Segmentation, Fragmentation and Reassembly

Complete Course on Computer Networks - Part II

Ravindrababu Ravula • Lesson 10 • Mar 1, 2021

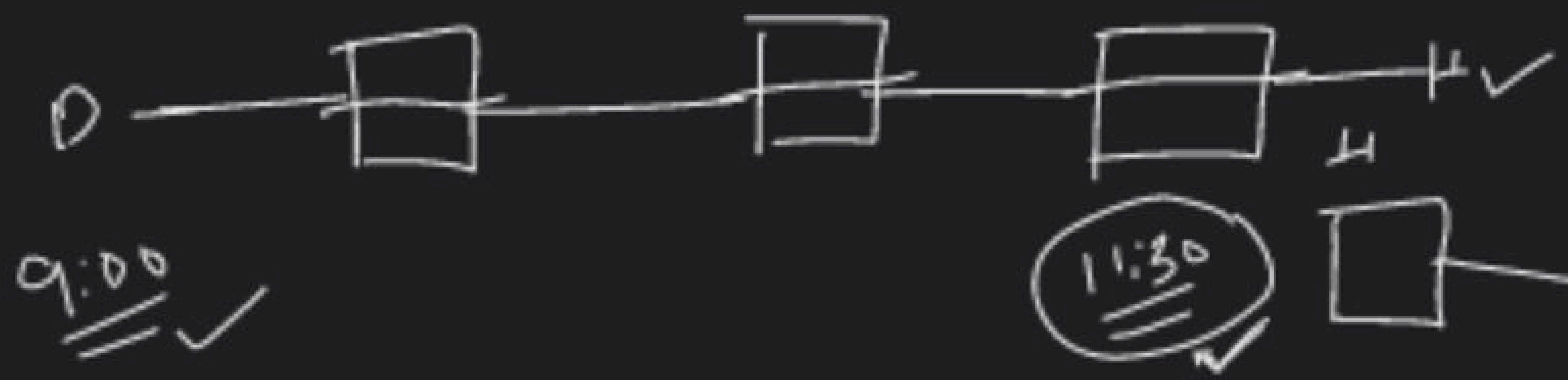
Computer Networks

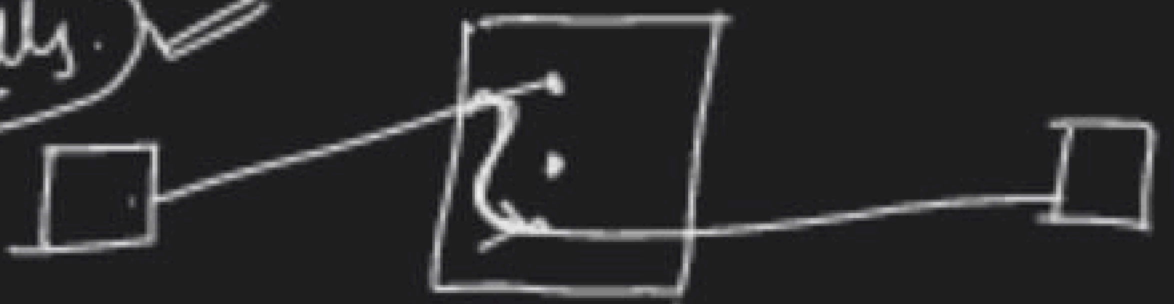
GATE QUESTIONS

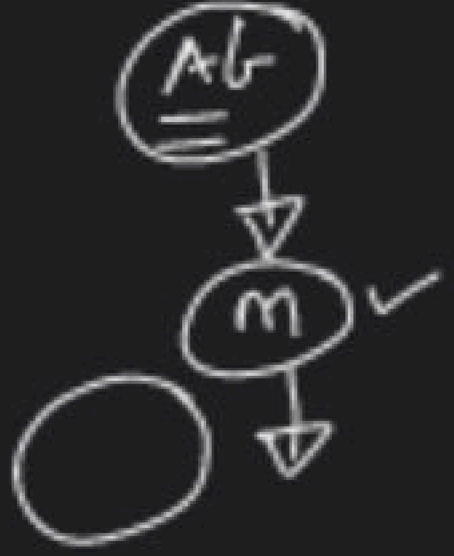
f of n/w layer

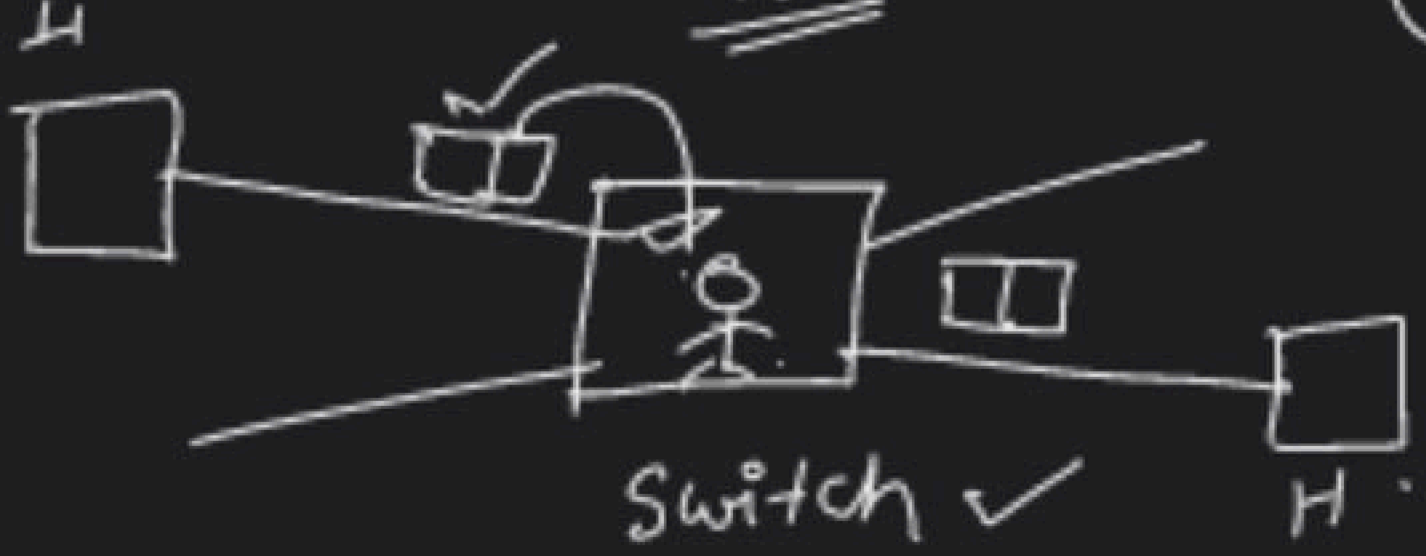
STD

D → H → Trunk calls



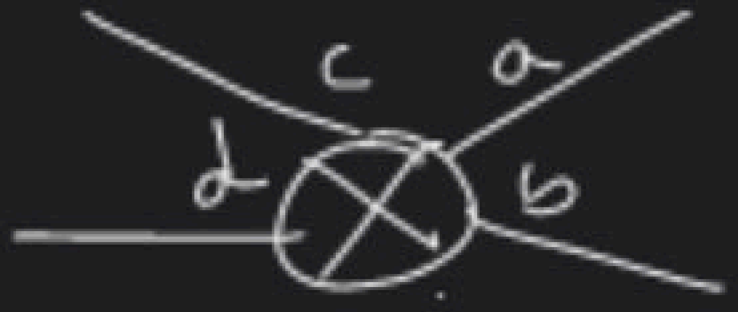






switch
×
software

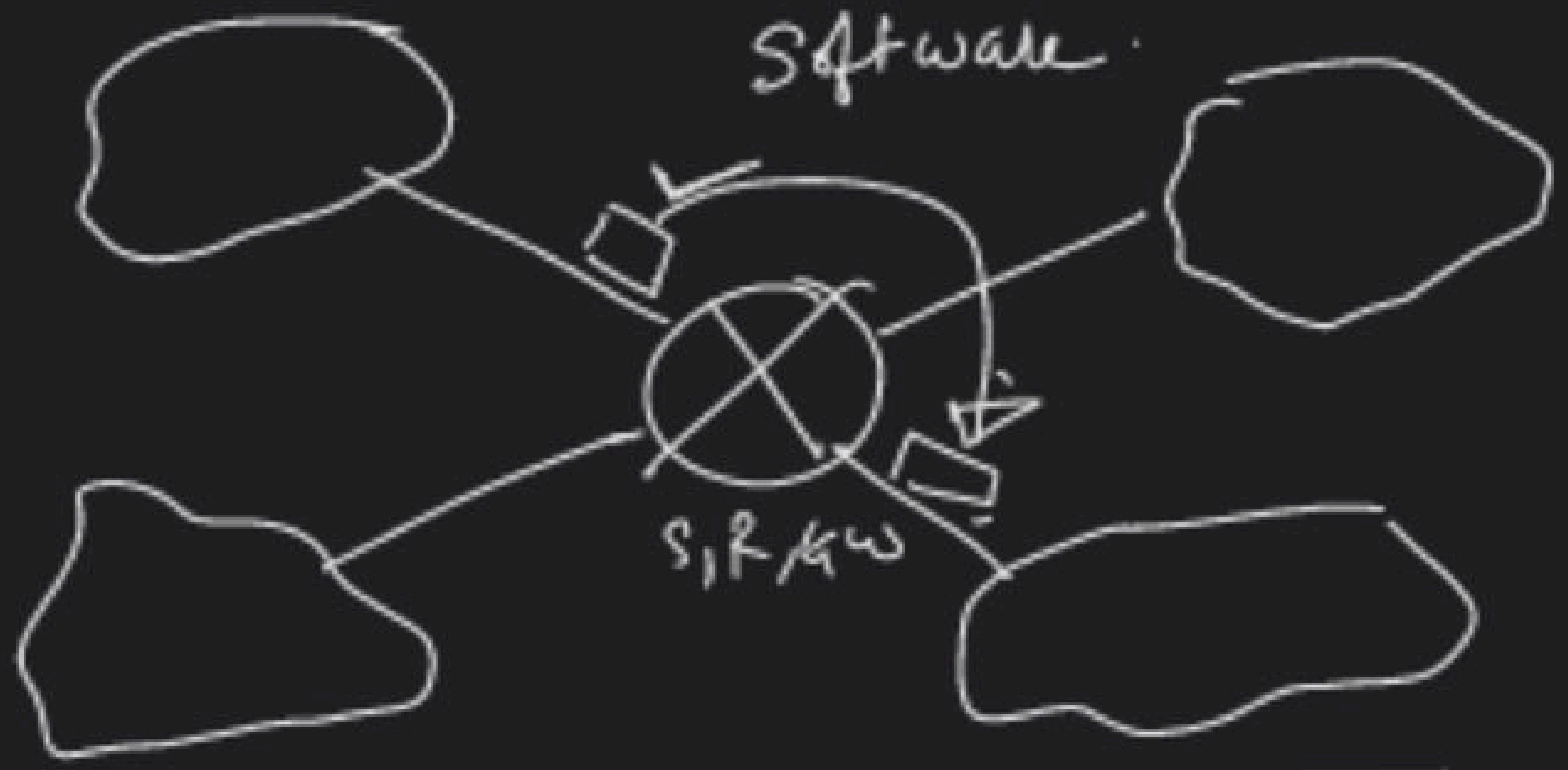
100



Routing table

DIP	SM	I
–	–	–
–	–	–

Routing



Switching

1.) An organization requires a range of IP addresses to assign one to each of its 1500 computers. The organization has approached an Internet Service Provider (ISP) for this task. The ISP uses CIDR and serves the requests from the available IP address space 202.61.0.0/17. The ISP wants to assign an address space to the organization which will minimize the number of routing entries in the ISP's router using route aggregation. Which of the following address spaces are potential candidates from which the ISP can allot any one to the organization? [GATE 2020]

I. 202.61.84.0/21
II. 202.61.104.0/21
III. 202.61.64.0/21
IV. 202.61.144.0/21

1.) An organization requires a range of IP addresses to assign one to each of its 1500 computers. The organization has approached an Internet Service Provider (ISP) for this task. The ISP uses CIDR and serves the requests from the available IP address space 202.61.0.0/17. The ISP wants to assign an address space to the organization which will minimize the number of routing entries in the ISP's router using route aggregation. Which of the following address spaces are potential candidates from which the ISP can allot any one to the organization? (GATE 2020)

I. 202.61.84.0/21
II. 202.61.104.0/21
III. 202.61.64.0/21
IV. 202.61.144.0/21

Solution: Option C
Given CIDR IP is 202.61.0.0/17 and for HID 32 - 17 = 15 bits can be used.
And to Assign an IP address for 1500 computer, we require 11 bit from HID part.
So NID + SID = 17 + 4 = 21 bits and HID = 11 bits
NID HID
202.61.0 0000 000.00000000
So, from the given option, possible IP Address is
I. 84 - >0 1010 100 (Because in HID bit 1 is not possible)
II. 104 ->0 1101 000
III. 64 -> 0 1000 000
IV. 144->1 0010 000 (Because in NID bit 1 is not possible)

2.) A computer network uses polynomials over GF(2) for error checking with 8 bits as information bits and uses x3 + x + 1 as the generator polynomial to generate the check bits. In this network, the message 01011011 is transmitted as [GATE 2017]

A	01011011010
B	01011011011
C	01011011101
D	01011011100

Solution:

Given CRC generator polynomial = x3+x+1

= 1·x3+0·x2+1·x1+1·x0

=1011

Message =01011011

```
        01011011000
1011  ⊕ 0000          01000011
        -----------
        01011
         1011
        -----
         00000
          0000
         -----
          00001
           0000
          -----
           00011
            0000
           -----
            00110
             0000
            -----
             01100
              1011
             -----
              01110
               1011
              -----
              0[101]  CRC
```

101

So, the message 01011011 is transmitted as $\boxed{0101\ 1011\ 101}$

3.)The value of parameters for the Stop-and-Wait ARQ protocol are as given below:

- Bit rate of the transmission channel = 1 Mbps.
- Propagation delay from sender to receiver = 0.75 ms.
- Time to process a frame = 0.25 ms.
- Number of bytes in the information frame = 1980.
- Number of bytes in the acknowledge frame = 20.
- Number of overhead bytes in the information frame = 20.

Assume that there are no transmission errors. Then, the transmission efficiency (expressed in percentage) of the Stop-and-Wait ARQ protocol for the above parameters is _________ (correct to 2 decimal places). [GATE 2017]

BW = 1mbps
T_p = 0.75ms

CN, CO, OS

↳ lagm.

P, T_p < Q.

O

3.)The value of parameters for the Stop-and-Wait ARQ protocol are as given below:

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Number of overhead bytes in the information frame = 20.

Assume that there are no transmission errors. Then, the transmission efficiency (expressed in percentage) of the Stop-and-Wait ARQ protocol for the above parameters is __________ (correct to 2 decimal places). [GATE 2017]

Solution:
Given Data:
B = 1Mbps, L = 1980Bytes, Overhead = 20Bytes
TProc = 0.25ms, LAck = 20Bytes
Tp=0.75ms
Total Data size(L) = (L + overhead) = 1980+20 = 2000Bytes
Efficiency of Stop & Wait ARQ?
Tt = L/B = 2000Bytes/1Mbps = (2000×8bits)/(106 b/s) = 16msec
TAck = LAck/B = (20×8bits)/(106 bits/sec) = 0.16msec
∴ In Stop and Wait ARQ, efficiency
η = Tt/(Tt+TAck+2Tp+TProc) = 16ms/(16+0.16+2×0.75+0.25ms)
= 16ms/17.91ms = 0.8933 ≈ $\boxed{89.33\%}$

89.33%

4.)A sender uses the Stop-and-Wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps (1Kbps = 1000 bits/second). Size of an acknowledgement is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one-way propagation delay is 100 milliseconds.

Assuming no frame is lost, the sender throughput is _________ bytes/second. [GATE 2016]

4.)A sender uses the Stop-and-Wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps (1Kbps = 1000 bits/second). Size of an acknowledgement is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one-way propagation delay is 100 milliseconds.

Assuming no frame is lost, the sender throughput is _________ bytes/second. [GATE 2016]

NAT ✓

3 ✓

3 min

10 min ✓

2 min ✓

Solution:
Given,
Frame size (L) =1000 bytes
Sender side bandwidth (BS) = 80 kbps = 10 * 103 bytes/sec
Acknowledgement size (LA) =100 bytes
Receiver side bandwidth (BR) = 8 kbps = 1 * 103 bytes/sec
Propagation delay (Tp) =100 ms
By formula:
Transmission delay (Tt) = L/BS = 1000 bytes / 10 * 103 bytes/sec = 100 ms
Acknowledge delay (Tack) = LA / BR = 100 bytes / 1 * 103 bytes/sec = 100 ms
Total cycle time = Tt + 2 * Tp + Tack = 100 ms + 2 * 100 ms + 100 ms = 400 ms
Efficiency (η) = Tt / Total cycle time = 100 ms / 400 ms = 1 / 4 = 0.25
Throughput = Efficiency (η) * Bandwidth (BS) = 0.25 * 10 *103 bytes/s = 2500 bytes/second

5.) A network has a data transmission bandwidth of 20 × 106 bits per second. It uses CSMA/CD in the MAC layer. The maximum signal propagation time from one node to another node is 40 microseconds. The minimum size of a frame in the network is _________ bytes. [GATE 2016]

bps

Bps

bits

Bytes

5.) A network has a data transmission bandwidth of 20×106 bits per second. It uses CSMA/CD in the MAC layer. The maximum signal propagation time from one node to another node is 40 microseconds. The minimum size of a frame in the network is _________ bytes. [GATE 2016]

Solution:

For frame size to be minimum, its transmission time should be equal to twice of one way propagation delay. i.e, $Tt = 2 \times TP$

Given,

Bandwidth (B) = 20×106 bps

$TP = 40\ \mu s \Rightarrow 40 \times 10\text{- }6$ sec

Suppose minimum frame size is L.

$Tt = 2 \times TP \Rightarrow L / B = 2 \times TP$

$\Rightarrow L = 2 \times TP \times B = 2 \times 40 \times 10\text{-}6 \times 20 \times 106 = 1600$ bits $\Rightarrow$ 200 bytes

Therefore, L = 200 bytes

6.) Consider a 128 × 103 bits/ second satellite communication link with one way propagation delay of 150 milliseconds. Selective retransmission (repeat) protocol is used on this link to send data with a frame size of 1 kilobyte. Neglect the transmission time of acknowledgement. The minimum number of bits required for the sequence number field to achieve 100% utilization is __________ [GATE 2016]

10

6.) Consider a 128 × 103 bits/ second satellite communication link with one way propagation delay of 150 milliseconds. Selective retransmission (repeat) protocol is used on this link to send data with a frame size of 1 kilobyte. Neglect the transmission time of acknowledgement. The minimum number of bits required for the sequence number field to achieve 100% utilization is __________ [GATE 2016]

Solution:

To achieve 100% efficiency, the number of frames that we should send N = 1 + 2 * a

a = Tp / Tt where Tp is propagation delay, and Tt is transmission delay.

Given, B = 128 kbps, Tp = 150 msec,

L = 1 KB = 1 * 8 * 210 bits

Tt = L / B ⇒ 1 * 8 * 210 bits / 128 * 103 bps ⇒ 0.064 sec = 64 msec

So, a = 150 msec / 64 msec = 2.343

Efficiency (η) = 100 % ⇒ 1 = N/ 1 + 2 * a

So, N = 1 + 2 * a ⇒ 1 + 2 * 2.343 = 5.686

No. of sequence numbers requires in SR is 2*N = 2 *5.686 = 11.375

Minimum No. of bits required in the sequence number = [log2 (11.375)] = 4

Computer Networks

Transport Layer

Functions of Transport layer

- End – End Connectively
- Flow Control
- Error Control
- Segmentation
- Multiplexing and Demultiplexing
- Congestion Control

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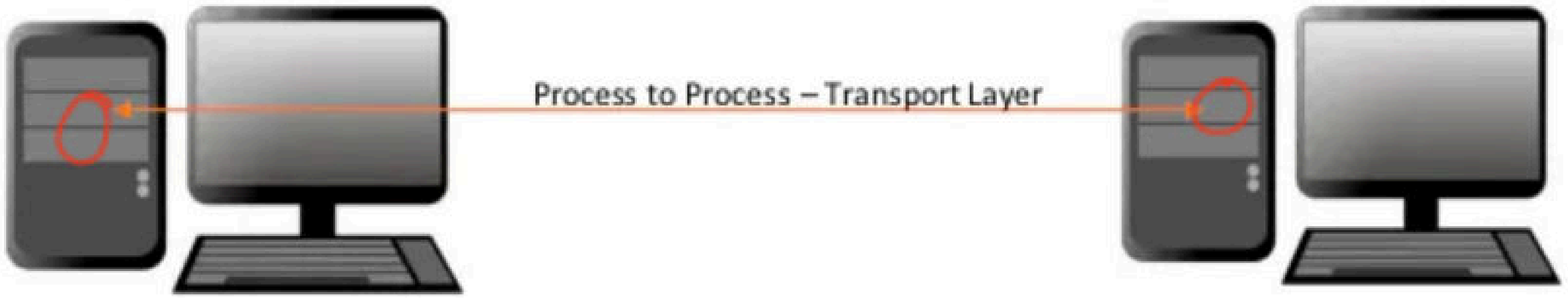

The transport layer transmits the entire message to the destination. Therefore, it ensures the end-to-end delivery of an entire message from a source to the destination.

Functions of Transport layer

- End – End Connectively
- Flow Control
- Error Control
- Segmentation
- Multiplexing and Demultiplexing
- Congestion Control

DLL TL

S&W, GBN, SR

TL - TCP

75% SR 25% GBN

It uses the sliding window protocol SR that makes the data transmission more efficient as well as it controls the flow of data so that the receiver does not become overloaded.

TL - SR

Functions of Transport layer

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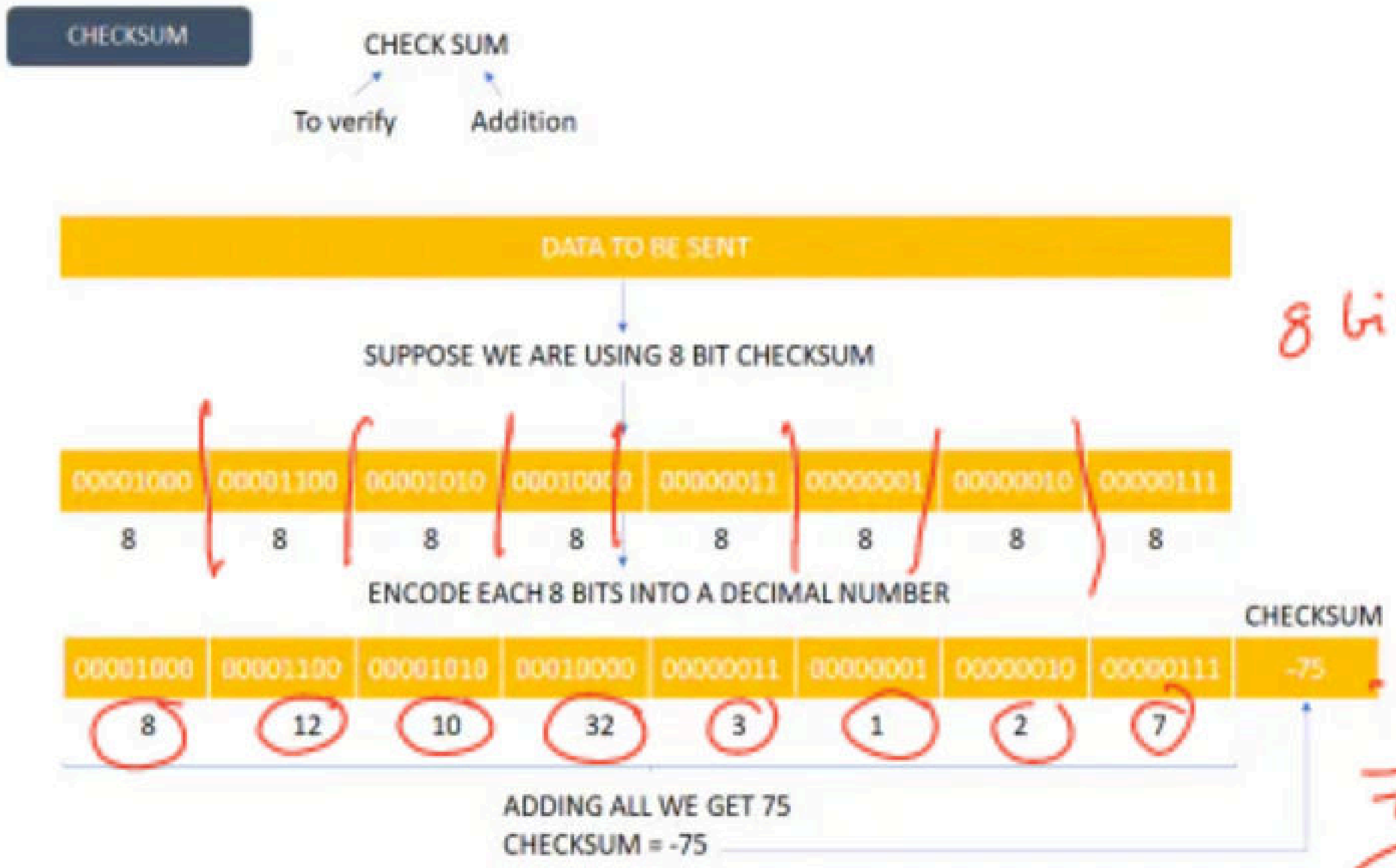
CRC → DLL

CS → TL



8 bit CS.

75.

-75

"0"

The primary role of reliability is Error Control.
Checksum is used for error control by transport layer.

90% ← S → 70% CS

G → <100 CRC

n

⇓

(n+1)

Functions of Transport layer

- End – End Connectively
- Flow Control
- Error Control
- Segmentation
- Multiplexing and Demultiplexing
- Congestion Control

Segmentation means to divide something into pieces. When data arrives at the transport layer from the upper layers, it is taken then divided into segments. That is why data at this layer is called segments rather than data.

Functions of Transport layer

- End – End Connectively
- Flow Control
- Error Control
- Segmentation
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- Congestion Control

Transport layer gathers chunks of data it receives from different sockets and encapsulate them with transport headers. Passing these resulting segments to the network layer is called multiplexing.

The reverse process which is delivering data to the correct socket by the transport layer is called demultiplexing.
This is done by port nos.
We will see about this in further lectures.

Functions of Transport layer

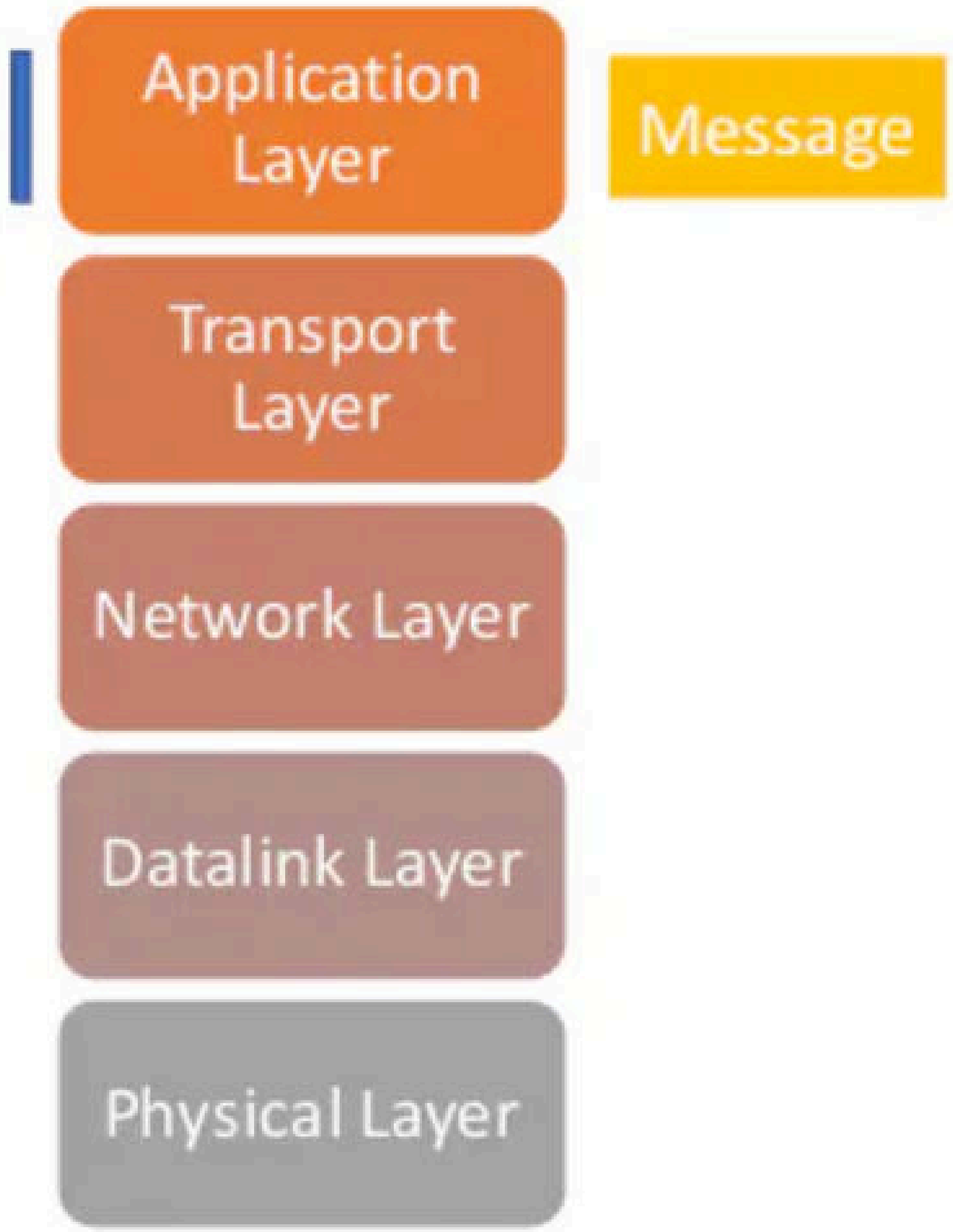
- End – End Connectively
- Flow Control
- Error Control
- Segmentation
- Multiplexing and Demultiplexing
- Congestion Control

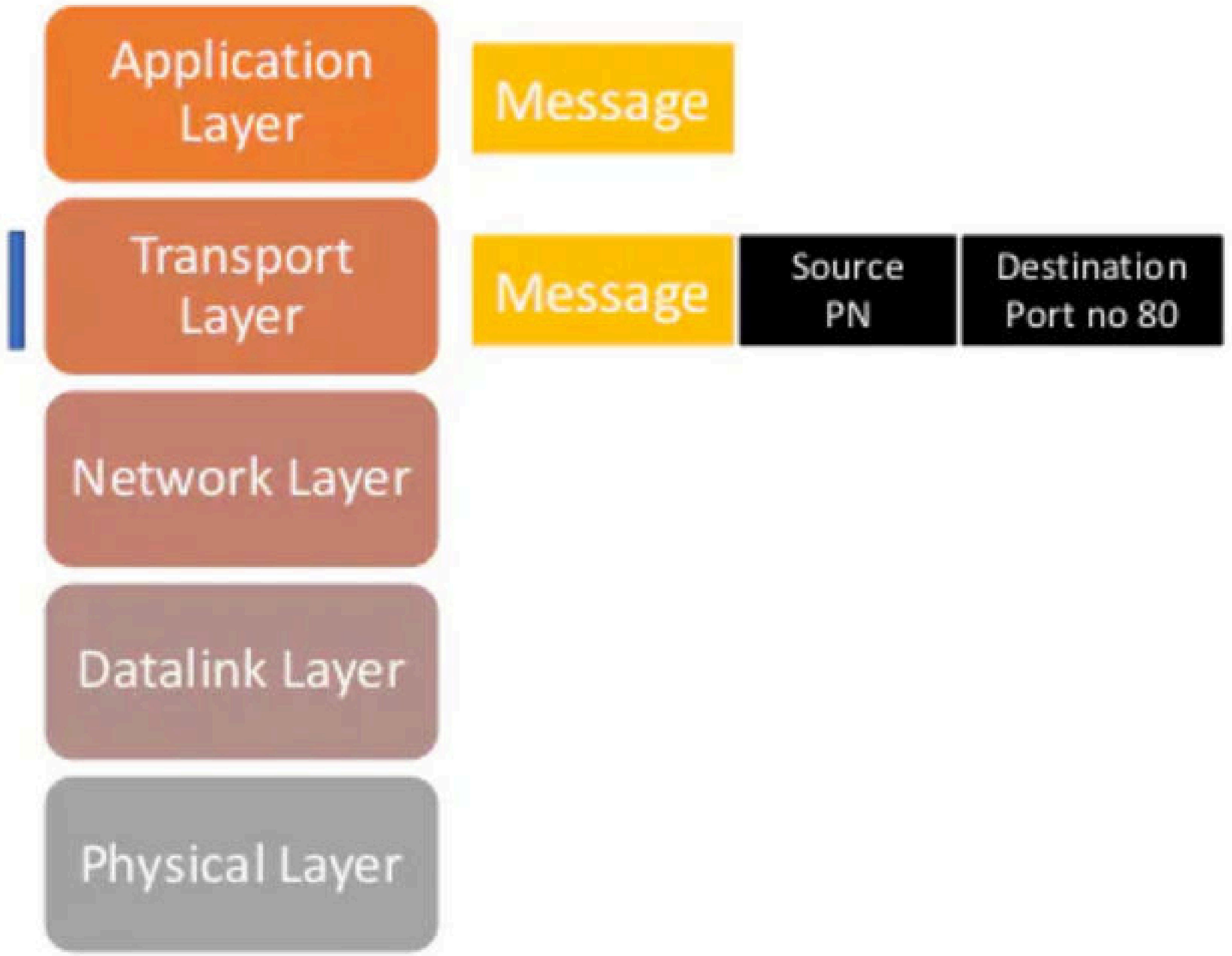
What is congestion?
A state occurring in network layer when the message traffic is so heavy that it slows down network response time.

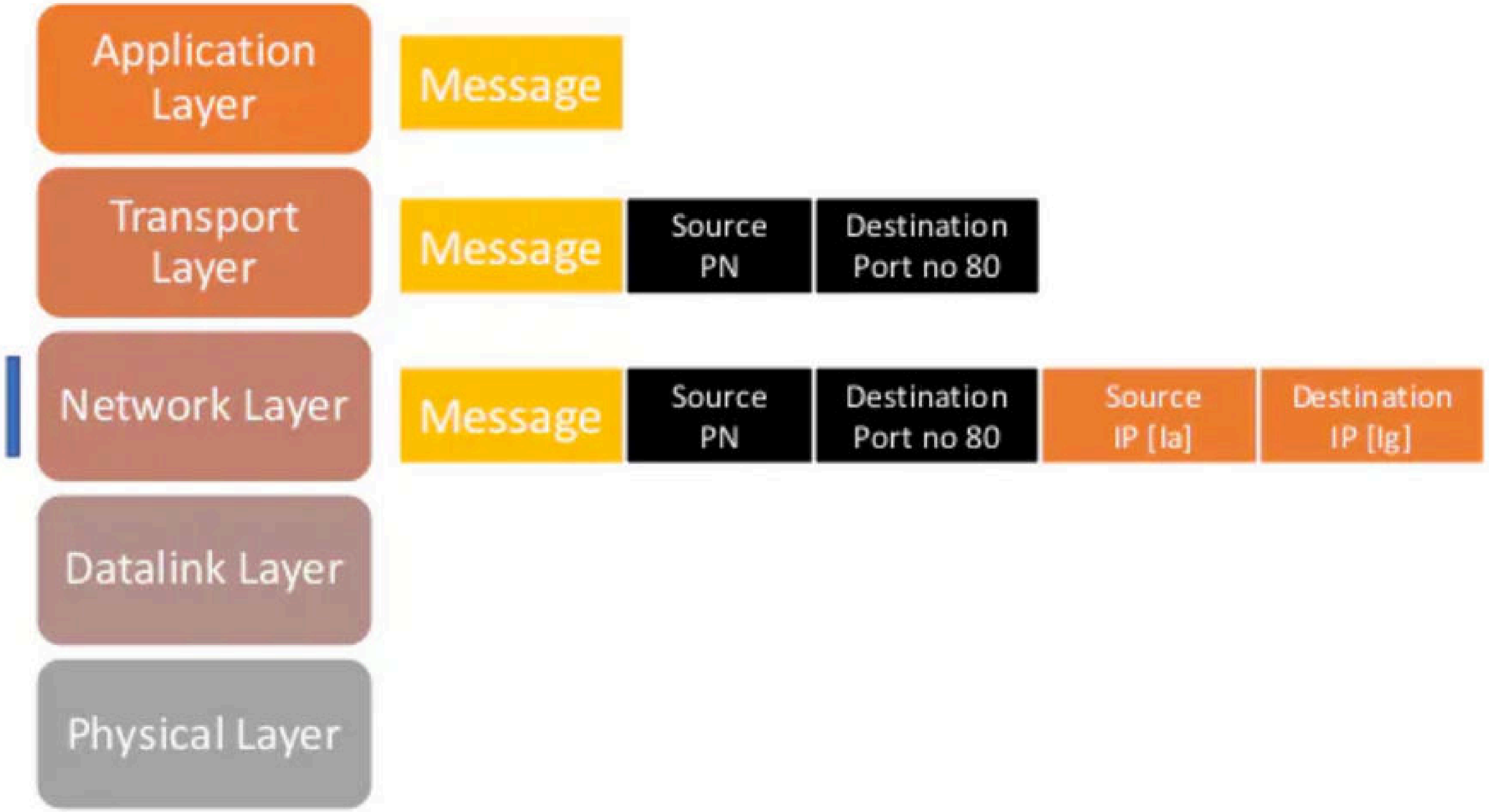
Transport Layer has various algorithms to control this, We will see that in the coming lectures.

Computer Networks

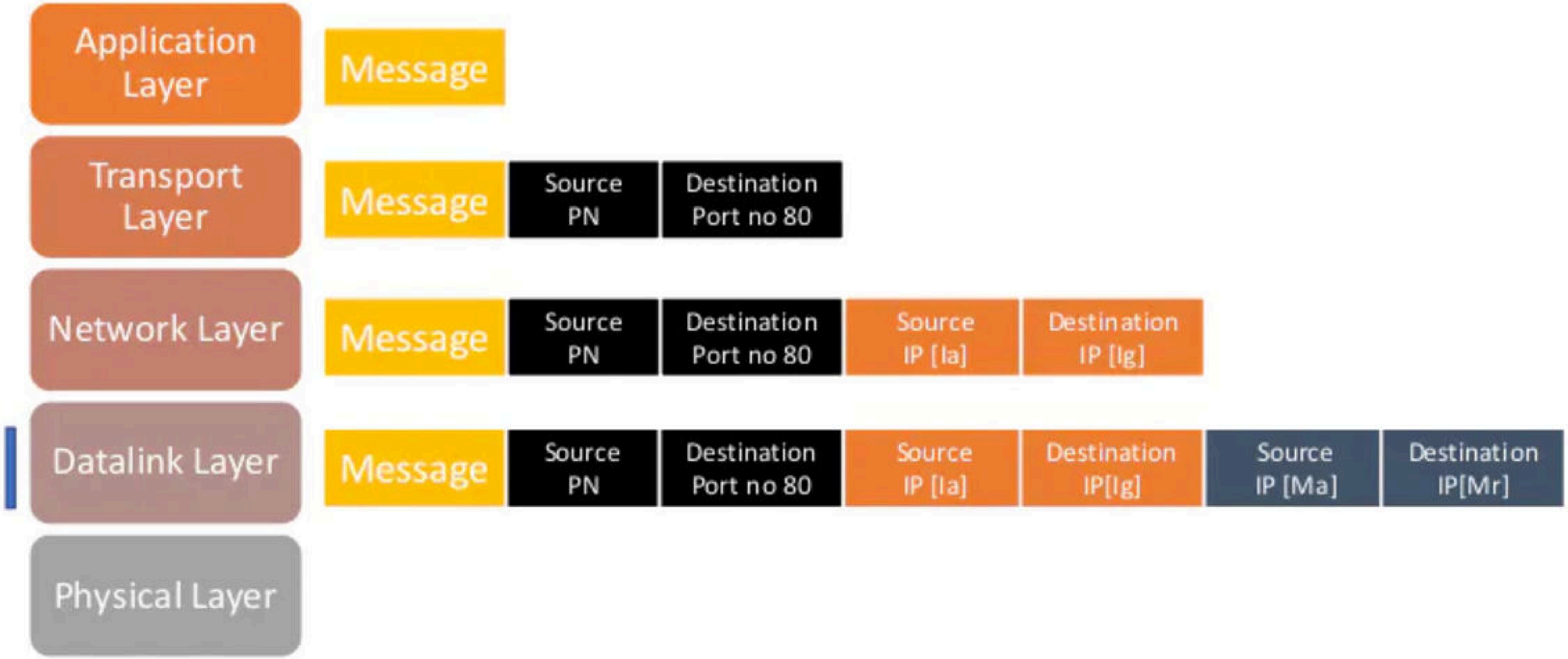
How all Layers Work Together

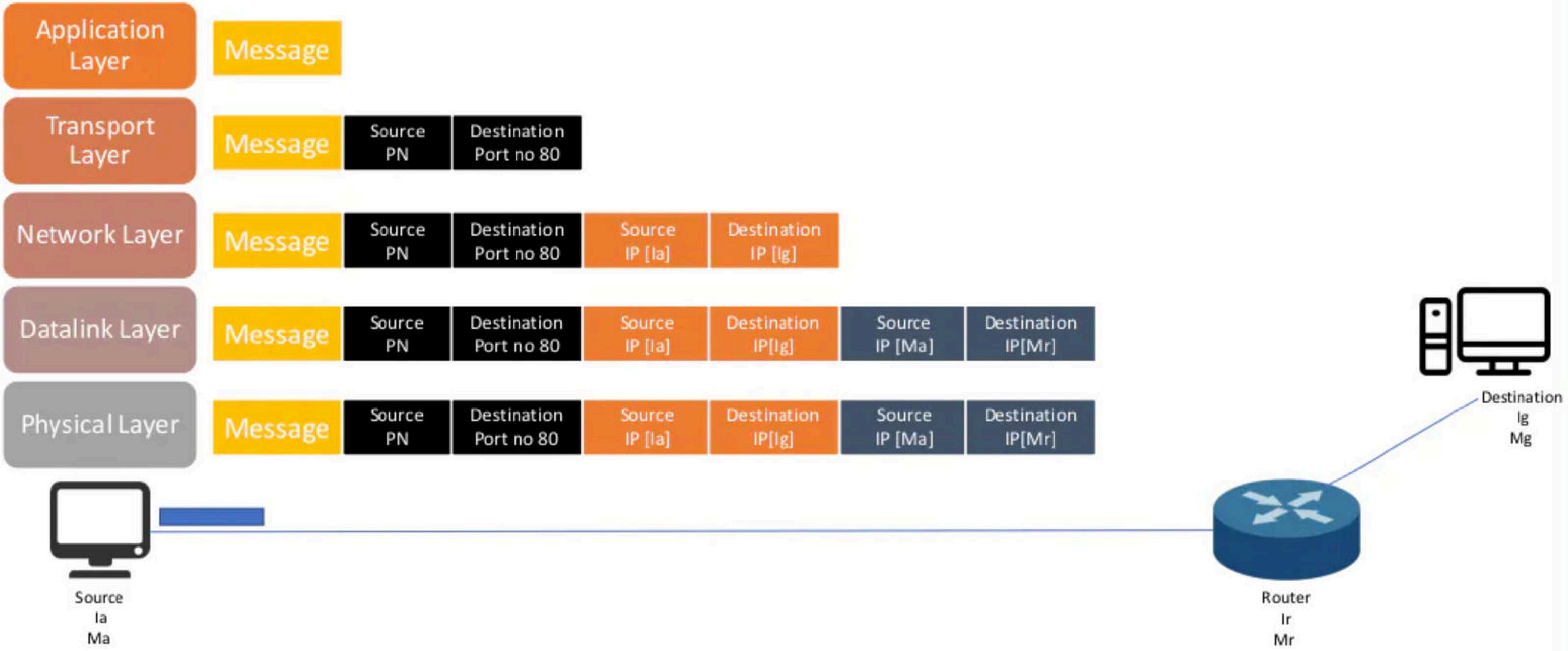

Application Layer
Message
Transport Layer
Network Layer
Datalink Layer
Physical Layer


Application Layer
Message
Transport Layer
Message
Source PN
Destination Port no 80
Network Layer
Datalink Layer
Physical Layer

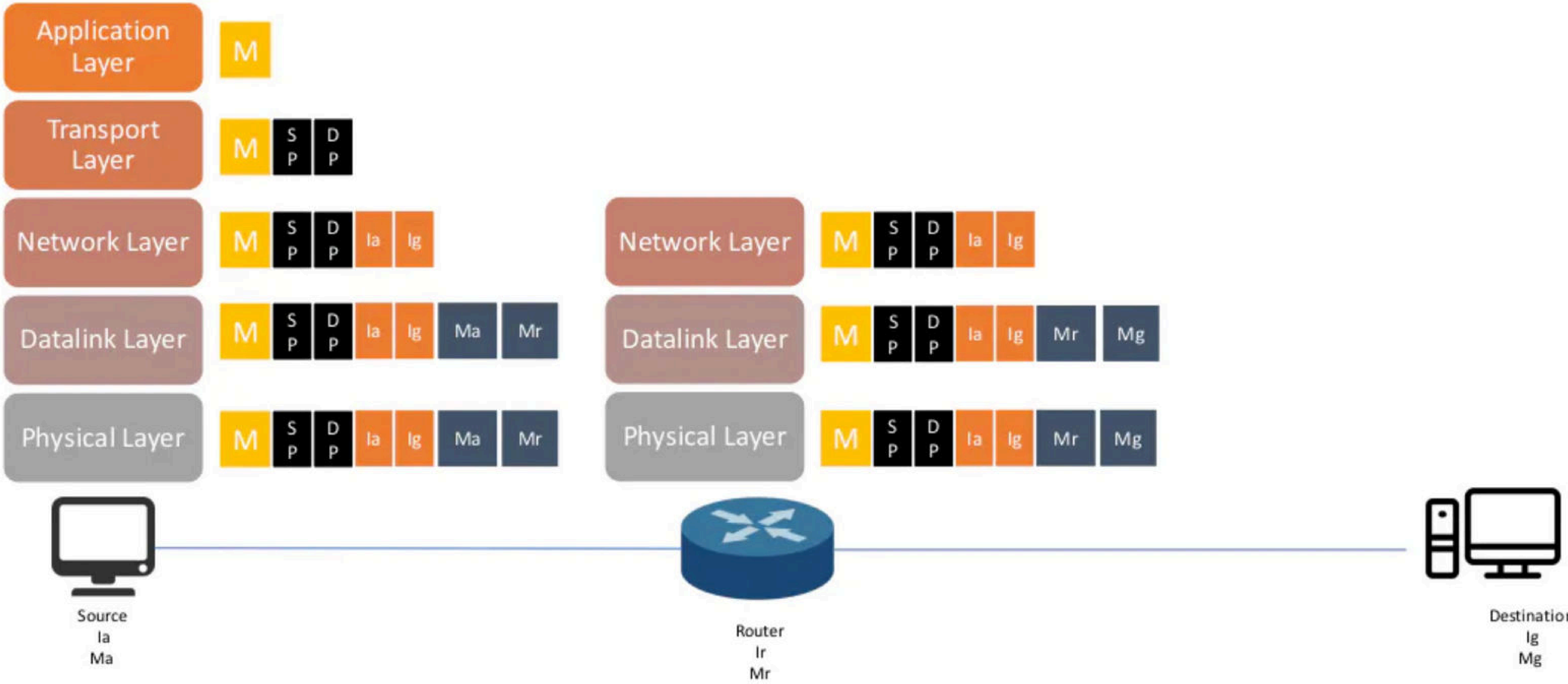


Application Layer
Message
Transport Layer
Message
Source PN
Destination Port no 80
Network Layer
Message
Source PN
Destination Port no 80
Source IP [Ia]
Destination IP [Ig]
Datalink Layer
Physical Layer


Application Layer
Message
Transport Layer
Message
Source PN
Destination Port no 80
Network Layer
Message
Source PN
Destination Port no 80
Source IP [Ia]
Destination IP [Ig]
Datalink Layer
Message
Source PN
Destination Port no 80
Source IP [Ia]
Destination IP[Ig]
Source IP [Ma]
Destination IP[Mr]
Physical Layer



Application Layer
Message
Transport Layer
Message
Source PN
Destination Port no 80
Network Layer
Message
Source PN
Destination Port no 80
Source IP [Ia]
Destination IP [Ig]
Datalink Layer
Message
Source PN
Destination Port no 80
Source IP [Ia]
Destination IP[Ig]
Source IP [Ma]
Destination IP[Mr]
Physical Layer
Message
Source PN
Destination Port no 80
Source IP [Ia]
Destination IP[Ig]
Source IP [Ma]
Destination IP[Mr]
Destination Ig Mg
Source Ia Ma
Router Ir Mr


Application Layer
M
Transport Layer
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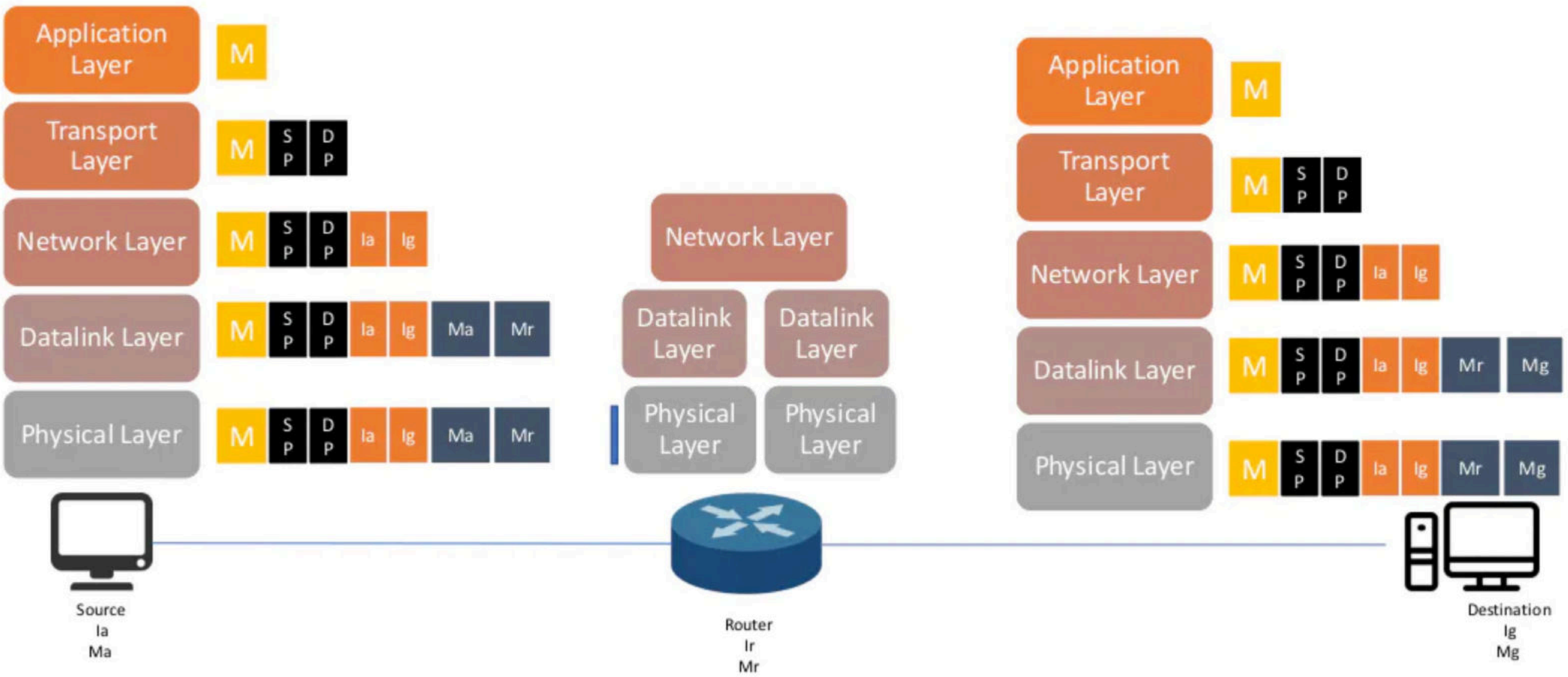

Application Layer
M
Transport Layer
M S P D P
Network Layer
M S P D P Ia Ig
Datalink Layer
M S P D P Ia Ig Ma Mr
Physical Layer
M S P D P Ia Ig Ma Mr
Network Layer
Datalink Layer
Datalink Layer
Physical Layer
Physical Layer
Application Layer
M
Transport Layer
M S P D P
Network Layer
M S P D P Ia Ig
Datalink Layer
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Source
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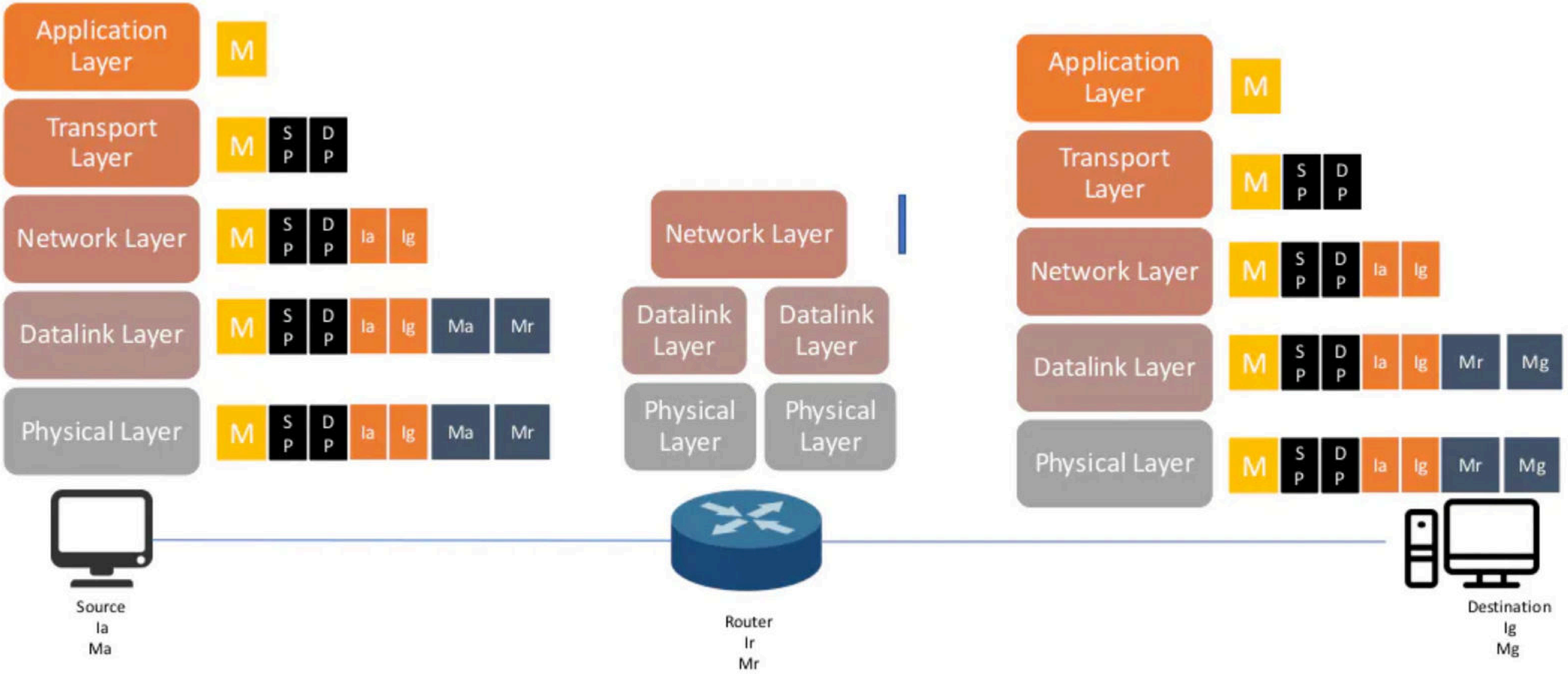

Application Layer
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Transport Layer
M S P D P
Network Layer
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Datalink Layer
M S P D P Ia Ig Ma Mr
Physical Layer
M S P D P Ia Ig Ma Mr
Network Layer
Datalink Layer
Datalink Layer
Physical Layer
Physical Layer
Application Layer
M
Transport Layer
M S P D P
Network Layer
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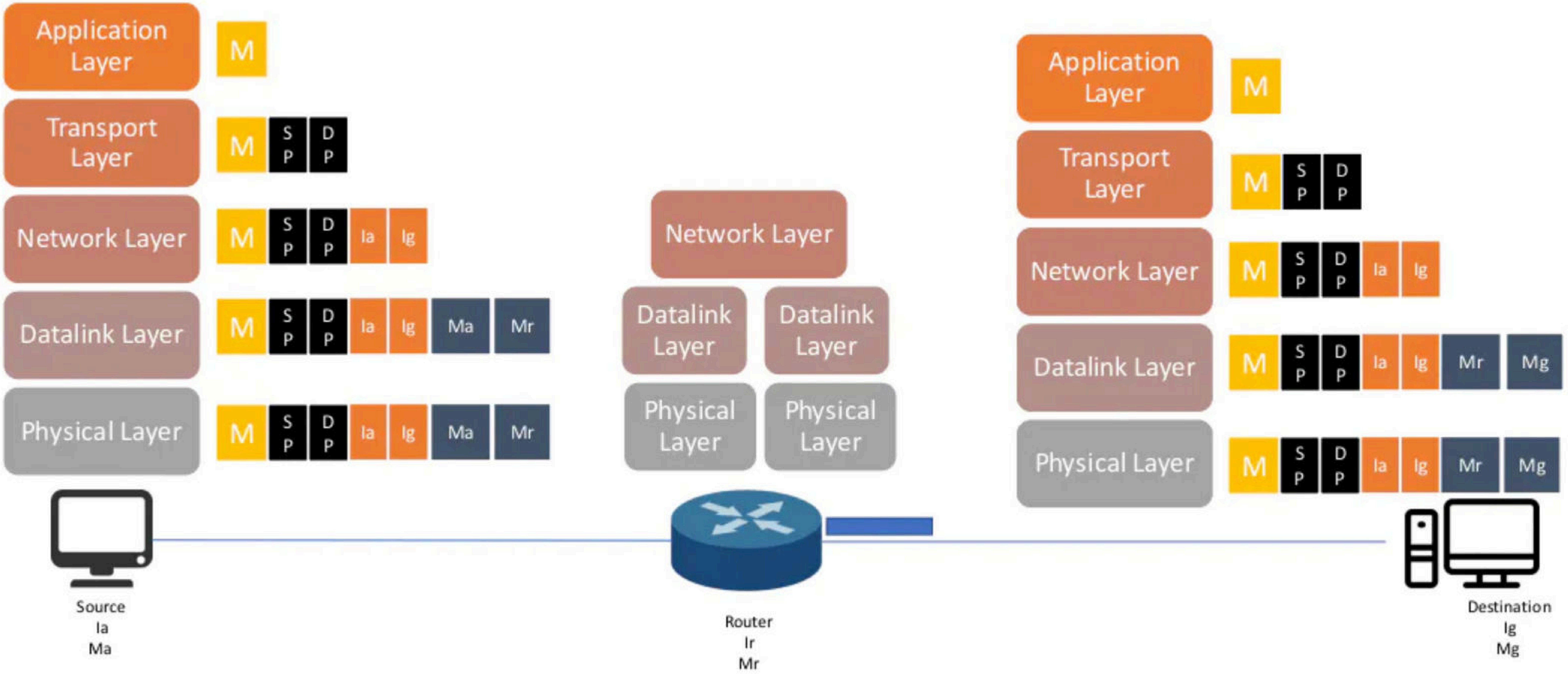

Application Layer
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Transport Layer
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Network Layer
M S P D P Ia Ig
Datalink Layer
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M S P D P Ia Ig Ma Mr
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Datalink Layer
Physical Layer
Physical Layer
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Application Layer
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Transport Layer
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Destination
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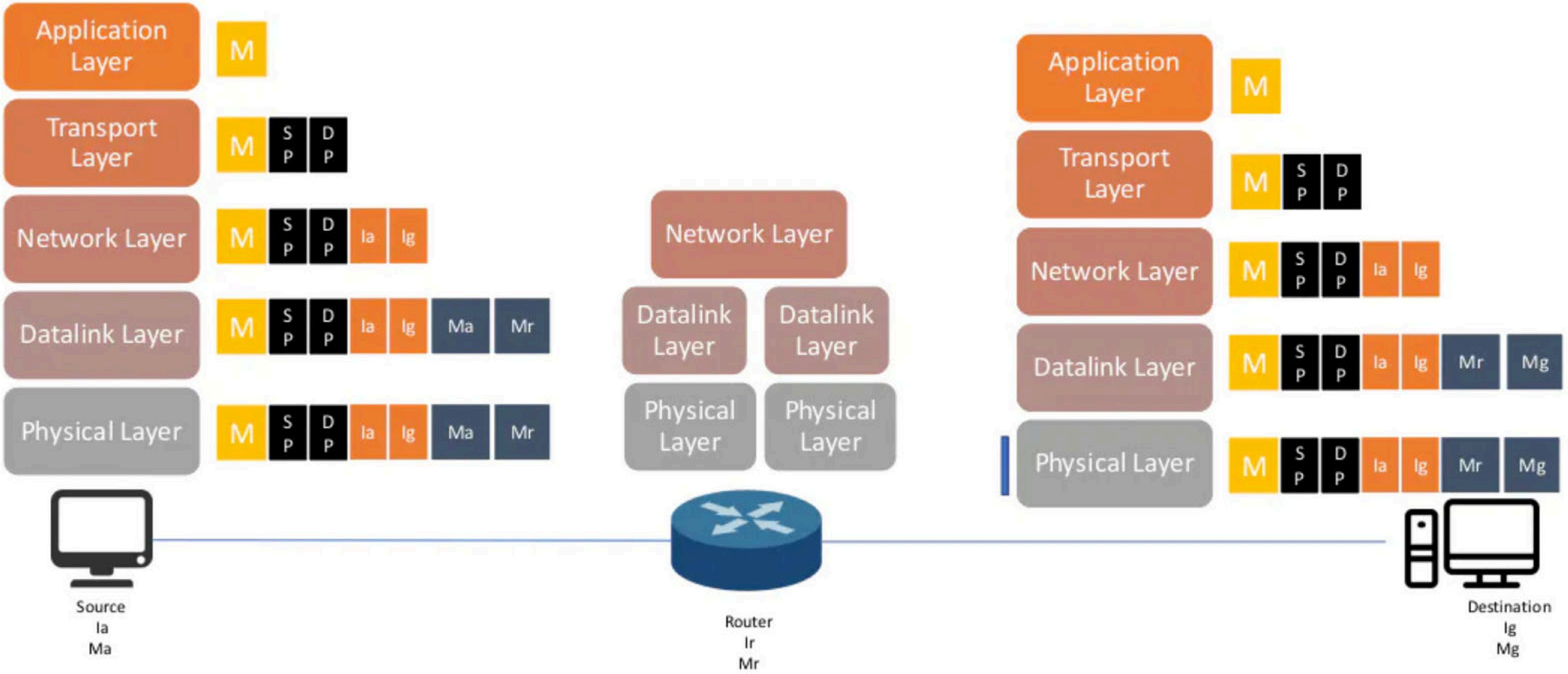
Application Layer
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Transport Layer
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Datalink Layer
M S P D P Ia Ig Ma Mr
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M S P D P Ia Ig Mr Mg
Physical Layer
M S P D P Ia Ig Mr Mg
Destination
Ig
Mg