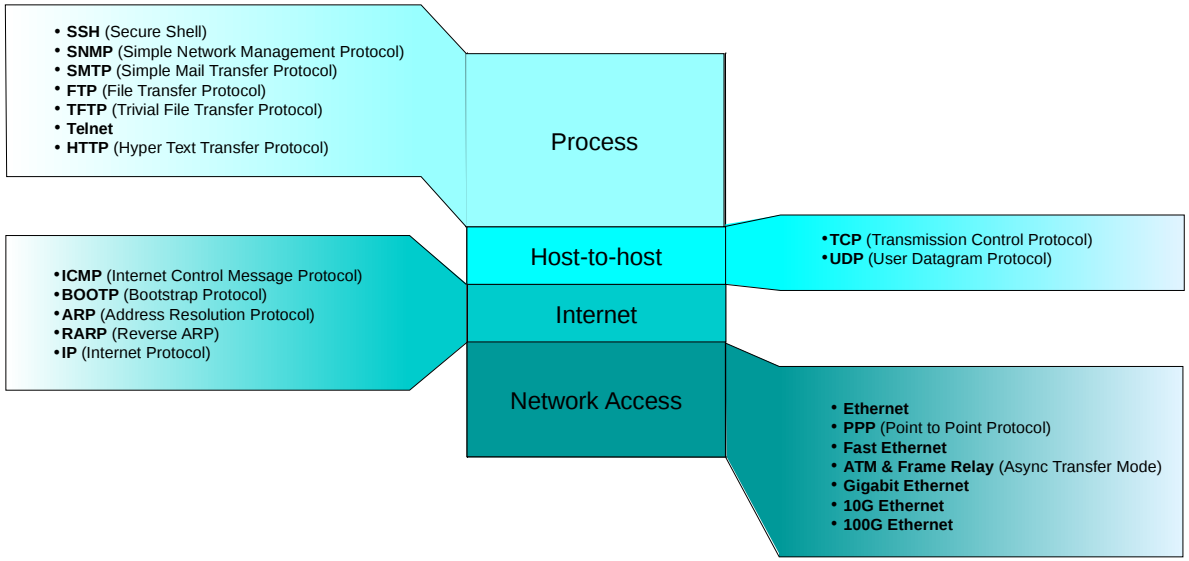
TEL3214
Computer Communication Networks

Lecture 2

Internetworking models



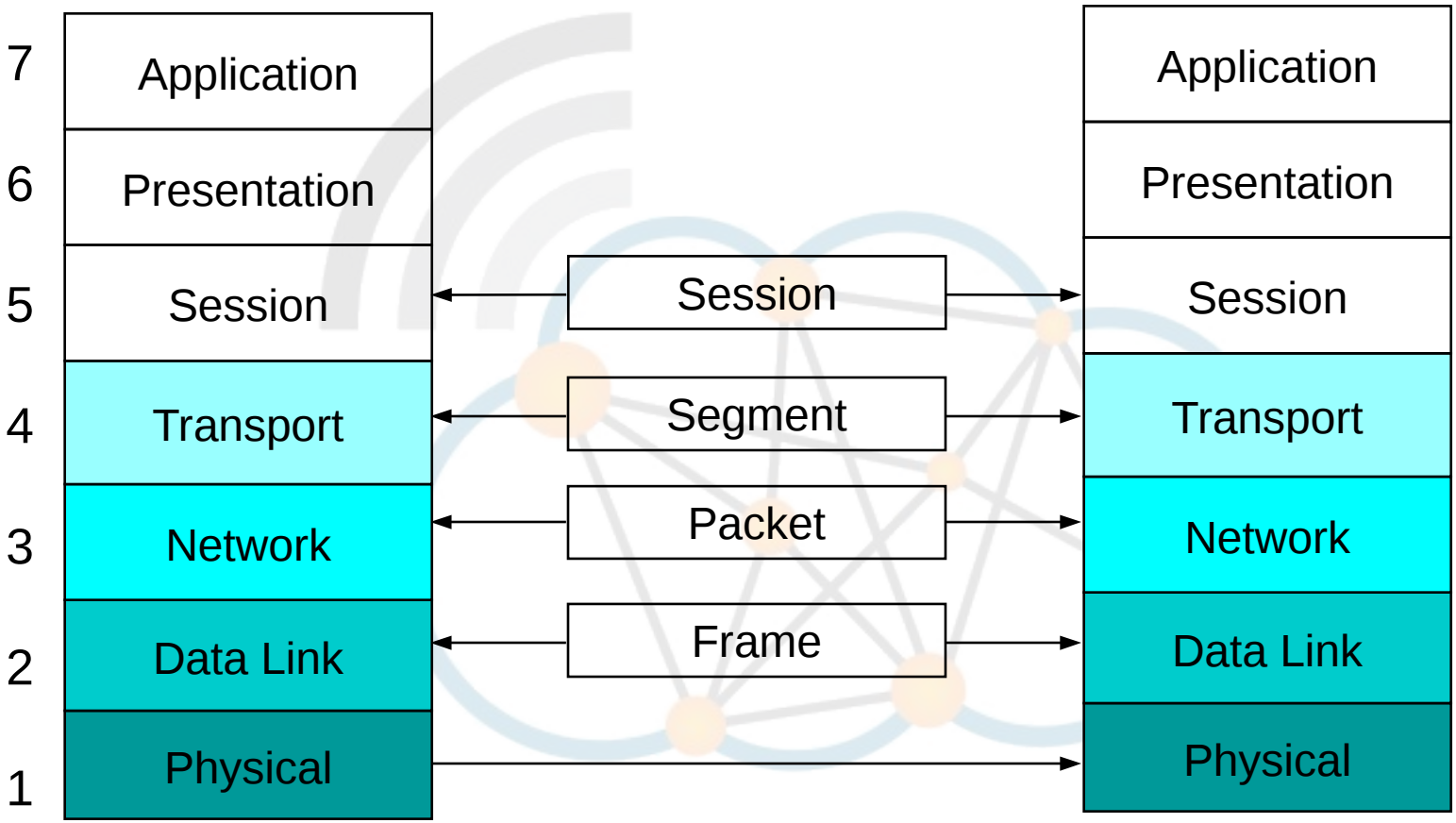
Diarmuid Ó Briain
CEng, FIEI, FIET, CISSP

diarmuid@obriain.com

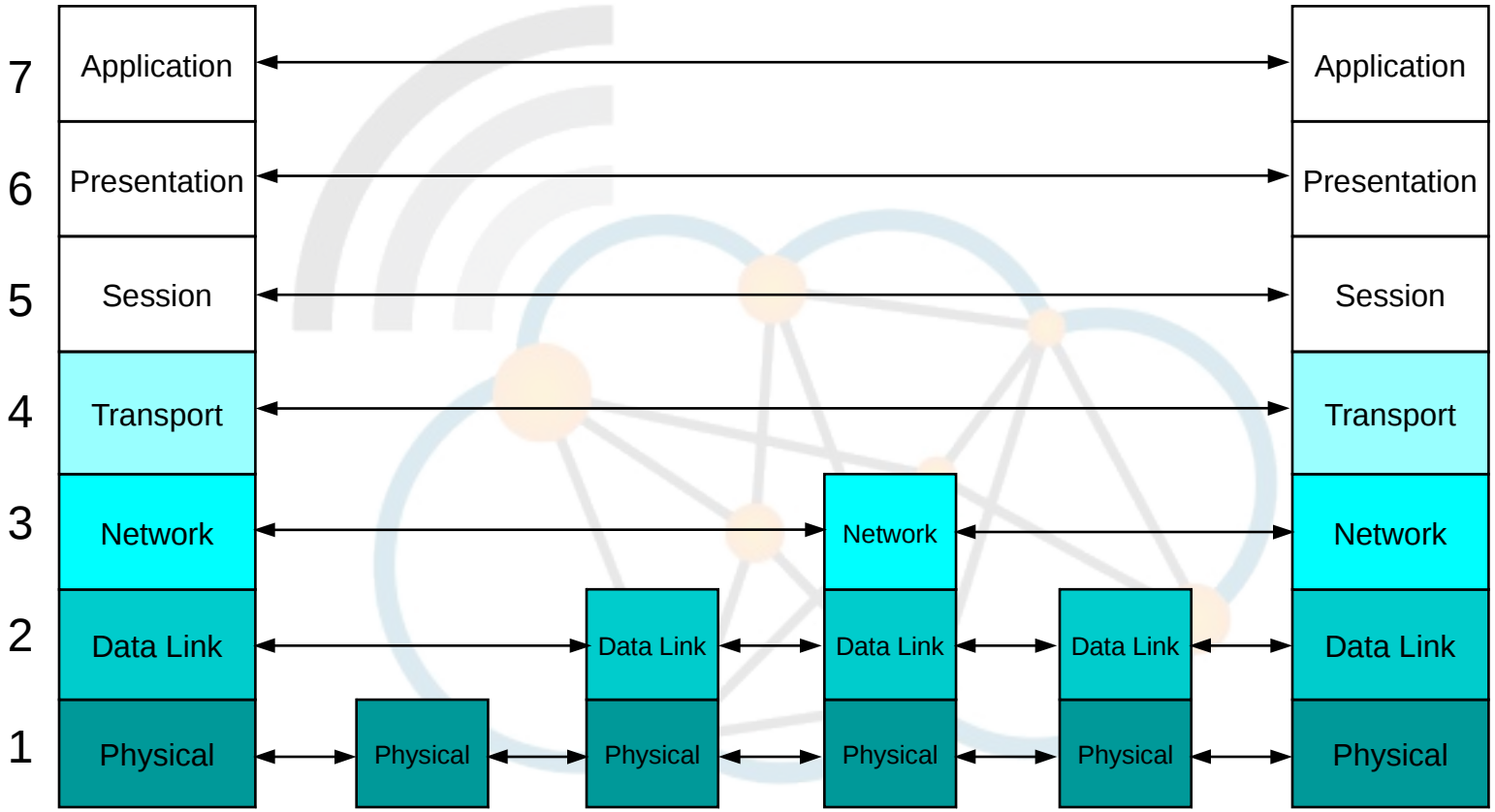
Internetworking Models - OSI

OSI Layer		
7	Application	File, Print, database & Application services
6	Presentation	Data encryption, compression & translation services
5	Session	Dialogue control
4	Transport	End to End connection
3	Network	Routing
2	Data Link	Framing, Bridging, Switching
1	Physical	Physical network topology

Internetworking Models - OSI



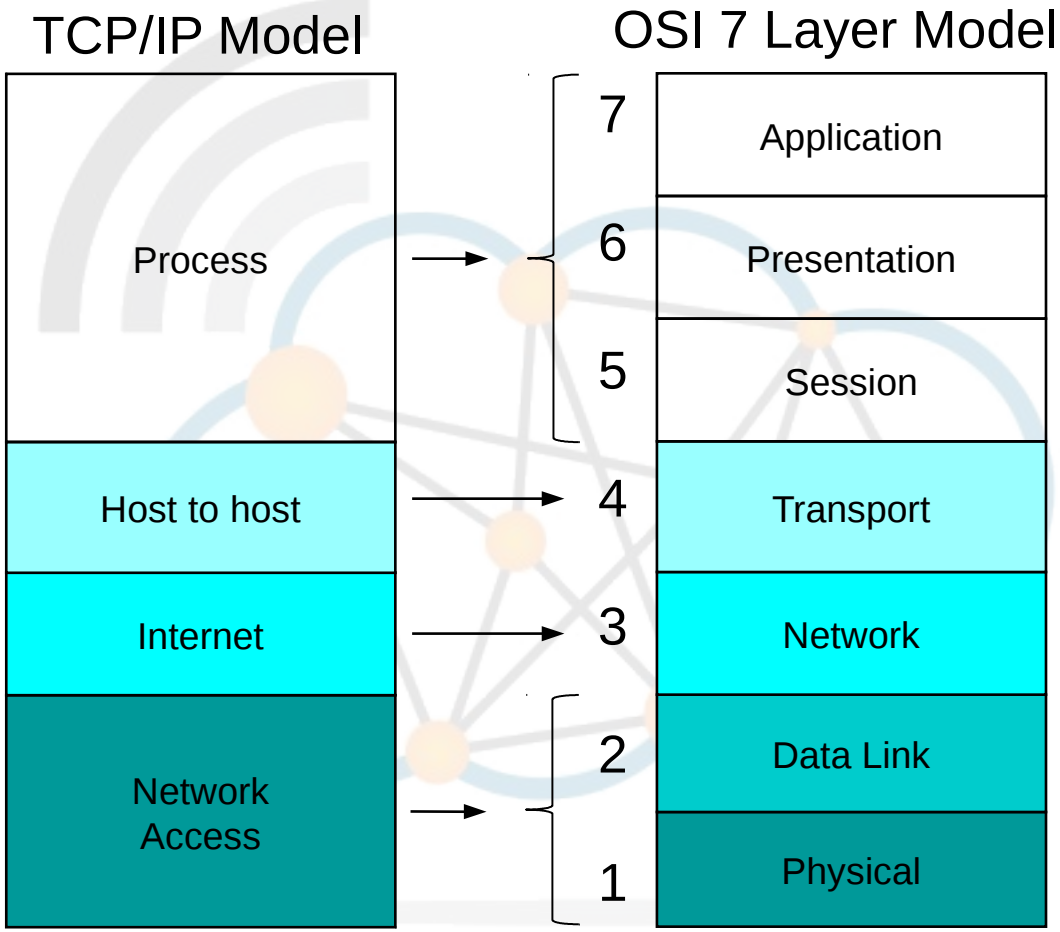
Internetworking Models - OSI



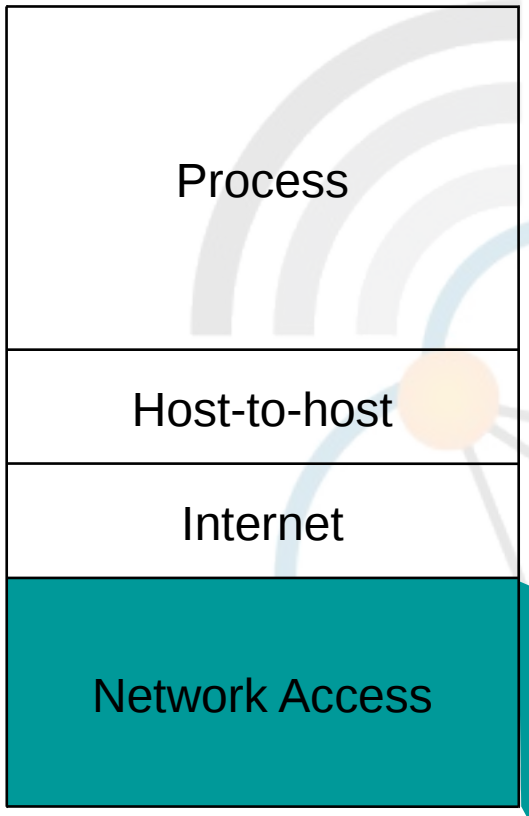
DoD Networking Model (TCP/IP)

- The DoD Four-Layer Model was developed in the 1970s for the DARPA Internetwork Project that eventually grew into the Internet.
- The four layers in the DoD model:
  - The Network Access Layer is responsible for delivering data over the particular hardware media in use. Different protocols are selected from this layer, depending on the type of physical network.
  - The Internet Layer is responsible for delivering data across a series of different physical networks that interconnect a source and destination machine. Routing protocols are most closely associated with this layer, as is the IP Protocol, the Internet's fundamental protocol.
  - The Host-to-Host Layer handles connection rendezvous, flow control, retransmission of lost data, and other generic data flow management. The mutually exclusive TCP and UDP protocols are this layer's most important members.
  - The Process Layer contains protocols that implement user-level functions, such as mail delivery, file transfer and remote login.

DoD Networking Model (TCP/IP)

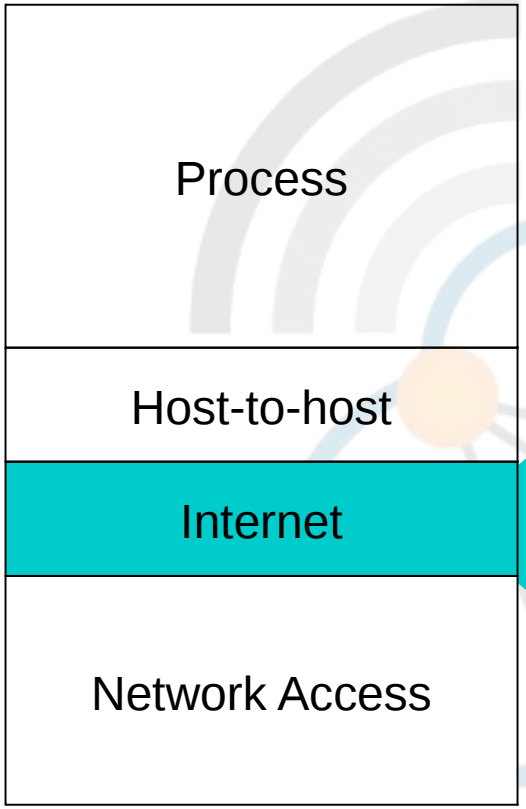


Network Access Protocols



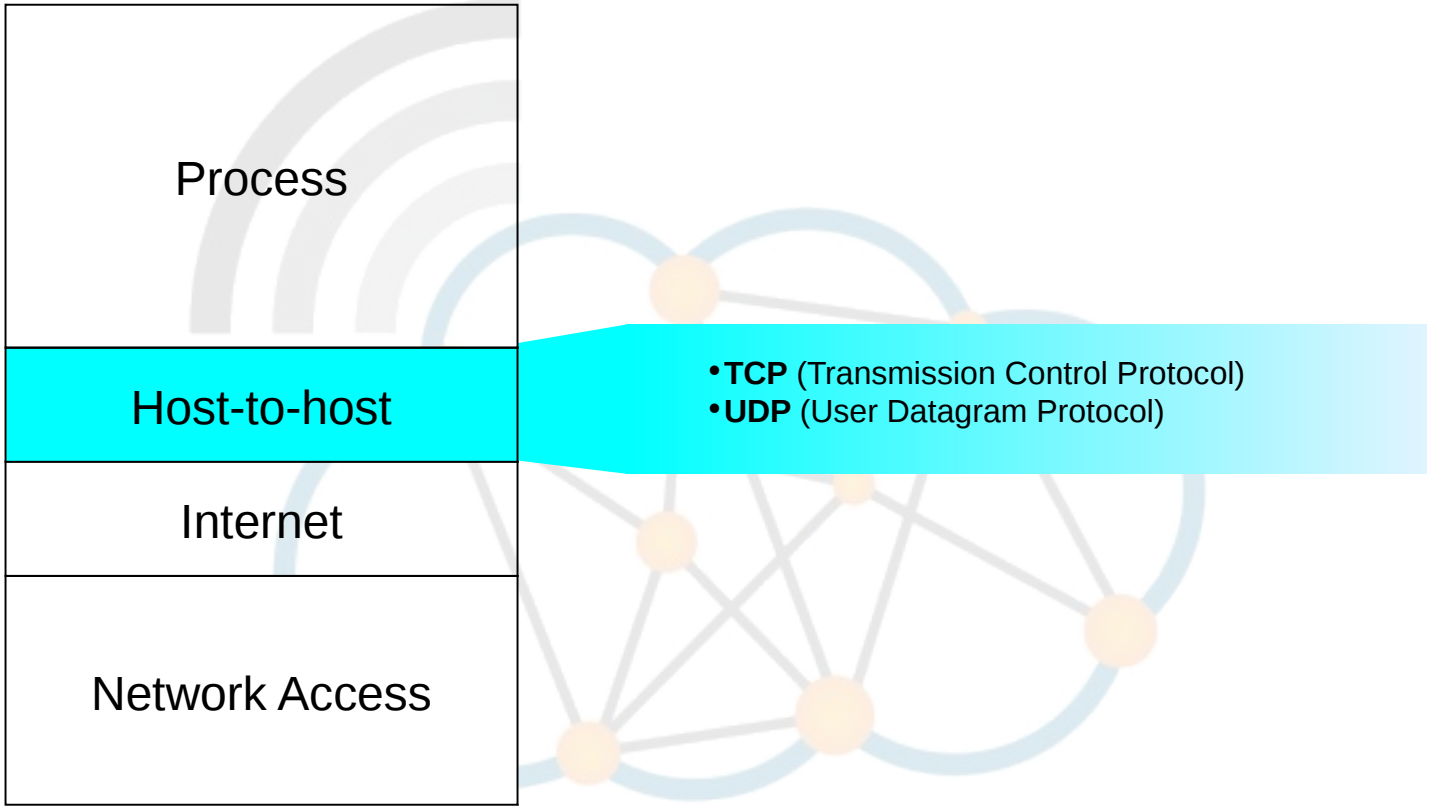
- **Ethernet**
- **PPP** (Point to Point Protocol)
- **Fast Ethernet**
- **ATM & Frame Relay** (Async Transfer Mode)
- **Gigabit Ethernet**
- **10G Ethernet**
- **100G Ethernet**

Internet Protocols

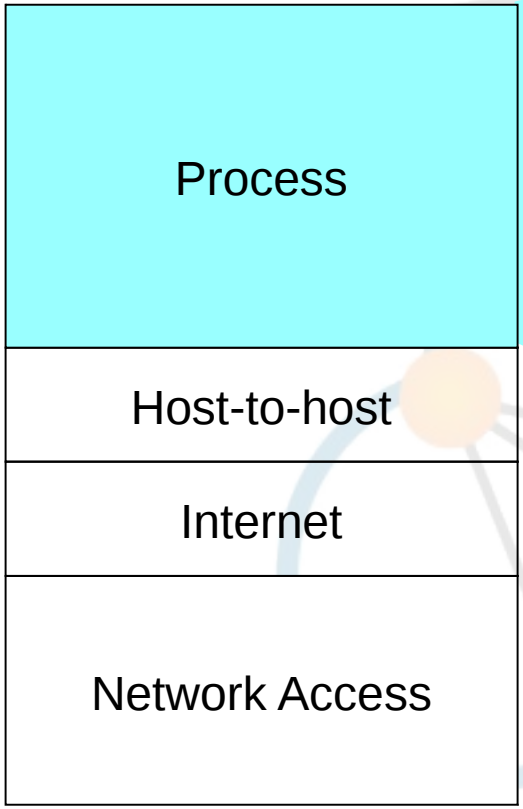


- **ICMP** (Internet Control Message Protocol)
- **BOOTP** (Bootstrap Protocol)
- **ARP** (Address Resolution Protocol)
- **RARP** (Reverse ARP)
- **IP** (Internet Protocol)

Internet Protocols

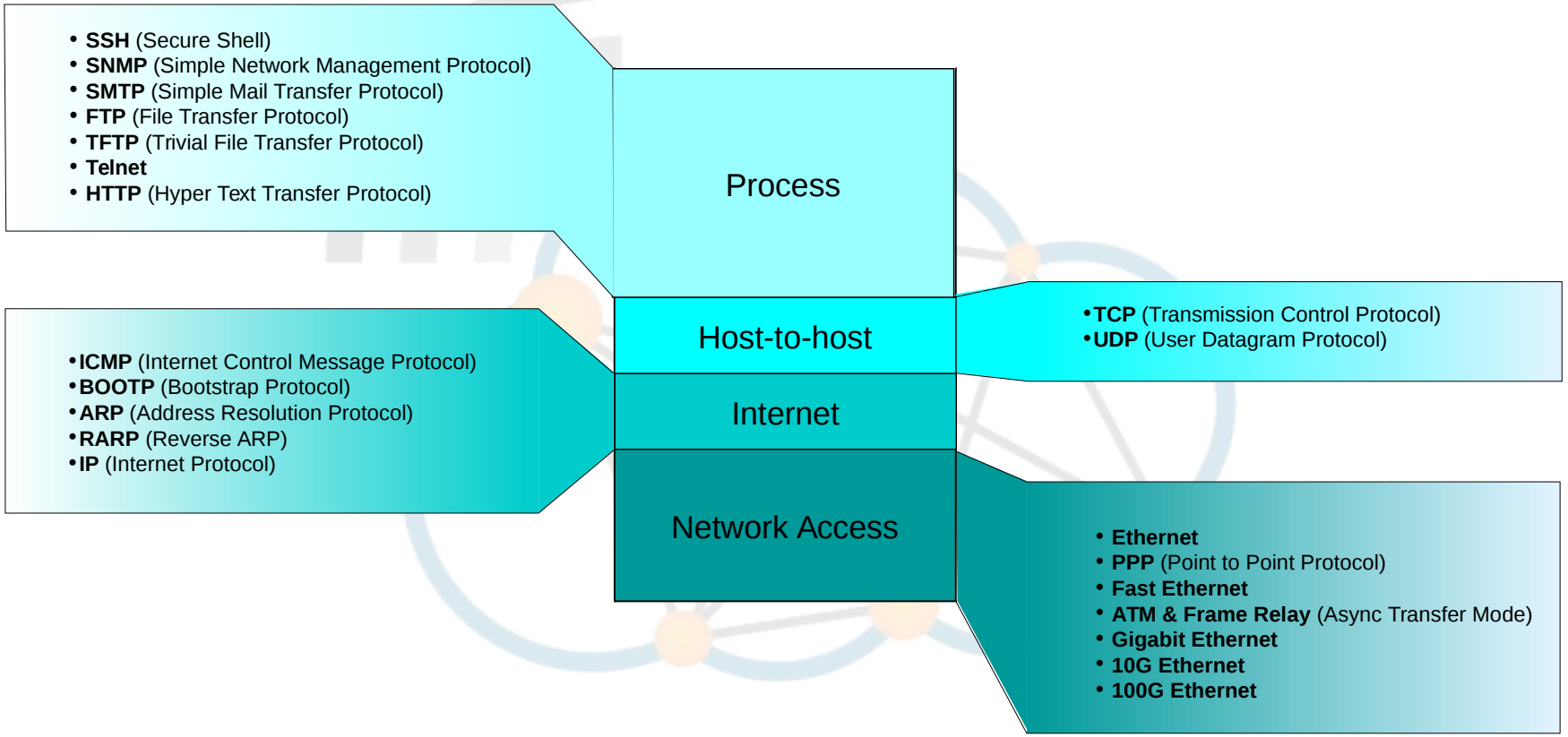


Application Protocols

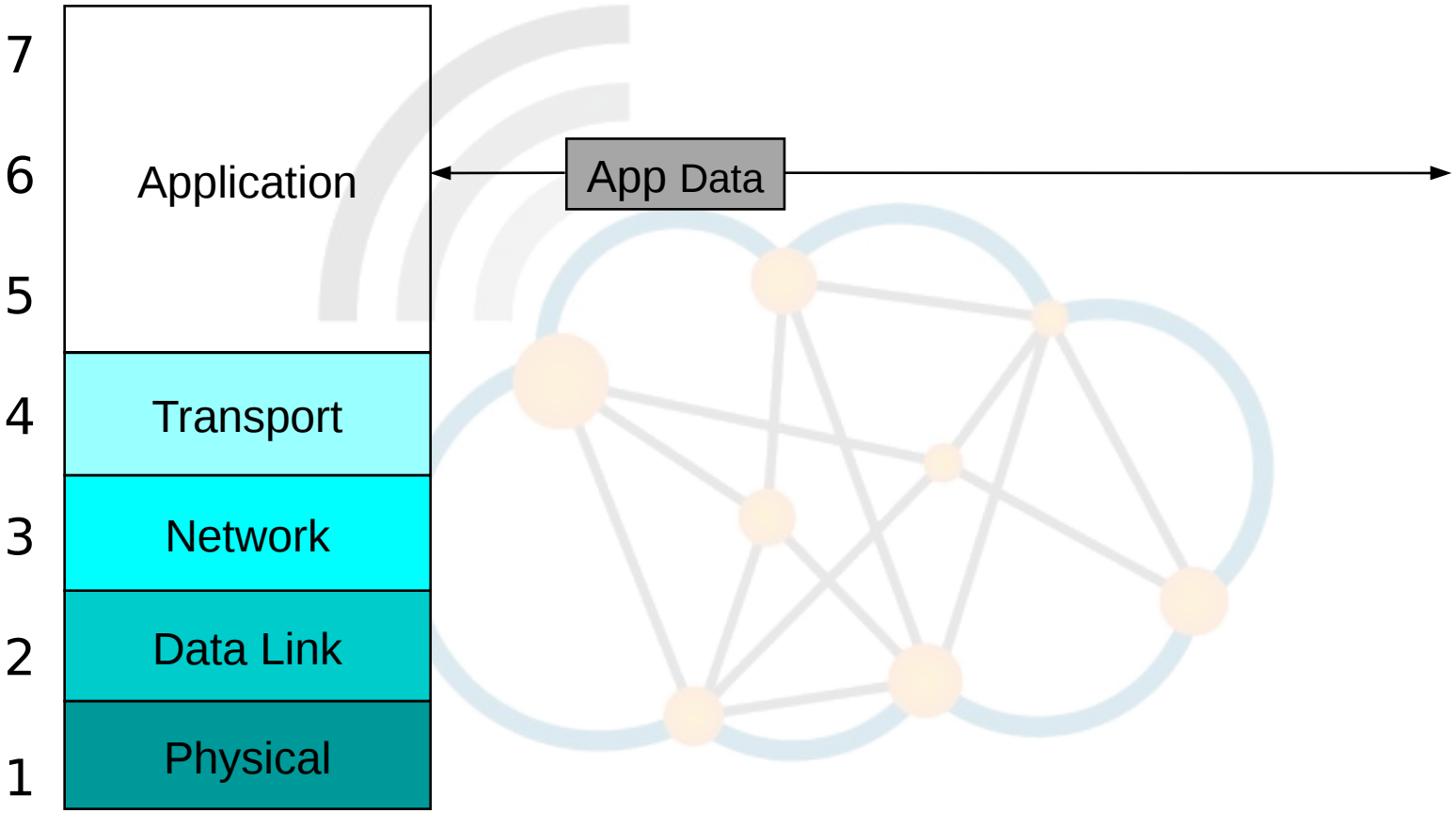


- **SSH** (Secure Shell)
- **SNMP** (Simple Network Management Protocol)
- **SMTP** (Simple Mail Transfer Protocol)
- **FTP** (File Transfer Protocol)
- **TFTP** (Trivial File Transfer Protocol)
- **Telnet**
- **HTTP** (Hyper Text Transfer Protocol)

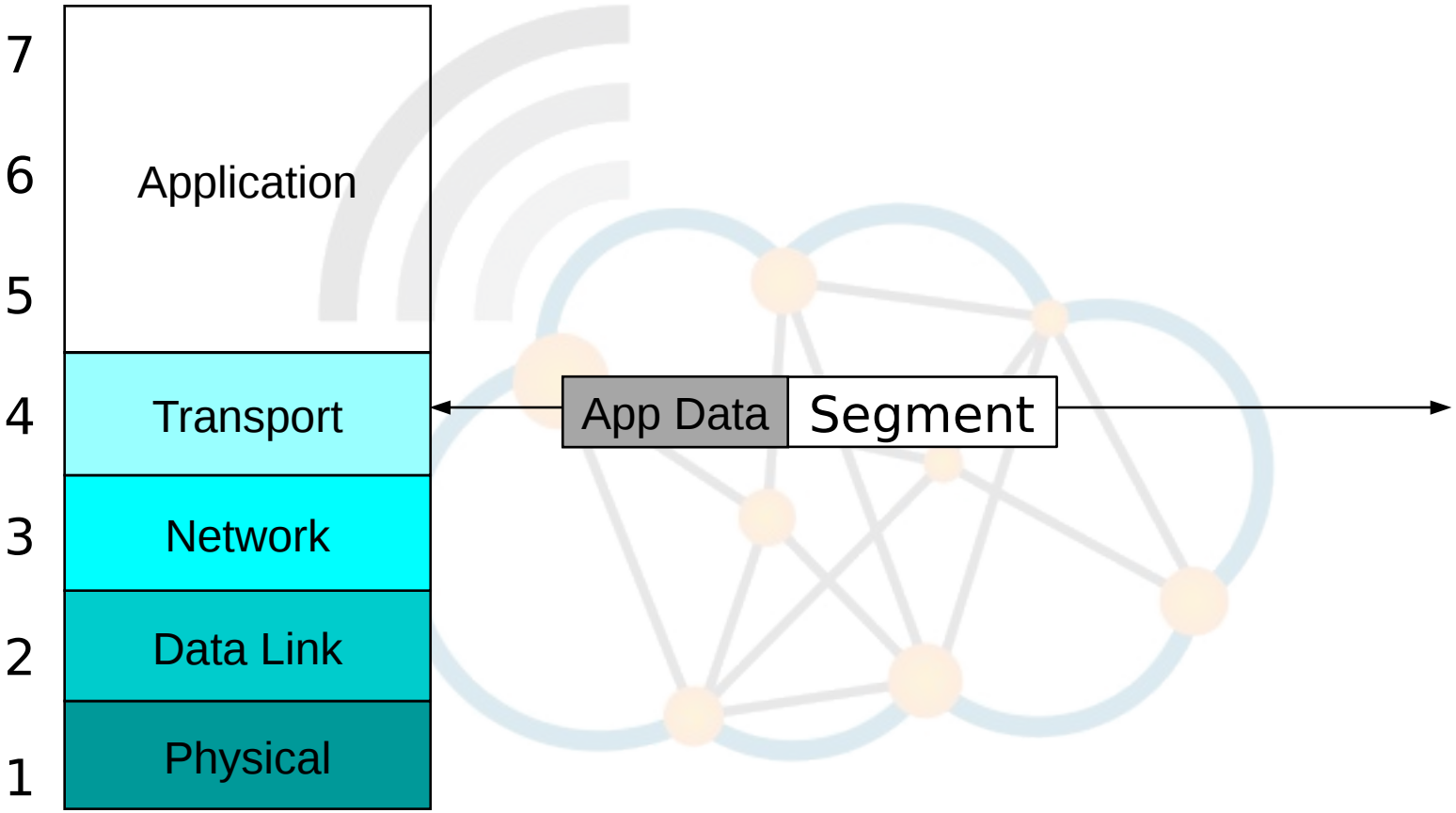
Application Protocols



Internetworking Model



Internetworking Model



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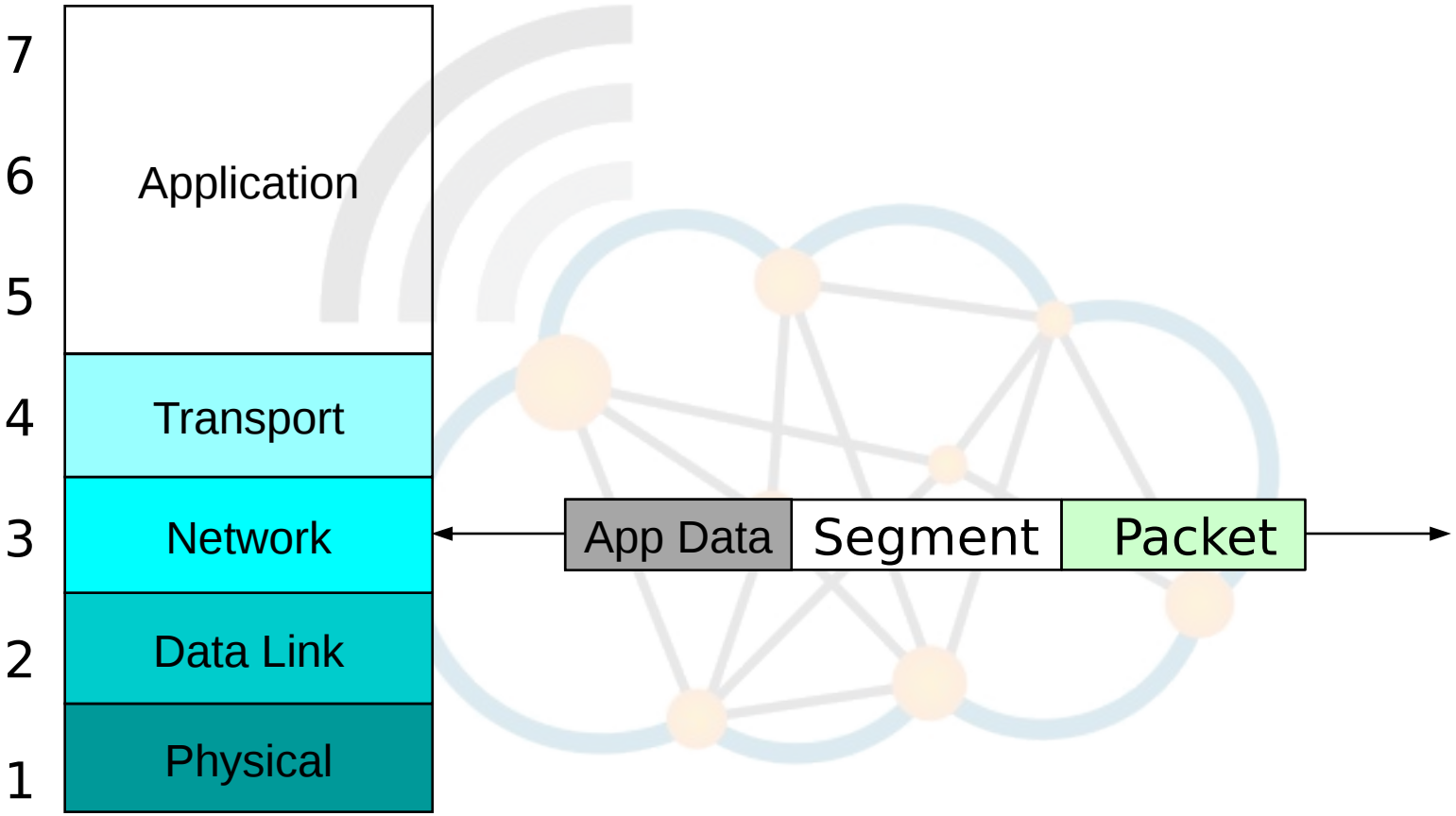

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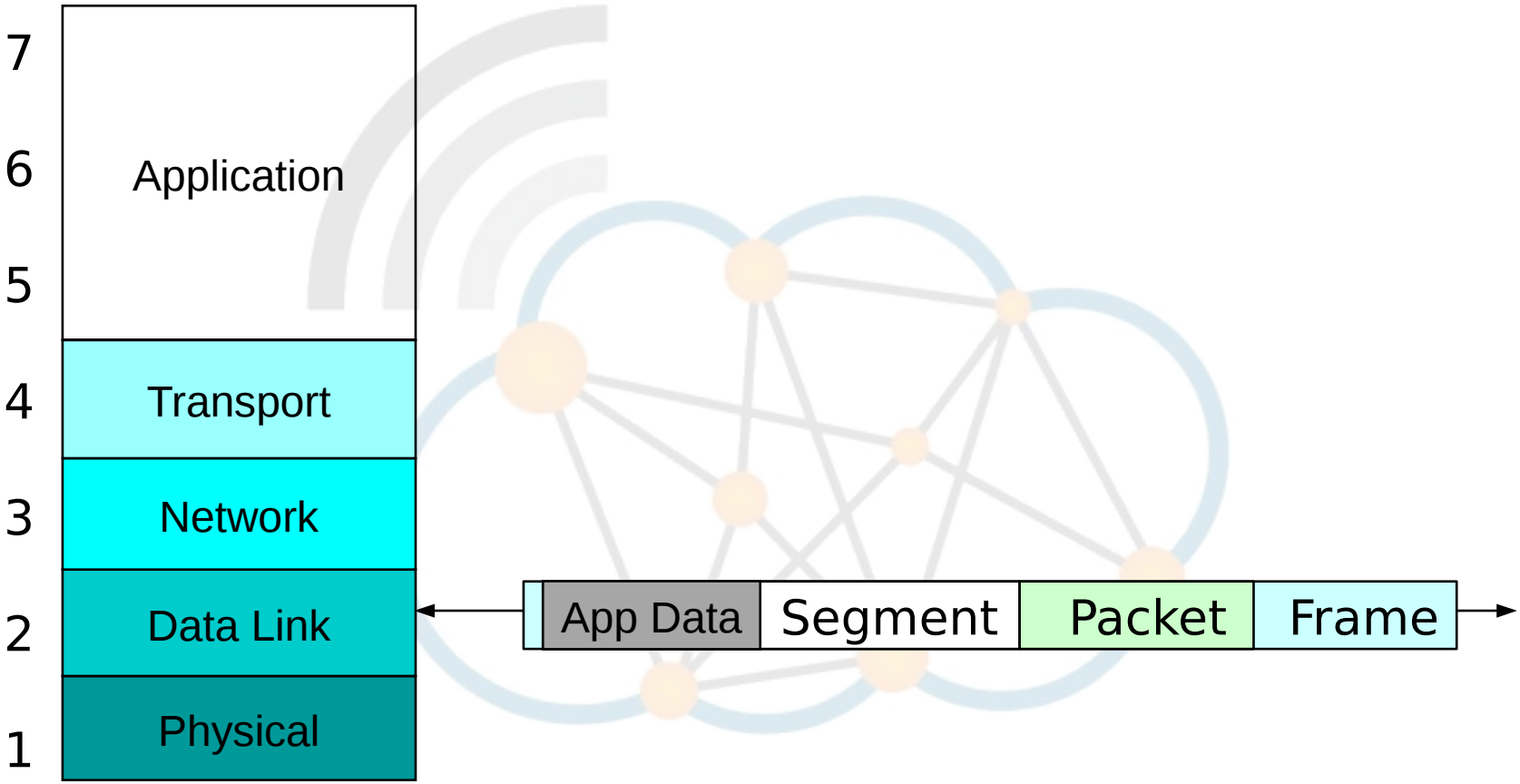
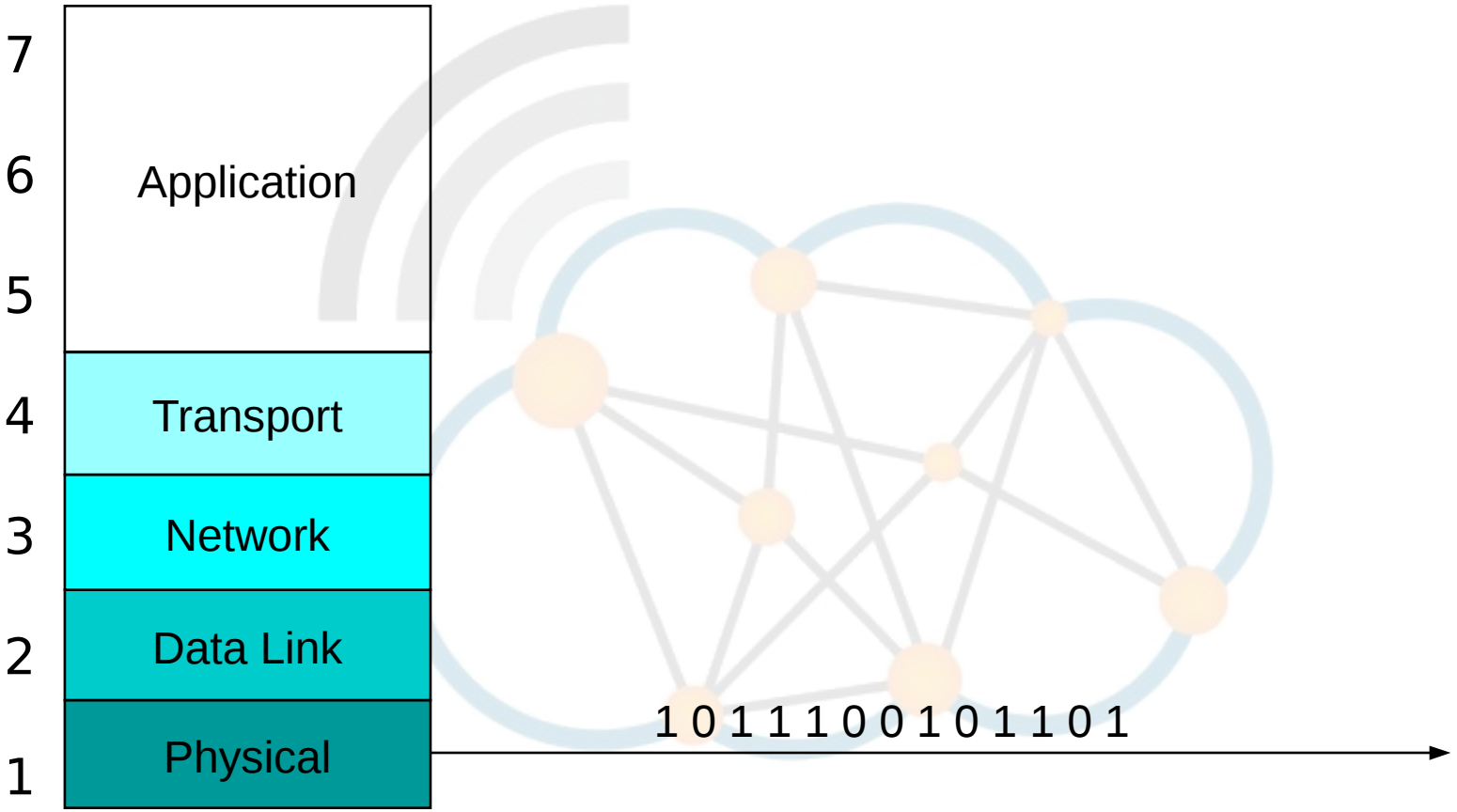
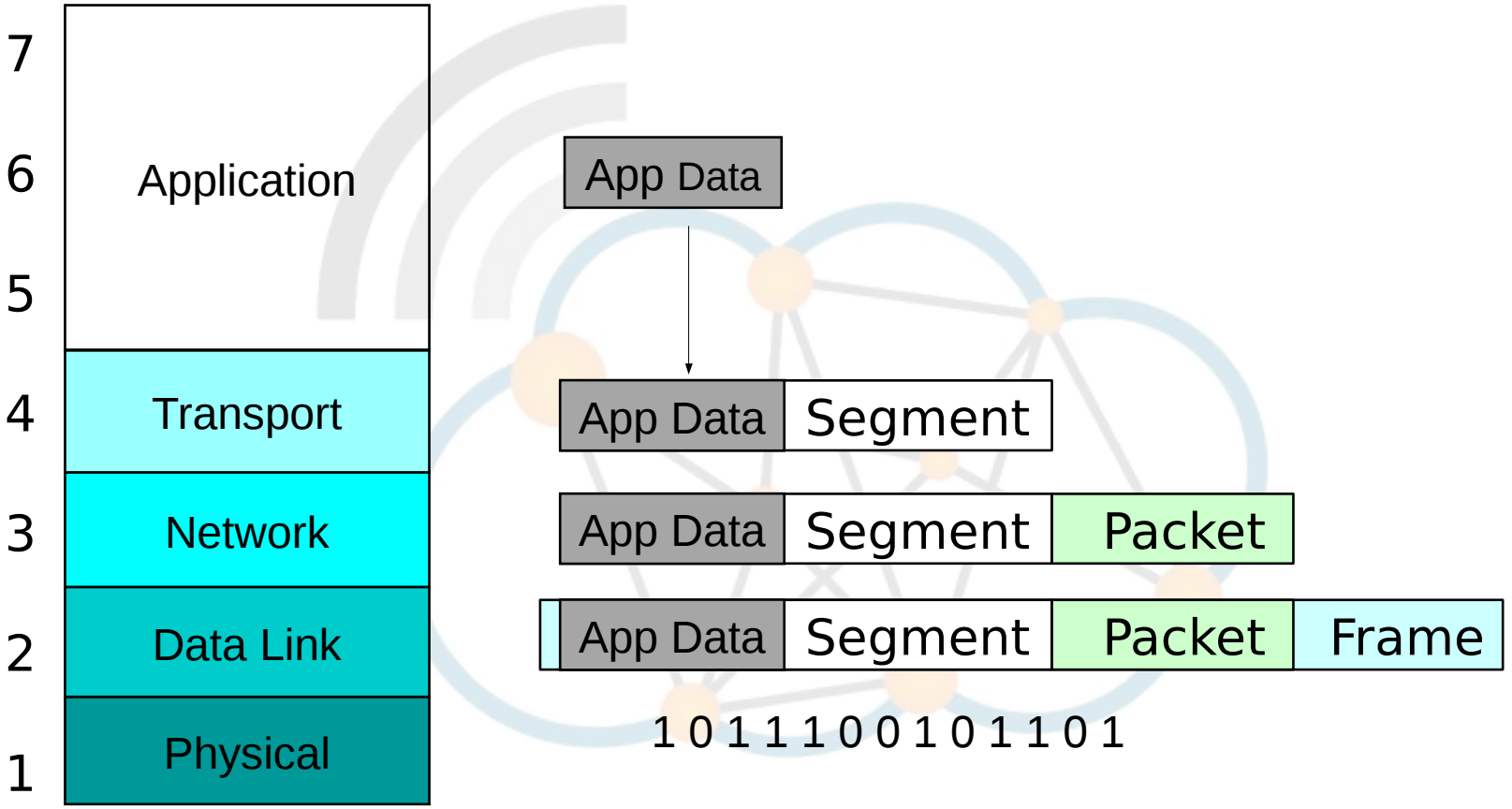


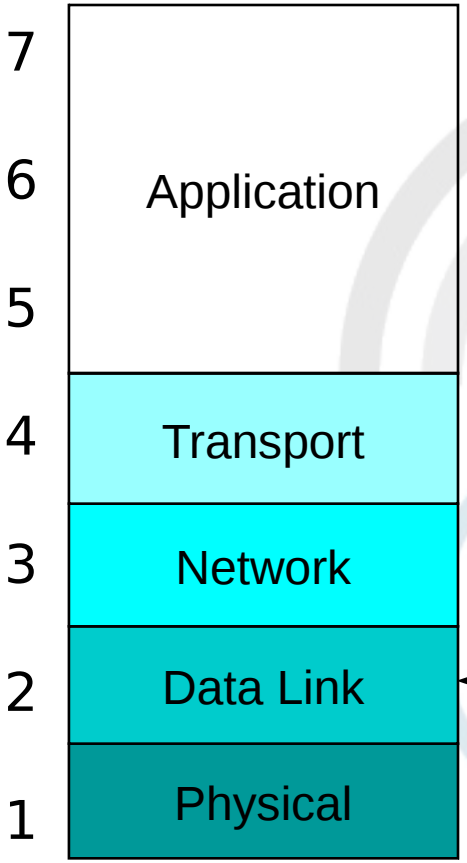
Internetworking Model



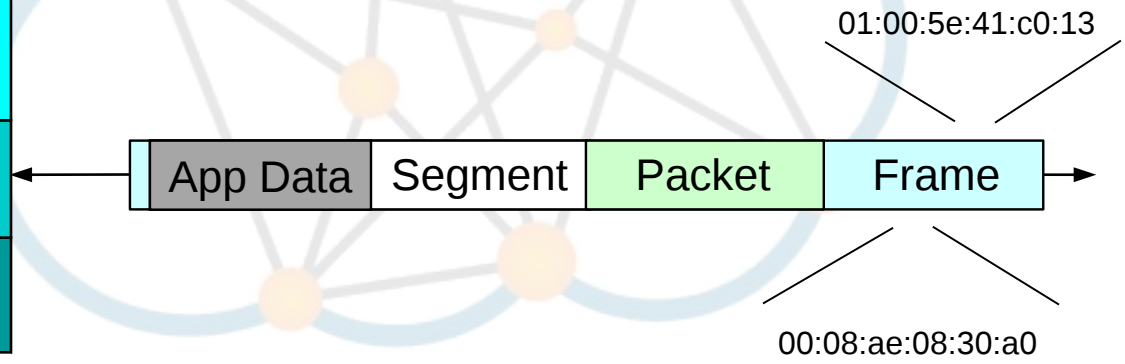
Internetworking Model



MAC Address

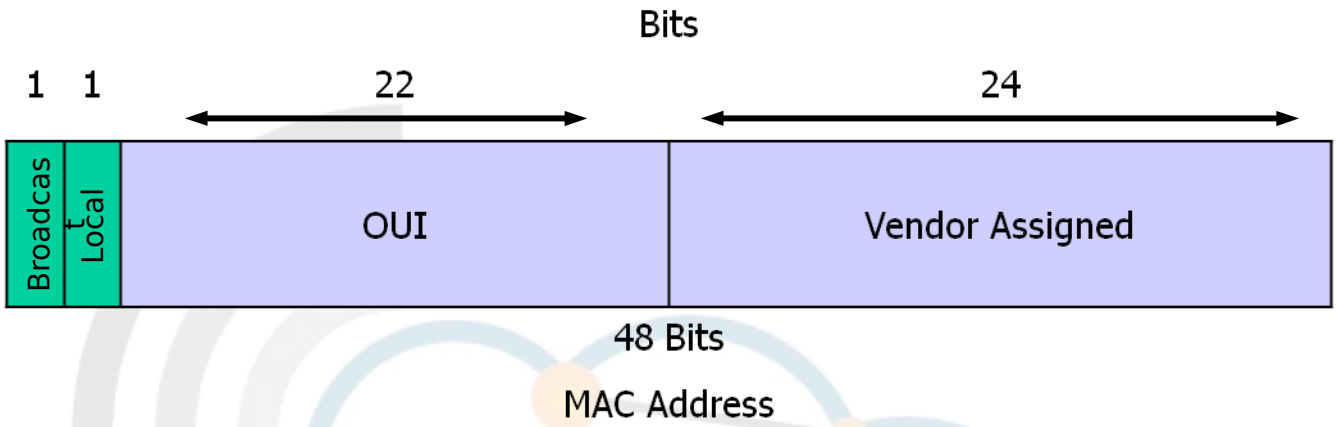


Frame
Arrival Time: Aug 23, 2006 18:33:00.593062000
Frame Number: 418890
Packet Length: 1358 bytes
Capture Length: 1358 bytes
Ethernet II, Src: 00:08:ae:08:30:a0, Dst: 01:00:5e:41:c0:13
Destination: **01:00:5e:41:c0:13**
Address: 01:00:5e:41:c0:13
....1 .... = IG bit: Group address (multicast/broadcast)
.... ..0. .... = LG bit: Globally unique address
Source: **00:08:ae:08:30:a0**
Address: 00:08:ae:08:30:a0
....0 .... = IG bit: Individual address (unicast)
.... ..0. .... = LG bit: Globally unique address
Type: **IP (0x0800)**



- Media Access Control address (MAC address) is a unique ID attached to most NICs.
- It is a number that acts like a name for a particular NIC.

MAC Address



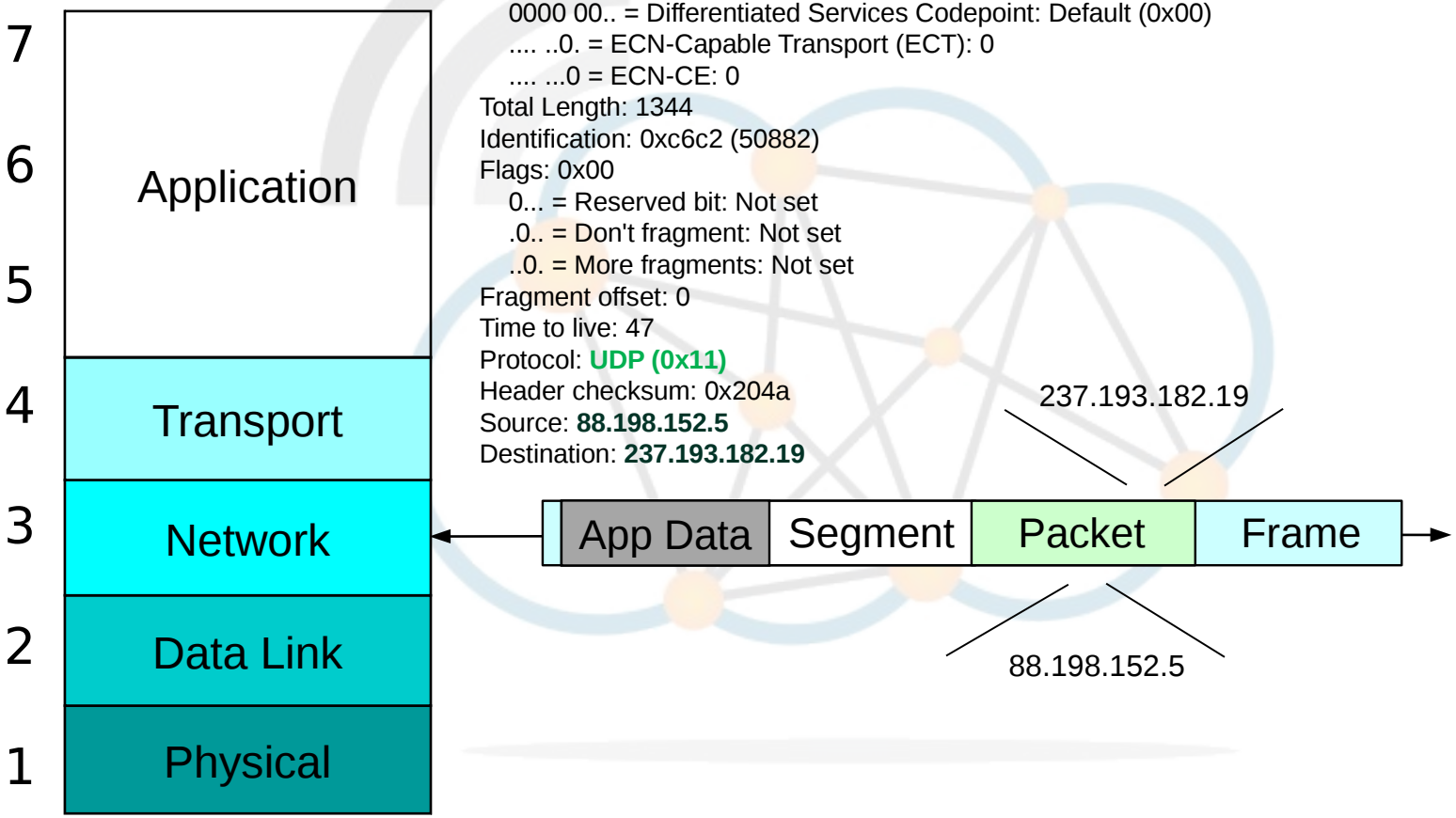
Size, in bits	22 Bits	24 Bits
Size, in Hex digits	6 Hex Digits	6 Hex Digits
Example	00 60 3F	B6 58 A4
Structure	3Com	Individual NIC

MAC Address

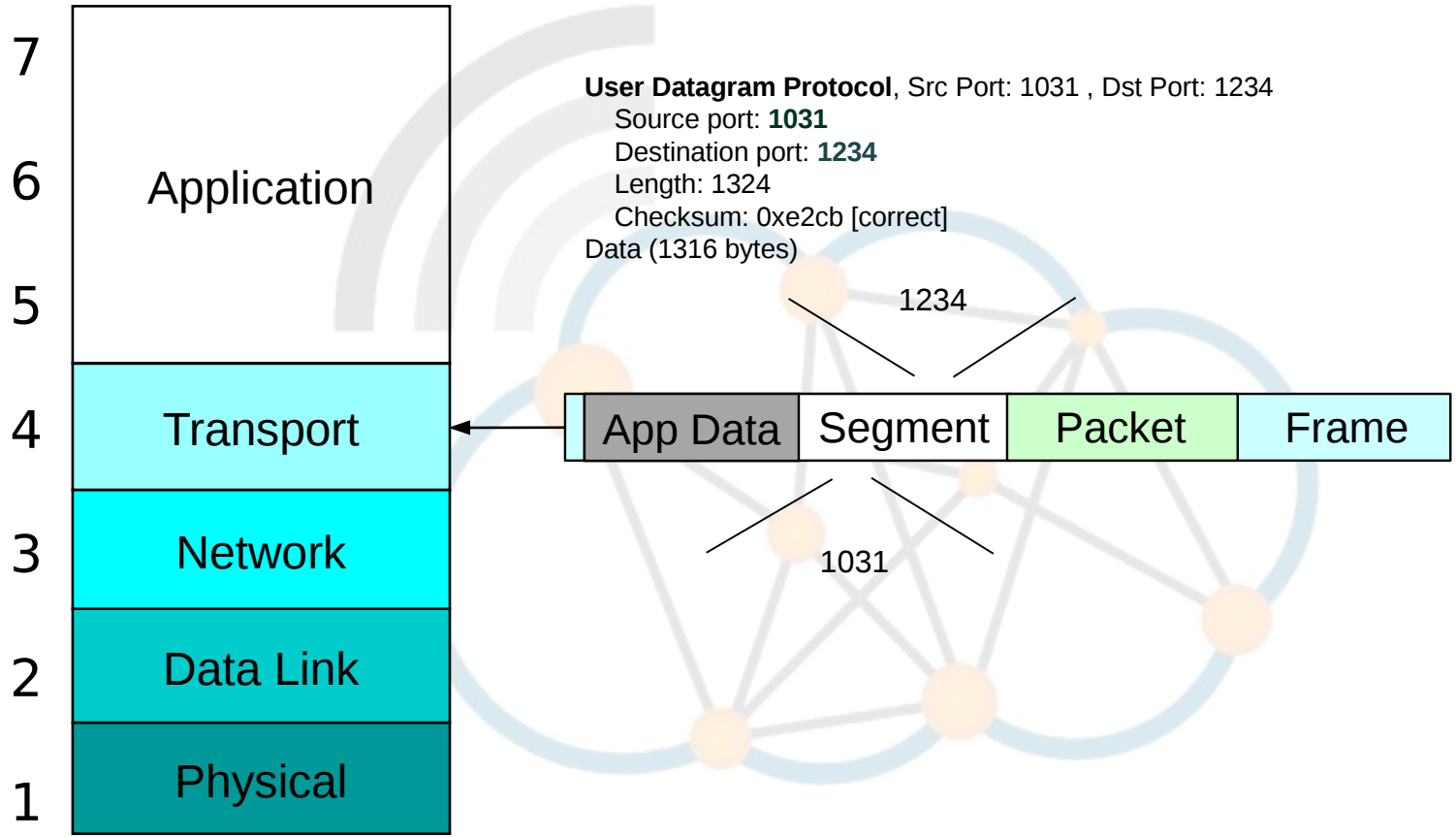
- So the address used in an Ethernet LAN is the means by which data is directed to the proper receiving location, the address is associated with the network adaptor otherwise known as the NIC. The NIC has a unique address burned onto it called the MAC address.
- The address that is on the NIC is the MAC address (Media Access Control) – often referred to as the Burned In Address (BIA).

IP Address

Internet Protocol, Src: 88.198.152.5, Dst: 237.193.182.19
Version: 4
Header length: 20 bytes
Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00)
0000 00.. = Differentiated Services Codepoint: Default (0x00)
.... ..0. = ECN-Capable Transport (ECT): 0
....0 = ECN-CE: 0
Total Length: 1344
Identification: 0xc6c2 (50882)
Flags: 0x00
0... = Reserved bit: Not set
.0.. = Don't fragment: Not set
..0. = More fragments: Not set
Fragment offset: 0
Time to live: 47
Protocol: **UDP (0x11)**
Header checksum: 0x204a
Source: **88.198.152.5**
Destination: **237.193.182.19**

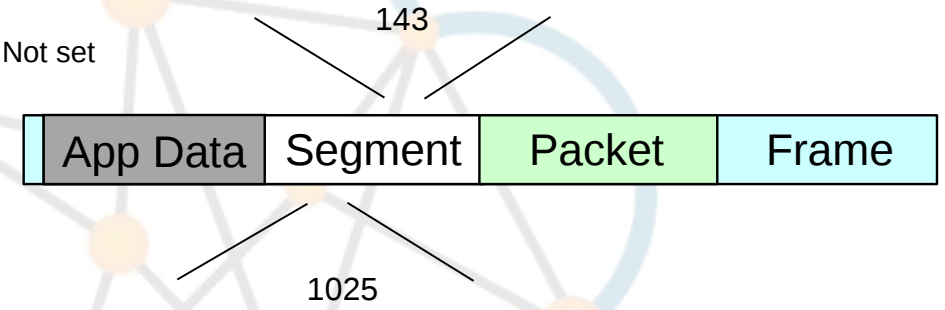


Port Number - UDP



Port Number - TCP

Transmission Control Protocol, Src Port: 1025 , Dst Port: 143, Seq: 1019, Ack: 9456, Len: 35
- Source port: **1025**
- Destination port: **143 (imap)**
- Sequence number: **1019** (relative sequence number)
- [Next sequence number: 1054 (relative sequence number)]
- Acknowledgement number: 9456 (relative ack number)
- Header length: 20 bytes
- Flags: 0x18 (PSH, ACK)
  - 0... .... = Congestion Window Reduced (CWR): Not set
  - .0.. .... = ECN-Echo: Not set
  - ..0. .... = Urgent: Not set
  - ...1 .... = Acknowledgment: Set
  - .... 1... = Push: Set
  - .... .0.. = Reset: Not set
  - .... ..0. = Syn: Not set
  - ....0 = Fin: Not set
- Window size: 64311
- Checksum: 0x20bf [incorrect, should be 0xb4a6 (maybe caused by checksum offloading?)]
- [SEQ/ACK analysis]
  - [This is an ACK to the segment in frame: 214]
  - [The RTT to ACK the segment was: 0.000231000 seconds]



Address Resolution Protocol

C:\>**arp -a**

```
Interface: 192.168.0.2 --- 0x8
  Internet Address      Physical Address      Type
  192.168.0.1           00-18-4d-0d-20-9c     dynamic
  192.168.0.255         ff-ff-ff-ff-ff-ff     static
  224.0.0.22            01-00-5e-00-00-16     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
```

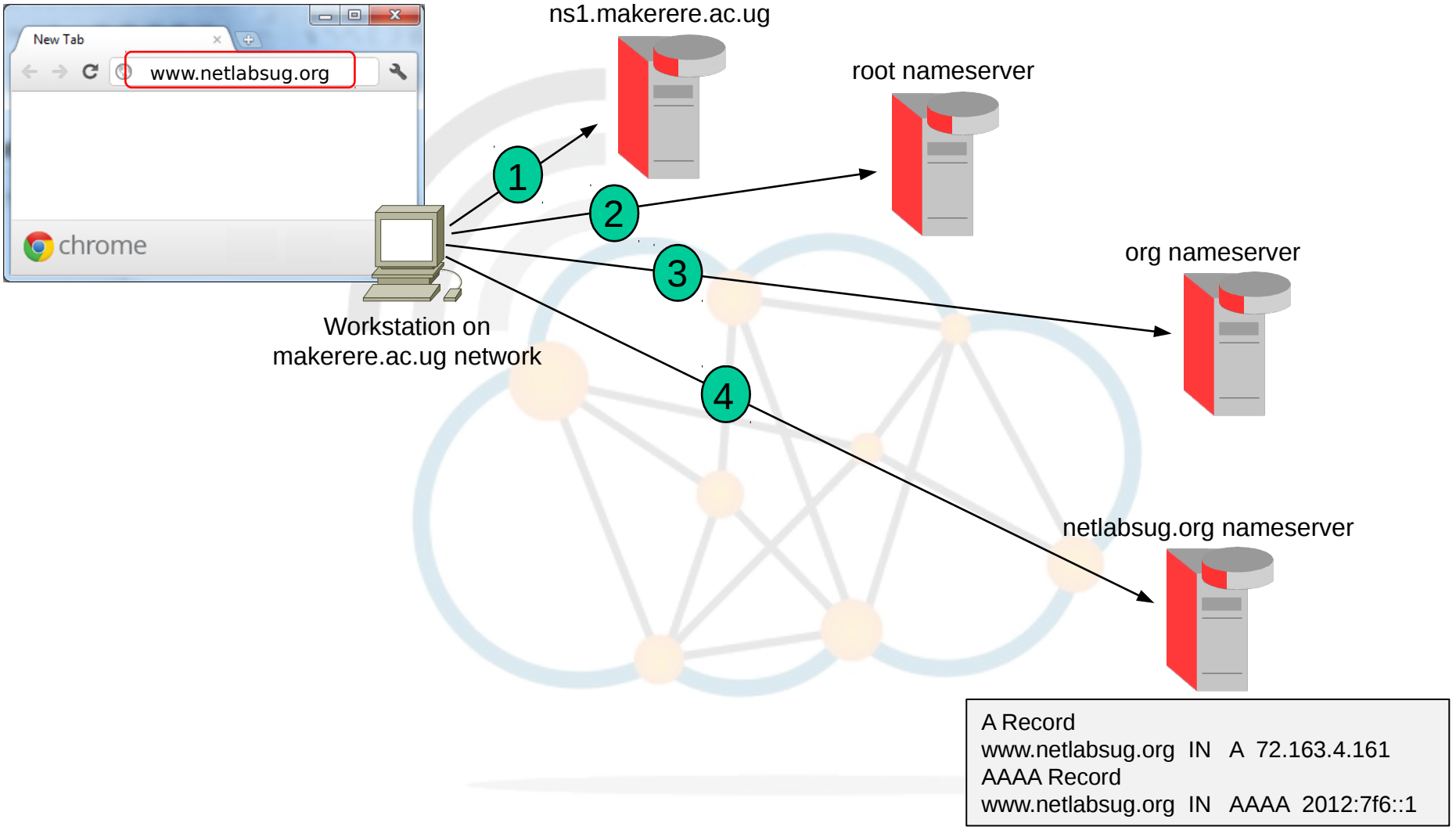
C:\>**arp -av**

```
Interface: 127.0.0.1 --- 0x1
  Internet Address      Physical Address      Type
  224.0.0.22                                  static
  239.255.255.250                             static

Interface: 192.168.0.2 --- 0x8
  Internet Address      Physical Address      Type
  192.168.0.1           00-18-4d-0d-20-9c     dynamic
  192.168.0.2           00-00-00-00-00-00     invalid
  192.168.0.255         ff-ff-ff-ff-ff-ff     static
  224.0.0.22            01-00-5e-00-00-16     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
```

Address Resolution Protocol

```
Linux :~ # arp
Address                  HWtype  HWaddress           Flags Mask            Iface
10.10.10.10              ether   00:08:A1:7A:F4:82   C                     eth1
172.27.228.163           ether   00:0D:56:05:18:5F   C                     eth0
172.27.228.70            ether   00:0D:56:98:31:C6   C                     eth0
172.27.228.157           ether   00:11:43:A3:0B:D4   C                     eth0
172.27.228.158           ether   00:0F:1F:E0:36:D9   C                     eth0
172.27.228.69            ether   00:11:43:20:3A:F7   C                     eth0
172.27.228.1             ether   00:0D:65:53:3F:C2   C                     eth0
172.27.228.150           ether   00:0D:56:05:18:53   C                     eth0

Linux :~ # arp -v
Address                  HWtype  HWaddress           Flags Mask            Iface
10.10.10.10              ether   00:08:A1:7A:F4:82   C                     eth1
172.27.228.163           ether   00:0D:56:05:18:5F   C                     eth0
172.27.228.70            ether   00:0D:56:98:31:C6   C                     eth0
172.27.228.157           ether   00:11:43:A3:0B:D4   C                     eth0
172.27.228.158           ether   00:0F:1F:E0:36:D9   C                     eth0
172.27.228.69            ether   00:11:43:20:3A:F7   C                     eth0
172.27.228.1             ether   00:0D:65:53:3F:C2   C                     eth0
172.27.228.150           ether   00:0D:56:05:18:53   C                     eth0
Entries: 8      Skipped: 0      Found: 8
```

Domain Name Service (DNS)



Protocol Mapping

Layer	Name	TCP/IP	SS 7	OSI	UMTS
7	Application	HTTP, RIP, SMTP, SMPP, SNMP, FTP, Telnet, NFS, NTP, RTP	ISUP, INAP, MAP, TUP, TCAP	FTAM, X.400, X.500, DAP	
6	Presentation	MIME, XDR, SSL, TLS		ISO 8823, X.226	
5	Session			ISO 8327, X.225	
4	Transport	TCP, UDP, SCTP		TP0, TP1, TP2, TP3, TP4	
3	Network	IP, ICMP, IPsec, ARP, BGP, OSPF	MTP-3, SCCP	X.25, CLNP	RRC
2	Data Link	Ethernet, 802.2, 802.3, 802.5, 802.11, 802.14, 802.16, PPP, HDLC	MTP-2	X.25 (LAP-B)	MAC
1	Physical	RS-232, V.35, V.34, E1, T1, 10BASE-T, 100BASE-TX, 802.11, 802.15, 802.16, DSL, DOCSIS	MTP-1	X.25, EIA/TIA-232, EIA/TIA-449, EIA-530, G.703	PHY

Thank you

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