Mobile IP

Dr. Ansuman Bhattacharya

Indian Institute of Technology, Dhanbad

Winter Semester 2017-18

Outline I

ADDRESSING I

- The main problem that must be solved in providing mobile communication using the *IP* protocol is addressing.
- The *IP* addresses are designed to work with stationary hosts because part of the address defines the network to which the host is attached.
- When a host moves from one network to another, the IP addressing structure needs to be modified.

ADDRESSING II

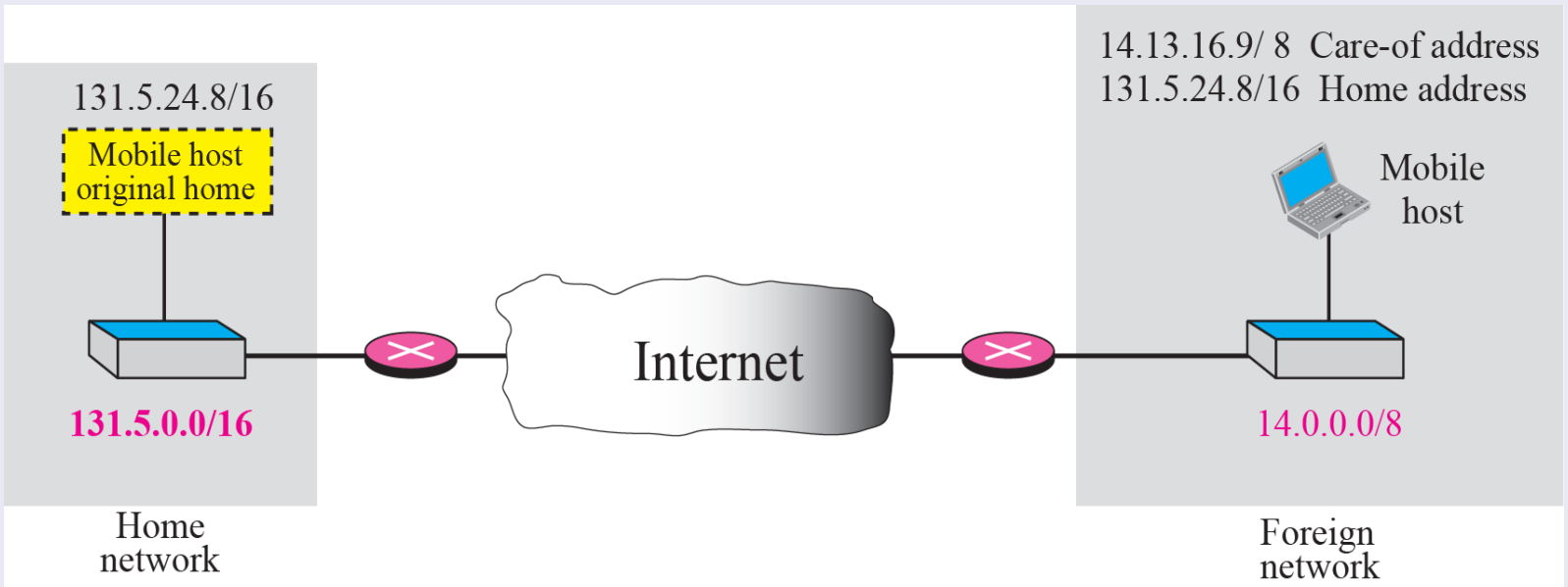
- **Changing the Address :** Let the mobile host change its address as it goes to the new network. The host can use DHCP to obtain a new address to associate it with the new network. This approach has several drawbacks:
  - The configuration files would need to be changed.
  - Each time the computer moves from one network to another, it must be rebooted.
  - The DNS tables need to be revised so that every other host in the Internet is aware of the change.
  - If the host roams from one network to another during a transmission, the data exchange will be interrupted. This is because the ports and IP addresses of the client and the server must remain constant for the duration of the connection.

ADDRESSING III

- **Two Addresses :** The approach that is more feasible is the use of two addresses. The host has its original address, called the home address, and a temporary address, called the care-of address. The home address is permanent; it associates the host to its home network, the network that is the permanent home of the host. The care-of address is temporary. When a host moves from one network to another, the care-of address changes; it is associated with the foreign network, the network to which the host moves.

ADDRESSING IV

Home address and care-of address

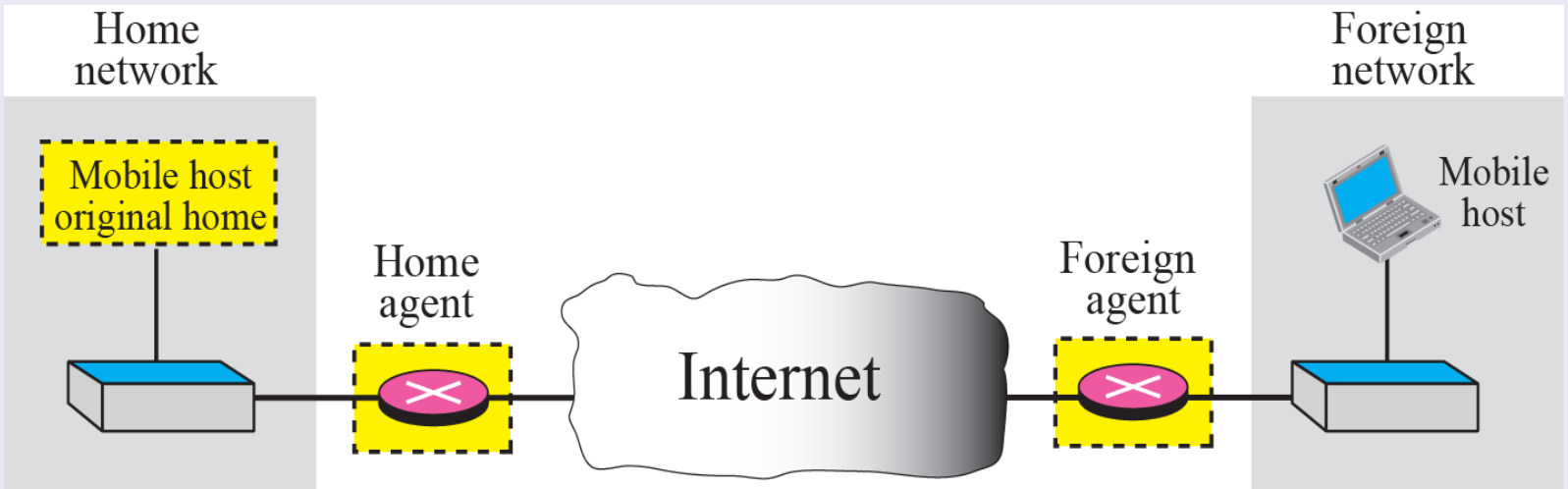


AGENTS I

- To make the change of address transparent to the rest of the Internet requires a home agent and a foreign agent.

AGENTS II

Home agent and foreign agent



Home Agent I

- The home agent is usually a router attached to the home network of the mobile host.
- The home agent acts on behalf of the mobile host when a remote host sends a packet to the mobile host.
- The home agent receives the packet and sends it to the foreign agent.

Foreign Agent I

- The foreign agent is usually a router attached to the foreign network.
- The foreign agent receives and delivers packets sent by the home agent to the mobile host.
- The mobile host can also act as a foreign agent.
- In other words, the mobile host and the foreign agent can be the same.
- However, to do this, a mobile host must be able to receive a care-of address by itself, which can be done through the use of *DHCP*.
- In addition, the mobile host needs the necessary software to allow it to communicate with the home agent and to have two addresses: its home address and its care-of address.

Foreign Agent II

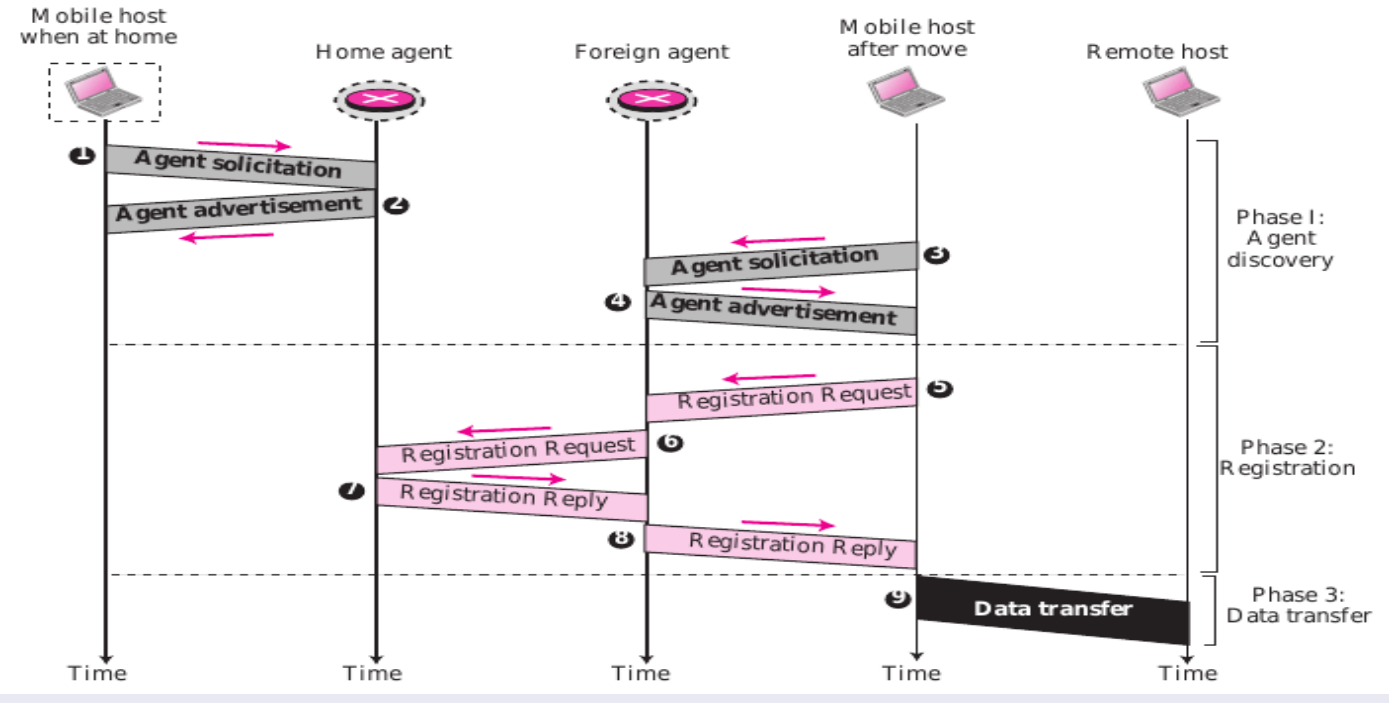
- This dual addressing must be transparent to the application programs.
- When the mobile host acts as a foreign agent, the care-of address is called a colocated care-of address.
- The advantage of using a colocated care-of address is that the mobile host can move to any network without worrying about the availability of a foreign agent.
- The disadvantage is that the mobile host needs extra software to act as its own foreign agent.

THREE PHASES I

- To communicate with a remote host, a mobile host goes through three phases:
  1. **Agent Discovery :** Involves the mobile host, the foreign agent, and the home agent.
  2. **Registration :** Also involves the mobile host and the two agents.
  3. **Data Transfer :** The remote host is also involved.

THREE PHASES II

Remote host and mobile host configuration



Agent Discovery I

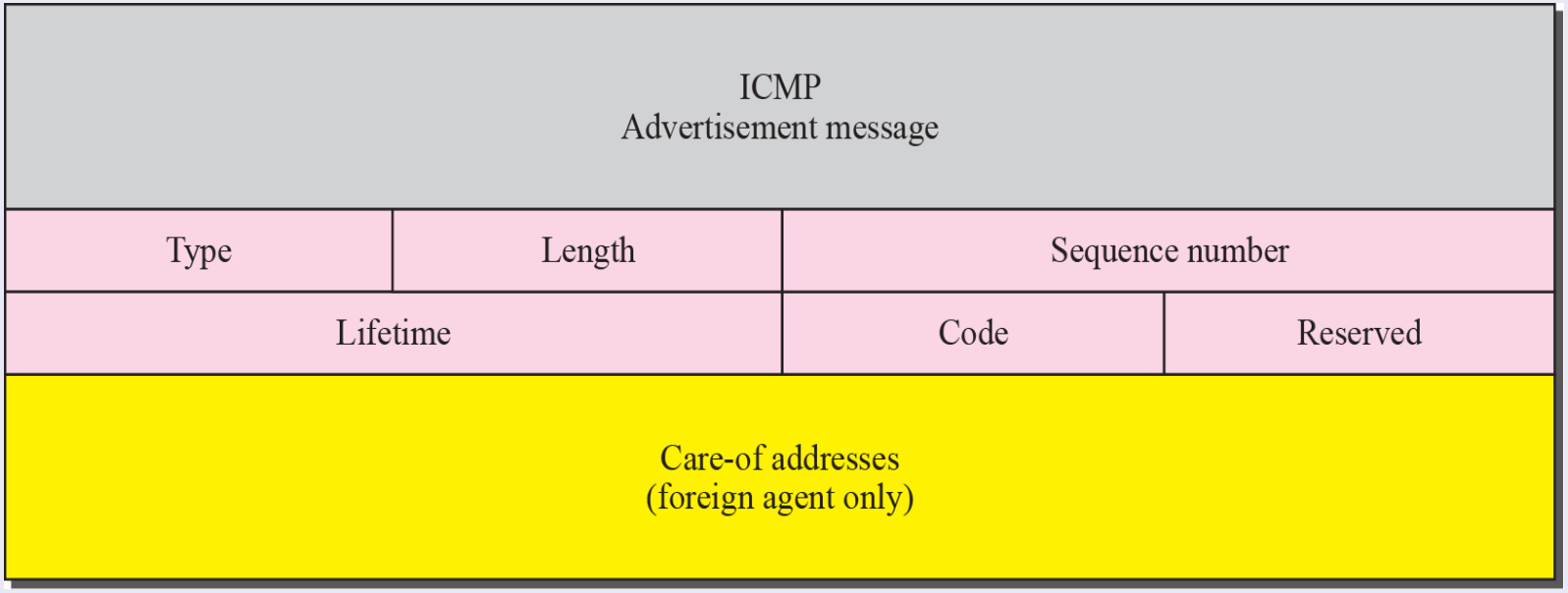
- The first phase in mobile communication, agent discovery, consists of two subphases.
- A mobile host must discover (learn the address of) a home agent before it leaves its home network.
- A mobile host must also discover a foreign agent after it has moved to a foreign network.
- This discovery consists of learning the care-of address as well as the foreign agents address.
- The discovery involves two types of messages: advertisement and solicitation.

Agent Advertisement I

- When a router advertises its presence on a network using an ICMP router advertisement, it can append an agent advertisement to the packet if it acts as an agent.
- Mobile *IP* does not use a new packet type for agent advertisement; it uses the router advertisement packet of *ICMP*, and appends an agent advertisement message.

Agent Advertisement II

Agent advertisement



Agent Advertisement III

- The field descriptions are as follows:
  - **Type :** The 8-bit type field is set to 16.
  - **Length :** The 8-bit length field defines the total length of the extension message (not the length of the ICMP advertisement message).
  - **Sequence number :** The 16-bit sequence number field holds the message number. The recipient can use the sequence number to determine if a message is lost.
  - **Lifetime :** The lifetime field defines the number of seconds that the agent will accept requests. If the value is a string of 1s, the lifetime is infinite.
  - **Code :** The code field is an 8-bit flag in which each bit is set (1) or unset (0).

Agent Advertisement IV

Code Bits

Bit	*Meaning*
0	Registration required. No colocated care-of address.
1	Agent is busy and does not accept registration at this moment.
2	Agent acts as a home agent.
3	Agent acts as a foreign agent.
4	Agent uses minimal encapsulation.
5	Agent uses generic routing encapsulation (GRE).
6	Agent supports header compression.
7	Unused (0).

Agent Advertisement V

- **Care-of Addresses :** This field contains a list of addresses available for use as care-of addresses. The mobile host can choose one of these addresses. The selection of this care-of address is announced in the registration request. Note that this field is used only by a foreign agent.

Agent Solicitation I

- When a mobile host has moved to a new network and has not received agent advertisements, it can initiate an agent solicitation.
- It can use the *ICMP* solicitation message to inform an agent that it needs assistance.
- Mobile *IP* does not use a new packet type for agent solicitation; it uses the router solicitation packet of *ICMP*.

Registration I

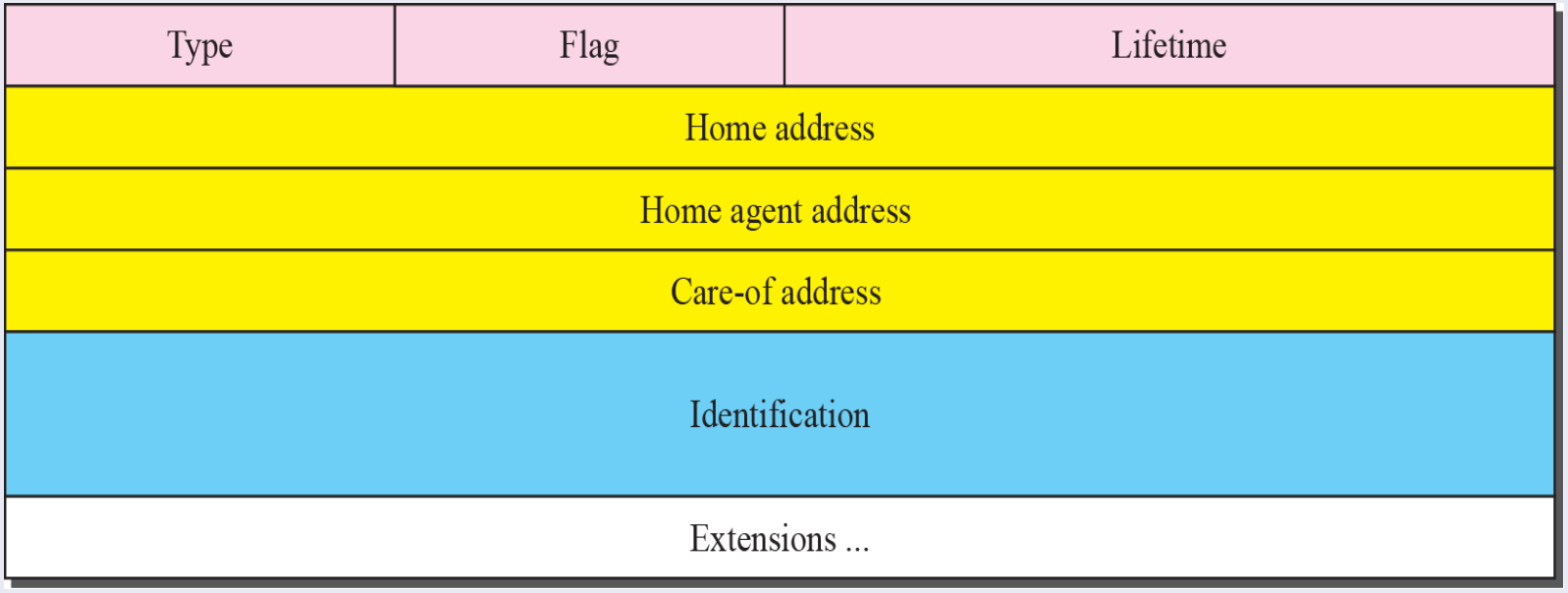
- After a mobile host has moved to a foreign network and discovered the foreign agent, it must register.
- There are four aspects of registration:
  1. The mobile host must register itself with the foreign agent.
  2. The mobile host must register itself with its home agent. This is normally done by the foreign agent on behalf of the mobile host.
  3. The mobile host must renew registration if it has expired.
  4. The mobile host must cancel its registration (deregistration) when it returns home.
- To register with the foreign agent and the home agent, the mobile host uses a registration request and a registration reply.

Registration Request I

- A registration request is sent from the mobile host to the foreign agent to register its care-of address and also to announce its home address and home agent address.
- The foreign agent, after receiving and registering the request, relays the message to the home agent.
- Note that the home agent now knows the address of the foreign agent because the IP packet that is used for relaying has the IP address of the foreign agent as the source address.

Registration Request II

Registration request format



Registration Request III

- The field descriptions are as follows:
  - **Type :** The 8-bit type field defines the type of the message. For a request message the value of this field is 1.
  - **Flag :** The 8-bit flag field defines forwarding information. The value of each bit can be set or unset.

Registration Request IV

Registration request flag field bits

Bit	Meaning
0	Mobile host requests that home agent retain its prior care-of address.
1	Mobile host requests that home agent tunnel any broadcast message.
2	Mobile host is using colocated care-of address.
3	Mobile host requests that home agent use minimal encapsulation.
4	Mobile host requests generic routing encapsulation (GRE).
5	Mobile host requests header compression.
6–7	Reserved bits.

Registration Request V

- **Lifetime :** This field defines the number of seconds the registration is valid. If the field is a string of 0s, the request message is asking for deregistration. If the field is a string of 1s, the lifetime is infinite.
- **Home address :** This field contains the permanent (first) address of the mobile host.
- **Home agent address :** This field contains the address of the home agent.
- **Care-of address :** This field is the temporary (second) address of the mobile host.

Registration Request VI

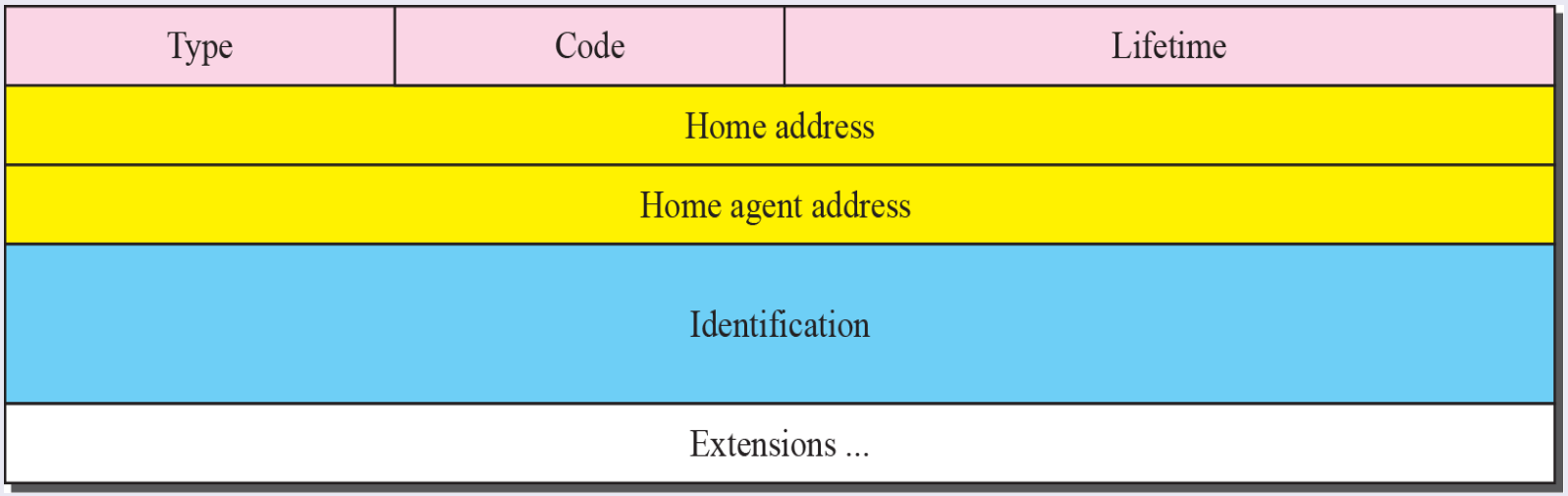
- **Identification :** This field contains a 64-bit number that is inserted into the request by the mobile host and repeated in the reply message. It matches a request with a reply.
- **Extensions :** Variable length extensions are used for authentication. They allow a home agent to authenticate the mobile agent.

Registration Reply I

- A registration reply is sent from the home agent to the foreign agent and then relayed to the mobile host. The reply confirms or denies the registration request.
- The fields are similar to those of the registration request with the following exceptions.
- The value of the type field is 3. The code field replaces the flag field and shows the result of the registration request (acceptance or denial).
- The care-of address field is not needed.

Registration Reply II

Registration reply format



Encapsulation I

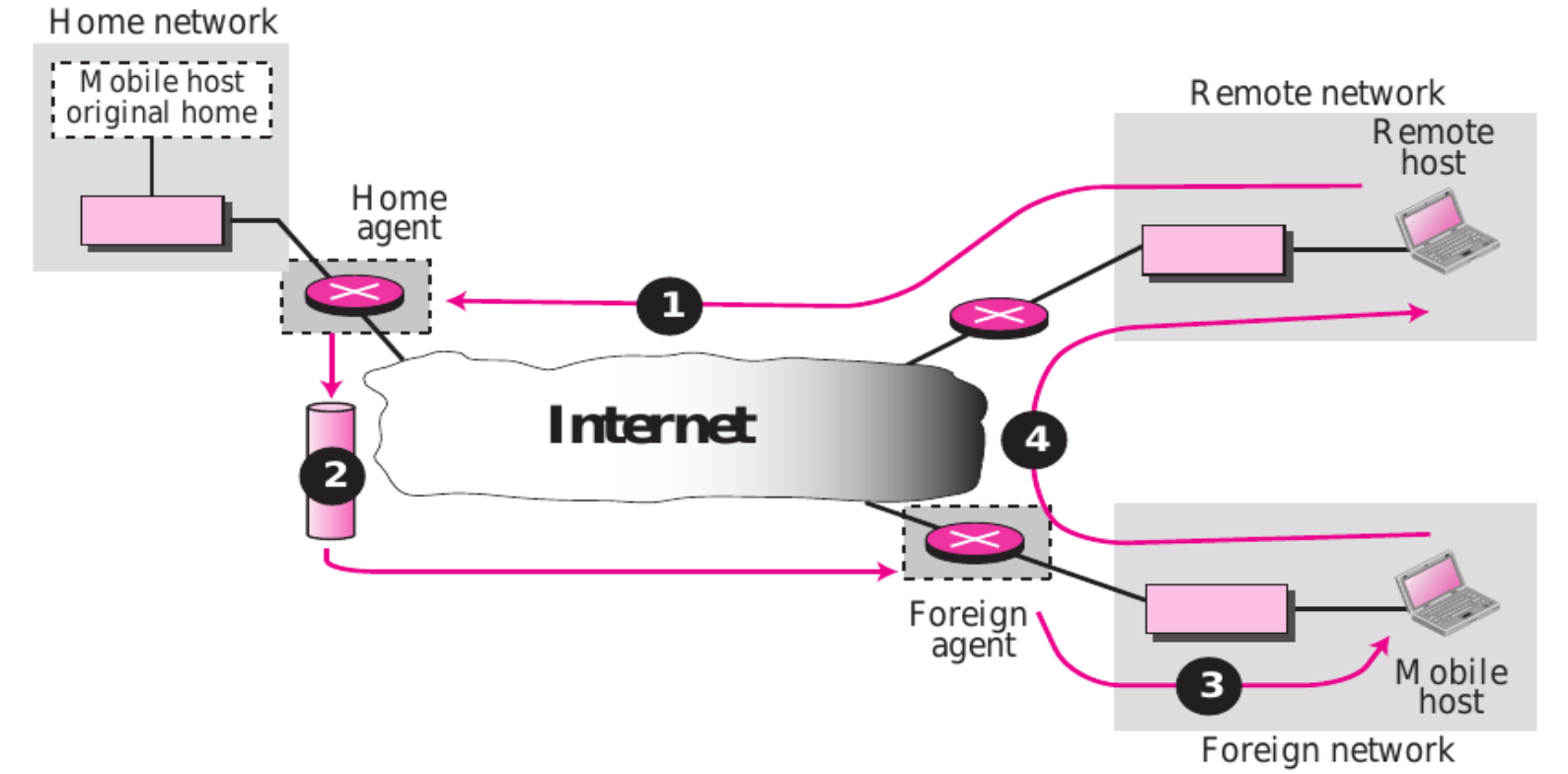
- Registration messages are encapsulated in a UDP user datagram.
- An agent uses the well-known port 434; a mobile host uses an ephemeral port.

Data Transfer I

- After agent discovery and registration, a mobile host can communicate with a remote host.

Data Transfer II

Data transfer



From Remote Host to Home Agent I

- When a remote host wants to send a packet to the mobile host, it uses its address as the source address and the home address of the mobile host as the destination address.
- In other words, the remote host sends a packet as though the mobile host is at its home network.
- The packet, however, is intercepted by the home agent, which pretends it is the mobile host.
- This is done using the proxy *ARP* technique.

From Home Agent to Foreign Agent I

- After receiving the packet, the home agent sends the packet to the foreign agent using the tunneling concept.
- The home agent encapsulates the whole *IP* packet inside another *IP* packet using its address as the source and the foreign agents address as the destination.

From Foreign Agent to Mobile Host I

- When the foreign agent receives the packet, it removes the original packet.
- However, since the destination address is the home address of the mobile host, the foreign agent consults a registry table to find the care-of address of the mobile host.
- Otherwise, the packet would just be sent back to the home network.
- The packet is then sent to the care-of address.

From Mobile Host to Remote Host I

- When a mobile host wants to send a packet to a remote host (for example, a response to the packet it has received), it sends as it does normally.
- The mobile host prepares a packet with its home address as the source, and the address of the remote host as the destination.
- Although the packet comes from the foreign network, it has the home address of the mobile host.

Transparency I

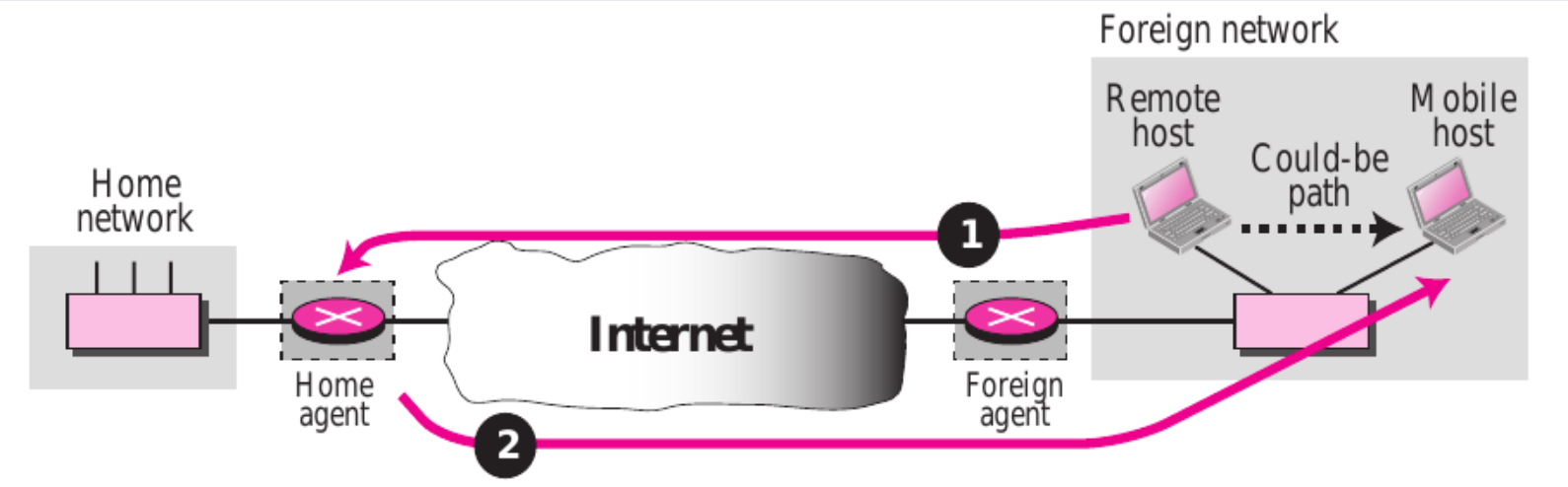
- In this data transfer process, the remote host is unaware of any movement by the mobile host.
- The remote host sends packets using the home address of the mobile host as the destination address; it receives packets that have the home address of the mobile host as the source address.
- The movement is totally transparent.
- The rest of the Internet is not aware of the mobility of the moving host.

INEFFICIENCY IN MOBILE IP I

- Communication involving mobile IP can be inefficient.
- The inefficiency can be severe or moderate.
- The severe case is called double crossing or 2X.
- The moderate case is called triangle routing or dog-leg routing.

Double Crossing I

Double crossing

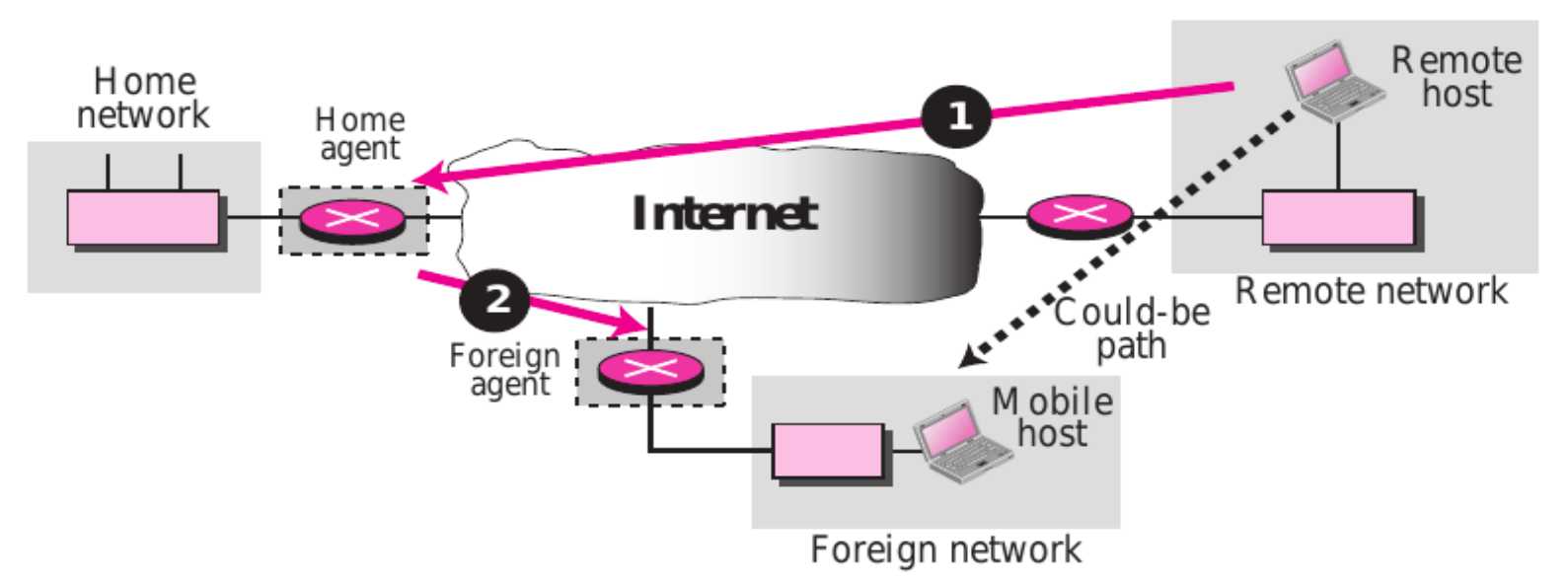


Double Crossing II

- Double crossing occurs when a remote host communicates with a mobile host that has moved to the same network (or site) as the remote host.
- When the mobile host sends a packet to the remote host, there is no inefficiency; the communication is local.
- However, when the remote host sends a packet to the mobile host, the packet crosses the Internet twice.
- Since a computer usually communicates with other local computers (principle of locality), the inefficiency from double crossing is significant.

Triangle Routing I

Triangle routing



Triangle Routing II

- Triangle routing, the less severe case, occurs when the remote host communicates with a mobile host that is not attached to the same network (or site) as the mobile host.
- When the mobile host sends a packet to the remote host, there is no inefficiency.
- However, when the remote host sends a packet to the mobile host, the packet goes from the remote host to the home agent and then to the mobile host.
- The packet travels the two sides of a triangle, instead of just one side.

Solution I

- One solution to inefficiency is for the remote host to bind the care-of address to the home address of a mobile host.
- For example, when a home agent receives the first packet for a mobile host, it forwards the packet to the foreign agent; it could also send an update binding packet to the remote host so that future packets to this host could be sent to the care-of address.
- The remote host can keep this information in a cache.
- The problem with this strategy is that the cache entry becomes outdated once the mobile host moves.
- In this case the home agent needs to send a warning packet to the remote host to inform it of the change.