

Some networking issues

Some of the problems that plague networks are not limited to a single layer.

Among them are:

- **Congestion**—a situation when demand for the services of a link or router cannot be met.
- **Transmission errors.**

Congestion control

Congestion control is attempted in several layers:

AL: not much can be done. However, connectionless TL gives the AL feedback which can be used.

TL: connection-oriented protocols usually have a built-in mechanism that slows down a virtual circuit that passes through a congested router(s).

NL: this is where congestion control is most sophisticated (TTLive, priorities, dropping datagrams, etc.).

DLL: most MAC protocols eliminate congestion within a link by imposing some sort of reservation mechanism (e.g. Ethernet).

PL: the most crude form—the physical medium has a limited capacity (nominal bandwidth) and in a properly configured network one sender cannot flood its receiver.

Congestion control is done by giving feedback to the layer above, ending in the TL for TCP and in AL for UDP.

When the PL is congested, it simply takes more time to send a frame, returning to the DLL after a longer delay.

When the DLL is congested, it refuses to accept datagrams from NL, resulting in buffer overrun in NL.

When NL is congested, it drops packets, forcing reliable TL to slow down (waiting for timeouts).

Transmission errors

There is no way to prevent transmission errors from happening.

Errors occur because the signal is corrupted during its trip from the transmitter to the receiver. While some errors can be detected immediately by the receiver (PL), most result in the signal being incorrectly decoded.

Errors also occur when a router is overwhelmed with traffic and is forced to drop packets because all the buffer space is full.

Finally, errors occur when packets are imperfectly delivered (too late, in wrong order, etc.).

Error handling

Transmission errors are handled by every layer—within the ability of the layer.

How to detect transmission errors?

A TL protocol that claims to be reliable must be able to detect transmission errors and to recover from them.

Symptoms of errors:

- A host expecting a segment hears a long period of silence, an error is probable.
- A receiver receives a corrupted segment (based on length or CRC).
- A receiver receives a packet out of order (based on sequence numbers).
- A host receives an acknowledgment that does not match (perceived) reality.

The alternative is not to bother with error detection at all, leaving it to the AL.

The acknowledgment

The basic tool in error detection is the requirement to acknowledge received segments. The acknowledgment may form a separate segment or be piggybacked on a data segment.

Possible strategies:

- Send a short ACK packet after receiving each segment.
- Acknowledge the highest segment number received.
- Send a list of correctly received segments.
- Negative acknowledgments: report the segment number expected next.