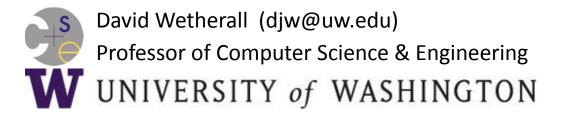
#### Computer Networks

Protocols and Layering (§1.3)



#### **Networks Need Modularity**

- The network does much for apps:
- Make and break connections
  - Find a path through the network
- Transfers information reliably
  - Transfers arbitrary length information
  - Send as fast as the network allows
  - Shares bandwidth among users
- Secures information in transit
- Lets many new hosts be added

<del>-</del> ..

#### **Networks Need Modularity**

The network does much for apps:

```
Make and break connections
We need a form of modularity, to help mation ows
manage complexity ows
and support reuse
Lets many new hosts be added
```

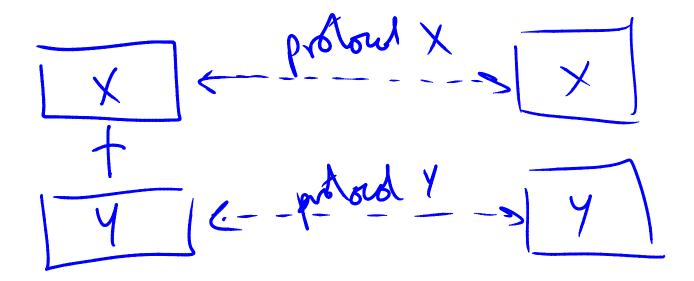
#### **Protocols and Layers**

- Protocols and layering is the main structuring method used to divide up network functionality
  - Each instance of a protocol talks
     virtually to its <u>peer</u> using the protocol
  - Each instance of a protocol uses only the services of the lower layer

**Computer Networks** 

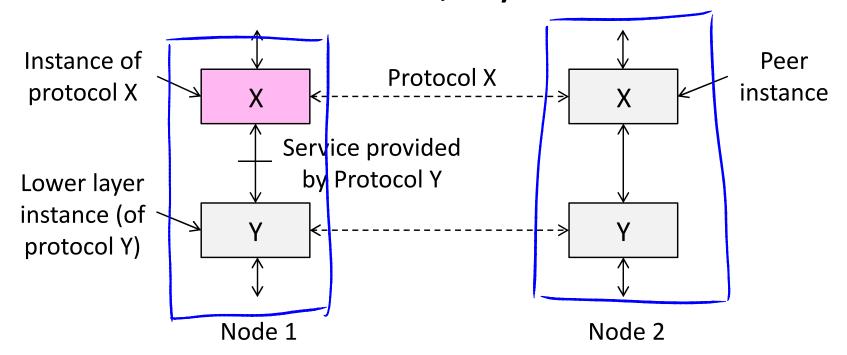
4

#### Protocols and Layers (2)



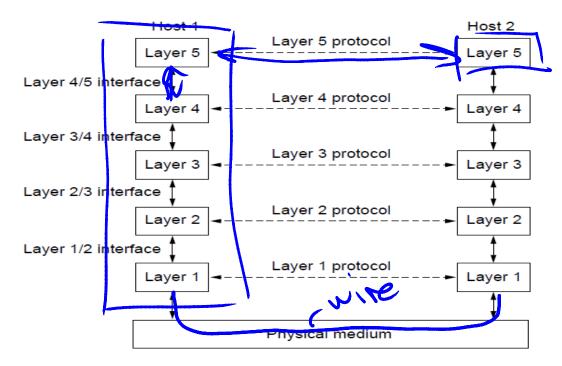
## Protocols and Layers (3)

Protocols are horizontal, layers are vertical



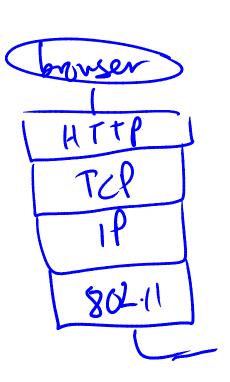
# Protocols and Layers (4)

Set of protocols in use is called a <u>protocol stack</u>



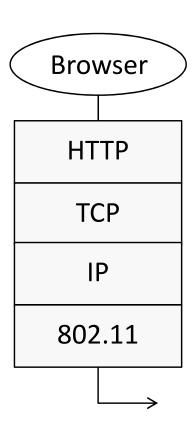
## Protocols and Layers (5)

- Protocols you've probably heard of:
  - TCP, IP, 802.11, Ethernet, HTTP, SSL, DNS, ... and many more
- An example protocol stack
  - Used by a web browser on a host that is wirelessly connected to the Internet



## Protocols and Layers (6)

- Protocols you've probably heard of:
  - TCP, IP, 802.11, Ethernet, HTTP, SSL,
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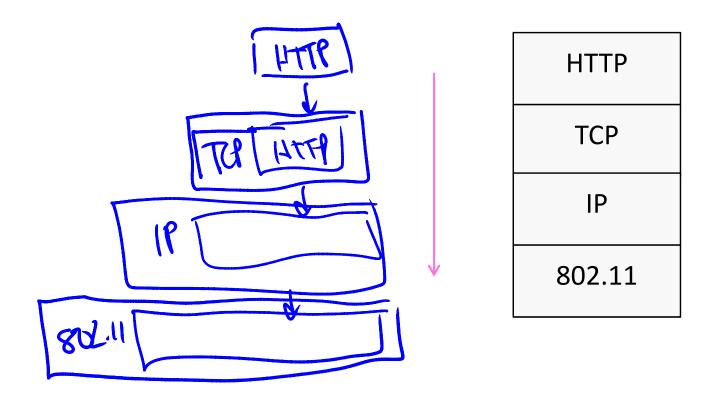
**Computer Networks** 

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#### Encapsulation

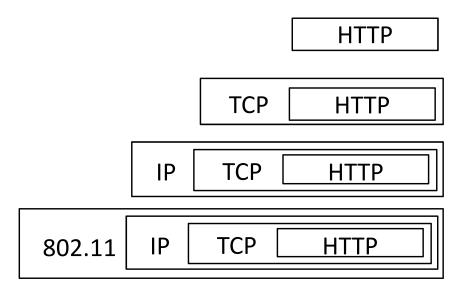
- Encapsulation is the mechanism used to effect protocol layering
  - Lower layer wraps higher layer content, adding its own information to make a new message for delivery
  - Like sending a letter in an envelope; postal service doesn't look inside

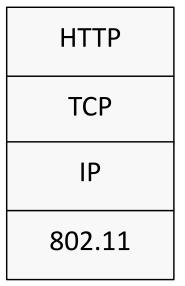
# Encapsulation (2)



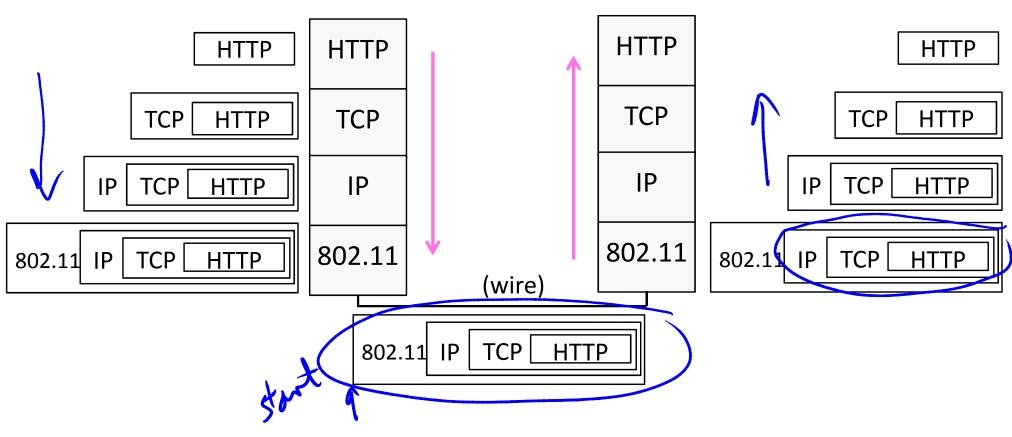
#### Encapsulation (3)

- Message "on the wire" begins to look like an onion
  - Lower layers are outermost



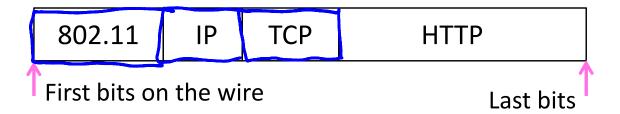


#### Encapsulation (4)



## Encapsulation (5)

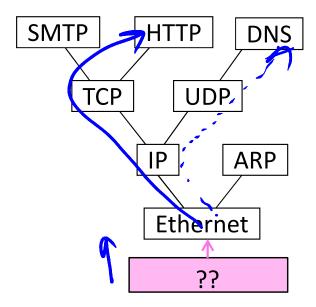
- Normally draw message like this:
  - Each layer adds its own header



- More involved in practice
  - Trailers as well as headers, encrypt/compress contents
  - Segmentation (divide long message) and reassembly

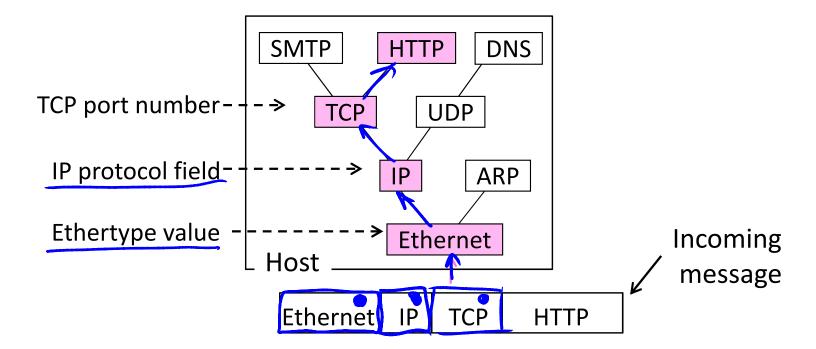
#### Demultiplexing

 Incoming message must be passed to the protocols that it uses



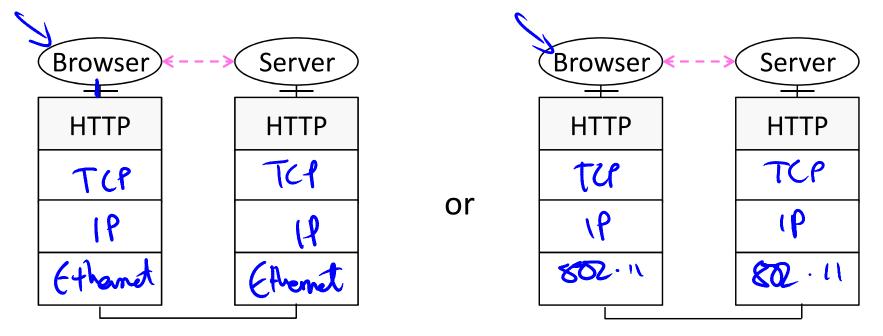
## Demultiplexing (2)

Done with <u>demultiplexing keys</u> in the headers



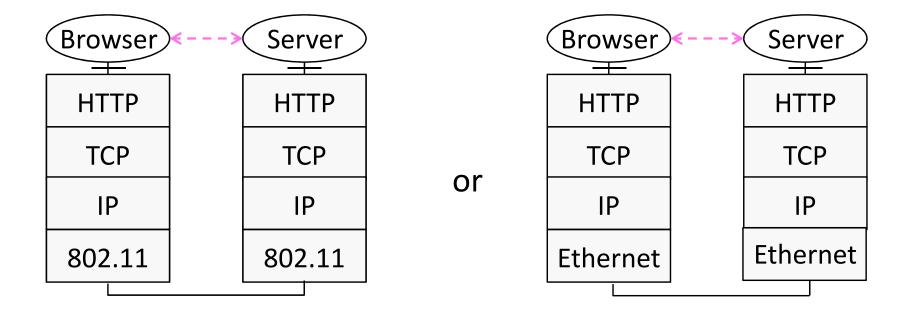
#### Advantage of Layering

Information hiding and reuse



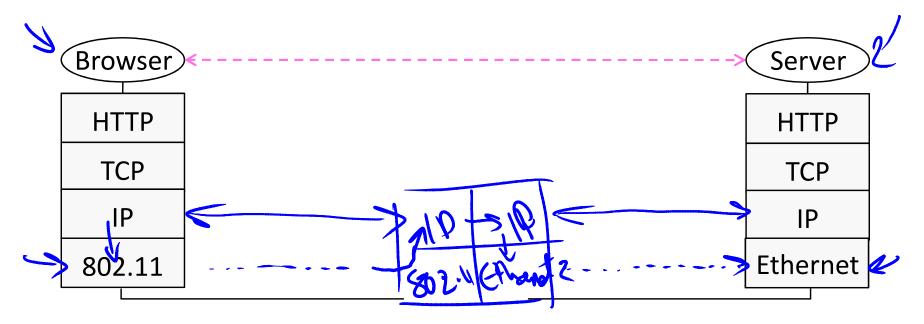
# Advantage of Layering (2)

Information hiding and reuse



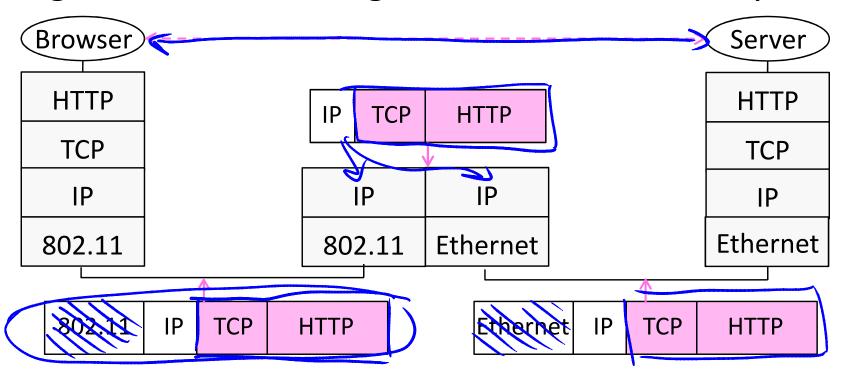
# Advantage of Layering (3)

Using information hiding to connect different systems



# Advantage of Layering (4)

Using information hiding to connect different systems



#### Disadvantage of Layering

- Adds overhead
  - But minor for long messages
  - Hides information
    - App might care whether it is running over wired or wireless!

#### **END**

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