Mobile Transport Layer

Lesson 03

Snooping TCP, Wireless TCP and Delayed DACK Protocol

TCP-aware link layer based methods

- Snoop TCP
- WirelessTCP (WTCP)
- Delayed Duplicate Acknowledgement protocol (Delayed DACK)

Snoop

- Looking into or examining something secretly
- A TCP connection splits into two—between the mobile node (MN) and base transceiver (BTS) and other between the BTS and the fixed node (FN)

Snoop

- Some changes in the BTS and some at the MN
- The BTS has a TCP-aware data-link sub-layer, DL_M
- The sub-layer DL_M — agent for snooping and buffering the TCP connection

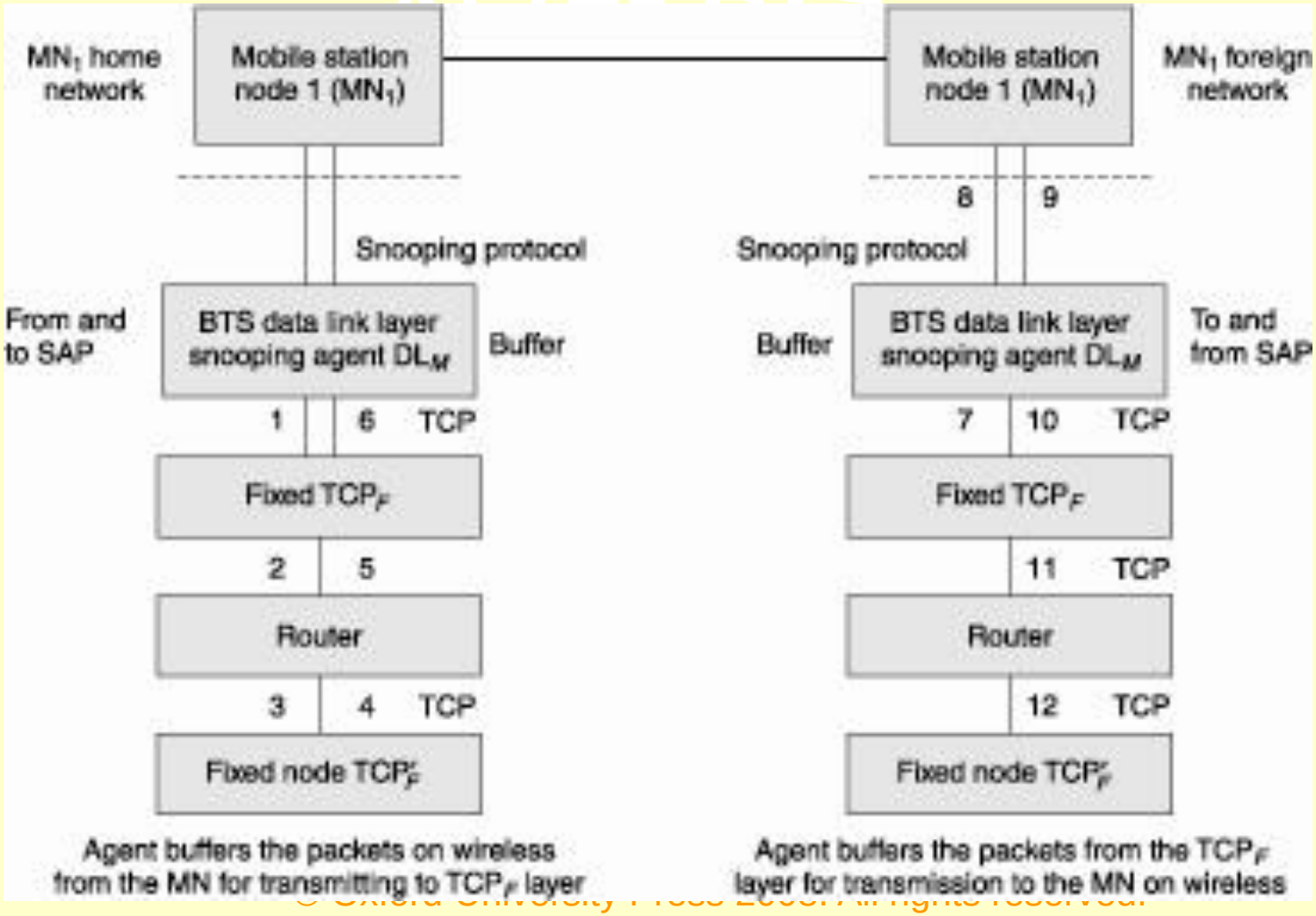
Role of the Agent DL_M

- Ensures the delivery of packets to the MN in their incoming sequence from the fixed network
- Attends to request from the MN for retransmission

Role of the Agent DL_M

- Buffers during snooping packets from the fixed connection TCP_F layer for transmission to the MN on wireless
- Also buffers the packets on wireless from MN for transmitting to TCP_F layer by a fixed line

Snooping at the TCP-aware data-link sub-layer DL_M added at the BTS



Method for acknowledgements to and from the MN

- Acknowledgements at agent detected on timeouts or duplicated acknowledgements detected from the MN

Alternate method for acknowledgement to and from the MN

- Acknowledgements at the MN detected by negative acknowledgement
- A request for retransmission is conveyed to the MN, in case the packets are not received (lost) through the wireless network

The method for acknowledgements to and from the MN

- Using snooping, the agent takes note of the acknowledgements from the MN and requests the MN for retransmission by sending a negative acknowledgement

Snooping TCP functioning

1. Data streams are received from the service access point (application) at the MN and buffered at the agent

   The data streams sent to the service access point (application) at the MN are buffered at the agent and then sent to the MN

Snooping TCP functioning

2. DL_M agent at the BTS also buffers the data and sends and receives the packets to and from the TCP_F layer at the fixed node

Transparent connection between the agent and TCP_F

Snooping TCP functioning

- DL_M layer agent at the BTS sends and receives the packets to and from TCP_F and then from another fixed node TCP'_F by multiple hops through the routers

Snooping TCP functioning

3. DLM agent at the BTS snoops into the packets (data stream) when sending and receiving to and from the MN

Snooping TCP functioning

4. The agent and MN control the acknowledgements, lack of acknowledgements, and DACKs of the received data stream from the MN and to the agent, respectively

Snooping TCP functioning

5. Packet loss discovered at the agent from the timeout or DACKs from the MN

The DL_M retransmits if needed to the MN in case of lost packets that are not acknowledged by the MN in the timeout period or if there are DACKs

Snooping TCP functioning

Packet loss discovered at the MN from the retransmission request from the agent to the MN

The MN retransmits to DL_M in case of lost packets for which a negative acknowledgement is sent by DL_M

Snooping TCP functioning

6. The buffer empties to the fixed network through TCP_F on receipt of an acknowledgement at the agent from the MN

   The buffer empties to the MN on receipt of acknowledgement at the agent from the MN

Snooping TCP functioning

7. The data stream transfer mechanism between the MN and DL_M simple, as in wireless networks

Only one hop. In retransmission from DL_M to MN

The delay is very small, unlike that between the fixed nodes

Handover of the MN while visiting a foreign network

- The packets for transmission now snooped into at DL'_M at the other end
- On handover, neither the socket (port and IP address) nor its present state migrates from DL_M to DL'_M

Advantage of snooping TCP

- Transparent end-to-end TCP connection (without any transport layer changes)
- The mobile part of the network between the base and the mobile node has very limited isolation and is completely isolated from the base and the conventional fixed TCP connection

Advantage of snooping TCP

- No change in the existing TCP network, only a snooping sub-layer is added at the base

Disadvantages of snooping TCP

- Security risk involved in snooping
- Difficulties in case of encrypted segment transmission
- Insufficient isolation between the fixed node transport layer and the snooping layer in case of an asymmetric path

Asymmetric path

- A fixed node connecting to the mobile node at the other end
- The node at the other end does not have a snooping layer for retransmission and acknowledgement

Wireless TCP

- A modification of snooping TCP
- WCTP modifies the time stamp on the packets while returning acknowledgements to compensate for the increased RTT

Advantage of WTCP

- Modifying Timeout periods by enhancing timestamp time compensating for the increased RTT between the agent at the base and the mobile node
- Useful when retransmission intervals are greater than the timeout period

Disadvantage of WTCP

- Can not be used on shared LANs

Delayed DACK protocol for delayed congestion response (TCP-DCR)

- DL_M agent is not TCP aware
- The difference between TCP aware and unaware—Retransmission takes place in TCP-aware DL_M, whenever there is timeout or DACK
- Both of these indicate loss of packets

Delayed DACK protocol for delayed congestion response (DCR)

- When a packet reaches the receiver out of order (TCP connection, for example the TCP layer in the mobile node) sends the DACK
- Further, the window is adjusted to a lower level for each instance of detection of packet loss, whether due to timeout or DACK

TCP UNAWARE DL_M

- Packet losses are due to two reasons, congestion and channel transmission errors
- The channel errors are due to interference in the medium
- Retransmission from the DL_M takes place when there is timeout or acknowledgement from the MN, but the MN delays the DACKs so that the channel can recover from the channel errors

TCP unaware DL_M

- Retransmission from the DL_M takes place when there is timeout or acknowledgement from the MN, but the MN delays the DACKs so that the channel can recover from the channel errors

TCP unaware DL_M

- The MN attempts to reduce interference between data stream bits of the MN and retransmitted bits from DL_M
- Delays the third and subsequent DACKs by a time interval T_{da}

TCP unaware DL_M

- When the first consecutive out of order packets (COP) reach, the MN responds by a DACK
- When further consecutive out of order packets reach, each DACK is delayed by a period = T_{da}

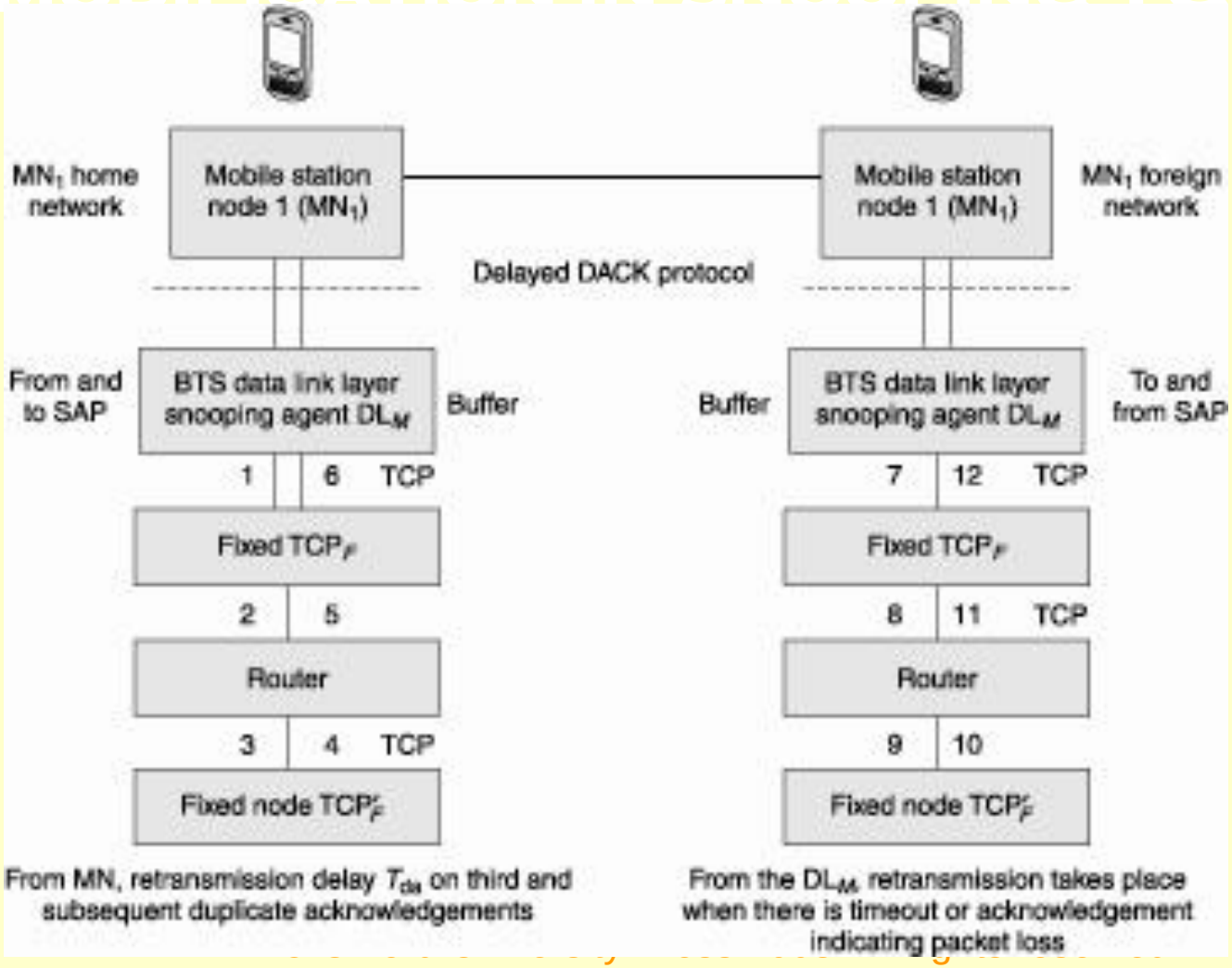
TCP unaware DL_M

- The MN no longer needs to send delayed DACKs if the next packet is in sequence within T_{da}— the channel has recovered from channel errors
- During T_{da}, the DL_M-MN channel recovers from channel errors

TCP UNAWARE DL_M

- The MN may permit out-of-order packet delivery from the agent and it may also look into the TCP header and reassemble the packets itself in order of sequence
- Between DL_M at one end and TCP_F and TCP'_F at the other, the data stream transfers, as in case of conventional fixed-end TCP

Delayed duplicate acknowledgements protocol, a modification in snooping TCP



Advantage of DelayedACK protocol

- TCP headers can be encrypted, as the agent is not TCP aware

Disadvantage of DelayedACK protocol

- Duplicate ACKs are delayed, the retransmission of the packets lost due to congestion also delayed

Summary

- TCP-aware data-link sub-layer, DL_M in TCP snooping
- Agent snooping and buffering the TCP connection
- Agent ensures the delivery of packets to the MN in their incoming sequence from the fixed network
- Attends to request from the MN for retransmission …

… Summary

- Wireless TCP modifies timestamp on packet for return ACK to compensate for increased RTT— retransmission delayed to enable recovery of lossed packet
- TCP unaware agent Delayed ACKs— retransmission delayed for a timeout to enable recovery of lossed packet

End of Lesson 03

Snooping TCP, Wireless TCP and Delayed DACK Protocol