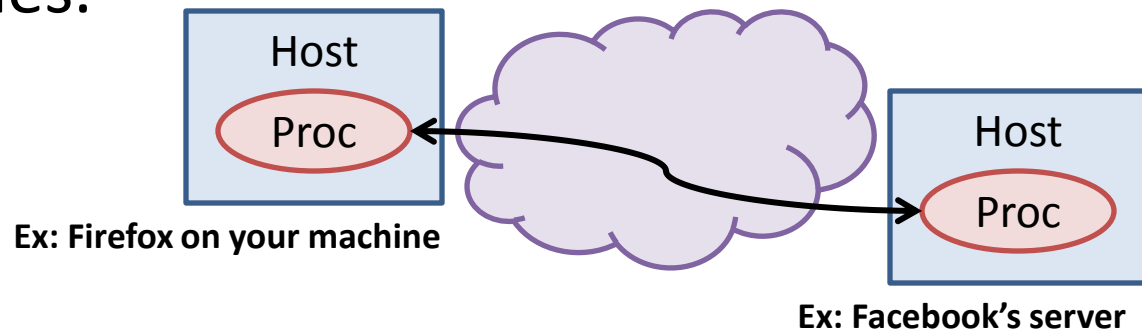# Introduction to Networking

CS 241

Nov. 8, 2013

Networking

- What do we expect out of networking?
  - An channel between two processes on two remote machines.

Ex: Firefox on your machine

Ex: Facebook's server

- Making this happen is complex!

  - **Hosts**
  - **Routers**
  - **Various Links**
  - **Applications**
  - **Protocols**
  - **Hardware**
  - **Software**

  - **Bit errors**
  - **Packet errors**
  - **Link failures**
  - **Node failures**
  - **Message delays**
 - **Out-of-order delivery**
  - **Eavesdropping**

Protocols

- A **protocol** is a message format and rules for exchanging these messages.

- You already use a lot of protocols:
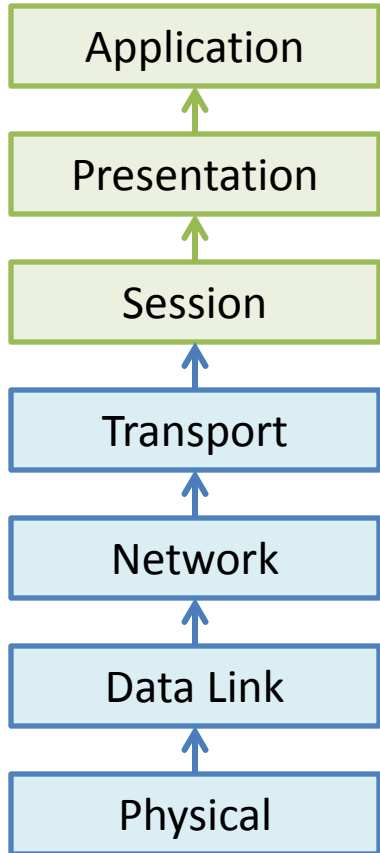
Networking Model: Layers of Protocols

- A network channel is effectively only a transmission of 0s and 1s:

```
0 1 0 0 1 1 0 1 0 0 0 1 0 1 1 0 0 1 0 1 1 1 1 0 1 0
```

- How do we translate these 0s and 1s into HTTP packets?   How do we get those to the right end-user?
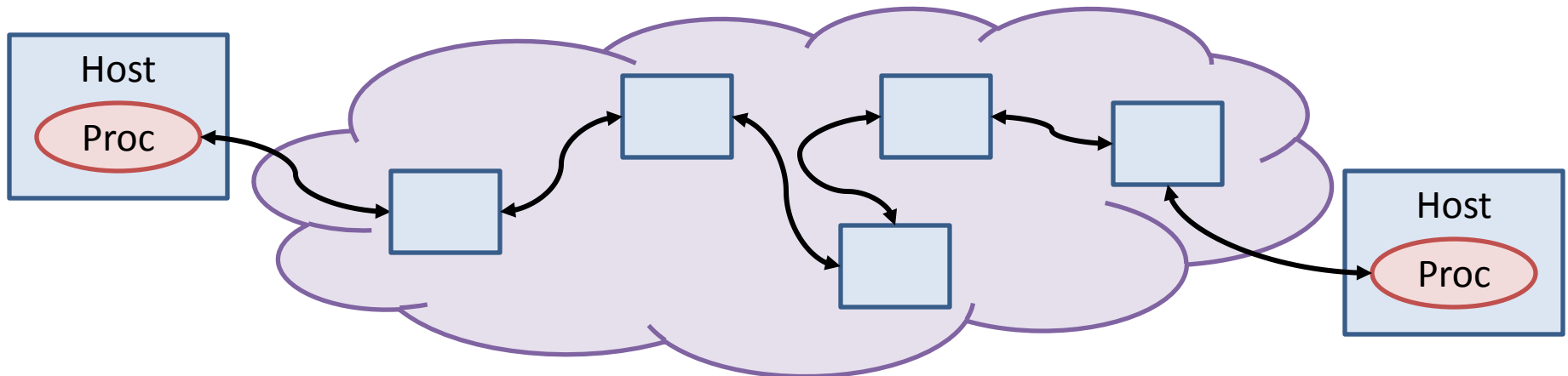
OSI Protocol Stack / "OSI Model"

| Application |
| :---: |
| Presentation |
| Session |
| Transport |
| Network |
| Data Link |
| Physical |

- The "OSI Model" for networking is a seven layer protocol stack.

- Each layer **encapsulates** the layers above it and provides specific features to higher-layer protocols.
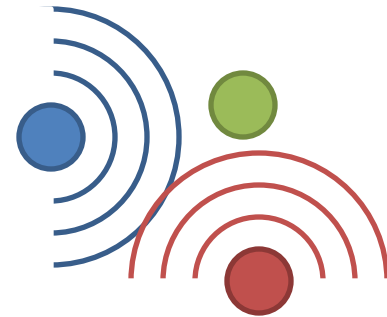
Layer 1: Physical Layer

Application
Presentation
Session
Transport
Network
Data Link
Physical
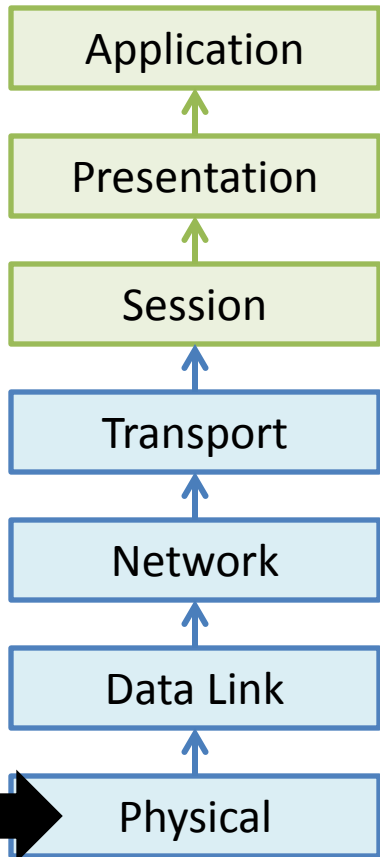
- The **Physical Layer** provides hardware-specific details on how to transmit a 0 vs. 1.
  - **100BASE-T**: Ethernet
  - **GSM "Um Interface"**: Cell phones
  - **802.11**: Wi-Fi

- <u>Provides</u>: A digital representation of the underlying signal; *a series of 0s and 1s*.

Layer 2: Data Link Layer

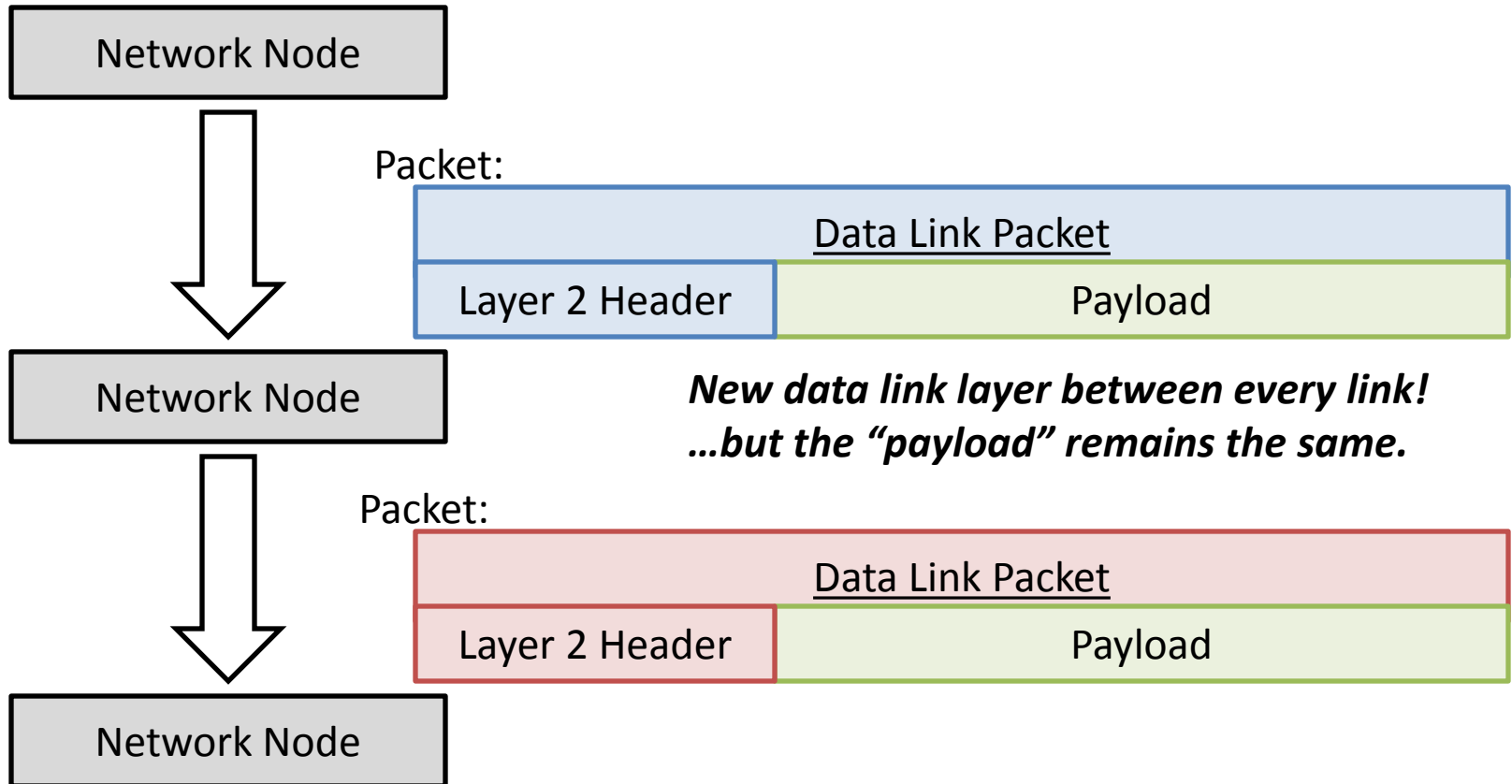| |
|---|
| Application |
| Presentation |
| Session |
| Transport |
| Network |
| **➡ Data Link** |
| Physical |
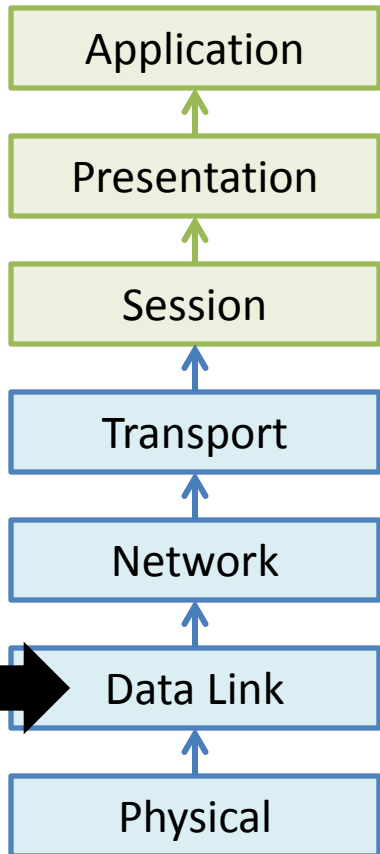
- The **Data Link Layer** provides link-to-link communications.
  - Consider Wi-Fi:
    - Every computer that is connected to a wi-fi access point uses the same channel: **every computer hears every other computer!**
    - *How do we know the data that is coming in is for us, not for our neighbor?*

  - Provides: Link-to-link communications

Layer 2: Data Link Layer

Network Node

Packet:

Data Link Packet	
Layer 2 Header	Payload

Network Node

New data link layer between every link!
…but the "payload" remains the same.

Packet:

Data Link Packet	
Layer 2 Header	Payload

Network Node

Layer 3: Network Layer

| Application |
| :---: |
| Presentation |
| Session |
| Transport |
| Network |
| Data Link |
| Physical |
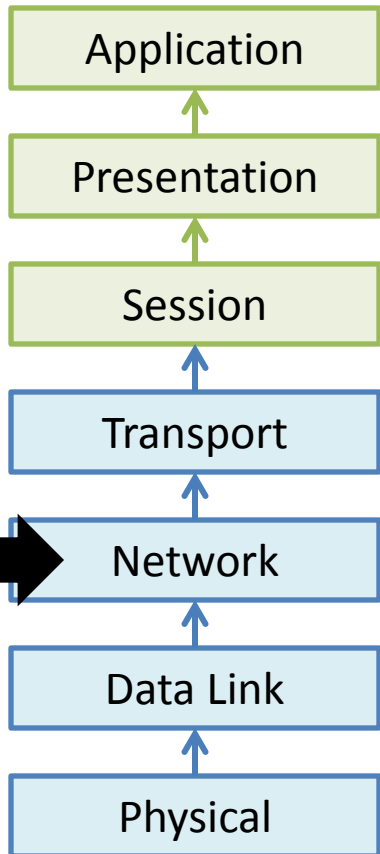
- The **Network Layer** provides host-to-host communications.
  - One protocols: IP (IPv4 and IPv6)

- <u>Provides</u>: Information on the source and destination **host**.
  - *Where should this packet go?*
  - *Who sent this packet in the first place?*

Layer 4: Transport Layer

Application
Presentation
Session
→ Transport
Network
Data Link
Physical
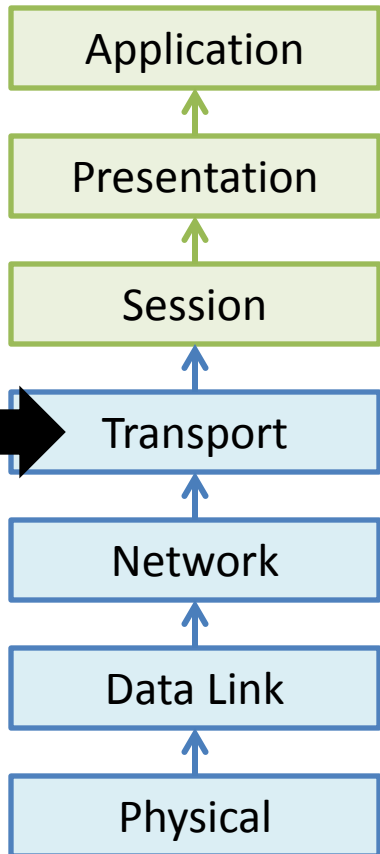
- The **Transport Layer** provides process-to-process communications.
  - Two main protocols: TCP and UDP

- <u>Provides</u>: Information on the source and destination **process**... *and much more.*
  - *Done via "network ports", a globally shared resource on a system that associates a **port number** with a process.*
  - *The process making the connection to a remote process needs to know the port number the remote process is listening on.*

TCP vs. UDP

- TCP and UDP both provide process-to-process communications via port numbers.
  - That is about all UDP does. UDP: fast and cheap!

- TCP provides several convenience features:
  - Reliable Transmission:
    - Packets will arrive in the order that they were sent
    - All packets will arrive (on an active connection)
    - All packets will be delivered once (no duplicates)
  - Flow and Congestion Control:
    - TCP negotiates a rate of transmission between the hosts so the receiver is not overwhelmed with data