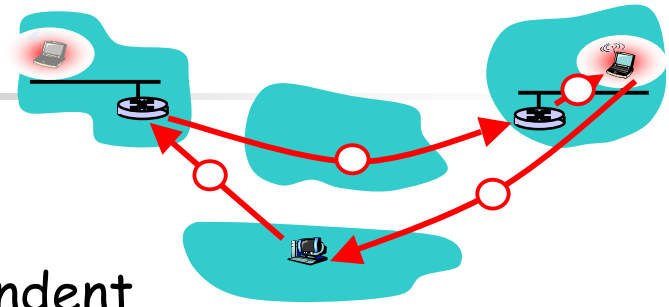
# Mobility via Indirect Routing



# Forwarding Packets to Remote Mobile: Encapsulation

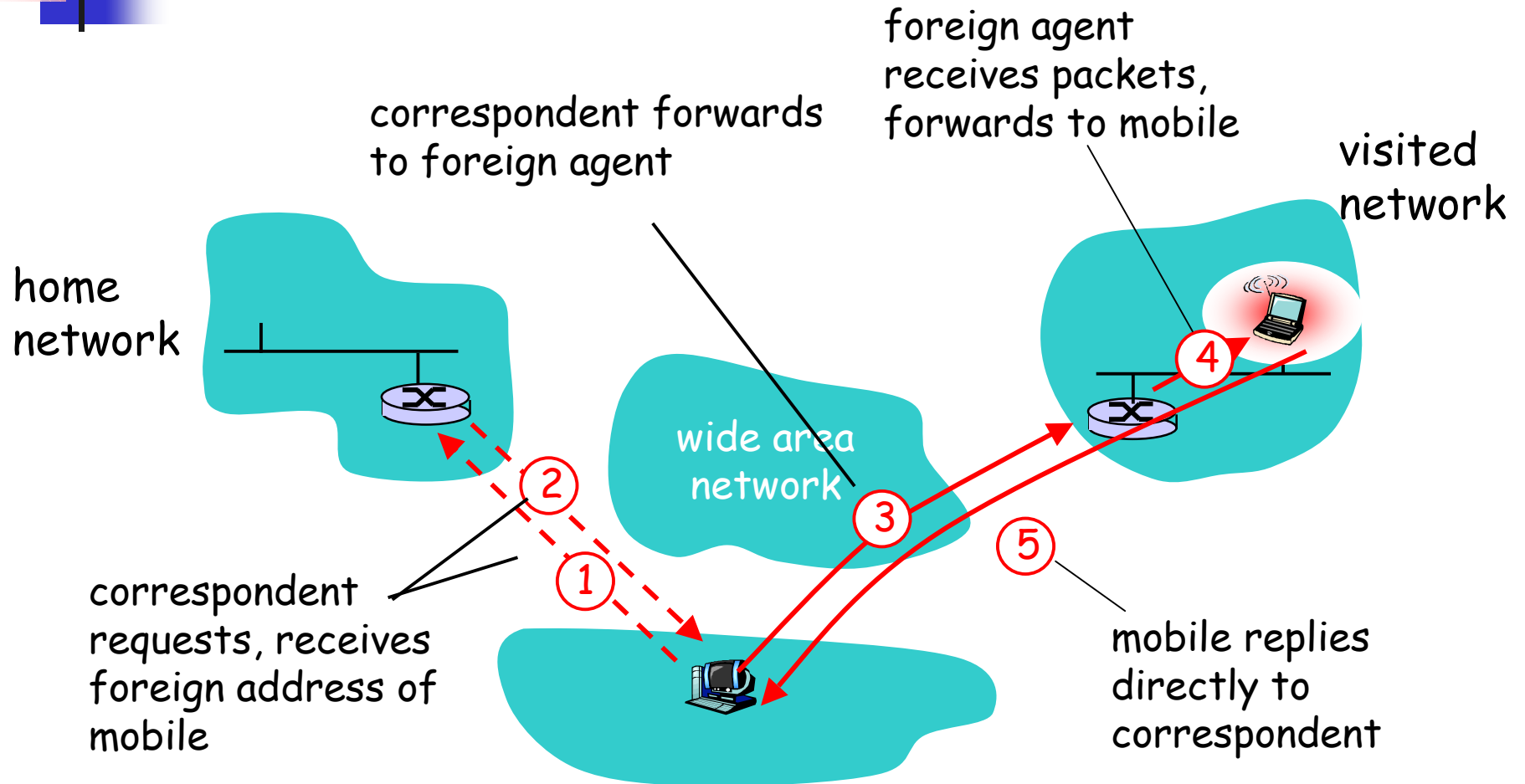


# Indirect Routing: Discussions

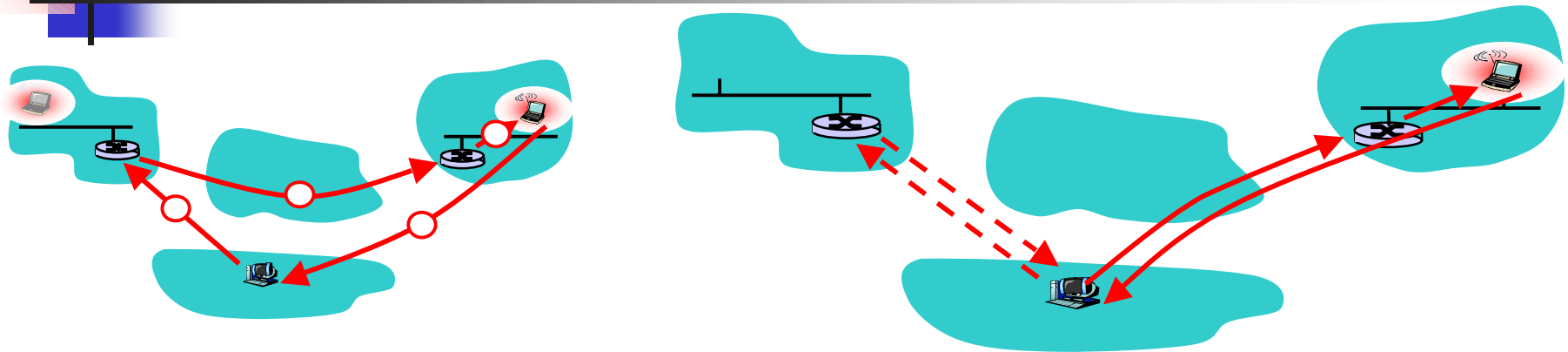


- Mobile uses two addresses:
    - **permanent address**: used by correspondent
    - **care-of-address**: used by home agent to forward packets to mobile
  - **triangle routing**: corres.-home-network-mobile
  - suppose mobile user moves to another network
    - registers with new foreign agent
    - new foreign agent registers with home agent
    - home agent updates care-of-address for mobile
    - packets continue to be forwarded to mobile (but with new care-of-address)
- ⇒ Mobility, changing foreign networks transparent

# Mobility via Direct Routing



# Indirect Routing vs. Direct Routing



- Efficiency

- Indirect routing is inefficient, especially when correspondent, mobile are near but home is far

- Transparency

- Indirect routing is transparent to correspondent, smoother handoff when moving between networks



# Mobile IP

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- Network-layer mobility protocol interoperable with IP [C. Perkins, 2002]
- Has many features we've seen:
  - home agents, foreign agents, foreign-agent registration, care-of-addresses, encapsulation (packet-within-a-packet)
  - use indirect routing



# Mobile Ad Hoc Networks

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- Open research area
- Addressing
  - Requirements for addressing in MANET?
- Routing
  - Any idea about finding good routes for MANET?



# Disclaimer

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