| CS 4/54201 Computer Communication Network | Kent State University Dept. of Computer Science | www.mcs.kent.edu/~javed/class-NET06F/ |

- A Course on Networking and Computer Communication
Class Mechanics

- Internet Engineering (Fall 2007)
  - Internet Technology (addressing, routing, management)
  - HTTP 1.1
  - Information Sharing (document session)
  - Network Programming
  - Web Server and Web Browser Design
  - Transoceanic Cache and Internet Performance

- Peer-to-Peer Networking (Spring 2007)
  - Architecture of major P2P systems
  - Theory complex network
  - Distributed Hashing
  - Search & Routing in P2P
  - Event Routing
  - Security & Scalability

Class Mechanics

- DO NOT Email be the Home Works
  - Email to TA: wchantam@cs.kent.edu

- Project#1 Due today: Submit your ZIP file to TA

- Midterm Monday OCT 23 rd
- But FlexFormat Midterm on Friday:
- Signup for exam Slot

- Midterm Exam
  - Open Book
  - 4 questions
  - Answer any three
  - 1 true/ false.
Packet Switching

- All machines are not connected directly

- Limiting Reasons:
  - Number of Nodes.
  - Length of Links.
Packet Switch

- Packet switch is a device which connects links logically. Upon receiving a packet from one link, it generates a new packet (perhaps with some logical modification of the original one) and transmits it towards its final destination.
Advantages of Switching

- Nodes can be connected using simple point-to-point links.
- Although a single switch has fixed number of input and output, but large networks can be built using many interconnected switches.
- Adding new host to a network by connecting it to the switch does not mean that the hosts already connected will get worse performance.
WANs with Packet Switches

How do they know which computer is where and where to forward?

Source Route based Forwarding

- Each packet contains enough information to find its path.
- The source knows the entire path.
- The source of the packet lists all the output port numbers along the path in the packet header.
- Each switch looks into the packet header and forwards it to the designated output port.
Example of Source Routing

Host A wants to send to Host B

Each switch rotates the list.

What to do with the Header?

- Rotate
- Truncate
- Pointer
Advantages and Disadvantages

• Size of the header?
• Is the header fixed sized?
• How do the host know the complete path?

Virtual Circuit Switching

• This is a connection-oriented model.
• The first step is to set up a virtual connection from the source to host.
• Once the connection is established, all switch on the way can determine the destination of a packet by looking at the small identifier of the packet.
Quiz

• 203: Explain True or False. In the source based routing Maximum diameter of the network will determine the packet size.

Example of VC

• Host A only knows how to reach to Switch 1. It appends an identifier., and sends an connection request.
• Switch 1 knows how to go to B. It routes it, as selects a new identifier.
• Once, connection is done, Host A sends data packets with the identifier
• When done, host A sends a tear down request....
Example of VC

• Communication Delay?
• Packet Size? (connection request packet vs. data packet)
• What if the connection is accidentally broken?
• How the switches decides about the way out?

Quiz

• 201: If the identifier of packet from host A in last example was 7, not 5 where it will be routed?
Advantages of VC

- More thing can be done while setting up connections:
  - There is really a route.
  - Every body on the way can allocate buffer for a connection.
  - A QOS can be ensured.
- In X.25:
  - Buffers are allocated.
  - Sliding-window protocol is run between each pair of nodes along the VC.
  - The circuit is rejected by a given node if not enough buffer is available.

Datagram Forwarding

- In this model, there is no need to setup a connection.
- Each packet contains just enough information to get to the destination (what is it?)
- Each switch decides how to forward it towards the destination.
Example of Datagram Forwarding

```
<table>
<thead>
<tr>
<th>Port</th>
<th>A</th>
<th>C</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
```

Characteristics of Datagram Forwarding

- No round trip delay.
- But large tables.
- While sending, no way of knowing if the connection is there.
- Failure of one switch may not have any effect on communication.
- Every packet must carry the destination address. The overhead is higher than connection-oriented model.
- No obvious way of setting up QOS.
Routing Algorithms

Routing

- How do the nodes, or switches find out about the network topology?
- Forwarding vs. Routing:
  - Forwarding consists of talking a packet, looking at its header or destination address, consulting a table, and sending the packet in the direction determined by the table.
  - Routing is the process by which the tables are built, and is a topic to which people can devote an entire career.
  - The basic objective is to find the lowest cost path between two nodes in the network.
- Generally networks are large and dynamic. Thus static approaches do not work.
Quiz

- 202: Datagram forwarding vs. Virtual Circuit, which one will you use for short communication (say only 10 byte communication). Explain why?

Computing Shortest Path
(Dijkstra’s Algorithm)

$W[i][j]$=link cost between node i and j. /*Collected from link states.*/
$S[i]$=all nodes except source; /*A list of target nodes*/
$R[i]$=source for all connected nodes otherwise $R[i]=zero$. /*Next hops*/

while(set $S$ is not empty) {
    choose a node $u$ from $S$ which is 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 ($c < D[v]$) {
                $R[v]=R[u]$;
                $D[v]=c$;
            }
        }
    }
}
Example routing table for node D

Quiz: 204: If distance BD is 3 instead of 11 which node will be picked in the confirmed list after D?