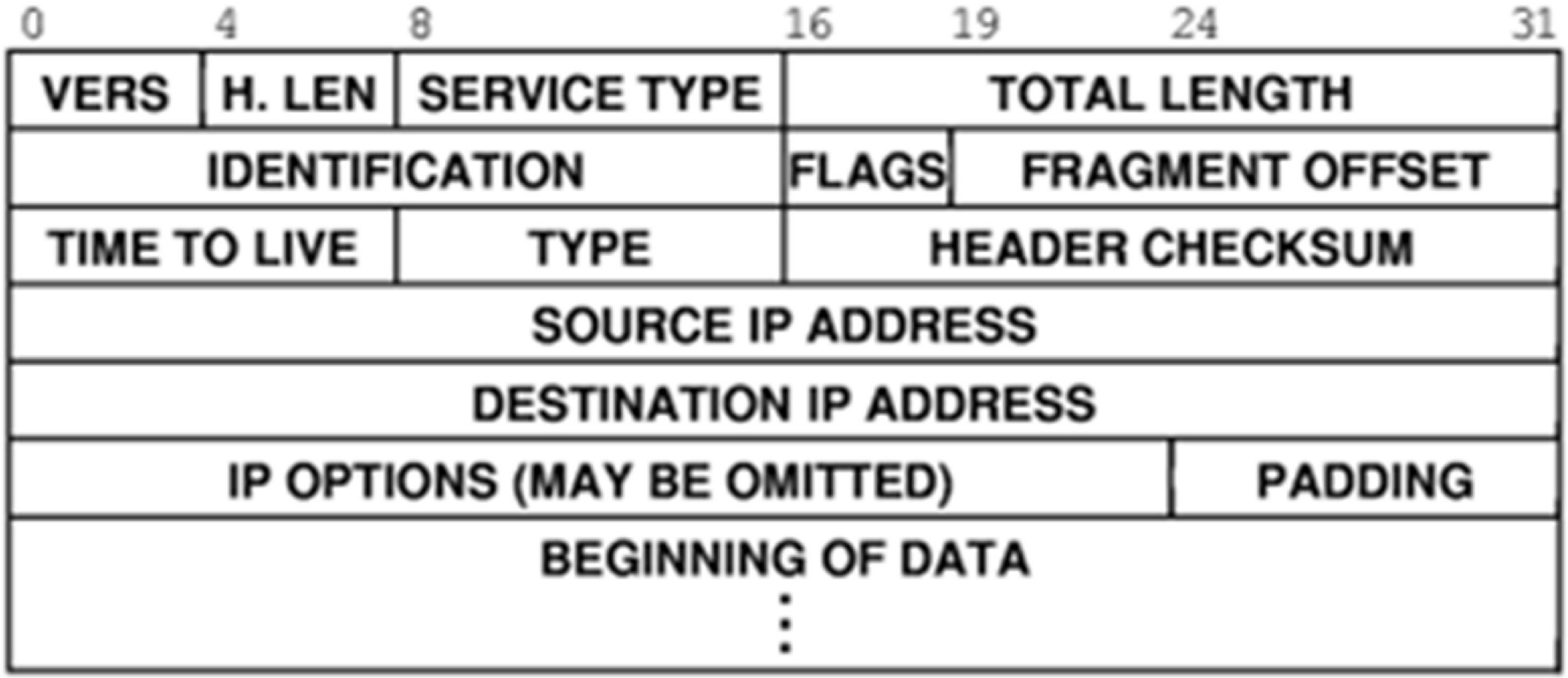
Format of Internet Packets

- The IP software defines its own internet packet format known as an *IP datagram.*
- It is a *universal*, *virtual* packet which has a particular format/structure which is very different to that of a hardware frame.
- It can carry a *single* octet of data or multiple octets up to a maximum of *64K* octets (including the header).

The IP Datagram Header Format



Forwarding an IP Datagram

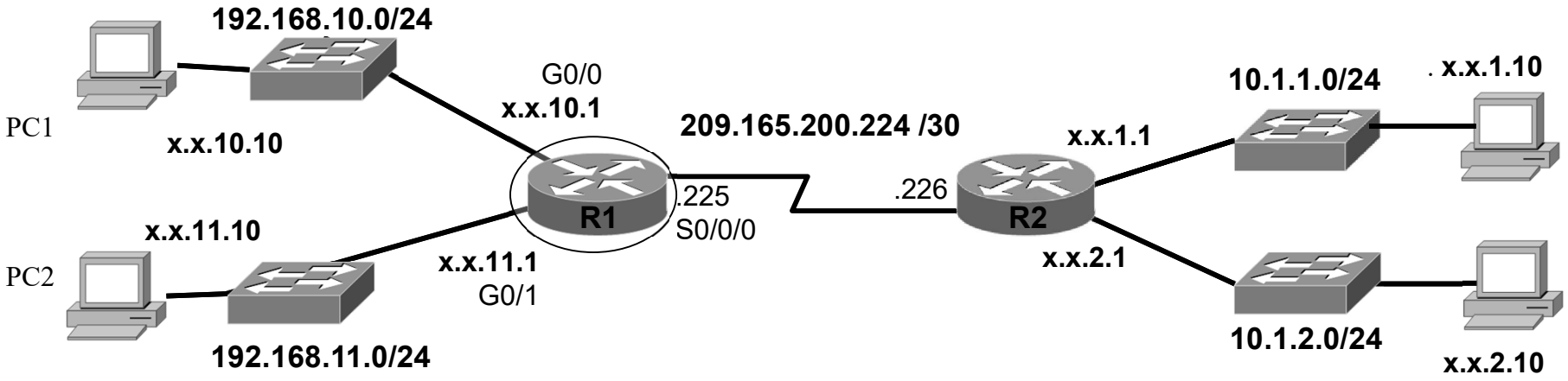
- Recall that a router makes its routing decision based on the *destination IP address.*
- Routing information is stored in a *routing table.*
  - This table must be *initialized* on boot-up and updated if the topology changes:
- The next three slides show example ***Routing Tables:***
  - The first slide recalls a high-level ***Routing Table*** from previous discussions,
  - The second and third slides shows a ***Routing Table*** from a real router.

Example IP Routing Table

(a)

Destination	Mask	Next Hop
30.0.0.0	255.0.0.0	40.0.0.7
40.0.0.0	255.0.0.0	deliver direct
128.1.0.0	255.255.0.0	deliver direct
192.4.10.0	255.255.255.0	128.1.0.9

Example IP Routing Table



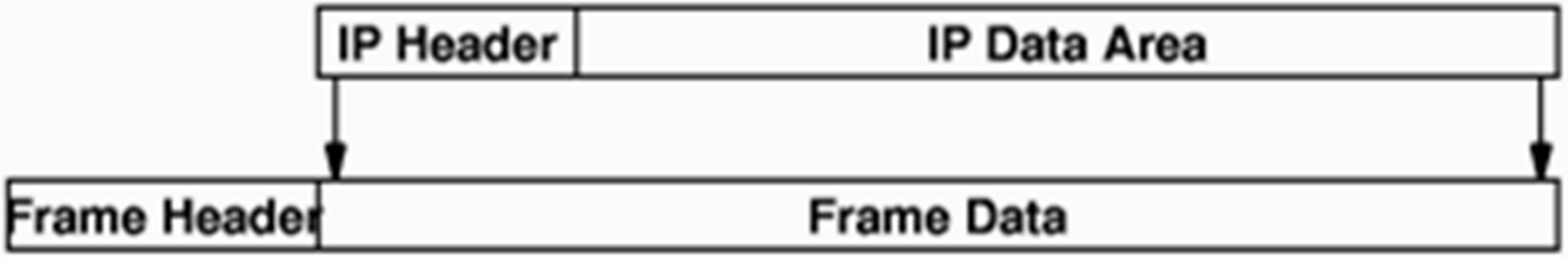
- Note the network numbers and the connections to the routers.
- The Routing Table router 1 (R1) is shown on the next slide.

Example IP Routing Table

```
R1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP

       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
D       10.1.1.0/24 [90/2170112] via 209.165.200.226, 00:00:05, Serial0/0/0
D       10.1.2.0/24 [90/2170112] via 209.165.200.226, 00:00:05, Serial0/0/0
     192.168.10.0/24 is variably subnetted, 2 subnets, 3 masks
C       192.168.10.0/24 is directly connected, GigabitEthernet0/0
L       192.168.10.1/32 is directly connected, GigabitEthernet0/0
     192.168.11.0/24 is variably subnetted, 2 subnets, 3 masks
C       192.168.11.0/24 is directly connected, GigabitEthernet0/1
L       192.168.11.1/32 is directly connected, GigabitEthernet0/1
     209.165.200.0/24 is variably subnetted, 2 subnets, 3 masks
C       209.165.200.224/30 is directly connected, Serial0/0/0
L       209.165.200.225/32 is directly connected, Serial0/0/0
R1#
```

IP Encapsulation

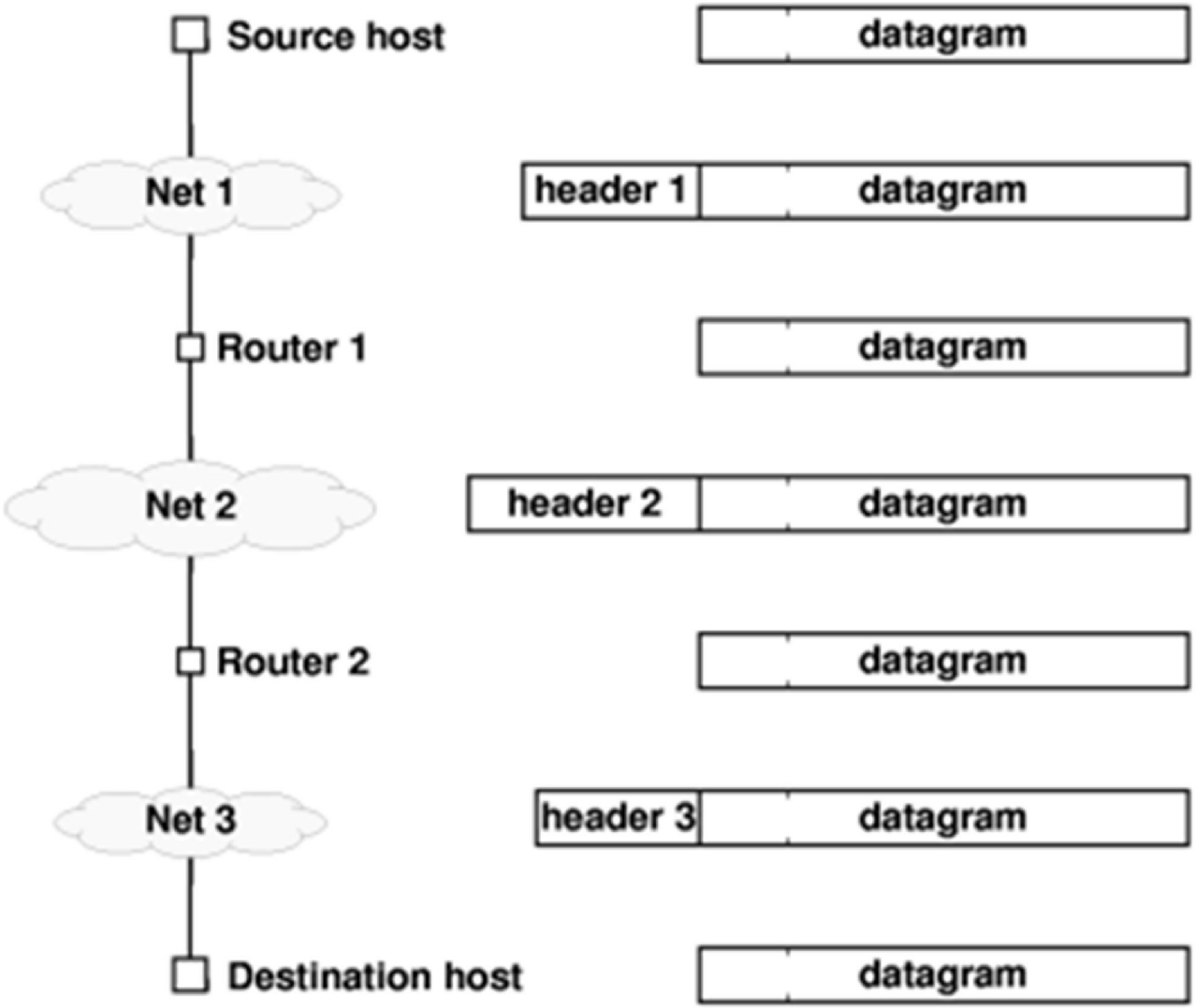
- The *physical network* does not understand the datagram format.
- Instead the *datagram* is placed in the data area of a *hardware frame.*
- This is known as *encapsulation.*



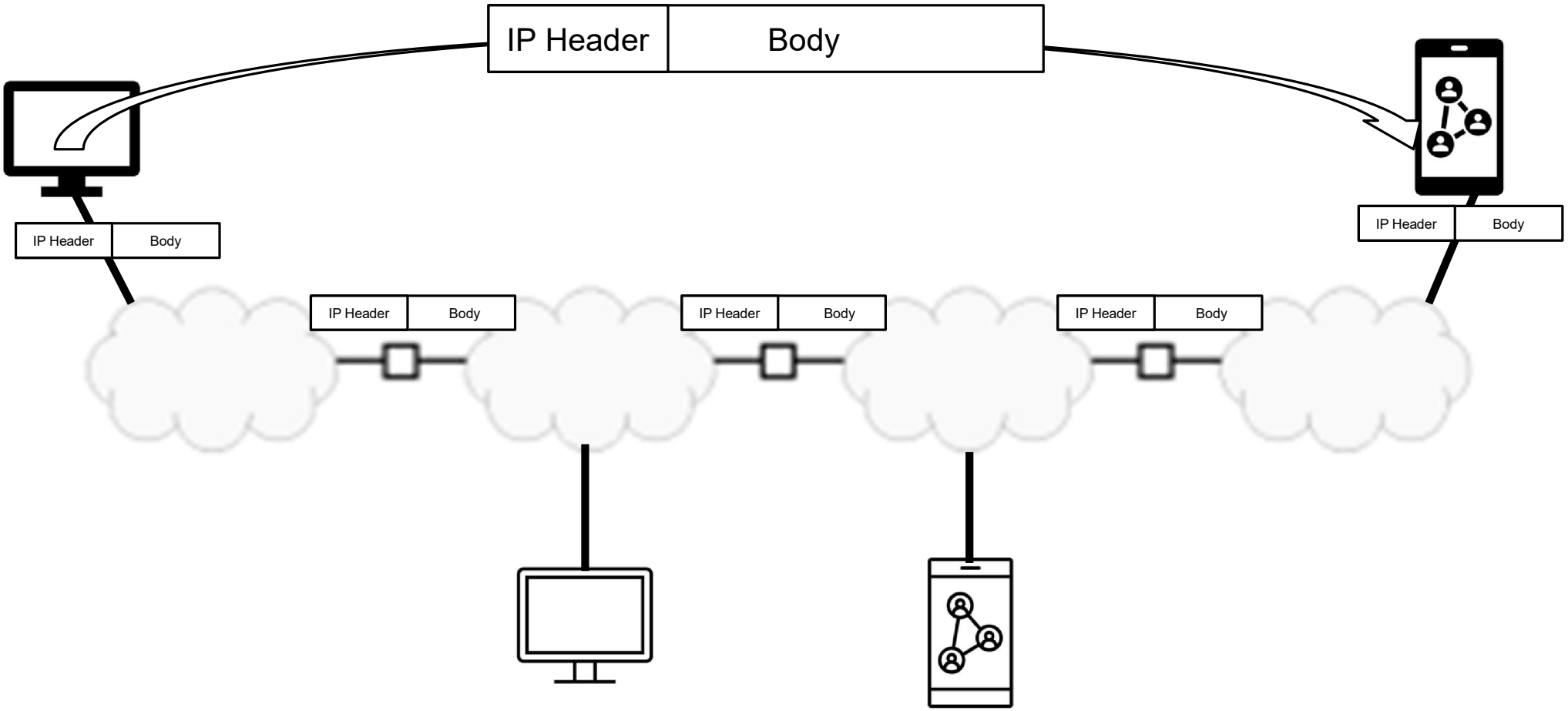
IP Encapsulation

- This process is applied on each leg of the transmission path.
- The *datagram* is stored in memory without the additional *frame header* information.
- The size of the *frame header* may vary as it traverses different network technologies.

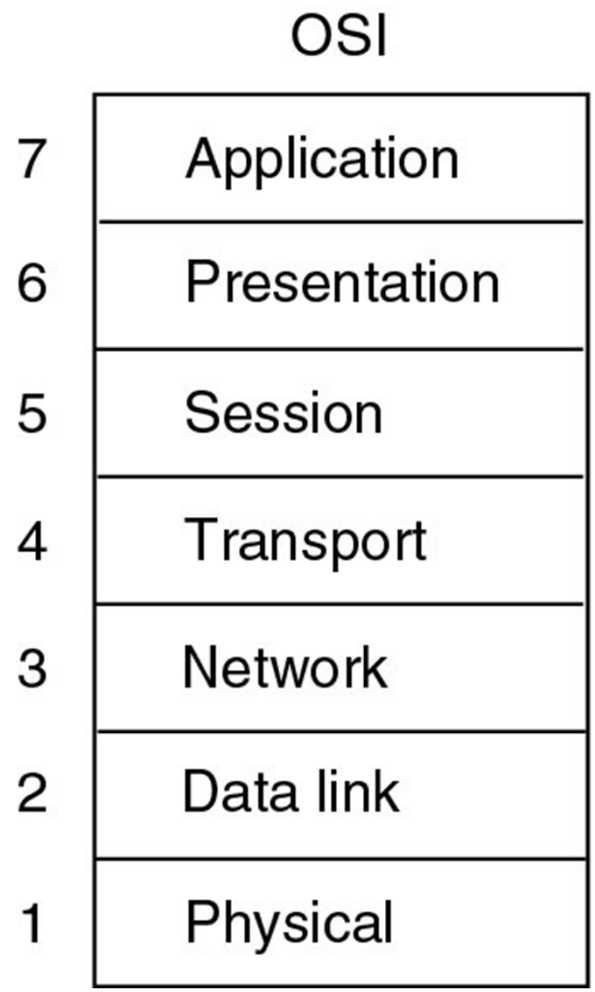
Encapsulation at work



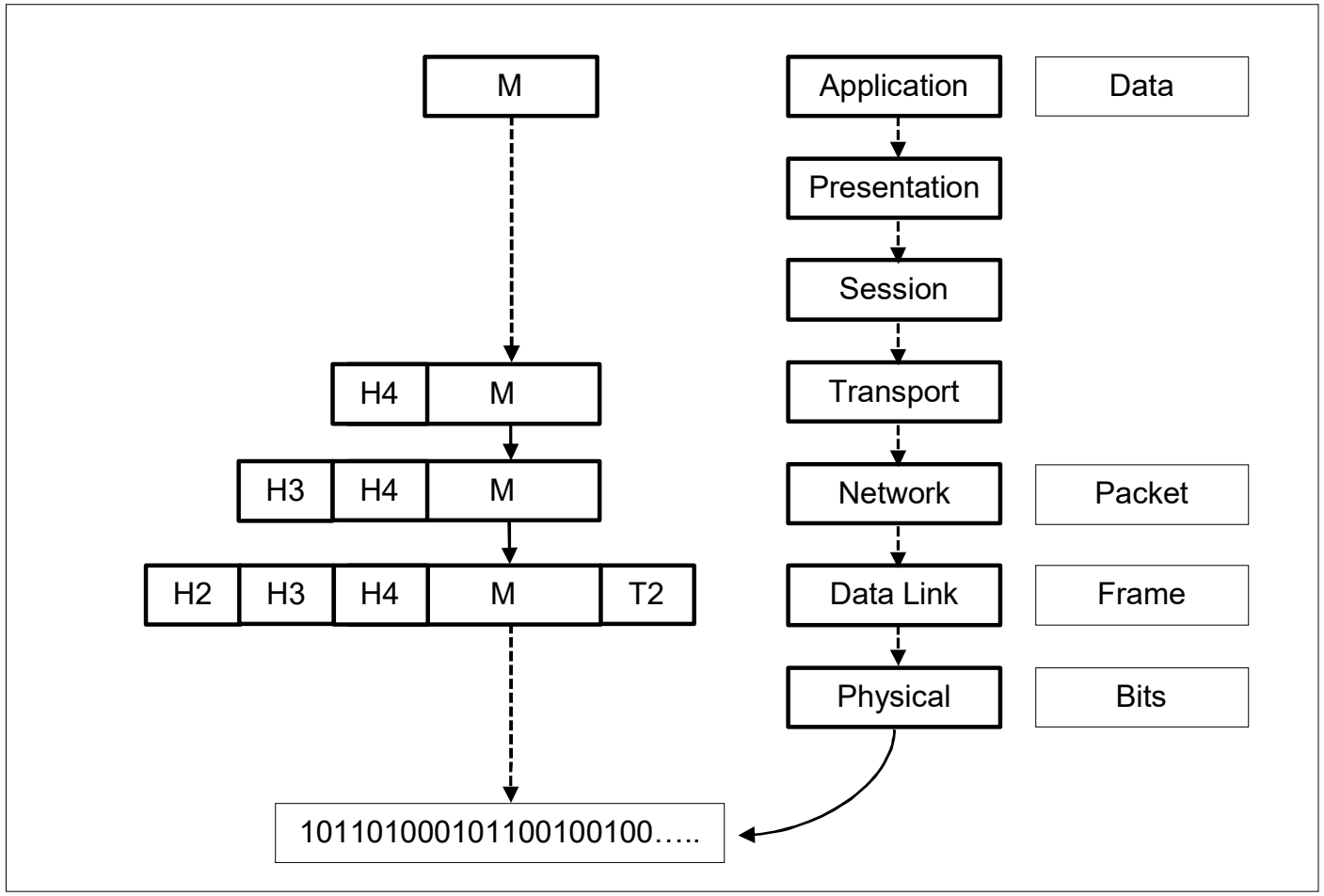
IP Datagram and the internet



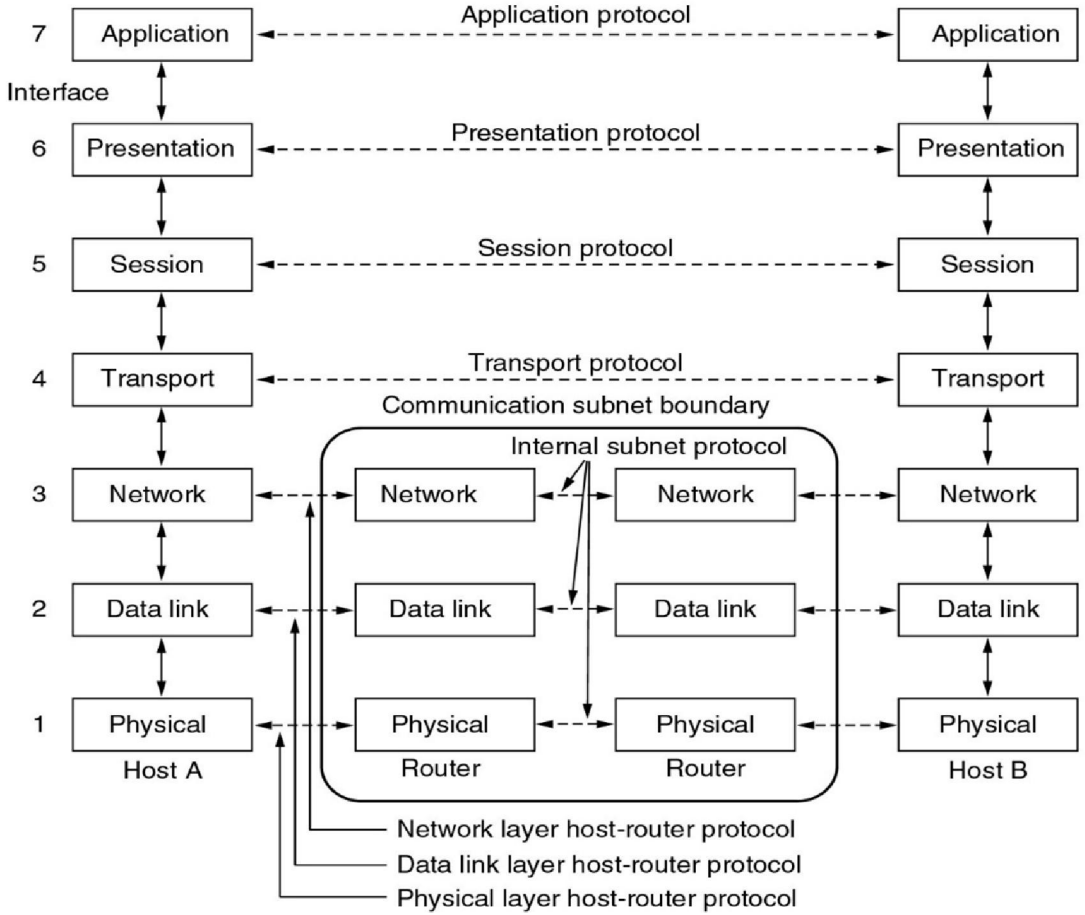
The *ISO OSI Reference Model*



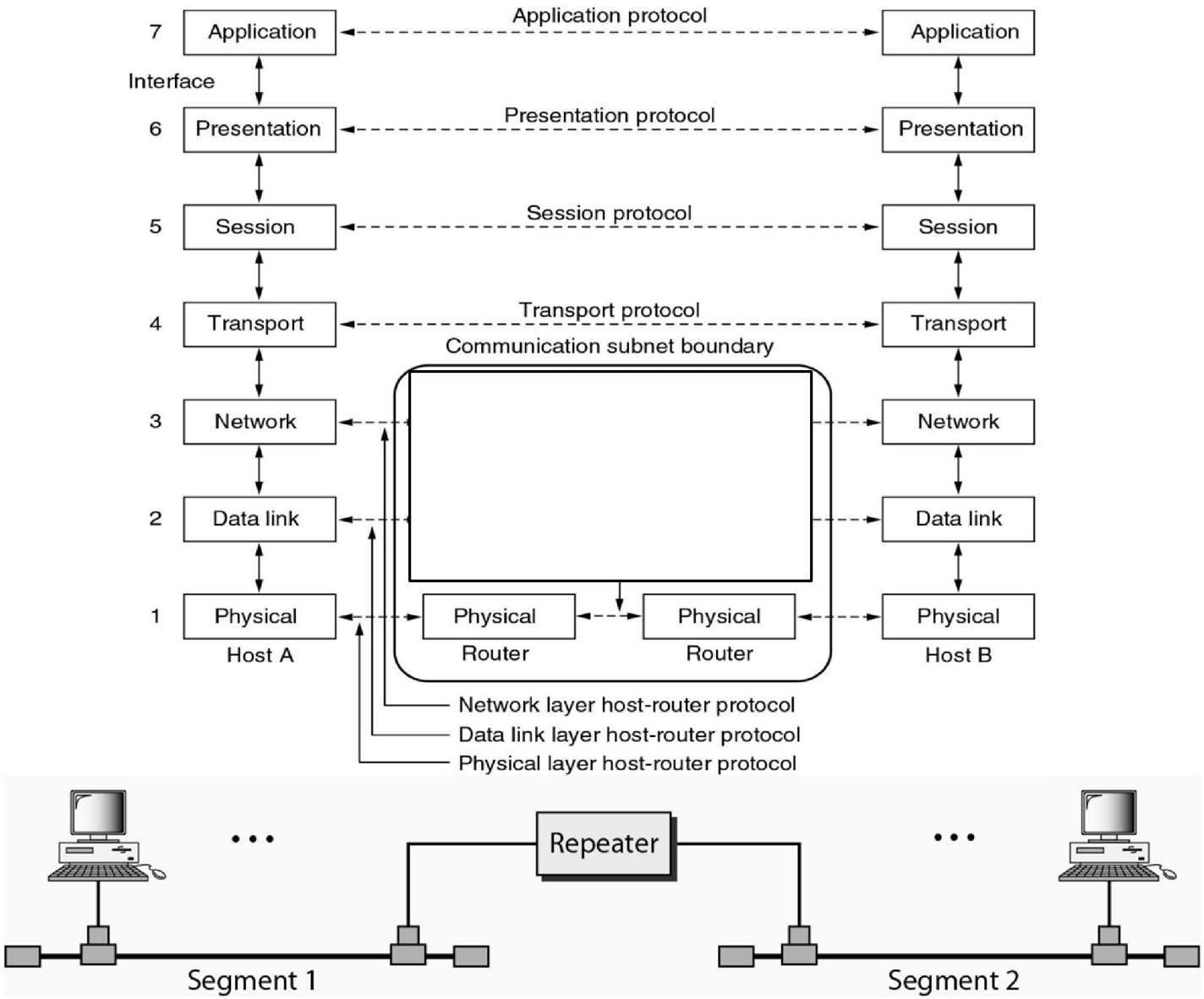
Encapsulation and Information flow between the layers on an end-host.



The *ISO Reference Model* – Layers 1-3 V Layers 4-7



Repeater Implementation



Repeater Implementation