

# Networking 2

---

## Recall

Circuit-Switched

Packet

Can gain efficiency from sharing

Ethernet introduction

(See previous handout)

## Ethernet Features

Less with more -- a basically great design

Cooperative / Decentralized -- no "center"

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 it hears on one arm to the other arms.

Normally, all 10-t connections are with "straight through" cables. Use a "cross-over" cable, to connect two 10-t computers to each other directly with no hub. At Fry's, cross-over cables are bright orange.

You can daisy-chain hubs to get more capacity -- connect the new hub by its "uplink" port to a regular port on an existing hub.

### 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 available (silent).

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

The notion of "collision" may go away with a smart enough hub and its star topology.

## 100T

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

Also, 100-t is capable of using 2 sets of wires in the cable to allow transmission in both directions at once ("full-duplex").

1000-T (gigabit ethernet) exists, but is a bit exotic at present. It may be approaching the limit of what copper wires are good for.

## "Balkanized" LAN picture: pre-Internet

Several different LANs which are not compatible in both hardware and software: token ring, wireless, ethernet, ATM, ...

Different cabling, name space, and packet formats.

The computers on each LAN speak their own language and the languages are not compatible. -- "Balkanized" or "Babel"

## Vendors: Balkanize is default

It's very easy to get stuck in the balkanized state since it is the natural state for the vendors. Microsoft makes each piece of their technology work with other Microsoft technology. IBM, Intel, Apple, Oracle, etc. all do the same. It's an obvious strategy.

### Network Effect

Each vendor is trying to help itself and hurt the others by "network effect". Network effect is the value something creates by interoperating with the largest number of other devices. It has been postulated that the network effect curve is a concave-up n-squared type. So each vendor wants to make their network-effect large while making the other vendor's small. We'll study network effects more later. (It is impossible to understand the Internet without understanding network effect incentives.)

## Two Problems

### EE/CS

Technical issues of getting various LANs, computers, OSs, etc. to work together.

Typically this comes down to: **standards**

### MBA

Incentive problem of getting the vendors to not balkanize. This goes against the vendor's basic network effect instinct. The customers will push for standards (non-balkanized) since the customers are the big losers in the balkanized picture. Ironically, the vendors ultimately thrive in the non-balkanized world.

## 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

Standard -- Lingua Franca

TCP/IP provides a standard namespace for computers

TCP/IP provides a standard way of sending packets.

TCP/IP is the standard language used by heterogeneous computers to talk to each other.

Like Esperanto.

Two languages

Every computer will speak two languages: it's "local" LAN language, and the "standard" TCP/IP language it can use to speak to any other computer that speaks TCP/IP.

On Top of LAN

TCP/IP does not replace the LAN technology

TCP/IP is built on top of the LAN technology.

## Internet summary

TCP/IP standard for naming, packet format, and routing

Computers + LANs + their routers all agreeing on TCP/IP

standard = the Internet

Pt: Any computer can contact and exchange bytes with any other computer on the Internet.

Allows us to get bytes from one computer to another.

Next: what does TCP/IP look like, how does it work

Next: we have the ability to send bytes -- what can you build in that?

For TV: we have described infrastructure but not programming.