Mobile IP Network Layer

Lesson 06

Tunnelling and Encapsulation

Mobile node (MN) foreign agent (FA) at visiting foreign network

- FA has the COA (care-of address) of the MN
- The FA receives the IP packets, that were received at the home agent (HA) through a tunnel from the HA to the FA– from HA IP address to the COA IP address at the FA

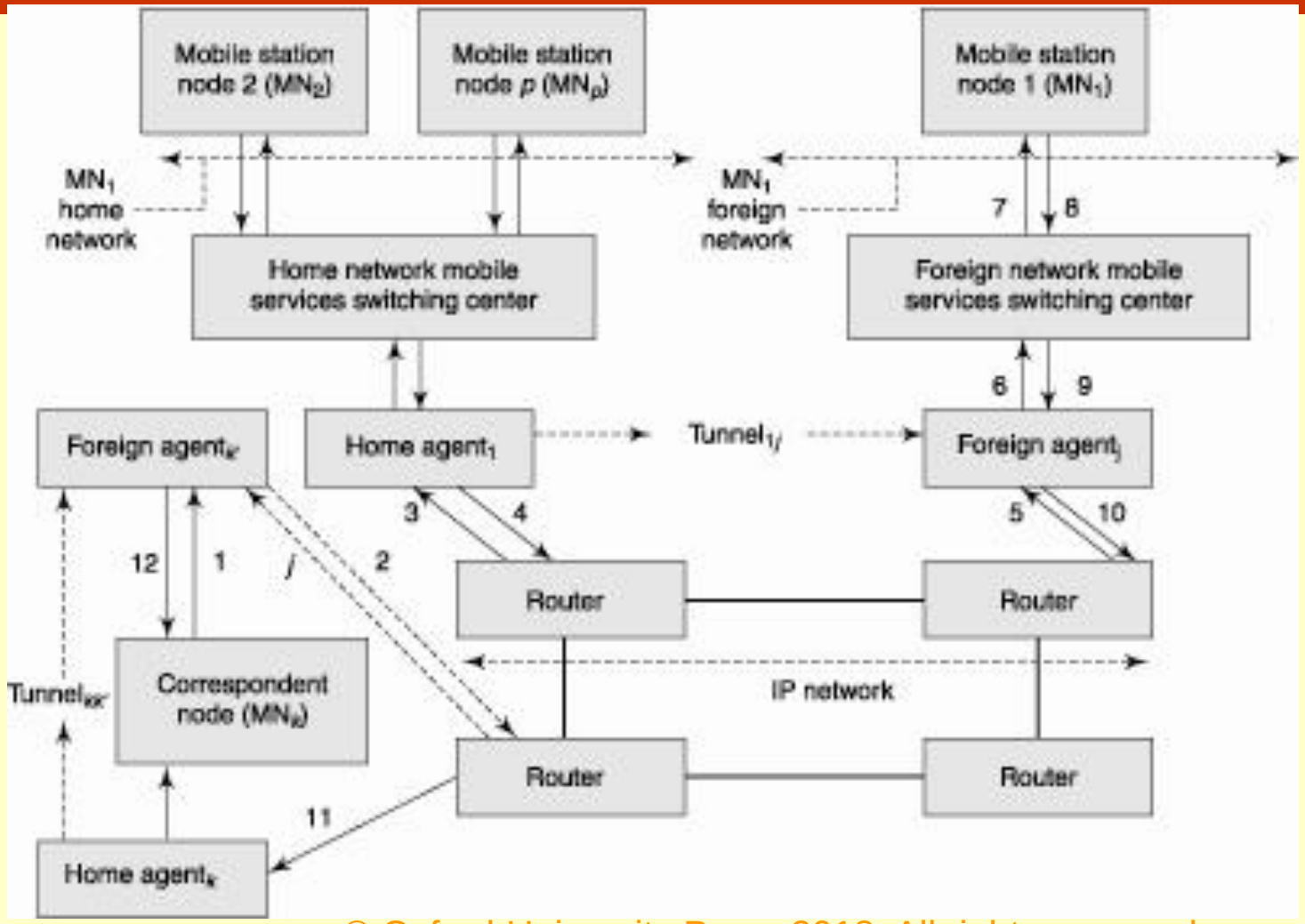
Mobile node (MN) foreign agent (FA) at visiting foreign network

- Packets received at the HA—transmitted through the tunnel after encapsulation

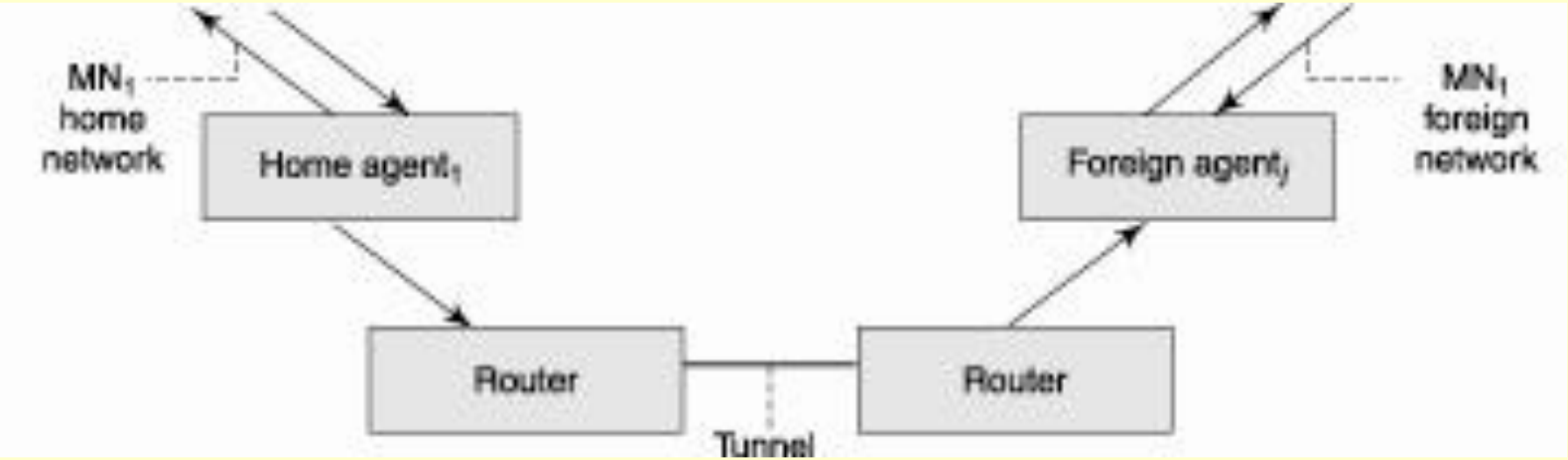
Tunnelling

- Establishing of a pipe
- Pipe– a data stream between two connected ends
- The data stream– inserted from one end
- FIFO (first in first out) words from the other end

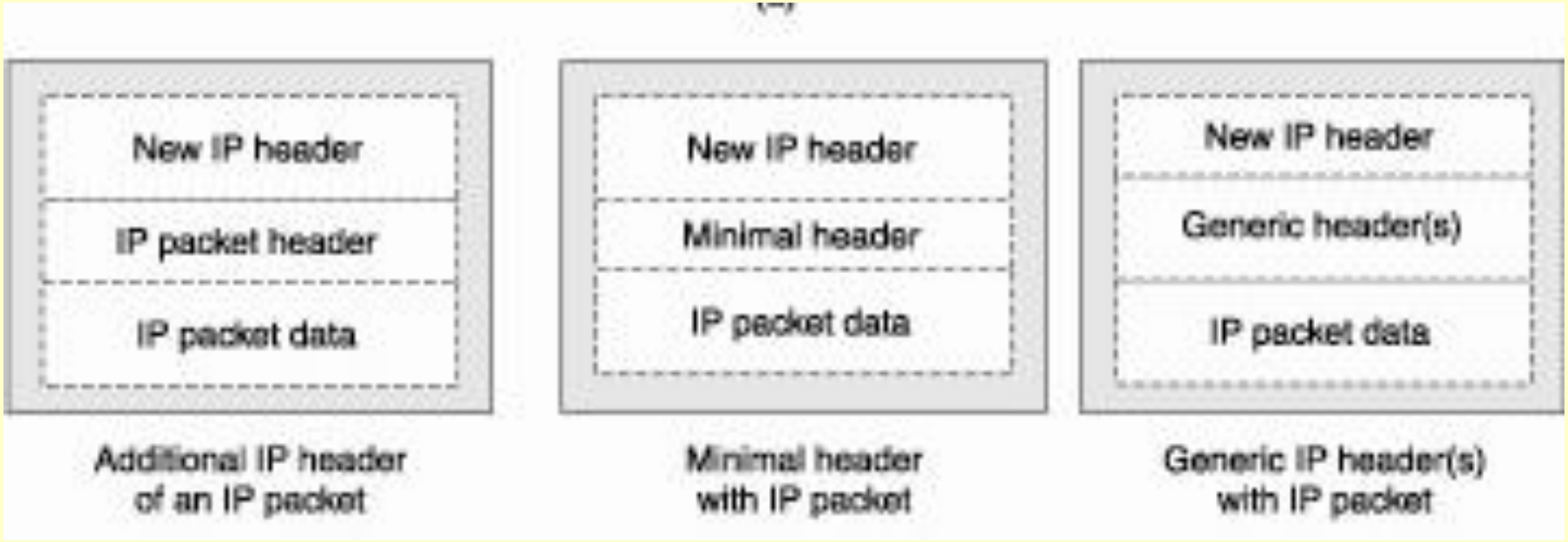
Two tunnels T_{LJ} and $T_{KK'}$



A tunnel between the HA and FA to carry the encapsulated packet



Three ways of encapsulation



IP header-in-IP header Method of encapsulation

- Over the IP packet received at the HA
- Maximum 2^{16}-byte IP packet
- New IP header– the IP address of the HA as the source and the IP address of the FA as the destination

Format of Encapsulated data

- First 32-bit word to specify the IP version (IPv4 or IPv6 for Internet or broadband Internet), length of header (= 5 words), precedence of the packet, and total packet-length (which is now 5 words more than that of IP packet received at the HA)

Format of Encapsulated data

- Second 32-bit word, to specify the ID for the packet, flags, and fragment offset for the same packet ID

Format of Encapsulated data

- Third 32-bit word, to specify the time-to-live (number of attempts to hop before expiry of packets at the network), type of protocol, checksum of the header (for finding transmission errors, if any)

Format of Encapsulated data

- Fourth 32-bit word (four decimal numbers separated by dots and each less than 256) to specify the IP address of the home agent

Format of Encapsulated data

- Fifth 32-bit word (four decimal numbers separated by dots and each less than 256) to specify the IP address of the destination COA (care-of address)

Format of Encapsulated data

- Sixth to tenth words are the IP header of 5 words with the fourth word as the IP address of the correspondent node (CN), and the fifth word as the IP address of the MN

Format of Encapsulated data

- First 32-bit word to specify the IP version (IPv4 or IPv6 for Internet or broadband Internet), length of header (= 5 words), precedence of the packet, and total packet-length (which is now 5 words more than that of IP packet received at the HA)

Format of Encapsulated data

- Second 32-bit word, to specify the ID for the packet, flags, and fragment offset for the same packet ID

IP header-in-IP header encapsulation

7. IP Packet data received from the transport layer at the correspondent node, so that each packet has a maximum of 2^{16} bytes

Redundancy in IP header-in-IP header method

- First words in the new IP header (of five words) and the IP packet header (of five words)
- Same and duplicating in case of IP-in-IP encapsulation

Minimum Encapsulation (ME) method by IP header of an IP Packet

- Combines header of 10 words specified into 7 or 8 words
- The 6th and 7th words in the 6th item of the new IP header are not present in ME as both words are mere repetitions

ME method b IP header to an IP Packet

- The 8th word in the 6th item—changed and now specifies the type of protocol, a one bit flag, seven reserved bits, and a 16-bit checksum of the modified three-word IP header (from the original five) for finding transmission error, if any.

ME method by IP header to an IP Packet

- The 9th word in the 6th item—changed and now specifies (instead of the CN IP address) the MN IP address (which was earlier specified by the 10th word)

ME method by IP header of an IP Packet

- The 10th word in the 6th item—changed and now specifies (instead of the MN IP address) the CN IP address in case the flag bit is set to 1 and the 10th word in the 6th item is removed in case the flag bit is set to 0.

Action by FA in case of ME method

- Reads the first five words in ME
- Transmits the packet to the MN using the COA
- The MN IP address is specified by the 7th or the 8th word, depending upon the flag bit

Deficiencies in the IP header-in-IP header and ME methods

(a) Routing information for tunnelling—not given

(b) No provision for recursive encapsulations

Recursive encapsulations needed when the tunnel transmits multiple pieces of information for the MN and each piece of information encapsulates in one protocol

Deficiencies in the IP header-in-IP header and ME methods

(c) No provision for a key that can be used for authentication or encryption

Generic Routing Encapsulation (GRE) by IP header of an IP Packet

- One or more GRE headers depending on the number of recursions required to send multiple pieces of information

Tunnel characteristics

- The tunnel does not need an extra hop (attempt) so time-to-live can be set to 1

Tunnel characteristics

- Tunnel does not get blocked like routers due to external IP address transmissions
- Has fixed source and destination endpoints

GRE by IP header of an IP Packet

- Same as the 1st to 5th words in the 1st to 5th items of the new IP header
- Time-to-live is however set as 1
- Results in once-only forwarding to the FA by the HA

GRE (GRE) Header(s)

- The 6th 32-bit word in encapsulation and the 1st word of the first GRE header

GRE (GRE) Header(s)

- 16-bit flags– bits to define the number of recursions, reserve bits, and version bits
- Next 16 bits– specify the protocol for encapsulating the information sent with the GRE header

GRE (GRE) Header(s)

- The 7th word– specifies a 16-bit checksum and a 16-bit offset

Both are optional as indicated by the flag bits used to define these options

GRE (GRE) Header(s)

- The 8th word– a 32-bit key
- Optional as indicated by the flag bit to used define the key-option
- The key at the GRE header– enables authentication or encryption at the FA

GRE (GRE) Header(s)

- The 9th word– specifies a 32-bit sequence number information
- Optional as indicated by the flag bit used to define the sequencing-option
- Sequencing at the GRE header enables the FA to rearrange the packets sent by the HA

GRE (GRE) Header(s)

- The 10th word– specifies a 32-bit routing information
- optional as indicated by the flag bit used to define the routing-option
- Routing at the GRE header enables use of routing information at the FA

GRE (GRE) Header(s)

- 11th word onwards– , if number of recursions are defined in the first word of the GRE header, then the next GRE header is inserted before the IP header and IP data sent by the HA

GRE (GRE) Header(s)

- If number of recursions specified in the 11th word in the GRE header is two, then the next two GRE headers are also inserted before the IP header and IP data sent by the HA

IP Header and IP Packet data

- This part remains the same as that in the un-encapsulated IP header and the data received from the CN (correspondent node) IP packet at the HA

IP Header and IP Packet data

- The first word has 5 flag bits and three recursion-number-defining bits
- The five flag bits are—checksum option flag, sequence number field option flag, key-option flag, and source-routing option flag

Source routing

- Source of a packet provides the route information
- Router uses the routing information word for routing a packet

Summary

- Tunnelling by HA to FA
- From HA IP address to new COA address of visiting mobile node
- Encapsulation

Summary

- IP header-in-IP header method of encapsulation
- Minimum encapsulation method
- Generic routing encapsulation method

End of Lesson 06

Tunnelling and Encapsulation