Subject: Computer Networks
Topic: Congestion control
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CONGESTION CONTROL

Congestion Control versus Flow Control

- Flow control
  - controls point-to-point traffic between sender and receiver
  - e.g., a fast host sending to a slow host
- Congestion Control
  - controls the traffic throughout the network

24-3 CONGESTION CONTROL

Congestion control refers to techniques and mechanisms that can either prevent congestion, before it happens, or remove congestion, after it has happened. In general, we can divide congestion control mechanisms into two broad categories: open-loop congestion control (prevention) and closed-loop congestion control (removal).

Topics discussed in this section:

Open-Loop Congestion Control
Closed-Loop Congestion Control

Congestion Control

- When one part of the subnet (e.g. one or more routers in an area) becomes overloaded, congestion results.
- Because 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.

Two Categories of Congestion Control

- Open loop solutions
  - Attempt to prevent problems rather than correct them
  - Does not utilize runtime feedback from the system
- Closed loop solutions
  - Uses feedback (measurements of system performance) to make corrections at runtime.

General Principles of Congestion Control

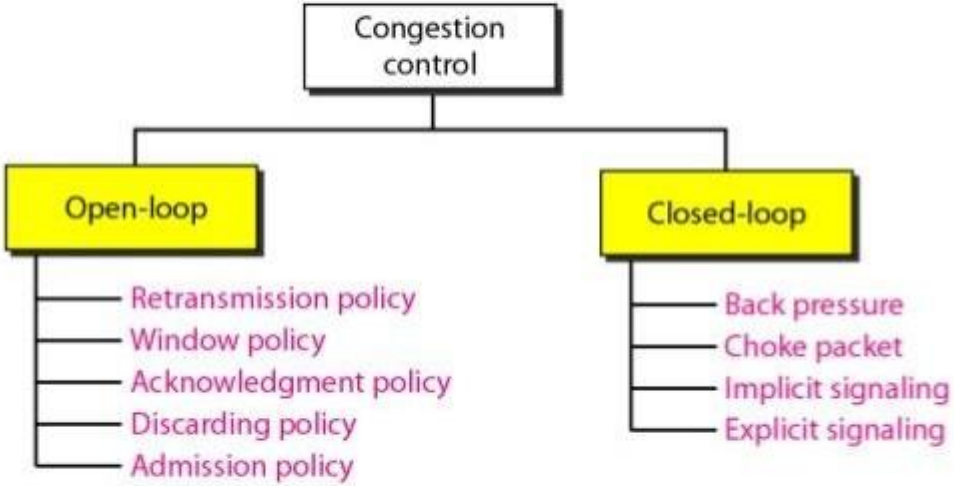
- Analogy with Control Theory:
  - Open-loop, and
  - Closed-loop approach.

- Open-loop approach
  - Problem is solved at the design cycle
  - Once the system is running midcourse correction are NOT made.
  - Tools for doing open-loop control:
    - Deciding when to accept new traffic,
    - Deciding when to disregard packets and which ones.
    - Making scheduling decision at various points in the network.
    - Note that all those decisions are made without regard to the current state of the network.

General Principles of Congestion Control

- Closed-loop approach
  - It is based on the principle of feedback-loop. The approach has three parts when applied to congestion control:
    1. Monitor the system to detect when and where congestion occurs,
    2. Pass this information tot places where action can be taken
    3. Adjust system operation to correct the problem.

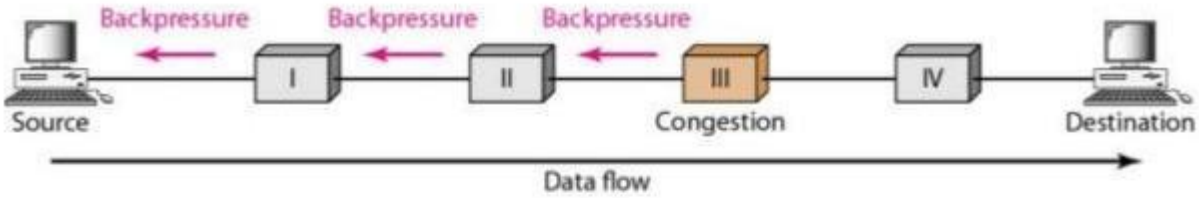
Figure 24.5 *Congestion control categories*



Warning Bit/ Backpressure

- 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.
- The sender monitors the number of ACK packets it receives with the warning bit set and adjusts its transmission rate accordingly.

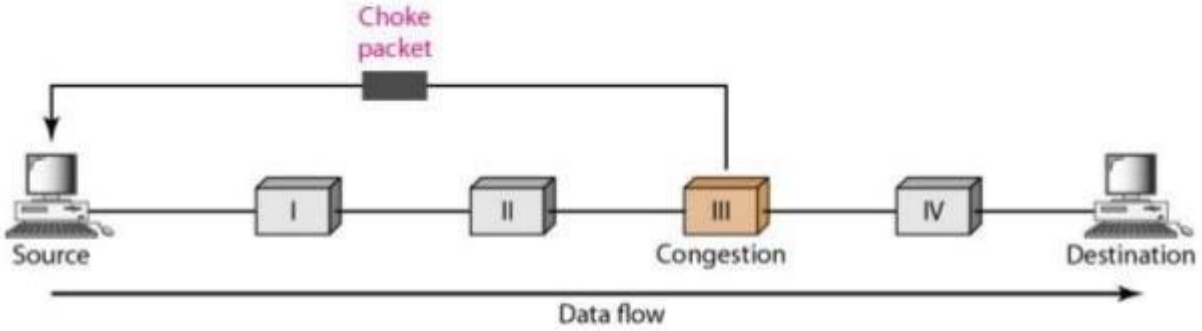
Figure 24.6 *Backpressure method for alleviating congestion*



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.

Figure 24.7 *Choke packet*



Open-Loop Control

- Network performance is guaranteed to all traffic flows that have been admitted into the network
- Initially for connection-oriented networks
- Key Mechanisms
  - Admission Control
  - Policing
  - Traffic Shaping
  - Traffic Scheduling

Policing

- Network monitors traffic flows continuously to ensure they meet their traffic contract
- When a packet violates the contract, network can discard or tag the packet giving it lower priority
- If congestion occurs, tagged packets are discarded first
- *Leaky Bucket Algorithm* is the most commonly used policing mechanism
  - Bucket has specified leak rate for average contracted rate
  - Bucket has specified depth to accommodate variations in arrival rate
  - Arriving packet is *conforming* if it does not result in overflow

Traffic Shaping

- Another method of congestion control is to "shape" the traffic before it enters the network.
- Traffic shaping controls the *rate* at which packets are sent (not just how many). Used in ATM and Integrated Services networks.
- At connection set-up time, the sender and carrier negotiate a traffic pattern (shape).
- Two traffic shaping algorithms are:
  - Leaky Bucket
  - Token Bucket

The Leaky Bucket Algorithm

- The **Leaky Bucket Algorithm** used to control rate in a network. It is implemented as a single-server queue with constant service time. If the bucket (buffer) overflows then packets are discarded.