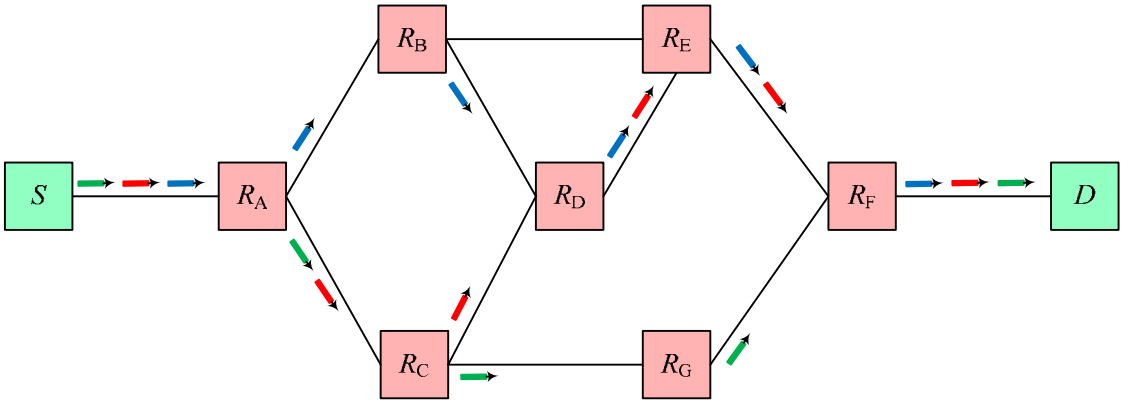
Ref: A. Leon Garcia and I. Widjaja, *Communication Networks*, 2nd Ed. McGraw Hill, 2006
Latest update of this lecture was on 13-01-2011

Lecture 35: Packet Switching Networks

Connectionless vs. Connection-Oriented Packet Switching

There are two modes of communication over packet switched networks:

- **Connectionless:** In this mode, transmission of packets from a source machine to a destination machine is done on a per-packet basis, meaning that each packet is transmitted and routed independently from all other packets. So, even if the source and destination machines do not change, routers in the middle may decide to change the routs that different packets follow resulting in the different packets sometimes reaching their destination out of order because of the difference in path length, difference in path transmission rates, and the amount of congestion of the different routers that the different packets travelled through. This is illustrated in the following figure. In this figure, three packets are transmitted from the same source machine heading towards the same destination machine. Each route of the network shows the packets that have travelled over it. In this case, it is clear that due to a combination of reasons, the packets may arrive at the destination machine in an order different from the transmission order.



In connectionless transmission, routers use a simple (but long) routing table that has the following two main columns.

Destination Address	Output Port

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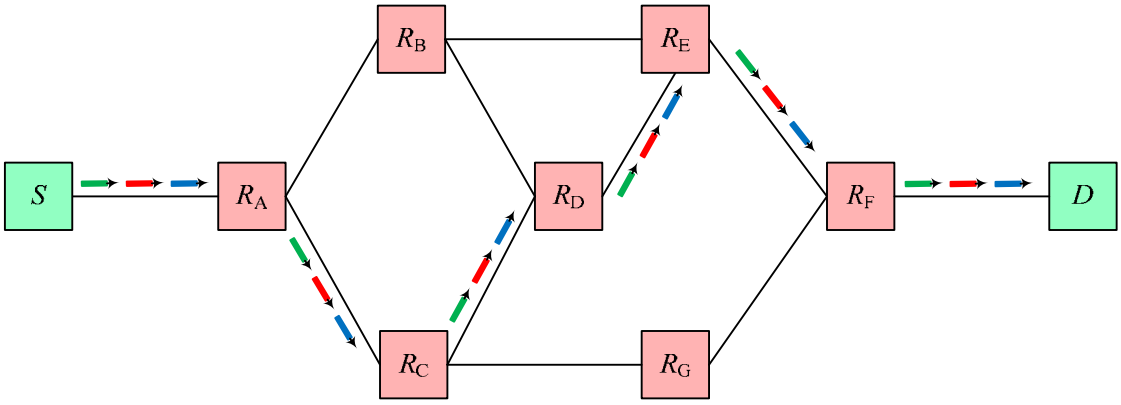
Since the details of this routing table change, the routing of different packets often changes. The process of transmission in this case involves the following steps:

- Transmit Packet 1
- Transmit Packet 2
- ……
- Transmit Packet *N*

- **Connection-Oriented (Virtual-Circuit Packet Switching):** In this mode, transmission of packets from a source machine to a destination machine is done on a per source-destination pair basis, meaning that all packets from the same source going to the same destination are transmitted over the same routes and through the same routers. This results in having almost a constant delay of transmission for the different packets and the different packets reaching their destination in order. This is illustrated in the following figure. In this figure, three packets are transmitted from the same source machine heading towards the same destination machine. Each route of the network shows the packets that have travelled over it. In this case, it is also clear that due to the use of the same routers and same routes, the packets will experienced almost the same delay and will arrive at the destination machine in the same order of transmission.



It is clear from the above figure that a circuit-like connection has been established. The process of transmission in the above case is called **Virtual-Circuit Packet Switching**. Virtual-Circuit Packet Switching involves the establishment of a fixed path called **Virtual Circuit** or **Virtual Connection** between the source and destination prior to the transfer of packets. An advantage of virtual circuit packet switching is that resources are allocated for the connection such allocating buffer in the different switches over which the virtual connection passes over and allocating a specific bandwidth for the connection.

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The process of transmission in this case involves the following steps:

- ***Connection Request***
- ***Connection Confirm***
- Transmit Packet 1
- Transmit Packet 2
- ……
- Transmit Packet *N*
- ***Connection Release***

Notes:

- If a packet switch does not have enough resources, it sends a Connect Reject and the Connection Establishment Fails.
- Virtual Circuits guarantee the ordered arrival of packets.
- A Virtual Circuit Identifier (VCI) is used to identify the VC (VCI is generally modified at each packet switch for traveling on the next hop) → VCI are local to each switch or link

Benefits of using Local VCI (local to each switch) over Global VCI (global for all switches in the network)

1) more VC can be assigned
2) searching for an unused VCI is simple

The format of the Virtual Circuit Switching Table is as follows:

Input Port	Input VCI	Output Port	Output VCI

Advantages of Virtual Circuit Packet Switching over Connectionless Packet Switching:

- Shorter headers are required for VC (VCI is shorter than full network address: VCI may have a length of 1 or 2 bytes, while Full IP address has length of 4 bytes for IPv4 and 12 bytes of IPv6).
- Faster because no routing is done (VCI list is shorter and all packets are made to follow each other along the same path by simply looking up the VC table)

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- Resources are set up in advance for the VC (reserve buffers and some bandwidth at each switch)

Disadvantage of VC Packet Switching

- When a failure occurs in the connection, all Virtual Circuits must be set up again.