

Lecture 3a

Mobile IP

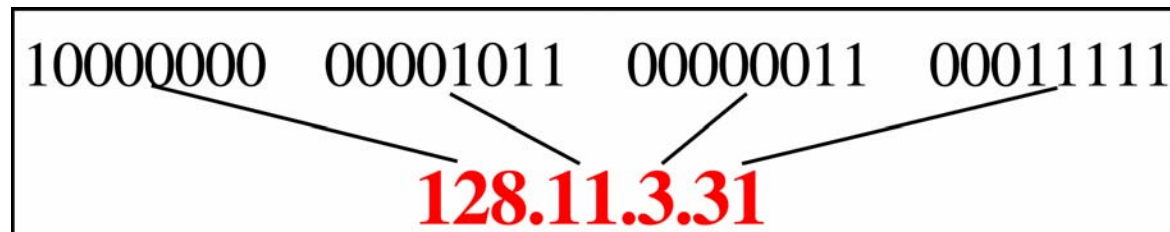
Outline

- How to support Internet mobility?
 - by Mobile IP.
- Our discussion will be based on IPv4 (the current version).

IP Address

- IP address is a **32-bit number** assigned to each **network interface** of a node.
- Nodes (such as routers) with multiple network interfaces have **multiple IP addresses**.

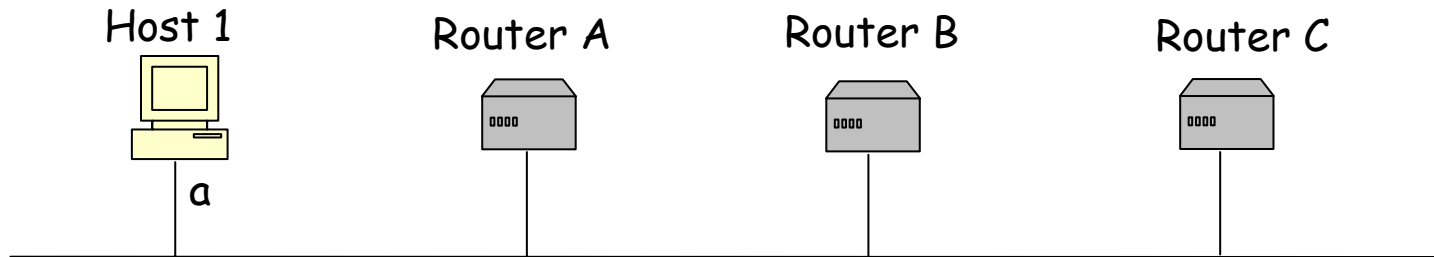
IP Address in
Dotted-Decimal
Notation



Network Prefix; Host Portion

- An IP address has two components
 - Network prefix
 - Identifying a link
 - Identical for all nodes attached to the same link
 - Host portion
 - Identifying a specific host or router connected to that link
- Example: 129.61.18.26, prefix length = 24
 - Network prefix = 129.61.18
 - Host portion = 26

Routing Table



Host 1 wants to forward a packet to 7.7.7.1

Host 1's routing table

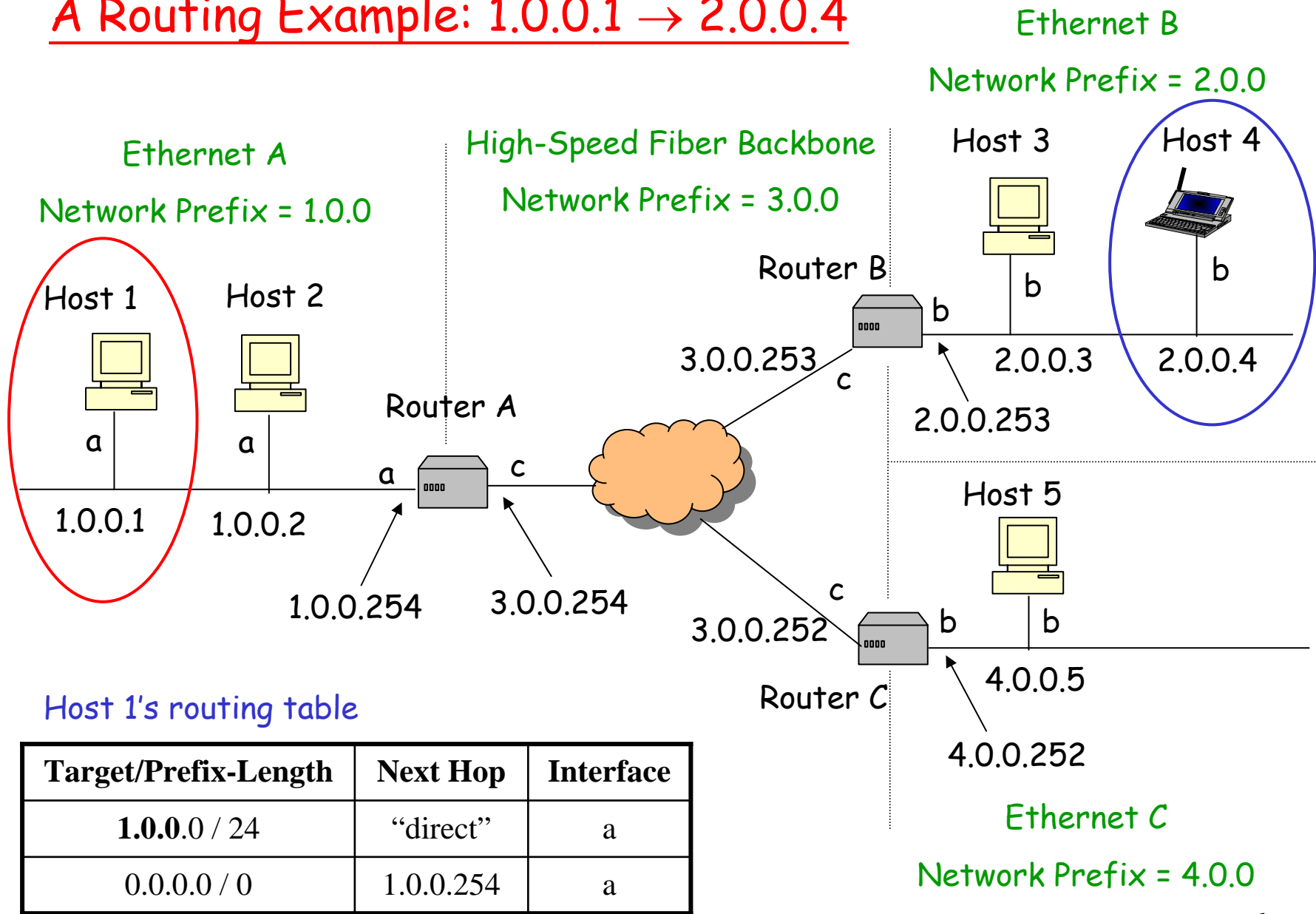
Target / Prefix-Length	Next Hop	Interface
7.7.7.99 / 32	router 1	a
7.7.7.0 / 24	router 2	a
0.0.0.0 / 0	router 3	a

Default route

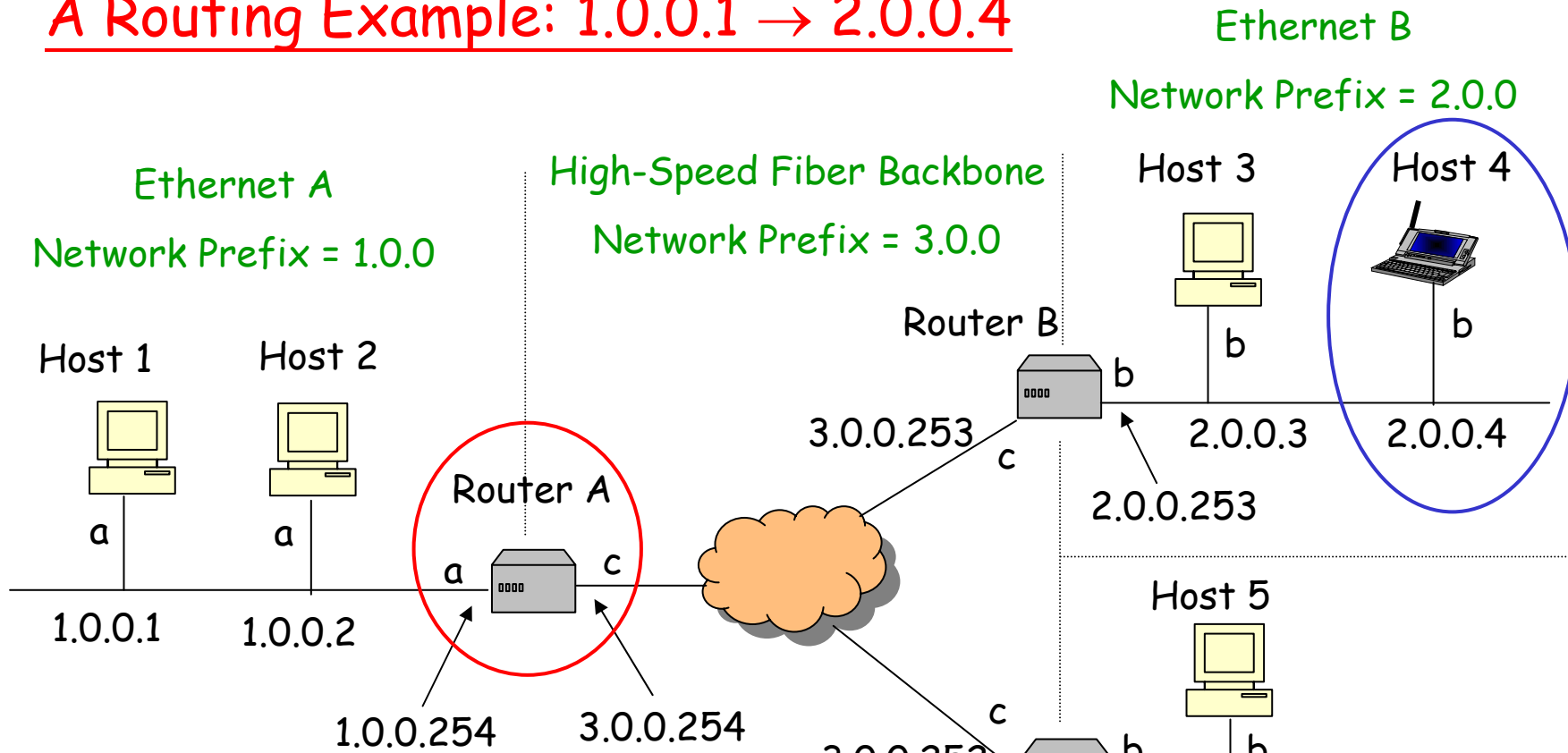
Rules for Routing:

1. Compare the **left-most Prefix-Length bits** of each Target with the IP destination address.
2. Choose the matching route with the **largest Prefix-Length**.

A Routing Example: 1.0.0.1 → 2.0.0.4



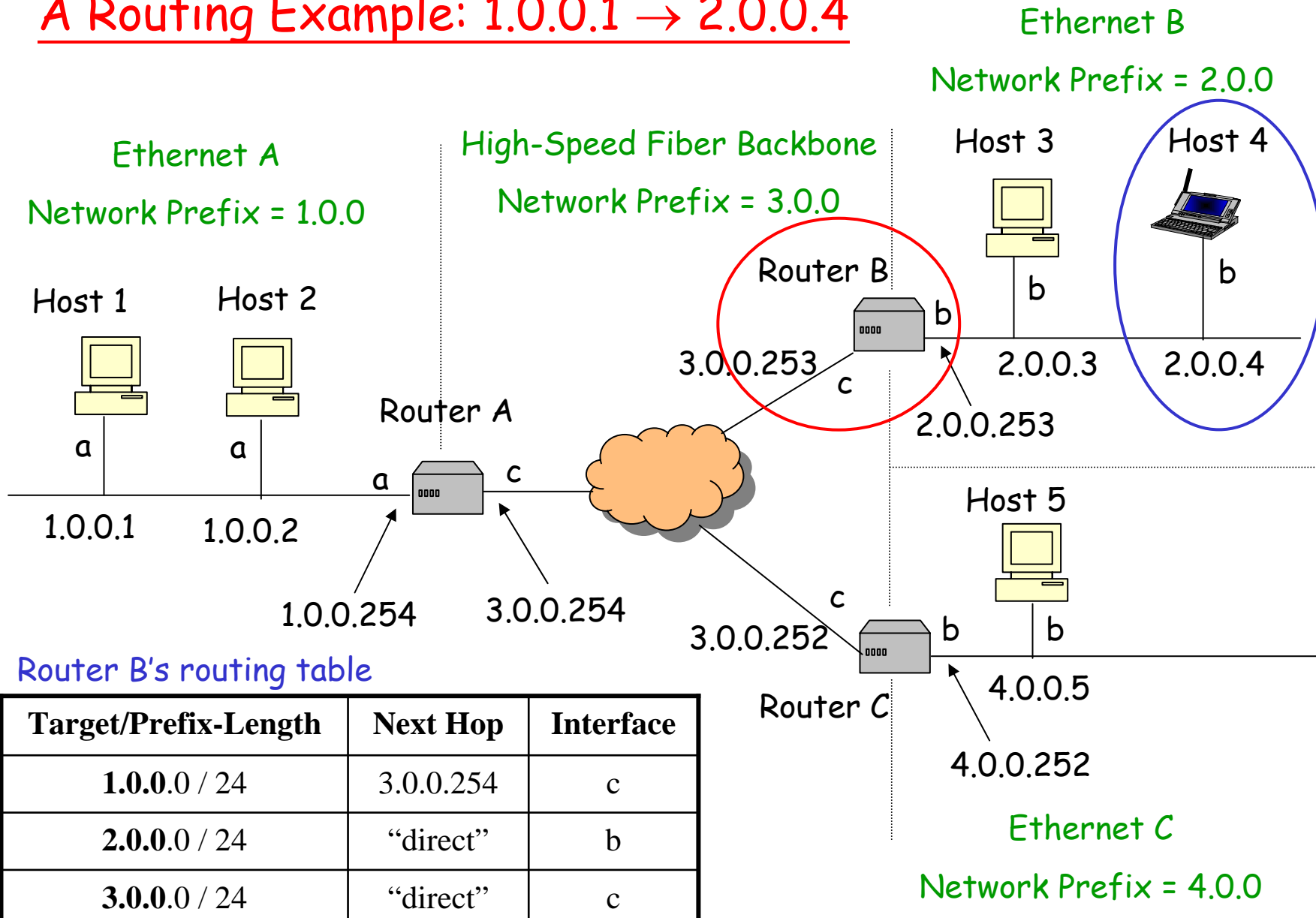
A Routing Example: 1.0.0.1 → 2.0.0.4



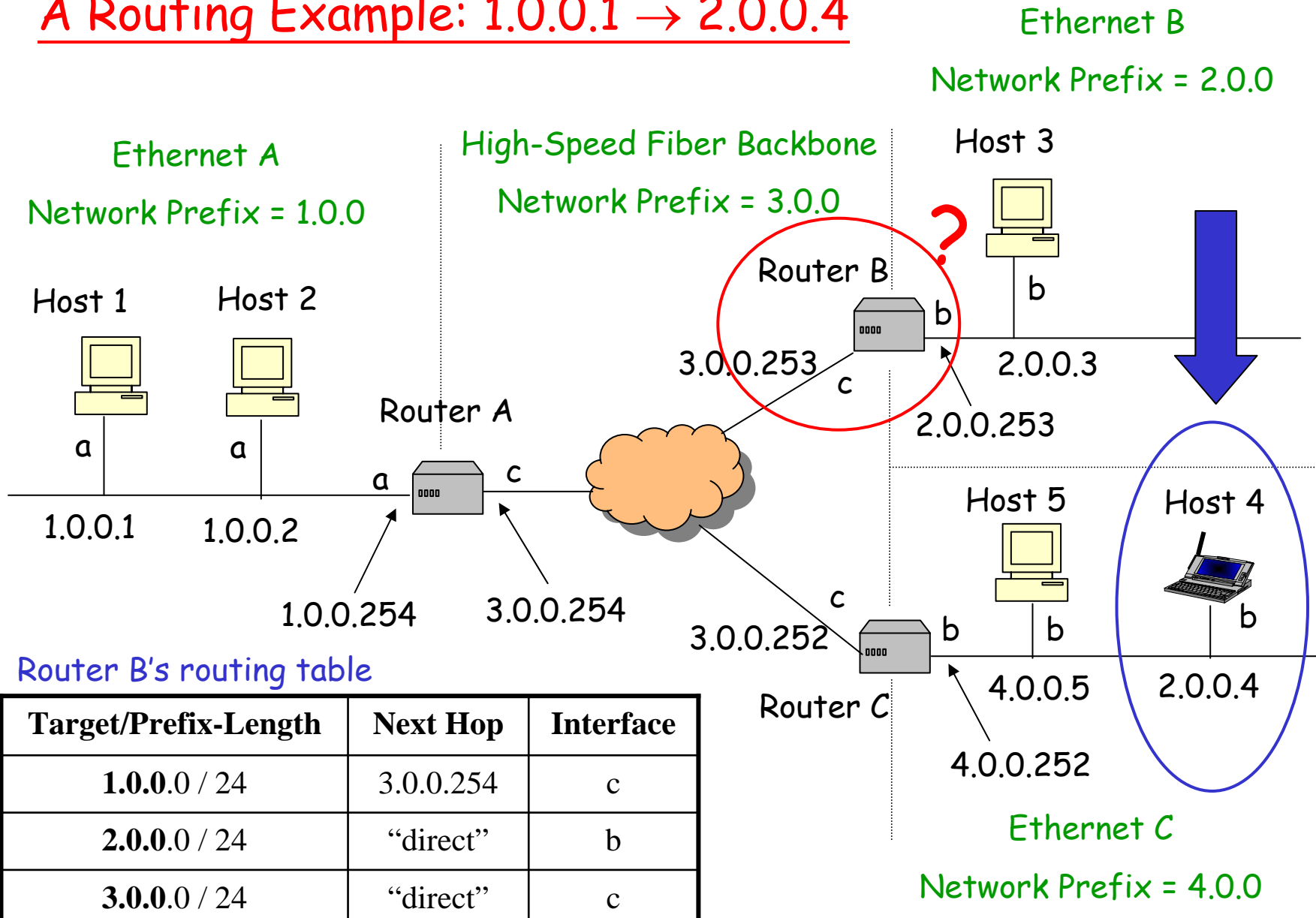
Router A's routing table

Target/Prefix-Length	Next Hop	Interface
1.0.0.0 / 24	"direct"	a
3.0.0.0 / 24	"direct"	c
2.0.0.0 / 24	3.0.0.253	c
4.0.0.0 / 24	3.0.0.252	c

A Routing Example: 1.0.0.1 → 2.0.0.4



A Routing Example: 1.0.0.1 → 2.0.0.4



Router B's routing table

Target/Prefix-Length	Next Hop	Interface
1.0.0.0 / 24	3.0.0.254	c
2.0.0.0 / 24	"direct"	b
3.0.0.0 / 24	"direct"	c

Problem

- The packet is undeliverable
 - Host 4 is **not connected to Ethernet B.**
- Router B will then send a *Host Unreachable error message* back to Host 1.
- *Q: How to solve it?*

Solution 1: Host-Specific Route

- Place **host-specific routes** in the routing tables of Router A, B, and C as follows:

Router A

Target/Prefix-Length	Next Hop	Interface
2.0.0.4 / 32	3.0.0.252	c

Router B

Target/Prefix-Length	Next Hop	Interface
2.0.0.4 / 32	3.0.0.252	c

Router C

Target/Prefix-Length	Next Hop	Interface
2.0.0.4 / 32	“direct”	b

Is this a
good
solution?

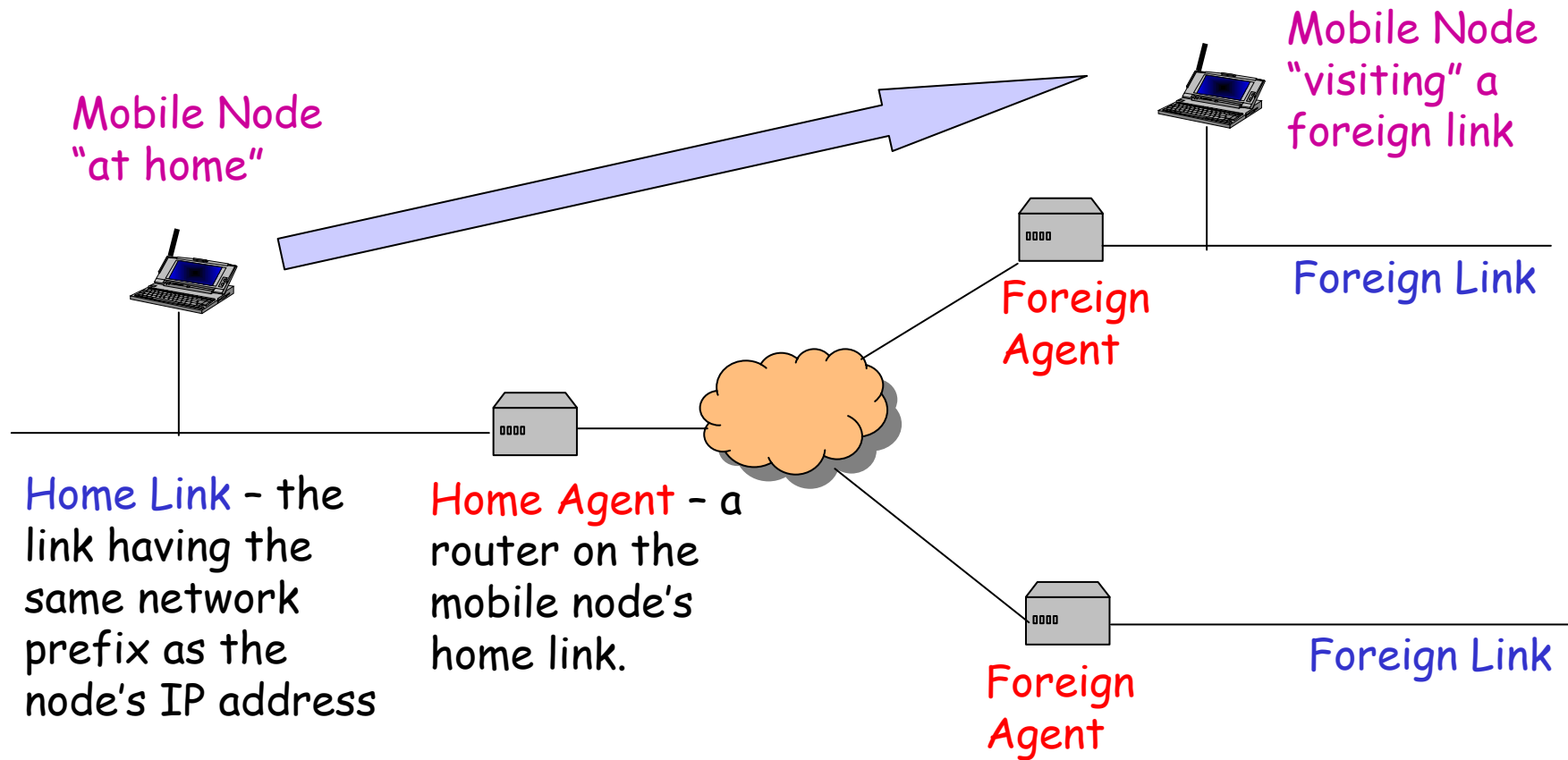
Solution 2: Change IP Address

- Simply **change the IP address of host 4**, as it moves from Ethernet B to Ethernet C.
- For example, **Dynamic Host Configuration Protocol (DHCP)** can be used to acquire a new IP address.
- *Q: Is this a good solution?*

Solution 3: Mobile IP

- A standard proposed to solve the problem of Internet mobility.
- It allows the mobile node to use **two IP addresses**:
 - a fixed **home address**
 - a **care-of address** that changes at each new point of attachment

Entities and Relationships



Care-of Address

- Two conceptual types of care-of addresses
 - Foreign agent care-of address
 - Collocated care-of address

Foreign Agent Care-of Address

- IP address of a foreign agent which has an interface on the foreign link.
 - The foreign agent may have more than one IP address; hence, the network-prefix need not equal the network prefix of the foreign link
- The same address can be shared by many mobile nodes simultaneously.

Collocated Care-of Address

- An IP address temporarily assigned to a mobile node.
 - It can be used by only one mobile node at a time.
- The network prefix must equal the network prefix of the foreign link.
- It might be used by a mobile node in situations where no foreign agents are available.

Three Mechanisms

1. Agent Discovery
2. Registration
3. Routing

1. Agent Discovery

- Home Agents and Foreign Agents **periodically broadcasts *Agent Advertisements***.
 - e.g. once every few seconds
 - If the mobile node does not want to wait for the periodic advertisement, it can **broadcast *Agent Solicitations*** that will be answered by any foreign agent that receives it.
- Mobile nodes **determine whether they have moved** from one link to another. (*How?*)

Move Detection

- *Agent Advertisement* has a *Lifetime* field.
 - specify how soon a mobile node should expect to hear another advertisement from that same agent.
- If the mobile node *fails to hear an advertisement from that agent within the specified Lifetime*, then it assumes that it has moved to a different link.

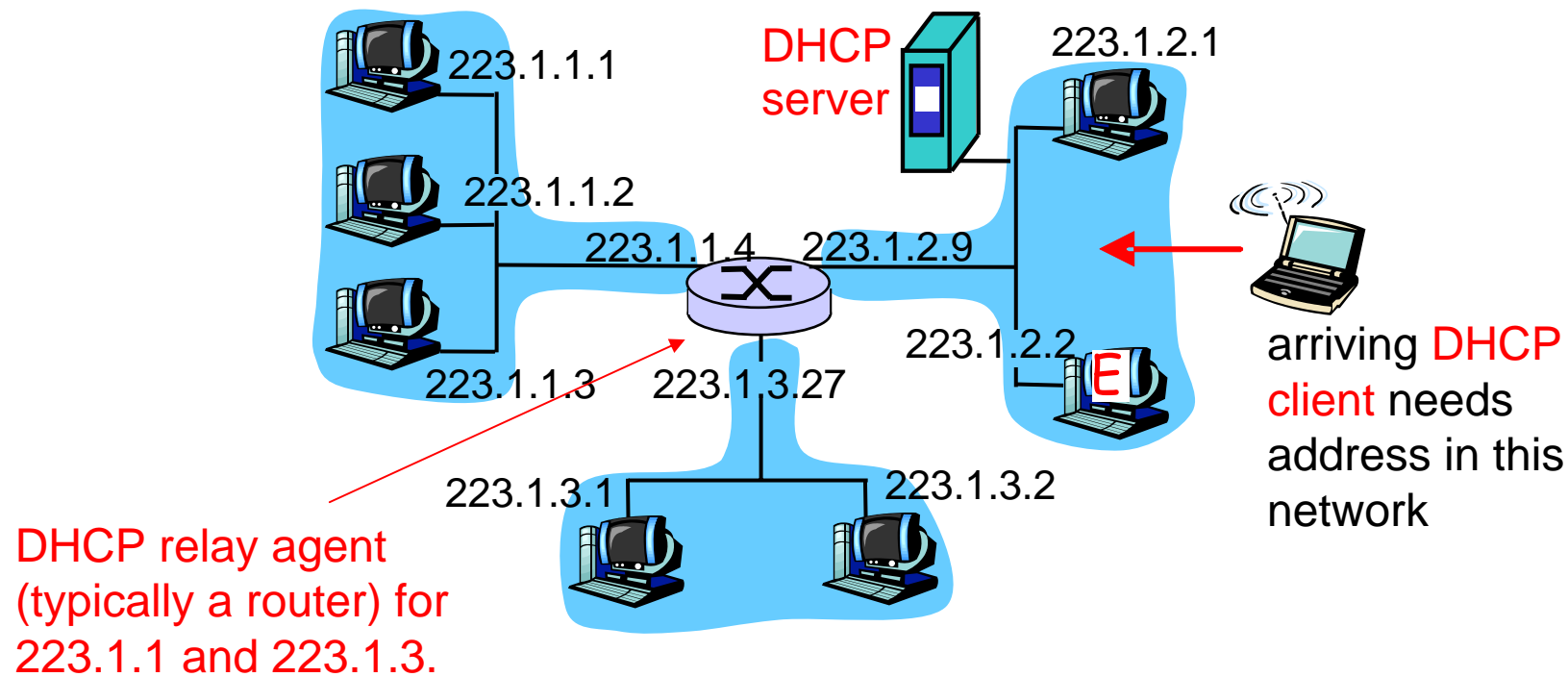
Care-of Address

- A mobile node connected to a foreign link acquire a foreign agent care-of-address from the *Agent Advertisements*.
 - If multiple care-of-addresses are listed, any one of them can be used.
- If a foreign agent is unavailable, the mobile node obtain a collocated care-of address by Dynamic Host Configuration Protocol (DHCP).

DHCP

- Goal
 - allow host to *dynamically* obtain its IP address from network server when it joins a network
- A client-server protocol
- Four-way handshake

DHCP Client-Server Scenario



It knows the address of a DHCP server for these networks.

DHCP server: 223.1.2.5

Allocates an IP address and set the time for which the address will be valid.



time

DHCP discover

```
src : 0.0.0.0, 68
dest.: 255.255.255.255,67
yiaddr: 0.0.0.0
transaction ID: 654
```

arriving client



Broadcast Address:
255.255.255.255

UDP port 67

What is source address?

DHCP offer

```
src: 223.1.2.5, 67
dest: 255.255.255.255, 68
yiaddr: 223.1.2.4
transaction ID: 654
Lifetime: 3600 secs
```

Choose an offer if more than one server replies.

DHCP request

```
src: 0.0.0.0, 68
dest.: 255.255.255.255, 67
yiaddr: 223.1.2.4
transaction ID: 655
Lifetime: 3600 secs
```

DHCP ACK

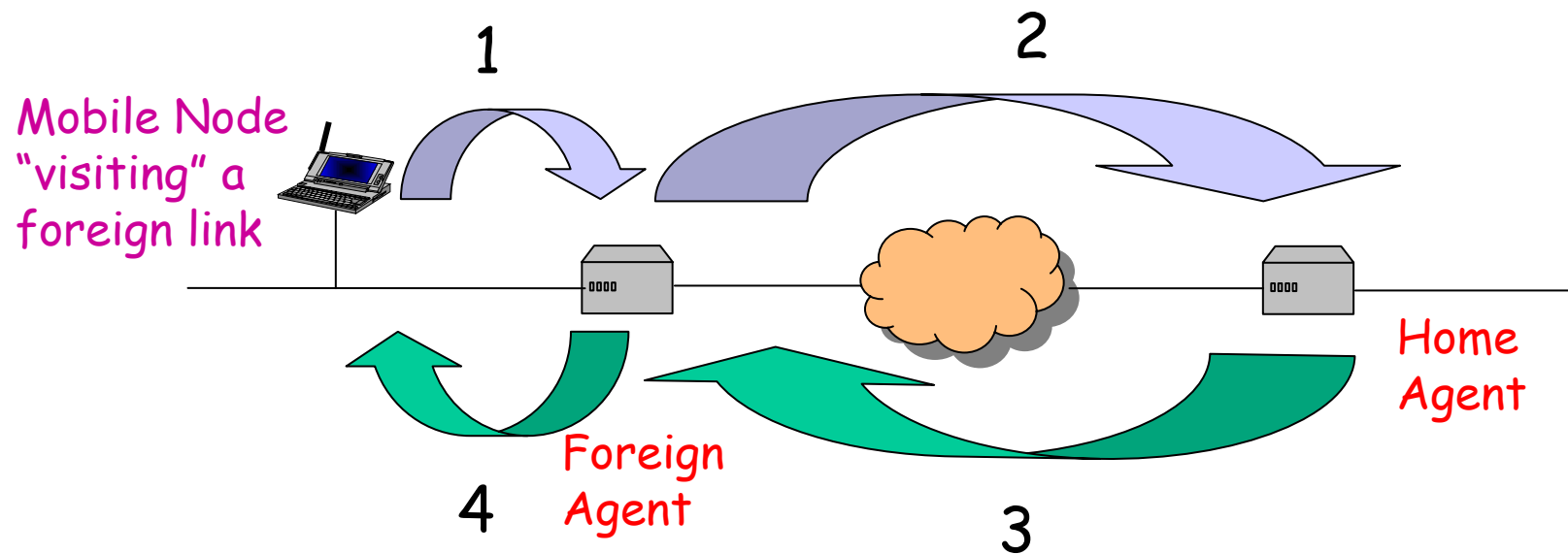
```
src: 223.1.2.5, 67
dest: 255.255.255.255, 68
yiaddr: 223.1.2.4
transaction ID: 655
Lifetime: 3600 secs
```


2. Registration

- Registration is the process by which a mobile node
 - requests routing services from a foreign agent;
 - informs its home agent of its current care-of address;
 - renews a registration which is due to expire;
 - deregisters when it returns to its home link.

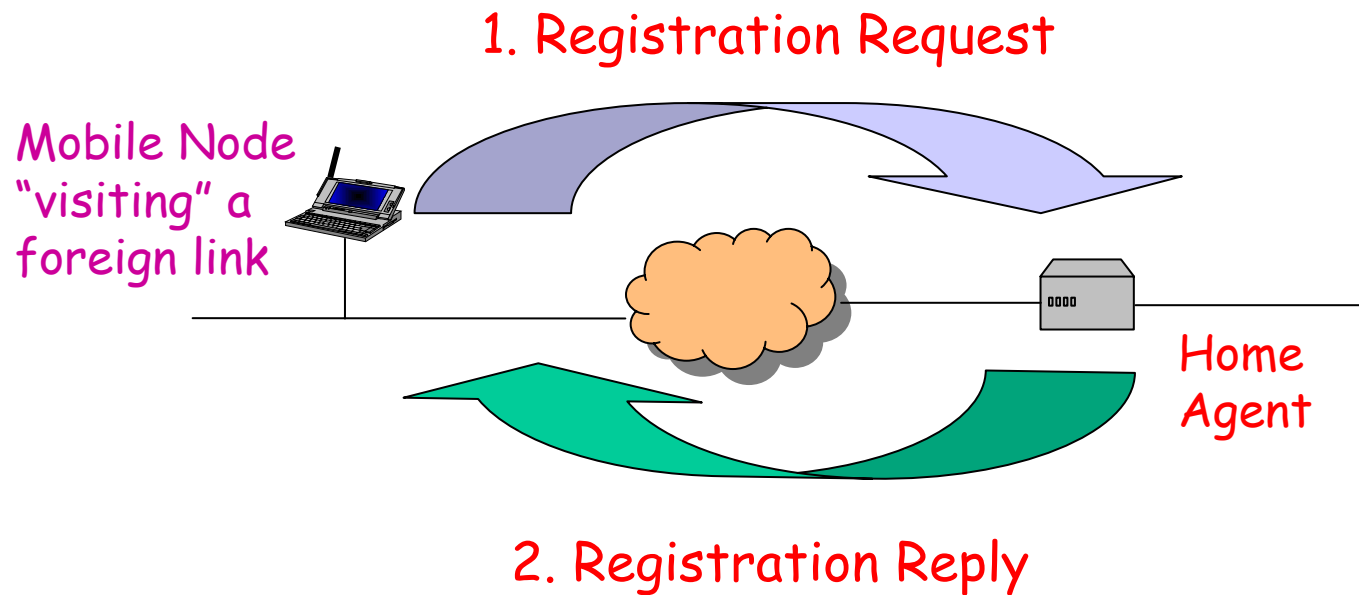
Scenario 1: Registering Foreign Agent Care-of Address

The mobile node, with the assistance of a foreign agent, sends a **Registration Request** with the care-of address information.

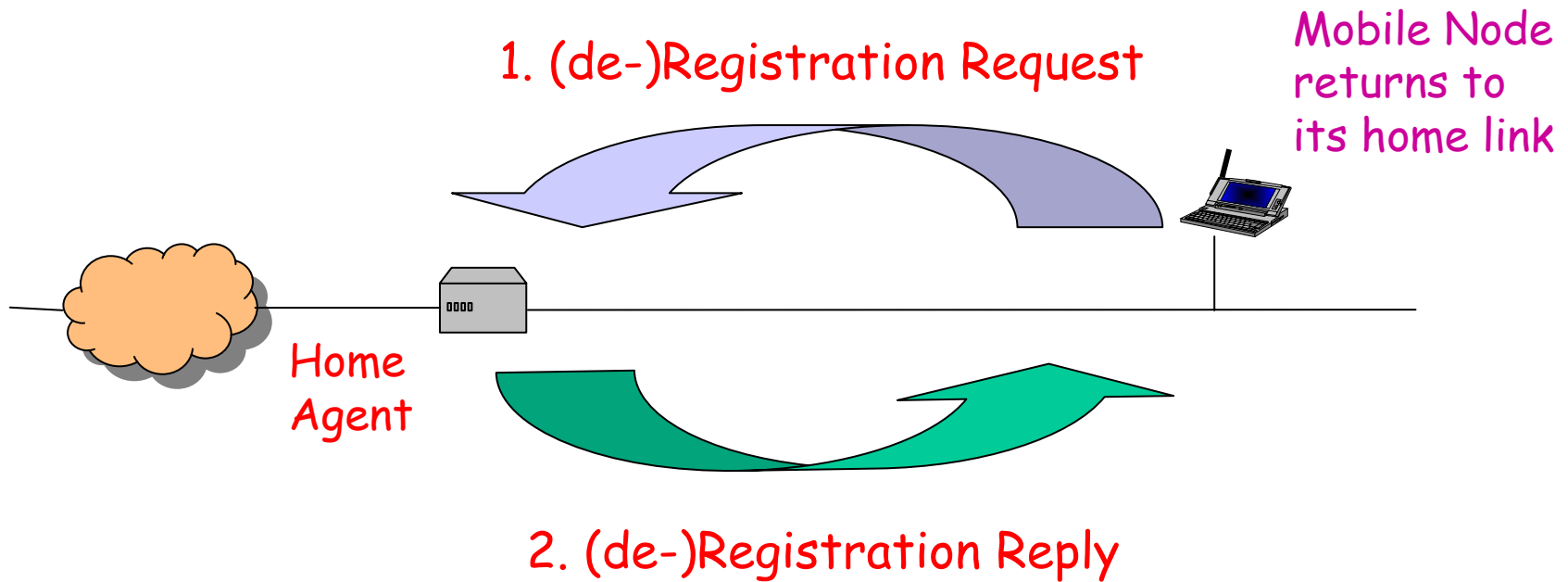


When the home agent receives this request, it adds the necessary information to its routing table, and sends a **Registration Reply** back to the mobile node.

Scenario 2: Registering Collocated Care-of Address



Scenario 3: Deregistration



Authentication

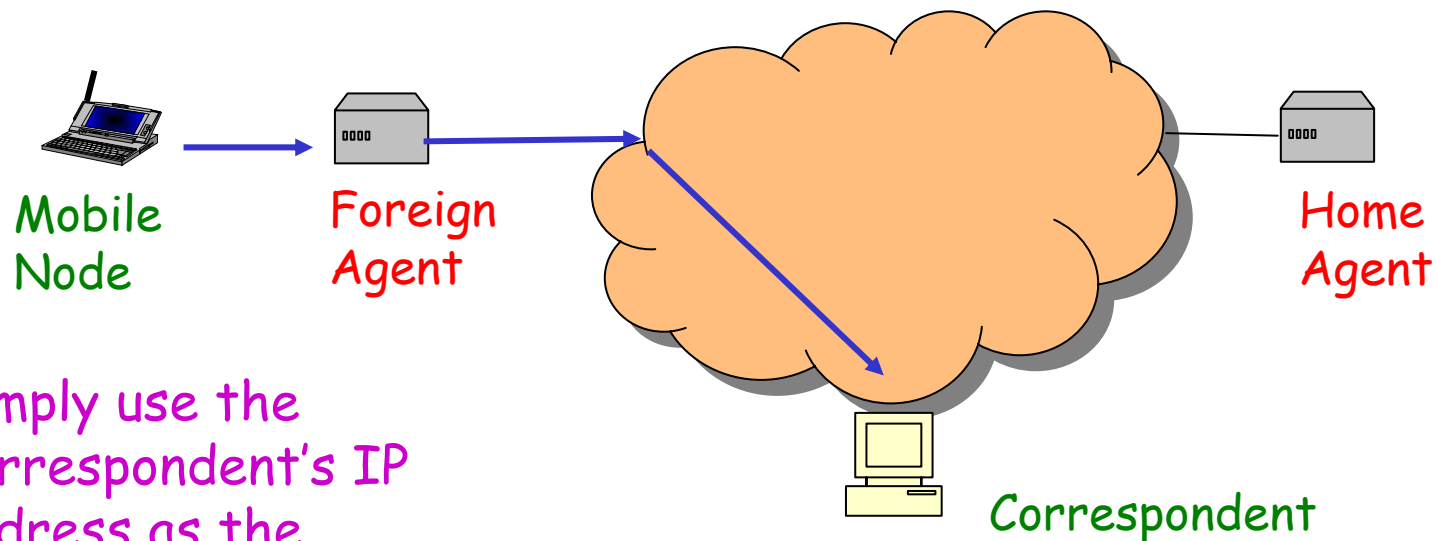
- The home agent must be certain that registration was originated by the mobile node and not by some other malicious node.
- Registration of the care-of address requires authentication.
 - The mobile node needs to prove its identity to its home agent.
 - It is done by making use of a secret key known only to the mobile node and its home agent.

3. Routing

Different Scenarios:

- Mobile Node → Correspondent Node
- Correspondent Node → Mobile Node
 - With a foreign agent
 - Without a foreign agent

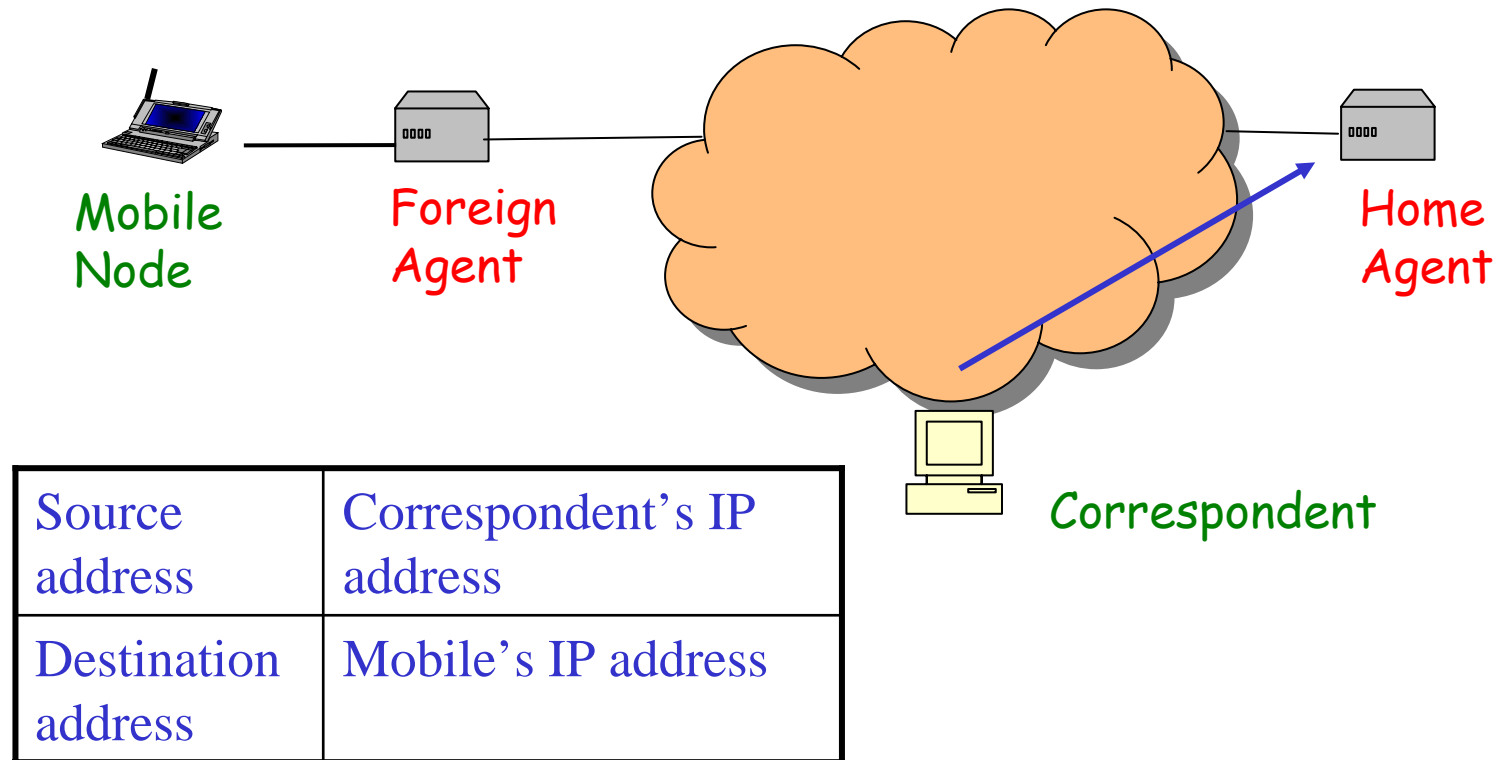
How to Send Packets to a Correspondent Node?



Simply use the Correspondent's IP address as the destination address.

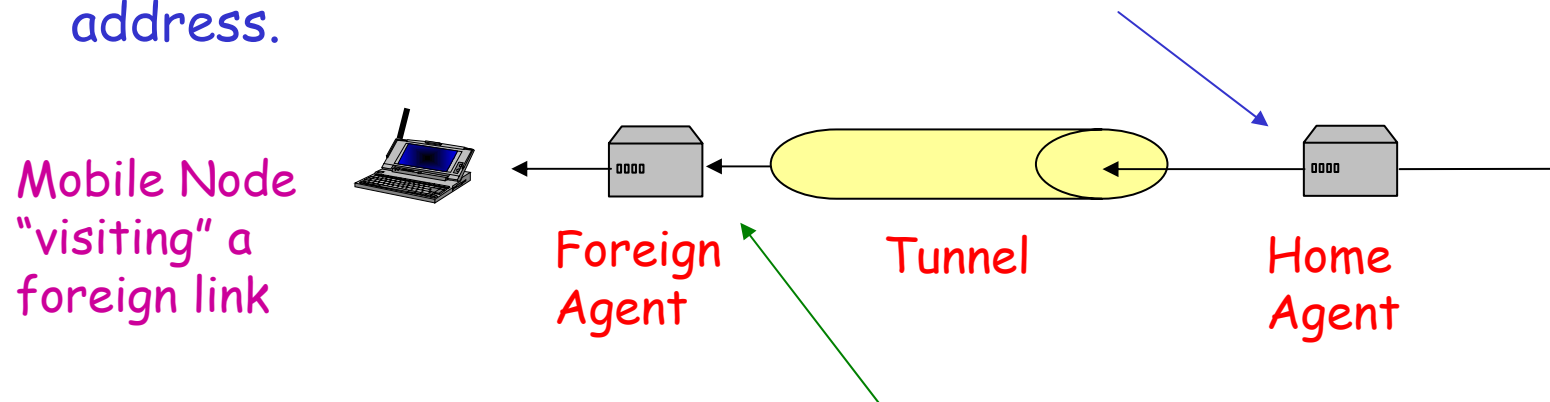
How about the source address? Original IP address? Care-of Address?

How to Send Packets to a Mobile Node?



Tunneling to the Care-of Address

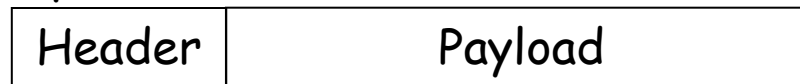
Home Agent intercepts packets destined to the mobile node's home address and **tunnels** them to the mobile node's care-of address.



Foreign Agent **removes original packet from the tunnel** and delivers the original packet to the mobile node over the foreign link.

IP in IP Encapsulation

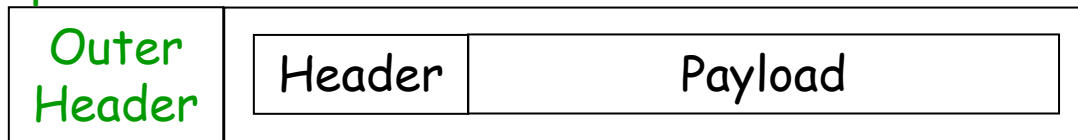
Ipsrc = Original Sender
Ipdes = Destination's Home Address



Original IP
packet

The home agent inserts a new IP header, or **tunnel header**, in front of the IP header of any datagram addressed to the mobile node's home address.

Ipsrc = Home Agent
Ipdes = Mobile node's Care-of Address

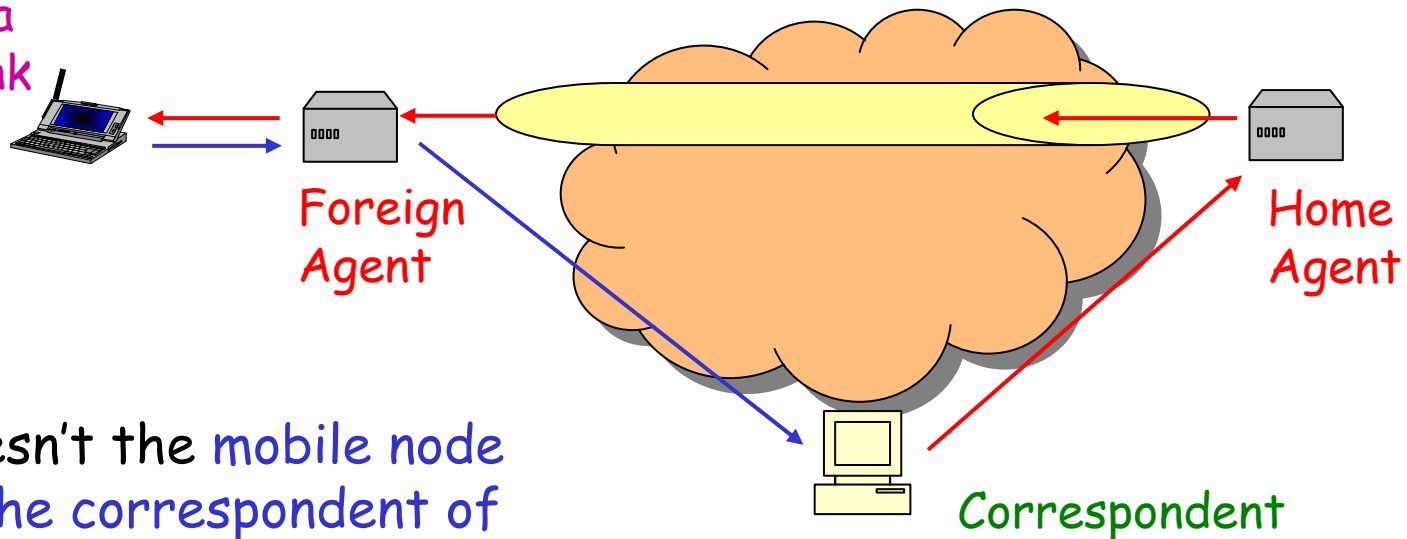


Outer Payload

Encapsulating
IP packet

Triangle Routing

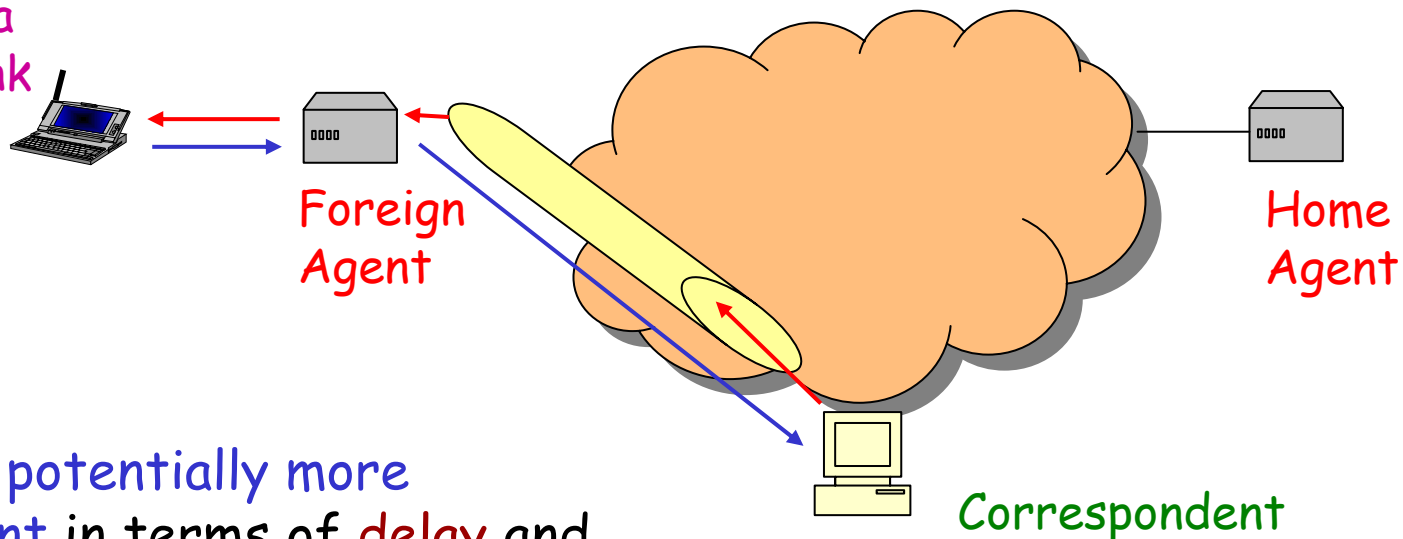
Mobile Node
"visiting" a
foreign link



Why doesn't the mobile node inform the correspondent of its care-of address and have it tunnel directly to the mobile node?

Optimized Routing

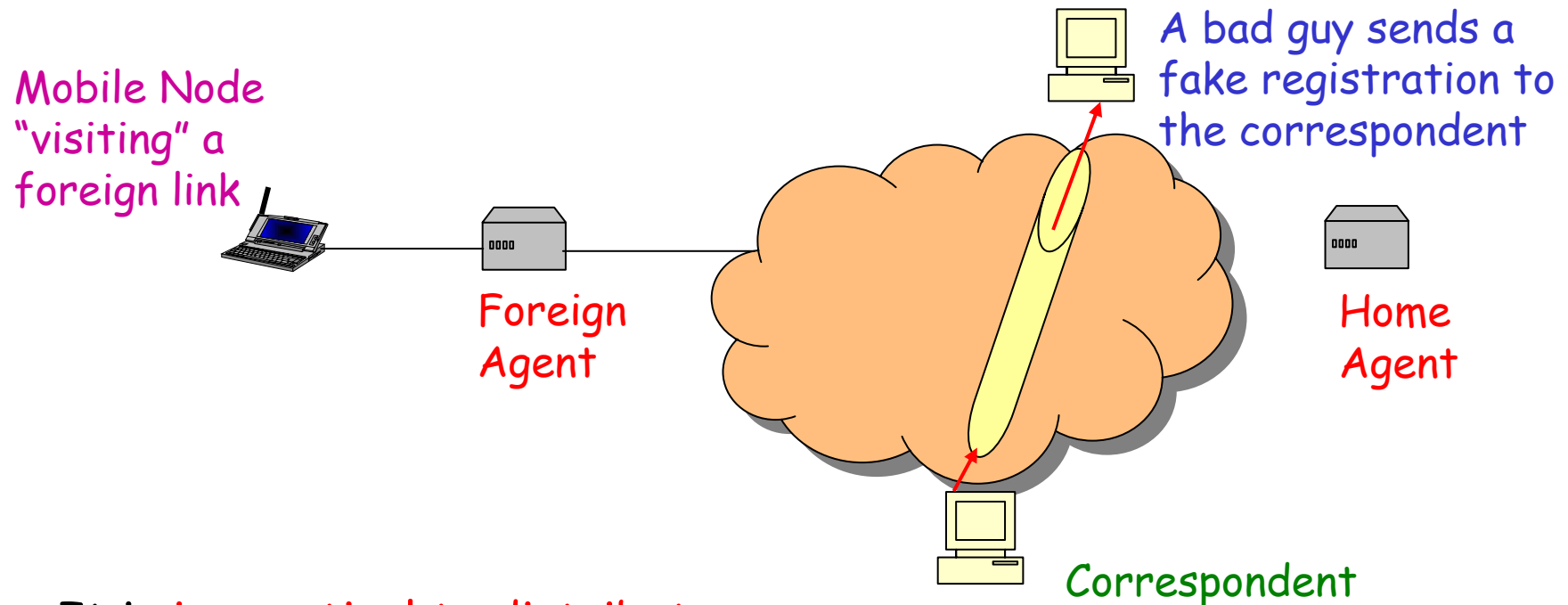
Mobile Node
"visiting" a
foreign link



This is potentially more efficient in terms of delay and resource consumption.

Why is it not used?

Main Obstacle: Security



It is **impractical to distribute keys** between a mobile node and every other node with which it might correspond.

References

- J. D. Solomon, *Mobile IP: the Internet unplugged*, Prentice Hall, 1998.
- C. E. Perkins, “Mobile networking through mobile IP,” *IEEE Internet Computing*, pp. 58-69, Jan/Feb, 1998.