Comparison of Datagram and Virtual Circuit

<table>
<thead>
<tr>
<th>Issue</th>
<th>Datagram</th>
<th>Virtual Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection setup</td>
<td>Not needed</td>
<td>Required</td>
</tr>
<tr>
<td>Addressing</td>
<td>Each packet contains the full destination address</td>
<td>Each packet contains a short VC identifier</td>
</tr>
<tr>
<td>State information</td>
<td>Switch doesn’t hold state information</td>
<td>Switch holds VC state information in a table</td>
</tr>
<tr>
<td>Routing</td>
<td>Each packet is forwarded independently</td>
<td>All packets follow the same route</td>
</tr>
<tr>
<td>Effect of switch failures</td>
<td>None, except for packets lost during the crash</td>
<td>All VCs passing through the failed switch are broken</td>
</tr>
<tr>
<td>QoS support</td>
<td>Difficult</td>
<td>Easy</td>
</tr>
<tr>
<td>Congestion control</td>
<td>Difficult</td>
<td>Easy</td>
</tr>
</tbody>
</table>
Forwarding Algorithm of Learning Bridge

- When a frame is received, look up the destination address in forwarding table.
- If destination is not found, forward the frame to all the other ports.
- If destination is found:
  - If destination and source are on the same port, discard the frame.
  - If destination and source are on different ports, forward the frame to the port indicated in the table entry.

Spanning Tree Protocol

- Bridges exchanges configuration messages; each configuration message contains
  1. ID of the bridge that the sending bridge believes to be the root
  2. Distance (in hops) from sending bridge to the root bridge
  3. ID of the sending bridge
- Initially, each bridge B thinks it is the root and sends a configuration message (B, 0, B) out on each of its ports.
- Upon receiving a configuration message over a port x, the bridge checks if the new message is better than the current best message recorded for port x
  - The new configuration message is better if
    1. It identifies a root with a smaller ID or
    2. It identifies a root with an equal ID but with a shorter distance or
    3. The root ID and distance are equal, but the sending bridge has a smaller ID
- If the new message is better, save the new information after adding 1 to the distance field.
- If the new message is case 1, the bridge stops generating configuration messages and only forwards configuration messages from other bridges after adding 1 to the distance field.
- If the new message is case 2 or 3, the bridge stops sending configuration messages over port x
- When the system stabilizes, only the root bridge is generating configuration messages, other bridges are forwarding these messages only over ports for which they are the designated bridge
Algorhyme by Radia Perlman

I think that I shall never see
A graph more lovely than a tree.
A tree whose crucial property
Is loop-free connectivity.
A tree that must be sure to span
So packets can reach every LAN.
First, the root must be selected.
By ID, it is elected.
Least-cost paths from root are traced.
In the tree, these paths are placed.
A mesh is made by folks like me,
Then bridges find a spanning tree.

Example of a virtual path.

ATM cell format. Field lengths are in bits.

Segmentation and reassembly in ATM.

AAL3/4 CS-PDU format

AAL3/4 ATM cell format

Encapsulation and segmentation for AAL3/4.
AAL5 CS-PDU format

Encapsulation and segmentation for AAL5.