

Networking 2 — TCP/IP

Ethernet Features

Less with more

Cooperative / Decentralized

Insecure

Unpredictable

You can't really say what the effective latency or bandwidth will be for an ethernet transmission -- the collisions make it random.

This could be a problem for delivering video smoothly.

This could be a problem for networking the control system of an airplane where delays are not acceptable.

Ethernet Variations

10-T with hub

Arrange the network in star configuration with a hub in the middle and arms radiating out. Max length of an arm is 100 meters.

The hub may just be a dumb repeater that copies whatever is on one arm to the other arms.

Smart Hub

Or, a fancier hub can isolate all the arms from each other. Only putting traffic on an arm that is destined for that arm. Storing temporarily the traffic for an arm until the arm is free (silent).

Putting in a smarter hub can increase the capacity of the whole LAN.

100T

Similar to 10-T, but signals at 100 Mbps instead of the old 10Mbps.

1000-T is in the works, but that may be approaching the limit of what copper wires are good for.

"Balkanized" LAN picture

LANs

Several different LANs which are not compatible -- different cabling, name space, and packet formats. Each LAN speaks its own language and they are not compatible.

1. Hardware: Router

A router is like a computer that is connected to two or more LANs. It is capable of participating on each LAN -- it has a name and it is connected to the LAN and understands the protocol. It speaks the language. You still need a software standard to allow computers on different LANs to communicate...

2. Software: TCP/IP

Standard -- Lingua Franca

TCP/IP is a standard way of sending packets.
 TCP/IP will be the standard language used by heterogeneous computers to talk to each other.
 Like Esperanto.

On Top of LAN

TCP/IP does not replace the LAN technology
 TCP/IP is built on top of the LAN technology.

1. IP Host Naming Standard

IP address :4 bytes: 24.13.45.123 (4 billion total addresses)

Like a phone number

Every host and router on the Internet has an IP address which uniquely identifies it for sending/receiving packets

The left parts of the IP address identify the neighborhood (subnet), and the right numbers identify the address of the host on its LAN. For example the machines in my office have IP addresses 171.64.64.171, and 171.64.64.250.

The left three numbers are the same because the machine are in the same LAN neighborhood.

Point: move a host to another neighborhood, it will need a different IP address (just like phone numbers).

2. Packet Standard

Format for the bytes

Where the address goes, where the data goes in the packet

Classic standards problem: boring, but you really need all the computers to just agree on one.

3. Routing Standard

Routers collectively need to have an overall scheme for knowing where things are

EG I contact some computer in Germany

Where do you send the data?

It's not on my LAN, and my router has no idea

Each router has a "superior" where it sends things it doesn't know how to handle

Dynamic routing problem

Pt: Decentralized - NOT a central super Yellow Pages for the whole world.

Have hierarchy of routers, each responsible for keeping track of routing and addresses in its local area.

Pt: flexible, heterogeneous, somewhat anarchic. A "bad apple" router can screw many systems up.

The routing part of the TCP/IP standard is dynamic and complex collective arrangement between all the routers.

Also deals with flow control — getting the sender to use a rate which the system can cope with. The recipient sends back "ok send more" packets to the sender to modulate the sending rate to one the recipient can handle.

TCP/IP in action

1. IP datagram

Sender formats the data as a standard IP datagram.

The datagram has the IP address of the sender and the ultimate recipient.

2. Send to router

Send the IP datagram to the closest router

Send the datagram **inside** whatever sort of packet the physical LAN uses.

The sender and router are on the same LAN -- use whatever sort of packet that LAN provides

3. Route - hop hop hop

The router unpacks the datagram, looks at the IP address of the destination, and sends it on one further hop to a router one closer to the destination.

4. Final router

Eventually it gets to a router that is on the same physical LAN as the destination