

# Chapter 4

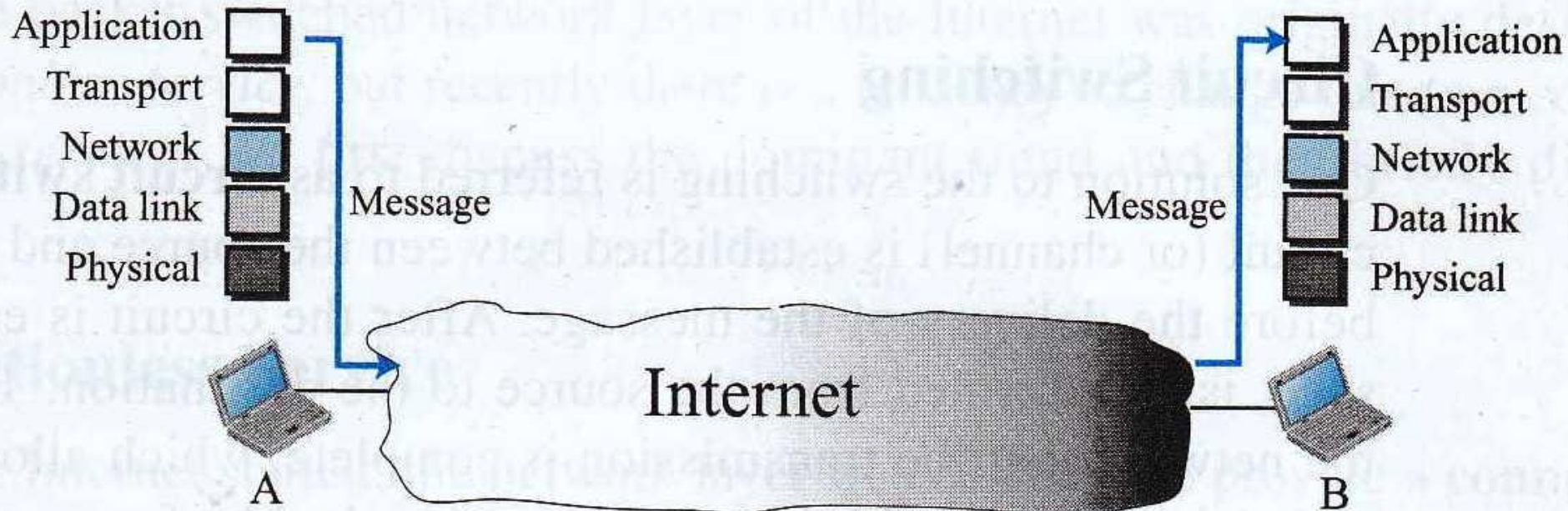
# *Introduction to Network Layer*

# INTRODUCTION

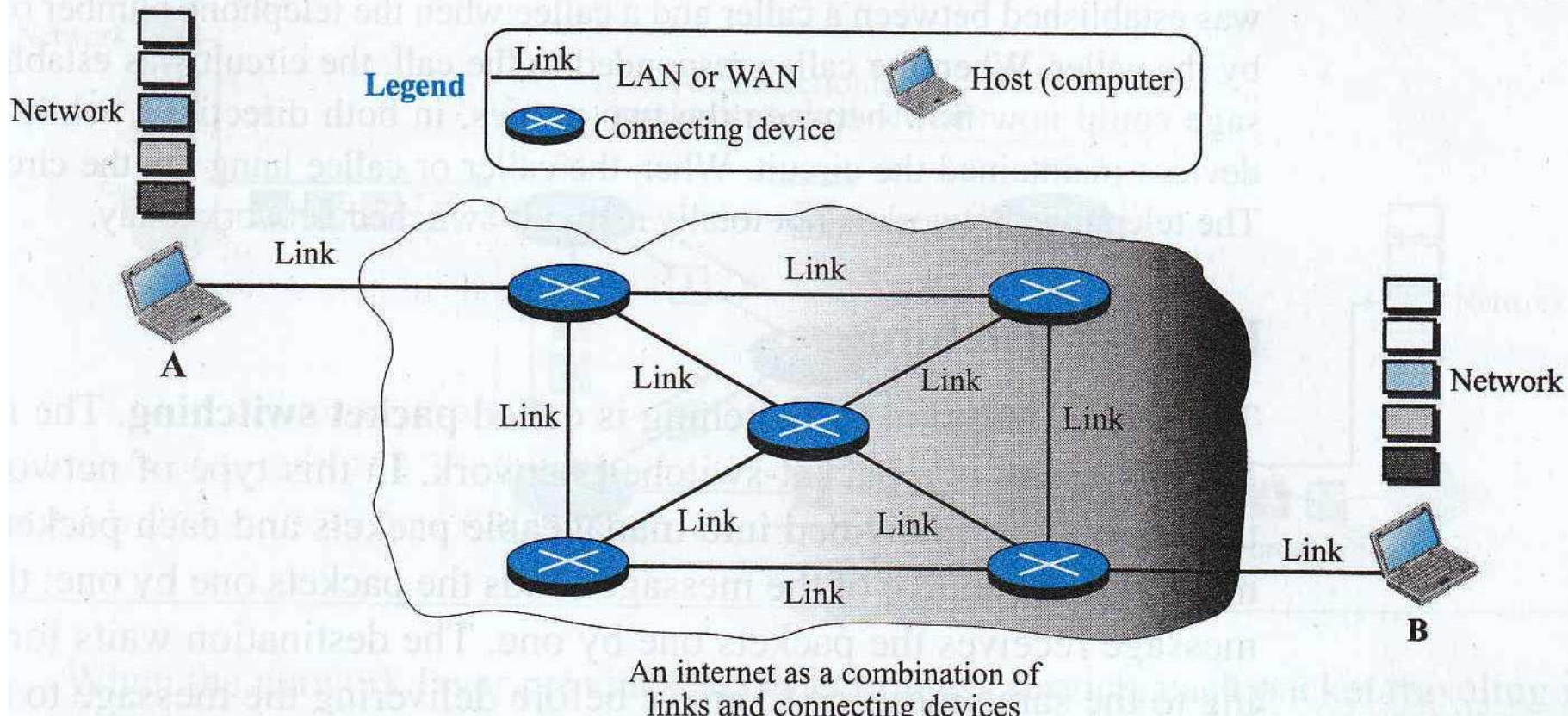
# Network Layer

- Network Layer: the most complex layer
  - Requires the coordinated actions of multiple, geographically distributed network elements (switches & routers)
  - Must be able to deal with very large scales
    - Billions of users (people & communicating devices)
  - Biggest Challenges
    - Addressing: where should information be directed to?
    - Routing: what path should be used to get information there?

# Internet as a Black Box



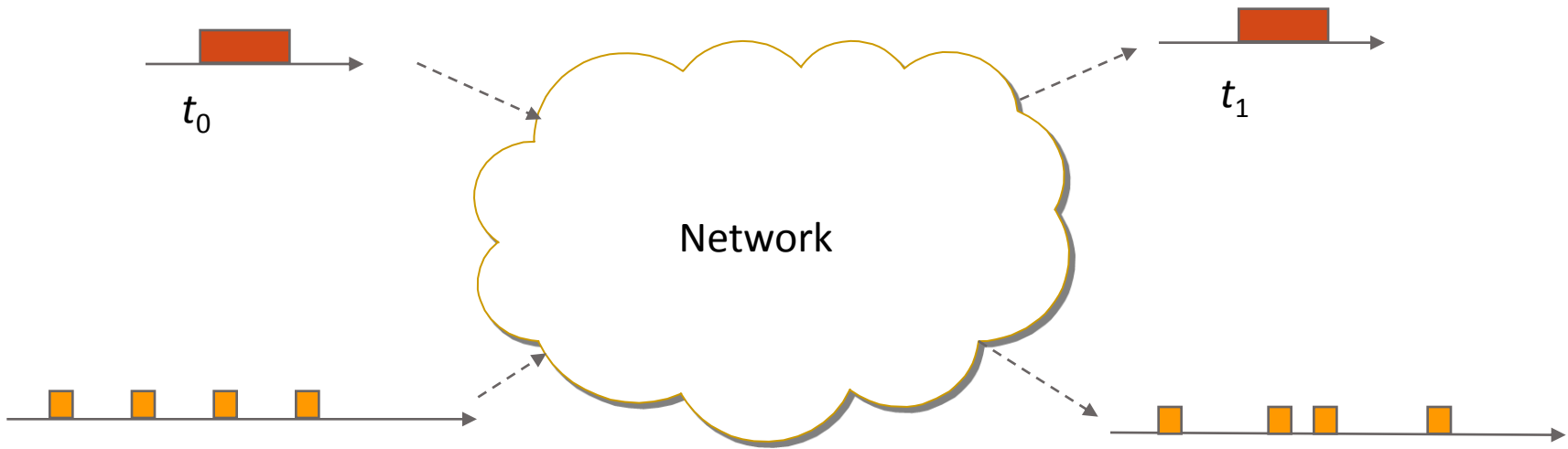
# Internet as a Combination of LANs and WANs



# Switching

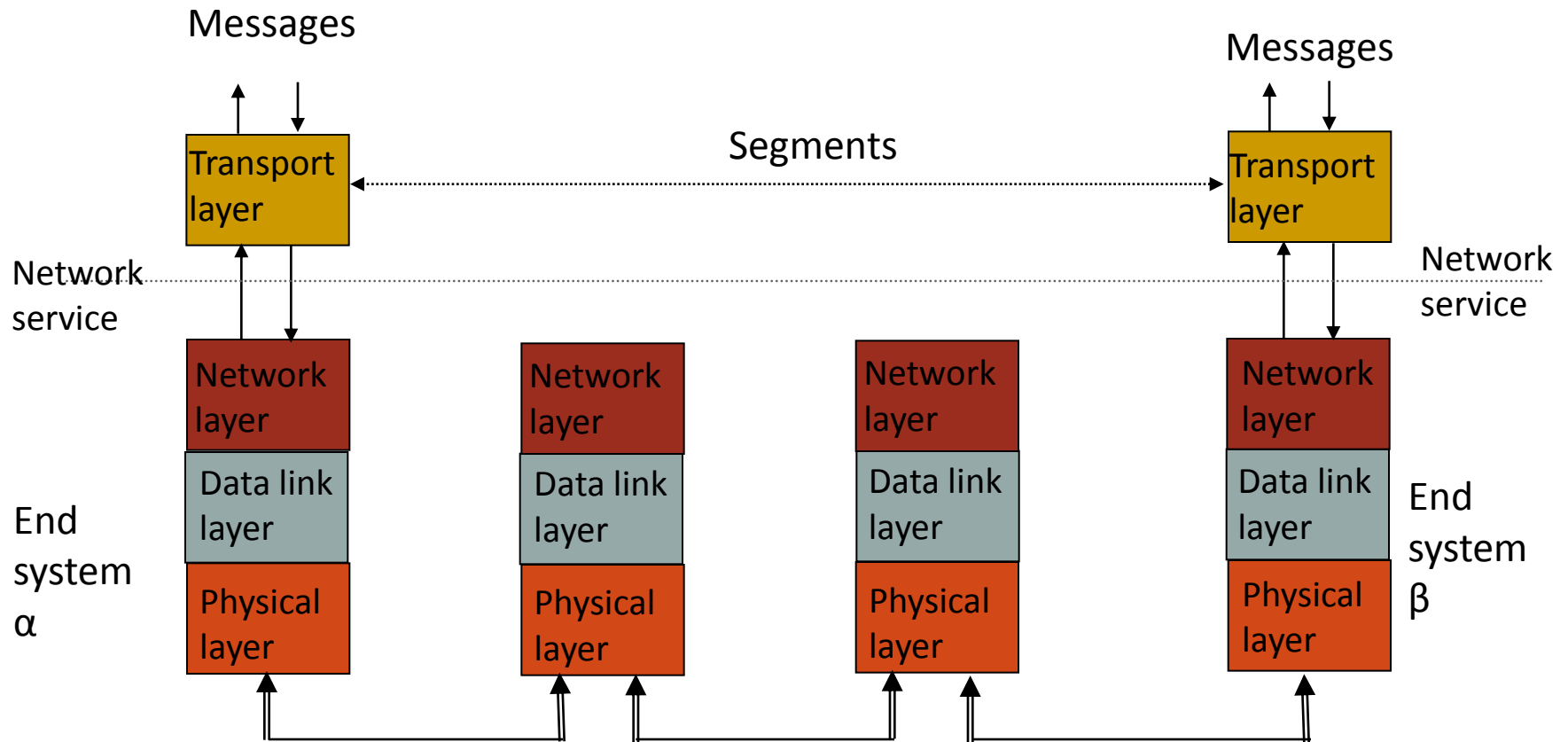
- Circuit Switching
  - The whole message is sent from source to destination without being divided into packets
- Packet Switching
  - The whole message is divided into some packets

# Packet Switching



- Transfer of information as payload in data packets
- Packets undergo random delays & possible loss
- Different applications impose differing requirements on the transfer of information

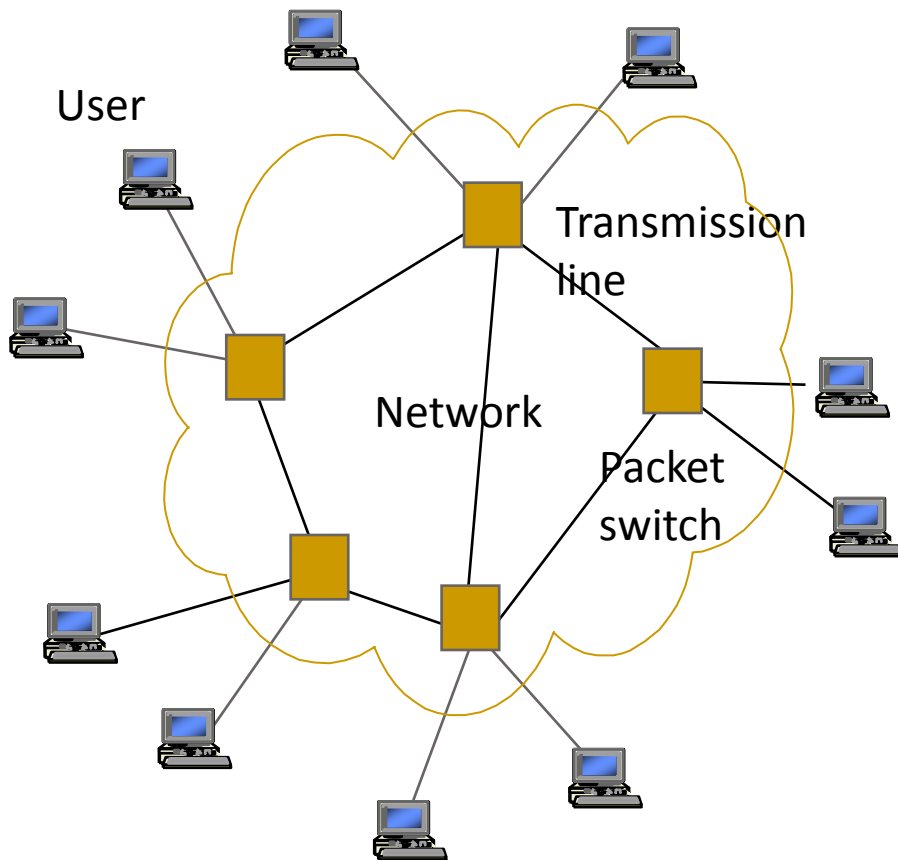
# Network Service



- Network layer can offer a variety of services to transport layer
- Connection-oriented service or connectionless service
- Best-effort or delay/loss guarantees



# Packet Switching Network



Packet switching network

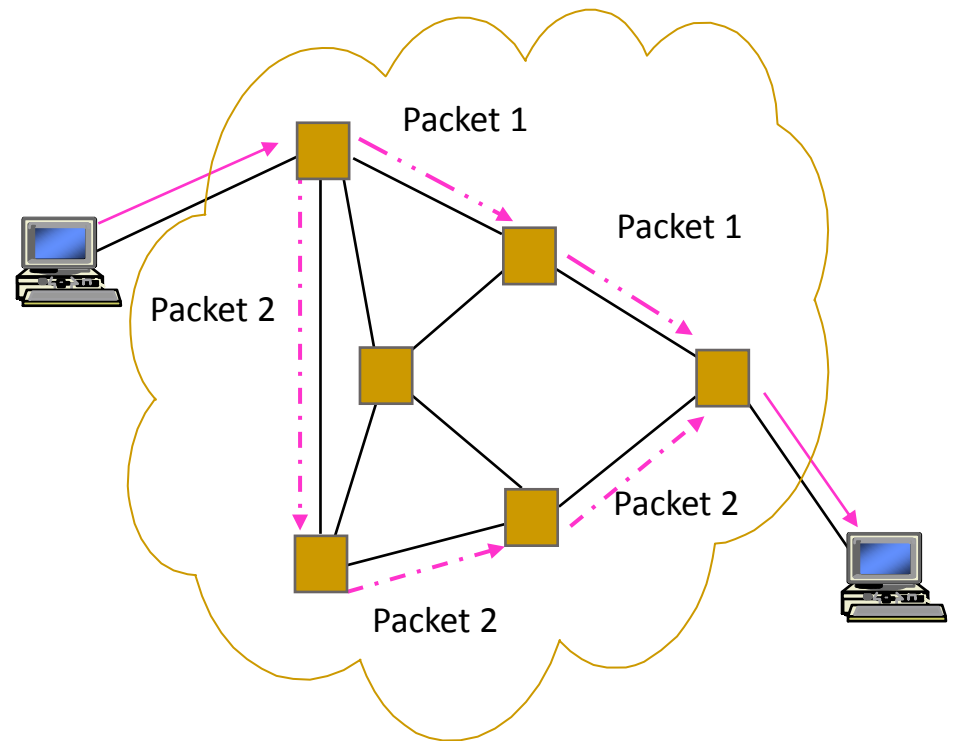
- Transfers packets between users
- Transmission lines + packet switches (routers)

Two modes of operation:

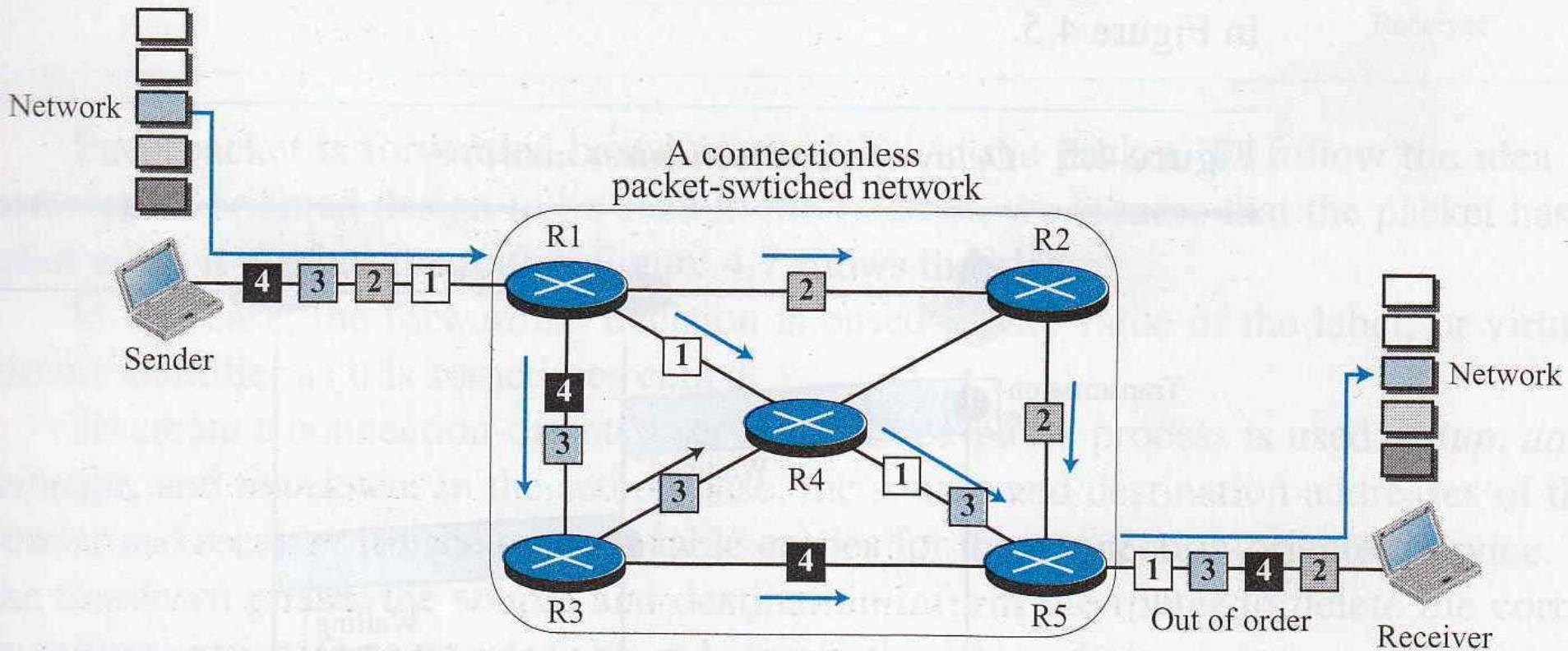
- Connectionless
- Virtual Circuit

# Packet Switching – Connectionless ( Datagram)

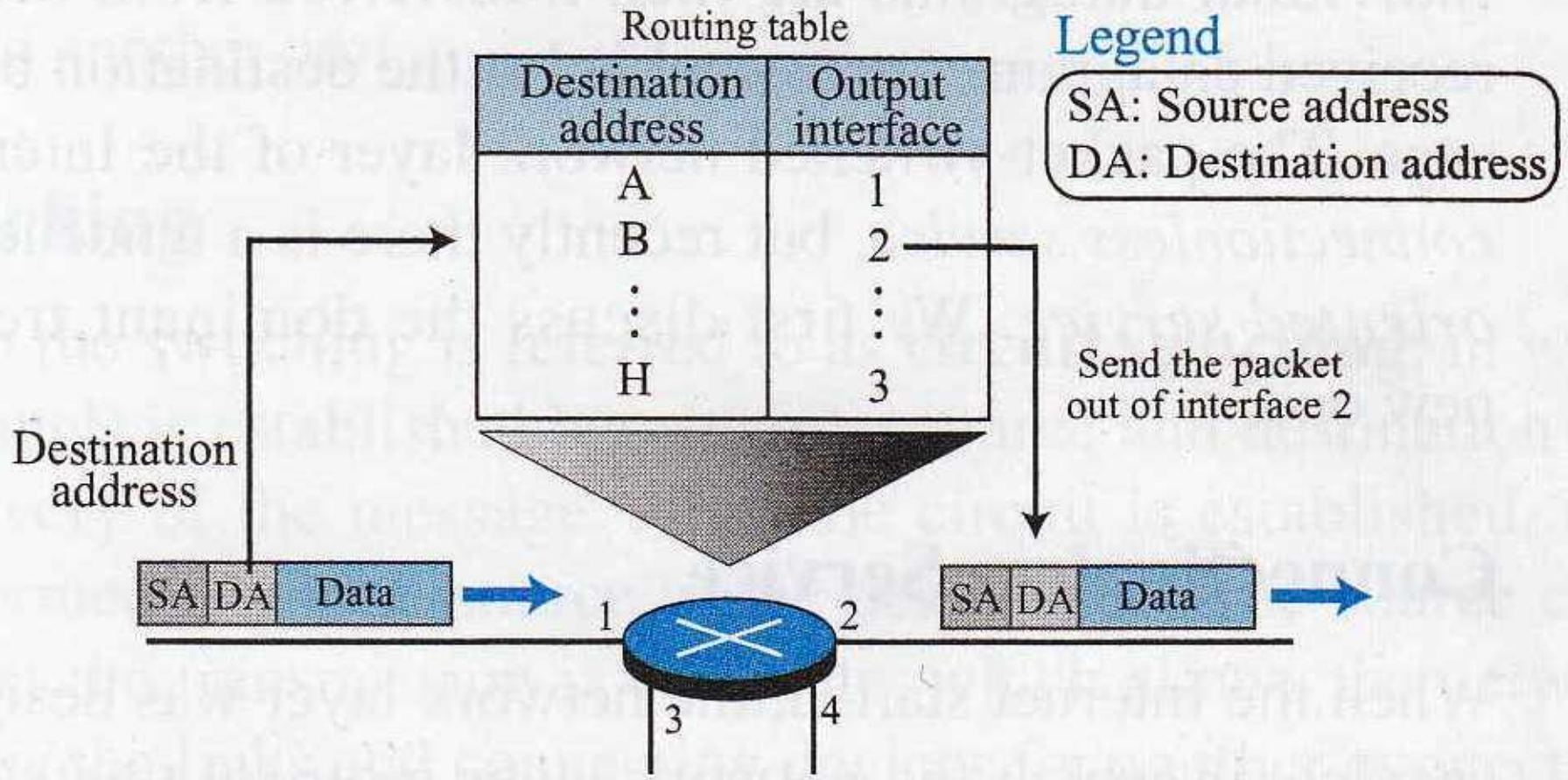
- Messages broken into smaller units (packets)
- Source & destination addresses in packet header
- Connectionless, packets routed independently (datagram)
- Packet may arrive out of order



# Connectionless Packet-Switched Network



# Forwarding Process in connectionless networks

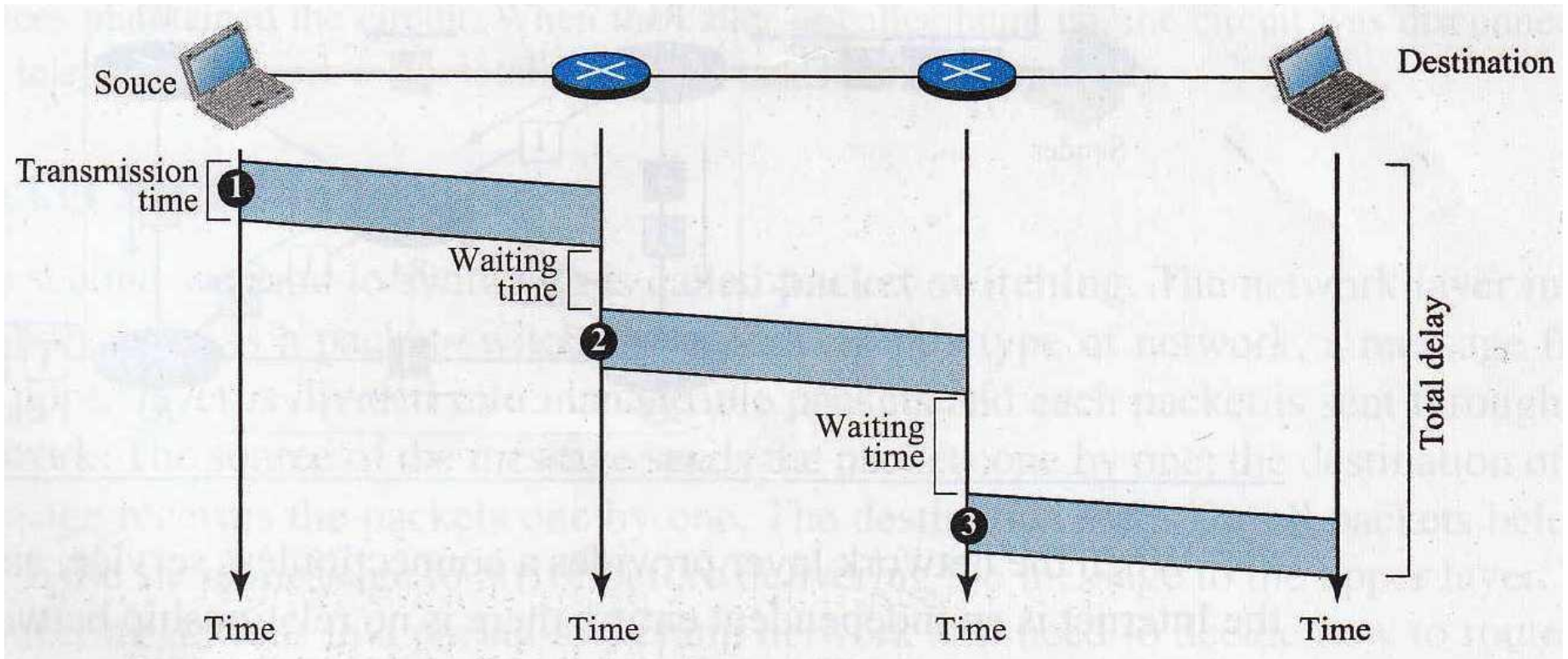


# Routing Tables in Datagram Networks

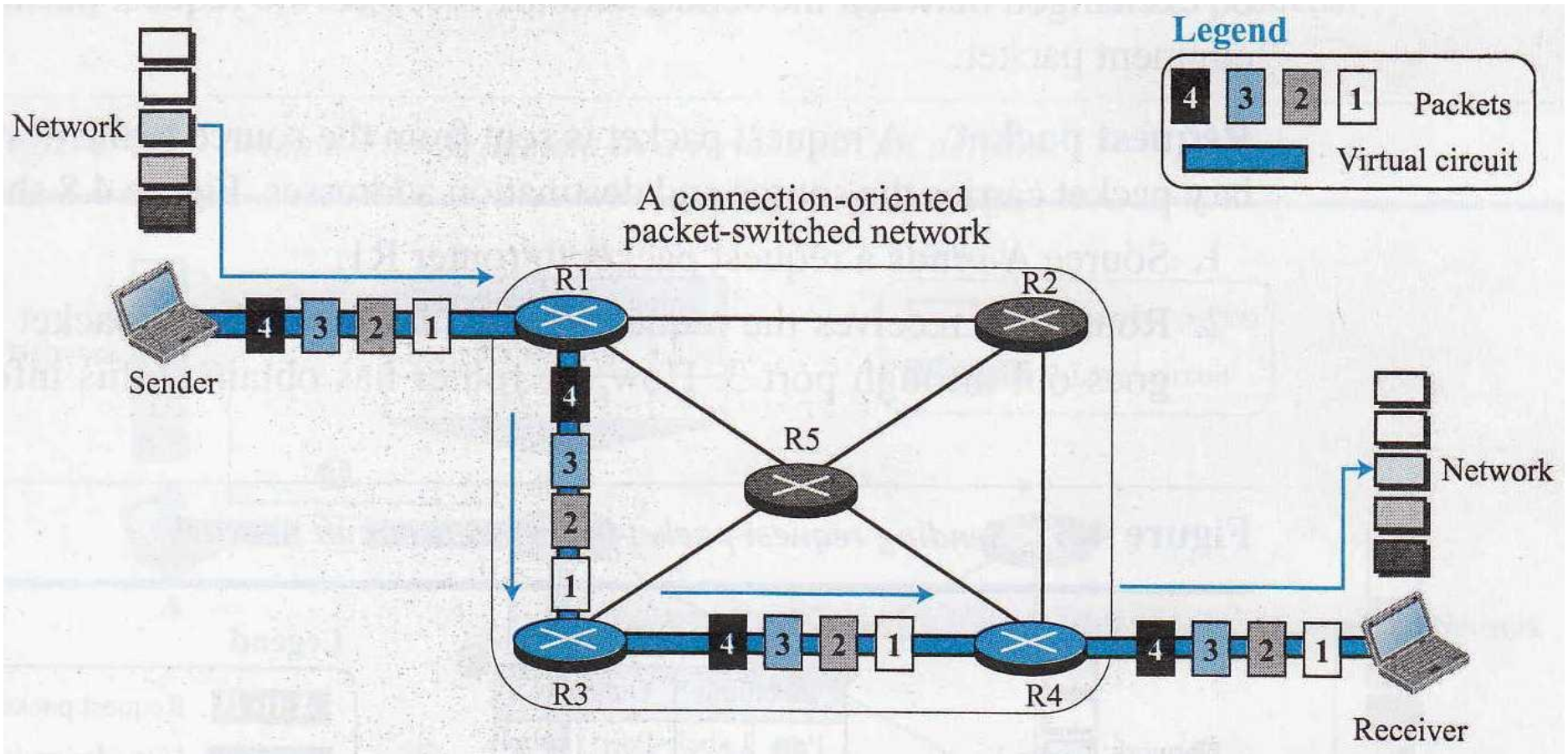
Destination address	Output port
0785	7
1345	12
1566	6
2458	12

- Route determined by table lookup
- Routing decision involves finding next hop in route to given destination
- Routing table has an entry for each destination specifying output port that leads to next hop
- Size of table becomes impractical for very large number of destinations

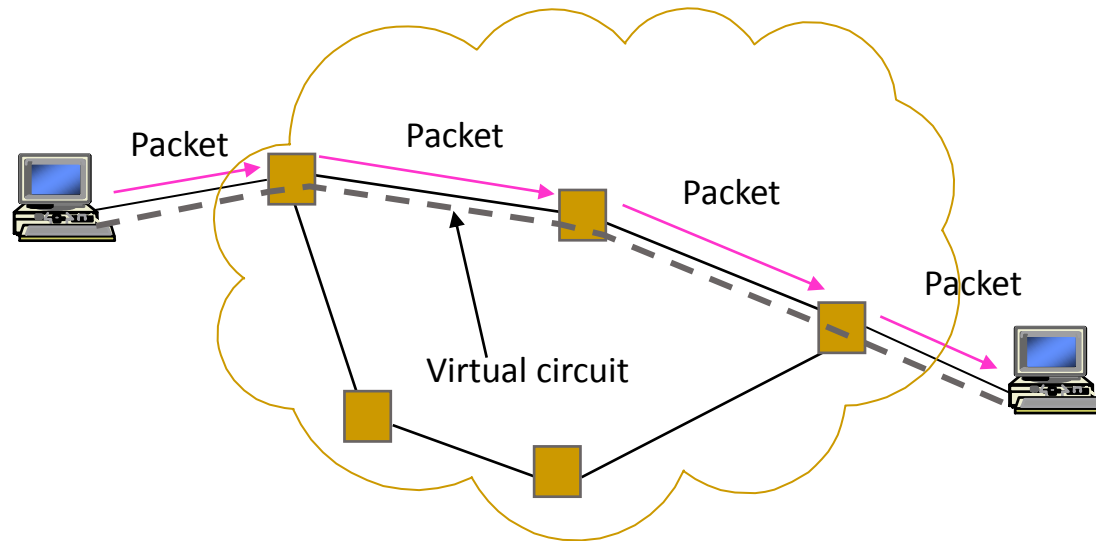
# Delay in connectionless network



# Connection oriented packet switched networks – virtual circuit



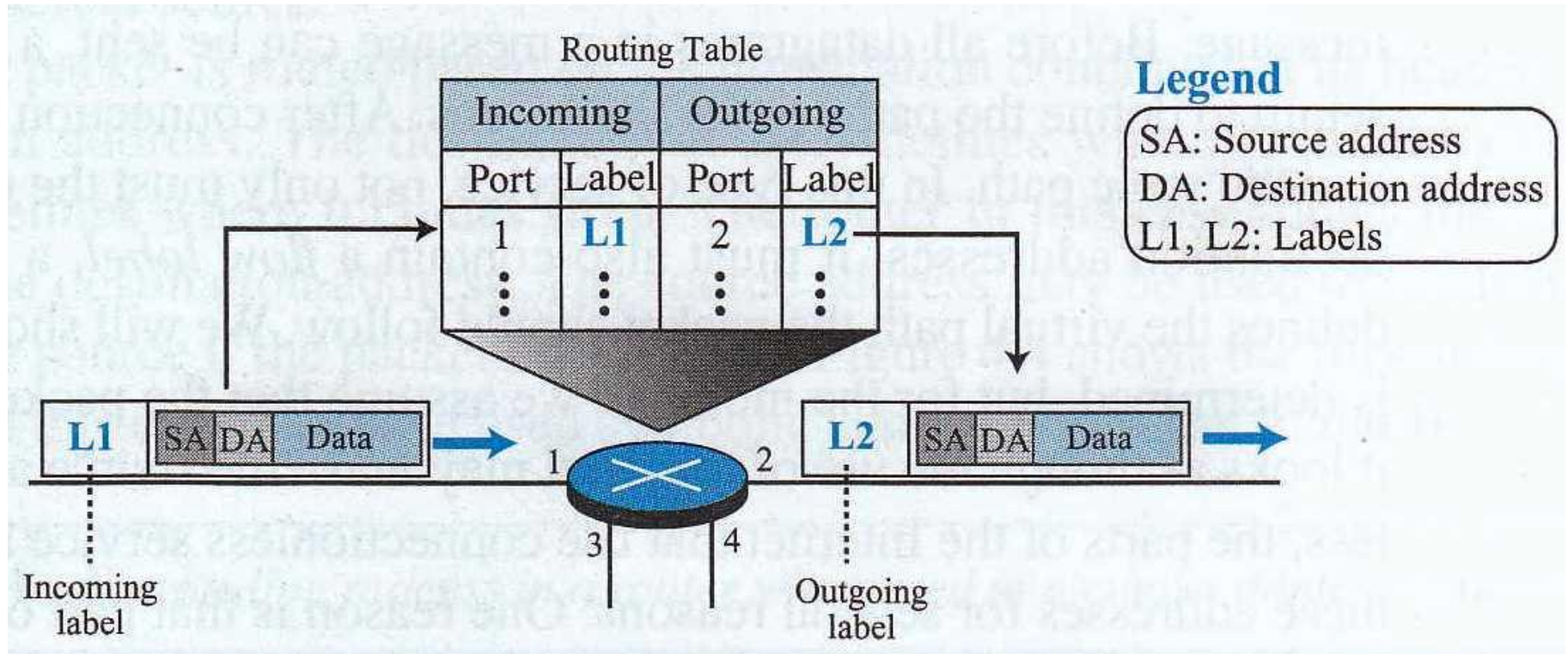
# Packet Switching – Virtual Circuit



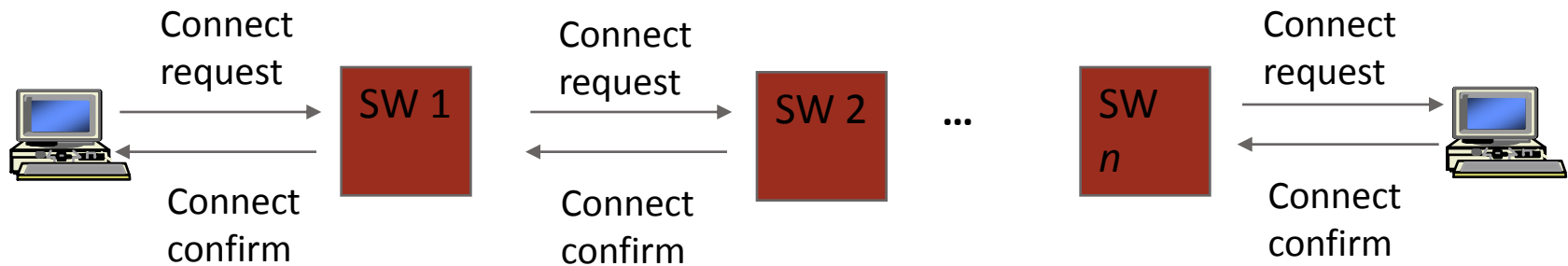
- Call set-up phase sets up pointers in fixed path along network
- All packets for a connection follow the same path
- Abbreviated header identifies connection on each link
- Packets queue for transmission
- Variable bit rates possible, negotiated during call set-up
- Delays variable, cannot be less than circuit switching



# Forwarding Process in connection oriented networks

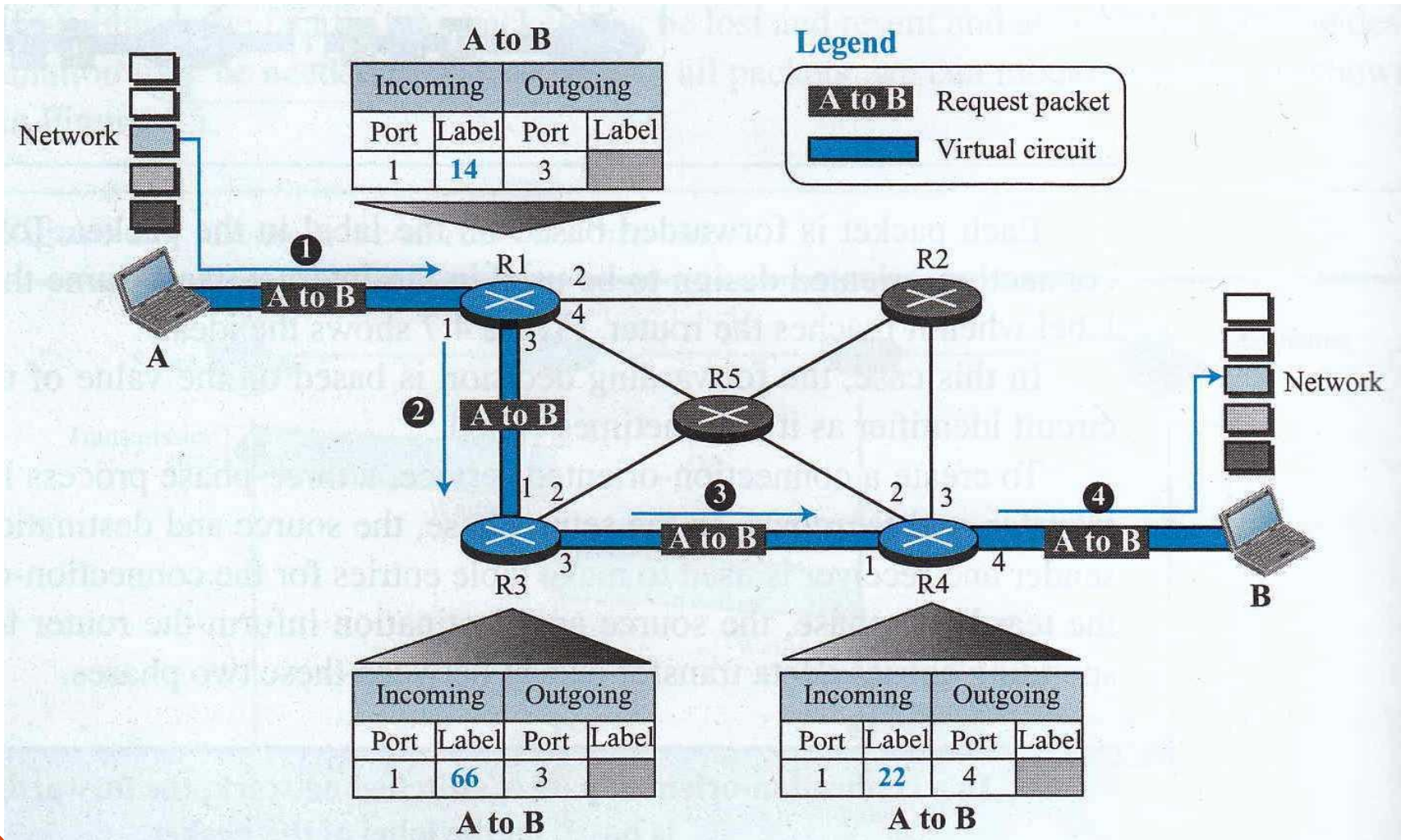


# Connection Setup

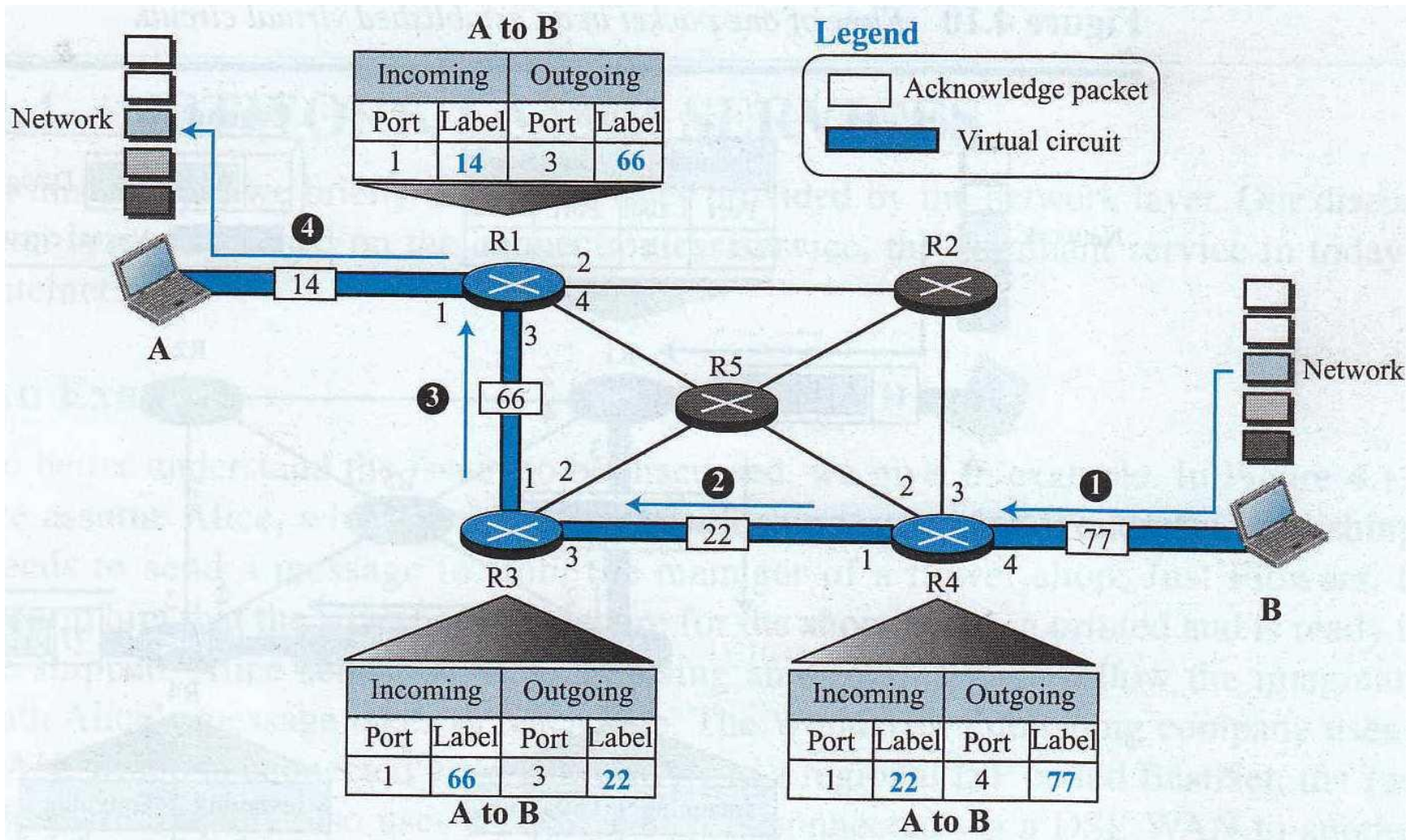


- Signaling messages propagate as route is selected
- Signaling messages identify connection and setup tables in switches
- Typically a connection is identified by a local tag, Virtual Circuit Identifier (VCI)
- Each switch only needs to know how to relate an incoming tag in one input to an outgoing tag in the corresponding output
- Once tables are setup, packets can flow along path

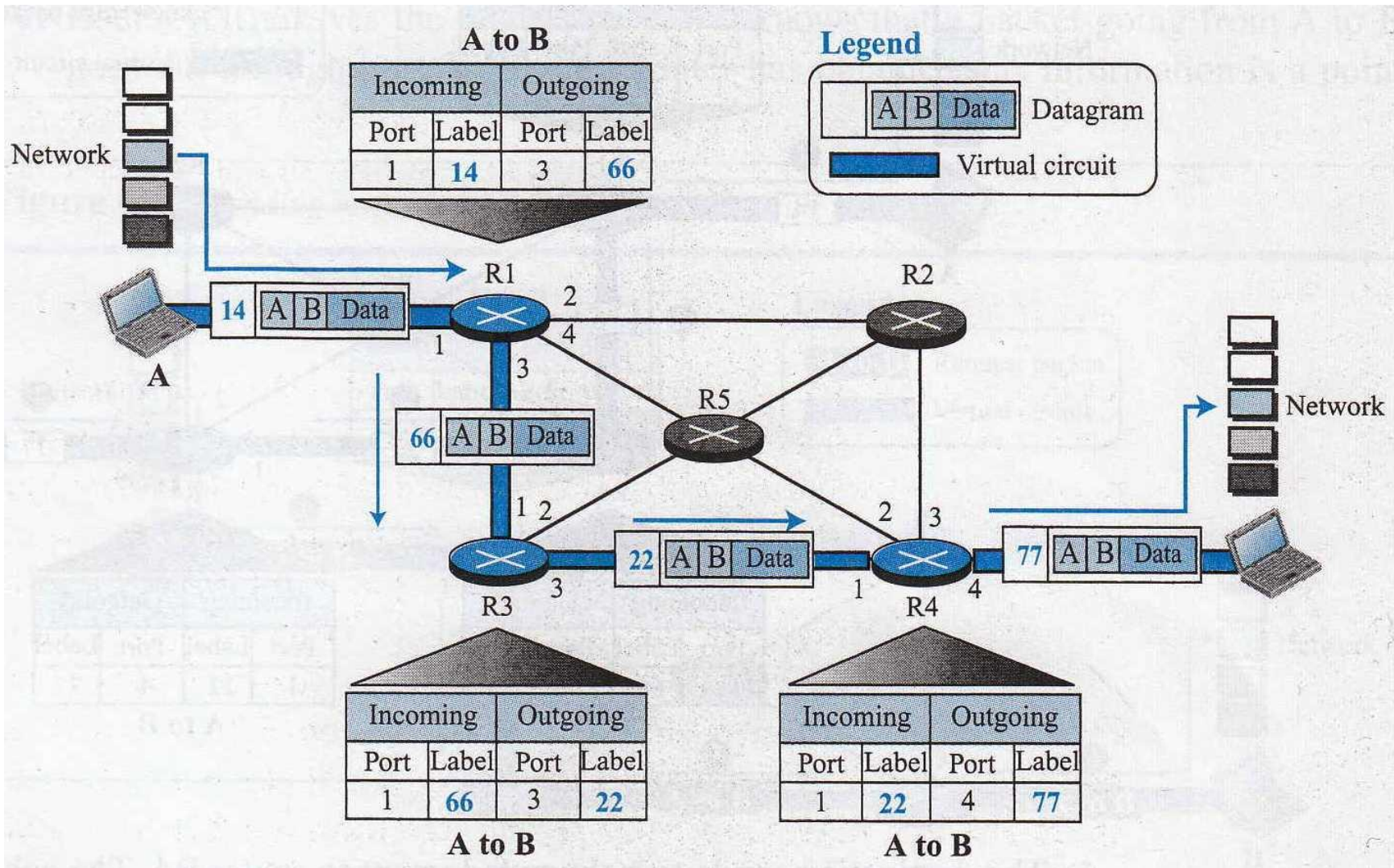
# Connection Setup



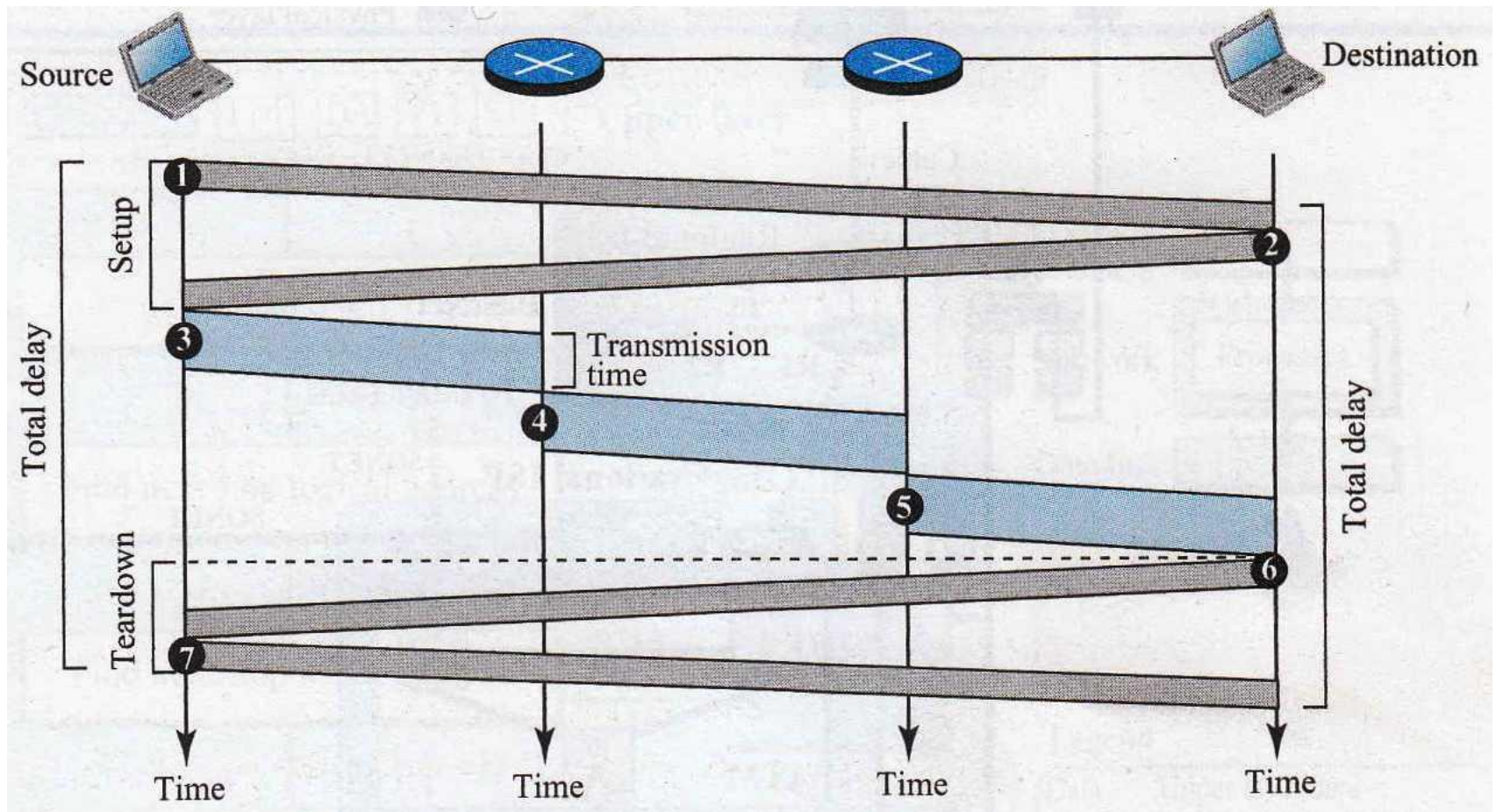
# Setup acknowledgment



# Data transfer

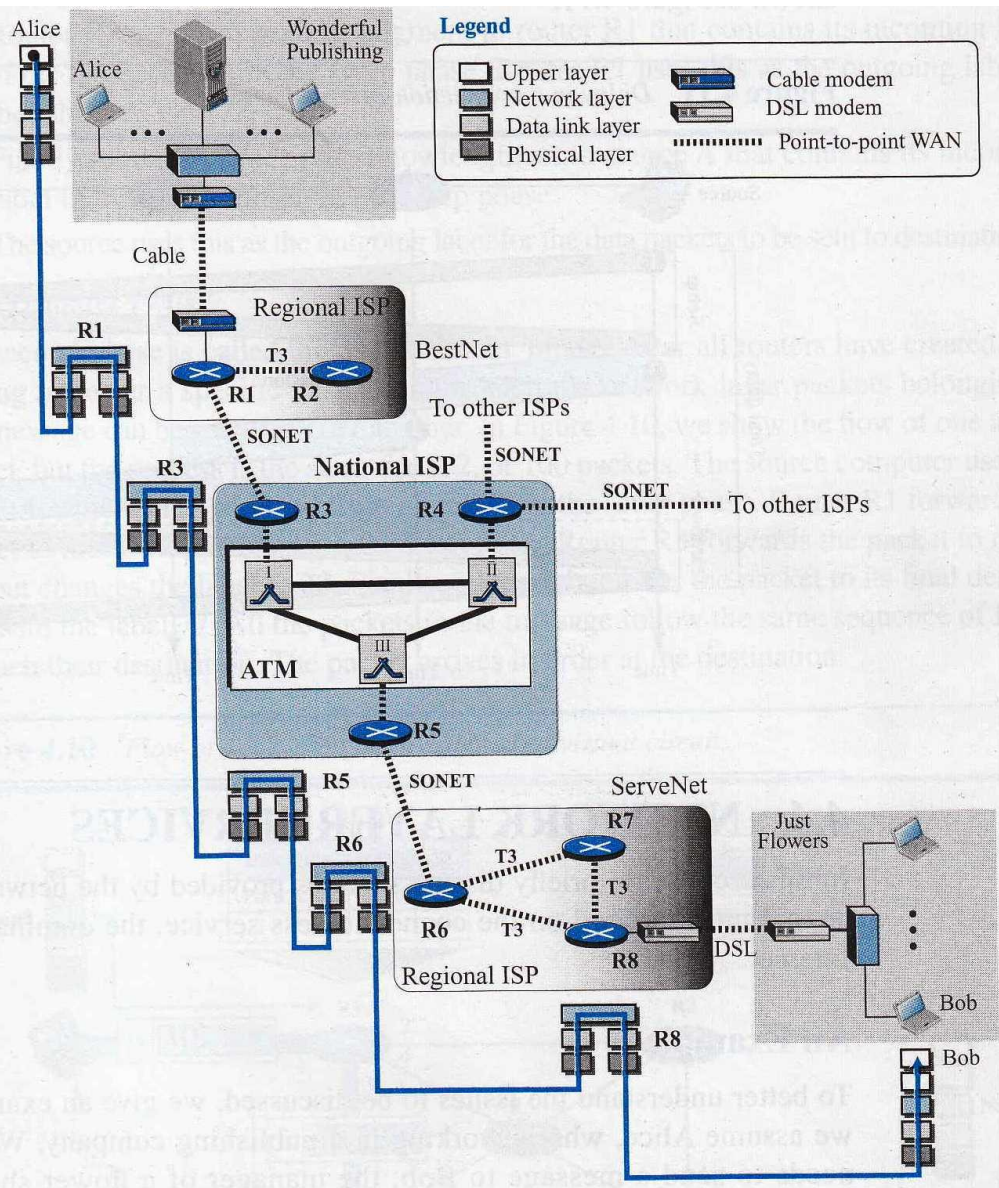


# Delay in connection oriented network



# Network layer services

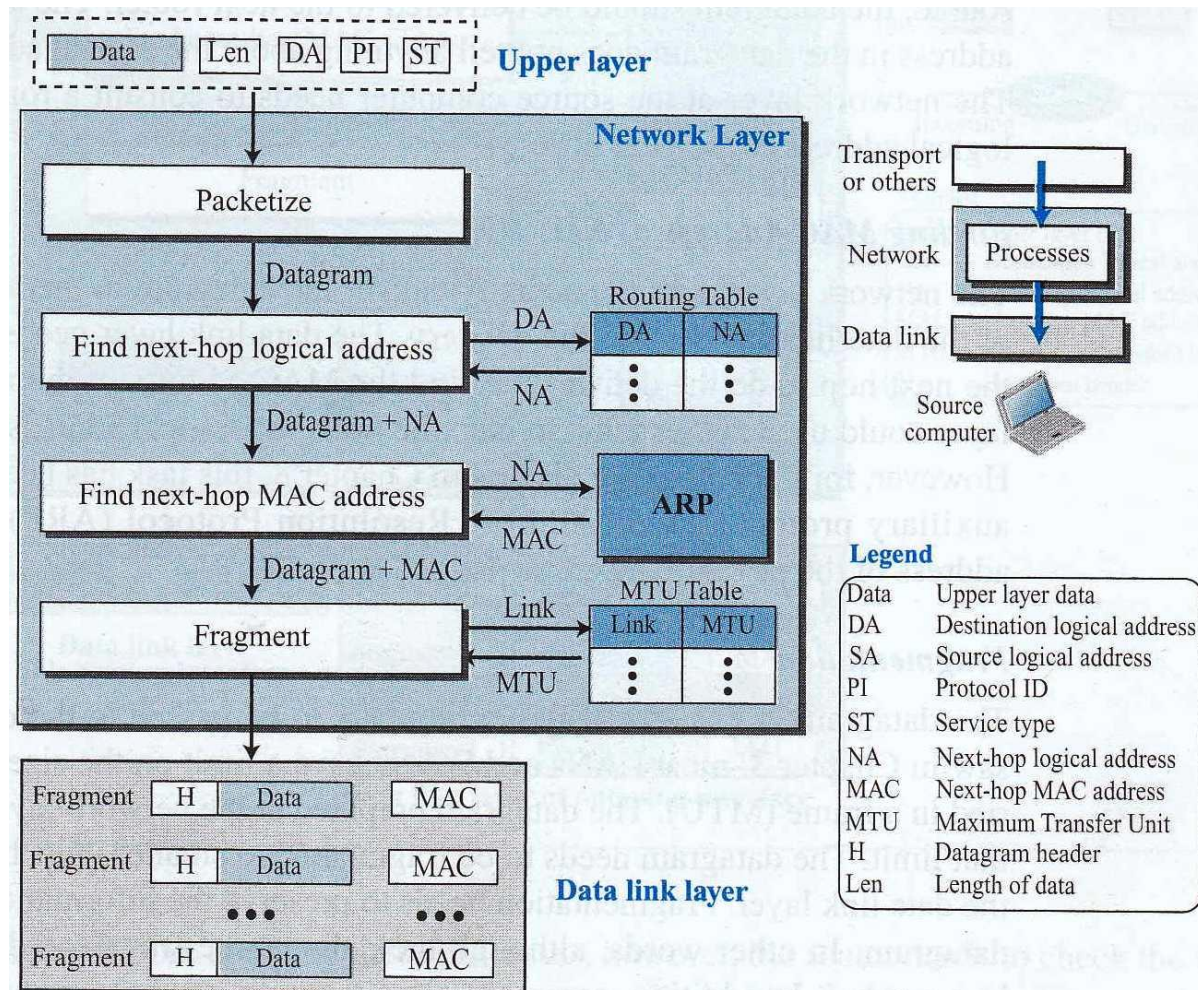
- Logical addressing
- Routing
- Service provided at the source computer
- Service provided at each router
- Service provided at the destination computer
- Error control
- Low control
- Congestion control
- Quality of service
- Security



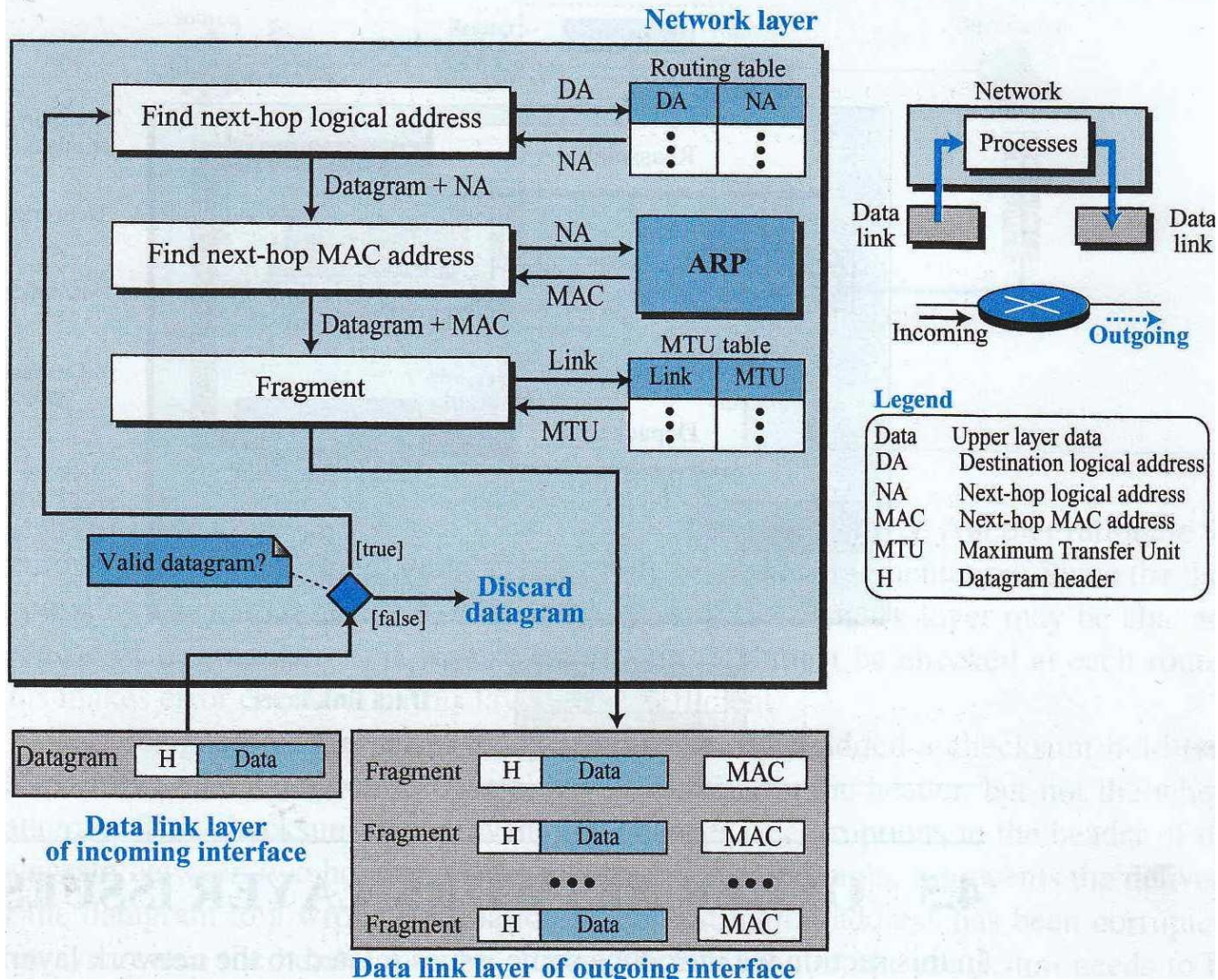
An  
imaginary  
part of the  
Internet



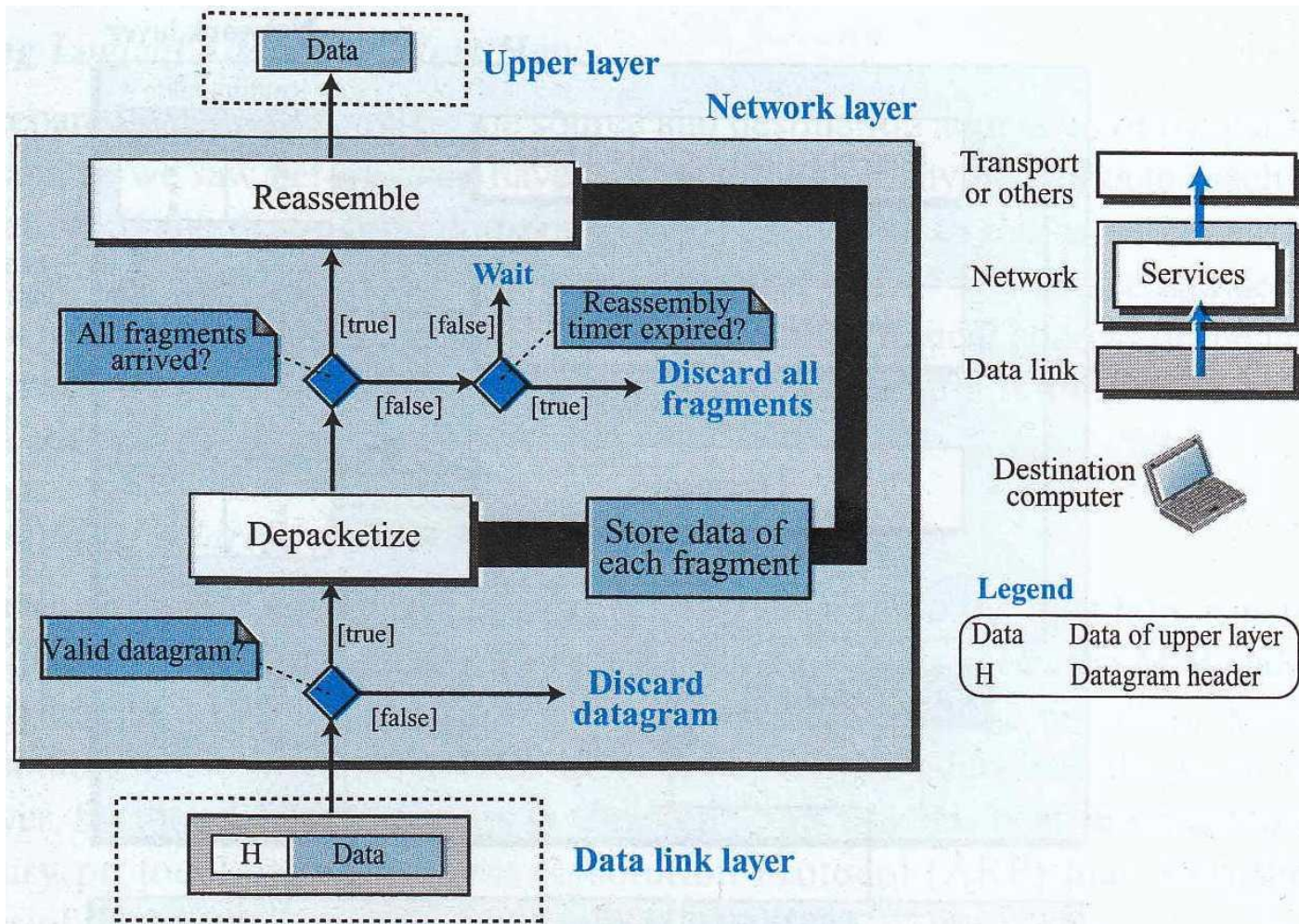
# Service provided at the source computer



# Processing at each router



# Processing at the destination computer



# Error checking at data link layer

