CONGESTION CONTROL

Congestion Control

- When routers are receiving packets faster than they can forward them, one of two things must happen:
  - The subnet must prevent additional packets from entering the congested region until those already present can be processed.
  - The congested routers can discard queued packets to make room for those that are arriving.
  - When one part of the subnet (e.g. one or more routers in an area) becomes overloaded, congestion results.

Factors that Cause Congestion

- Packet arrival rate exceeds the outgoing link capacity.
- Insufficient memory to store arriving packets
- Bursty traffic
- Slow processor

Congestion Control vs Flow Control

- Congestion control is a global issue – involves every router and host within the subnet
- Flow control – scope is point-to-point; involves just sender and receiver.

Congestion Control, cont.

- Congestion Control is concerned with efficiently using a network at high load.
- Several techniques can be employed. These include:
  - Warning bit
  - Choke packets
  - Load shedding
  - Random Early Detection (RED)
- The first 3 deal with congestion detection and recovery. The last one deal with the congestion avoidance.

Warning Bit

- A special bit in the packet header is set by the router to warn the source when congestion is detected.
- The bit is copied and piggy-backed on the ACK and sent to the sender.
- Algorithm at source
- The sender monitors the number of ACK packets it receives with the warning bit set and adjusts its transmission rate accordingly.
- As long as warning bits arrive: reduce traffic
- Less warning bits: increase traffic

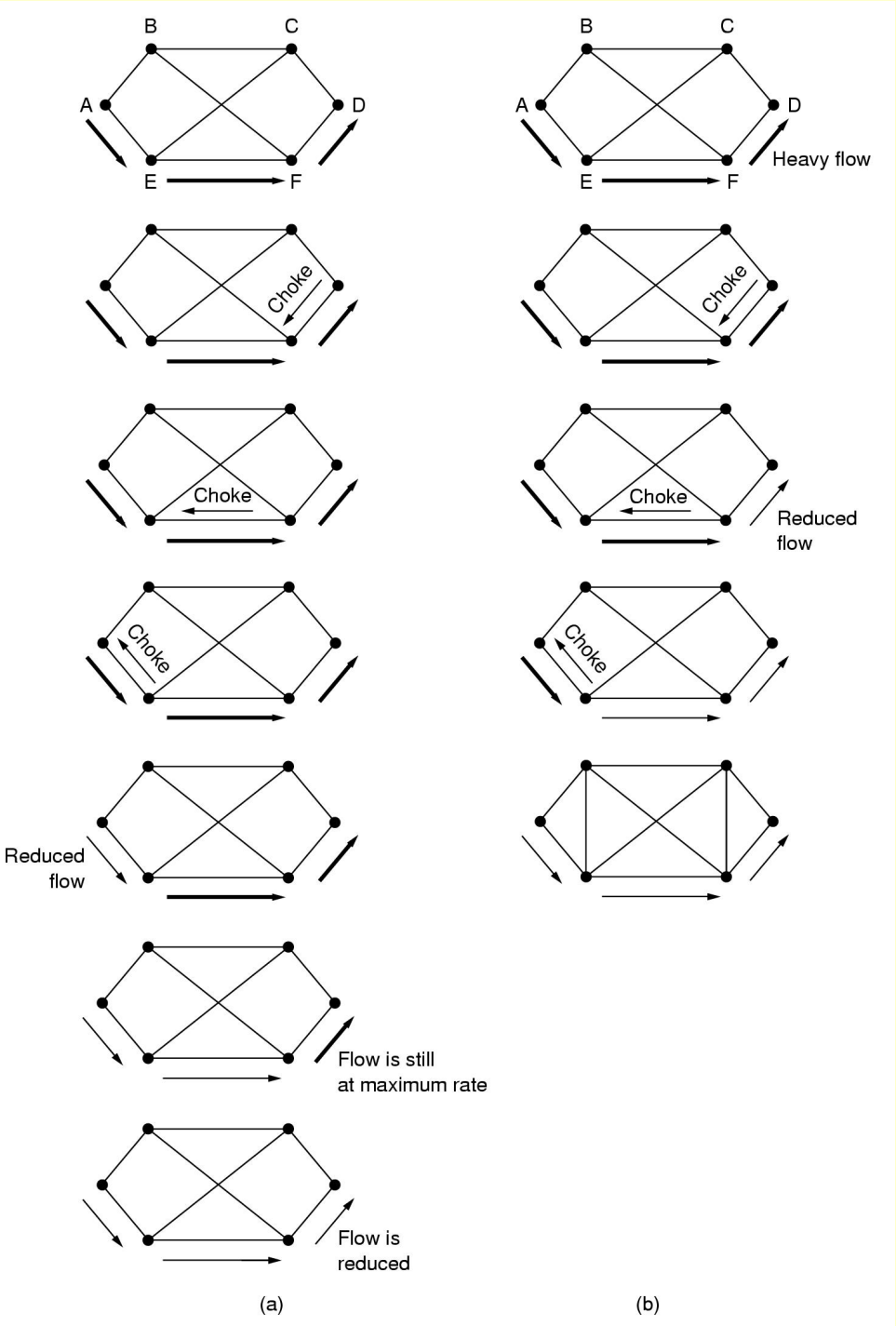
Choke Packets

- A more direct way of telling the source to slow down.
- A choke packet is a control packet generated at a congested node and transmitted to restrict traffic flow.
- The source, on receiving the choke packet must reduce its transmission rate by a certain percentage.

- An example of a choke packet is the ICMP Source Quench Packet.

Source based Choke packets

- Choke packets:
  - Example showing slow reaction
  - Solution: Hop-by-Hop choke packets

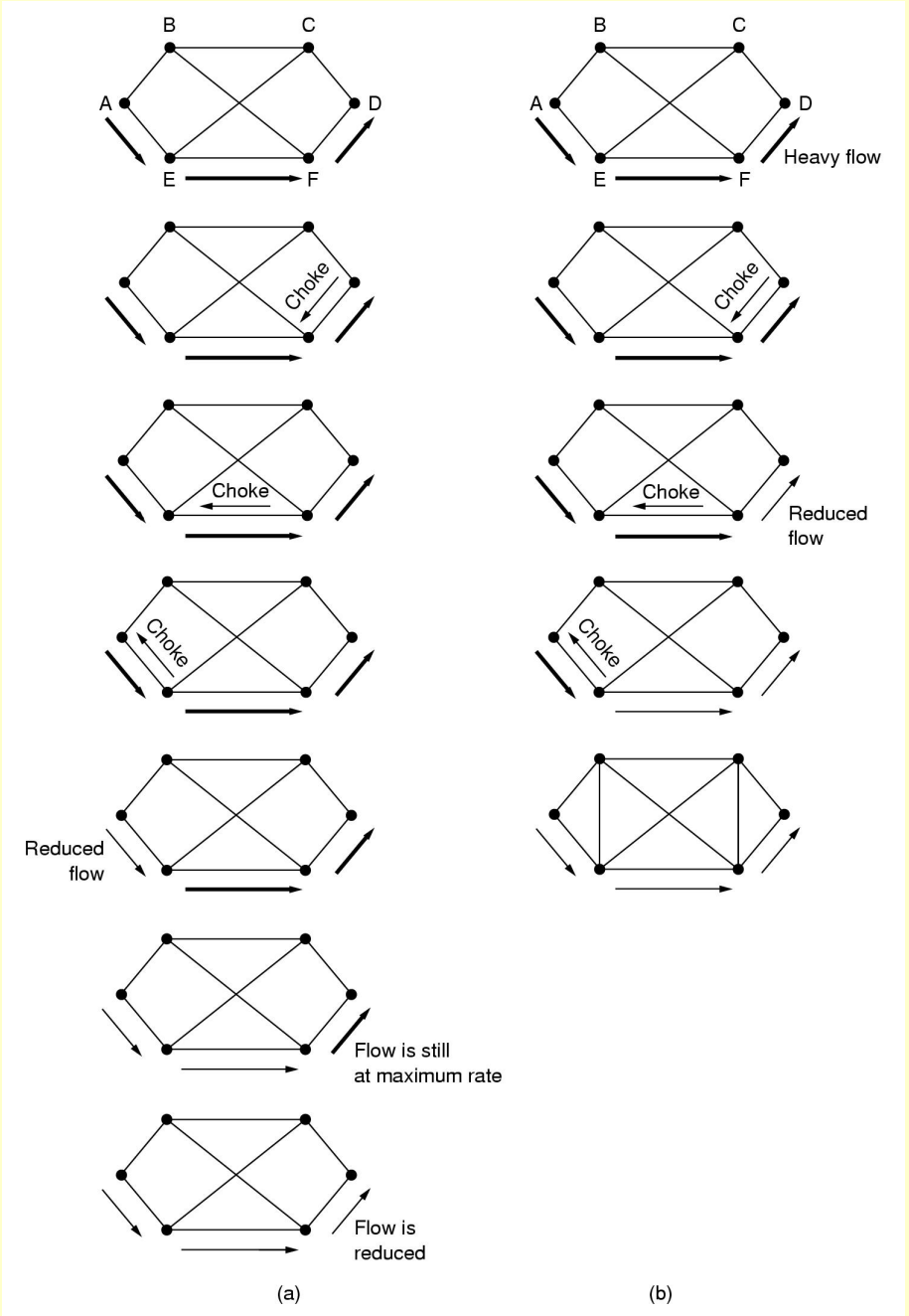


Hop-by-Hop Choke Packets

- Over long distances or at high speeds choke packets are not very effective.
- A more efficient method is to send to choke packets hop-by-hop.
- This requires each hop to reduce its transmission even before the choke packet arrive at the source.

Hop-by-hop choke packets

- Hop-by-Hop choke packets
  - Have choke packet take effect at every hop
  - Problem: more buffers needed in routers



Load Shedding

- When buffers become full, routers simply discard packets.
- Which packet is chosen to be the victim depends on the application and on the error strategy used in the data link layer.
- For a file transfer, for, e.g. it cannot discard older packets since this will cause a gap in the received data.
- For real-time voice or video it is probably better to throw away old data and keep new packets.

Random Early Detection (RED)

- This is a proactive approach in which the router discards one or more packets *before* the buffer becomes completely full.
- Each time a packet arrives, the RED algorithm computes the average queue length, ***avg***.
- If *avg* is lower than some lower threshold, congestion is assumed to be minimal or non-existent and the packet is queued.

RED, cont.

- If *avg* is greater than some upper threshold, congestion is assumed to be serious and the packet is discarded.
- If *avg* is between the two thresholds, this might indicate the onset of congestion. The probability of congestion is then calculated.