Switching and Bridging

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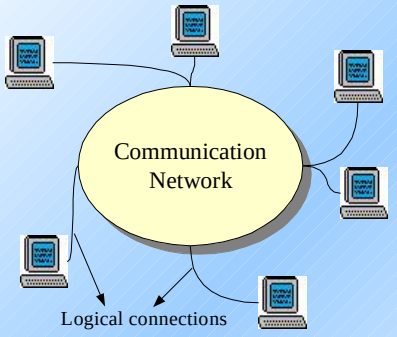
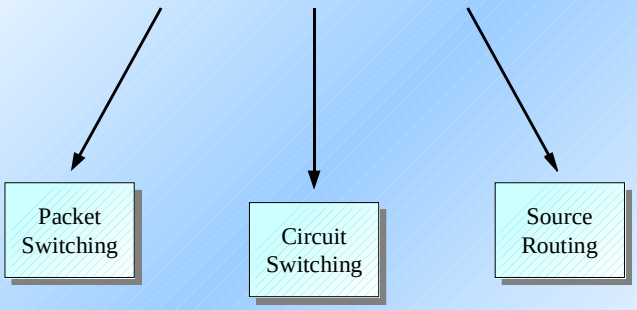
The Need for Switching

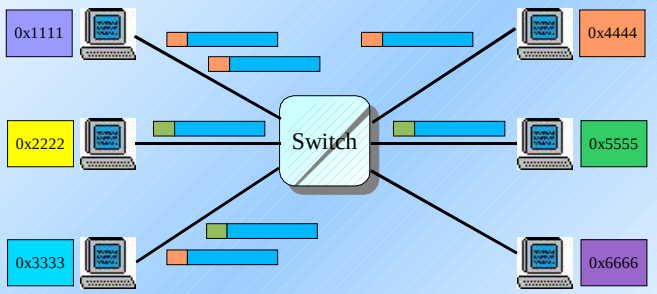


- Not all computers can communicate directly
  - Physical limitations
  - Eth: max 1024 hosts
  - Eth: max 2500m
- Switch: where messages are switched (from one interface to another)

Types of Switching

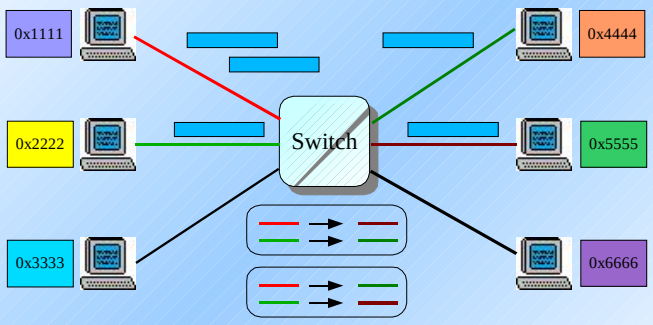


Packet Switching



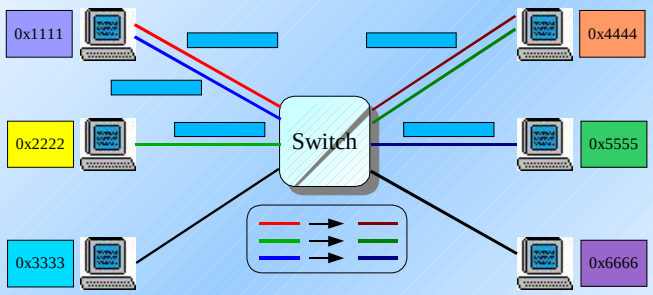
Each packet carries destination information

Circuit Switching

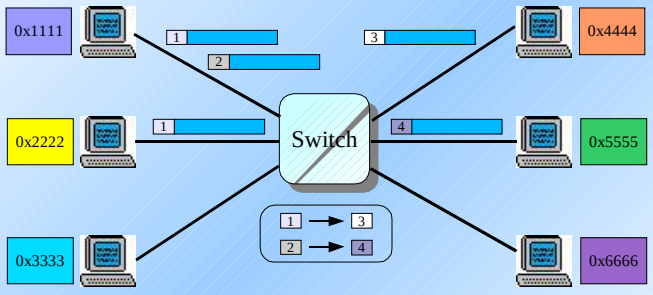


There is a "circuit" from source to destination

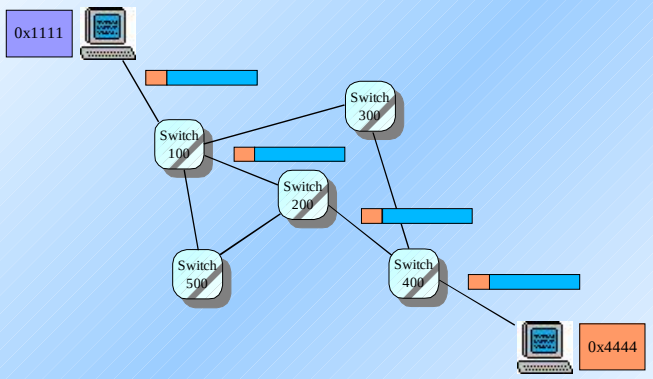
Circuit Switching (continued)



Virtual Circuit Switching

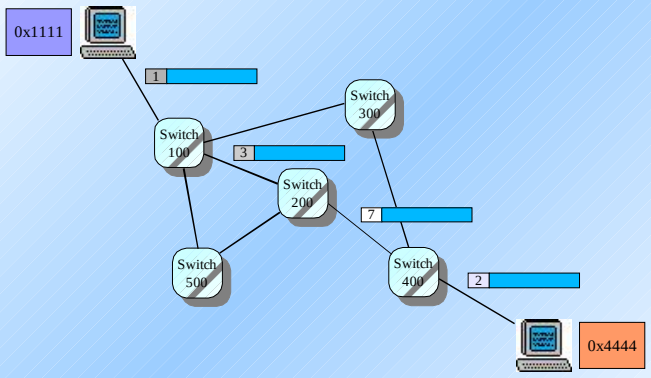


Packet Switching in a Network



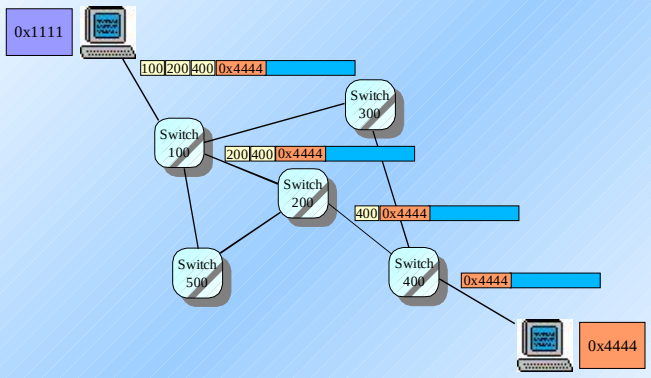
Routing: how to route from source to destination?

Circuit Switching in a Network



A circuit has to be setup before packets can be transferred

Source Routing

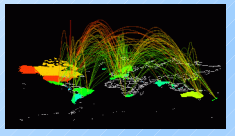


Similar to packet switching, but source decides the route

Some Examples

Packet Switching

Ethernet



Internet

Postal system

Circuit Switching

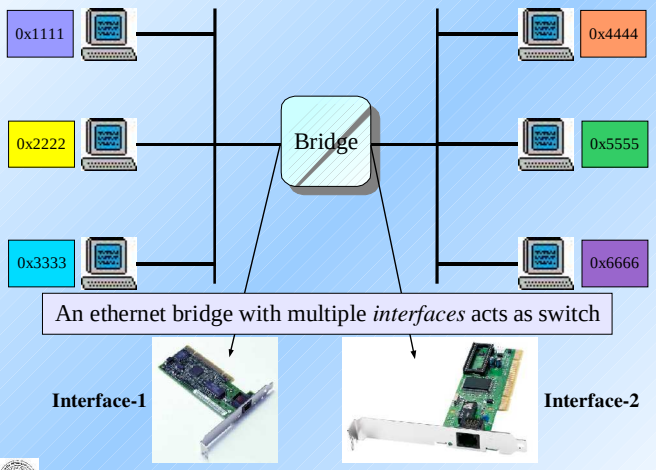
Telephone network

Asynchronous Transfer Mode (ATM)

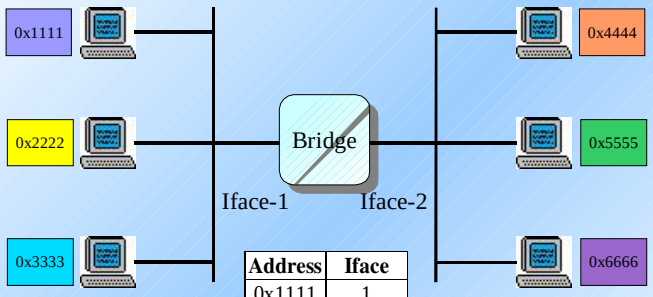
Source Routing

Internet Protocol (IP) has this as an option

Ethernet Bridging



Forwarding Table at the Bridge

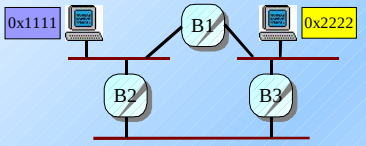


Address	Iface
0x1111	1
0x2222	1
0x3333	1
0x4444	2
0x5555	2
0x6666	2

Learning the Forwarding Table

- Manual configuration ==> cumbersome
- Learning:
  - On seeing a frame with a particular source address on an interface, make an entry
  - If no entry exists for a destination, broadcast on all interfaces other than the receiving interface

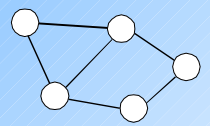
Problem: Bridging Loops



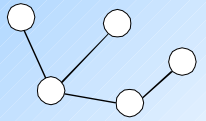
- Why might this happen?
  - Configuration error
  - On purpose: fault-tolerance
- Problem: loops in forwarding
- Solution: spanning-tree

Spanning Tree in the Bridged Network

- Define a graph
  - Consider each bridge and each LAN-segment as a node
  - And each interface/port as a link
- A spanning tree in this graph is defined
- Which spanning tree?



A graph

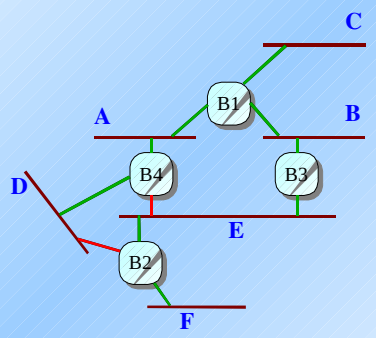


A spanning tree of the graph

Defining the Spanning Tree

- Each bridge has to select its active interfaces
- Define a root bridge: smallest id
  - All of its interfaces are active
- Each bridge computes the shortest path to the root bridge, and notes this interface
- In a LAN segment, a bridge is designated to be responsible for forwarding frames toward the root bridge
  - Closest to the root, smaller-id to break ties

Spanning Tree: An Example



Spanning Tree Algorithm

- Dynamic, distributed algorithm
- Each bridge starts by thinking itself to be the root
- Configuration messages are sent with: sending bridge's id (Y), id of the node it considers to be the root (X), and the distance from X (d)
- From among the configuration messages sent and received, it stores the "best" configuration

Choosing the "Best" Configuration Message

- Among two messages m1 and m2
  - One which identifies a smaller root id is better, or
  - One which has a shorter distance to the root, or
  - One which has a smaller sending bridge id
- Once a bridge identifies itself to be not the root, it stops generating configuration messages
- Root sends configuration messages periodically

Limitations of Bridging

- Spanning tree algorithm scales linearly
- Broadcast frames are sent everywhere
  - Example: ARP, DHCP

Summary

- Switching: packet, circuit, source routing
- Ethernet bridging
  - Learning bridges
  - Spanning tree protocol