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1) TCP Basics

TCP Basics

- (TCP)
  - → Byte stream Delivery
  - → Connection oriented
  - → Full duplex
  - → Reliability
    - → Checksums
    - → Duplicate data detection
    - → Retransmissions
    - → Sequencing
    - → Timers

① Byte stream delivery :

- When an application sends data to TCP, it does so in 8-bit byte streams.

② Connection Oriented :

- Before two communicating TCP entities can (The sender & receiver) can exchange data, they must first agree upon the willingness to communicate.

③ Full-Duplex :

- No matter what a particular application may be, TCP almost always operates in full duplex mode.

④ Reliability :

- A number of mechanisms help providing the reliability TCP gaarantees.

- i) Checksums :

All TCP segments carry a checksum, which is used by the receiver to detect errors with either the TCP header or data.

iii) Duplicate data detection:

TCP keeps track of bytes received in order to discard duplicate copies of data that has already been received.

iii) Retransmissions:

In order to guarantee delivery of data, TCP must implement retransmission schemes for data that may be lost or damaged.

iv) Sequencing:

TCP's job to properly sequence segments it receives

v) Timer:

TCP maintains various static & dynamic timers on data sent.

2) TCP header format

Bit → 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Source Port								Destination Port
Sequence Number								
Acknowledgement Number								
HLEN	Reserved	URG	ACK	PSH	RST	SYN	FIN	Window
Checksum								Urgent Pointer
options (if (any)								Padding
Data								
. . . . .								

figure) TCP header format.

- **Source Port** : The sending devices port.
- **Destination Port** : The receiving devices port.
- **Sequence Number** : [A device initiating TCP connection must choose a random initial sequence number], which is then incremented according to the number of transmitted bytes.

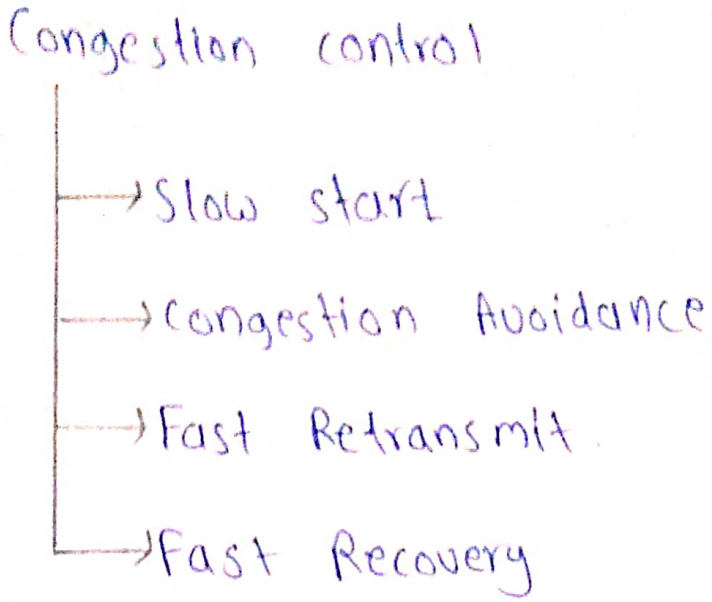
- **Acknowledgement number** : The receiving device maintains an acknowledgement number starting with zero.
- **Header length** : 4 bit field that specifies the total TCP header length in 32 bit words
- **Reserved** : 6 bit field, reserved for future use.
- **Control Bits** :
  - Urgent Pointer (URG)
  - Acknowledgement (ACK)
  - Push function (PSH)
  - Reset connection (RST)
  - Synchronize (SYN)
  - No more data from sender (FIN)
- **Window** : Used by TCP for flow control.
- **Checksum** : determine the integrity of the data transmitted over a network.
- **Urgent pointer** : It tells the receiver when the last byte of urgent dat in the segment ends

- Options :
  - Maximum segment size
  - Window scaling
  - Timestamps

- Padding : Used to ensure that the TCP header ends & data begins on a 32 bit boundary.

- Data :
  holds information about the connection & the current data being sent.

3) Congestion control



① Slow start :

- Slow start, a requirement for TCP software implementation, is a mechanism used by the sender to control the transmission rate.
- Whenever a TCP connection starts, the slow start algorithm at the sender initializes a congestion window to one segment. As the connection is carried out & acknowledgements are returned by the receiver, the congestion window increases

by one segment for each acknowledgement returned.

- Slow start, is a part of the congestion control strategy used by TCP in conjunction with other algorithms to avoid sending more data than the network is capable of forwarding that is to avoid causing network congestion.

② Congestion Avoidance :

- TCP uses a congestion window in the sender side to do congestion avoidance.
- During slow start that the network is forced to drop one or more packets due to overload or congestion. If this happens congestion Avoidance is used to reduce the transmission rate.

- In the congestion Avoidance algorithm, the expiration of a timer called Re-transmission time out (RTO).

- As data is received during congestion Avoidance the congestion window is increased.

③ Fast Retransmit :

- When a duplicate ACK is received the sender does not know if this is because of a TCP segment was lost or simply because a segment was delayed & received out of order at the receiver

- Typically, no more than one or two duplicate ACKs should be received when a simple out of order condition takes place.

- However more than two duplicates ACKs are received by the sender, it is a strong indication that atleast one segment has been lost.
- Thus, whenever three or more duplicate ACKs are received, the sender does not even wait for the RTO to expire & retransmits the segments.
- This process is called the Fast Retransmit algorithm.

④ Fast Recovery :

- Using fast Retransmit, the congestion window is dropped down to 1 each time network congestion is detected.

4) Effects of Partitions on TCP

A network partition occurs when a given mobile node moves away or is interrupted by the medium, thereby splitting its adjacent nodes into two isolated parts of the network that are called partitions.

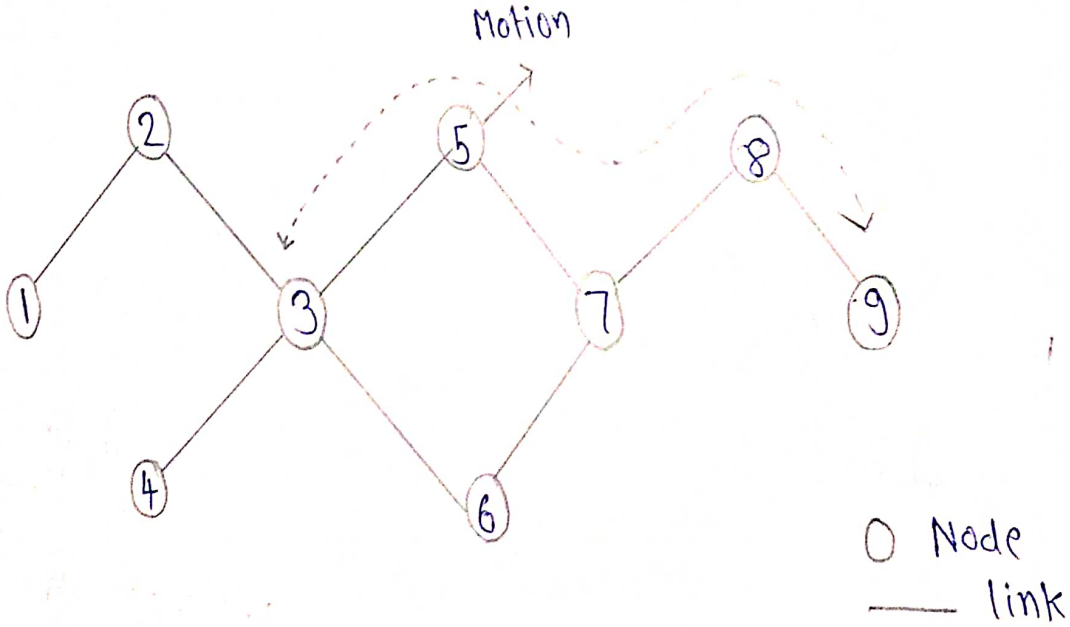


figure a) Node 5 moves away from Node 3.

(short term partition)

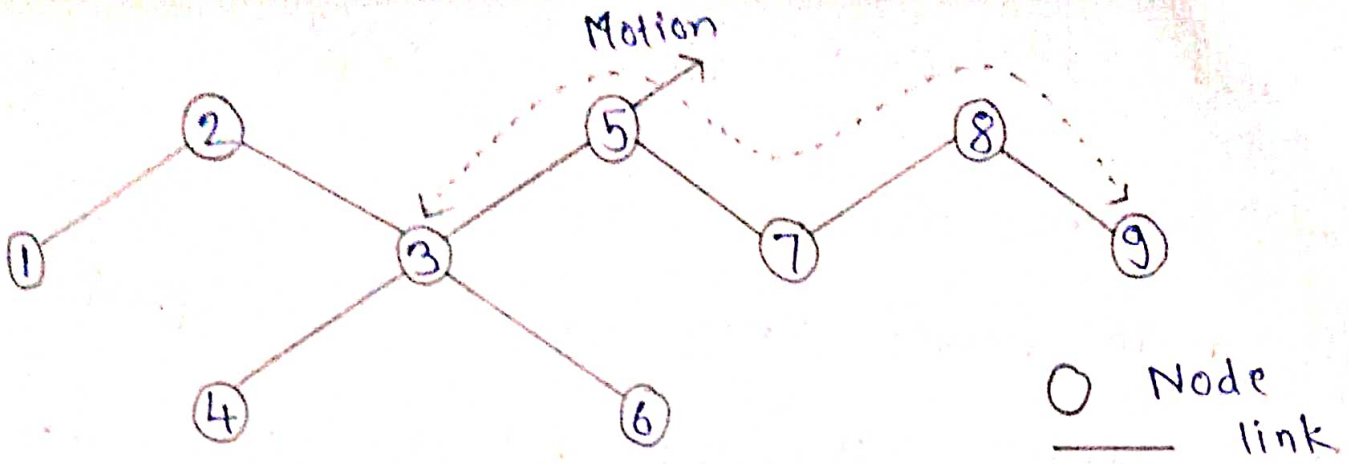


figure B) Node 5 moves away from Node 3 (long term partition)

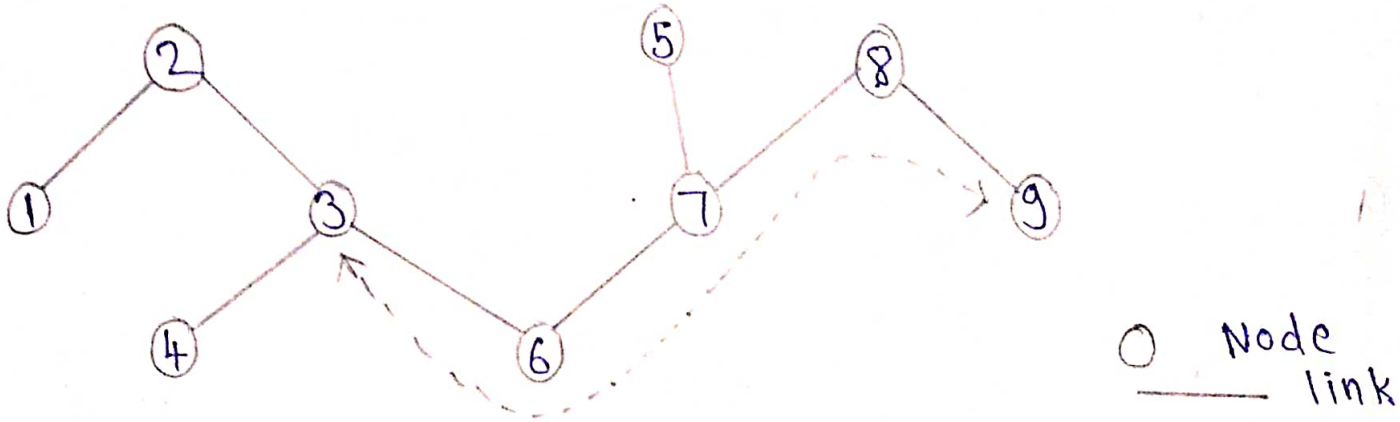


figure c) The routing protocol reestablishes the path through Node 6.

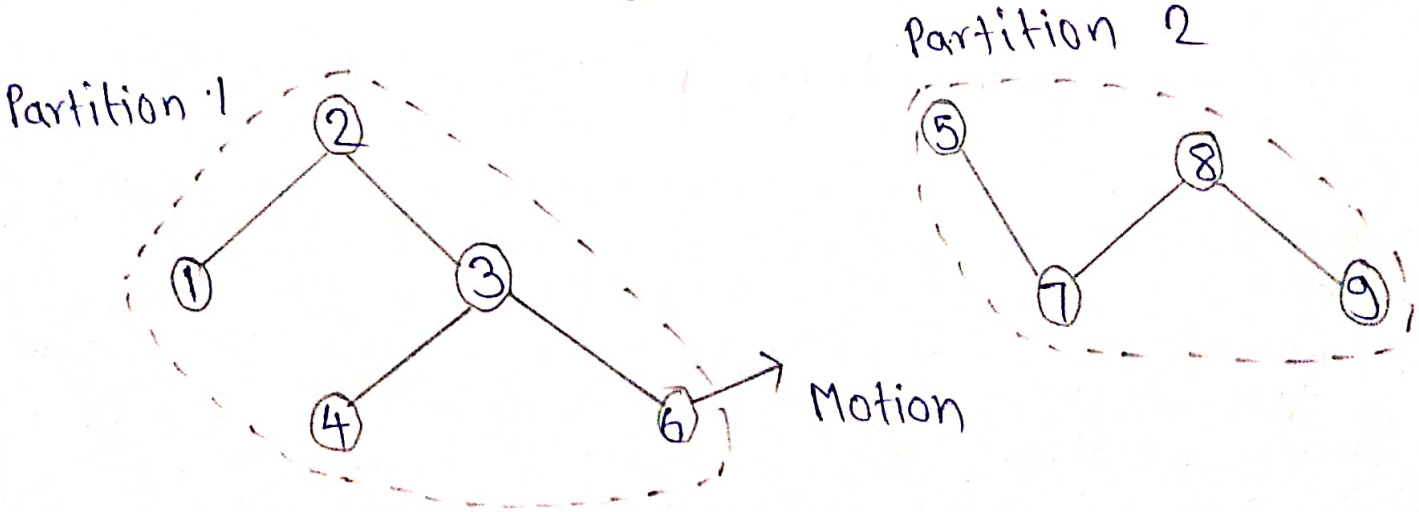


figure d) No communication between the Partitions.

Backoff Algorithm :

5)

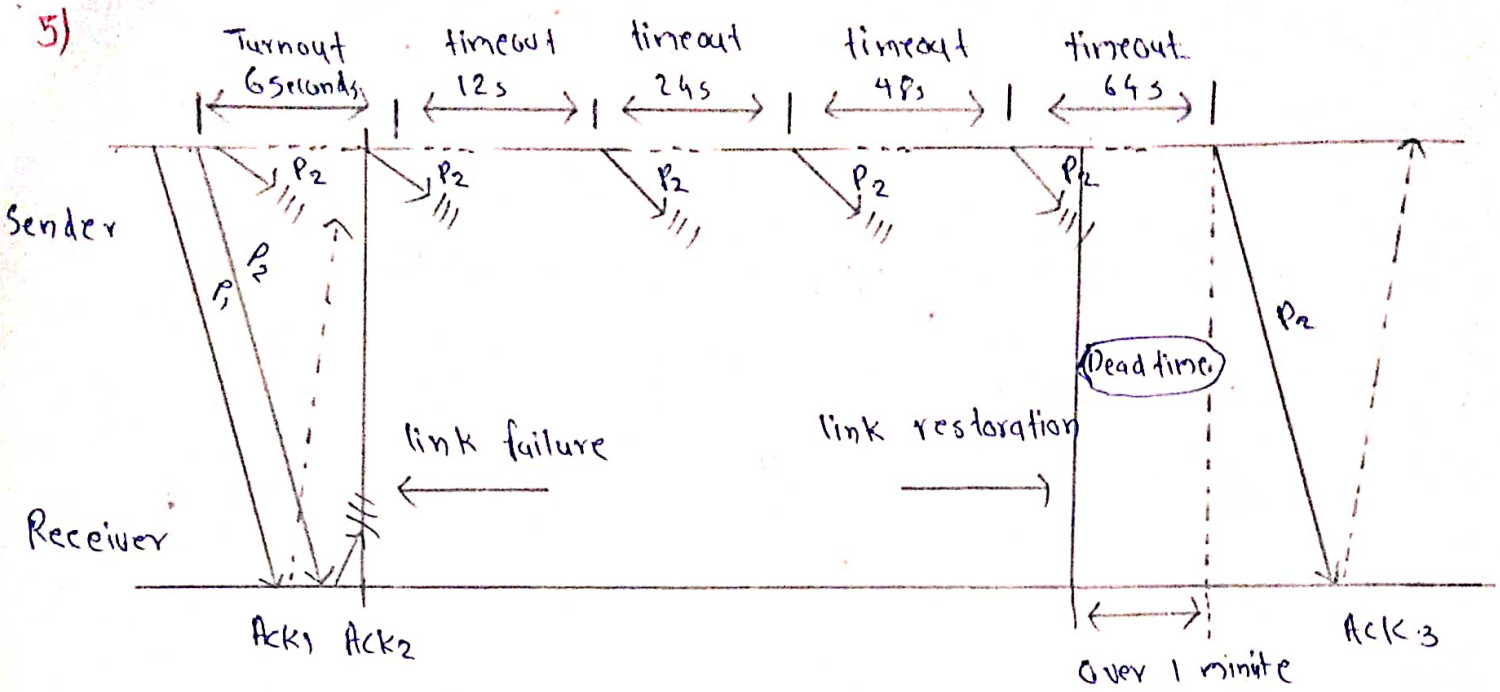


figure) Drawback of TCP exponential backoff algorithm in MANETs

6) MAC layer impact

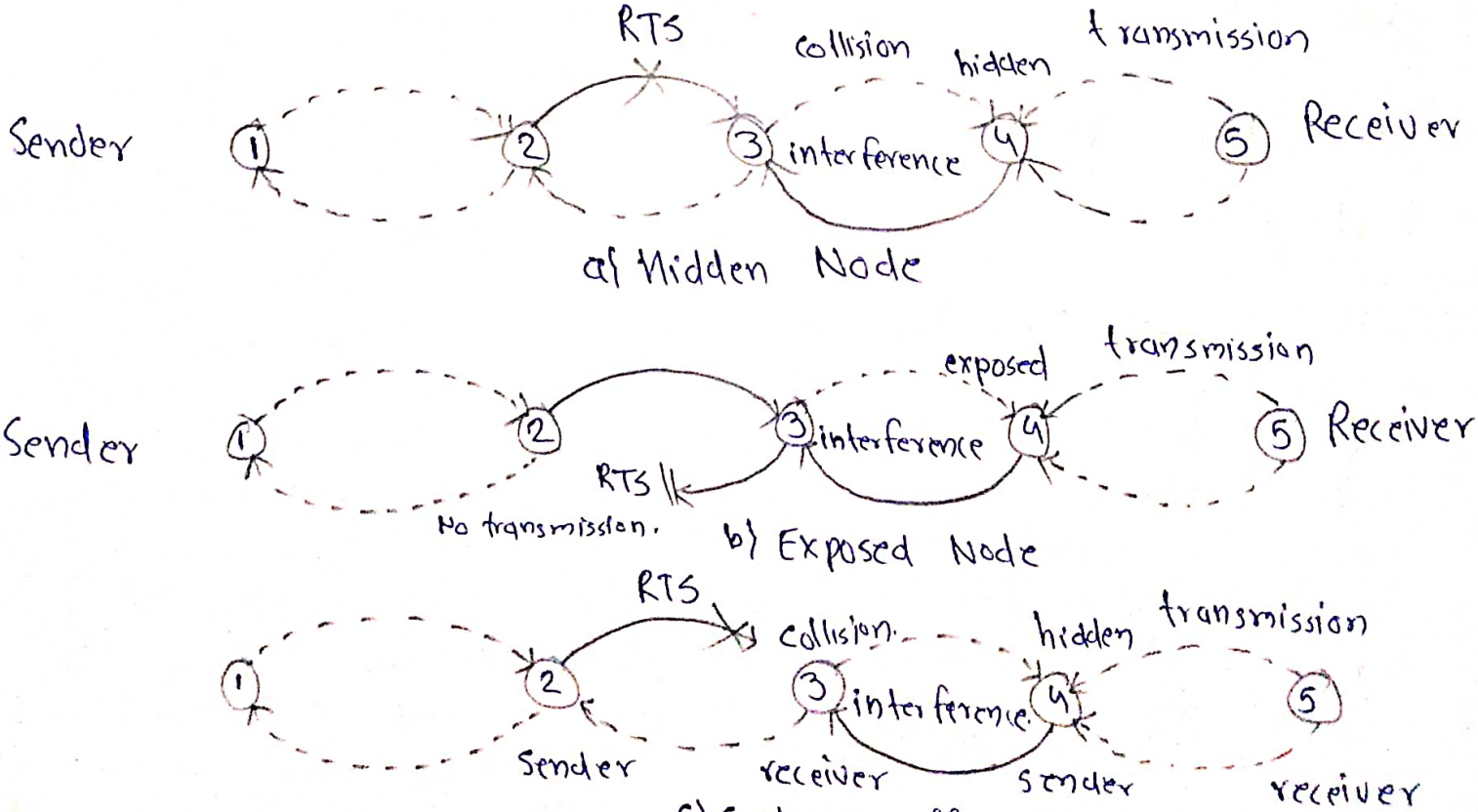


figure) Issues at the MAC layers.

- The wireless MAC layers rely on error control mechanisms in order to improve the transmission efficiency.
- The IEEE 802.11 DCF is standard MAC layer protocol for MANETs. This MAC ~~layer~~ Protocol which defines both physical & link layer mechanisms, is intended for providing an efficient shared broadcast channel through which the involved mobile nodes can communicate.
- ~~The~~ Another mechanism introduced by the IEEE 802.11 MAC is the virtual carrier sense used to track medium activity.
- The MAC protocol is certainly very robust in dealing with the possibility of collisions in the wireless shared medium.
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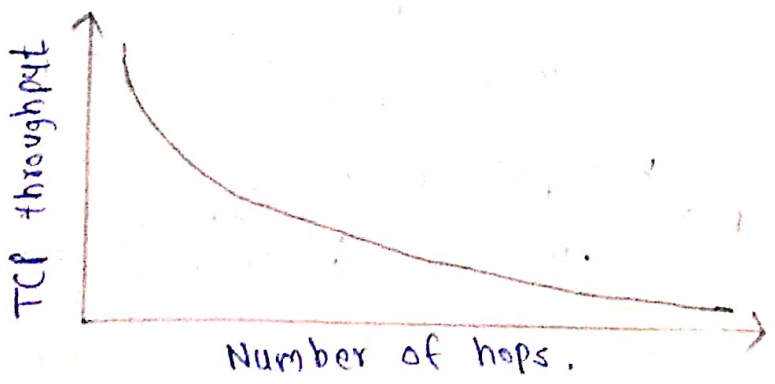

fig) TCP Throughput is inversely proportional to the number of hops.

7) TCP - Feedback

- As the name suggests, TCP feedback (TCP-F) is a feedback-based scheme in which the TCP sender can effectively distinguish between route failure & network congestion by receiving Route failure Notification (RFN) messages from intermediate nodes.
- The idea is to push the TCP into a "Snooze state" whenever such messages are received.
- In addition, a Route failure timer is employed to prevent infinite wait for RRN messages, and is started whenever a RFN is received.
- Results from TCP-F shows gains over standard TCP in conditions where the route establishment delay are high which are due to a fewer number of invoked reestablishment.

8) The ELFN Approach :

- The Explicit link failure Notification (ELFN) is a cross layer proposal in which TCP also interacts with the routing protocol in order to detect route failure and take appropriate actions.
- ELFN message are sent back to the TCP sender from the node detecting the failure. such messages are carried by the routing protocol that need to be adapted for this purpose.
- Basically, the ELFN (approach) messages contain sender & receiver addresses & ports, as well as the TCP sequence number.
- In general, the ELFN approach provides meaningful enhancements over the standard TCP, but further ~~pr~~ evaluation may be needed.