

CPE348: Introduction to Computer Networks

Lecture #9: Chapter 3.2



Jianqing Liu
Assistant Professor of Electrical and Computer
Engineering, University of Alabama in Huntsville

jianqing.liu@uah.edu
<http://jianqingliu.net>

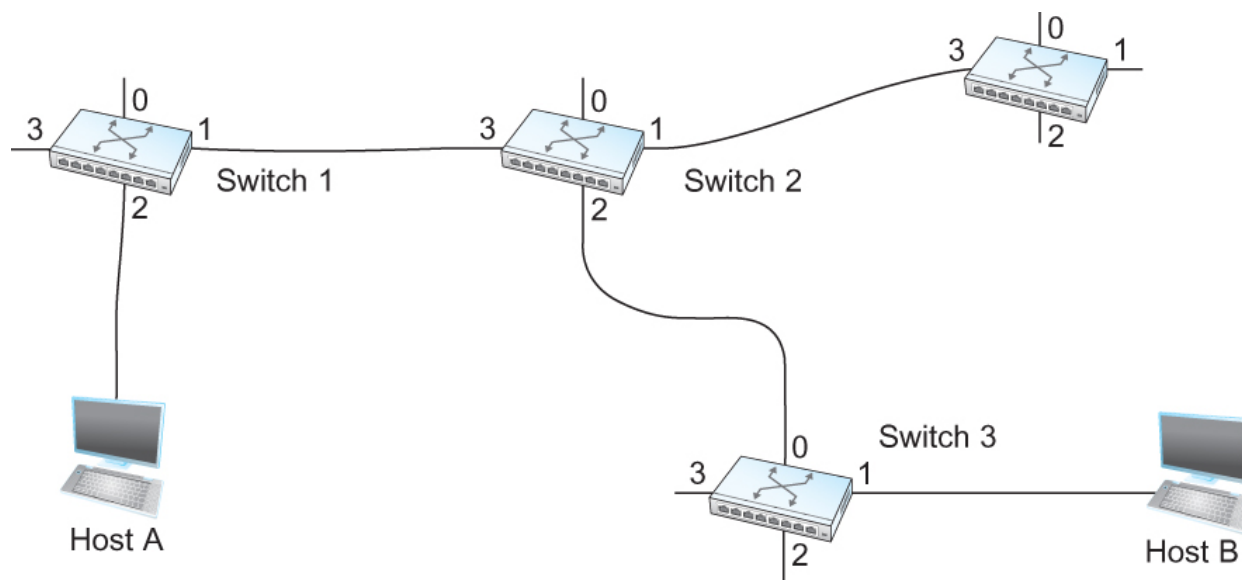
Virtual Circuit Switching

Virtual Circuit Switching

- Similar to circuit switching
- Widely used technique for packet switching
- Uses the concept of *virtual circuit (VC)*
- Provides **connection-oriented** service
- First set up a virtual connection from the source host to the destination host and then send the data

Virtual Circuit Switching

- Host A wants to send packets to host B



Virtual Circuit Switching

Two-stage process

- Connection setup
- Data Transfer

- Connection setup

- Establish “**connection state**” or “**label**” in each of the switches between the source and destination hosts
- The connection state for a single connection consists of an entry in the “**VC table**” in each switch

Virtual Circuit Switching

One entry in the VC table on a single switch contains

- A virtual circuit identifier (VCI)
 - Uniquely identifies the connection at this switch for the link
 - Carried inside the header of the packets that belong to this connection
- An incoming interface on which packets for this VC arrive at the switch
- An outgoing interface in which packets for this VC leave the switch

VC table in a Switch

Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
3	11	2	7

Virtual Circuit Switching

Note:

- There may be **many virtual connections** established in the switch at one time
- Incoming and outgoing **VCI** values are **not** generally the **same**
- Whenever a new connection is created, we need to assign a **new VCI** for that connection on each link that the connection will traverse
 - We need to ensure that the chosen VCI on a given link is not currently in use on that link by some existing connection.

Virtual Circuit Switching

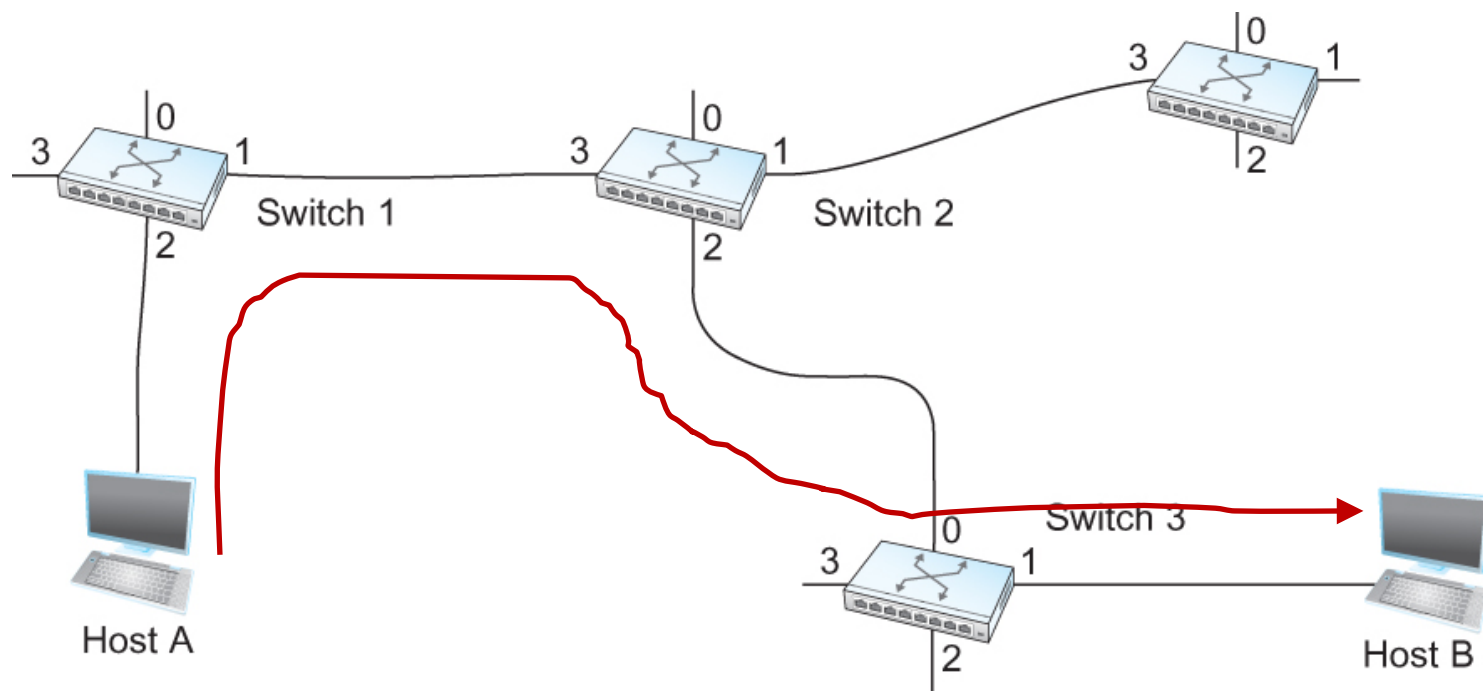
Two broad classes of approach to establishing a virtual circuit

- Network Administrator will configure the state (**centralized**)
- A host can send messages into the network to cause the state to be established (**distributed**)

Virtual Circuit Switching

Let's assume that a network administrator wants to manually create a new virtual connection from host A to host B

- First the administrator identifies a path through the network from A to B



[return](#)

Virtual Circuit Switching – centralized

The administrator then picks a VCI value that is currently unused on each link for the connection

- For our example,
 - Suppose the VCI value 5 is chosen for the link from host A to switch 1
 - 11 is chosen for the link from switch 1 to switch 2
 - So the switch 1 will have an entry in the VC table

Switch 1 VC table

Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
2	5	1	11

Virtual Circuit Switching – centralized

Similarly, suppose

- VCI of 7 is chosen to identify this connection on the link from switch 2 to switch 3
- VCI of 4 is chosen for the link from switch 3 to host B
- Switches 2 and 3 are configured with the following VC table

Switch 2 VC table

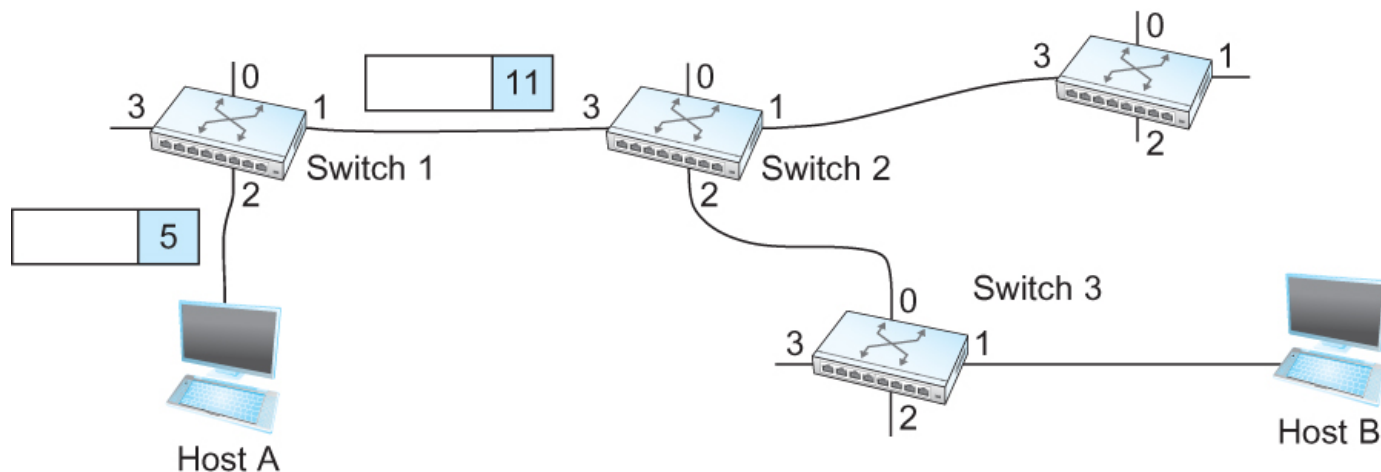
Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
3	11	2	7

Switch 3 VC table

Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
0	7	1	4

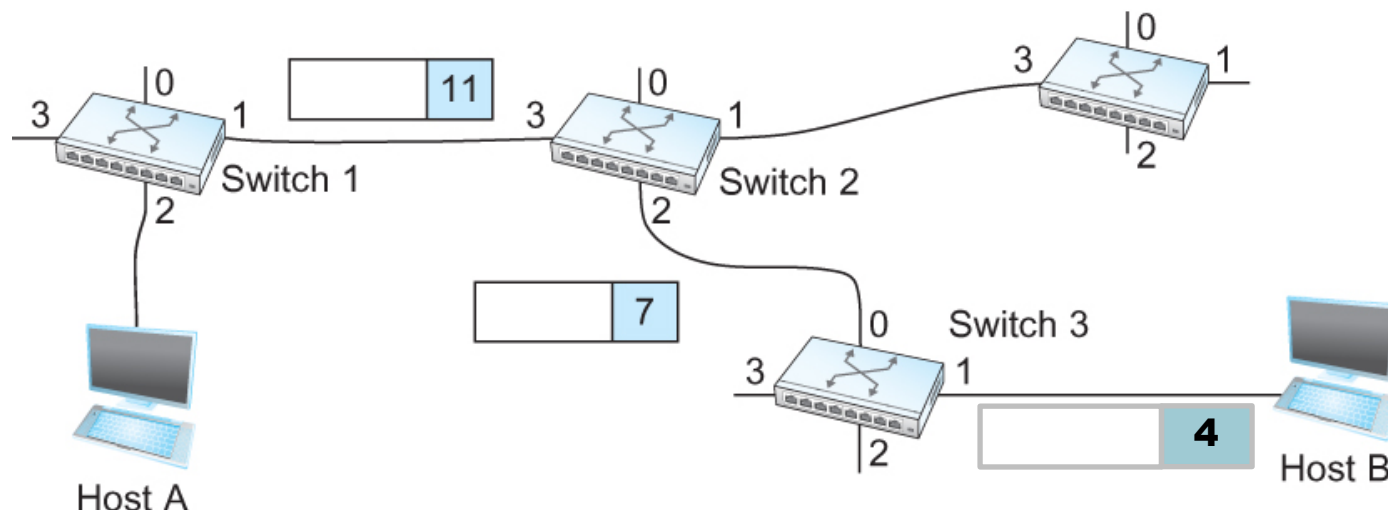
Virtual Circuit Switching – centralized

- For any packet that A wants to send to B, A puts the VCI=5 in the header of the packet and sends it to switch 1.
- Switch 1 receives a packet of VCI=5 on interface 2, and it searches for the appropriate VC table entry.
- The table entry on switch 1 tells the switch the output interface=1 and VCI=11.



Virtual Circuit Switching – centralized

- Packet will arrive at switch 2 on interface 3 bearing VCI=11
- Switch 2 looks up interface 3 and VCI=11 in its VC table and sends the packet on to switch 3 after updating the VCI=7
- This process continues until it arrives at host B with the VCI=4 in the packet

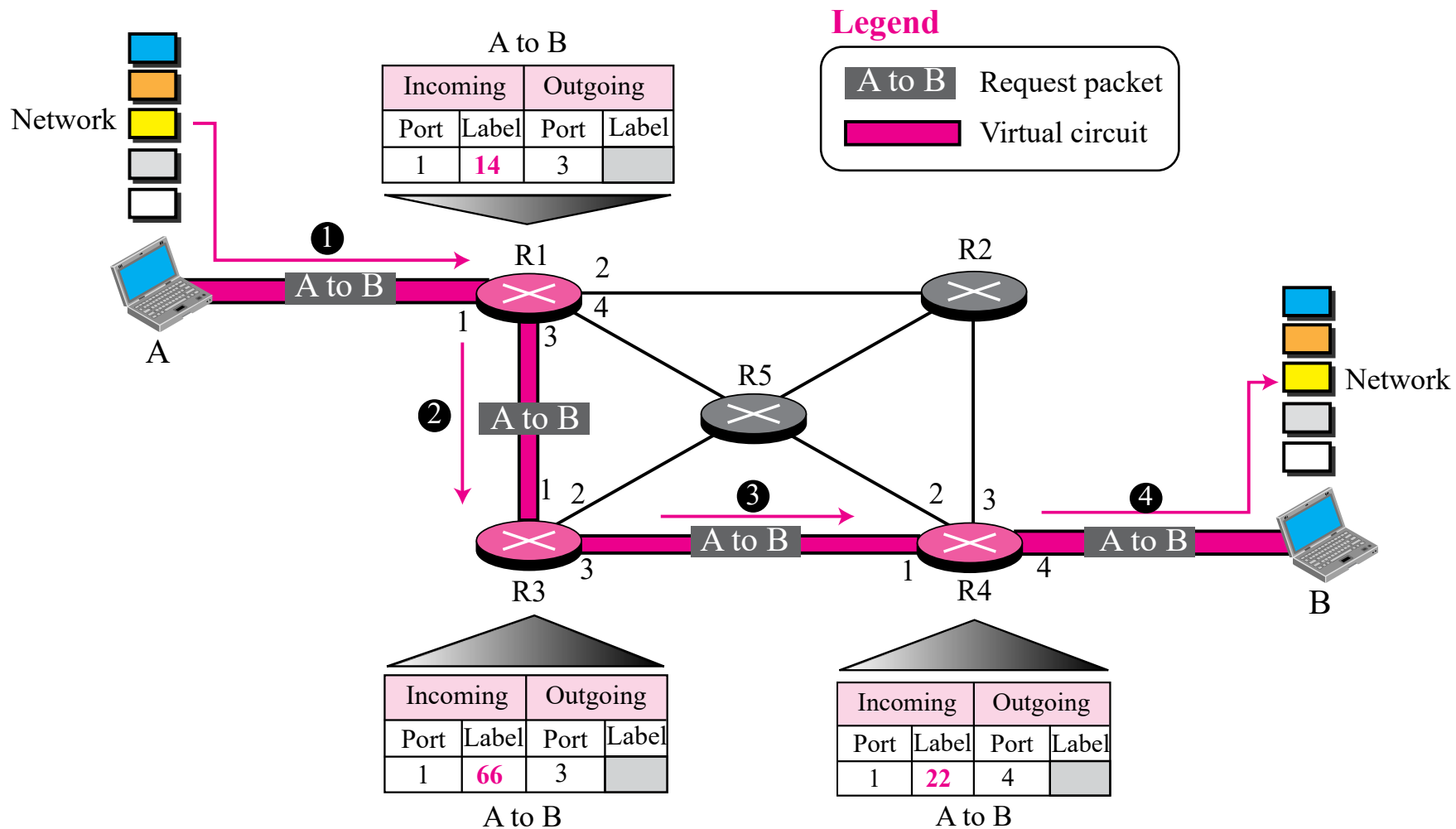


Virtual Circuit Switching – centralized

- In real networks of a large number of switches, the burden of configuring VC tables become excessive!!!
- A user-centric, on-demand approach to configuring VC tables is favorable!

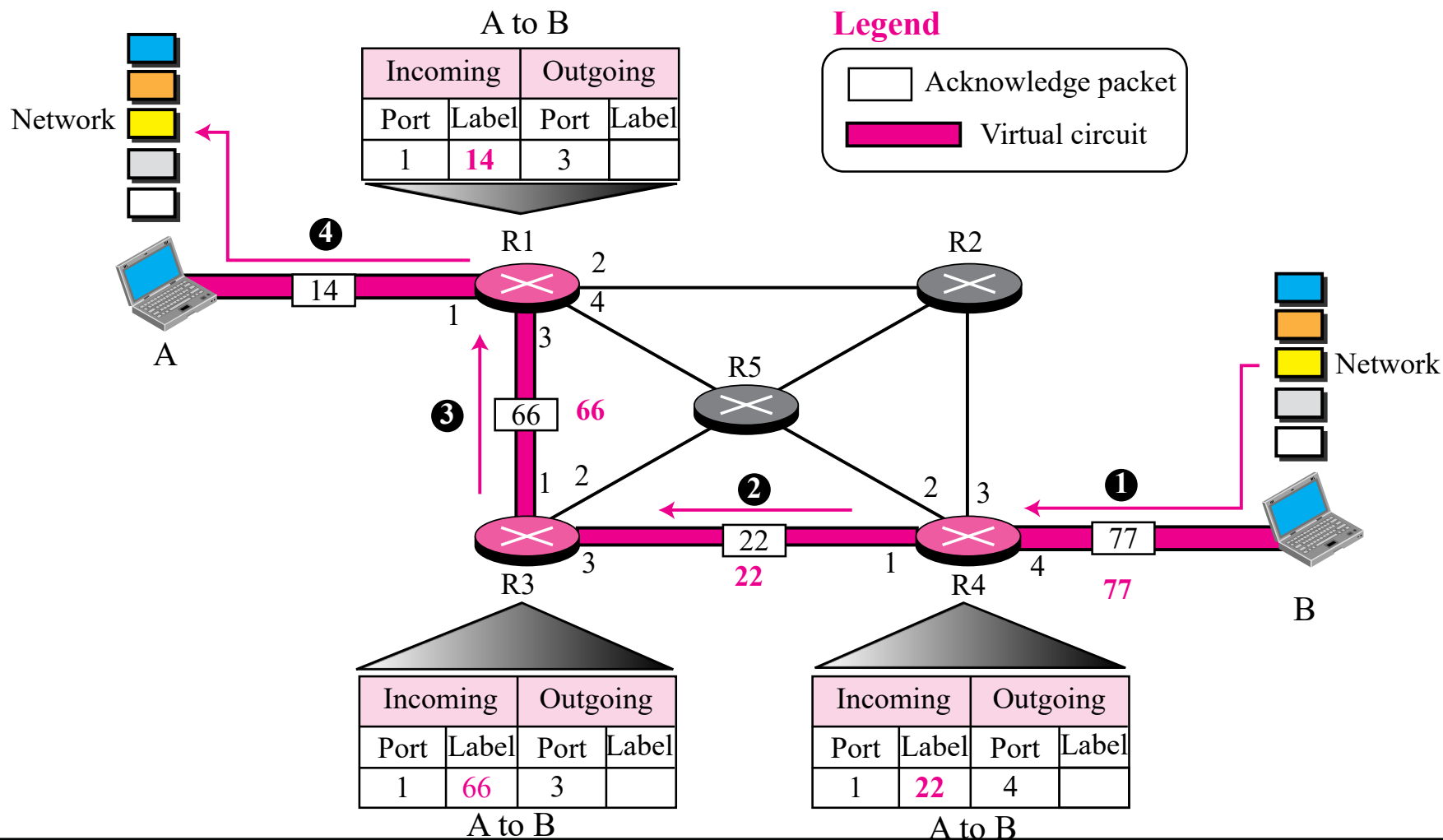
Virtual Circuit Switching – distributed

Overview: Part1 – Sending a *request packet*



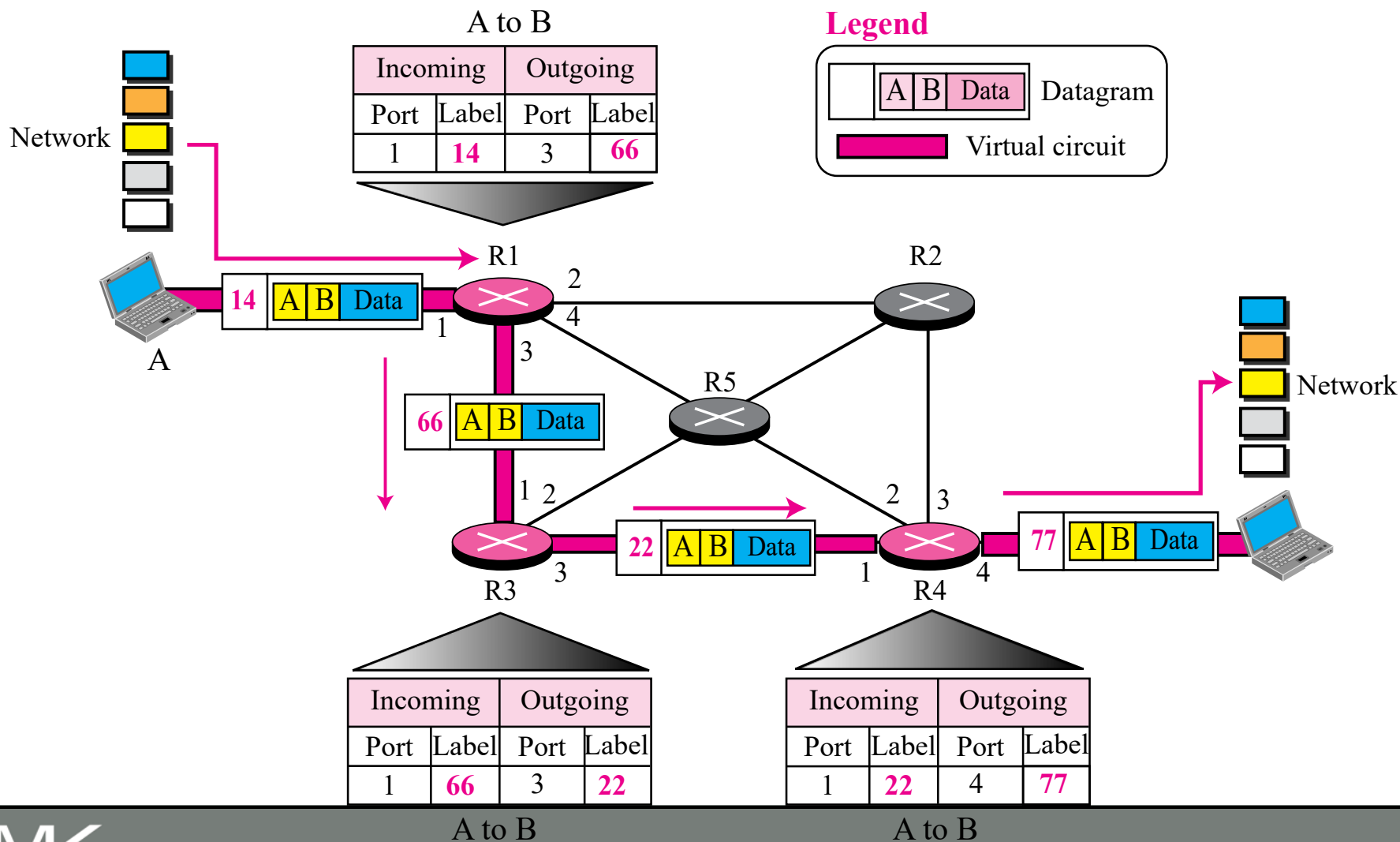
Virtual Circuit Switching – distributed

Overview: Part2 – Setup an *acknowledgement*



Virtual Circuit Switching – distributed

Overview: After Part 1 and Part 2, data communications



Virtual Circuit Switching – distributed

- When host A no longer wants to send data to host B, it tears down the connection by sending a teardown message to switch 1
- The switch 1 removes the relevant entry from its table and forwards the message to the other switches in the path which similarly delete the appropriate table entries

Virtual Circuit Switching – distributed

- Characteristics of setting up a Virtual Circuit
 - Connection request requires at least **one RTT of delay**, so there is a delay before data is sent.
 - If a switch or a link in a connection fails, the connection is broken and a new one will need to be established.
 - The issue of how a switch decides which link to forward the connection request on has similarities with the function of a routing algorithm. (We will discuss it in the next chapter.)

Asynchronous Transfer Mode

- ATM (Asynchronous Transfer Mode)
 - Based on virtual circuit switching
 - Connection-oriented packet-switched network
 - Packets are called cells (53 bytes total)
 - 5 byte header + 48 byte payload

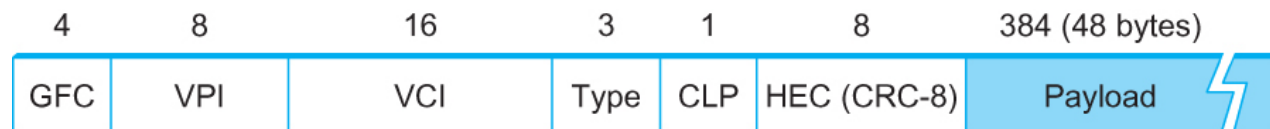


Asynchronous Transfer Mode

■ ATM Cell Structure

■ User-Network Interface (UNI) (Host-to-Switch format)

- GFC: Generic Flow Control
- VPI: Virtual Path Identifier
- VCI: Virtual Circuit Identifier
- Type: management, congestion control
- CLP: Cell Loss Priority
- HEC: Header Error Check (CRC-8)

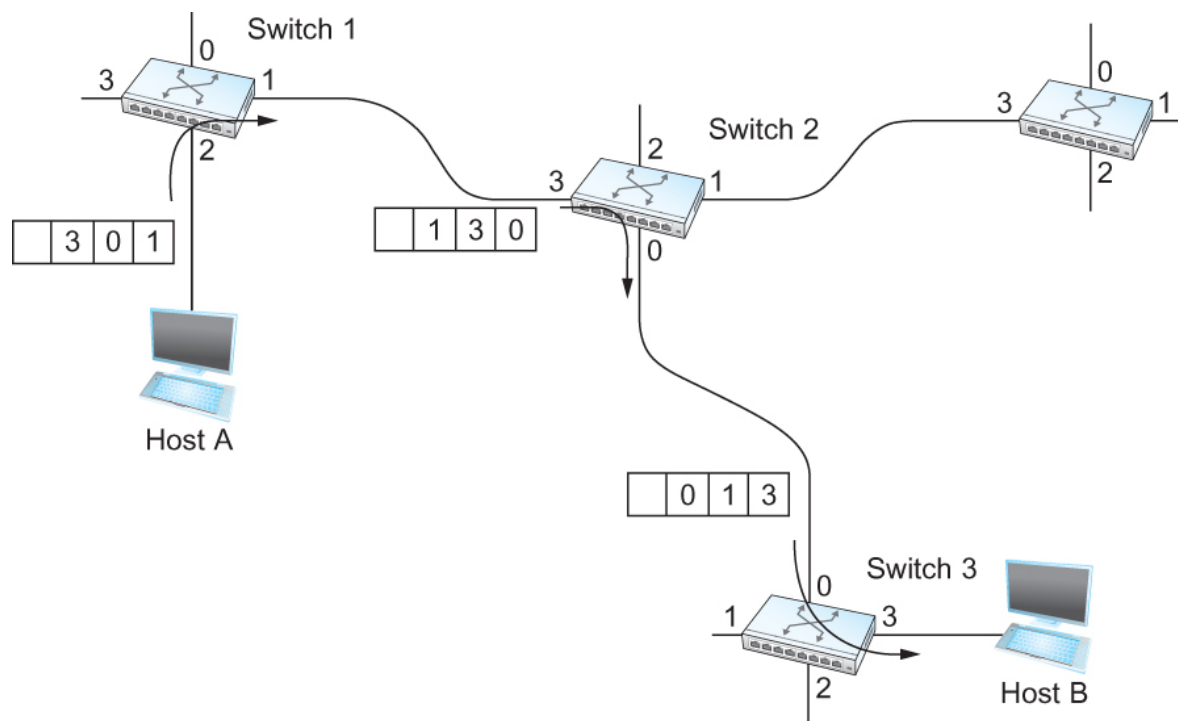


■ Network-Network Interface (NNI) (Switch-to-Switch format)

- GFC becomes part of VPI field

Source Routing

- Source Routing
 - All the information about network topology that is required to switch a packet across the network is provided by the source host
 - Header contains next port to use by receiving switch



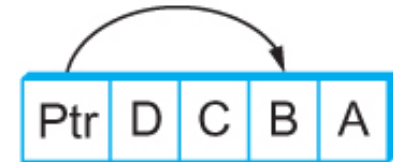
Source Routing

- Three other approaches in Source Routing

Header entering
switch



Header leaving
switch



(a)

(b)

(c)

- (a) – header is rotated
- (b) – header is stripped
- (c) – pointer is used