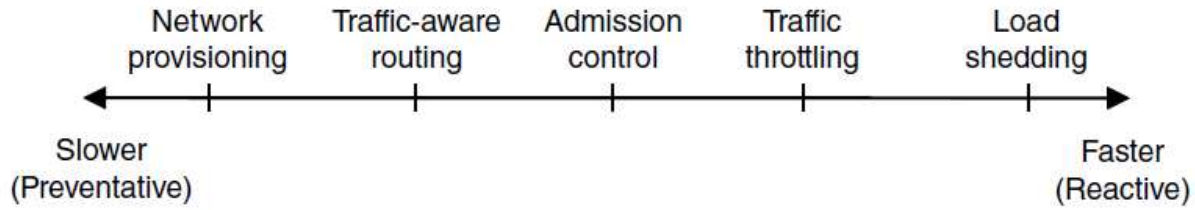
Congestion Control

When too many packets rushing to a node or part of network, the network causes packet delay and packet loss that degrades performance. This situation is called congestion. Network layer is directly affected due to congestion. Congestion control ensures that the network is able to carry the offered traffic.

Approaches to Congestion Control

- **Preventive** *The hosts and routers attempt to prevent congestion before it can occur.*
- **Reactive** *The hosts and routers respond to congestion after it occurs and then attempt to stop it.*



Network Provisioning

- Build network well matched to traffic
- Turn on spare resources as needed
- Upgrade heavily utilized routers and links
- Scaling based on trends of traffic

Traffic Aware Routing

- Choose routes depending on traffic, not just topology
- For example, routes may be changed to shift traffic away from heavily used paths
- This is called traffic-aware routing
- Splitting traffic across multiple paths is also helpful.

Admission Control

- One technique that is widely used to keep congestion at bay is admission control.
- The idea is simple that is to not set up a new connection unless the network can carry the added traffic without becoming congested.
- Thus, attempts for new connection may fail. This is better than letting more packets in when the network is busy just makes matters worse.

Traffic Throttling

- In the Internet and many other computer networks, senders adjust their transmissions to send as much traffic as the network can readily deliver.
- In this setting, the network aims to operate before the onset of congestion.
- When congestion is imminent, it must tell the senders to throttle back their transmissions and slow down.

Load Shedding

- When routers are being overwhelmed by packets that they cannot handle, they just throw them away.
- A router may randomly pick packets to drop but it can usually do better than this. Which packet to discard depends on the applications running.
    - **Wine policy:** *For file transfer, an old packet is worth more than a new one. This is because dropping an old packet may force more packets to be retransmitted (since receiver will discard out-of-order packets). For this kind of applications, "the older the better".*
    - **Milk policy:** *For multimedia, a new packet is more important than an old one. This is because packets become useless if they are delayed and miss the time at which they must be played out to the user. Thus, "fresher is better".*

Quality of Service

There are techniques for achieving Good Quality of Service. Traffic shaping is a technique for regulating the average rate of data flow. The leaky bucket approach is a technique for Traffic shaping.

The Leaky Bucket Approach

- If a bucket has a small hole at the bottom, the water leaks from the bucket at a constant rate as long as there is water in the bucket.
- The rate at which the water leaks does not depend on the rate at which the water is input to the bucket unless the bucket is empty.
- The input rate can vary, but the output rate remains constant.
- Similarly, in networking, a technique called leaky bucket can smooth out bursty traffic.
- Bursty chunks are stored in the bucket and sent out at an average rate.