Politecnico di Milano
Facoltà di Ingegneria dell'Informazione

6 – Mobility Management

Reti Mobili Distribuite

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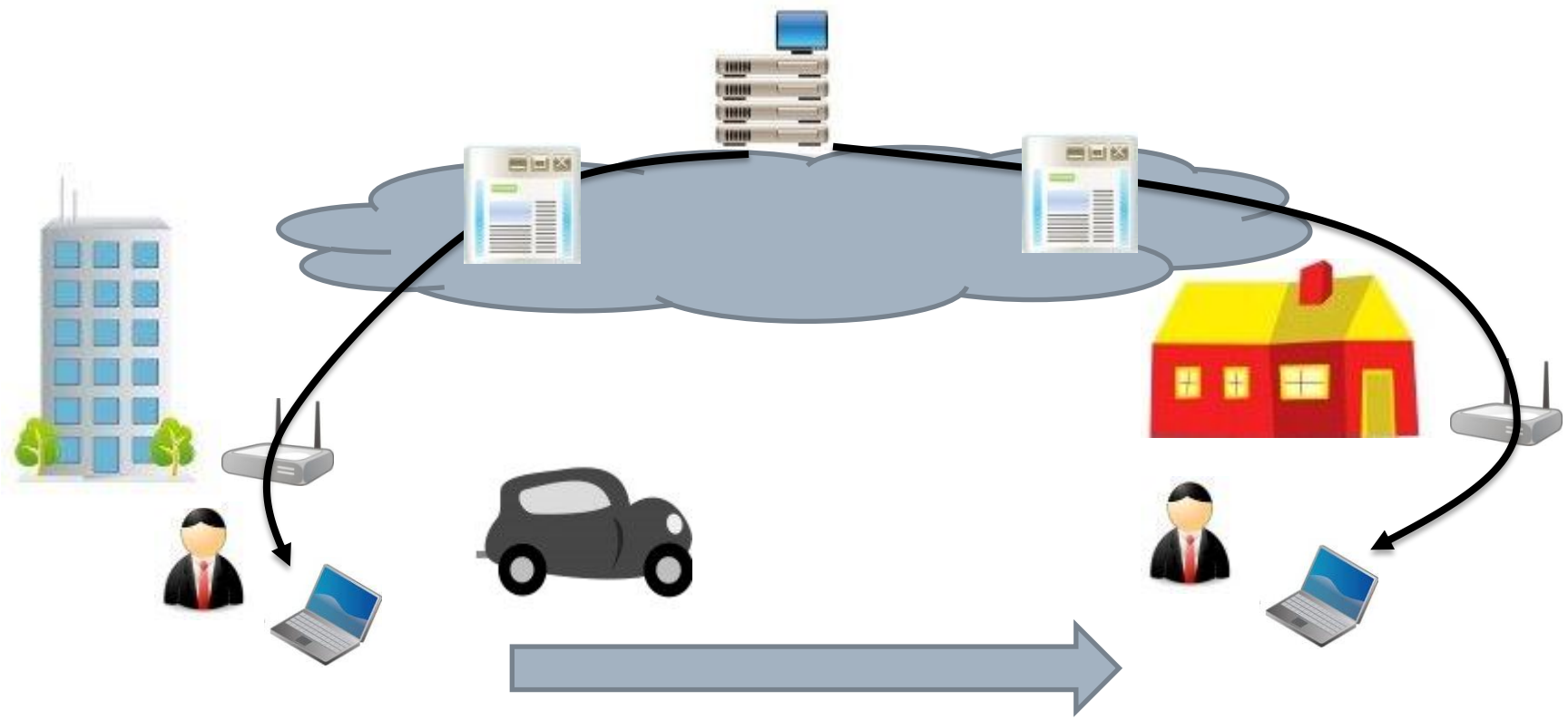
Introduction

- Mobility management allows a terminal to change its point of access to the network :
  - Without changing its address/identifier
  - Keeping sessions active (at application level)
- This is not always necessary
  - Application clients do not need to be reached with the same address/identifier
  - They can change address/identifier whenever they need and issue requests to servers as long as session continuity is not a problem

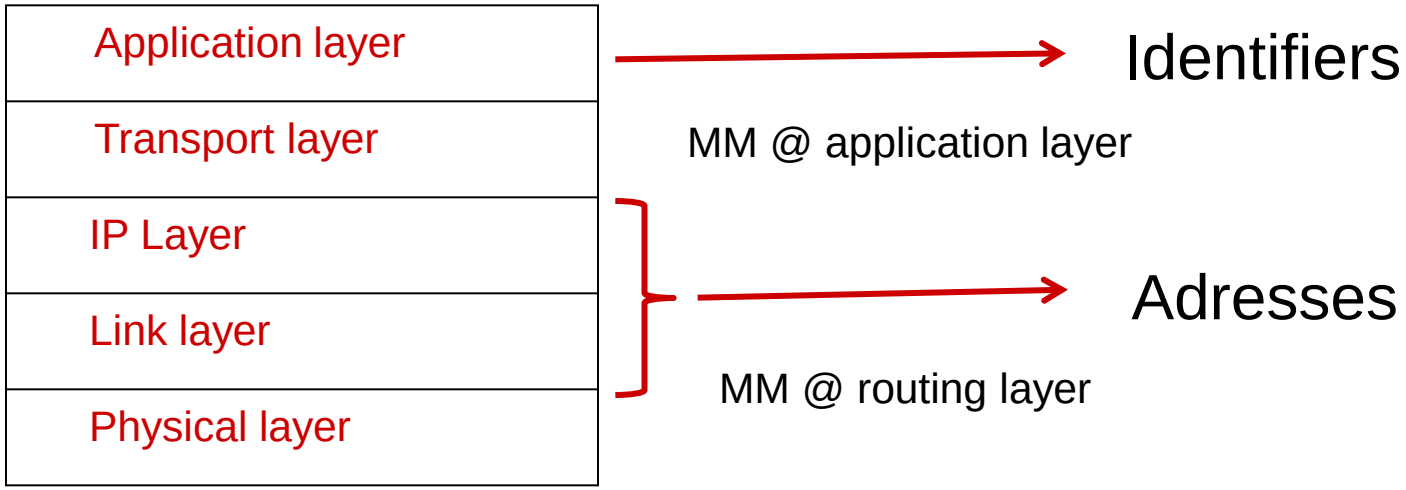
Client mobility



Change IP address
Start new sessions

Mobility Management (MM)

- If you must be reached by other hosts with your address/identifier:
  - Server applications
- And/or you want your sessions remain active
  - Real time applications
- Then you need some mobility management support by the network

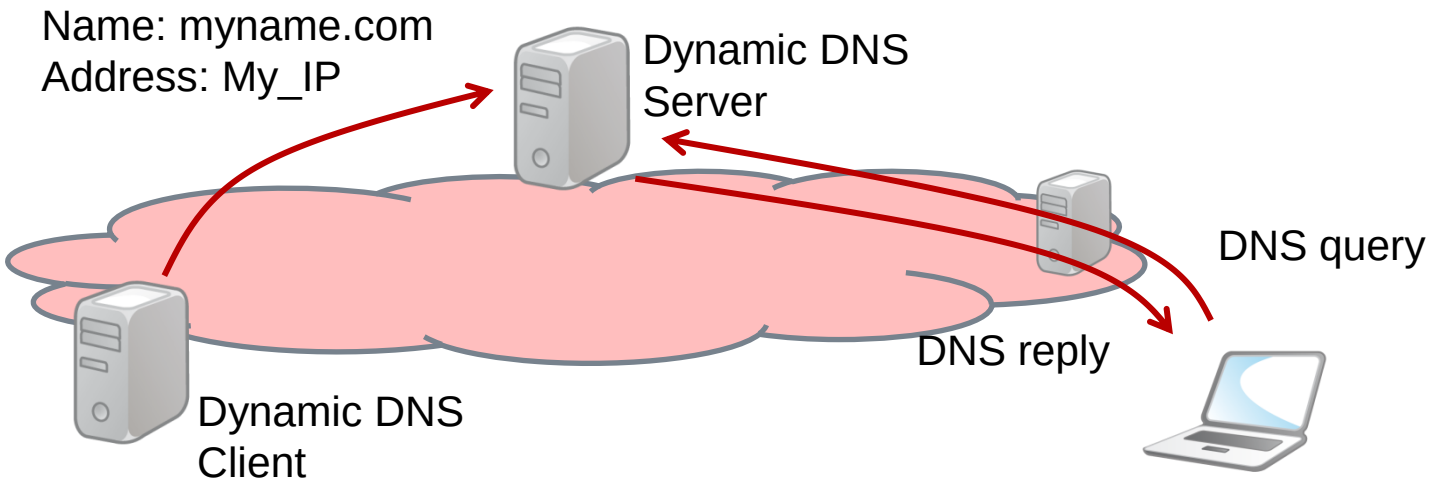


MM @ Application Layer

- Change address and keep the same application layer identifier
- Manage sessions changing their description when address change
- Examples:
  - Dynamic DNS
  - SIP

MM @ Application Layer

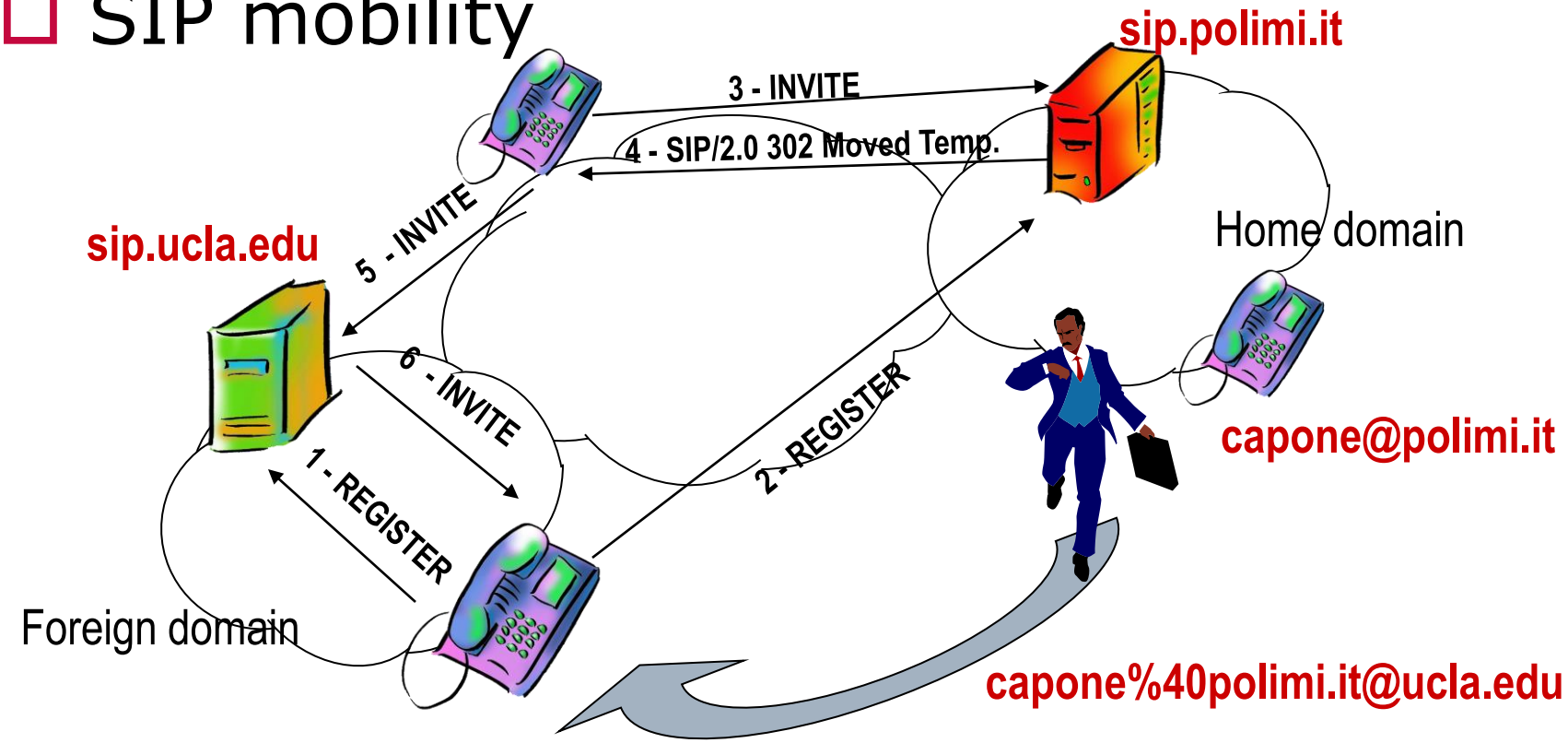
- Dynamic DNS



- No session continuity
- Mainly devised for static servers with dynamic IP addresses

MM @ Application Layer

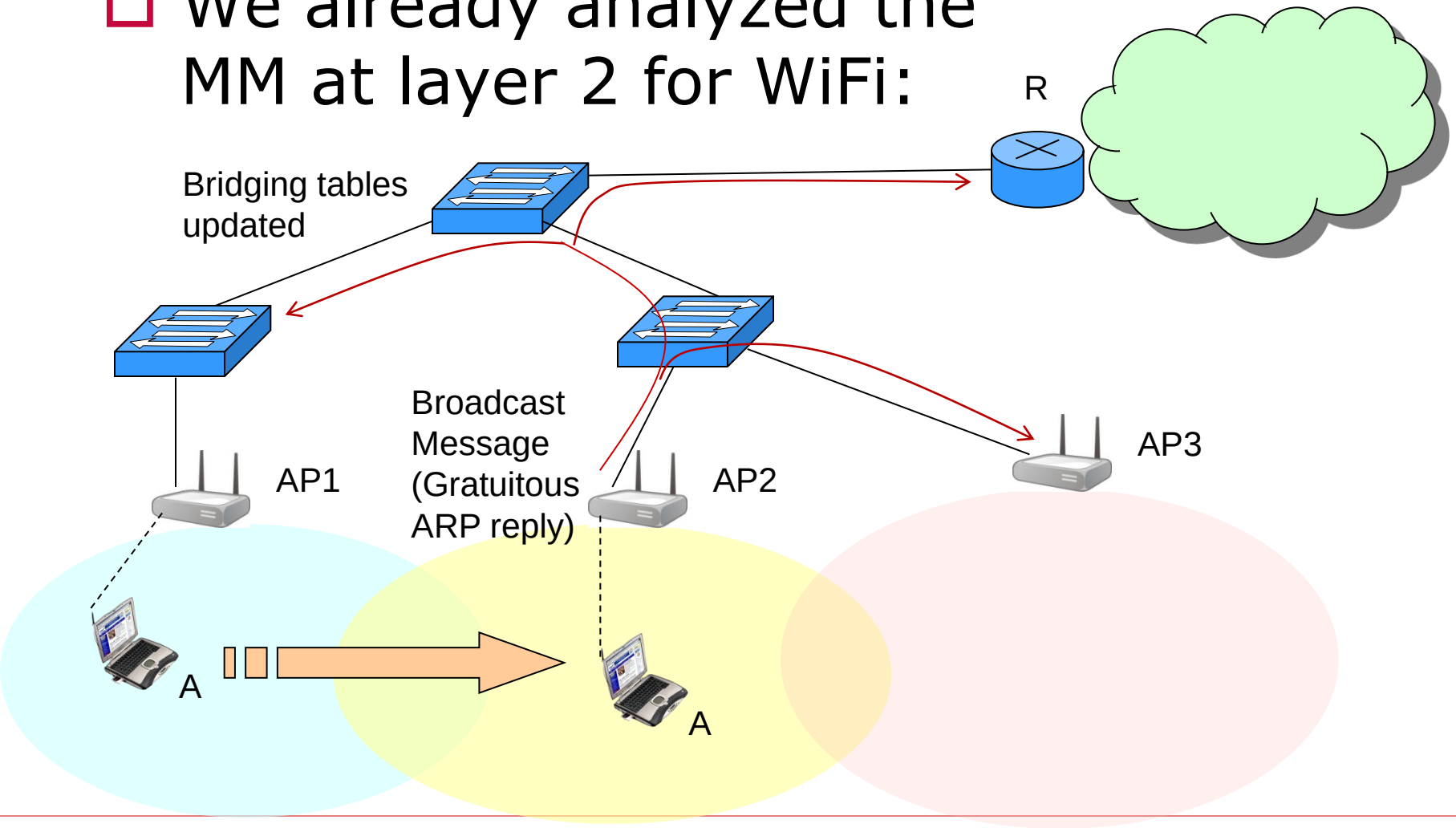
- SIP mobility



- Both pre-call and mid-call mobility can be provided with session continuity

MM @ routing layer: Link Layer

- We already analyzed the MM at layer 2 for WiFi:

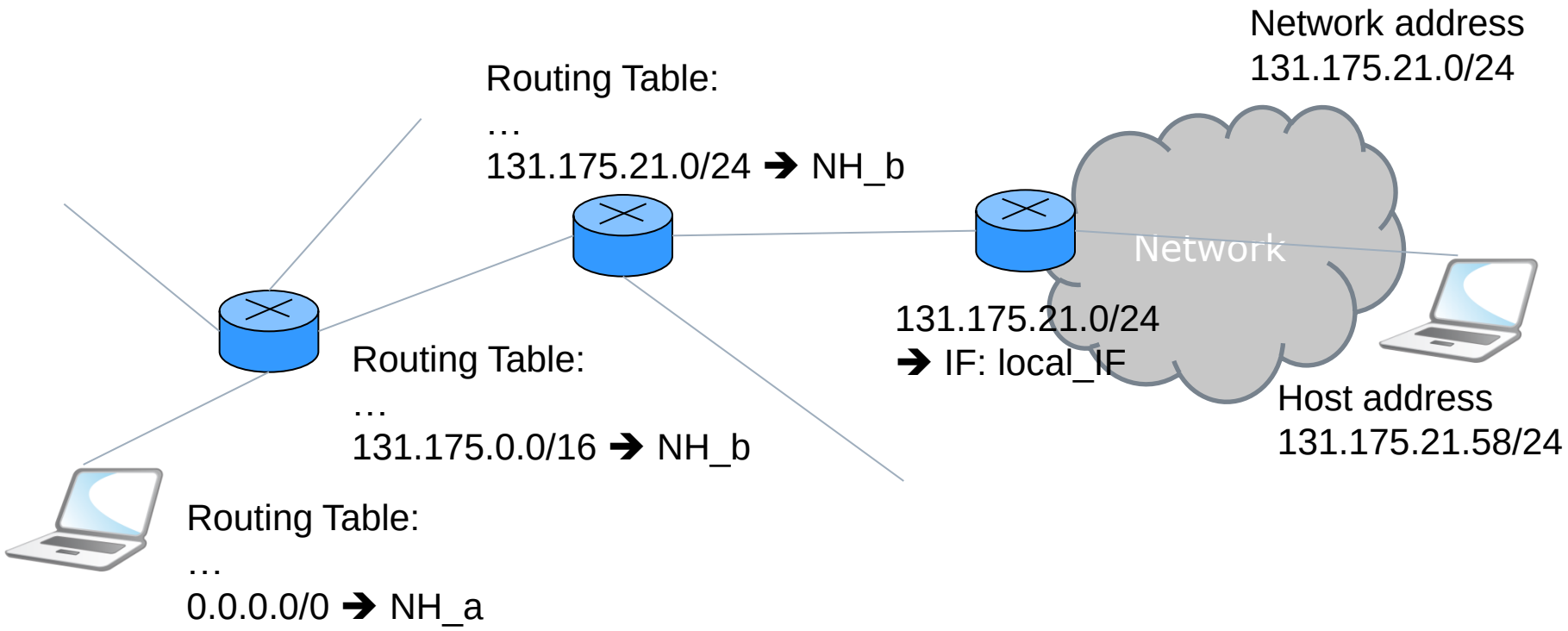


MM @ routing layer: Link Layer

- Let's take a closer look:
  - Bridging tables have an entry for each MAC address
  - When terminal changes its access point we "just" need to update the corresponding entries in all bridging tables of the network
  - This approach is suitable for LANs
  - It does not scale up to big networks

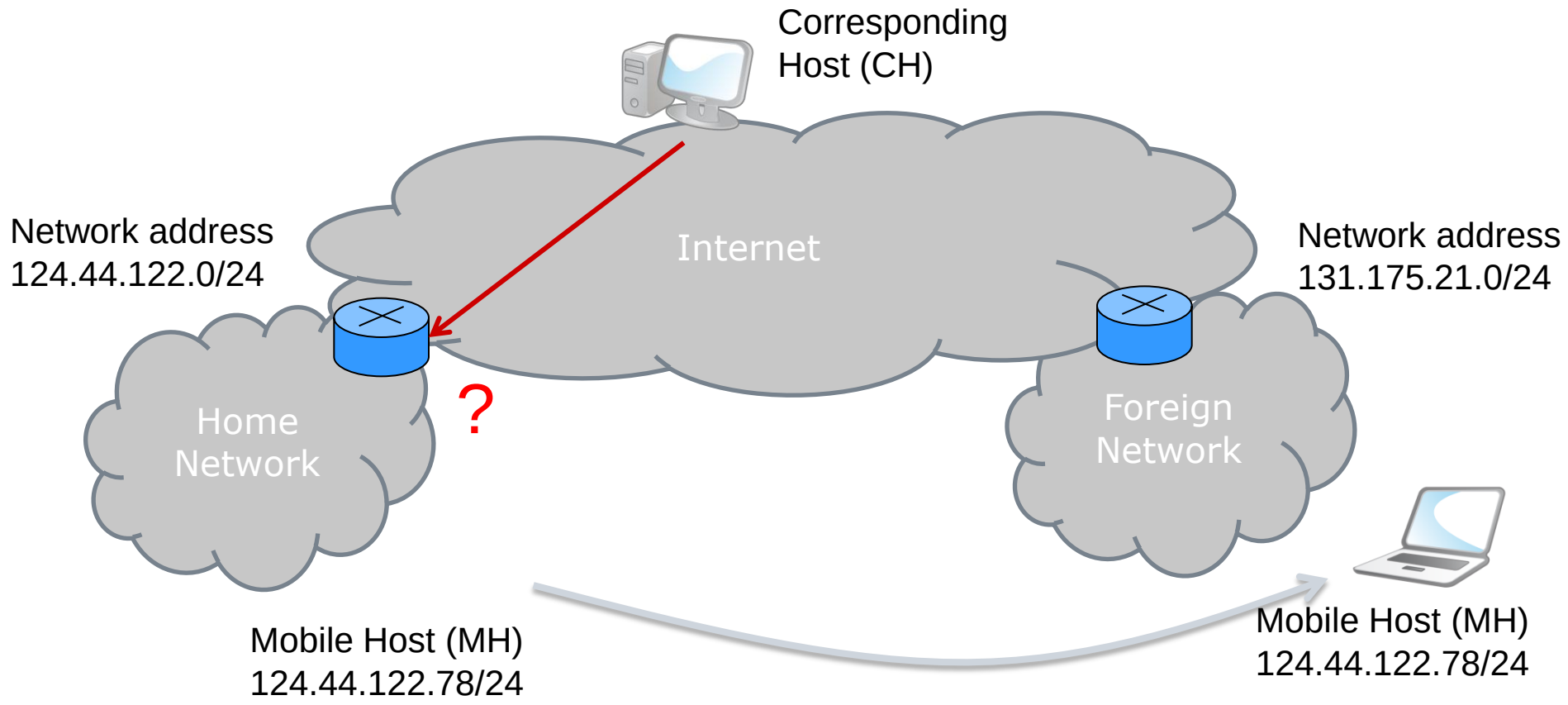
MM @ routing layer: IP Layer

- How to manage mobility at IP layer?
  - IP routing is based on the network address (prefix matching)



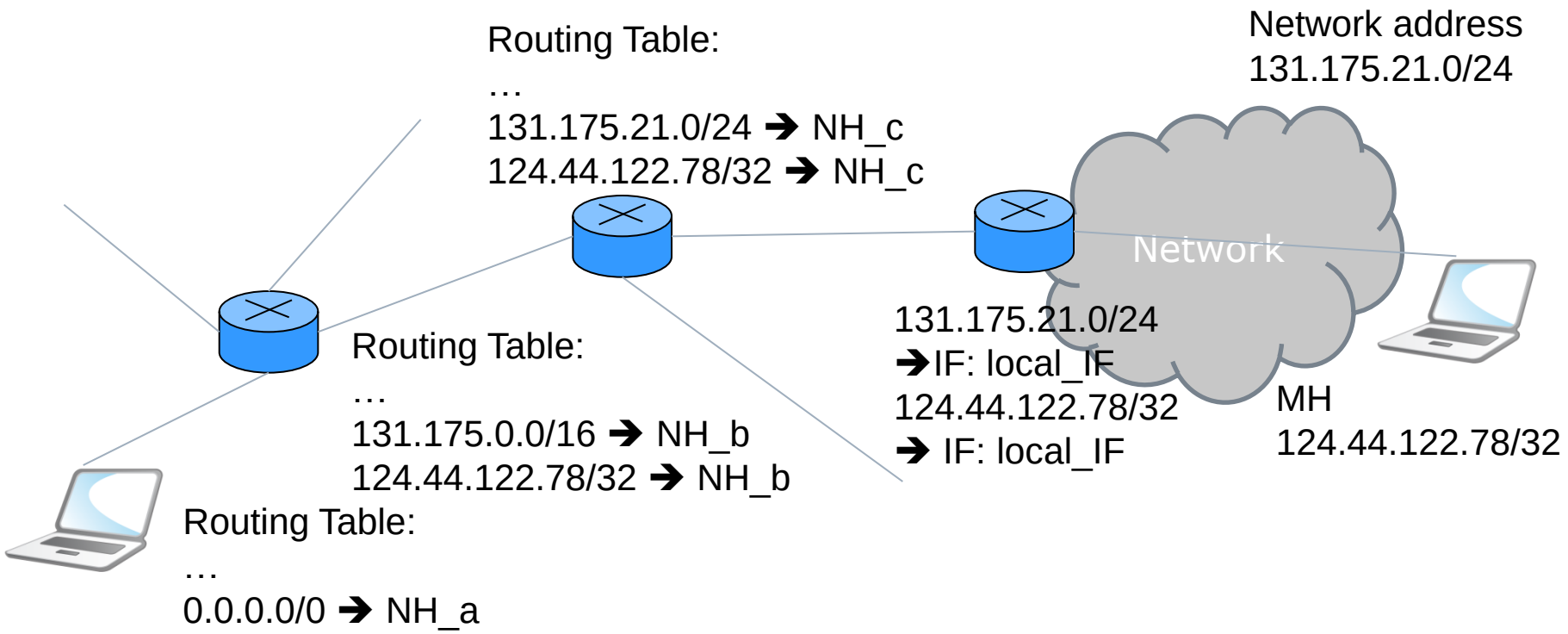
MM @ routing layer: IP Layer

- How to manage mobility at IP layer?



MM @ routing layer: IP Layer

- How to manage mobility at IP layer?
  - Can we use the same approach for link layer mobility ➔ per host routes ?



MM @ routing layer: IP Layer

- Per host routes
  - Large routing tables: potentially one entry per mobile host
  - Frequent routing updates that need to be distributed on the whole network
  - Even for a relatively small number of mobile hosts, managing mobility with per host routes would not be easy

MOBILE IP

Mobile IP

- Mobile IP was developed as a means for transparently dealing with problems of mobile users
  - Enables hosts to stay connected to the Internet regardless of their location
  - Enables hosts to be tracked without needing to change their IP address
  - Requires no changes to software of non-mobile hosts/routers
  - Requires addition of some infrastructure
  - Has no geographical limitations
  - Requires no modifications to IP addresses or IP address format
  - Supports security

Mobile IP

- Mobile IP is an Internet Engineering Task Force (IETF) standard communications protocol
- Mobile IP for IPv4 (**MIPv4**) is described in IETF RFC 3344 and in RFC 4721

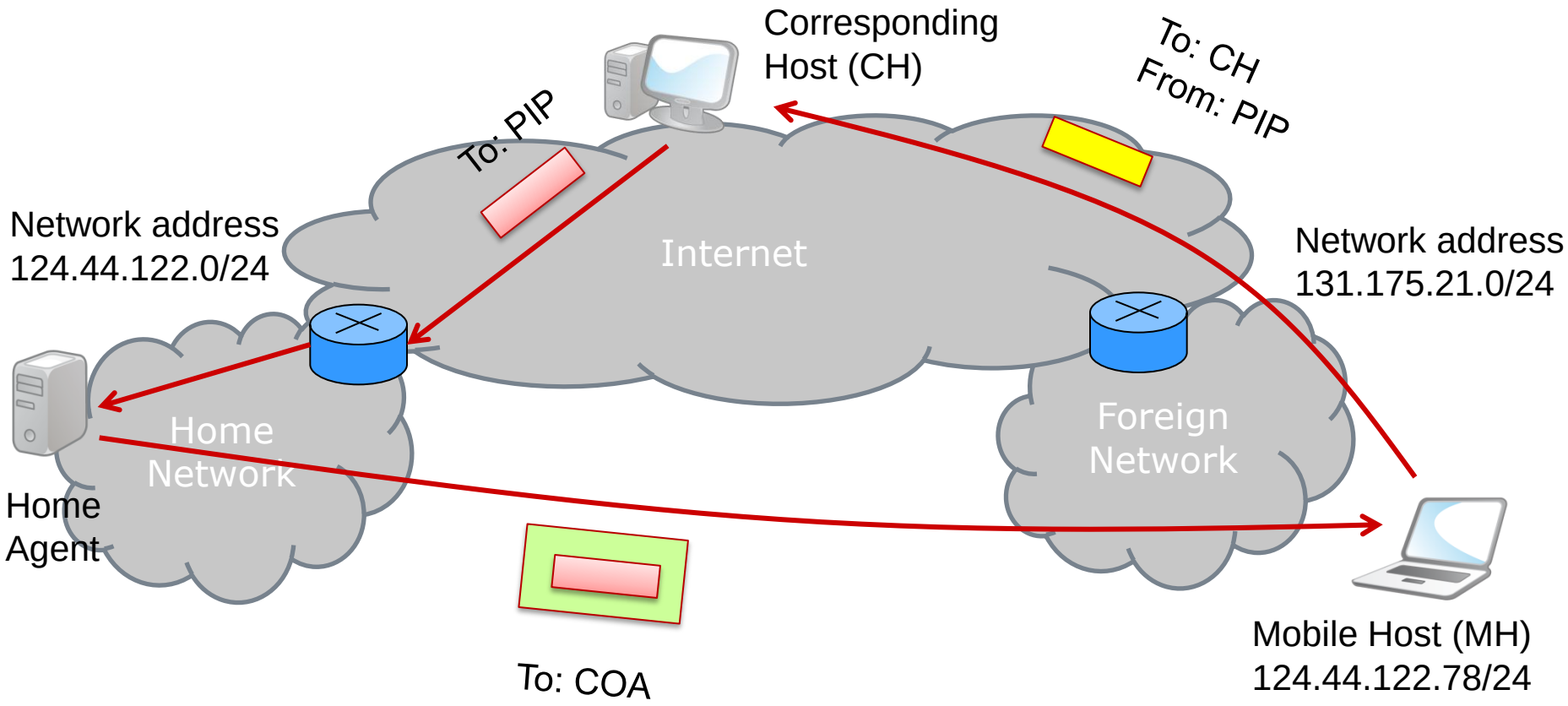
Basics

- Mobile IP allows a mobile host to move about without changing its ***permanent IP address (PIP)***
- Each mobile host has a ***home agent (HA)*** on its ***home network (HN)***
- Mobile host establishes a ***care-of address (COA)*** when it's away from home

Basics

- ***Correspondent host*** is a host that wants to send packets to the mobile host
- Correspondent host sends packets to the mobile host's IP permanent address
- These packets are routed to the mobile host's home network
- Home agent forwards IP packets for mobile host to current care-of address
- Mobile host sends packets directly to correspondent, using permanent home IP as source IP

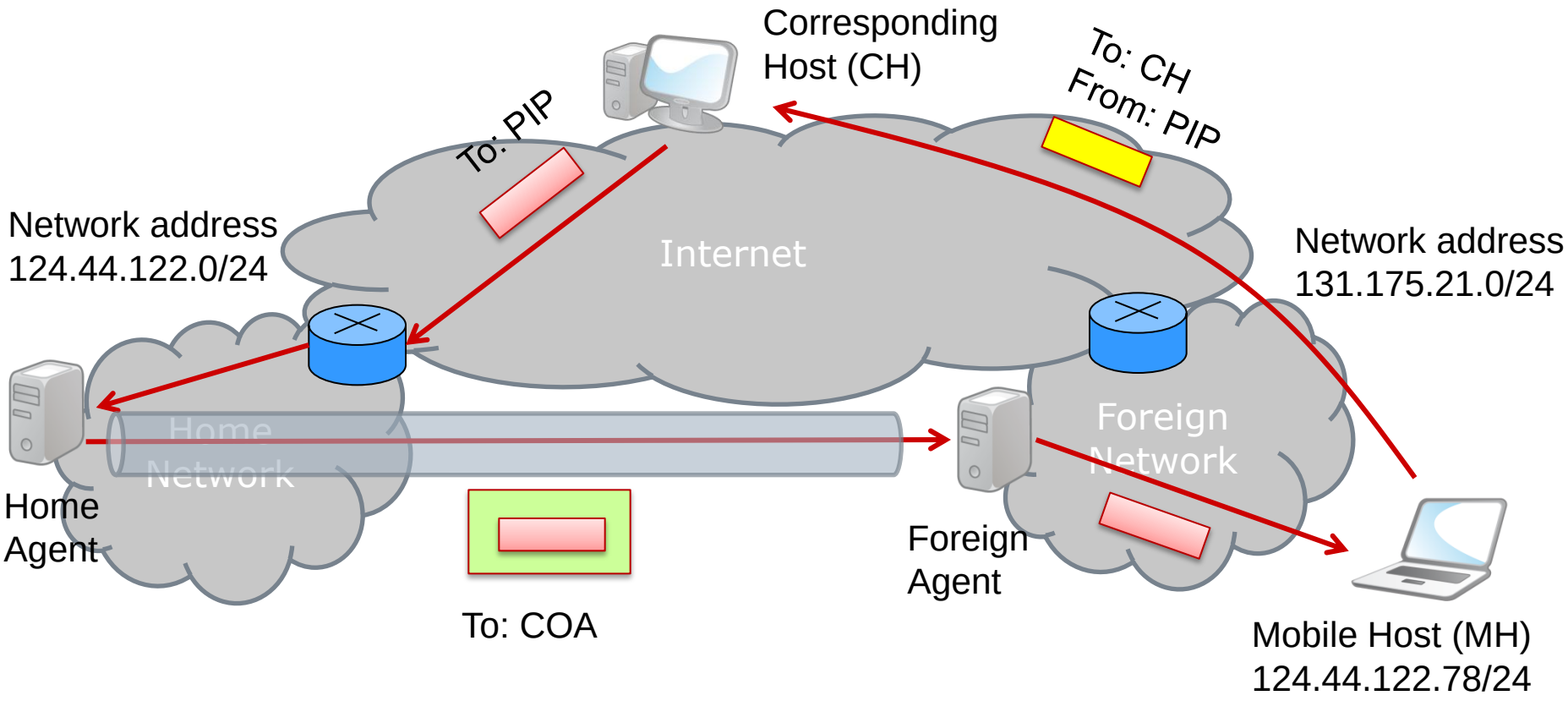
Basics


Corresponding
Host (CH)
To: CH
From: PIP
To: PIP
Network address
124.44.122.0/24
Internet
Network address
131.175.21.0/24
Home
Network
Foreign
Network
Home
Agent
To: COA
Mobile Host (MH)
124.44.122.78/24

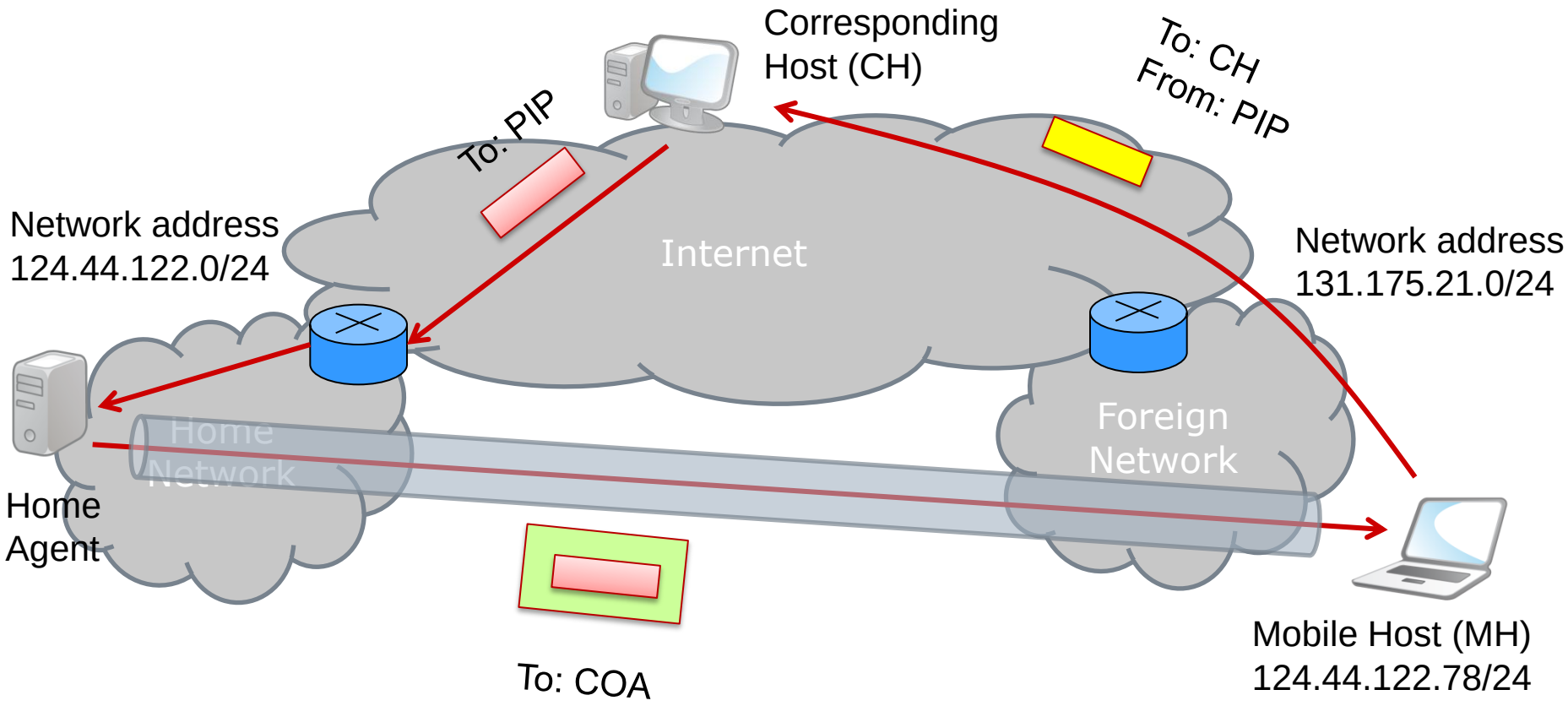
Care-of address

- MHs has two options for the care-of address:
  - **Foreign agent care-of address**: care-of address can be the address of a ***foreign agent*** on the remote network
    - home agent ***tunnels*** packets to the home agent
    - foreign agent delivers packets forwarded from home agent to mobile host
  - **Co-located care-of address**: care-of can be a temporary, foreign IP address obtained through DHCP
    - home agent ***tunnels*** packets directly to the temporary IP address
- In any case, care-of address must be ***registered*** with home agent

Foreign agent care-of address

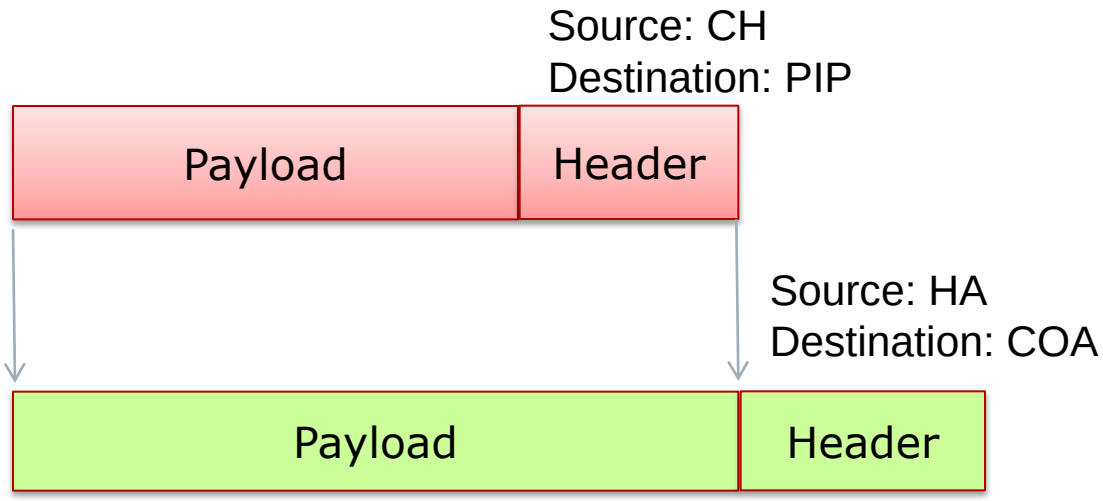


Co-located care-of address



Tunneling

- Packet is encapsulated in another IP packet



Tables

- Mobility Binding Table
  - Maintained on HA
  - Maps MH's home address with its current COA

Home address	Care-Of Address	Lifetime (s)
124.44.122.78	131.175.21.78	300
124.44.122.49	197.23.62.34	100
…		

- Visitor List
  - Maintained on FA serving an MN
  - Maps MN's home address to its MAC address and HA address

Home address	Home Agent Address	Lifetime (s)
124.44.122.78	124.44.122.1	300
167.34.32.44	167.34.32.254	300
…		

MIPv4 main functions

- Agent discovery
  - HA and FA advertize service availability
  - MHs can send solicitations to discover if an agent is present
- Registration
  - MHs registers their COA at the HA either directly or through the FA
  - Registrations are stored in the tables
- Tunneling
  - Has tunnel datagrams to the COA through the IP-in-IP encapsulation

MIPv4 (RFC 3344)

- Leaves Internet routing fabric unchanged
- Does not assume access points ("base stations") exist everywhere
- Simple
- CHs don't need to know about mobility
- Works both for changing domains and network interfaces

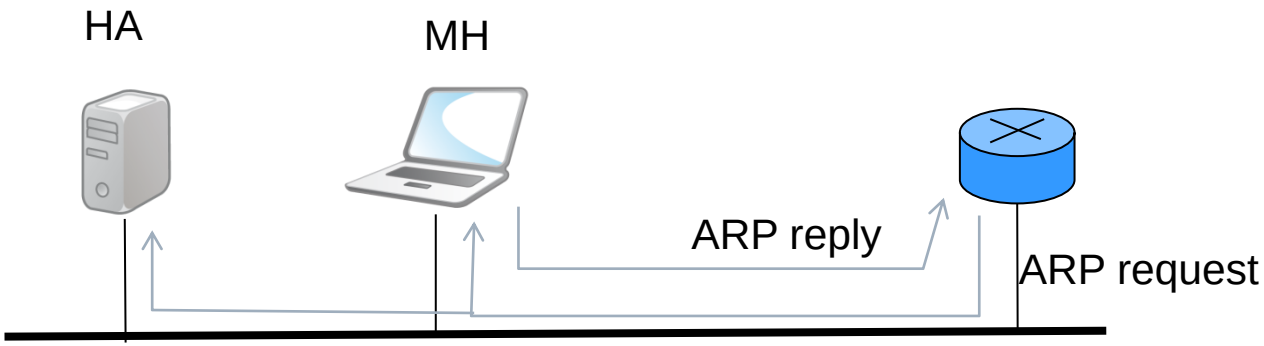
MIPv4 Operation (RFC 3344)

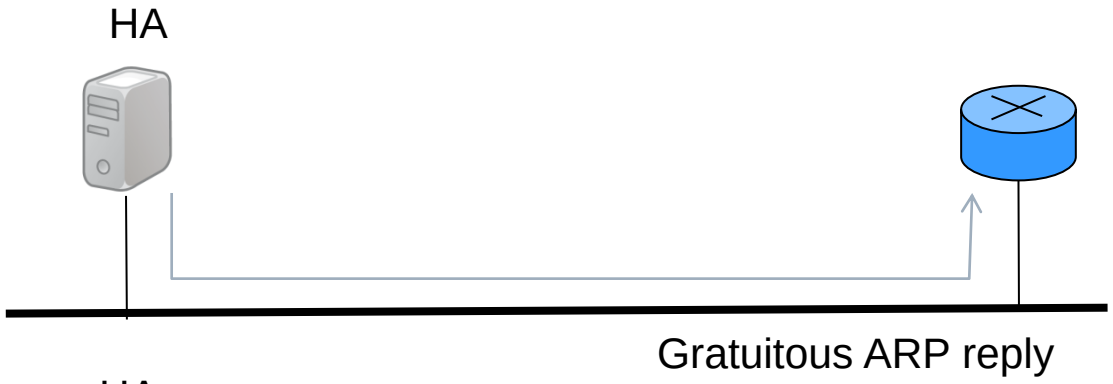
- HAs and FAs advertise their availability using agent-advertisement messages
- MHs receive advertisement messages and decide if it is a HA or a FA
- If it is its HA and MH is returning to home network, it deregisters previous COA on the HA
- If it a new FA, MH requests a COA (either FA COA, or a co-located COA)
- MH registers the COA at the HA possibly via the FA

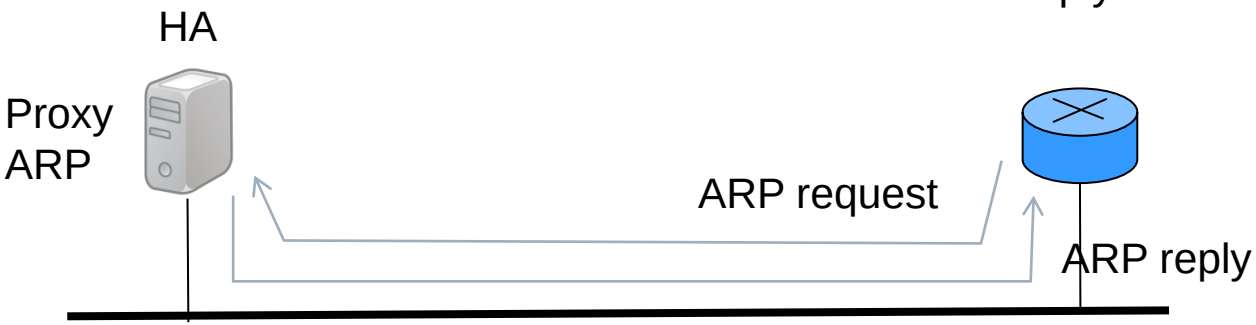
MIPv4 Operation (RFC 3344)

- HA intercepts packets sent to the MH
- HA tunnels packets to the COA
- Packets from the MH are sent directly to the CH

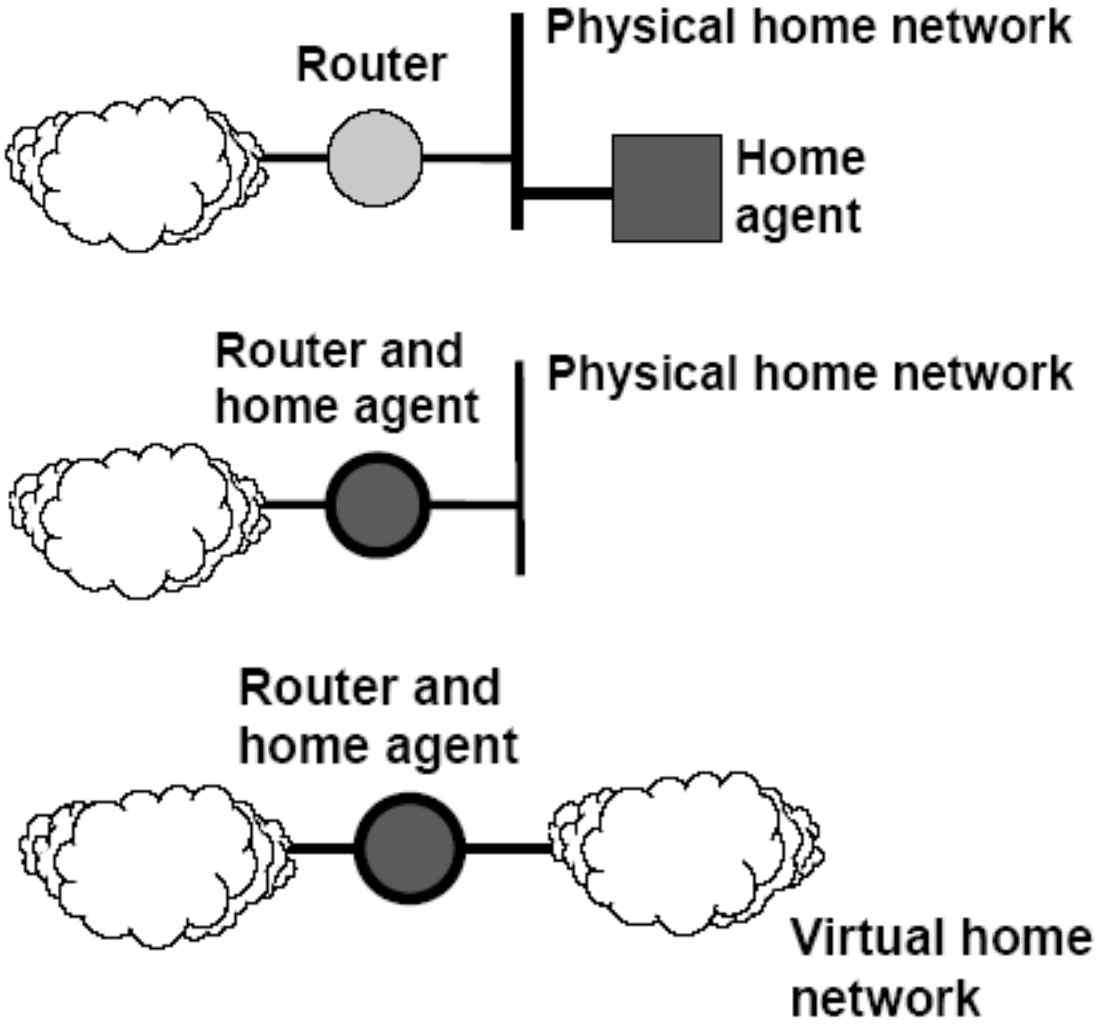
Home Agent Operation







Home Agent location

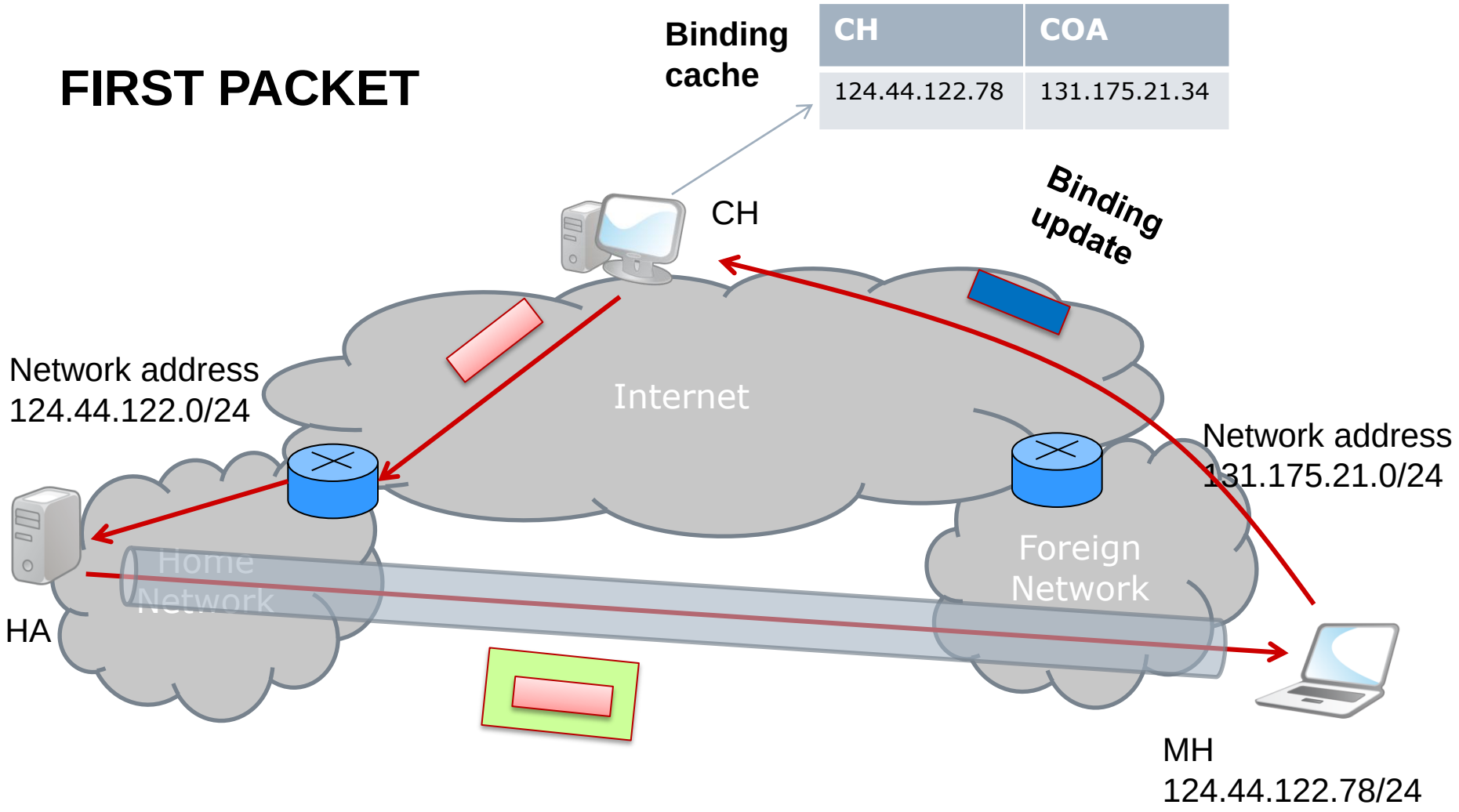


Routing Optimization

- Suboptimal "triangle" routing
  - Packets are sent to HA first and then tunneled to the MH
- Possible Solution:
  - Home agent sends current care-of address to correspondent host
  - Correspondent host caches care-of address
  - Future packets tunneled directly to care-of address

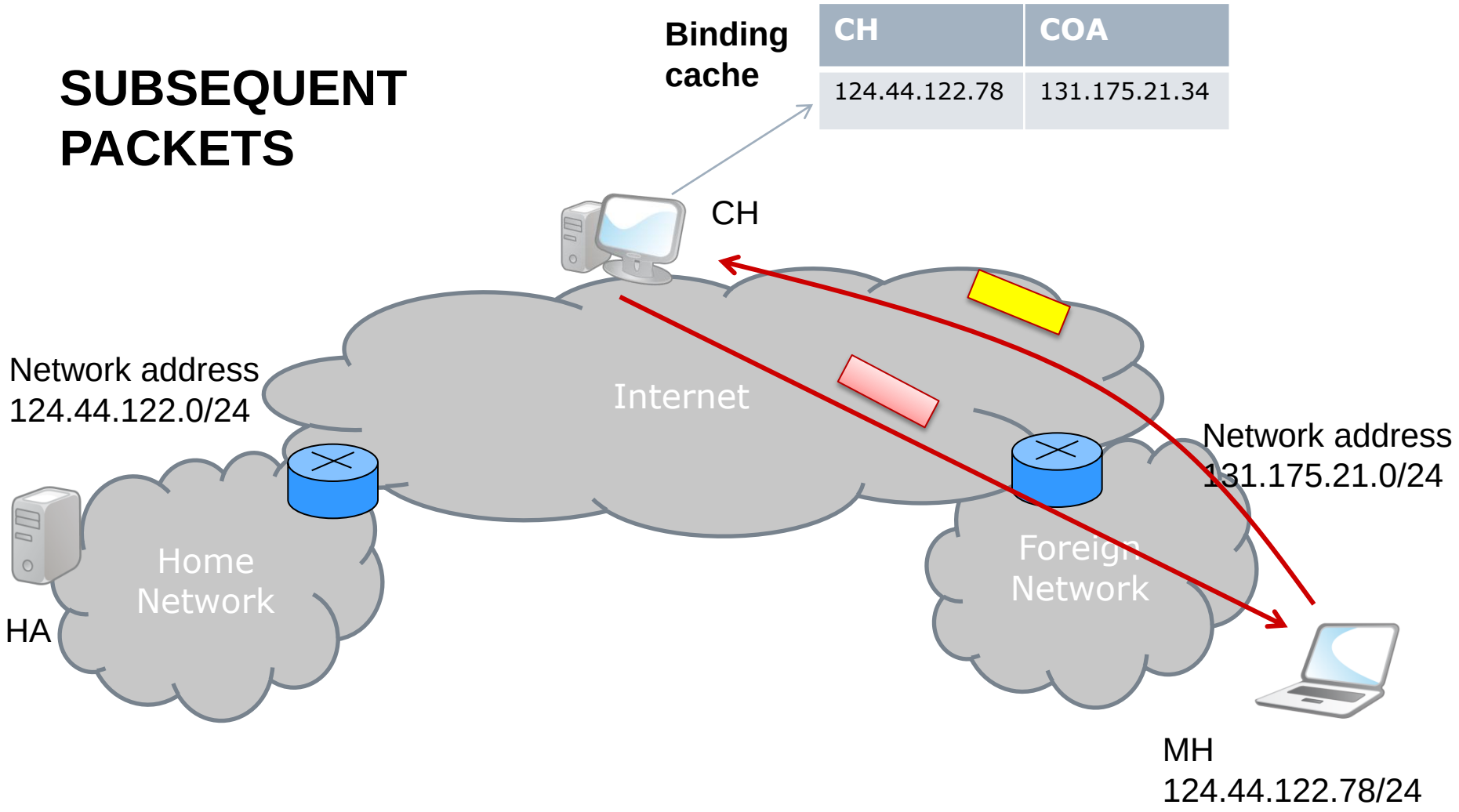
Routing Optimization

FIRST PACKET



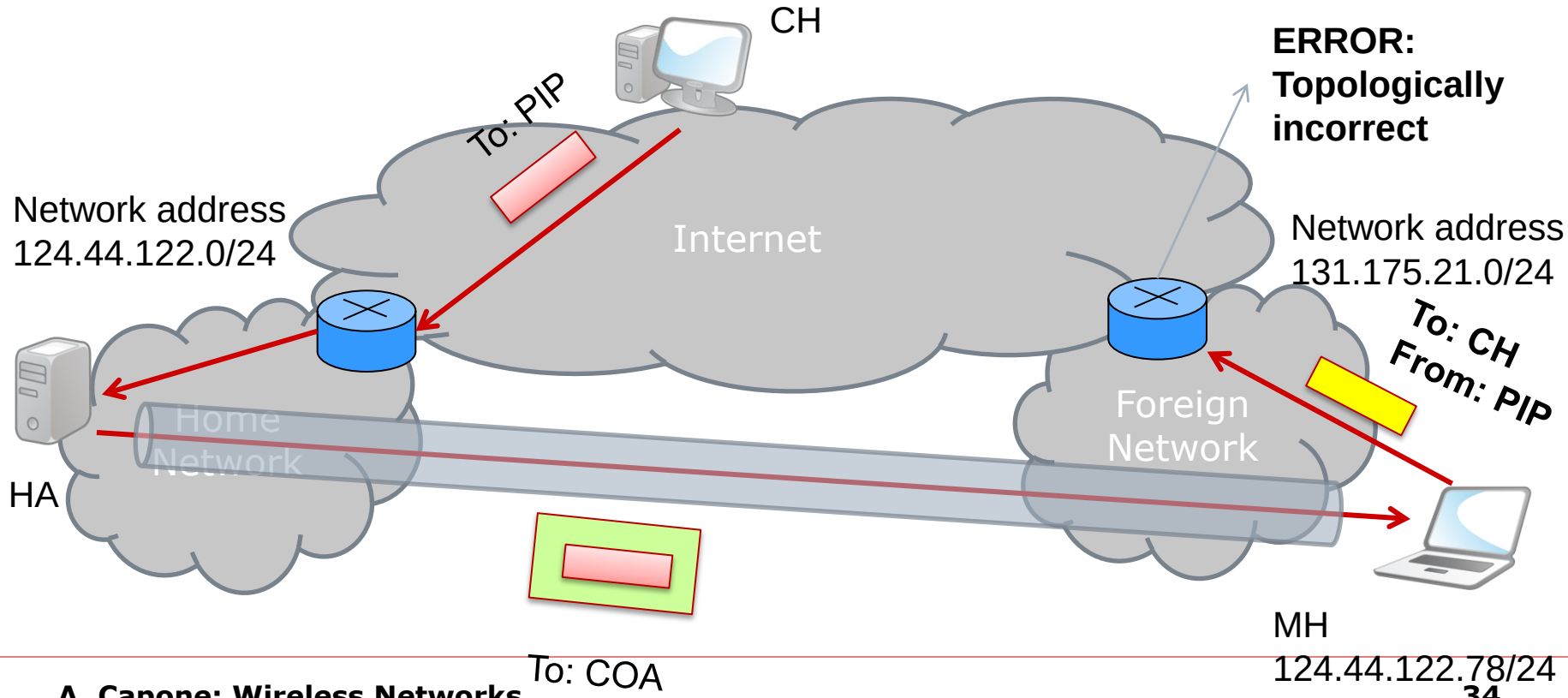
Routing Optimization

SUBSEQUENT PACKETS



Problems with MIP

- "Ingress" filtering
  - Routers which see packets coming from a direction from which they would not have routed the source address are dropped



Problems with MIP

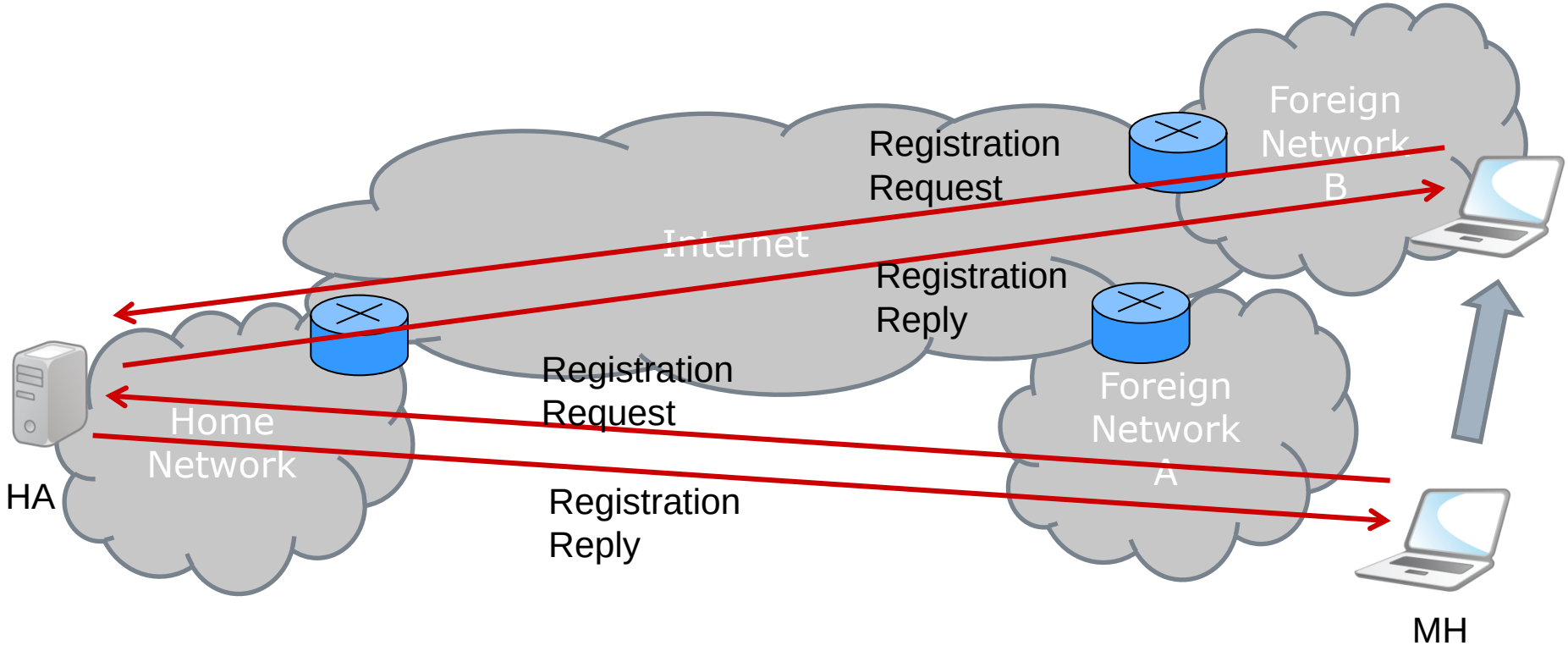
- Security issues:
  - Malicious host sends fake registration messages to home agent "on behalf" of the mobile host
  - Packets could be forwarded to malicious host or to the bit bucket
  - Solution: use secure authentication for registration request/reply
  - Several other security issues …

Mobility in IPv6

- Route Optimization is a fundamental part of Mobile IPv6
  - Mobile IPv4 it is an optional set of extensions that may not be supported by all nodes
- Foreign Agents are not needed in Mobile IPv6
  - MNs can function in any location without the services of any special router in that location
- Security
  - Nodes are expected to employ strong authentication and encryption

Hierarchy in MM

- Registration needed every time MH moves
- Registration adds delay when HA is far away



Hierarchy in MM

- Hierarchy of FAs or Mobility Routers
- Hierarchical MIP, Cellular IP, etc.