

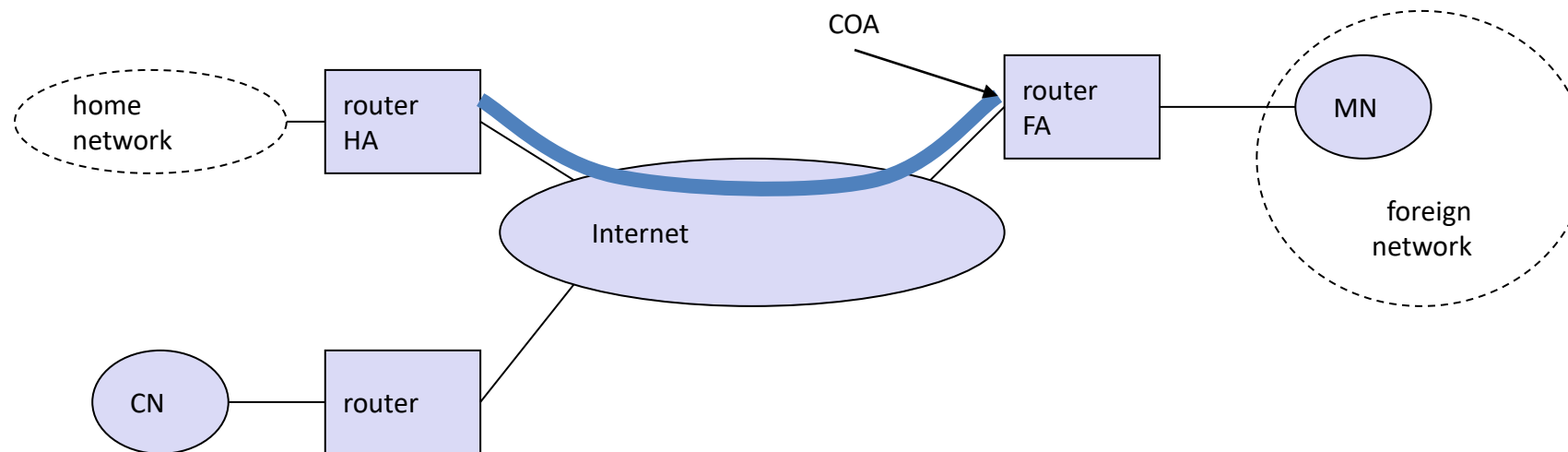
# MOBILE IP

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# LEARNING OBJECTIVES

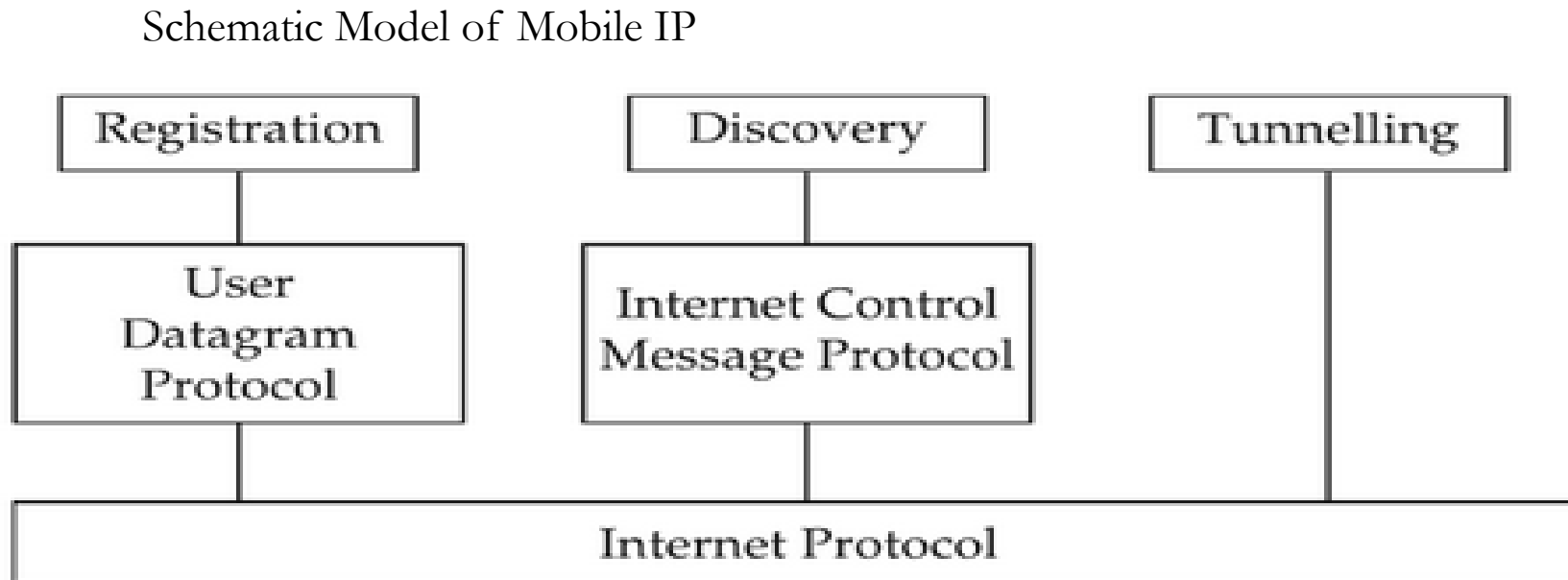
- To understand the basic concepts of Mobile IP, Registration

# SCENARIO



# KEY MECHANISM USED IN MOBILE IP

- 3 Basic Mechanism
  - Discovering the COA (Agent Discovery)
  - Registering the COA (Registration)
  - Tunneling to the COA (Tunneling)



# DISCOVERING THE COA

- Each MN uses a discovery protocol to identify the respective home and foreign agent.
- Discovery of COA consists of following steps:
  1. Mobile Agent periodically broadcast “Agent Advertisement” msg
  2. On receiving “Agent Advertisement” msg, the MN can determine if it is in home network or foreign network.
  3. If the MN does not wish to wait, it transmits “Agent Solicitation” msg. A mobile agent will respond for this.

# AGENT DISCOVERY

- How to find a foreign agent is the major problem.
- How does the MN discover that it has moved?
- 2 methods:
  - Agent advertisement
  - Agent solicitation

# AGENT ADVERTISEMENT

- Home Agents and Foreign Agents periodically send **advertisement messages** into their physical subnets
- Advertisement is similar to Beacon Broadcast
- MN listens to these messages and detects, if it is in the home or a foreign network (standard case for home network)
- MN reads a COA from the FA advertisement messages

# AGENT ADVERTISEMENT

RFC 1256 +mobility extension

(upper ICMP, lower mobility)

Type=9

Code 0 (normal) or 16 (only mobile)

type = 16

length = 6 + 4 \* #COAs

(6 = the number of bytes in the seq. no.,

Lifetime, Flags, and Reserved +

another 4 bytes per each COA)

R: registration required

B: busy, no more registrations

H: home agent

F: foreign agent

M: minimal encapsulation

G: Generic Routing Encapsulation

r: =0, ignored (former Van Jacobson compression)

T: FA supports reverse tunneling

reserved: =0, ignored

0	7	8	15	16	23	24	31					
type		code		checksum								
#addresses		addr. size		lifetime								
router address 1												
preference level 1												
router address 2												
preference level 2												
...												
type = 16		length		sequence number								
registration lifetime				R	B	H	F	M	G	r	T	reserved
COA 1												
COA 2												

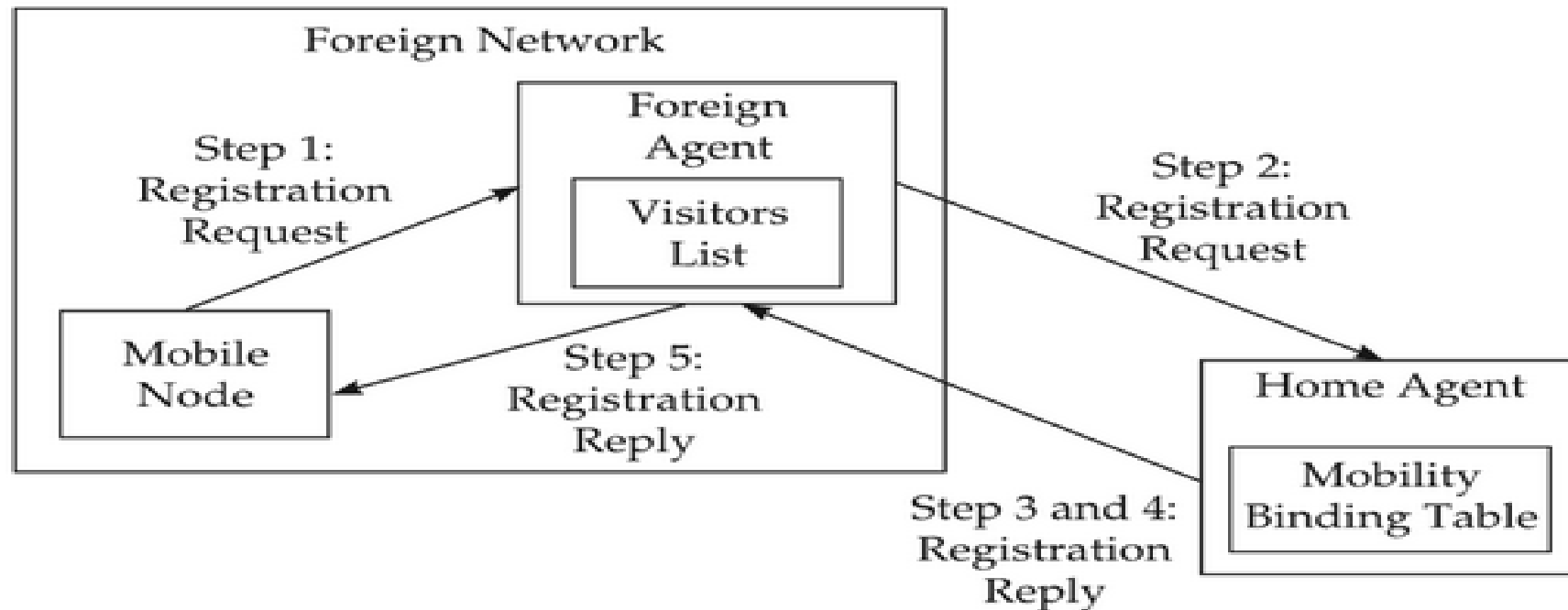


# AGENT SOLICITATION

- The mobile node must send **agent solicitations** when it enters a foreign network.
- When a mobile node enters into a new network it can send out three solicitations, one per second
- If a MN does not get a new address, many packets will be lost
- If a MN does not receive an answer to its solicitations it must decrease the rate of solicitations exponentially to avoid flooding the network
- When the MN discovers a new agent it stops sending agent solicitation.
- A MN understands its FA by receiving an advertisement

# REGISTERING THE COA

- MN Home network → No mobility services
- MN Foreign Network → Has COA
- Register the COA with HA.



# REGISTERING THE COA

- Step 1: Registration Request (MN  $\rightarrow$  FA)
  - Registration request msg includes MN's IP Address (permanent), IP address of HA
- Step 2: Registration Request (FA  $\rightarrow$  HA)
  - Registration request msg includes MN's IP Address (permanent), IP address of FA
- Step 3: Updation of mobility binding table (HA)
  - Bind COA of MN with HA
- Step 4: Registration Reply (HA  $\rightarrow$  FA)
  - Ack to FA
- Step 5: Registration Reply
  - Updates visitors list
  - Ack to MN

# TABLES MAINTAINED ON ROUTERS

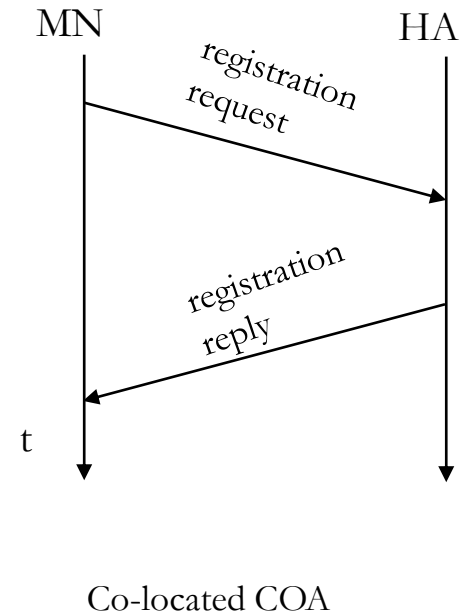
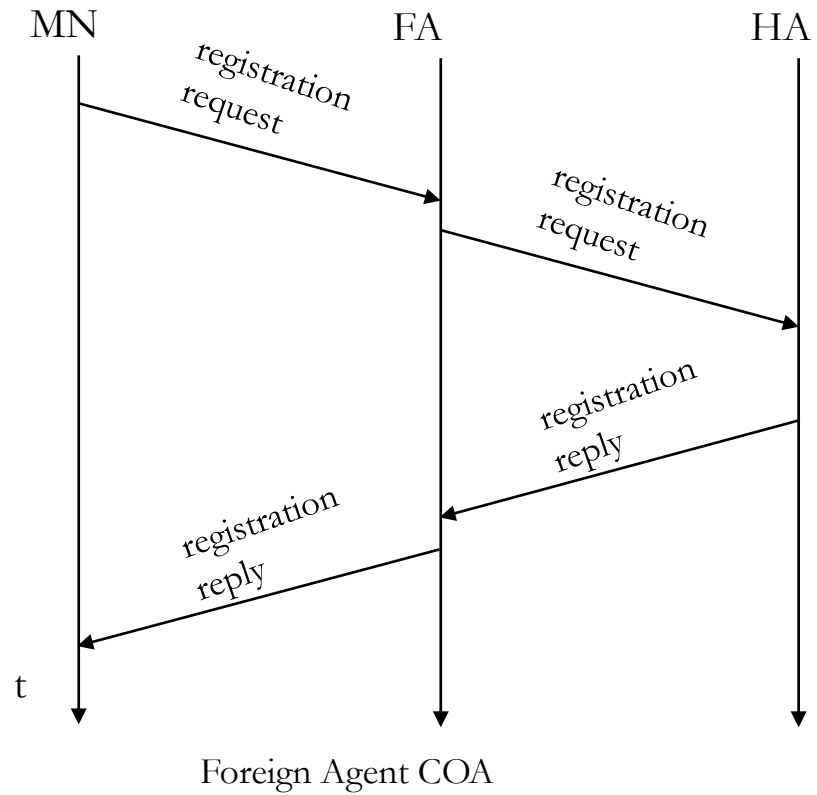
- Mobility Binding Table

Home Address	Care-of Address	Lifetime (in sec)
131.193.171.4	128.172.23.78	200
131.193.171.2	119.123.56.78	150

- Visitor List

Home Address	Home Agent Address	Media Address	Lifetime (in s)
131.193.44.14	131.193.44.7	00-60-08-95-66-E1	150
131.193.33.19	131.193.33.1	00-60-08-68-A2-56	200

# REGISTERING THE COA



# REGISTRATION REQUEST

0	7	8	15						16	23	24	31
type = 1		S	B	D	M	G	r	T	x	lifetime		
home address												
home agent												
COA												
identification												
extensions ...												

S: simultaneous bindings (If MN wants HA to retain prior mobility bindings)

B: broadcast datagrams (MN receives broadcast msgs which are broadcasted in Home network)

D: decapsulation by MN (Colocated COA → Decapsulation at MN)

M: minimal encapsulation

G: GR Encapsulation

r: =0, ignored

T: reverse tunneling requested

x: =0, ignored

Identification : 64 bit id generated by MN to identify a request and match it with registration replies.

# REGISTRATION REPLY

0	7	8	15	16	31
type = 3		code		lifetime	
home address					
home agent					
identification					
extensions . . .					

## Example codes:

registration successful

0 registration accepted

1 registration accepted, but simultaneous mobility bindings unsupported

registration denied by FA

65 administratively prohibited

66 insufficient resources

67 mobile node failed authentication

68 home agent failed authentication

69 requested Lifetime too long

registration denied by HA

129 administratively prohibited

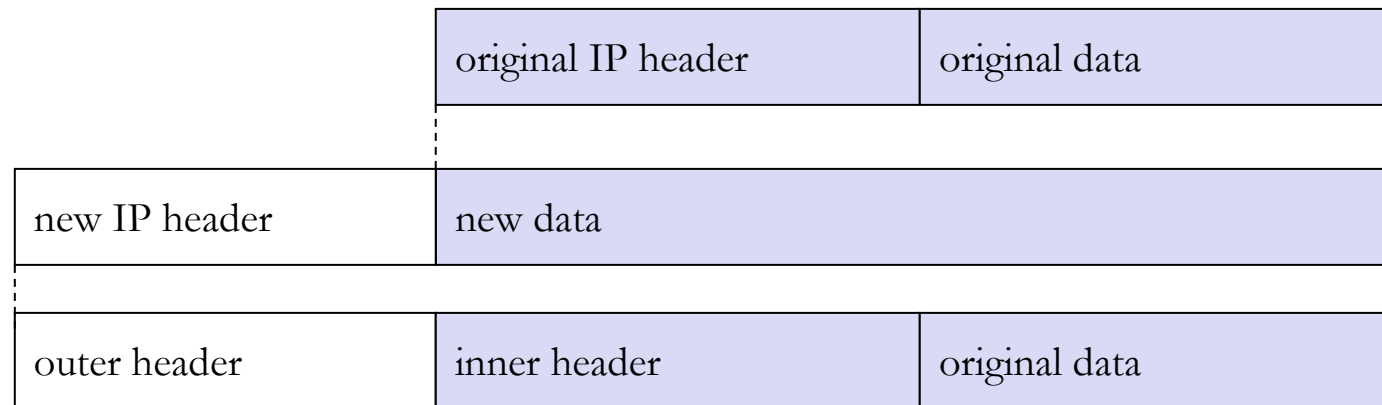
131 mobile node failed authentication

133 registration Identification mismatch

135 too many simultaneous mobility bindings

# TUNNELING TO THE COA

- Tunnel establishes a virtual pipe for data packets between a tunnel entry and a tunnel end point.
- Tunneling → sending a pkt through a tunnel is achieved by encapsulation
- Encapsulation → Taking a pkt (data + header), putting it into the data part of a new pkt.
- Decapsulation





# ENCAPSULATION

- e.g. IPv6 in IPv4 (6Bone), Multicast in Unicast (Mbone)
- here: e.g. IP-in-IP-encapsulation, minimal encapsulation or GRE (Generic Record Encapsulation)
- IP-in-IP
  - Tunnel between HA and COA

ver.	IHL	DS (TOS)	length	
IP identification			flags	fragment offset
TTL		<i>IP-in-IP (4)</i>	IP checksum	
IP address of HA				
Care-of address COA				
ver.	IHL	DS (TOS)	length	
IP identification			flags	fragment offset
TTL		lay. 4 prot.	IP checksum	
IP address of CN				
IP address of MN				
TCP/UDP/ ... payload				

# ENCAPSULATION

- Minimal encapsulation (optional)
  - avoids repetition of identical fields
  - e.g. TTL, IHL, version, DS (RFC 2474, old: TOS)
  - only applicable for non fragmented packets, no space left for fragment identification

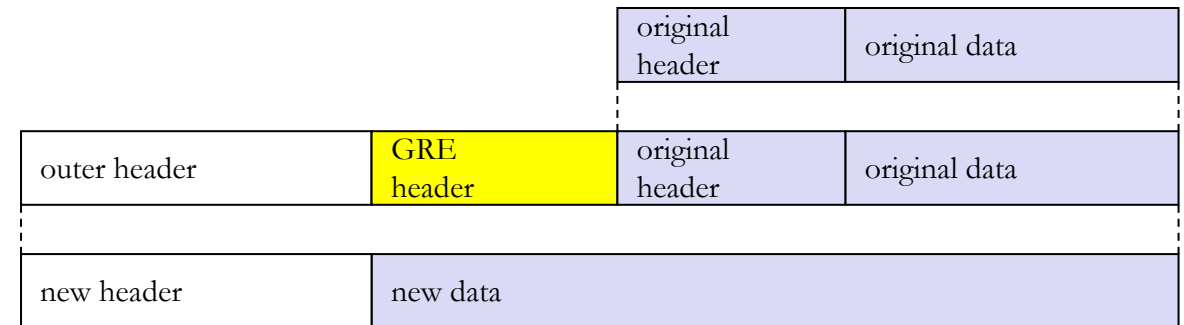
ver.	IHL	DS (TOS)		length	
IP identification				flags	fragment offset
TTL		<i>min. encap (55)</i>		IP checksum	
IP address of HA					
care-of address COA					
lay. 4 protoc.		S	reserved	IP checksum	
IP address of MN					
original sender IP address (if S=1)					
TCP/UDP/ ... payload					

# ENCAPSULATION

- Generic Routing Encapsulation

RFC 1701

ver.		IHL		DS (TOS)		length			
IP identification				flags		fragment offset			
TTL		GRE(47)				IP checksum			
IP address of HA									
Care-of address COA									
C	R	K	S	s	rec.	rsv.	ver.	protocol	
checksum (optional)							offset (optional)		
key (optional)									
sequence number (optional)									
routing (optional)									
ver.		IHL		DS (TOS)		length			
IP identification				flags		fragment offset			
TTL		lay. 4 prot.				IP checksum			
IP address of CN									
IP address of MN									
TCP/UDP/ ... payload									



RFC 2784 (updated by 2890)

C	reserved0	ver.	protocol
checksum (optional)		reserved1 (=0)	

C: Valid checksum

R: Routing fields are present

K: valid key for authentication

S: Sequence number is present

s: strict source routing

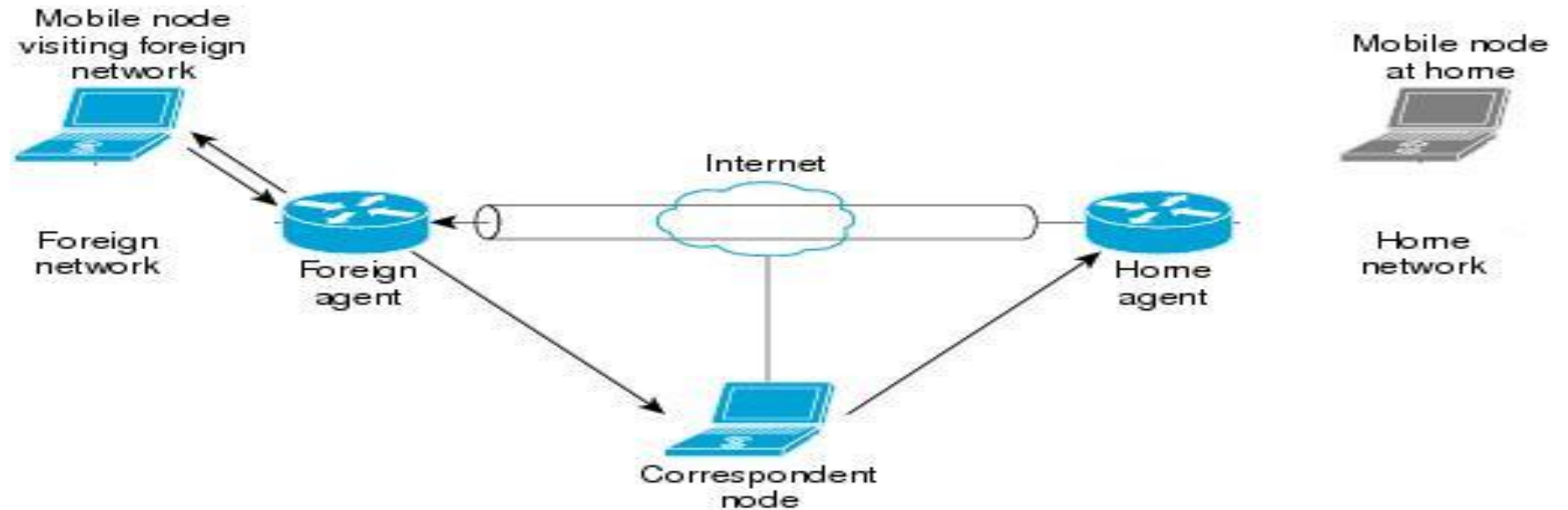
rec: recursion control (no. of recursive encapsulation allowed)

res: 0

ver: 0

# ROUTE OPTIMIZATION

- Triangular Routing (CN – HA, HA – COA/MN, MN – CN)
- 3 steps to optimize the route
  - Direct notification to CN
  - Direct tunnelling between CN and MN
  - Binding cache maintained at CN

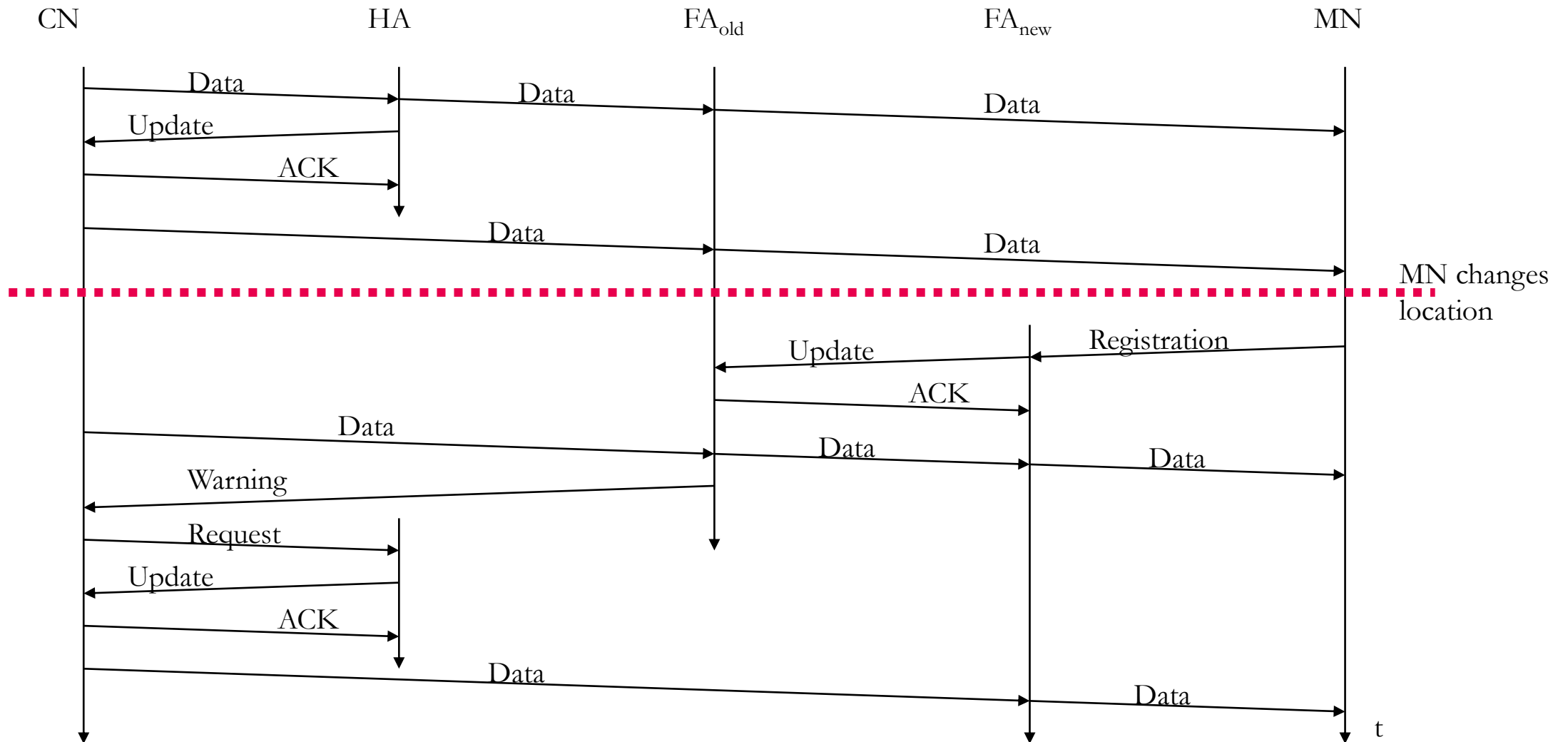


# ROUTE OPTIMIZATION

- Binding → the association of Home address (IP of MN) with COA

<i>Message type</i>	<i>Description</i>
1. Binding request	If a node wants to know the current location of a <b>mobile</b> node (MN), it sends a request to home agent (HA).
2. Binding acknowledgement	On request, the node will return an acknowledgement message after getting the binding update message.
3. Binding update	This is a message sent by HA to CN mentioning the correct location of MN. The message contains the fixed <b>IP</b> address of the <b>mobile</b> node and the care-of-address. The binding update can request for an acknowledgement.
4. Binding warning	If a node decapsulates a packet for a <b>mobile</b> node (MN), but it is not the current foreign agent (FA), then this node sends a binding warning to the home agent (HA) of the <b>mobile</b> node (MN).

# ROUTE OPTIMIZATION



# SUMMARY

- Key mechanisms in Mobile IP
  - Agent Discovery
  - Registration
  - Tunneling and Encapsulation
- Route Optimization
- DHCP
  - Different messages and steps in DHCP

# TEST YOUR KNOWLEDGE

- Which Internet Protocol (IP) number is used by a computer to send a message back to itself?
  - 0.0.0.0
  - 127.0.0.1
  - 255.255.255.255
- Which TCP/IP model layer does DHCP work at?



# REFERENCES

- Jochen H. Schller, “Mobile Communications”, Second Edition, Pearson Education, New Delhi, 2007.
- Prasant Kumar Pattnaik, Rajib Mall, “Fundamentals of Mobile Computing”, PHI Learning Pvt. Ltd, New Delhi – 2012.