CS6504

Mobile Computing

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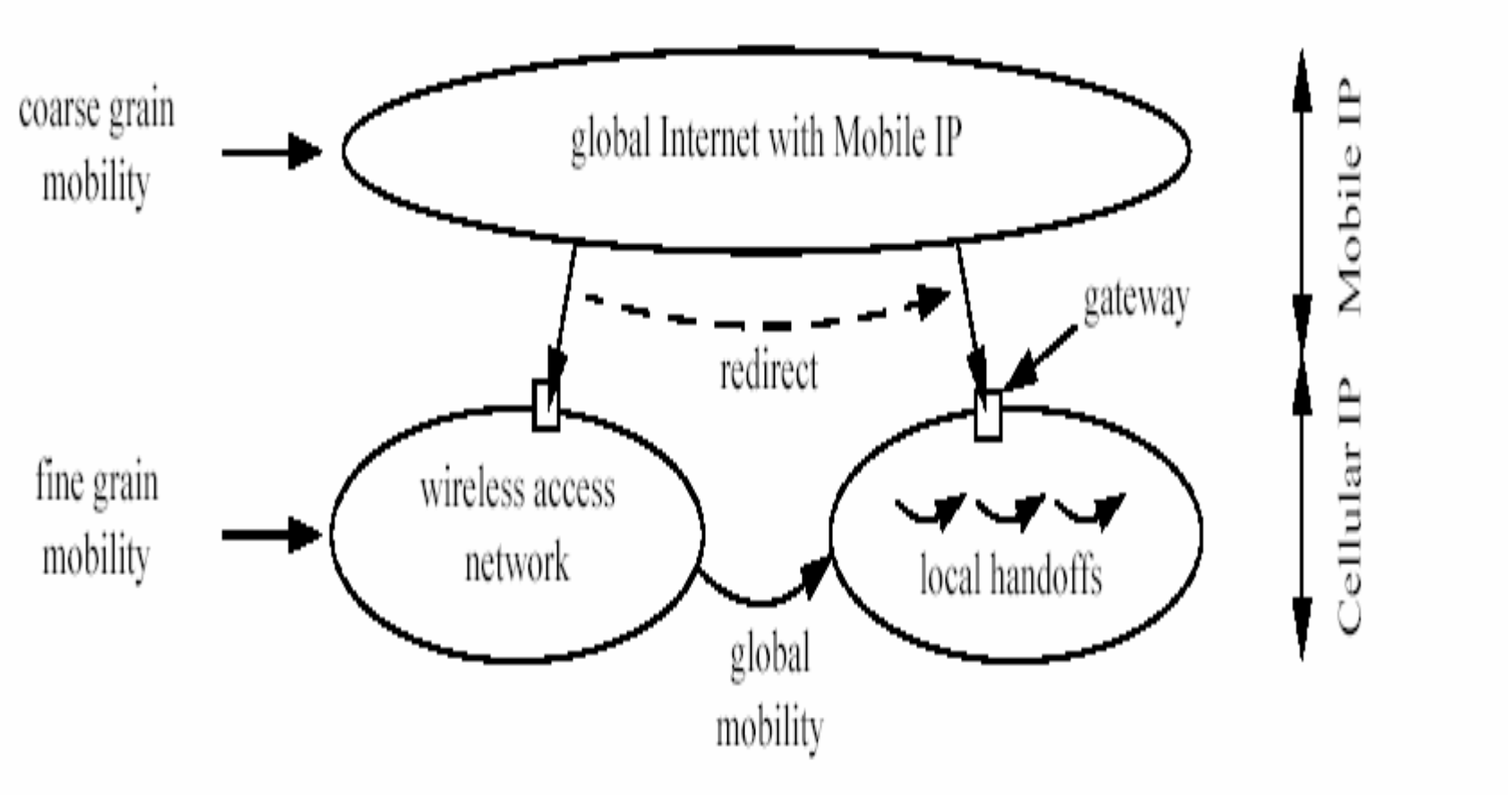
Mobile IPv4 Micro-mobility

Host-based Routing

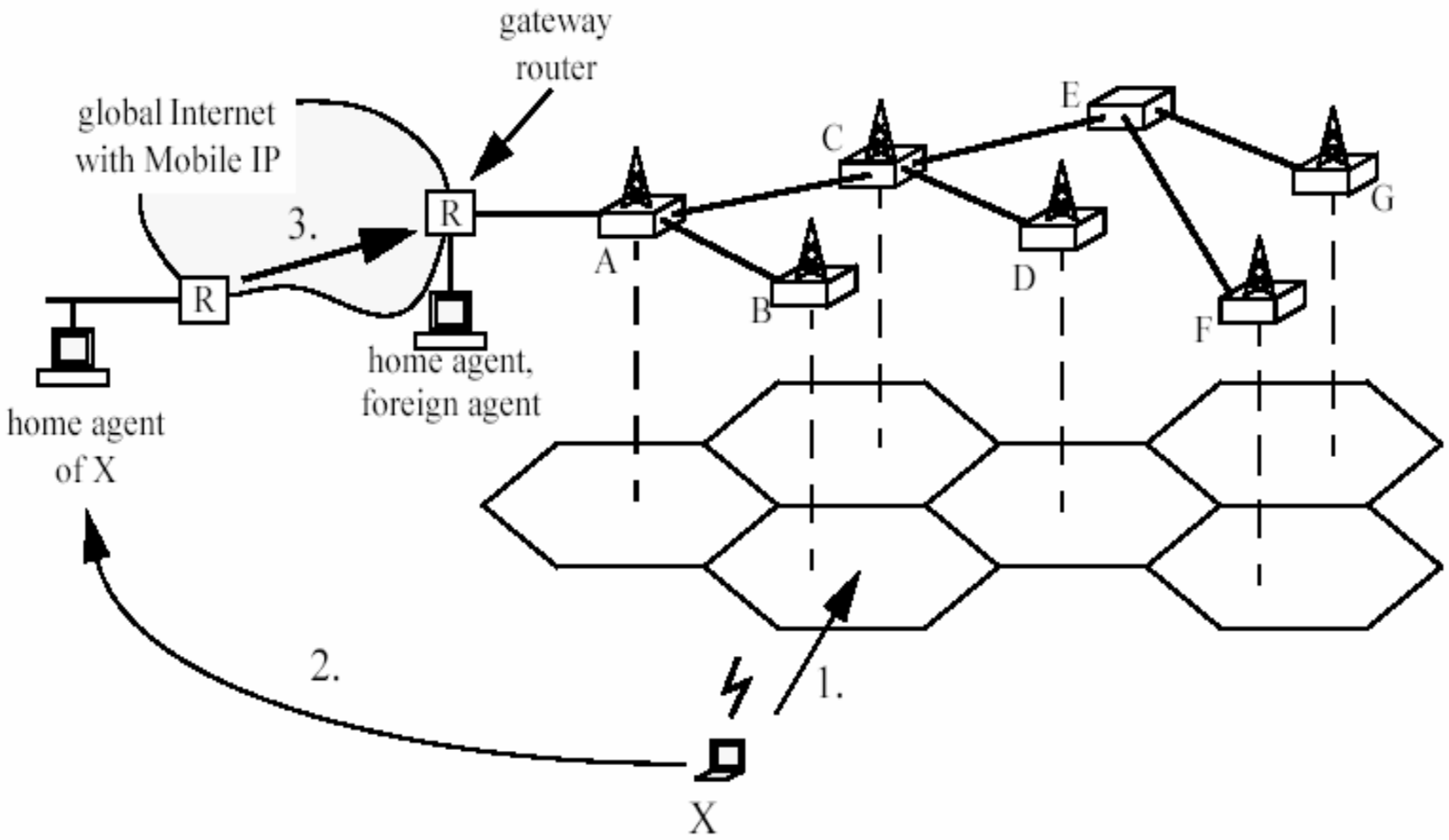
Outline

- MIPv4 Micro-mobility solutions
  - ➢ Host-based Routing Protocols
    - ✓ Cellular IP
    - ✓ HAWAII (Handoff-Aware Wireless Access Internet Infrastructure)

Wireless Access Network and Mobile IP



Wireless Access Networks model 1/3



Wireless Access Networks model 2/3

•Packets addressed to a mobile host are routed to its current base station on a *hop-by-hop* basis where each node only needs to know on which of its outgoing ports to forward packets.

•*Mappings:* map mobile host identifiers (IP addresses) to node ports.

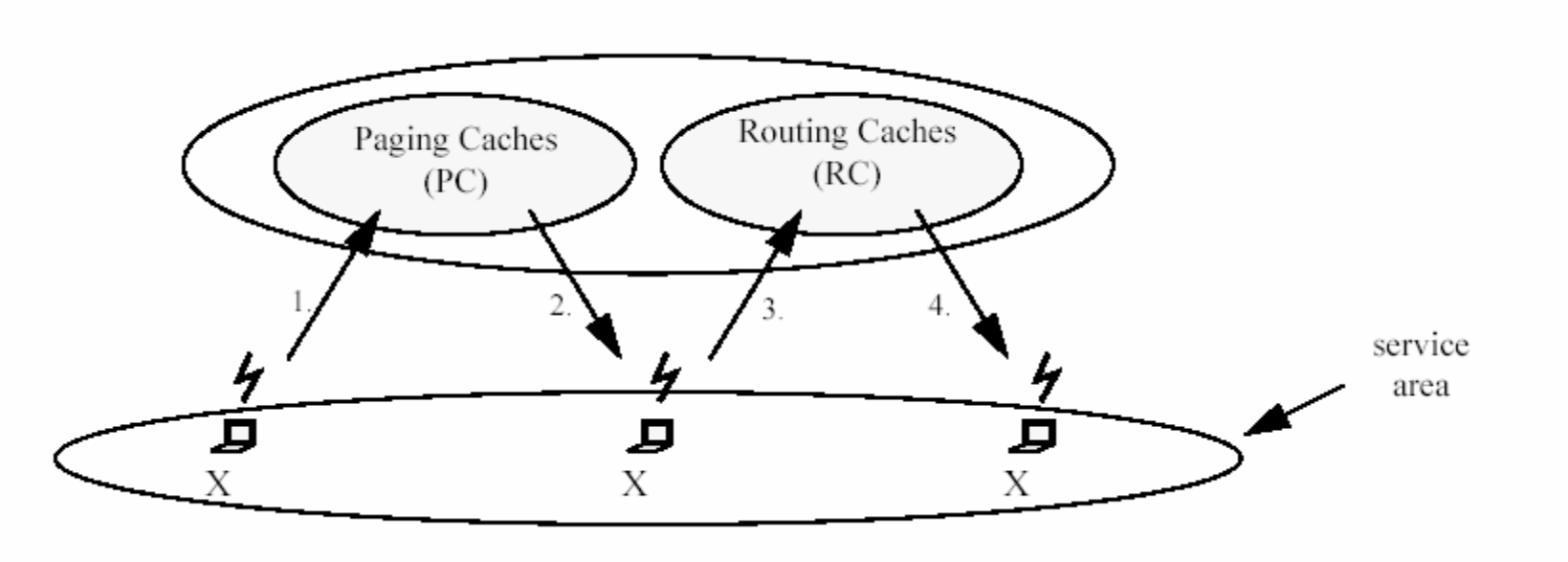
•Mappings are created by packets transmitted by mobile hosts. (packets travel toward the gateway router, routed on a hop-by-hop basis)

•mappings are not cleared in an explicit way after handoff (timers to clear outdated mappings)

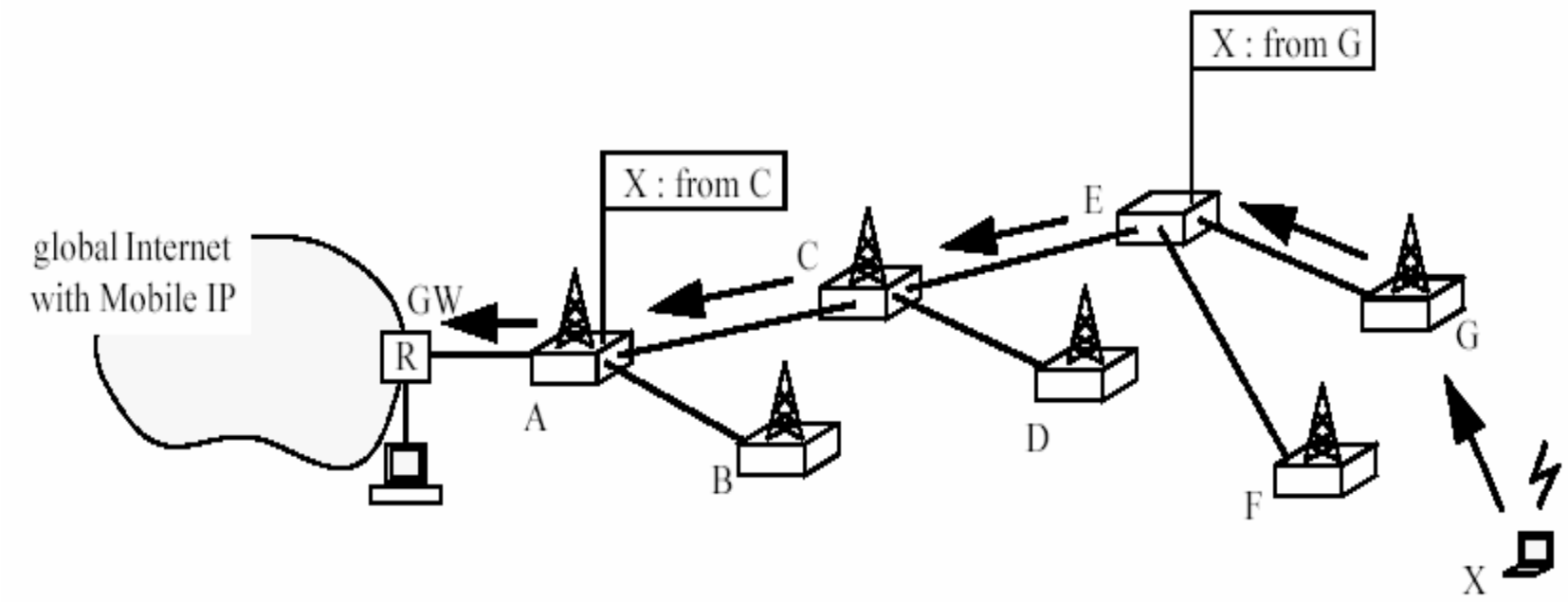
•Cheap passive connectivity: use of paging

Wireless Access Networks model 3/3

- two parallel structures of mappings
  - Paging caches for idle mobile hosts
    - Timeout in order of seconds or minutes (migration frequency)
  - Routing caches for active mobile hosts (receiving or expecting to receive data)
    - Timeout in order of packet time scale

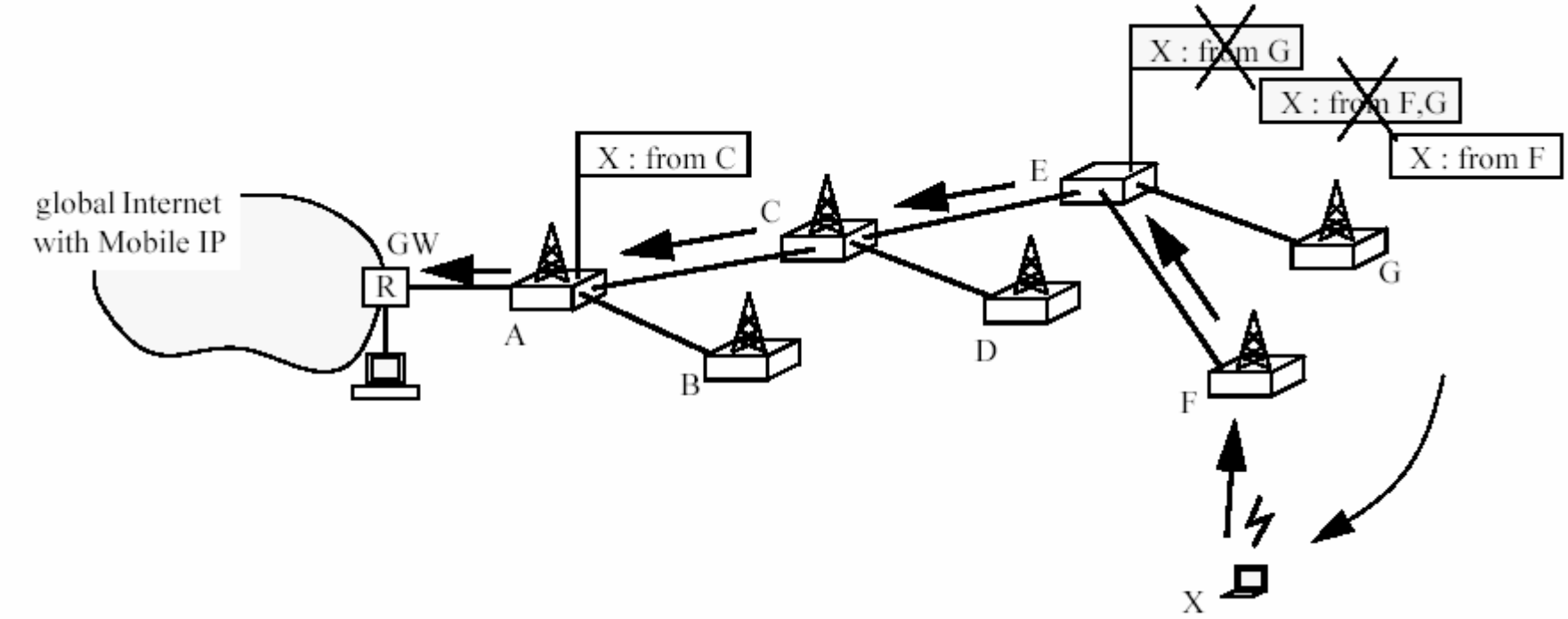


Paging 1/2



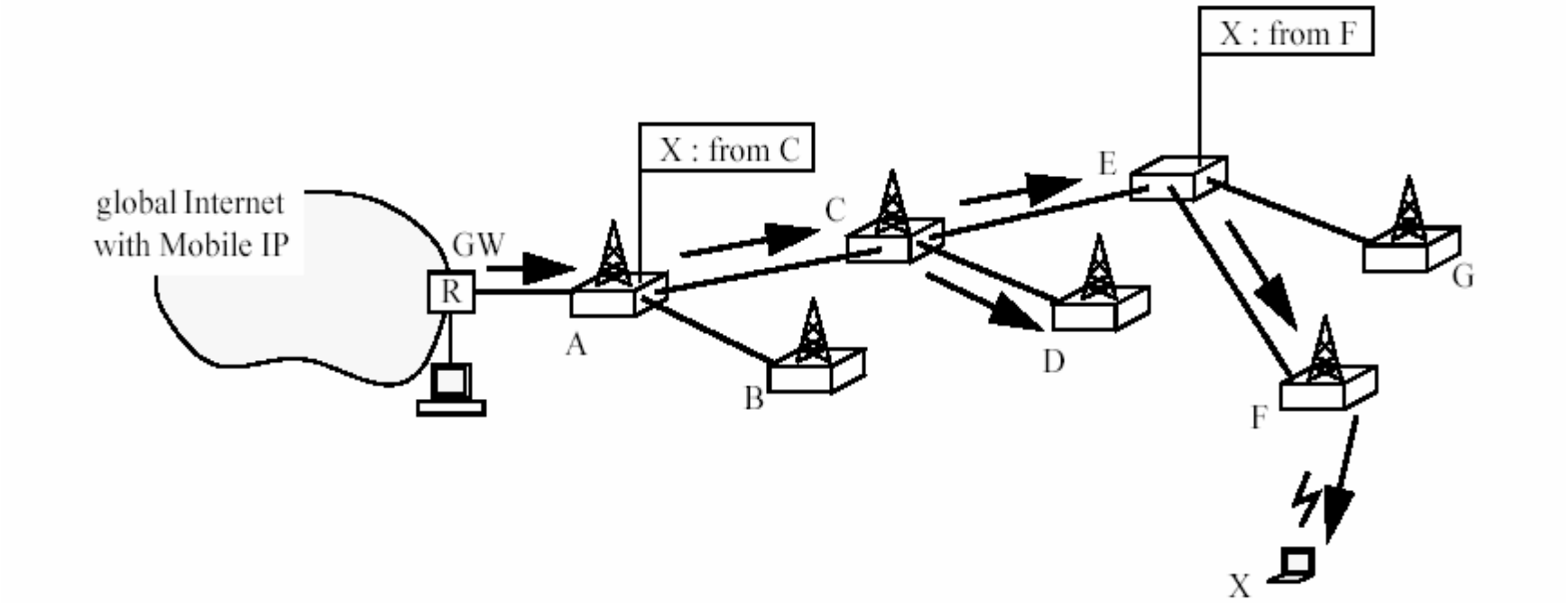
Idle mobile hosts periodically generate *paging-update packets* sending them to the nearest available base station.

Paging 2/2



For a short time two mappings can coexist (at E for example) guaranteeing that the host always remains reachable during migration.

Use of paging caches to locate MH



When IP packets arrive at the GW, addressed to a MH for which no up-to-date routing information is available, the gateway queues the arrived IP packets and generates a *paging packet*

Upon receiving the paging packet, the MH creates a *route-update packet*. Route-update packets travel to the GW routed on a hop-by-hop basis, and create mappings for the MH in Routing Caches on the way.

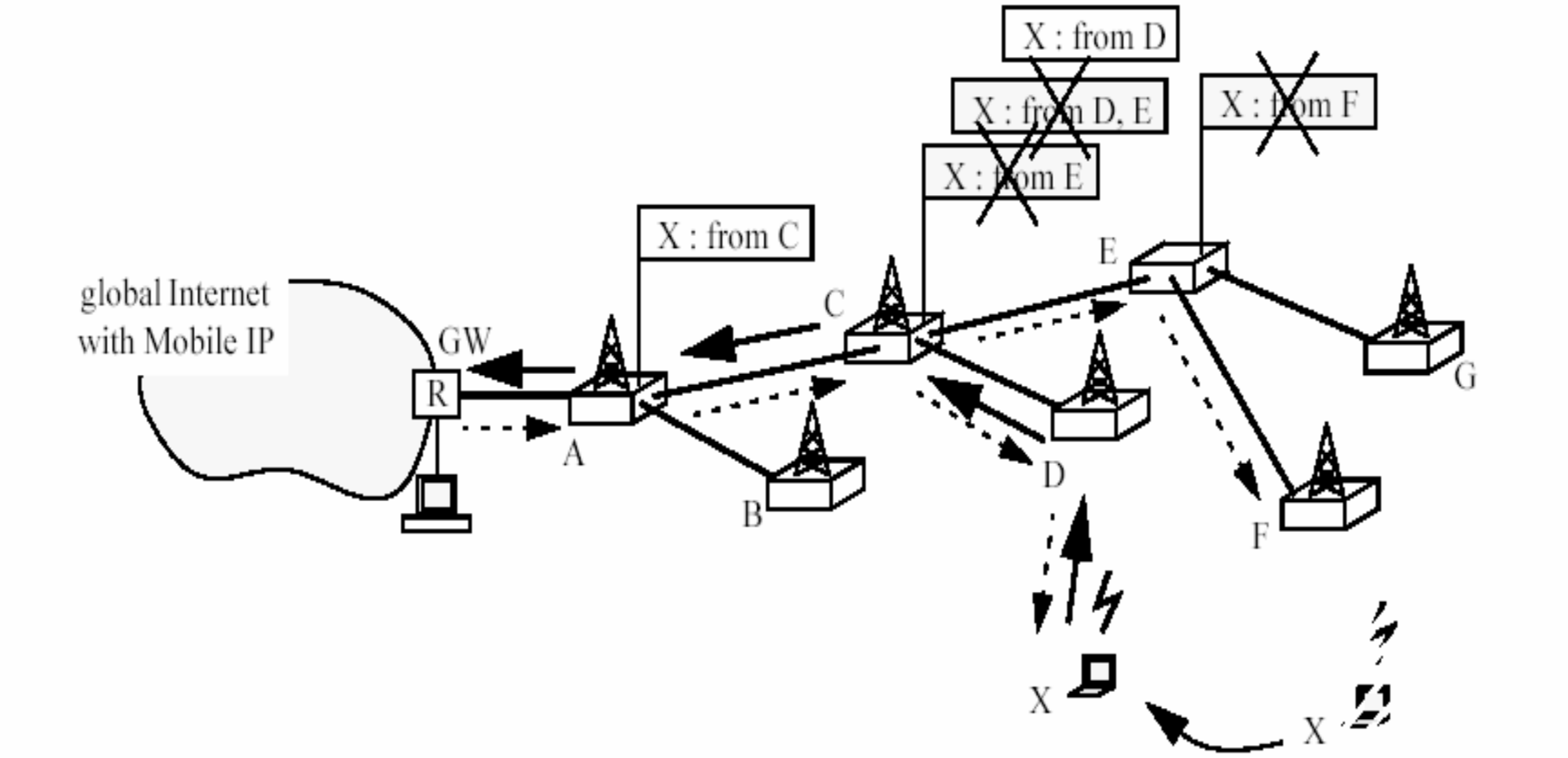
Routing

Table 1: Comparison of Paging and Routing

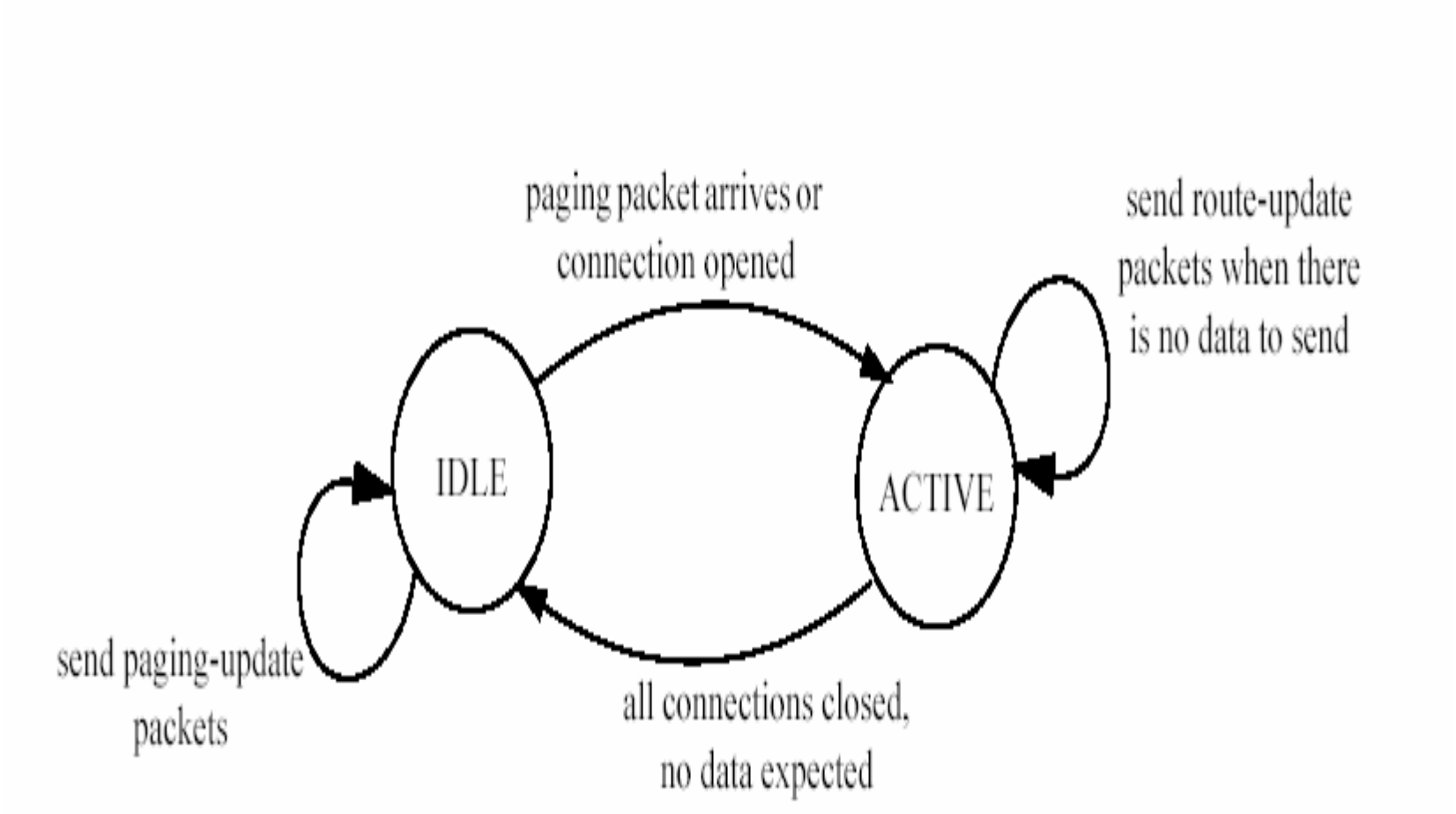
	Paging Cache (PC)	Routing Cache (RC)
driven by	all mobile-originated packets (data, route-update, paging-update)	mobile originated data and route-update packets
scope	both idle and active mobile hosts	active mobile hosts only
purpose	route paging packets	route mobile-addressed data packets
time scale	mobility	packet

The MH may keep receiving data packets without sending data for some time. To keep RCs configured and to avoid repeated paging, MHs expecting data (when, for instance, a TCP connection is open) but having no packets to transmit *must keep* transmitting route-update packets periodically.

Handoff


X : from D
X : from D, E
X : from F
X : from E
X : from C
E
C
global Internet
with Mobile IP
GW
R
A
B
D
F
G
X
X

MH State Diagram



HAWAII

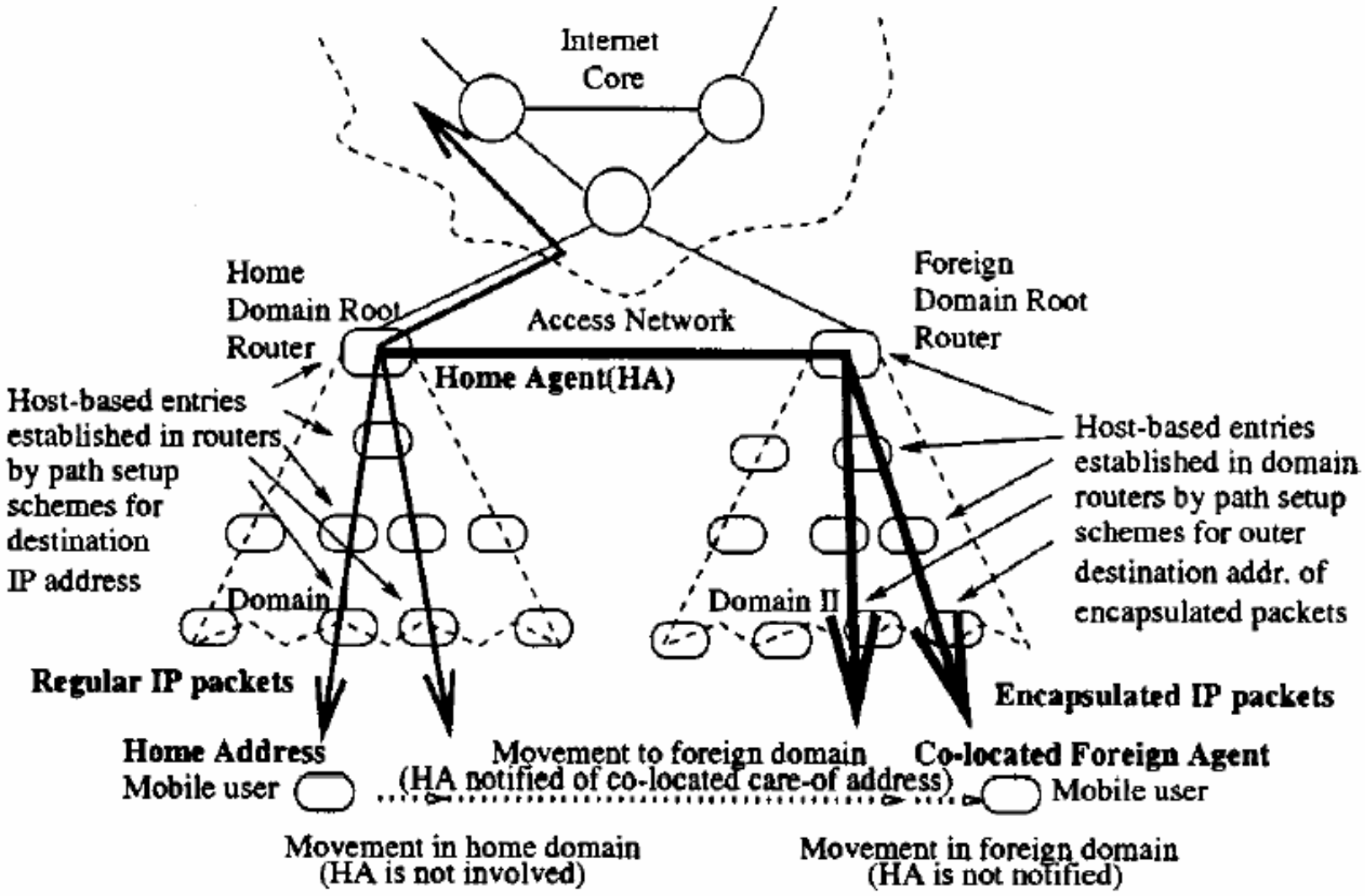
•Uses specialized path setup schemes which install host-based forwarding entries in **specific routers** to handle intra-domain micro-mobility

•defaults to using mobile IP for inter-domain macro-mobility

•requires that MH obtains a **co-located care of address** within a domain, nevertheless *MH is required to register with a BS* within the domain to be able to better handle handoffs

•MH sends **path setup update** messages during power up and after handoffs

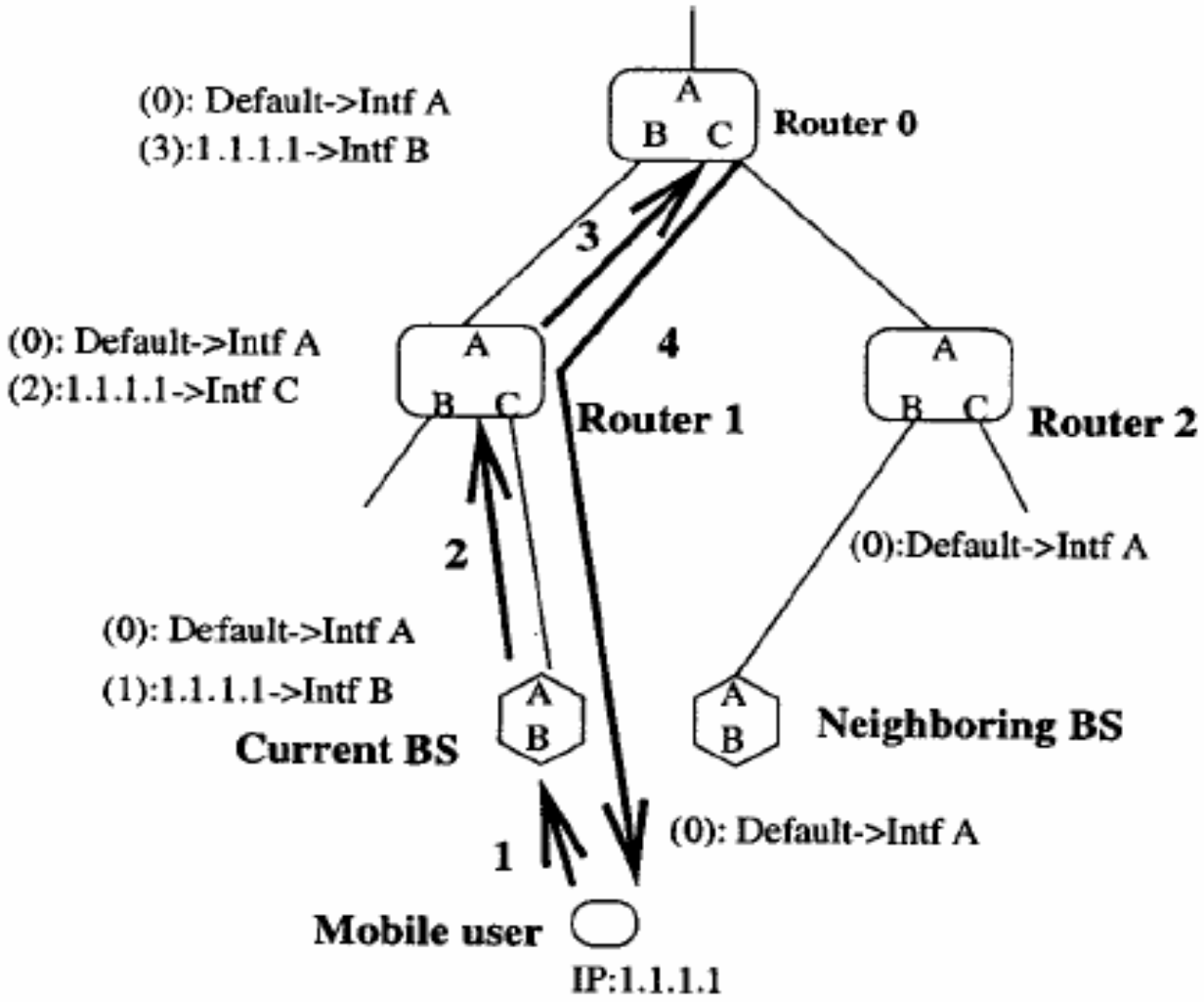
Network Architecture 1/2



Network Architecture 2/2

- Packets destined to MH reach home domain root router, and are forwarded to MH based on specially established dynamic paths
- When first entering foreign domain, MH assigned a co-located care-of address (DHCP for example) and register according to Mobile IP protocol
- Packets intercepted by HA, tunneled to foreign domain root router and forwarded to MH based on specially established paths
- *Message types*
  - Power up (establish host-specific routes)
  - Update (establish and update host-specific routes)
  - Refresh (path state is soft-state, MH sends periodic messages to BS to maintain host-based entries, BS and intermediate routers send aggregate hop-by-hop refresh messages towards domain root router)

Path Setup Message after Power up

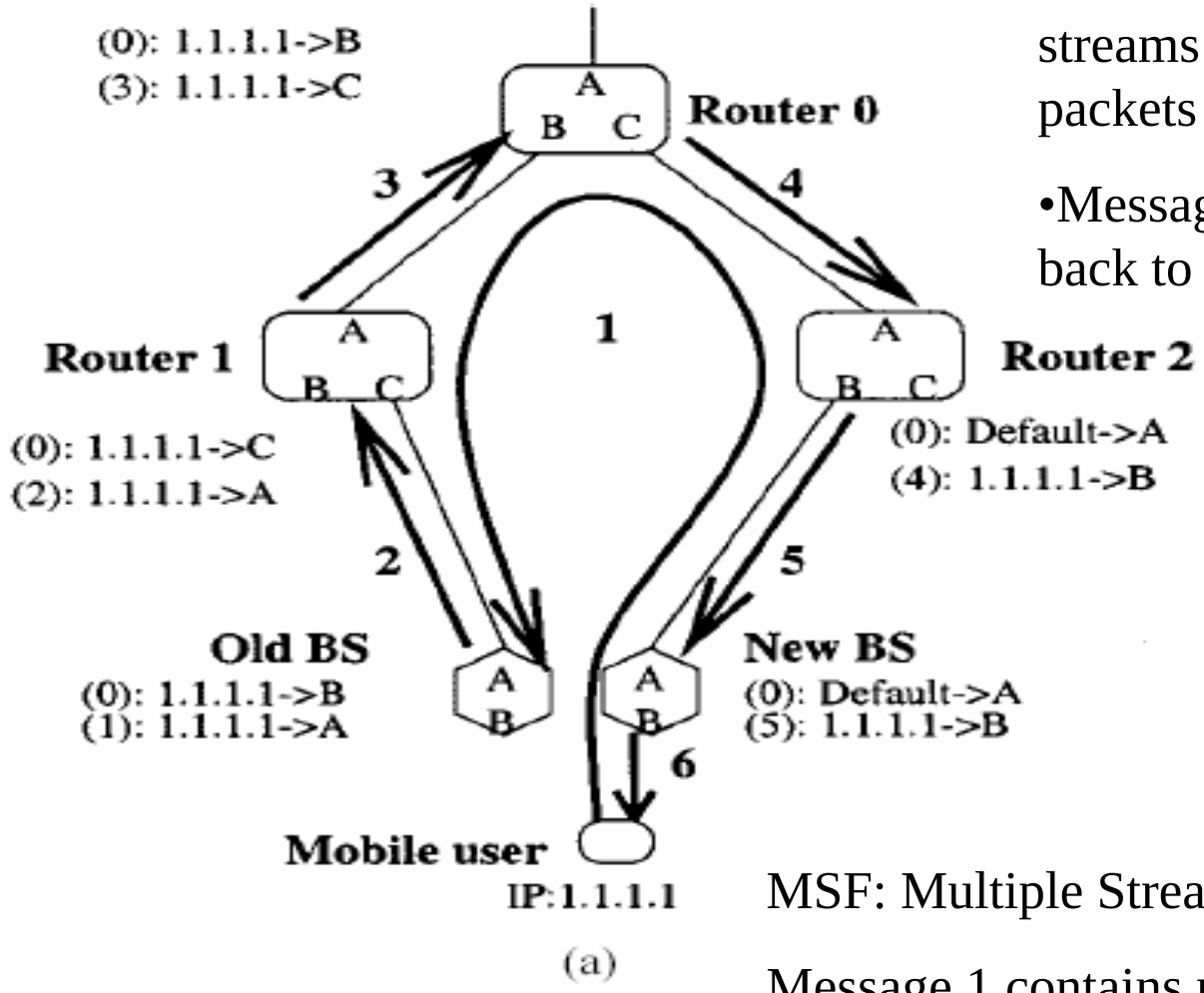


- Other routers in the domain that do not maintain host-based entries?
- When receive packets for MH, forward on default route to domain root router
- If in foreign domain, MH performs Mobile IP registration with HA

Path Setup Schemes

- Forwarding
  - ➢Packets forwarded from old BS to new BS before being diverted at crossover router
  - ➢Rely on wired network to buffer packets and deliver to new BS
- Non-forwarding
  - ➢Packets diverted at crossover router resulting in no forwarding of packets at new BS
  - ➢Takes advantage of some wireless links capabilities where connectivity can be maintained between MH and old BS and new BS during a handoff

Forwarding Path Setup Schemes: MSF



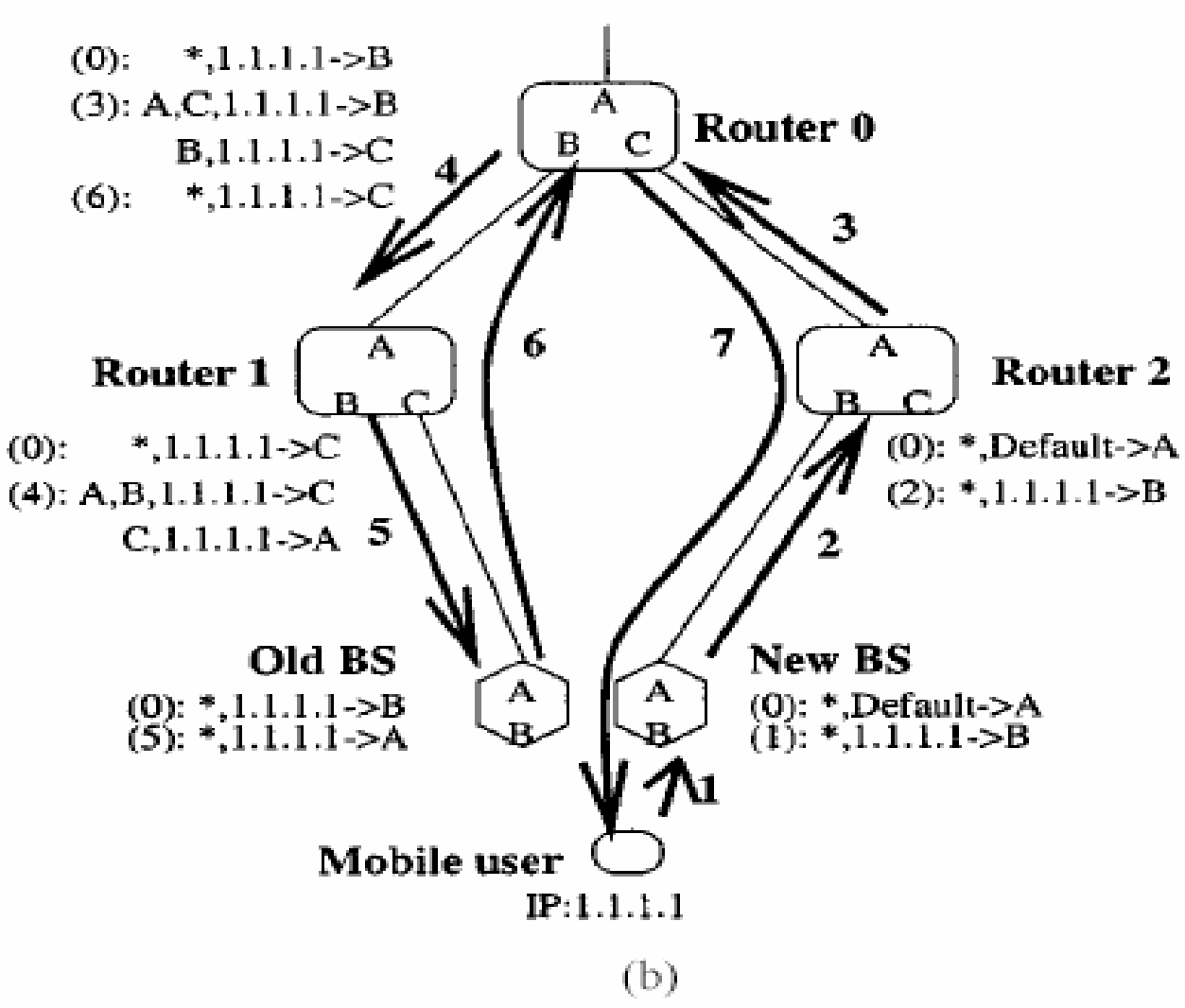
(a)

- Can create multiple streams of misordered packets at MH
- Message 6 is the ACK back to the MH

MSF: Multiple Stream Forwarding

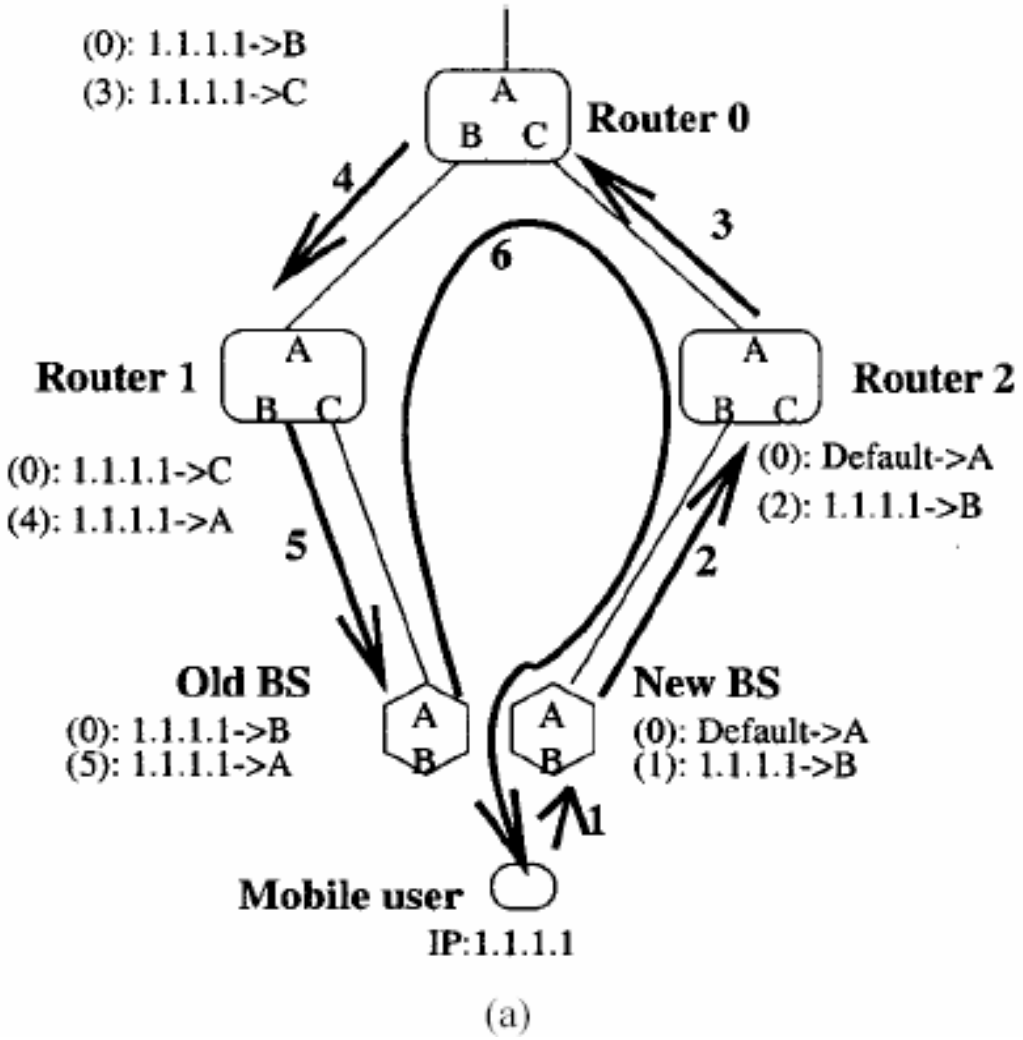
Message 1 contains new BS's address

Forwarding Path Setup Schemes: SSF



- SSF: Single Stream Forwarding
- Similar to Mobile IP RO, but does not require tunneling
- Uses interface-based forwarding (extends routing table entry)
- Route packets based on incoming interface of the packet and MH IP address
- Message 7 is the ACK back to MH

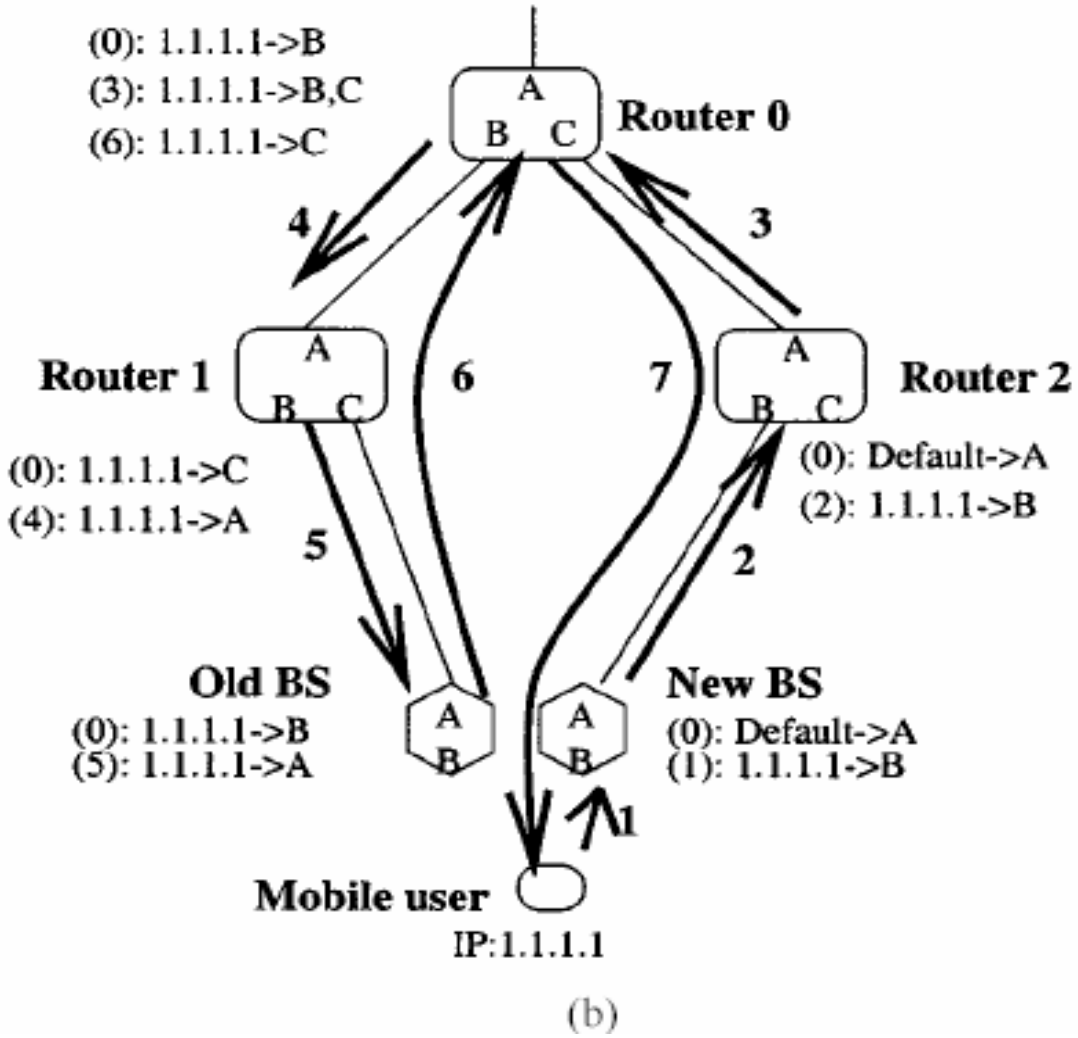
Non Forwarding Path Setup Schemes: UNF



(a)

- *Unicast non-forwarding*
- MH is able to listen/transmit to two or more BSs for a short duration (CDMA)
- As a result from Message 1, new BS, looks up the interface towards old BS
- Message 6 is ACK to the MH

Non Forwarding Path Setup Schemes: MNF



- *Multicast non-forwarding*
- MH is able to listen/transmit to only one BS (TDMA)
- Router 0 bi-casts data packets on interfaces B and C for a short duration until message 6 is received
- Message 7 is ACK to MH