Distributed & Mobile Computing

IS384

Introduction to Mobile Computing

Introduction:

Mobile Computing refers to the utilization of portable computing devices in conjunction with wireless networks to enable communication and access to data and information on the go.

- **Key Components**
  - **Mobile Devices:** Smartphones, tablets, wearables, laptops.
  - **Wireless Networks**: Wi-Fi, cellular networks, Bluetooth, satellite connections.

Evolution of Mobile Computing

Historically, mobile computing has evolved from bulky, limited-functionality devices to highly sophisticated, multi-functional smartphones and wearable gadgets.

- Rise of mobile operating systems: Android, iOS, and others have shaped the mobile software landscape.
- Mobile app explosion: Apps have transformed how we work, play, and connect on the go.

1. 1G (1980s): The Dawn of Mobility

2. 2G (1990s): Texting Takes Center Stage

3. 3G (2000s): Connecting to the World Wide Web

4. 4G (2010s): The Age of the App

Significance of Mobile Computing

- Ubiquitous Connectivity: Users can access information and services irrespective of their location, enhancing convenience and productivity.
- Enhanced Communication: Instant communication through various platforms, including voice, video, and messaging applications.
- On-the-Go Access: Access to a myriad of services such as emails, social media, navigation, and multimedia content anytime, anywhere.

Challenges and Opportunities

- Challenges: Battery life, network reliability, security, limited computational resources.

- Opportunities: Innovations in mobile applications, IoT integration, augmented reality, and personalized user experiences.

Mobile MAC Protocols

- MAC (Media Access Control) protocols manage the access to the communication medium in wireless networks.
- These protocols are crucial for handling transmission between mobile devices and the network infrastructure efficiently.

Category of Mobile MAC Protocols:

Contention-Based: These protocols rely on carrier-sense multiple access (CSMA) mechanisms like Carrier Sense Multiple Access with Collision Avoidance (**CSMA/CA**) or Aloha. Devices listen before transmitting, back off after collisions, and use random backoff timers to avoid contention. Examples include IEEE 802.11 DCF and ALOHA.

Scheduled-Based: These protocols pre-assign time slots to devices for transmission, eliminating collisions and ensuring predictable data delivery. Examples include Time Division Multiple Access (**TDMA**) and Frequency Division Multiple Access (**FDMA**).

Hybrid: These protocols combine elements of both contention-based and scheduled-based approaches,

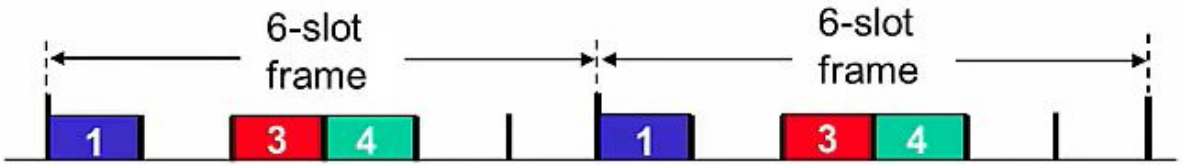
Types of Mobile MAC Protocols:

- **CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance)**
  - Prevents collisions by using a mechanism where devices sense the medium before transmitting data.
  - Widely used in Wi-Fi networks.
- **TDMA (Time Division Multiple Access)**
  - Divides the time into slots allowing different devices to transmit during assigned time frames.
  - Commonly employed in cellular networks.
- **FDMA (Frequency Division Multiple Access)**
  - Allocates different frequency bands to different devices for simultaneous communication.
  - Utilized in some older cellular systems.

Channel partitioning MAC protocols: TDMA

TDMA: time division multiple access

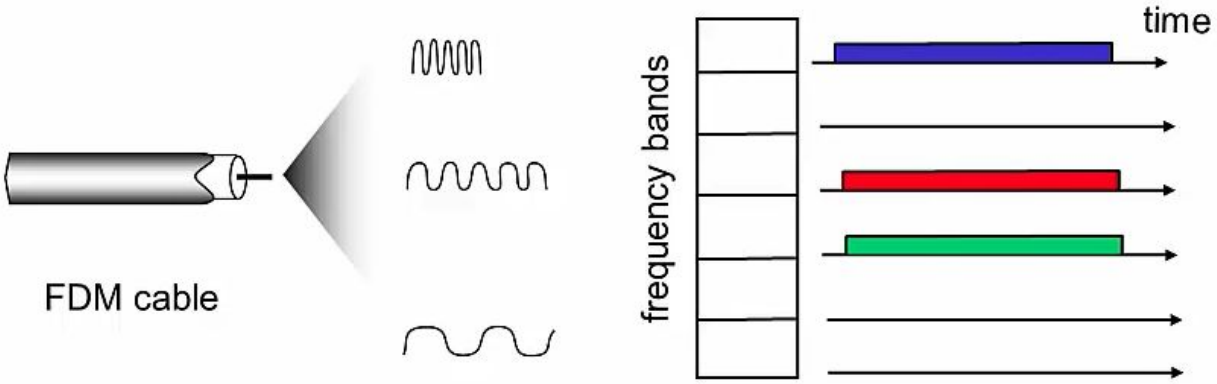
- access to channel in "rounds"
- each station gets fixed length slot (length = pkt trans time) in each round
- unused slots go idle
- example: 6-station LAN, 1,3,4 have pkt, slots 2,5,6 idle



Channel partitioning MAC protocols: FDMA

FDMA: frequency division multiple access

- channel spectrum divided into frequency bands
- each station assigned fixed frequency band
- unused transmission time in frequency bands go idle
- example: 6-station LAN, 1,3,4 have pkt, frequency bands 2,5,6 idle

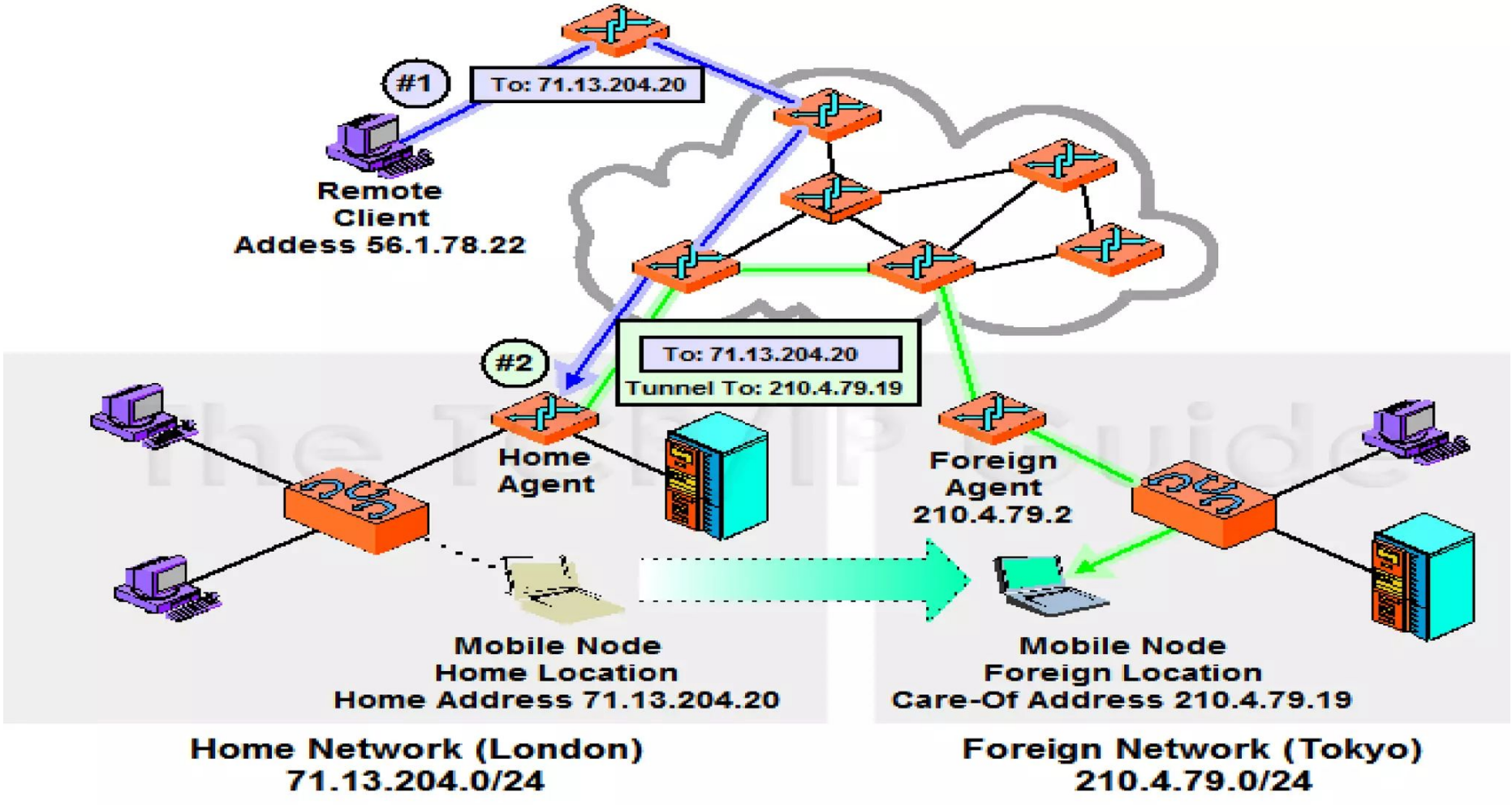


Mobile Internet Protocol

- **Overview of Mobile IP**
  - Mobile IP is a protocol enabling mobile devices to maintain continuous connectivity while moving across different networks.
  - Allows devices to keep the same IP address despite changing networks.
  - Mobile IP is designed to allow mobile devices users to move from one area to another while maintaining a permanent IP address

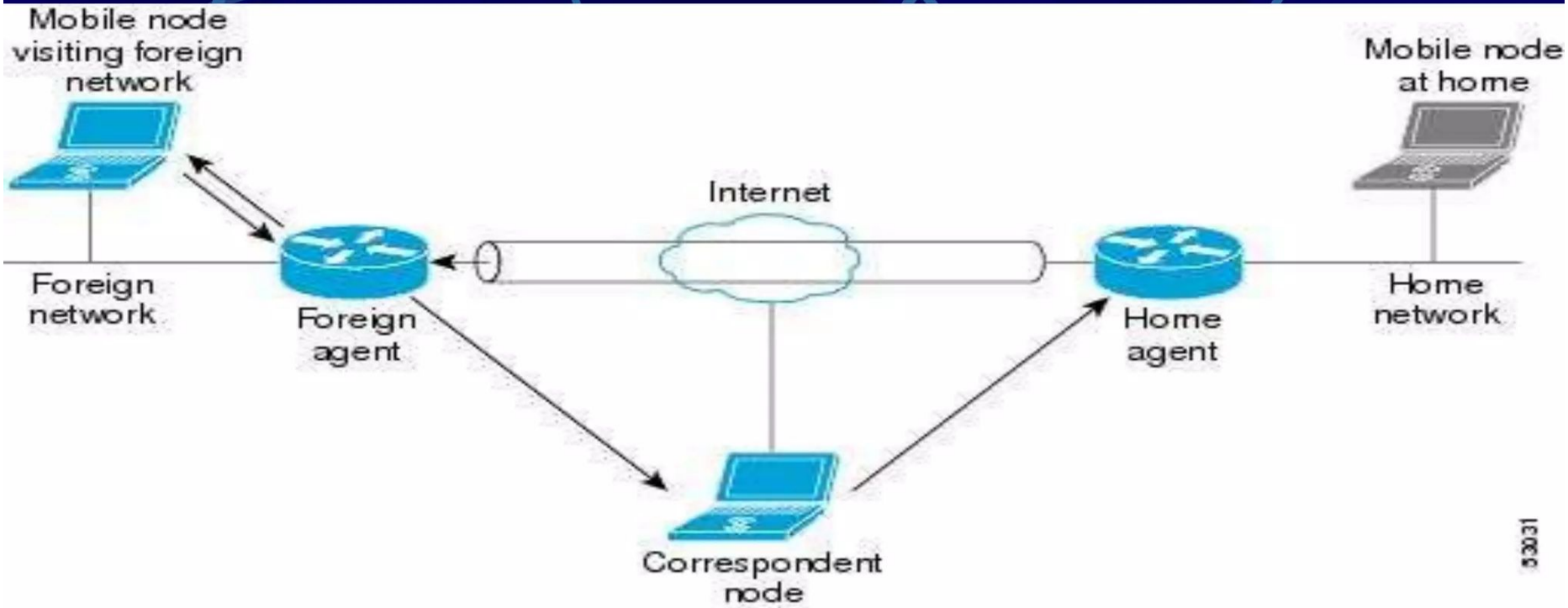
Challenges and Solutions

- **Handover**
  - The process of transferring a connection from one network to another.
  - Seamless handover is crucial for uninterrupted communication.
- **Security**
  - Ensuring data security during movement between networks.

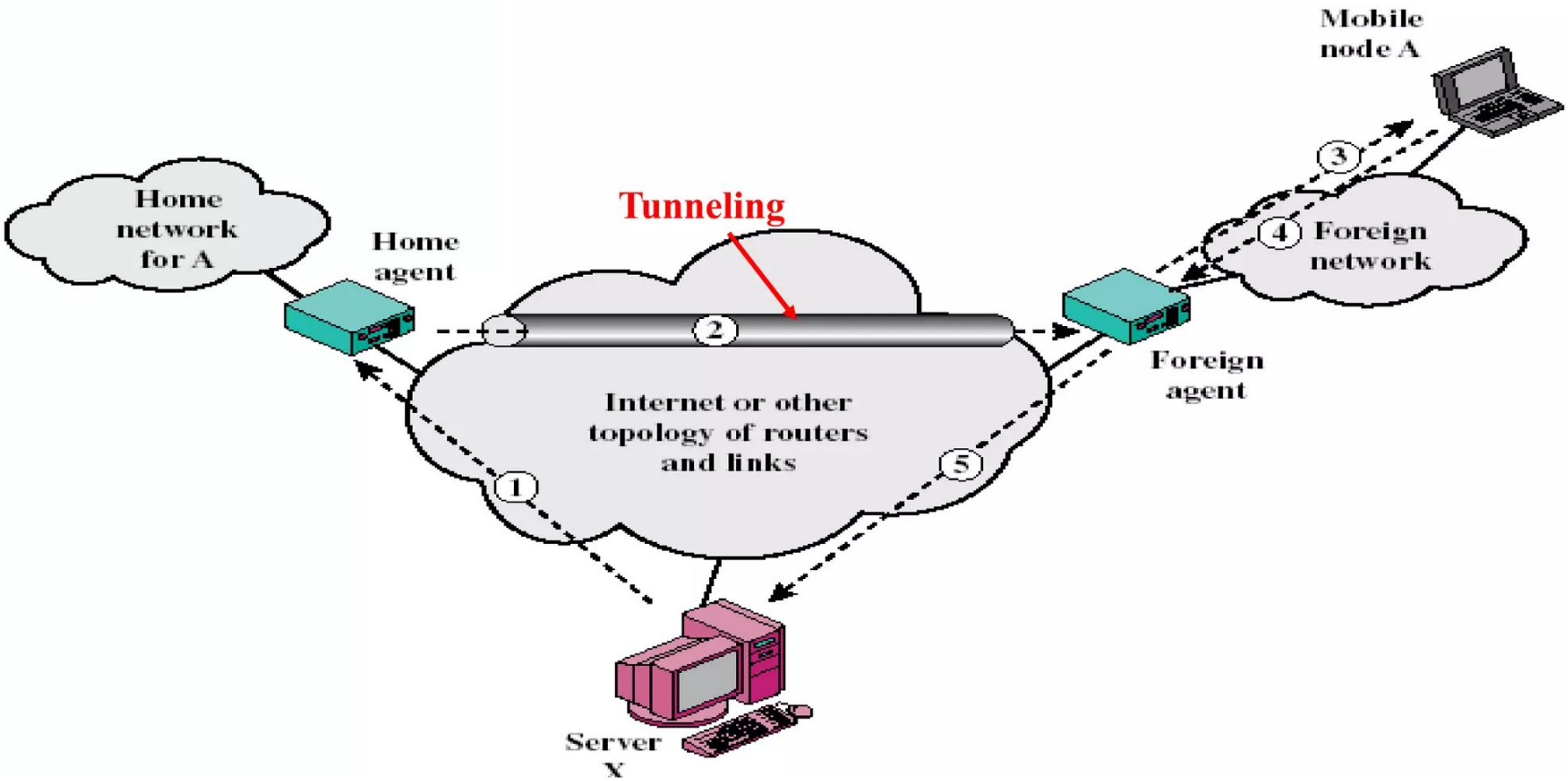

#1
To: 71.13.204.20
Remote
Client
Addess 56.1.78.22
#2
To: 71.13.204.20
Tunnel To: 210.4.79.19
Home
Agent
Foreign
Agent
210.4.79.2
Mobile Node
Home Location
Home Address 71.13.204.20
Mobile Node
Foreign Location
Care-Of Address 210.4.79.19
Home Network (London)
71.13.204.0/24
Foreign Network (Tokyo)
210.4.79.0/24

Mobile IP

- Mobile IP enables an IP node to retain the same IP address and maintain existing communications while traveling from one link to another.



Mobile IP


Mobile node A
Home network for A
Home agent
Tunneling
Foreign network
Foreign agent
Internet or other topology of routers and links
Server X
1
2
3
4
5

Mobile IP Components

- Mobile node (MN)
- Home agent (HA)
- Foreign agent (FA)
- Correspondent Node (CN)

Mobile node (MN)

The Mobile Node is a device such as

-a cell phone,

-personal digital assistant,

-or laptop

whose software enables network roaming capabilities.

Home agent (HA)

- Home Agent is a router on the home network serving as the anchor point for communication with the Mobile Node;
- it tunnels packets from a device on the Internet, called a Correspondent Node, to the roaming Mobile Node.

(A tunnel is established between the Home Agent and a reachable point for the Mobile Node in the foreign network.)

Foreign agent (FA)

- The Foreign Agent is a router that may function as the point of attachment for the Mobile Node when it roams to a foreign network, delivering packets from the Home Agent to the Mobile Node.

Correspondent Node (CN)

- End host to which MN is corresponding (eg. a web server)

How Mobile IP Works

The Mobile IP process has three main phases

the following sections.

- Agent Discovery
  A Mobile Node discovers its Foreign and Home Agents during agent discovery.
- Registration
  The Mobile Node registers its current location with the Foreign Agent and Home Agent during registration.
- Tunneling
  A reciprocal tunnel is set up by the Home Agent to the care-of address (current location of the Mobile Node on the foreign network) to route packets to the Mobile Node as it roams.

Two IP addresses for mobile node

- **Home address: static**
- **Care-of address: topologically significant address**

The care-of address is the termination point of the tunnel toward the Mobile Node when it is on a foreign network. The Home Agent maintains an association between the home IP address of the Mobile Node and its care-of address, which is the current location of the Mobile Node on the foreign or visited network

Mobile IP Binding: Is the association of Mobile Node home IP and its care-of address.

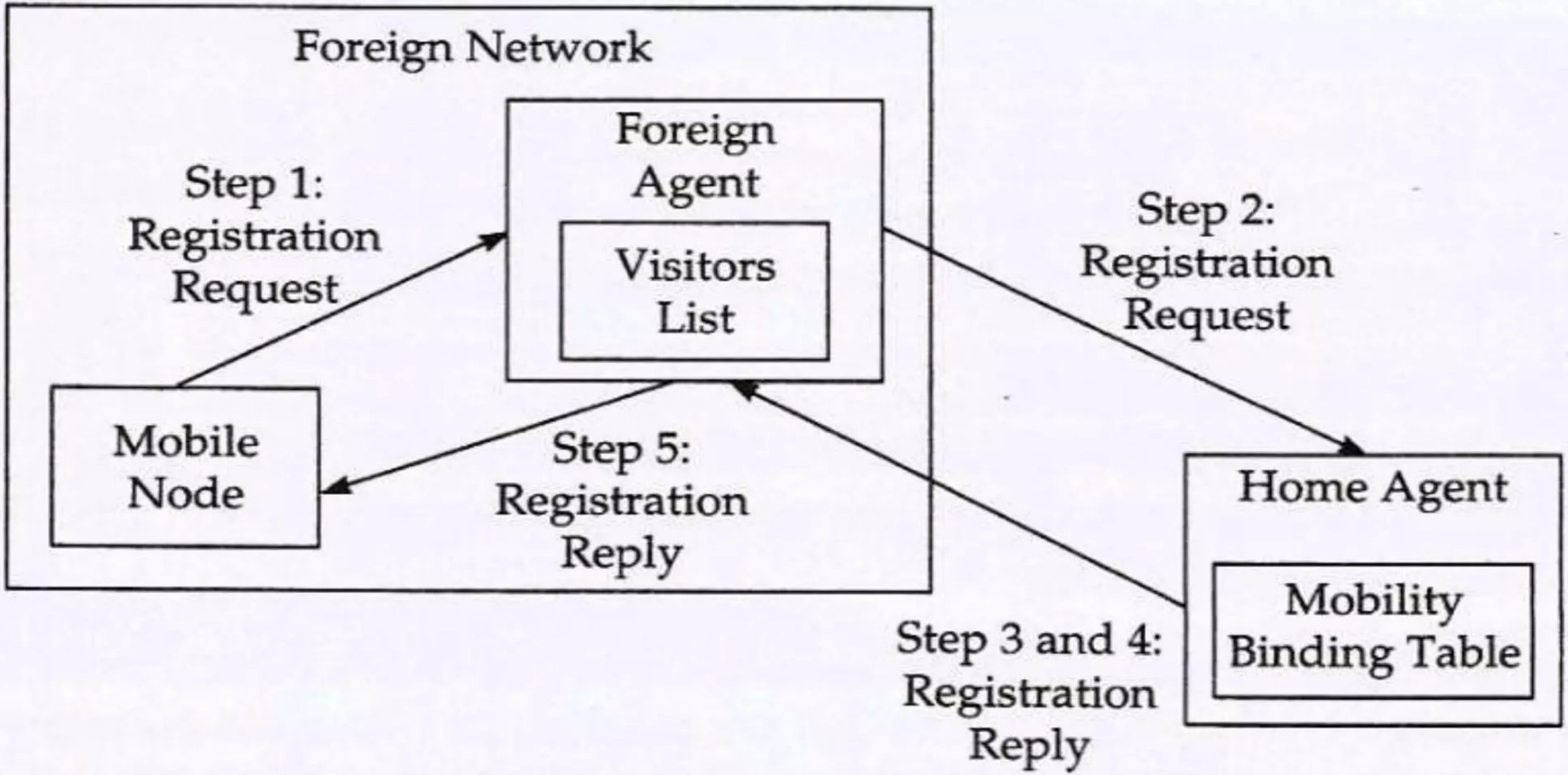


Figure 4.3 *Registration process in Mobile IP.*

Features of Mobile IP

- Transparency : IP address should not be any effect of mobility on any ongoing communication
- Compatibility: It should compatible with existing Internet protocols.
- Security: It should provide users with secure communication over internet.
- Efficiency : It should neither result in large number of message nor should it incur too much computational overheads
- Scalability: It should also be scalable to support billions of moving hosts worldwide.

Use cases of Mobile IP

- **Transportation Connectivity:** Mobile IP ensures continuous internet access for passengers on moving vehicles like trains, buses, and planes, switching across diverse network areas.
- **Enterprise Mobility:** Facilitates seamless connectivity for corporate devices (smartphones, tablets) moving between office Wi-Fi, cellular networks, and public hotspots.
- **Internet of Things (IoT) Flexibility:** Enables uninterrupted communication for dynamic IoT devices as they change locations or network connections.
- **Telecommunications Efficiency:** Crucial for cellular networks, allowing uninterrupted voice/data sessions while switching between different cell towers.

Use cases of Mobile IP Cont...

- **Public Wi-Fi Roaming**: Smooth transition between public Wi-Fi access points (airports, cafes) without interruption to user activities.
- **Remote Access & VPNs:** Enables professionals to switch between networks (home Wi-Fi, cellular, public Wi-Fi) while staying connected to corporate networks securely.
- **Emergency Services Reliability:** Vital for first responders and emergency personnel, ensuring connectivity across diverse networks during critical situations.

Operating Systems for Mobile Computing Devices

- **Characteristics of Mobile OS**
  - **Resource Management**
    - Efficiently utilizing battery, CPU, memory, and other resources.
  - **Multitasking and Responsiveness**
    - Handling multiple applications while maintaining device responsiveness.

Conti..

- **Popular Mobile Operating Systems**
  - Android
  - iOS
  - Windows Mobile (historical context)
- **Key Features and Functionality**
  - App sandboxing, power management, security features, and user interface considerations.

WAP - Wireless Application Protocol

- **Introduction to WAP**
  - WAP enables access to the internet on mobile devices.
  - Designed for smaller screens and limited bandwidth.

Cont..

- **Components of WAP**
  - **WAP Gateway**
    - Translates web content to a format suitable for mobile devices.
  - **WML (Wireless Markup Language)**
    - A markup language similar to HTML for creating content on mobile devices.

Cont..

- **Applications and Advantages**
  - Accessing websites, email, and basic internet services on mobile phones.
  - Adapting content for mobile consumption.