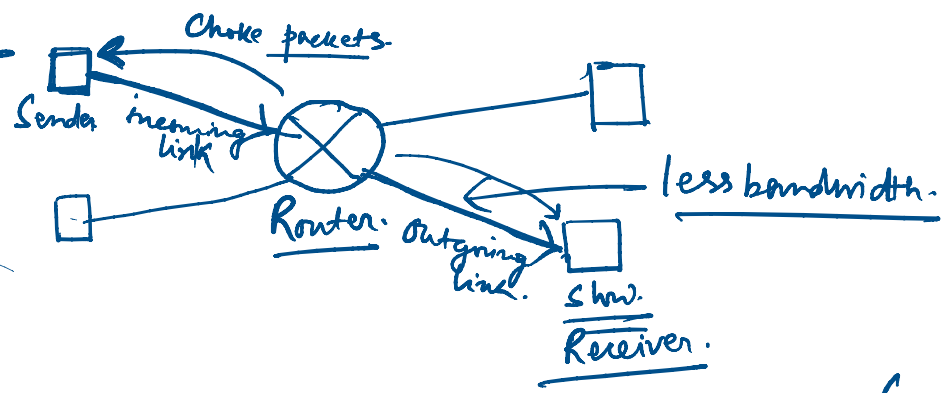
Module-3: Transport Layer - 4

Monday, February 21, 2022 3:26 PM

Congestion Control - 2 types : (i) Network-assisted congestion control.
(ii) End-to-end congestion control.

(i) Network-assisted congestion control.

- Network layer components (e.g. routers) provide explicit feedback to the sender regarding the congestion state of the network.
- Feedback - may be as simple as a single-bit indicating congestion at a link.
- Sophisticated feedback mechanism
  - Allows the router to inform the sender explicitly of the transmission rate it can support in the outgoing link.



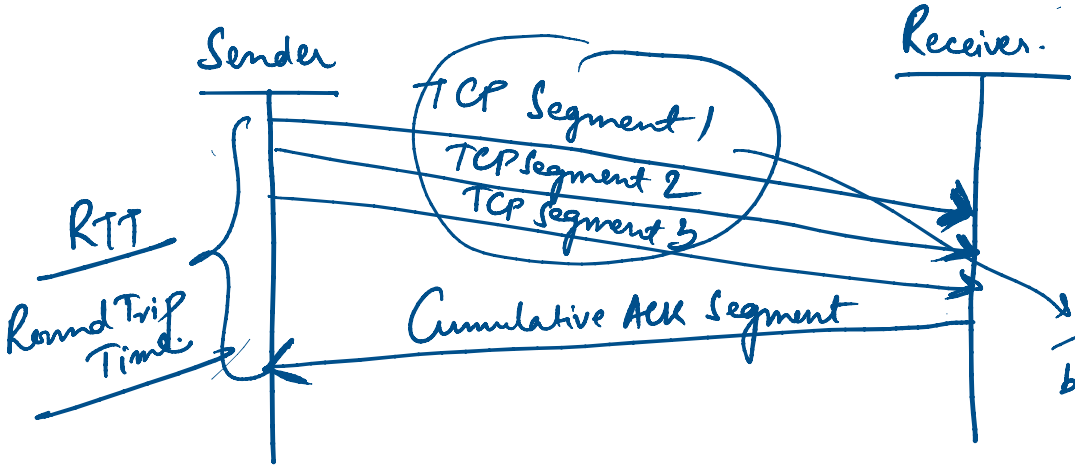
  - Router sends choke packets to the sender. (Direct feedback)
  - Router marks/updates a field in the packet flowing from sender to receiver to indicate congestion — the receiver then notifies the sender of the congestion situation. (Network feedback - via receiver)

(ii) End-to-end Congestion control.

... to the transport

(ii) End-to-end congestion control:

- Network layer provides no explicit support to the transport layer for congestion control.
- Presence of congestion is inferred by the end systems based only on observed network behavior (packet loss and delay).
- Indicators of congestion: TCP segment loss (indicated by timeout or a triple duplicate ACKs)
- TCP decreases its window size accordingly.



Sender's rate = 3/RTT.

how many segments to be pumped into the link is decided by the size of cwnd.

— Loss event → timeout / triple duplicate ACKs.

→ indicates to the sender that the network might be under a congestion.

- Too fast transmission — overloading of router — congestion situation.
- Too slow transmission — under utilization of link BW — delay — congestion situation.

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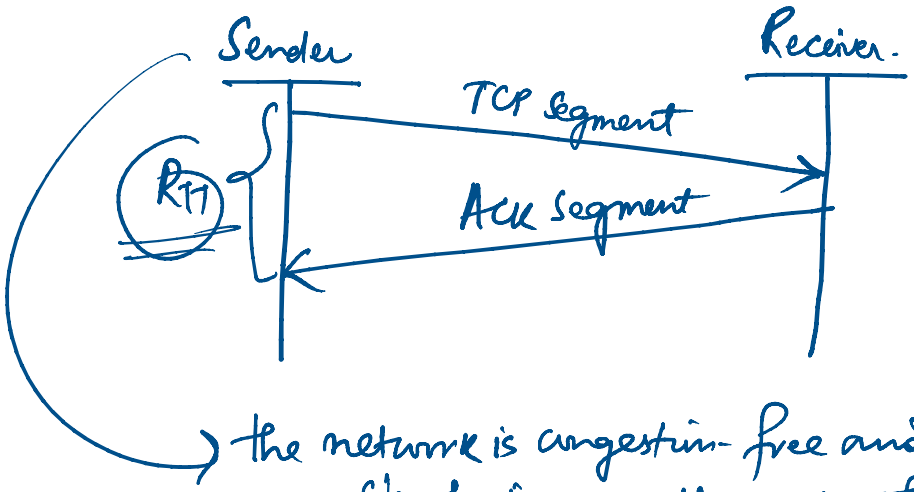
→ trade-off



→ the network is congestion-free and now it can slowly increase the rate of data generation.

TCP Congestion Control Algorithm → Slow start, Congestion Avoidance, Fast Recovery. } Three states.

TCP Congestion Control maintains two variables:

1. Congestion Window (cwnd)
2. Slow start threshold (ssthresh)

Congestion avoidance state

1. If the cwnd = ssthresh, then a conservative approach is taken by which the cwnd is increased linearly by 1 MSS per RTT, and this continues until a loss event is encountered.

2. If a loss event happens (i.e. timeout), then the congestion

(2) If a loss event happens (i.e. timeout), then the congestion control algorithm updates its two variables as:

$$\boxed{\begin{aligned} ssthresh &= cwnd/2; \\ cwnd &= 1\ MSS. \end{aligned}}$$

And, the algorithm enters into the <u>slow start state</u>.

(3) If a loss event in form of <u>receipt of triple duplicate ACKs</u> happens, then the congestion control algorithm updates its two variables as:

$$\boxed{\begin{aligned} ssthresh &= cwnd/2; \\ cwnd &= ssthresh + 3.\ MSS. \end{aligned}}$$

And, the algorithm enters into the <u>fast recovery state</u>.