EXTENDING LAN
winning the distance limitation

EXTENDING LAN
• Why LANs are distance limited?
  – Signal loss at physical level
  – Coordination at logical level
• Engineers have developed a variety of ways to extend LAN connectivity.
• Most extension mechanisms use standard interface hardware and insert additional hardware components that can extend signals at longer distances.
• Fiber optic extensions, repeaters, bridges or switches and hubs can be used for extending LANs.

Fiber Modems
• The simplest LAN extension mechanism uses optical fibers and a pair of fiber modems extend the connection between a computer and a transceiver. Fibers have low delayed and high bandwidth.

Repeaters
• Repeaters connects a pair of cables and is an analog device.
• Its main job is to repeats every signal that it hears on one side to the other.
**Extended Ethernet LAN with Repeaters**

Repeaters repeat everything, collision, noise, even thunderstorm!

**Bridges**
- Bridges also connect two networks, but they understand frame format.
- Has a separate HW address.
- Can talk to each other.
- Listens to both the networks in promiscuous mode and can copy every frame it receives intact to the other network.
- Thus two LANs can work as one LAN.
- Computers would not know on which segment they are in.

**Bridges**

- Bridges can also perform frame filtering:
  - It looks into hardware address in the frames.
  - Relays the frames only if it is for a computer in other segment.

**Bridging Between Buildings**

- Each site has a bridge. Why?

**Cycle of Bridges**

- How to avoid Cycles (DST): Parallelism
- How computers should be distributed at two segments?
WAN

how to win the limit on the number of computers?

Problem of Scale: WANs

- The techniques shown in last few slides show how the distance limitation of LANs be extended.
- But, they do not solve the problem of Scale. What if we have too many computers scattered across long distances, at different places?
- Solution:
  - Packet Switches
    - Moves packet from one network to another.
    - Not only one or two but, many switches creates a network of networks.
    - Distributed routing.

Switching

Computers can communicate in parallel. But costly. Thus a combination of Switch & Hub is used.

Packet Switching

- One side connects to computers, other side connects to other packet switches.

Back Bone WANs with Packet Switches

- Computers now talk in parallel.
- Switches does store and forward.

Visit to ABILANE Switch

- ABILANE
  - ABILANE WEATHERMAP
  - ROUTER TRAFFIC STATS
- OTHER INTERNET BACKBONES
Physical Addressing in a WAN

- Each address is divided into two parts: switch address and computer address.
- Each switch maintains a list of next-hop-address for each destination.

Example of Next Hop Forwarding

Forwarding Table of Switch#2

Further Scalable WAN

- Scalable Network
  - Interior and
  - Exterior Packet Switches
- Scalable Address Table
  - Universality
    - Each should know the path to any computer.
  - Optimality
    - The path should be optimum too.

Routing in a WAN

Size of address Table?

Default Routing

How to Determine Best Path?

- Dijkstra’s shortest vector algorithm is used.
- How to collect routing information needed for Dijkstra’s algorithm?
  - Distance Vector Algorithm
  - Link State Algorithm.
  - Refresh these up!
Connectionless vs. Connection-oriented Switching

- A packet can explicitly carry the destination address. However, if lots of packets are going to the same destination, they can carry a small label:
  - Cost of Address field
  - Example:
    - ID: 17 used
    - Channel identifier used only by the destination switch

Example WAN Technologies

- Frame Relay
  - Suitable for long distance LAN bridging
  - Supports up to 96 frames on 1.5 Mbps or 56Kbps.
- SMDS (switched multi-megabit data service)
  - Designed to carry data
  - Higher bandwidth than FR
- ATM
  - Most promising in WAN
  - Ensures quality of service
  - Available in 155 Mbps/622 Mbps

Example WAN Technologies -2

- ARPANET
  - A defense initiative started in 1960s.
  - Legacy of Internet. Based on 156Kbps leased serial lines.
- X.25
  - Developed by ITU, popular in Europe
  - Used for remote terminal placement of computers.
  - Not suitable for computer-to-computer communication.
- ISDN
  - Objective: data networking on voice system
  - 64 Kbps data/16 Kbps control channel.

Computing Shortest Path (Dijkstra’s Algorithm)

W[i][j]=link cost between node i and j
S[]=all nodes except source
R[i]=source for all connected nodes otherwise zero
D[i]=W[source][i] for nodes connected from src otherwise infinity.
while (set S is not empty) {
  choose u from S closest to source;
  if (D[u]==infinity) no path in S, exit;
  delete u from S;
  for each v such that W[u][v] is an edge {
    if (v is still in S) {
      c=D[u]+W[u][v];
      if (c < D[v]) {
        R[v]=R[u];
        D[v]=c;
      }
    }
  }
}
**Distributed Vector Distance Routing Table Computation**

Given a local routing table with weight and an incoming message:

Repeat forever {
  wait for next message from N;
  for each entry in the message {
    if V is destination and D is cost;
      edit distance to N + D;
    if V is a new destination
      add a new entry, for V with next-hop = N and D = c;
    if V is there and next-hop is also N
      replace local D with c;
    if V is there but next-hop is not N but D > c
      replace next-hop = N and local D = c;
  }
}

**Link-State Routing**

- Step-1: Every Switch broadcasts the status of links attached to it in regular interval.
- Step-2: Each Switch collects the incoming messages and builds its own network graph.
- Step-3: In parallel, they independently compute the best path.