

Basic Concepts in Computer Networking

Peerapon S.

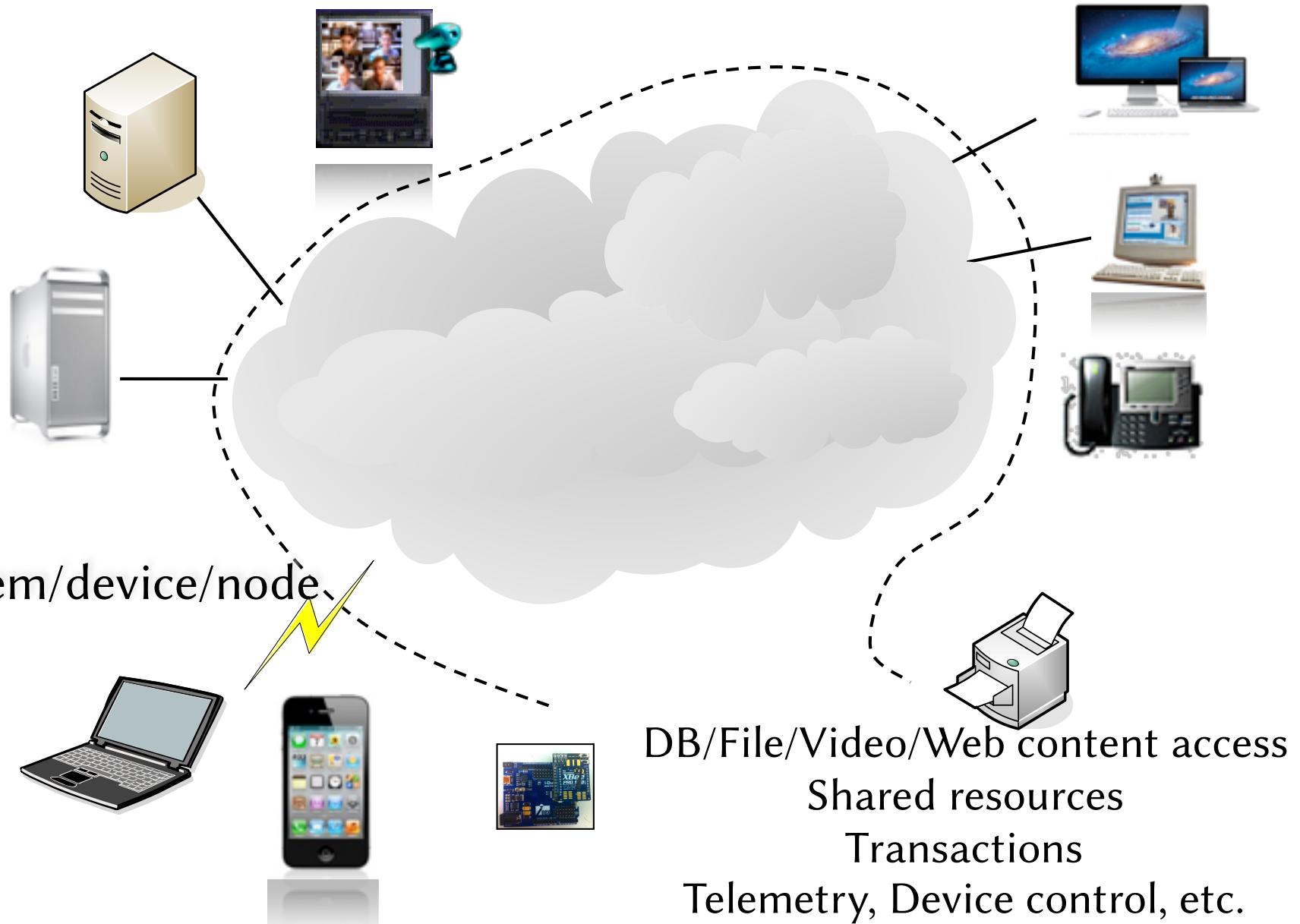
CPE 314: Computer Networks (2/61)

Topics

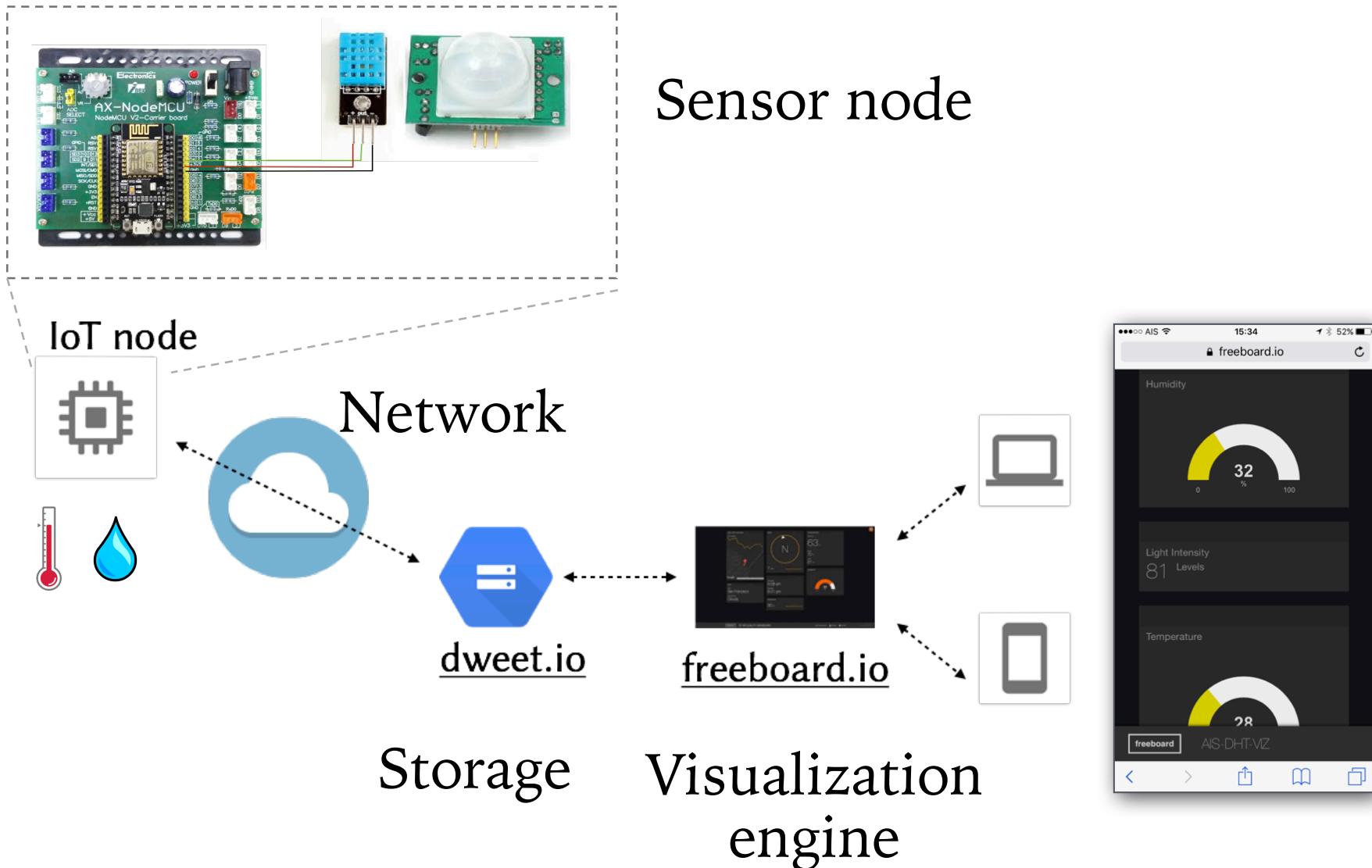
- Motivation: What are the roles of computer networks and its applications ?
- Protocols and layered architecture: How is data exchanged among entities?
- TCP/IP protocol stack: What are the building blocks of computer networks?
- Your roles: Why this course ?

- Reading
 - Forouzan text: Chapters 1, 2.1 - 2.3

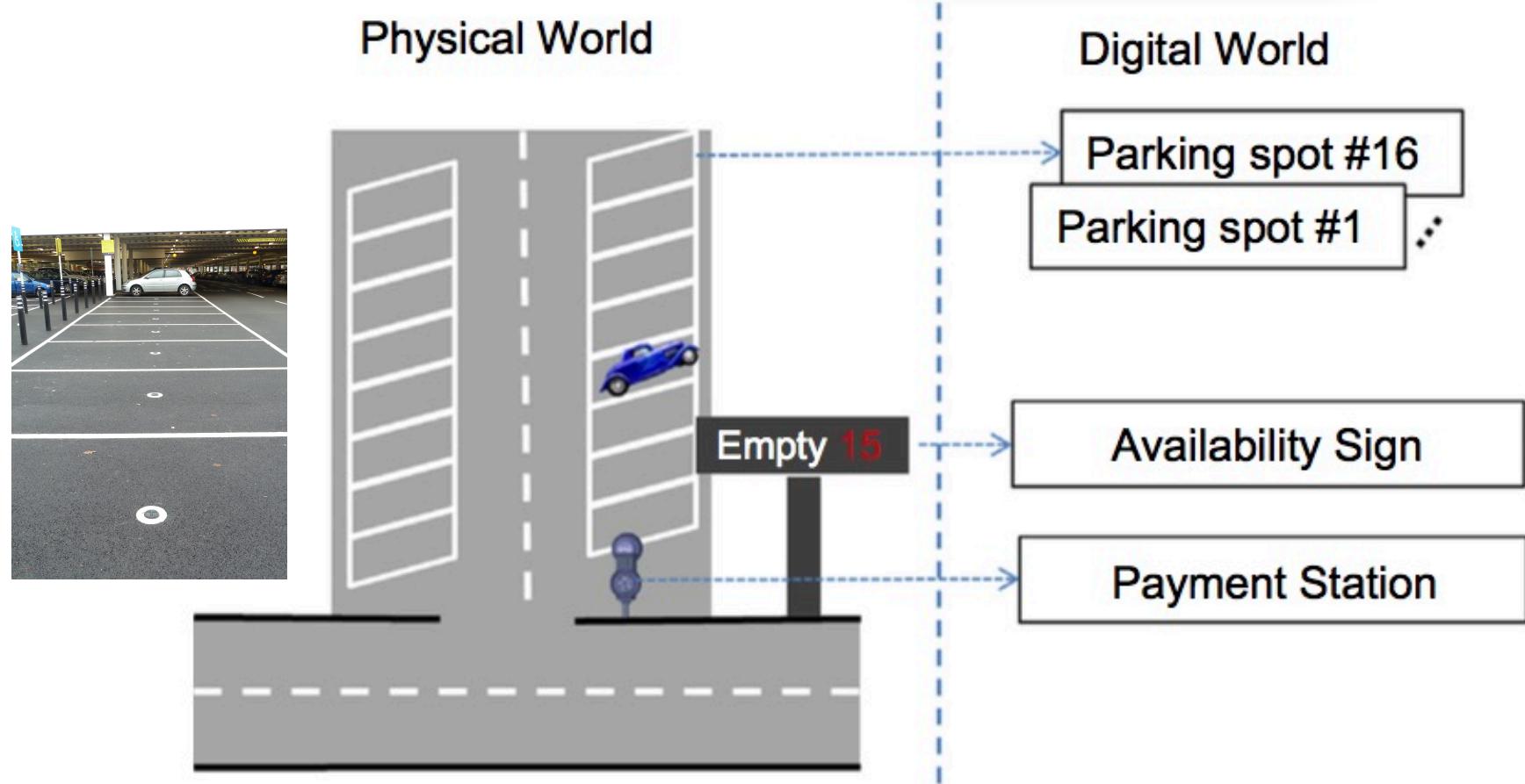
Motivation



Ex: Simple Environment Monitoring



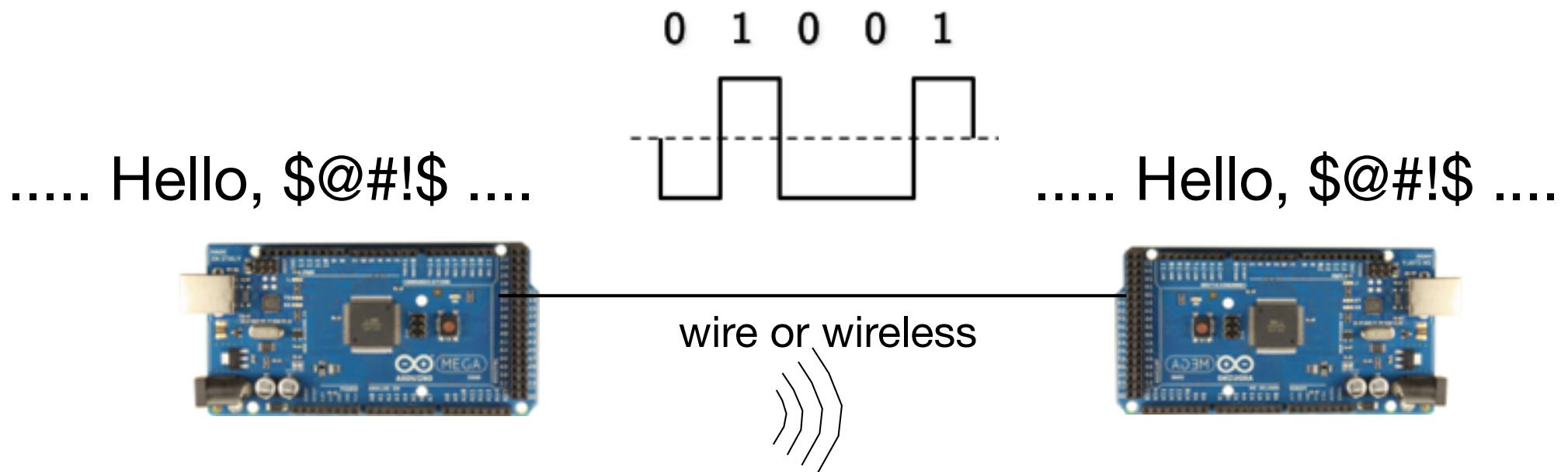
Ex: Smart Parking



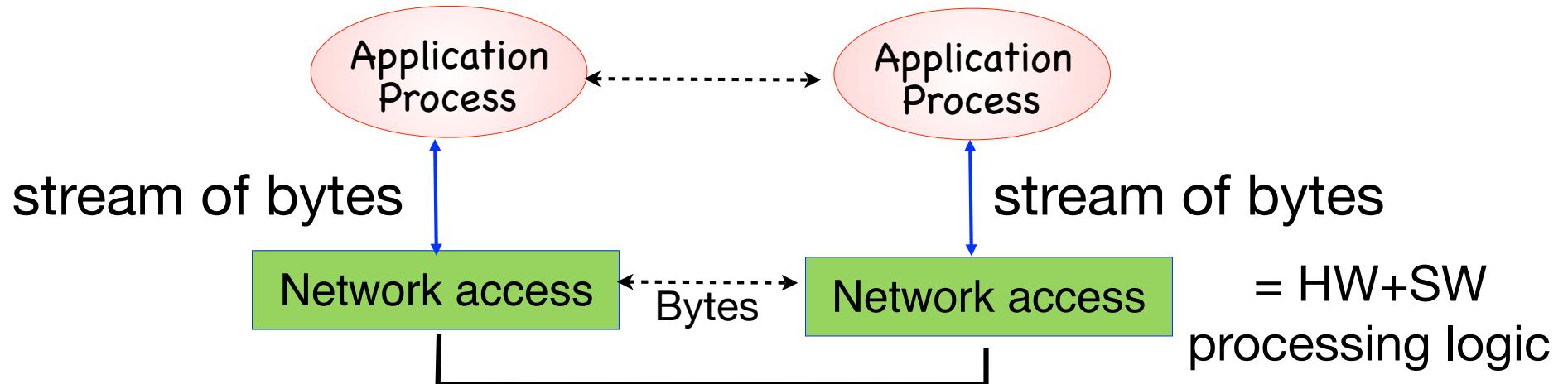
Protocols and Layered Architecture

Simple Point-to-Point Network

- Network chip/card responsible for data transmission
- Both sides agree on electrical signal format and data rate (bps, kbps, Mbps, Gbps).



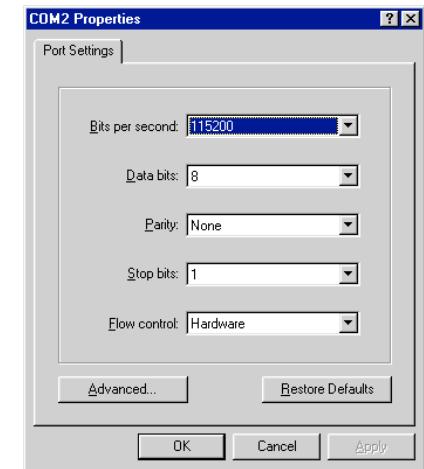
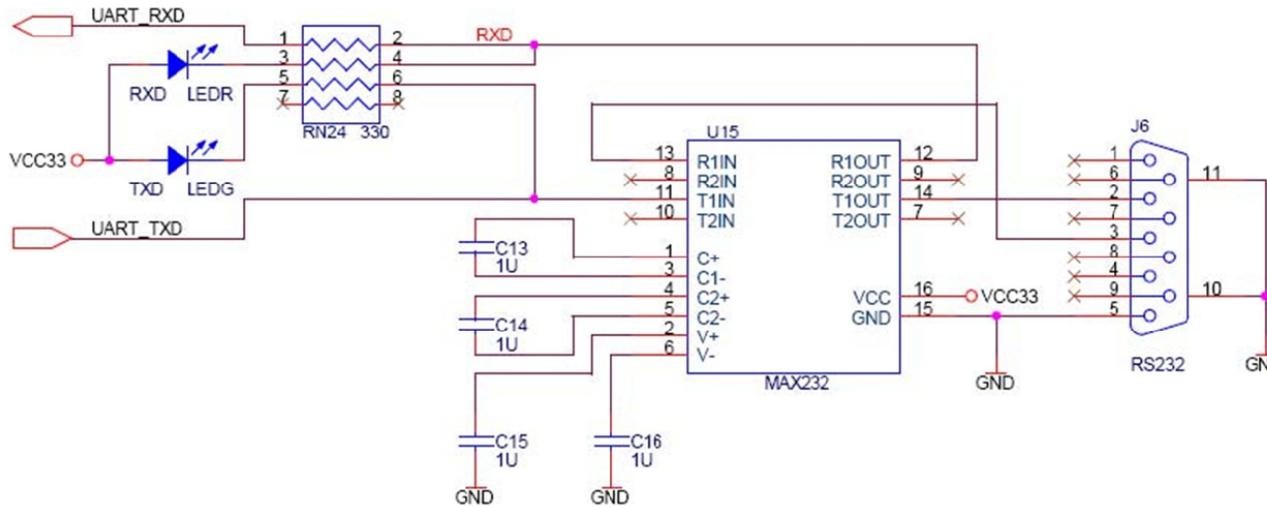
User data
"Hello, get me file x from directory y"



How does receiving side recover bytes from bits?
What is the largest distance between the two?
How much power is needed ?
How fast can we send the data ?

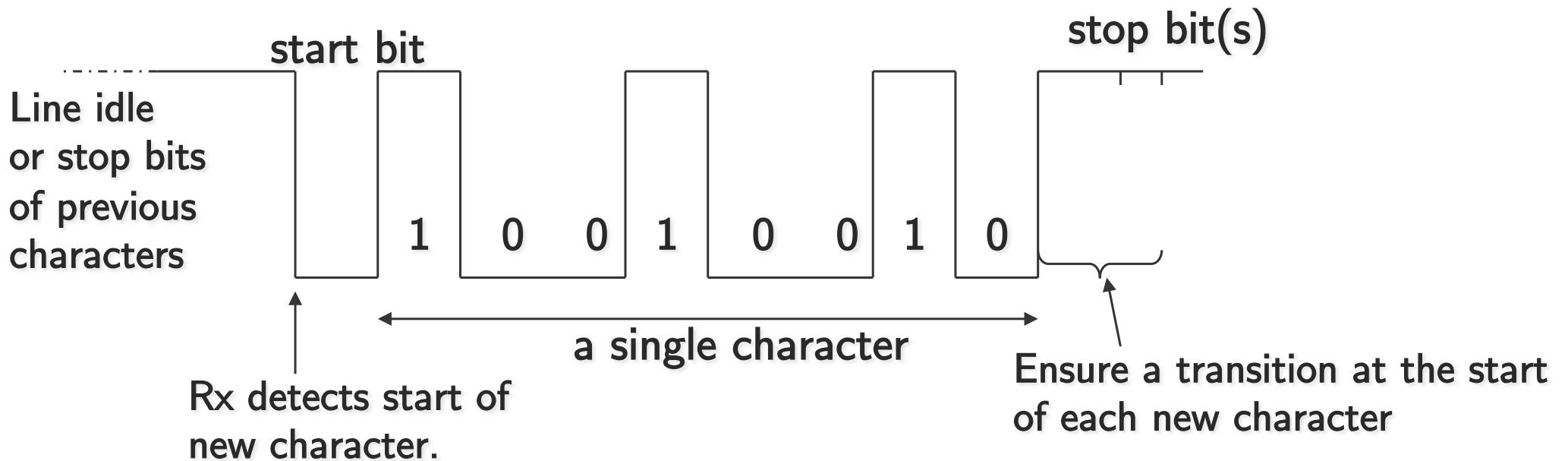
Physical (Bit) Transmission

- What power, signal representation to use ?
- What is the bit rate?
- Which type of connector is used?



Ex: Asynchronous Transmission

One character/byte at a time

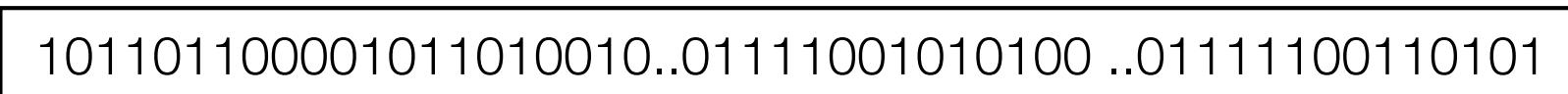
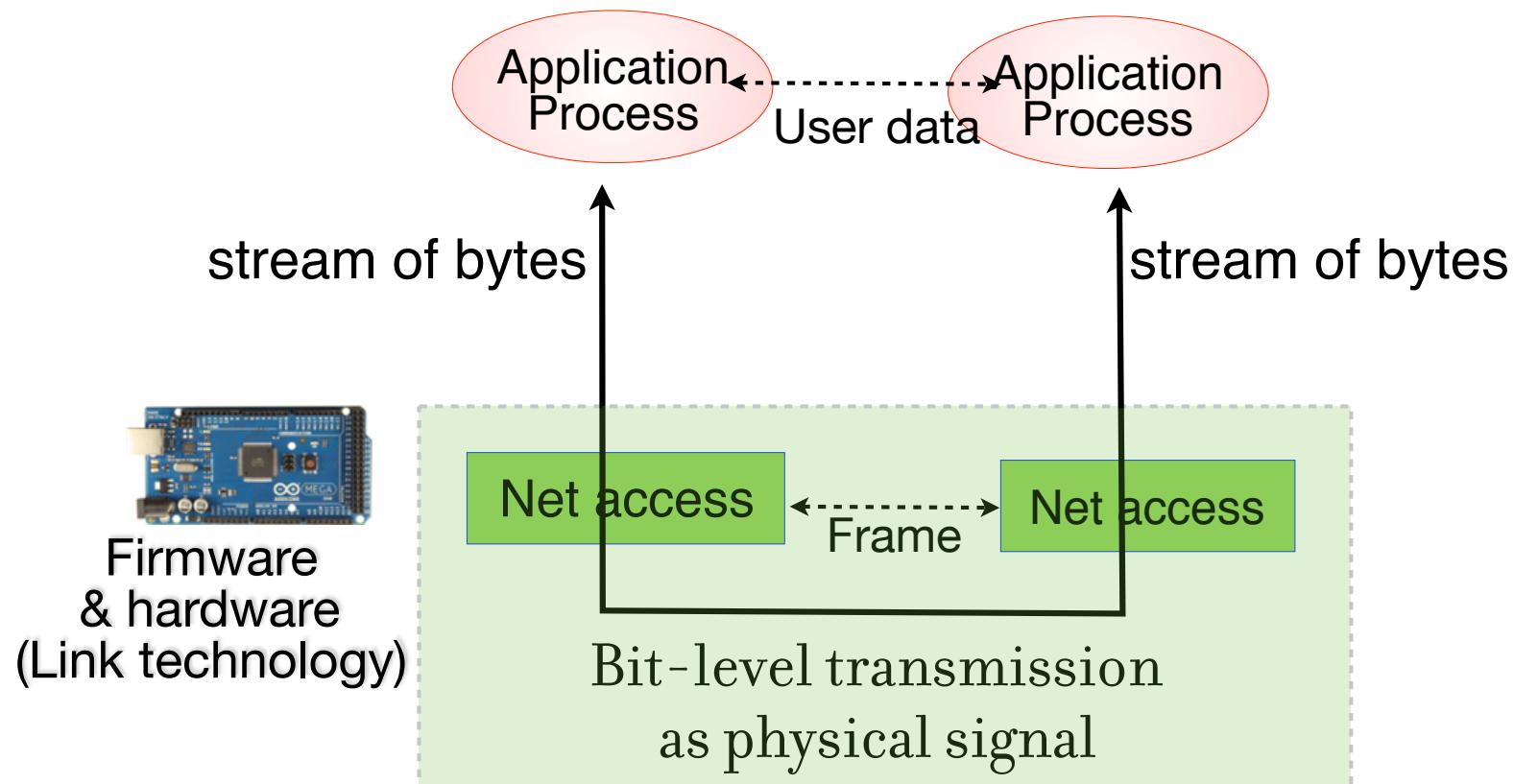


Now we have **Overhead** !

Start bit (Header) + Stop bit (Trailer) = 2.5 bits

Efficiency = %Data bits/Total bits = 76%

Overhead = %Non-data bits/Total bits = 24%



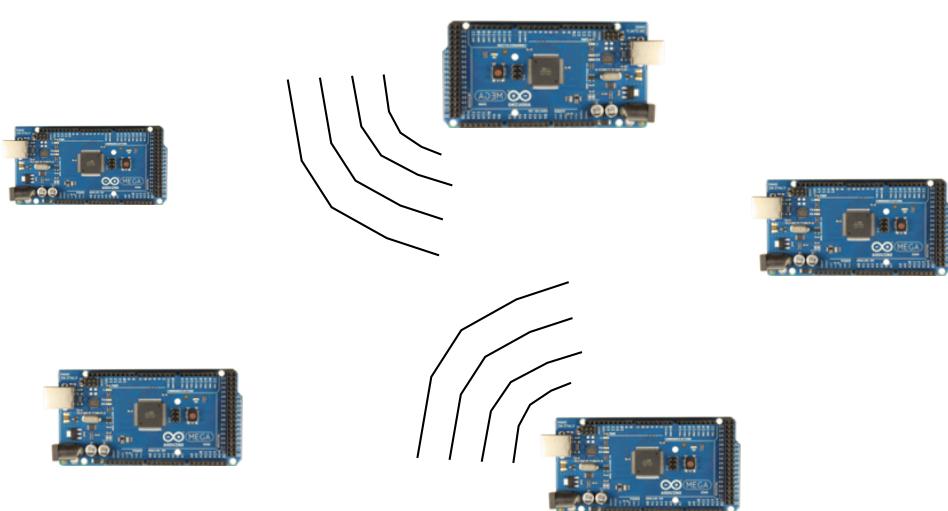
Frame
Bits

■ What about a wireless link?

- Transmission heard simultaneously by many others
- **Collisions** under simultaneous transmissions.

■ Need a way to arbitrate collisions

- When a node can send or should stay idle.
- How a node detects collisions and what to do.
- What to do when receiving a corrupted frame.



 **Bluetooth®**

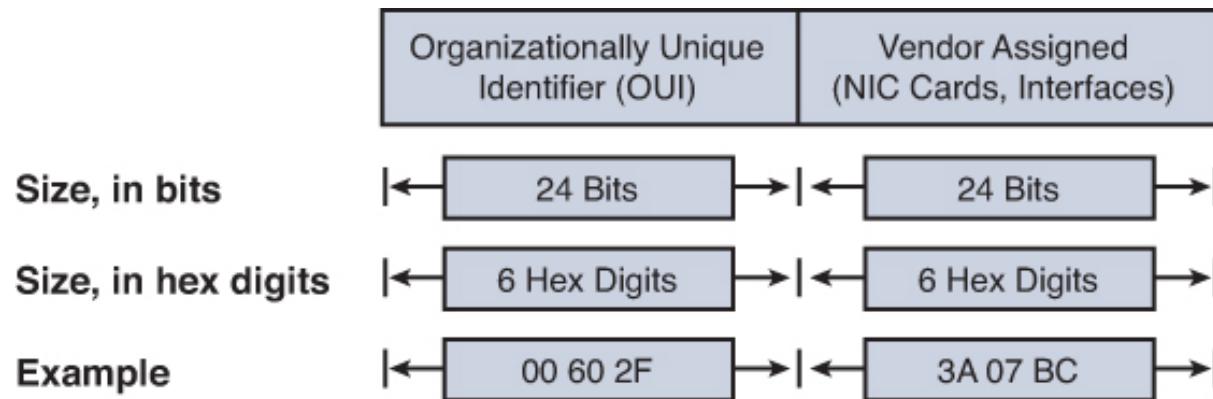
 **Wi-Fi™**

Question: What is in the header?

- Suppose frames are to be transmitted over a wireless link with the following requirements:
 - ◆ Receiver must know how many bytes is in the frame.
 - ◆ Receiver must know if any byte has been corrupted.
 - ◆ Receiver can ask sender to retransmit a corrupted frame.
- What information should you include in the frame besides the raw data?



Ex: Ethernet Addressing



Bridge Status TCP/IP DNS WINS Proxies **Hardware**

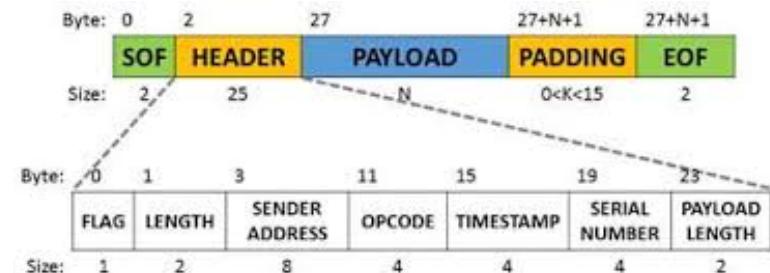
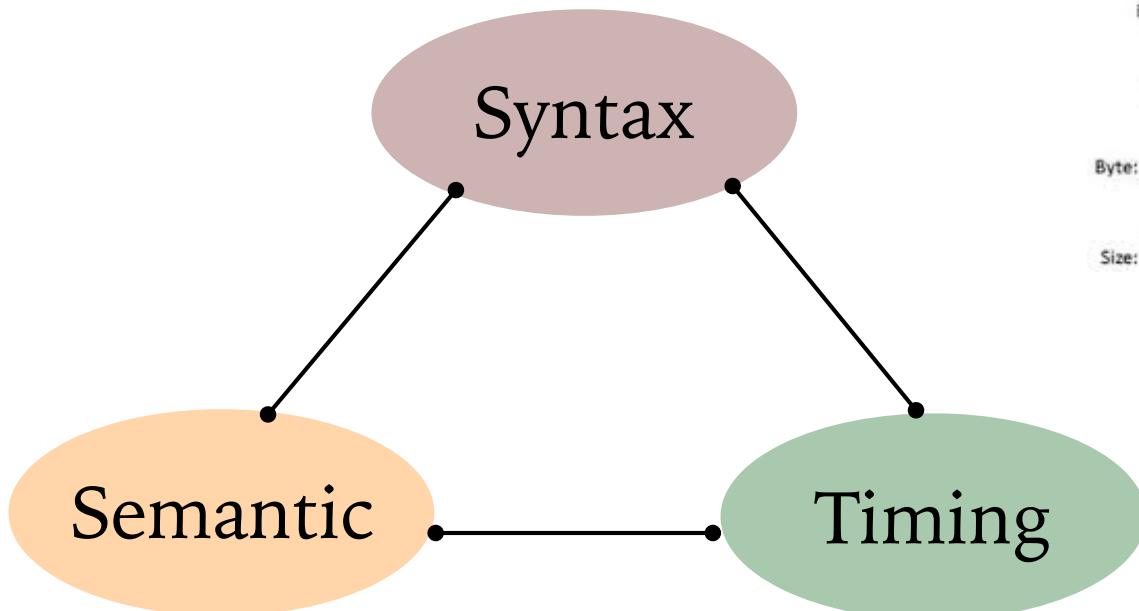
MAC Address: 10:dd:b1:de:68:b3
Configure: Automatically
MTU: Standard (1500)

□ Try it

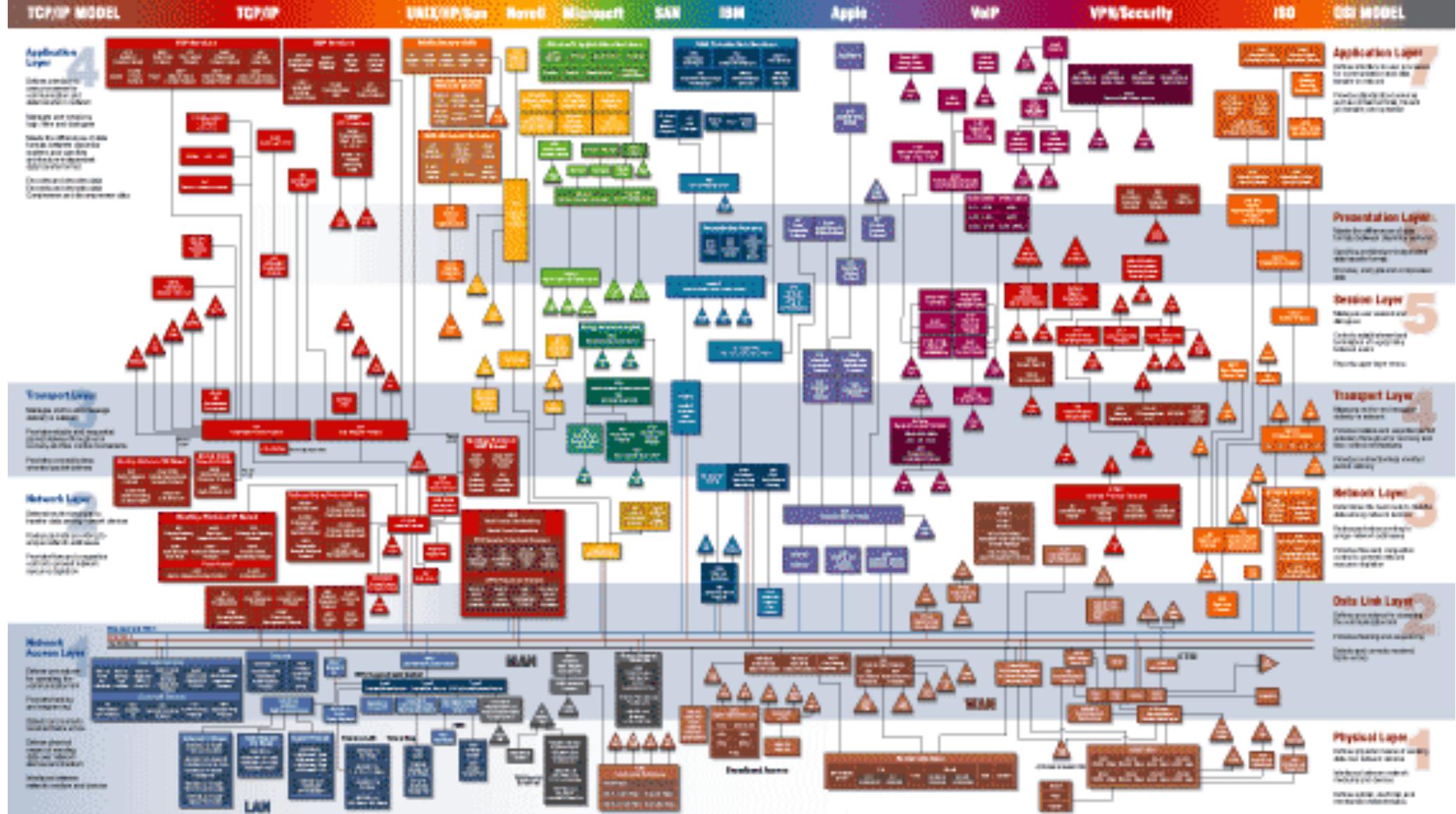
- Use ‘ifconfig’ in MacOS or ‘ipconfig’ in Windows to determine the MAC address.
- Look up your card vendor from <https://www.wireshark.org/tools/oui-lookup.html>

Network Protocol

- A set of rules governing communication among entities
- Computer networks are built upon a collection of either **open** or **proprietary** protocols.



Network Protocols Map



440

CEPHEI

10

EDDIE
EDWARD J. EDWARDS AND SISTER SISTERS, INC.
800-844-1000
POSTAL ADDRESS: P.O. BOX 104
THEATRE: 1000 BROADWAY
WEBSITE: WWW.EDDIE.EDU

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或打
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8811

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11
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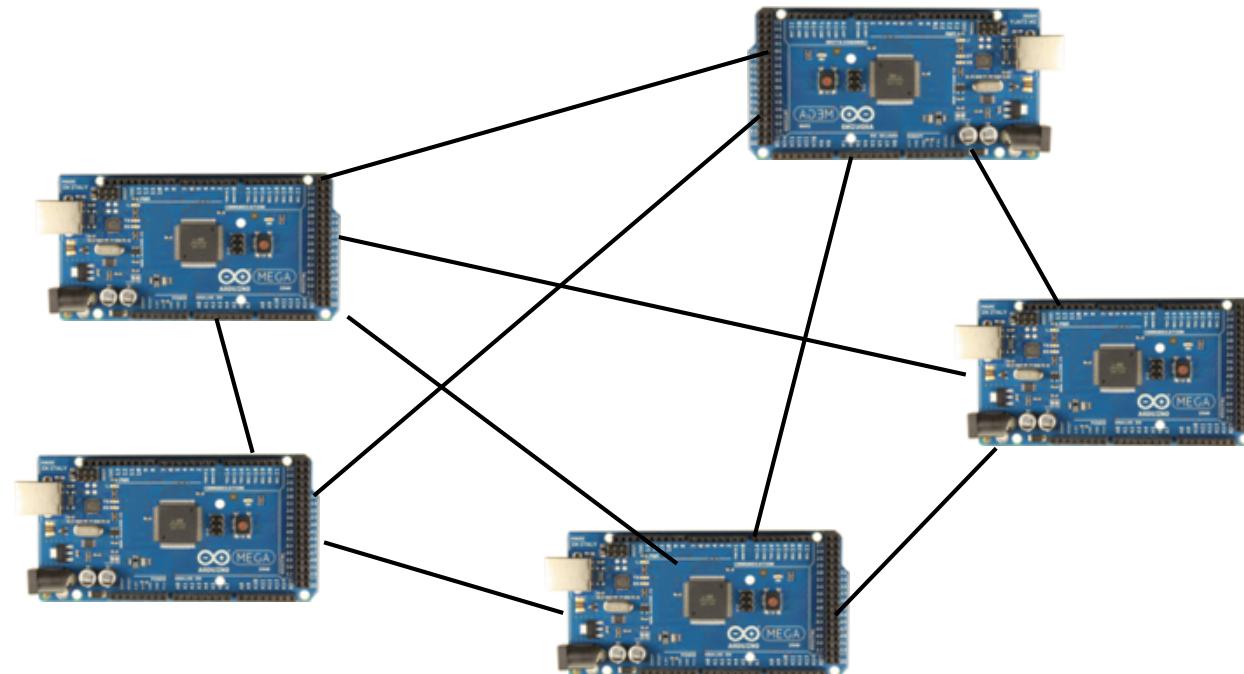
• [View Details](#)

100-1000

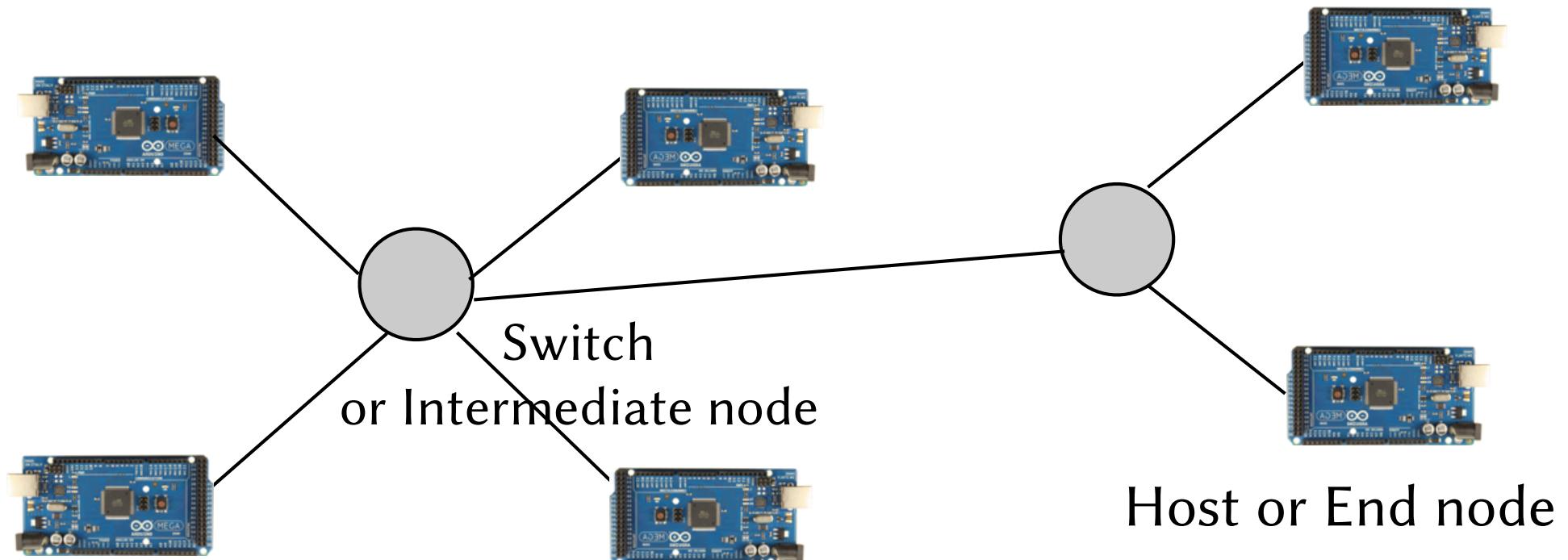
Javvin
www.javvin.com

Multiple-Link Network

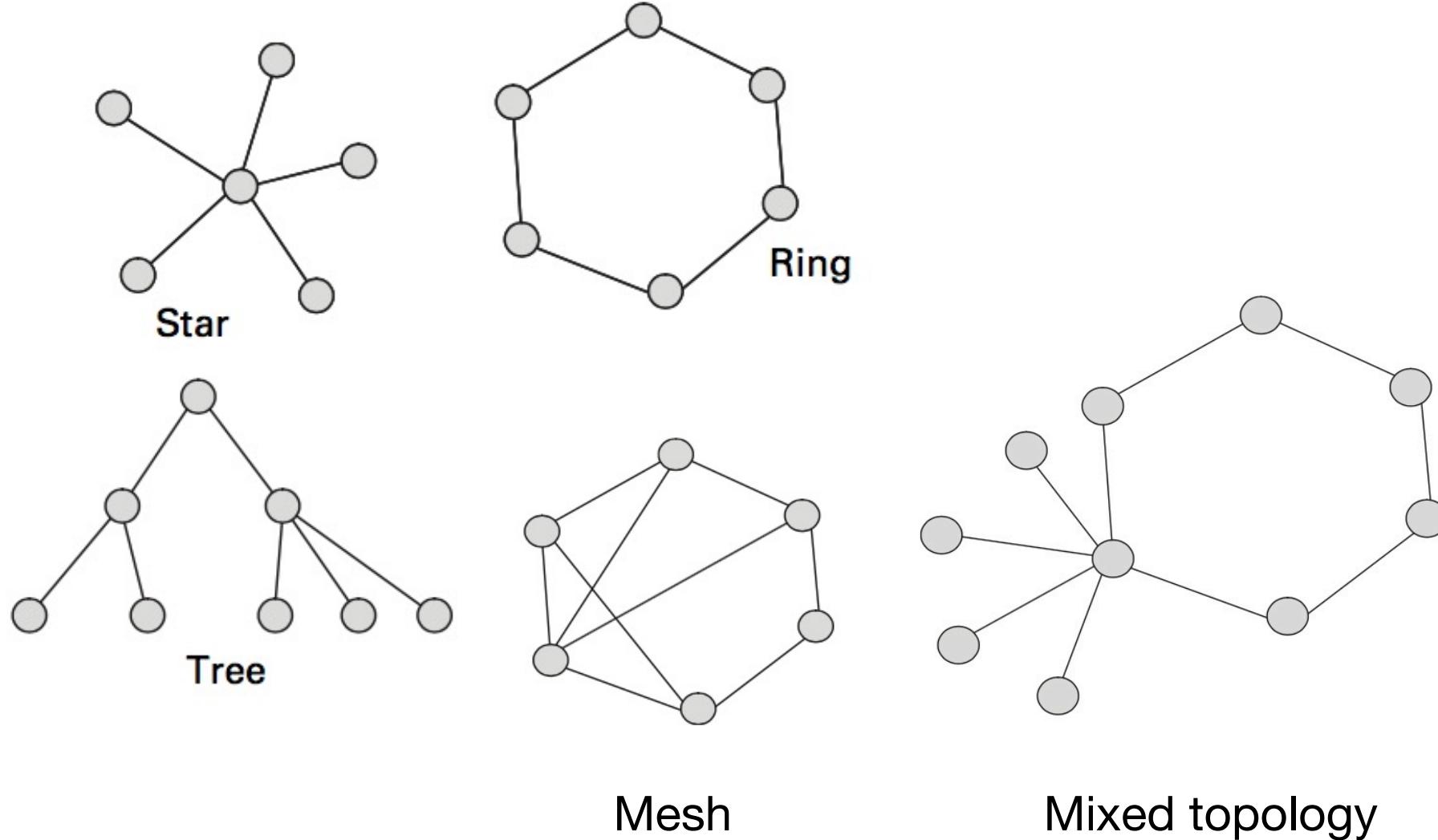
- Each node almost always sends/receives data from many others.
- Can we do a full mesh? Why or why not?

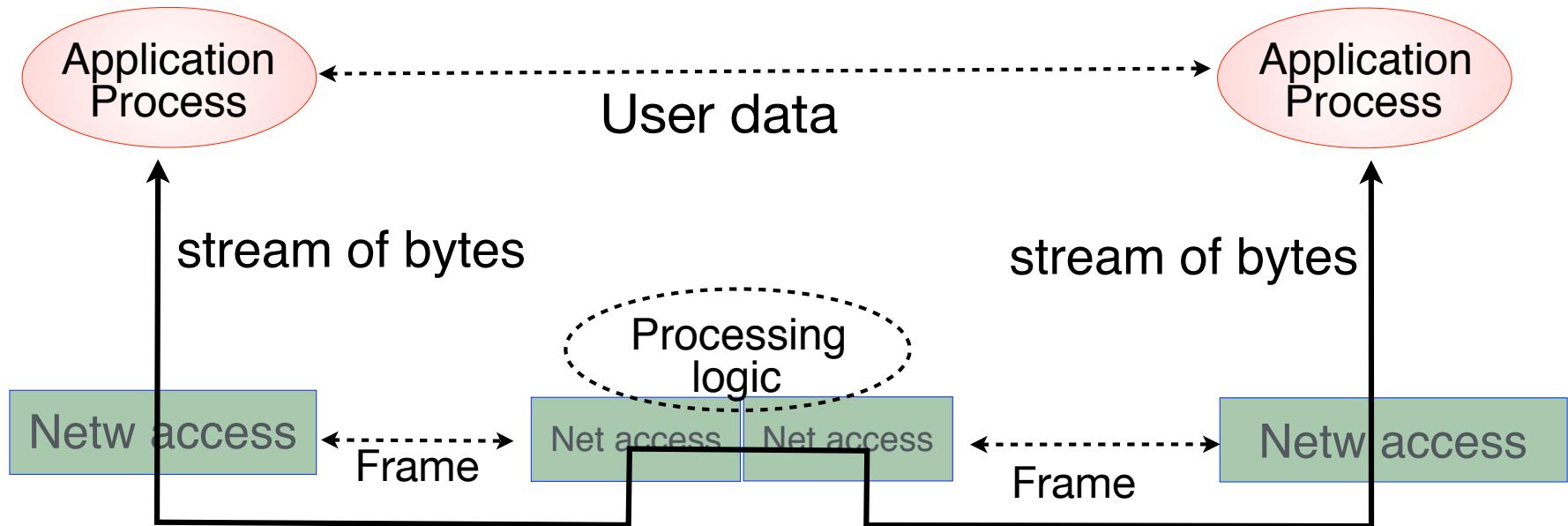


- How about this ?
- Intermediate node needs to know how to handle incoming frames.
 - **Addressing** mechanism
 - **Routing** mechanism



Network Topology

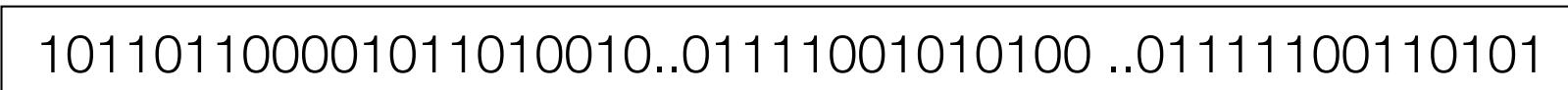




switch

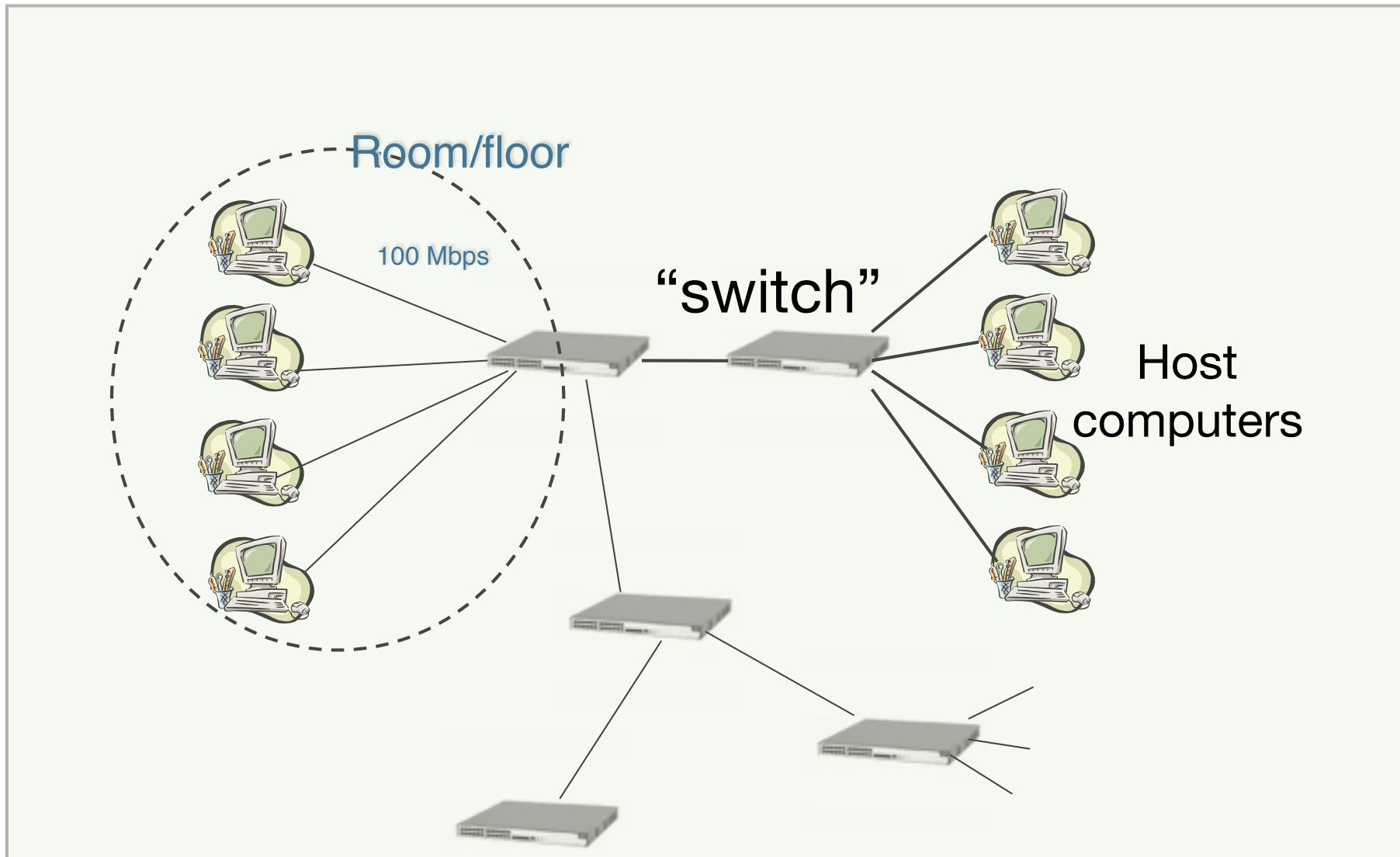


Frame

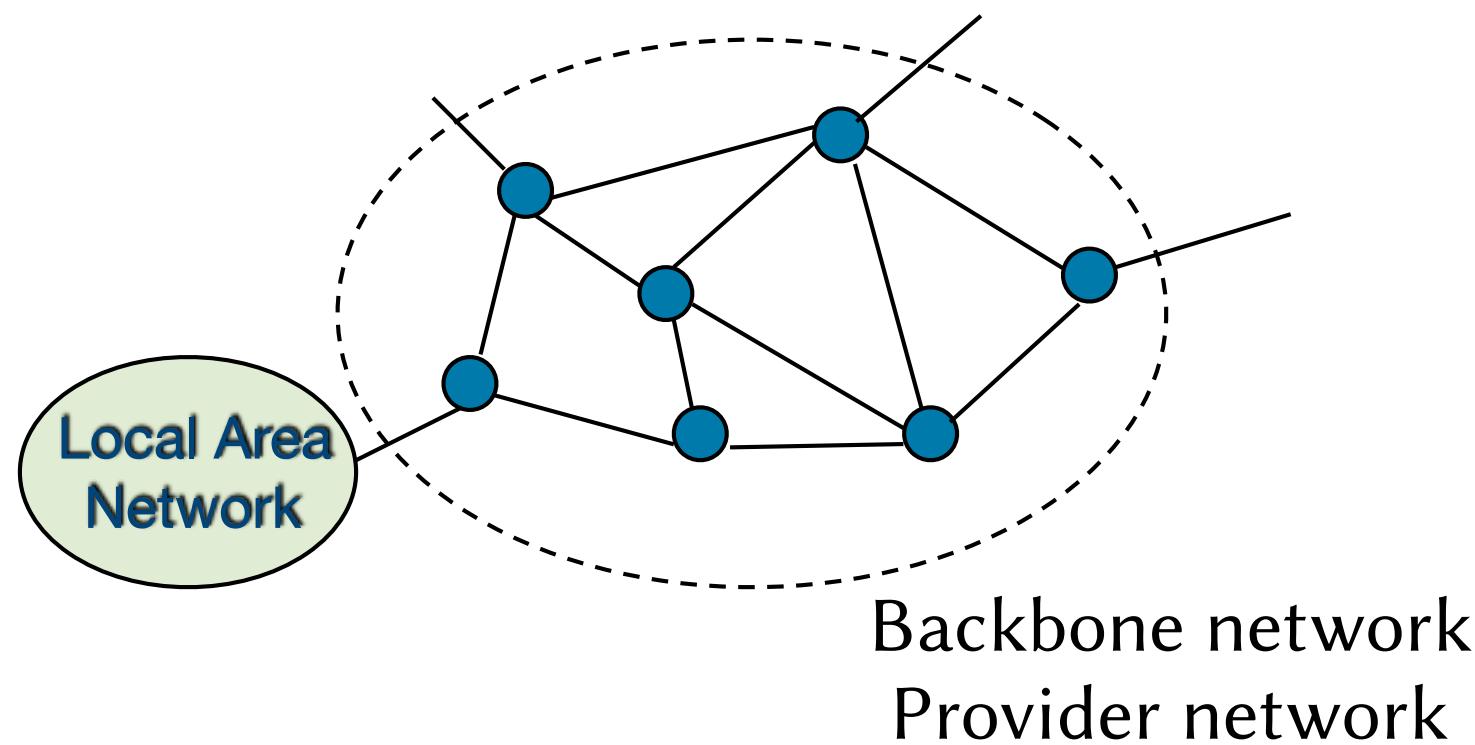


Bits

Local Area Network (LAN)

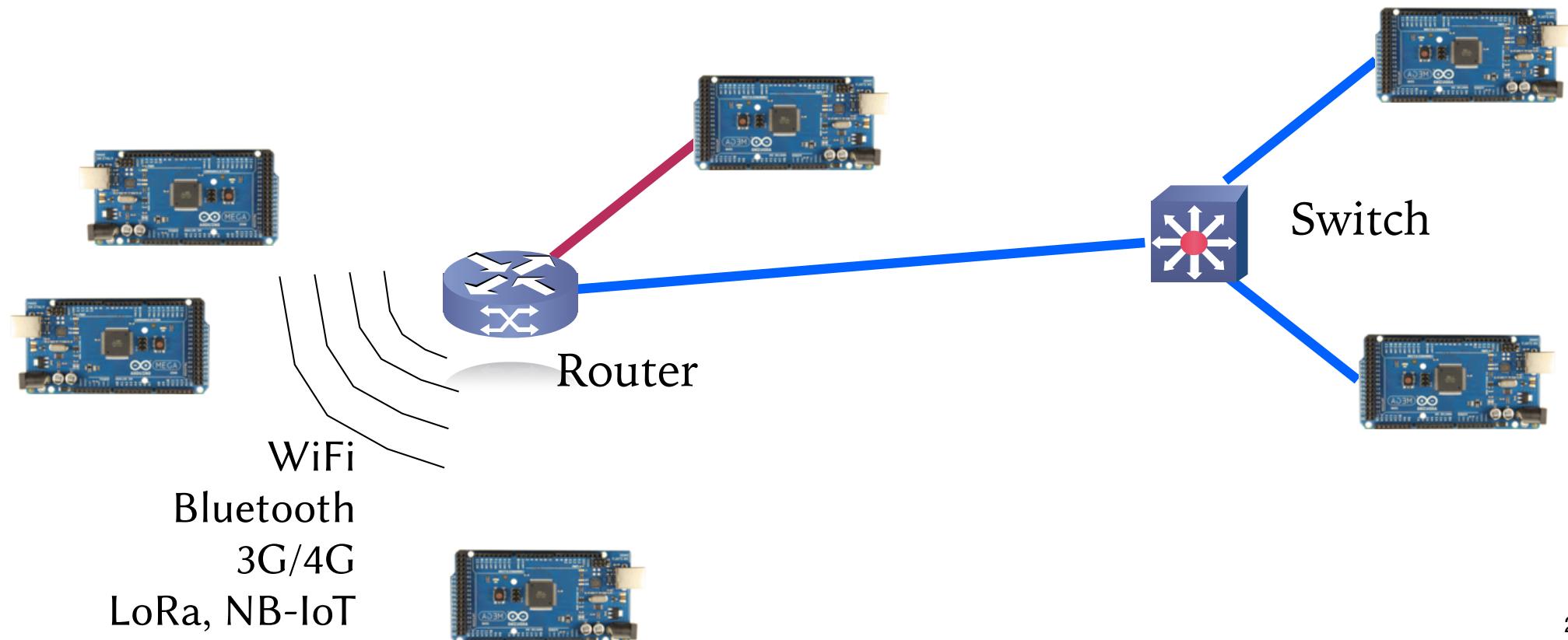


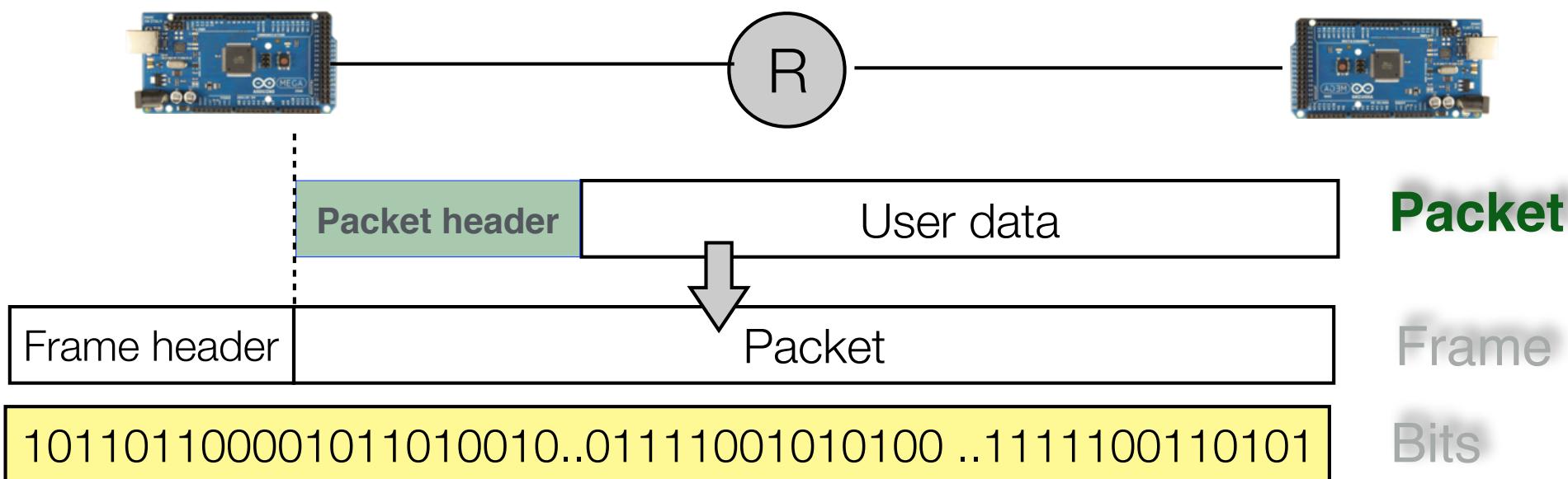
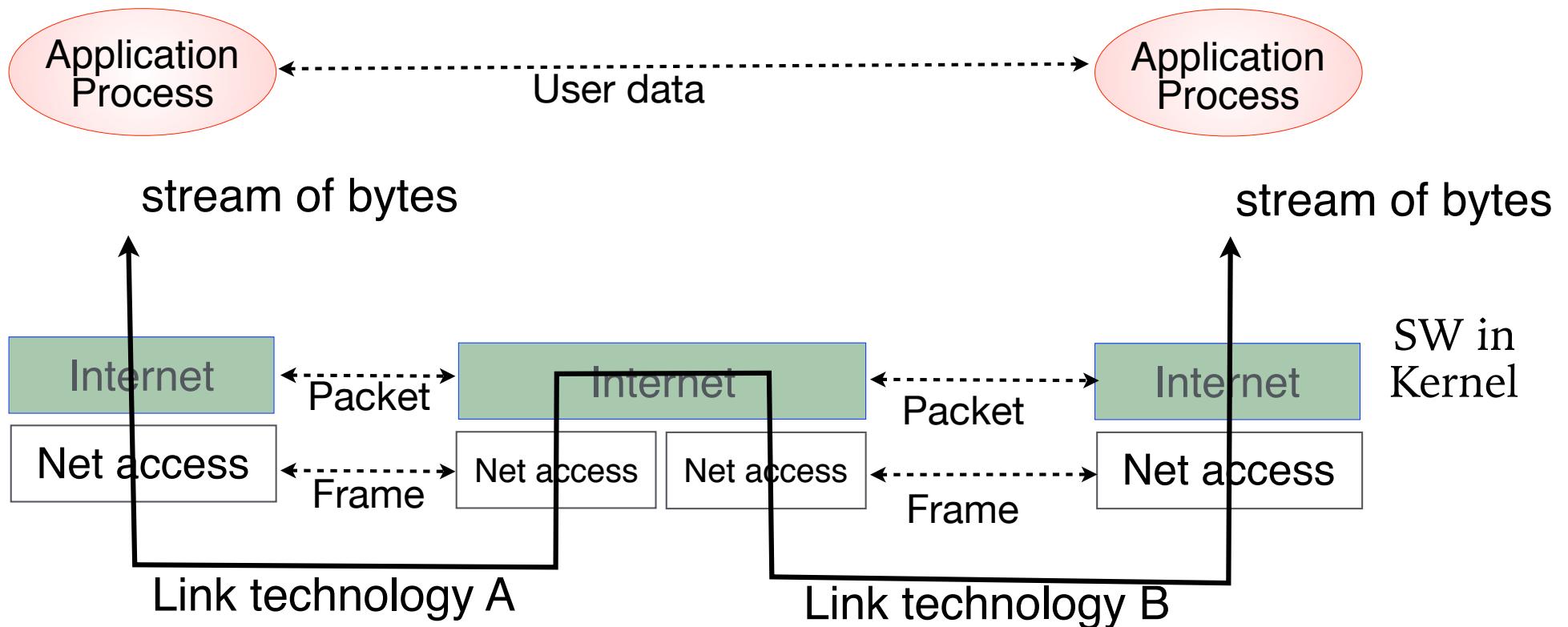
Wide Area Network (WAN)



Internetworking -- The Internet Layer

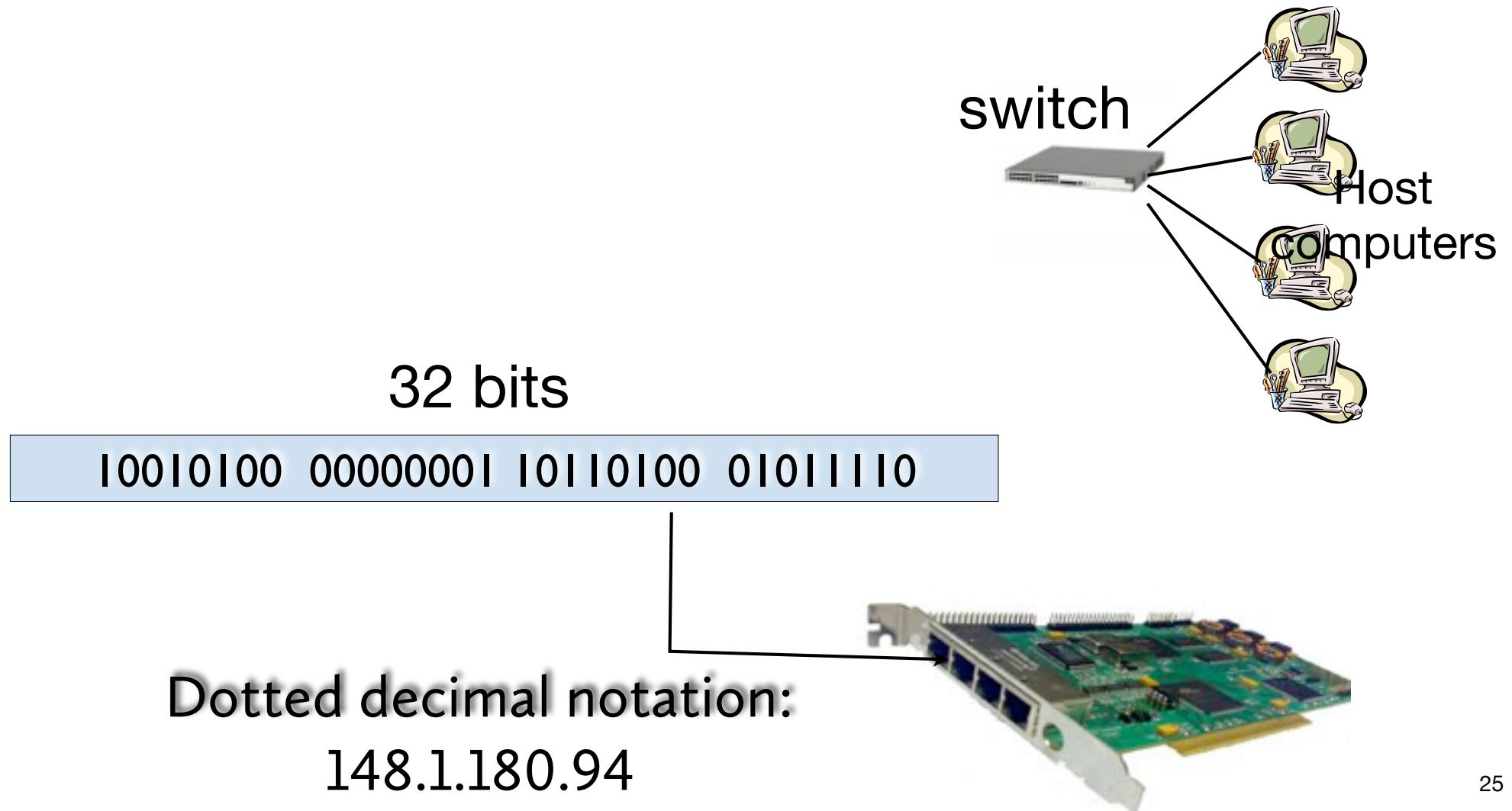
- Different link technologies have different frame formats
 - Need a layer independent of network link technologies
 - Use **unified address format** and its own operations

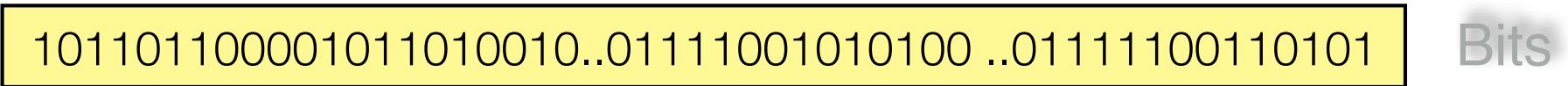
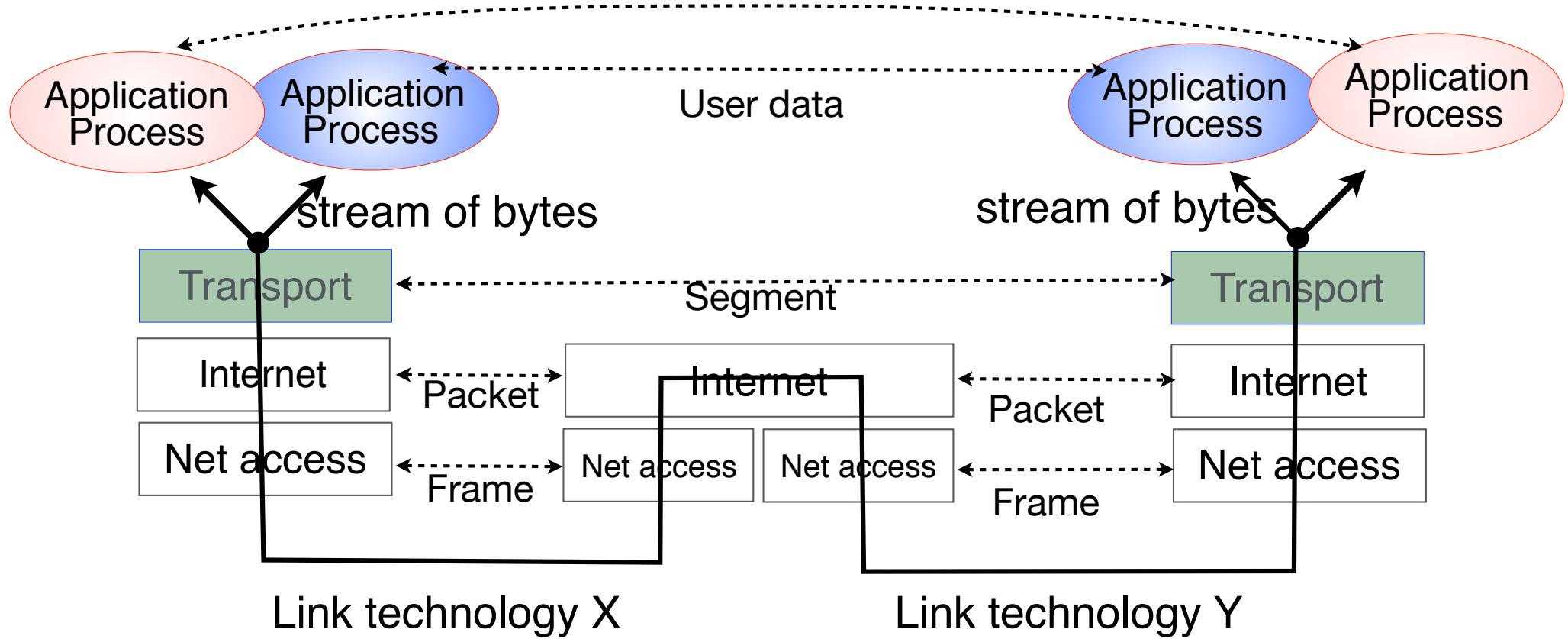




Ex: IP Addressing

- IP address is a logical identifier of a network interface





Self-Test

- When data is encapsulated, which is the correct order ?
 - A. Data, frame, packet, segment, bit
 - B. Segment, data, packet, frame, bit
 - C. Data, segment, packet, frame, bit
 - D. Data, segment, frame, packet, bit

Application
Process



GET /~peerapon.sir/index.html HTTP 1.1

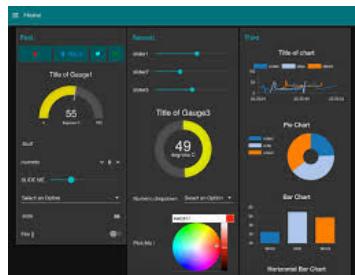
HTTP/1.1 200 OK

Content-Length: 11308

```
<html><head> ... </head>
<body> ... </body>
</hmtl>
```

Application
Process

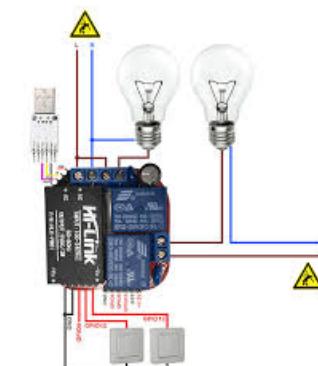
Application
Process

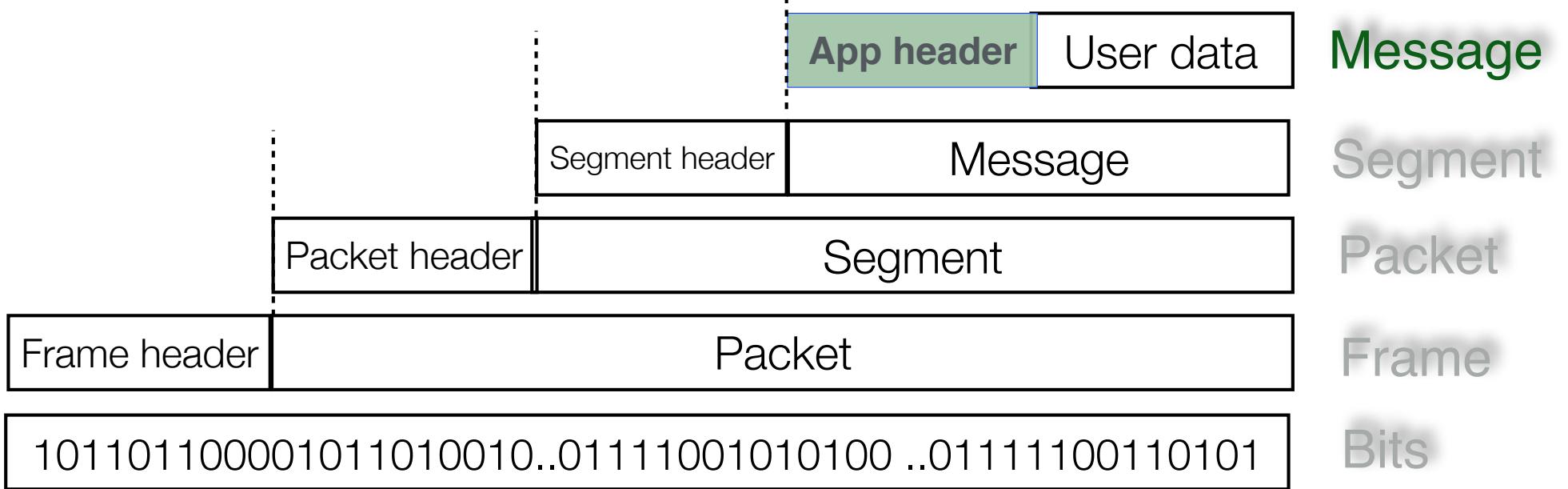
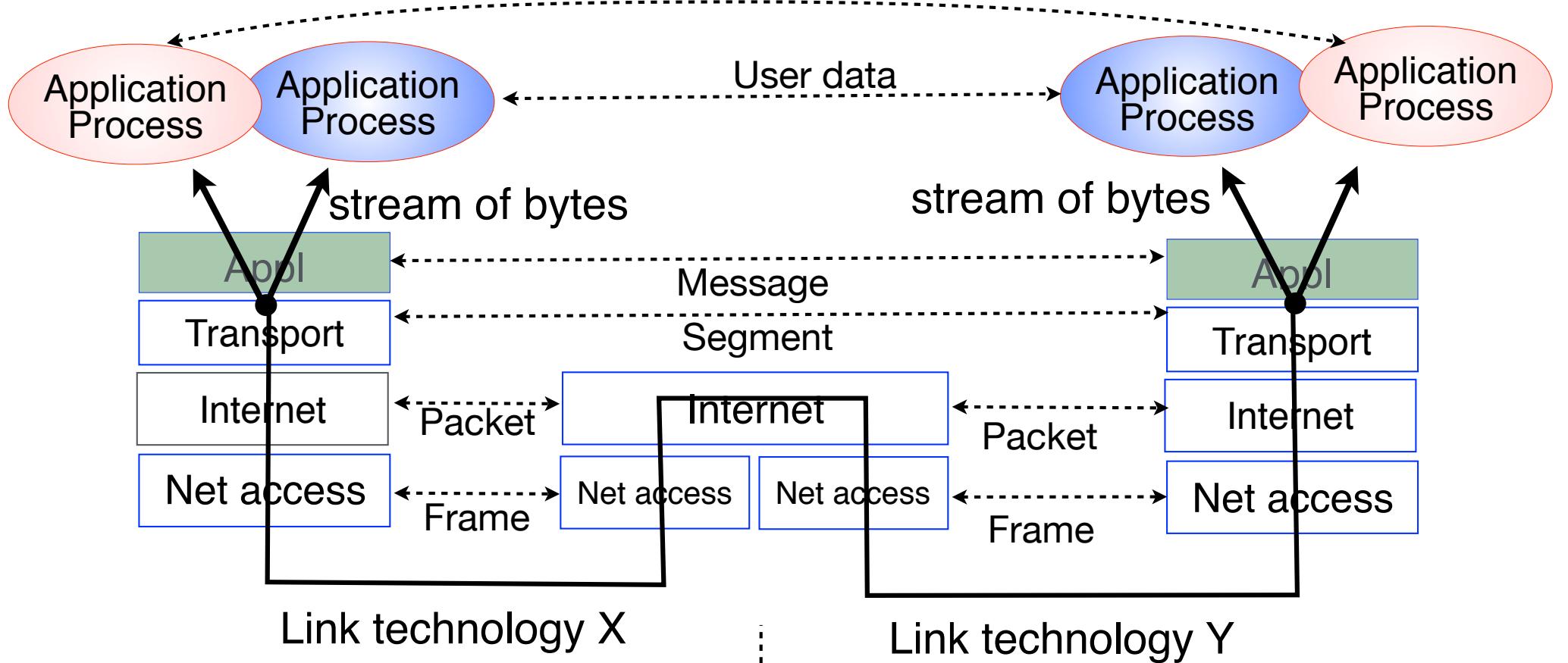


publish /room1/light value=on
publish /room2/light value=off

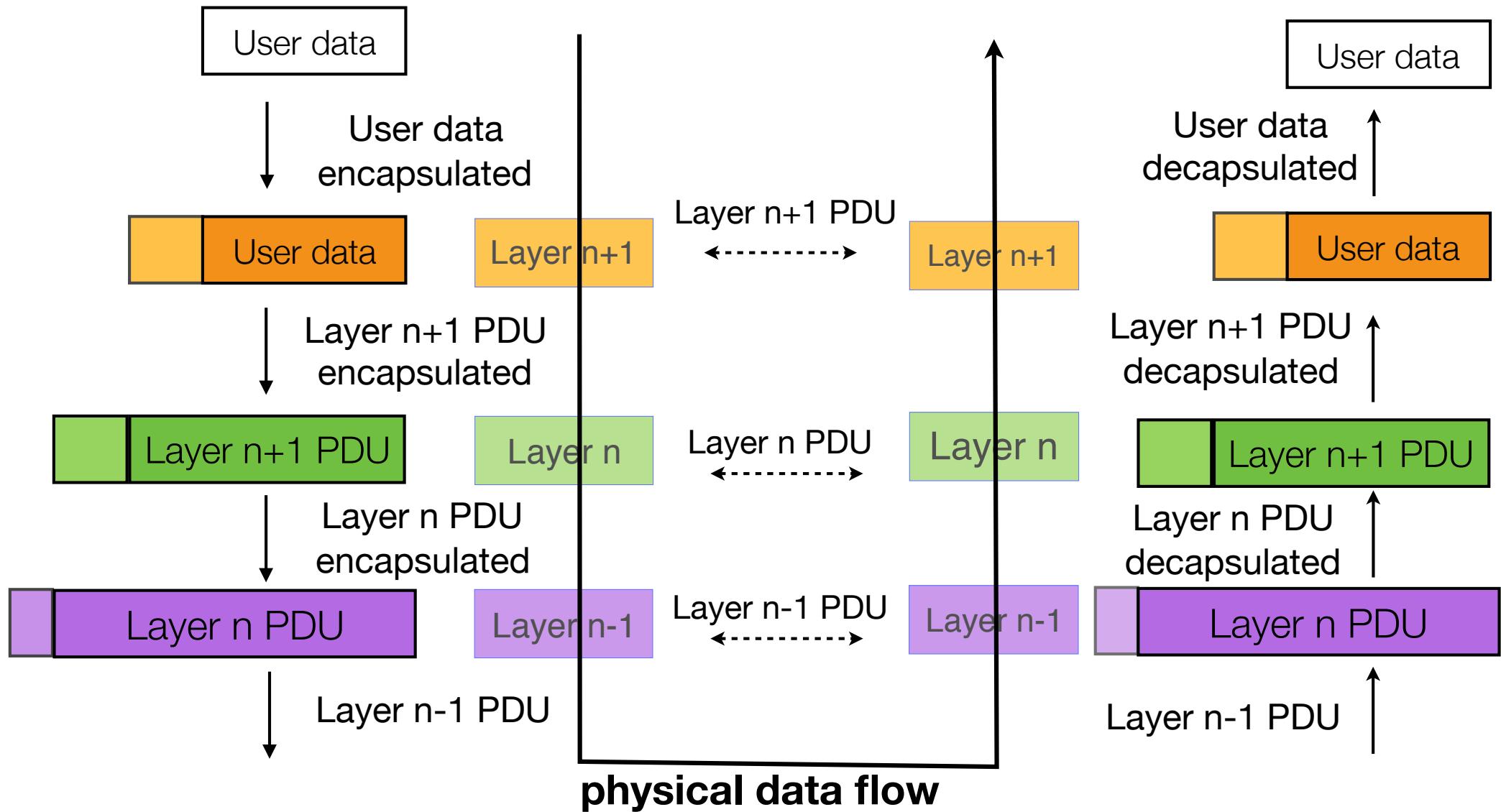
Success
Unsuccess

Application
Process

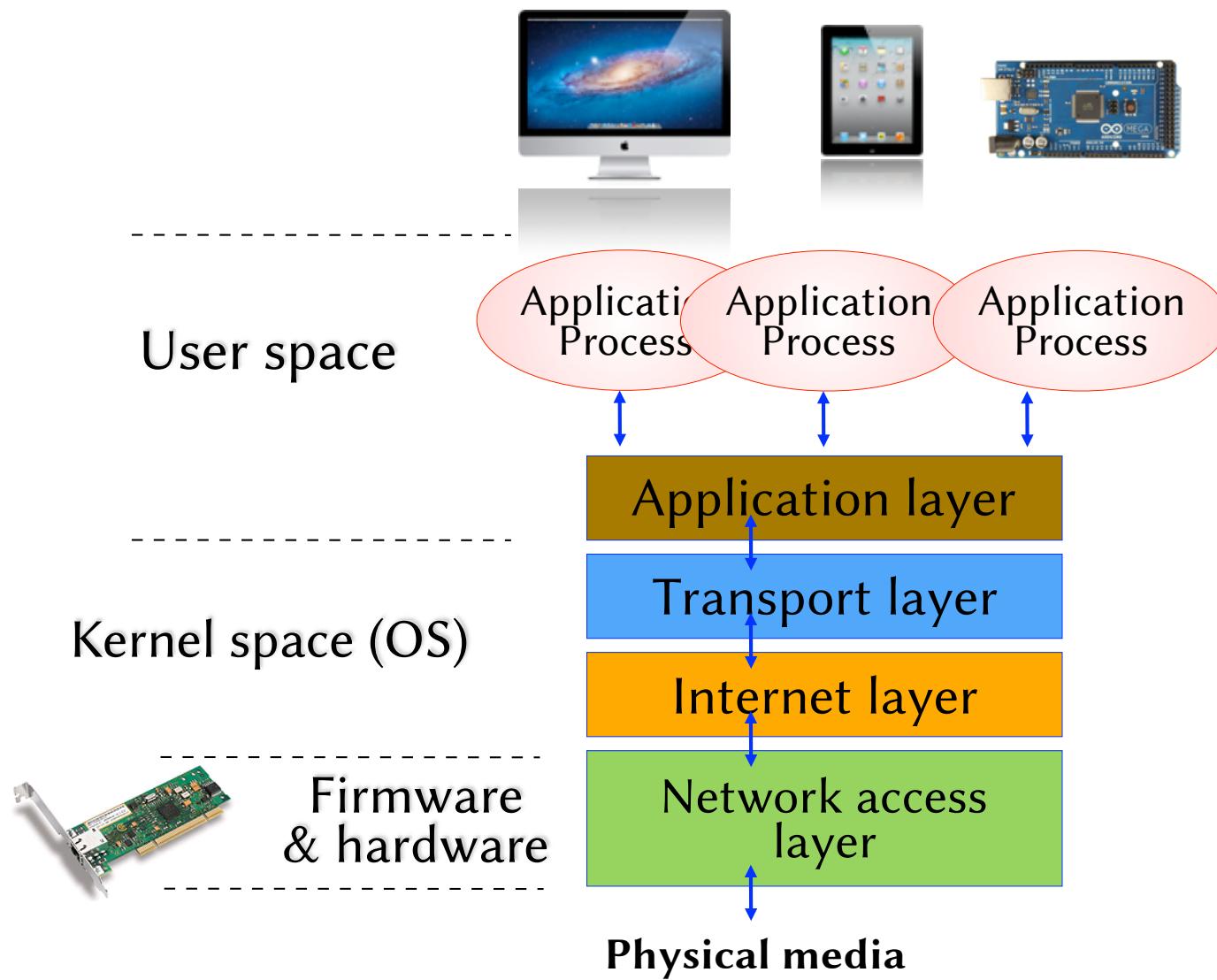




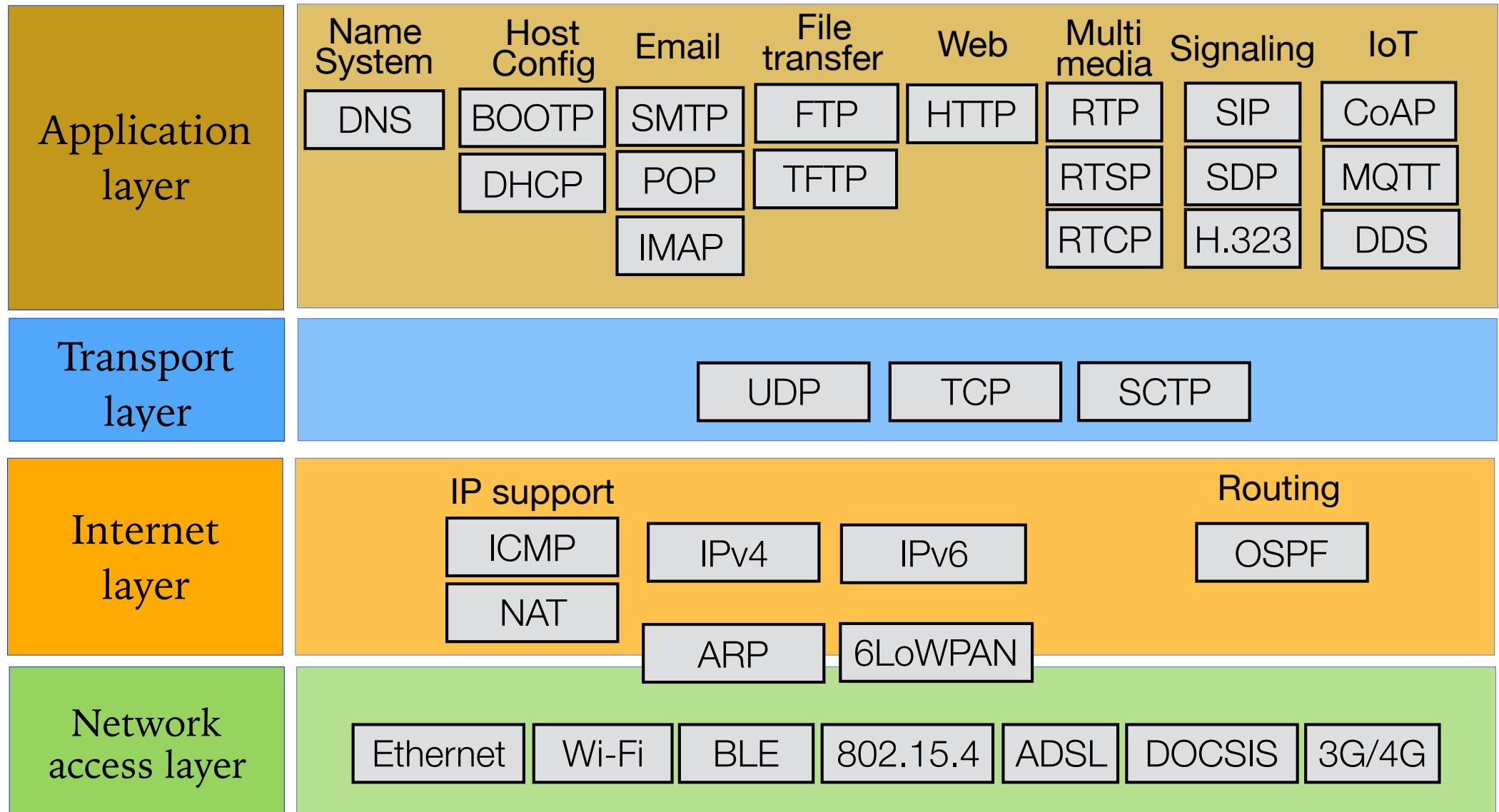
Layered Protocol Architecture

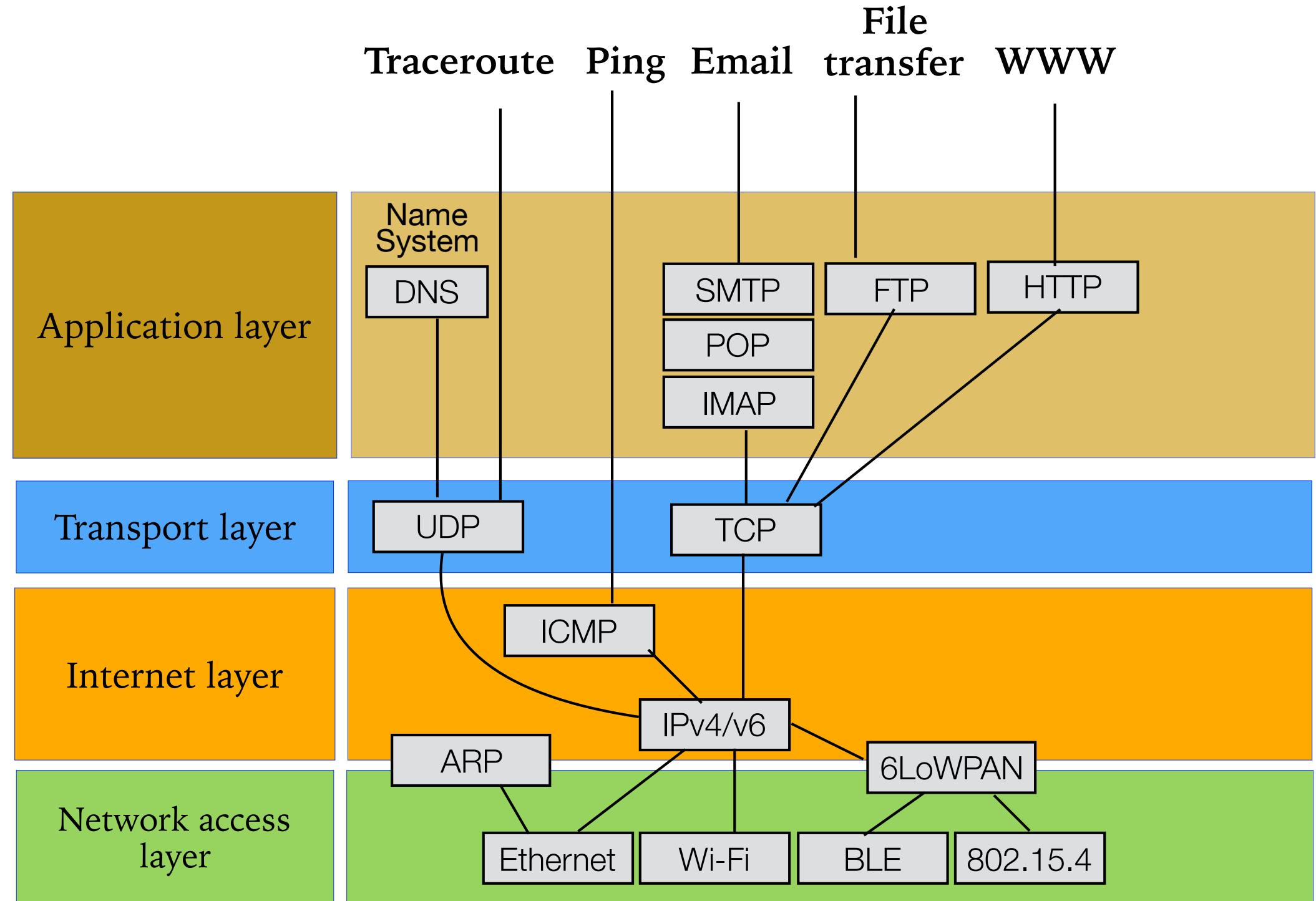


TCP/IP Reference Model

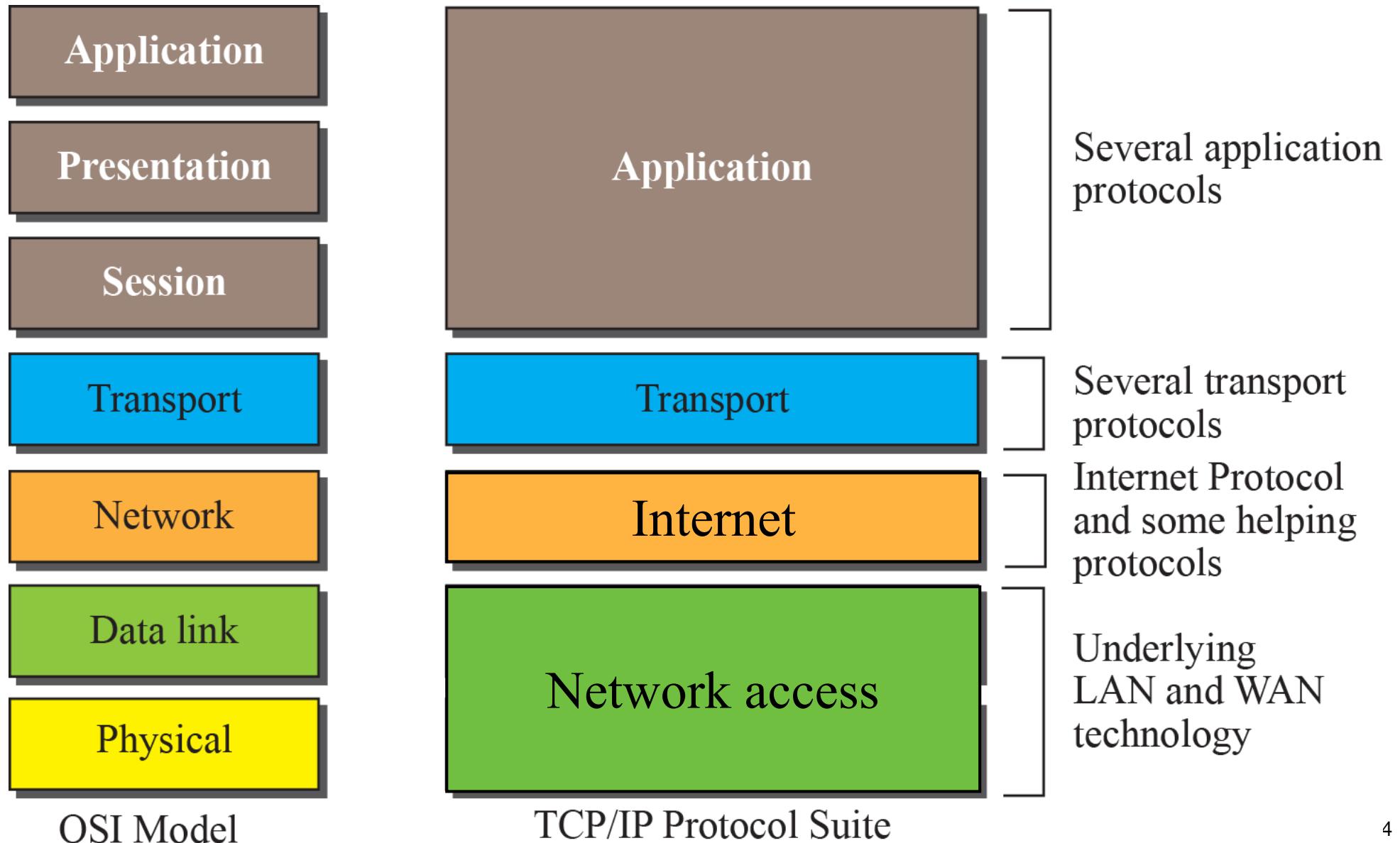


TCP/IP Protocol Suite

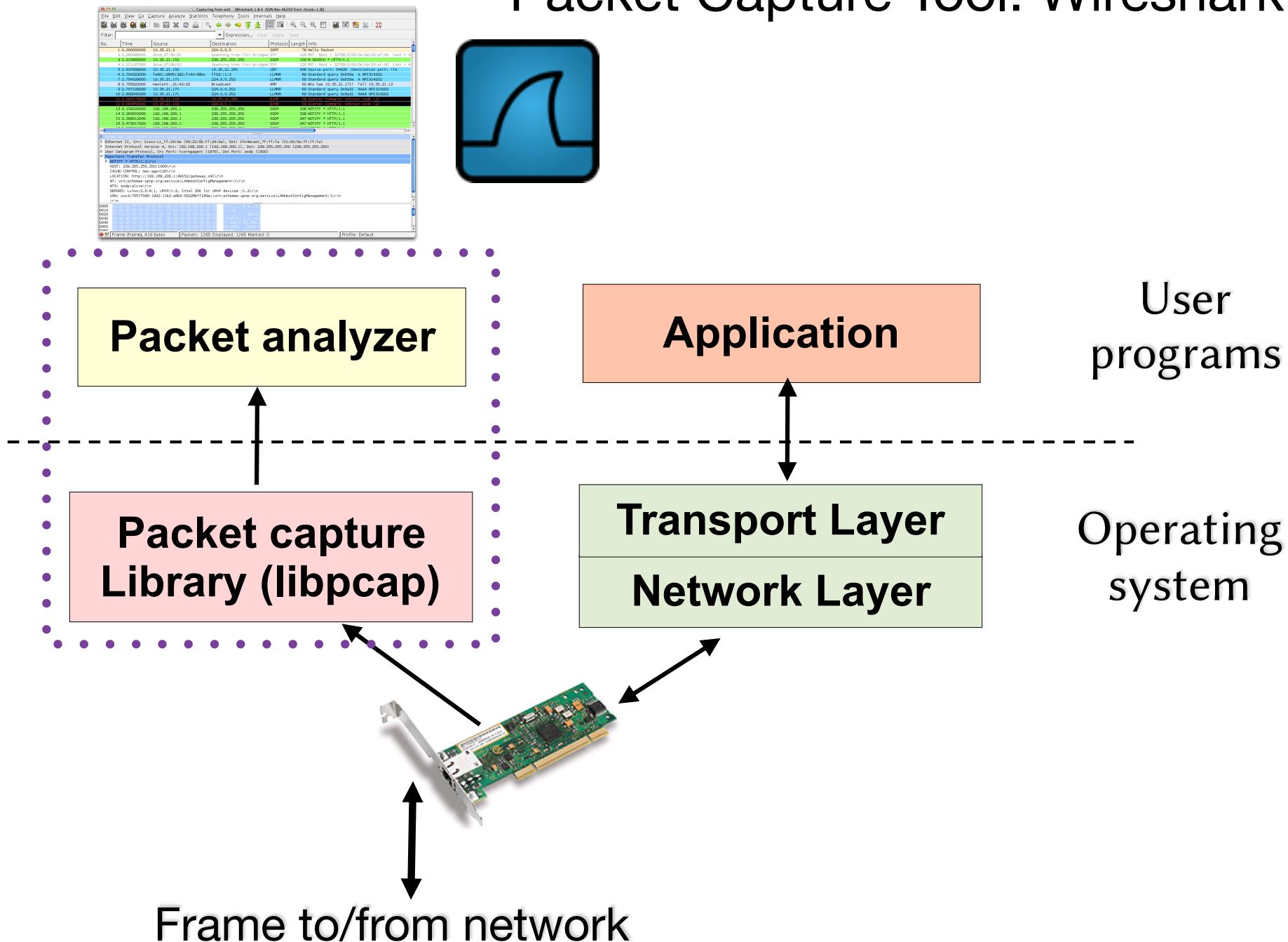




OSI Model and TCP/IP Model



Packet Capture Tool: Wireshark



Capturing from en0 [Wireshark 1.8.4 (SVN Rev 46250 from /trunk-1.8)]

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	10.35.21.2	224.0.0.5	OSPF	78	Hello Packet
2	0.260486000	3com_d7:0b:91	Spanning-tree-(for-bridges)STP	120	MST. Root = 32768/0/00:0e:6a:03:af:40 Cost = 40	
3	2.015666000	10.35.21.152	239.255.255.250	SSDP	159	M-SEARCH * HTTP/1.1
4	2.271167000	3com_d7:0b:91	Spanning-tree-(for-bridges)STP	120	MST. Root = 32768/0/00:0e:6a:03:af:40 Cost = 40	
5	2.637608000	10.35.21.150	10.35.21.255	UDP	348	Source port: 64626 Destination port: rfe
6	2.704322000	fe80::d945:3d2:f144:68be	ff02::1:3	LLMNR	89	Standard query 0xb59a A NPI314202
7	2.704328000	10.35.21.171	224.0.0.252	LLMNR	69	Standard query 0xb59a A NPI314202
8	2.705822000	Hewlett-_31:42:02	Broadcast	ARP	60	Who has 10.35.21.171? Tell 10.35.21.12
9	2.707109000	10.35.21.171	224.0.0.252	LLMNR	69	Standard query 0x6a31 AAAA NPI314202
10	2.806940000	10.35.21.171	224.0.0.252	LLMNR	69	Standard query 0x6a31 AAAA NPI314202
11	3.064178000	10.35.21.193	10.35.21.255	BJNP	58	Scanner Command: Unknown code (2)
12	3.064450000	10.35.21.193	224.0.0.1	BJNP	58	Scanner Command: Unknown code (2)
13	3.159333000	192.168.200.1	239.255.255.250	SSDP	338	NOTIFY * HTTP/1.1
14	3.263003000	192.168.200.1	239.255.255.250	SSDP	338	NOTIFY * HTTP/1.1
15	3.368012000	192.168.200.1	239.255.255.250	SSDP	347	NOTIFY * HTTP/1.1
16	3.473017000	192.168.200.1	239.255.255.250	SSDP	347	NOTIFY * HTTP/1.1
17	3.572001000	192.168.200.1	239.255.255.250	SSDP	416	NOTIFY * HTTP/1.1

Frame 46: 416 bytes on wire (3328 bits), 416 bytes captured (3328 bits) on interface 0

Ethernet II, Src: Cisco-Li_ff:24:9a (00:22:6b:ff:24:9a), Dst: IPv4mcast_7f:ff:fa (01:00:5e:7f:ff:fa)

Internet Protocol Version 4, Src: 192.168.200.1 (192.168.200.1), Dst: 239.255.255.250 (239.255.255.250)

User Datagram Protocol, Src Port: tcoregagent (1976), Dst Port: ssdp (1900)

Hypertext Transfer Protocol

NOTIFY * HTTP/1.1\r\n

HOST: 239.255.250.1900\r\n

CACHE-CONTROL: max-age=120\r\n

LOCATION: http://192.168.200.1:49152/gateway.xml\r\n

NT: urn:schemas-upnp-org:service:LANHostConfigManagement:1\r\n

NTS: ssdp:alive\r\n

SERVER: Linux/2.6.8.1, UPnP/1.0, Intel SDK for UPnP devices /1.2\r\n

USN: uuid:705770d6-1dd2-11b2-a6b9-00226bff249a::urn:schemas-upnp-org:service:LANHostConfigManagement:1\r\n

\r\n

0000	01 00 5e 7f ff fa 00 22 6b ff 24 9a 08 00 45 00	.^." k.\$...E.
0010	01 92 00 00 40 00 04 11 fc b6 c0 a8 c8 01 ef ff@...
0020	ff fa 07 b8 07 6c 01 7e 5f 10 4e 4f 54 49 46 59l.~_.NOTIFY
0030	20 2a 20 48 54 54 50 2f 31 2e 31 0d 0a 48 4f 53	* HTTP/ 1.1..HOS
0040	54 3a 20 32 33 39 2e 32 35 35 2e 32	T: 239.2 55.255.2
0050	35 30 3a 31 39 30 30 0d 0a 43 41 43 48 45 2d 43	50:1900. .CACHE-C
0060	4f 4a 54 52 4f 4c 3a 20 6d 61 78 2d 61 67 65 3d	ONTROL . max-age=

Frame (frame), 416 bytes Packets: 1265 Displayed: 1265 Marked: 0 Profile: Default

Conclusion

- Network for information exchange, resource sharing, device control and monitoring
- Network protocols as elementary building blocks -- Syntax, Semantic, Timing
- Network protocols organized into layers to gain benefits of modularity.
 - Many protocols in each layer -- TCP/IP protocol suite
 - Data units exchanged: Bits, Frames, Packets, Segments, Messages

Next Week

- Install a Anaconda Python 3 distribution in your labtop from
<https://www.continuum.io/downloads>
- Install Wireshark 3 from <https://www.wireshark.org/download.html>
- Read how to create and run a python program from <https://docs.python.org/3/tutorial/index.html>

Lab Sessions

- Enhance theoretical understanding
- Set up and config networking devices and services
- Analyze & troubleshoot basic network problems

Lab Equipment

Login: root
Password: networklab

Cisco Catalyst 2960 switch x 3



Cisco 2901 Router x 3



Raspberry Pi x 4



Before the lab session

- Download the activity sheet from MyLE
 - Do reading assignment
 - Try to answer self-test questions (no points)
- Skim through the lab procedures
- Bring a flash drive to save data.

During the lab session

- Sign out Ethernet cables (leave one student ID per group).
- Power-on RPi nodes
 - Username: root
 - Password: networklab
- Follow the procedures. Read the whole part before starting !!
- Answer the lab questions with TA and move on.

Lab Questions

Upon Finishing

- Delete* data files and screen capture files you have created
- Roll up* and return the cables and get back your ID.
- Shutdown* all RPi nodes and switch off the power cord extension

Review Questions

1. What is the role of file `/etc/resolv.conf` in a Unix-based file system? Explain the meaning of the following content in `/etc/resolv.conf`:

Lab Reports (If Required)

- Submit answers in the lab report for the part that says "*Report Questions*".
- Turn in the lab report (pdf) in myLE before you leave the room.
 - Name the file “lab-x-group-y.pdf”, where x = Lab number, y = Group number (C1, C2, .., D1, D2, ...)
 - Put the lab name, group members and their ID in the front page.
- For late submission, turn in a hard copy at the instructor homework box (one point off per day).

Report Questions:

Use the saved Wireshark output to answer the following questions. Include relevant parts of the Wireshark data to support each of your answers.

Participation and Attention (-5%)

- 0.5% off for > 15-min late or absence
- 0.25% off for games, social media, foods, flip-flops, shorts, inappropriate dress, etc.
- No points for lab report if absence

