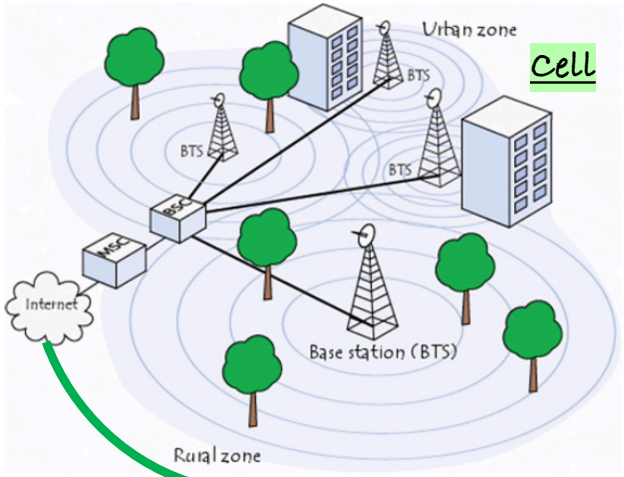
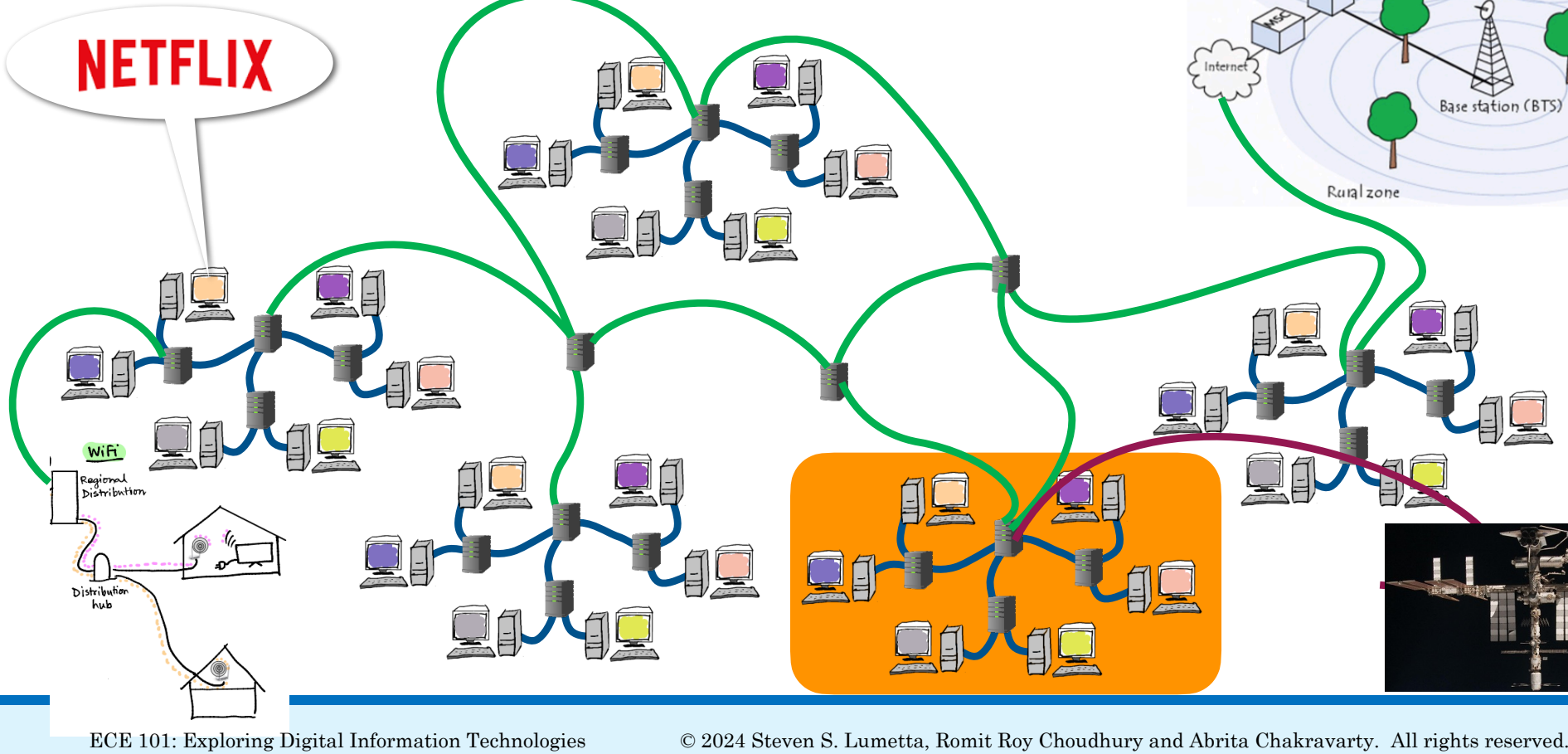
University of Illinois at Urbana-Champaign
Dept. of Electrical and Computer Engineering

ECE 101: Exploring Digital Information Technologies

The Internet: Layering and TCP (part 3 of 3)

Everyone Connected at the Edge





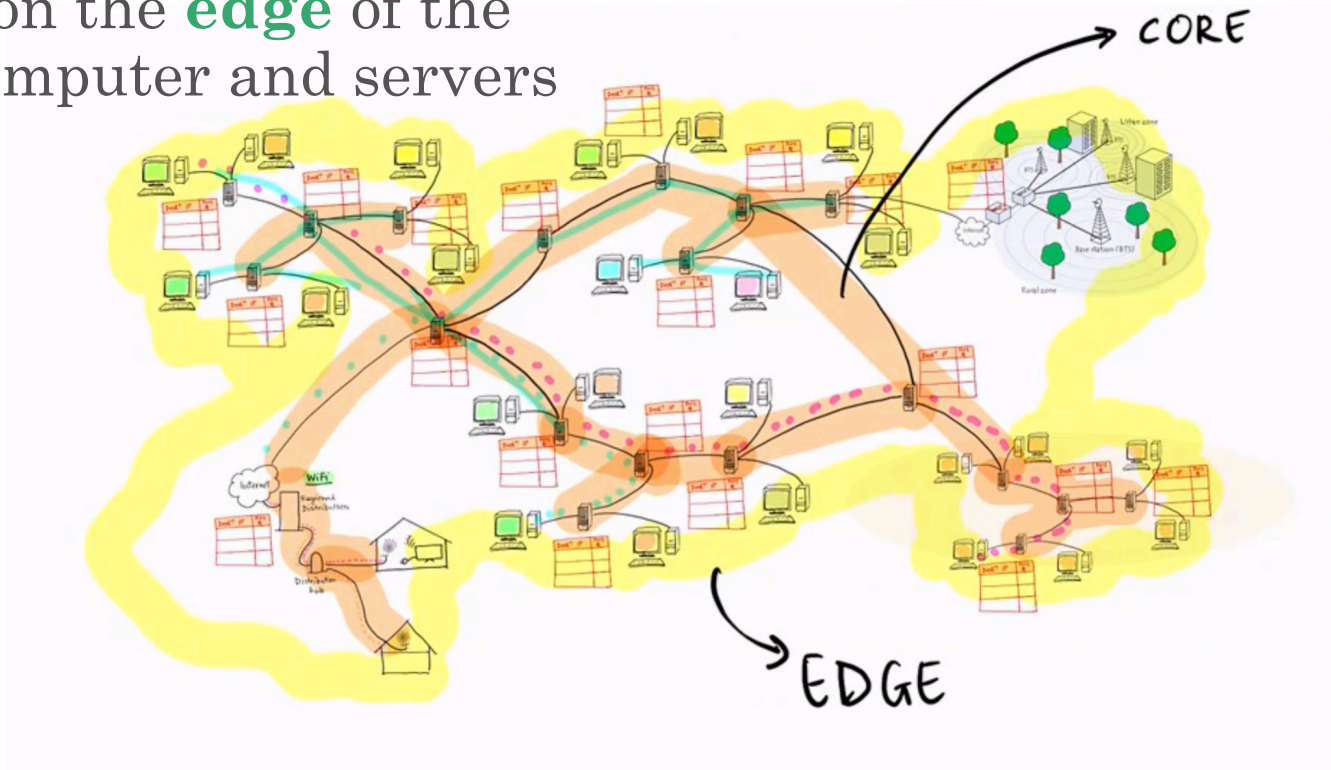
The Edge and the Core of the Internet

Applications operate on the **edge** of the network, where your computer and servers are connected.

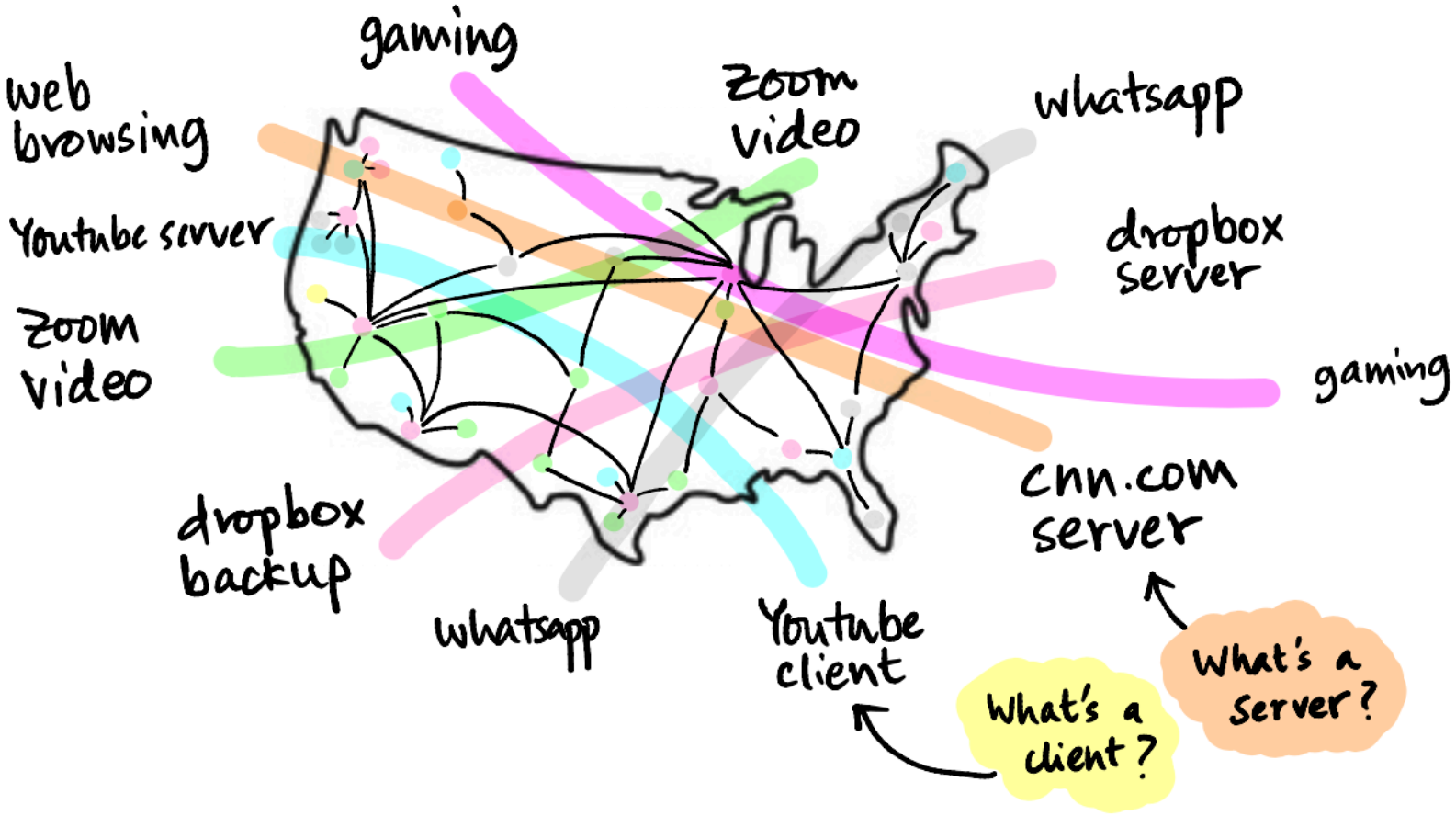
Everything else

- all of the routers,
- all of the rest of the hierarchy,
- the plumbing of the Internet,

…these form the **core of the Internet**.

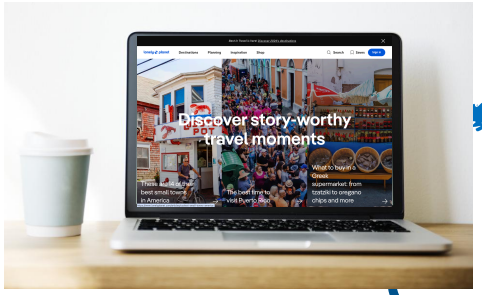


Applications running on the "edge"

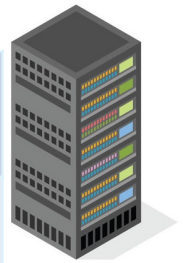


Requesting a webpage

The web browser application,
- prepares the packet
- and **sends it off**



52.84.52.66



Destination IP	Source IP	Protocol Name	Version	Browser	Name of webpage
00110100 01010100 00110100 01000010	10000010 01111110 11111111 11100100	1010…01	10	10011	10001010 10001000 10000101 10001011 10000111

Data Packets

really just a sequence of **bits.**

The request and response are sent as **data packets**

Request

Control Bits/Packet Header | **Data Payload**

Protocol Name	Version	Browser	…	Name of webpage
1010…01	10	10011		10001010 10001000 10000101 10001011 10000111

Response

Protocol Name	Version	Server	…	Contents of the webpage
1010…01	10	11001		1011010 11001000 10100001 11101011 10111111 1000010 10001000 10000101 10001011 10000111 … 1011011 10101000 10000101 11111011 11000111

HTTP: An Application Protocol for Browsing the Web

The computers participating in the exchange

- your browser on **your laptop** and
- the lonely planet **server**,
- must use the same **protocol**.

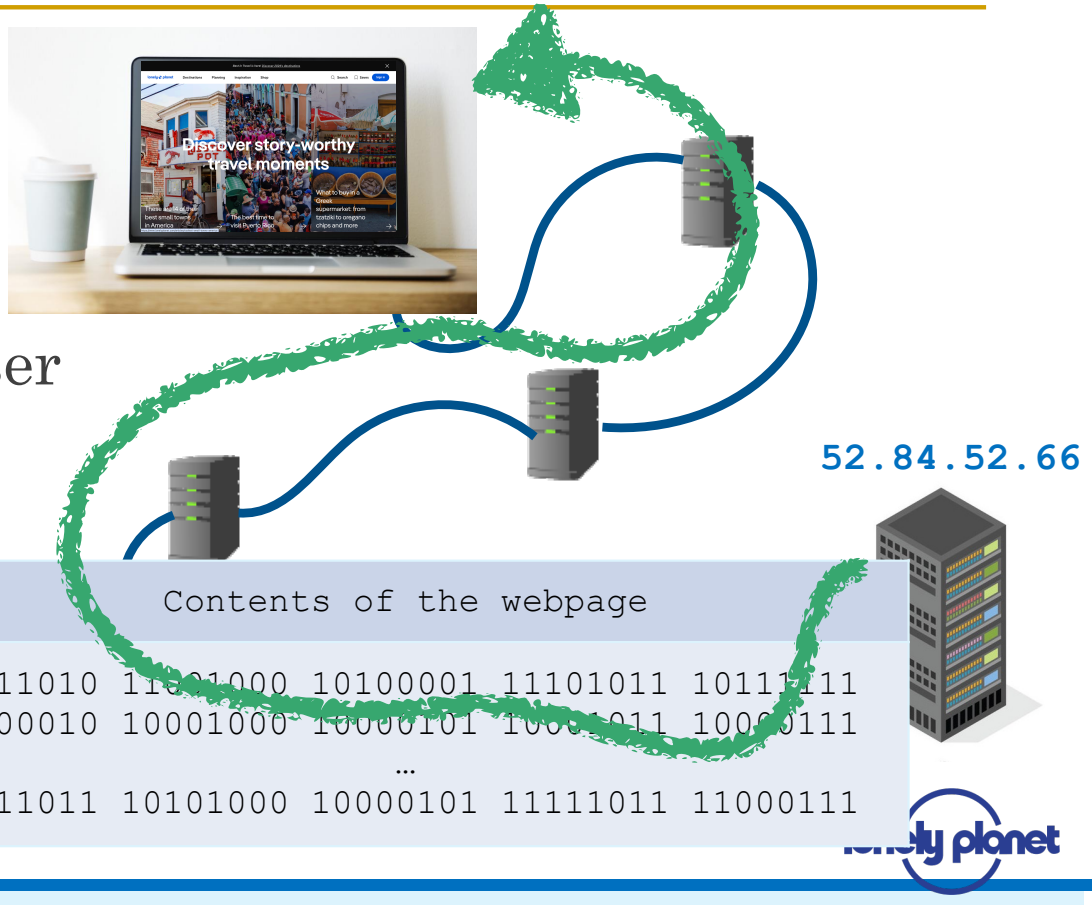
The protocol **used for web browsing is**

Hyper-Text Transfer Protocol (**HTTP**)

Getting a response …

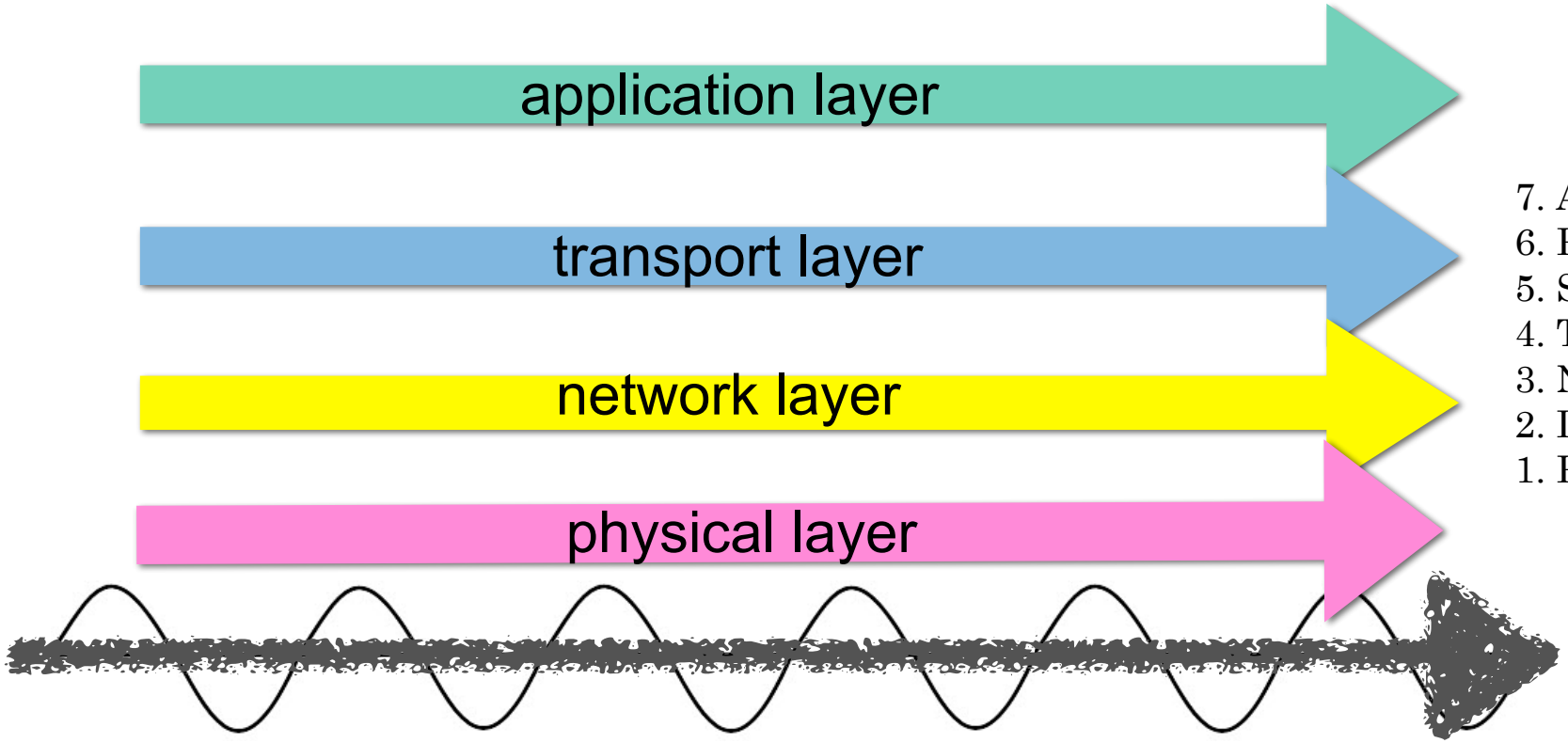
Once the server receives the request,

- it puts the webpage
- in a data packet
- and sends it back to the browser



Destination IP	Source IP	Protocol Name	Version	…	Contents of the webpage
10000010 00110100 01111110 01010100 11111111 00110100 11100100 01000010	1010…01	10			1011010 11001000 10100001 11101011 10111111 1000010 10001000 10000101 10001011 10000111 … 1011011 10101000 10000101 11111011 11000111

Communication actually happens in layers …



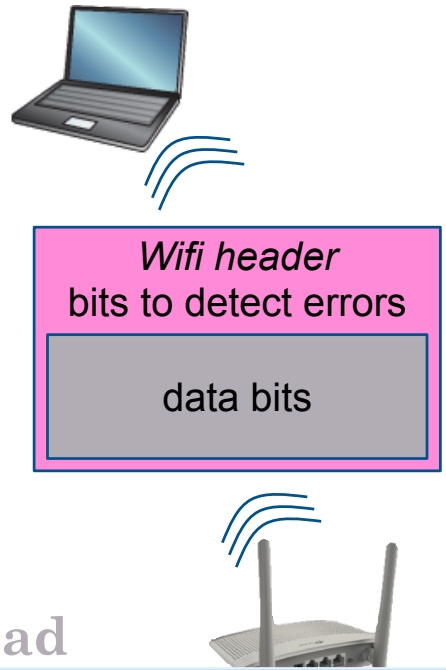
7. Application
6. Presentation
5. Session
4. Transport
3. Network
2. Data link
1. Physical

All on the same physical connection (wired/wireless)

The Physical Layer

Connections over the physical wires/wireless medium
- **bits** are being sent as **signals**

When we send **signals**,
- we send some **bits**, that contains the main information (**text, image, video**, etc.)
- but we **also send …**
- some **extra control bits** in front—a **header**—
- **to check for bit errors**.



Control Bits/Packet Header **Data Payload**

Error checking bits	Data bits
1010…00111	10001010 10001000 10000101 10001011 10000111

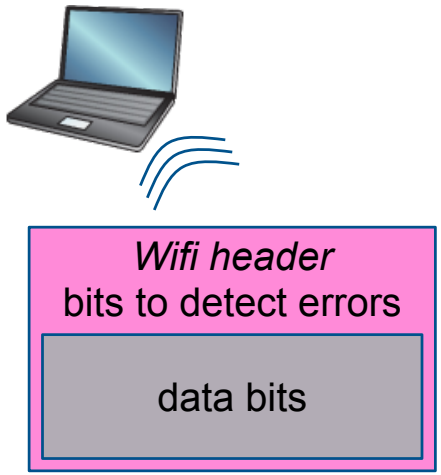
Delivery of Packets is Not Guaranteed

If a bit error is detected, the packet is discarded.

That's all.

There are no guarantees.

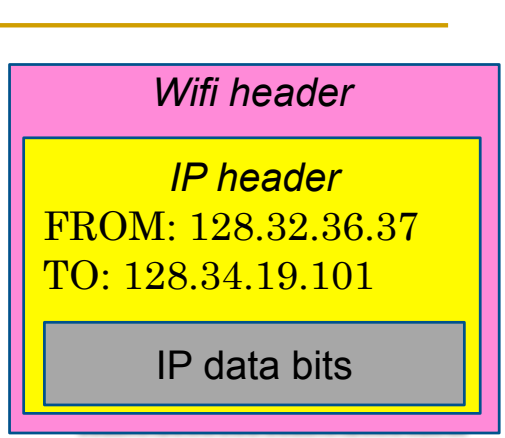
You need to try again.

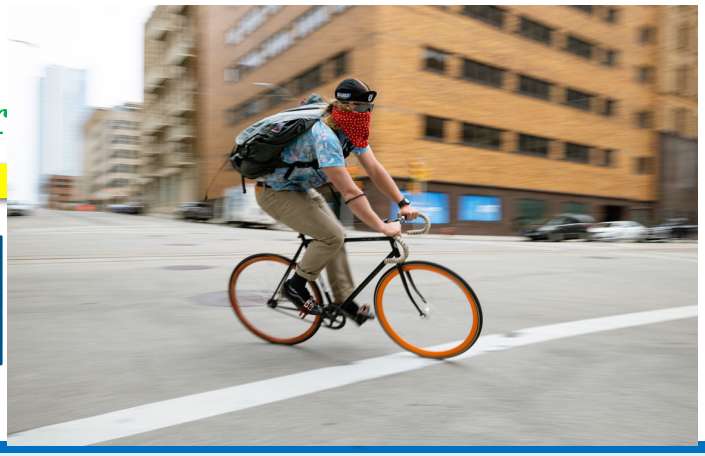


The Network Layer

- operates on top of the **physical layer**.
- uses the **Internet Protocol (IP)**.
- packages the data bits to hand over to physical layer.
- the packet has IP header bits
- **From** and **To** IP addresses
- IP data bits (from the layer above it)

across the network (vir





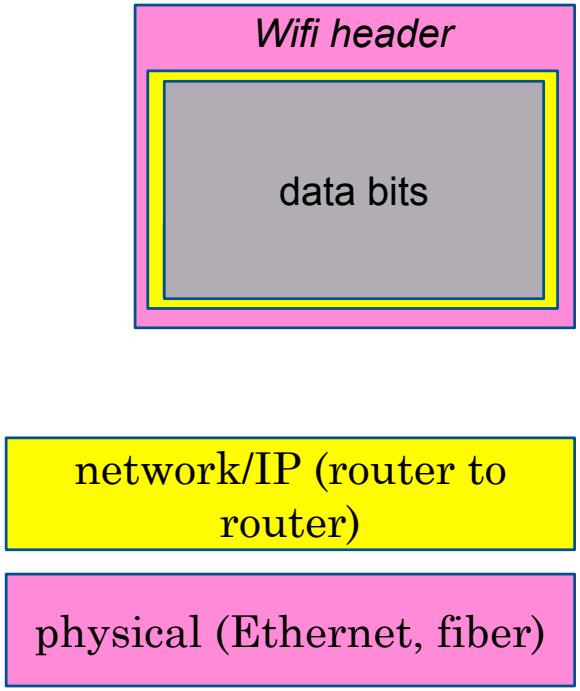
Each Protocol Packet is Encapsulated in the One Below

Notice that **the IP packet**—including the IP header—**is just data bits to the physical layer**.

This approach is called **encapsulation**:

- the **physical packet**
- is **wrapped around**
- the **IP packet** (like an envelope).

We draw a protocol stack with IP sitting on top of the physical layer.



IP Provides Only Best Effort Delivery

But **IP is still unreliable**!

IP does not guarantee that your packet is delivered.

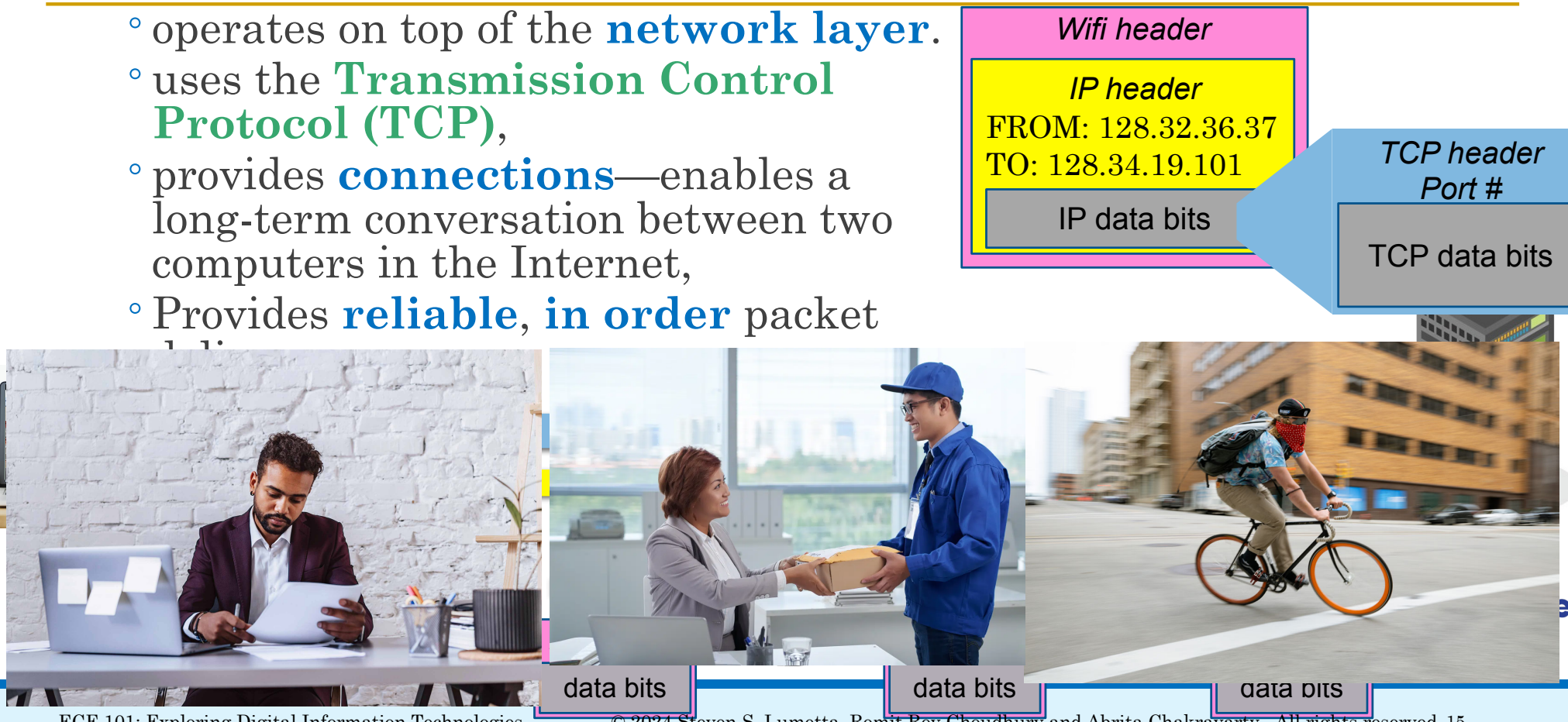
The service is called **best effort**:

- **if the network can deliver** your packet, **it will**.
- **Otherwise**, if errors or congestion or failed systems affect your packet, **it won't** (deliver your packet).

But we would like reliable delivery!

The Transport layer

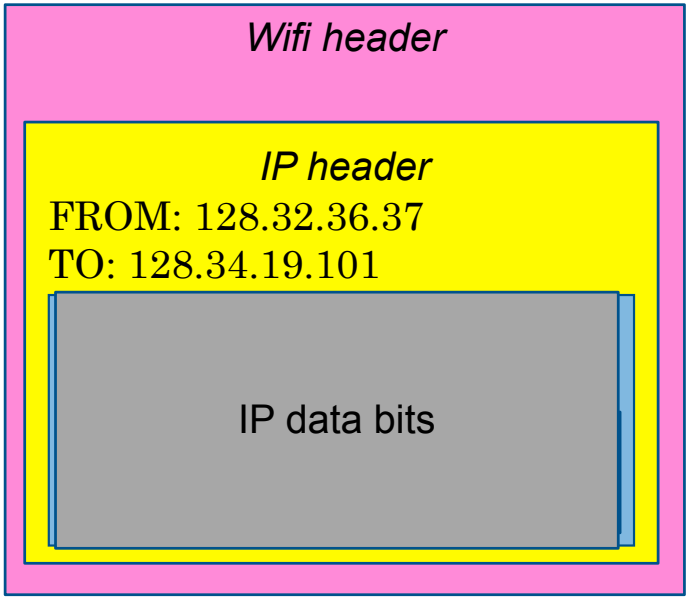
- operates on top of the **network layer**.
- uses the **Transmission Control Protocol (TCP)**,
- provides **connections**—enables a long-term conversation between two computers in the Internet,
- Provides **reliable**, **in order** packet



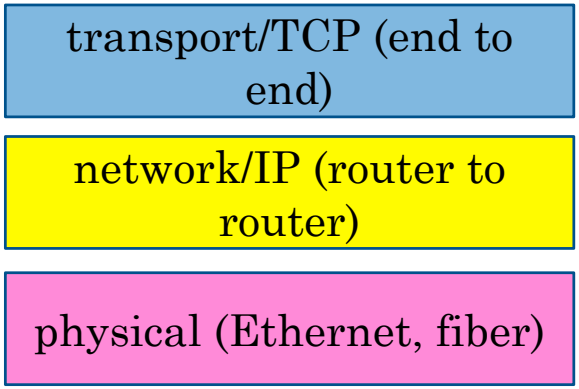
Encapsulation in the layered protocol stack

Notice that
- The TCP packet is just
- **Data bits** for the IP packet

There's your encapsulation again!

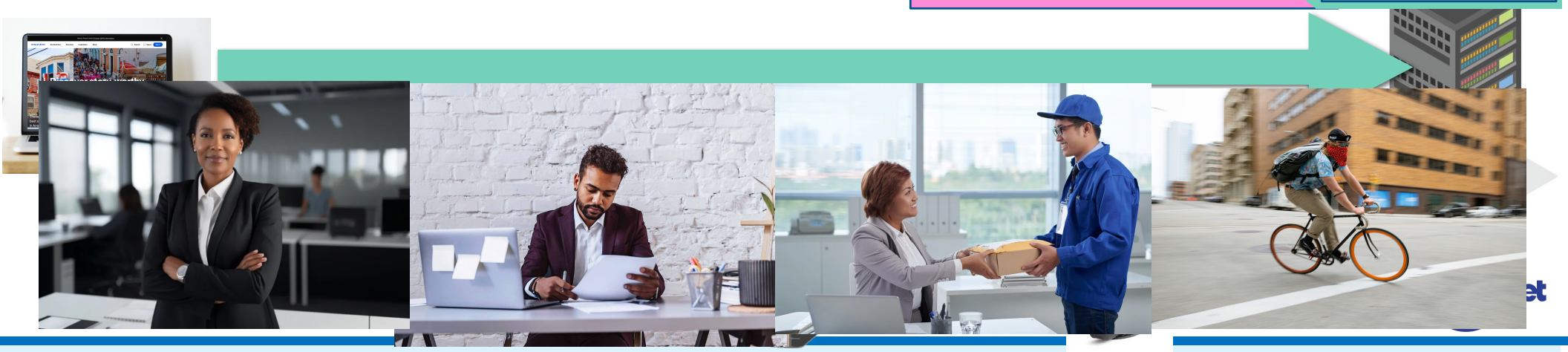


This is how the stack of protocol layers is looking …



The Application layer

- runs applications like web browser using **HTTP or DNS**
- allows you to browse the web or watch a movie or check your email.

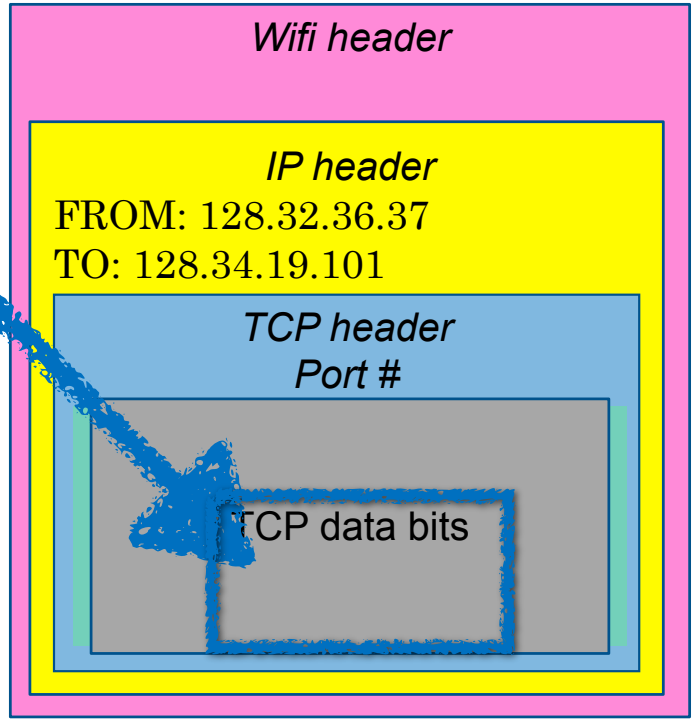


Your Data Encapsulated by HTTP, Then TCP, Then…

Notice that
- your desired **web page name**
- **and** the **web page** itself
- are **just data bits to HTTP**!

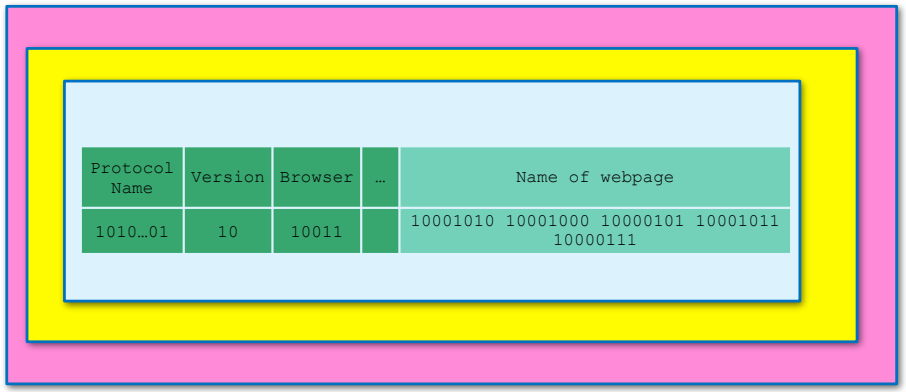
In turn
- the HTTP packet is just
- **data bits** for the TCP packet

There's your encapsulation again!



Abstraction Layers Hide the Complexity of the Internet

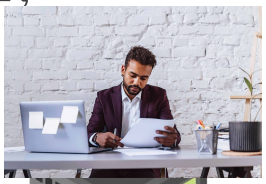
HTTP, DNS, others…	application layer
TCP (end to end)	transport layer
IP (router to router)	network layer
physical (Ethernet, fiber)	physical layer

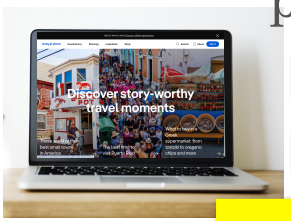


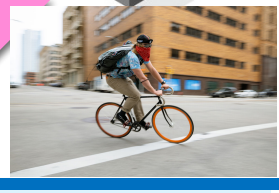
It works …

Even though getting data from one computer to another requires

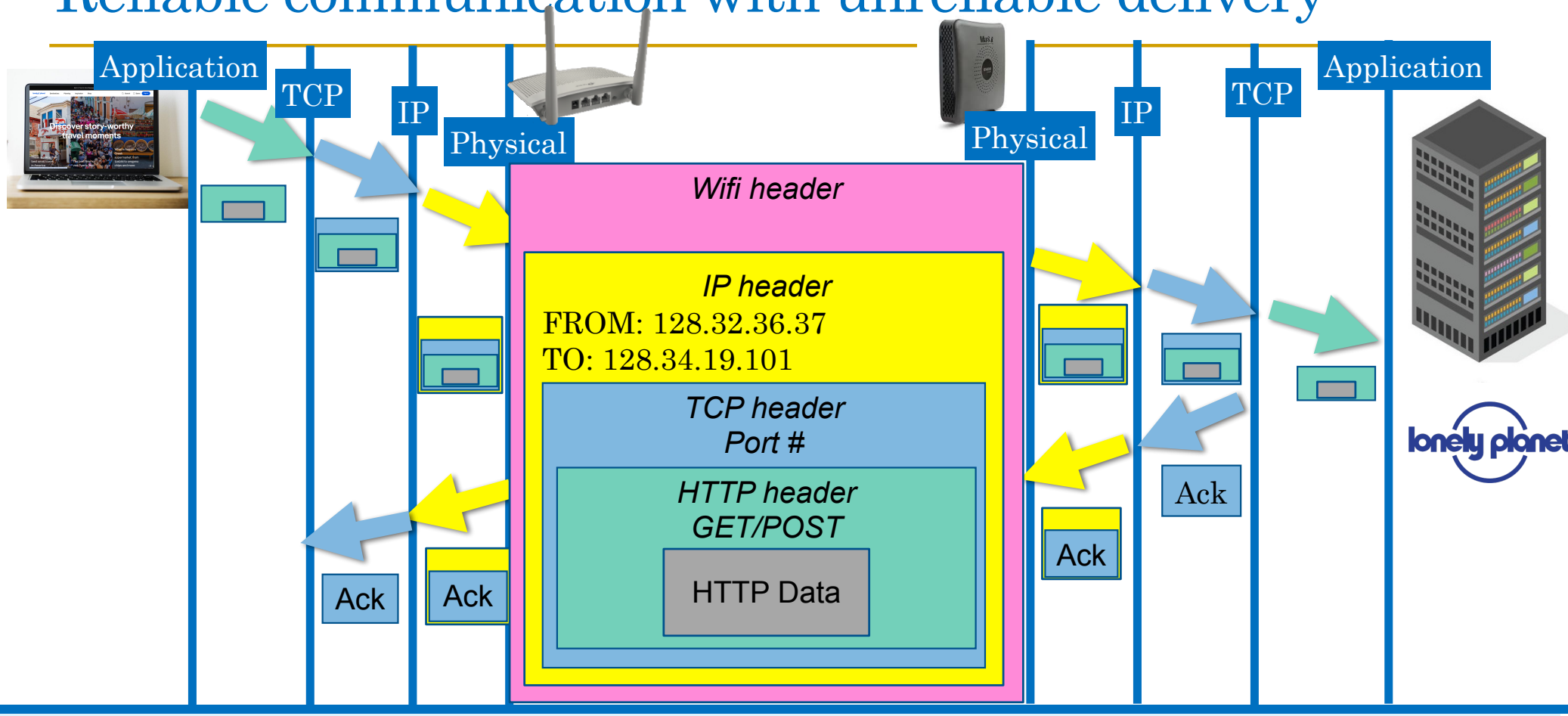
- **many physical connections**,
- **many routing decisions** and
- **acknowledging** and **re-ordering packets** arriving out of order,
- your browser **application** sitting on top of the protocol stack,
- uses the virtual connection as a reliable stream of bytes,
- pretty much **unaware of what is happening below**.



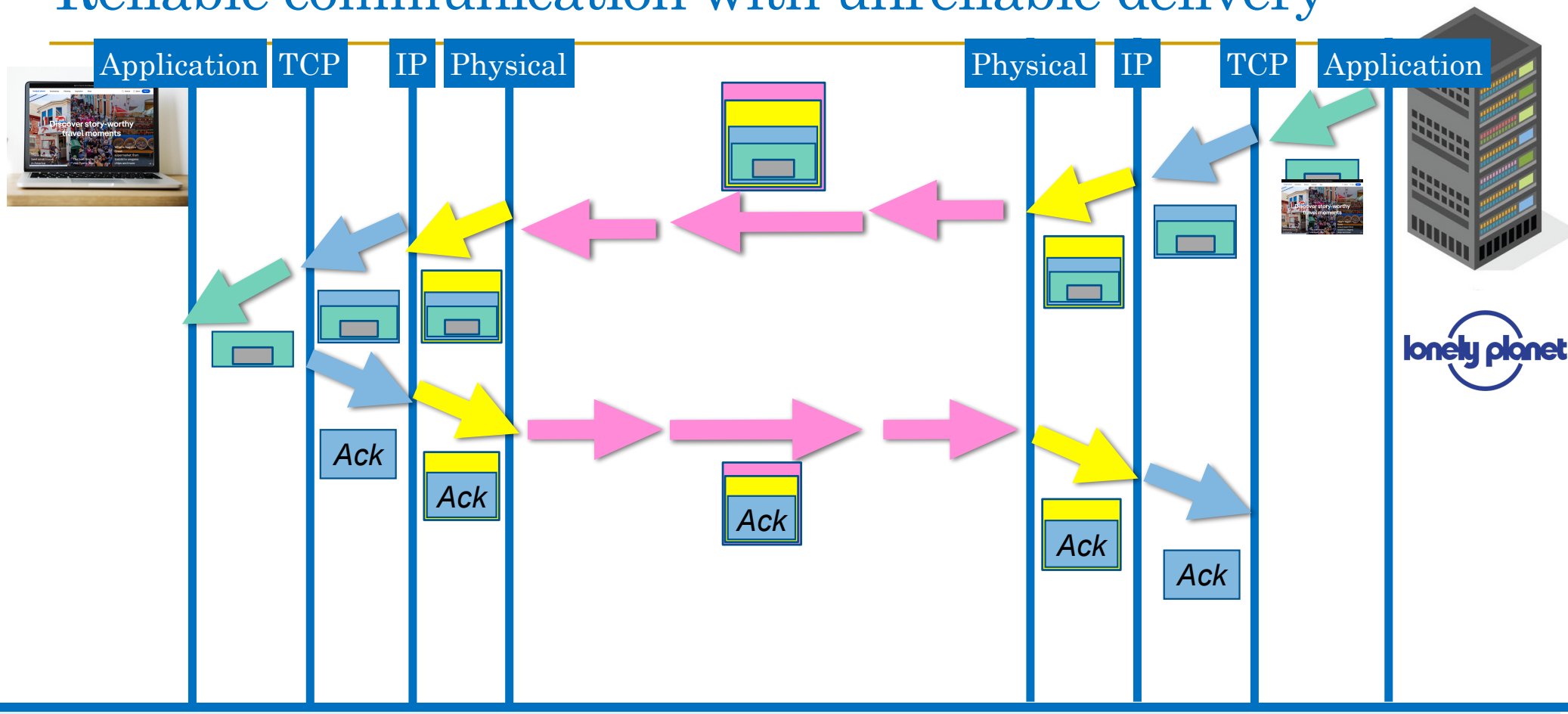




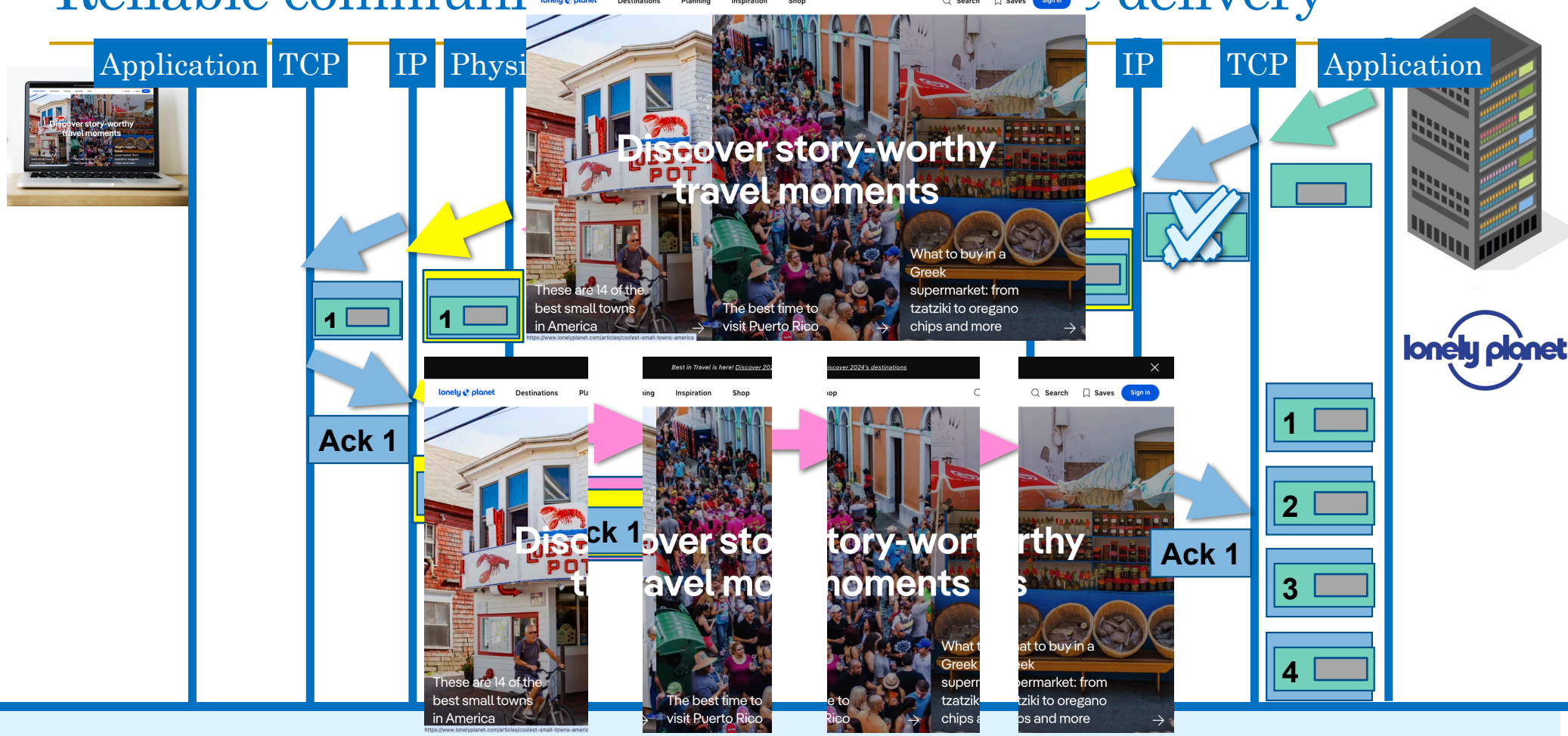
Reliable communication with unreliable delivery



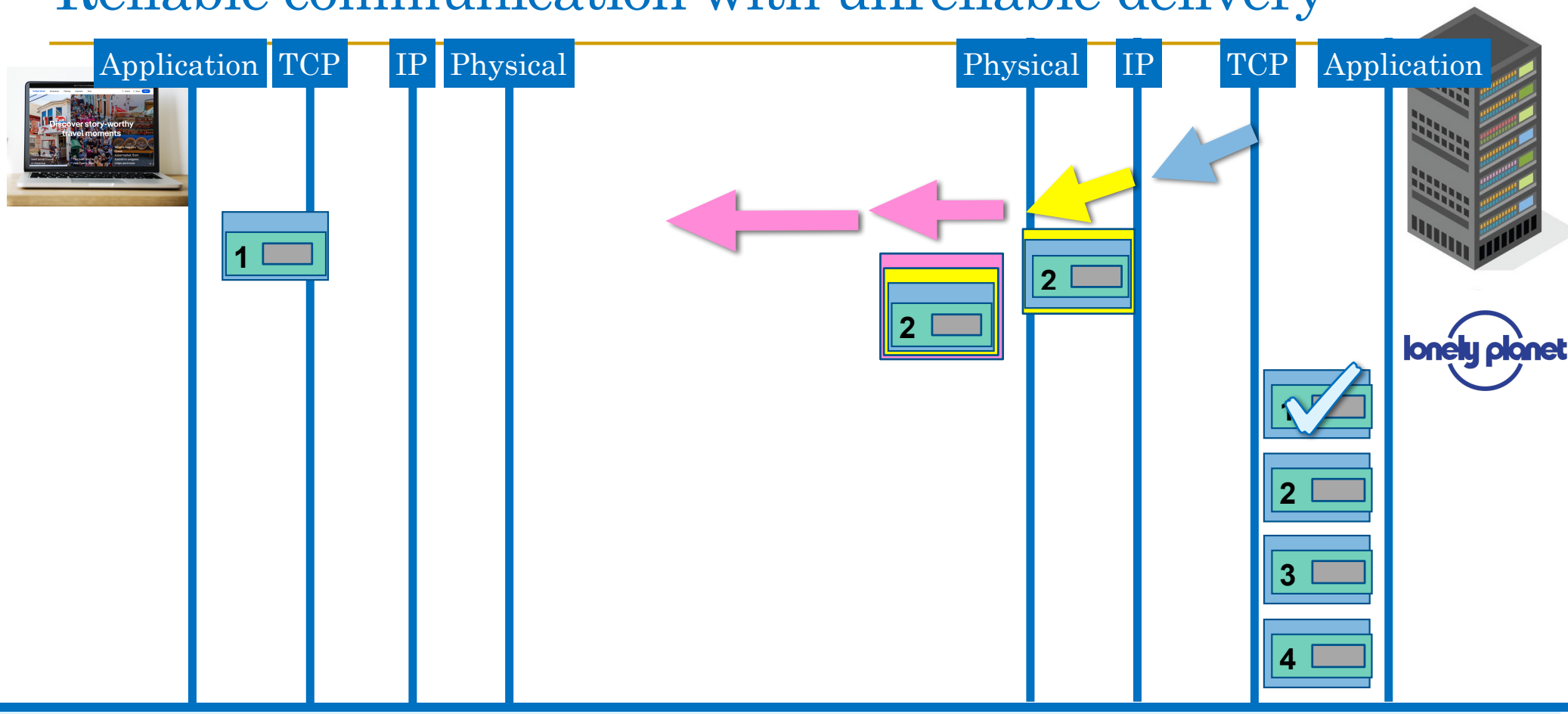
Reliable communication with unreliable delivery



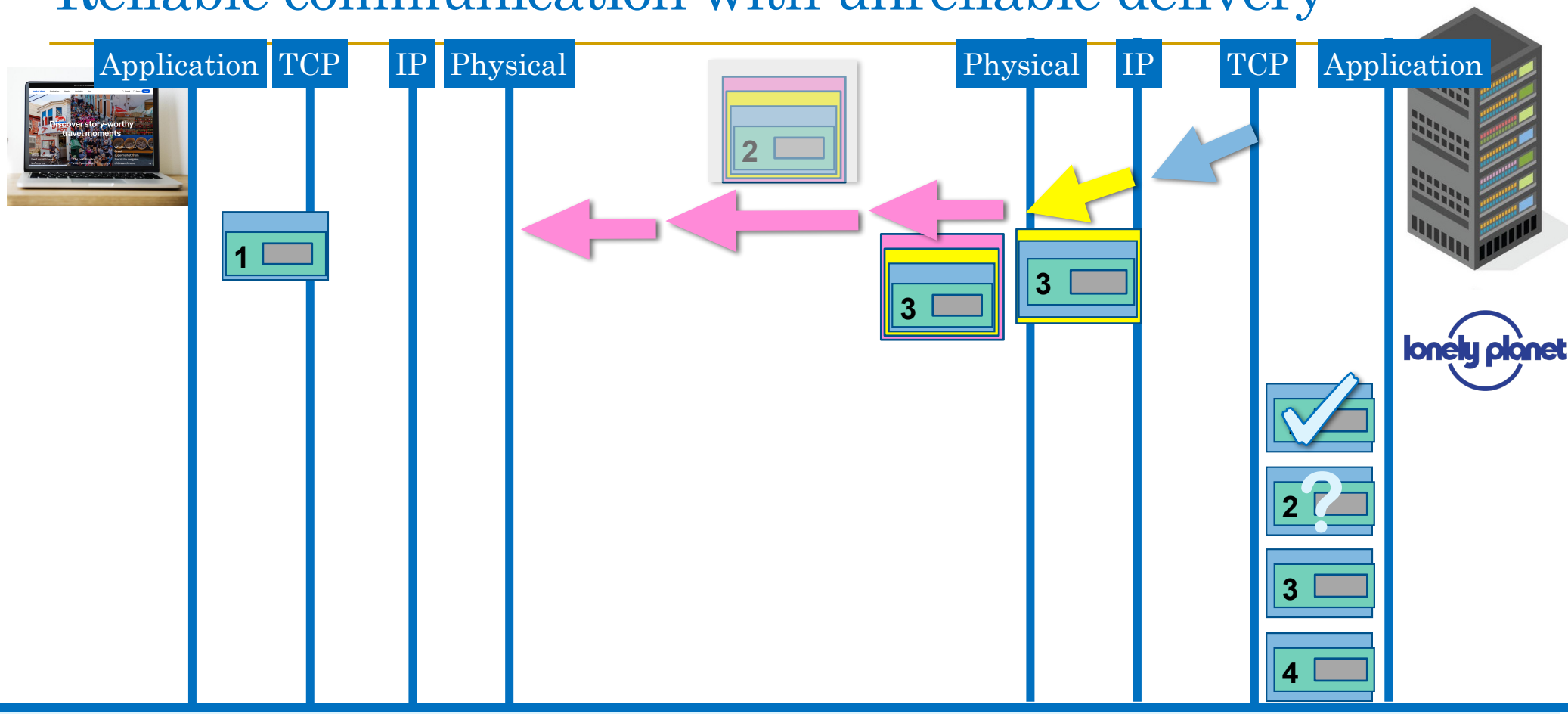
Reliable communi… delivery



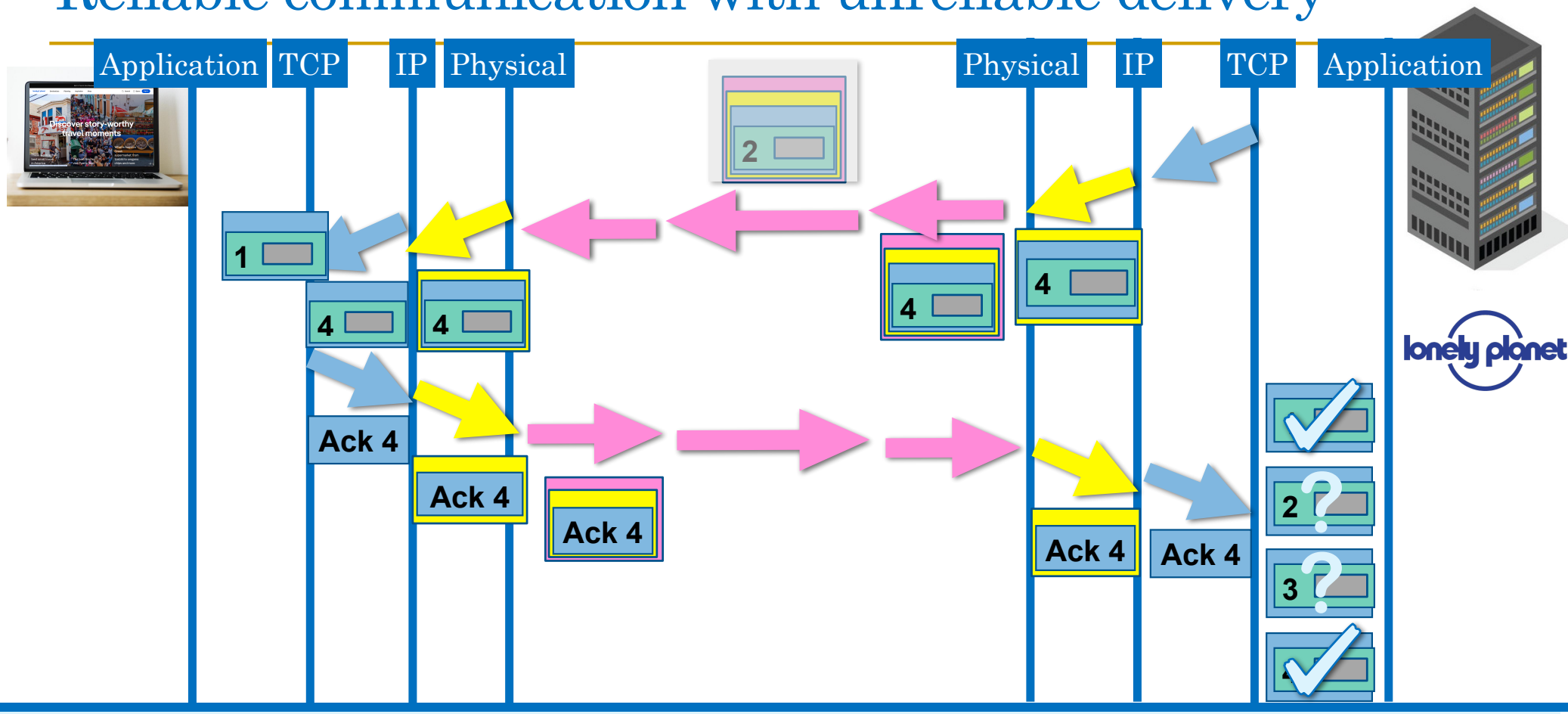
Reliable communication with unreliable delivery



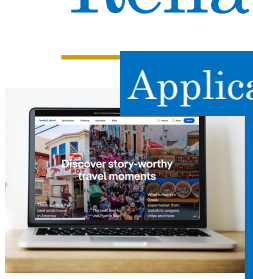
Reliable communication with unreliable delivery



Reliable communication with unreliable delivery



Reliable communication with unreliable delivery

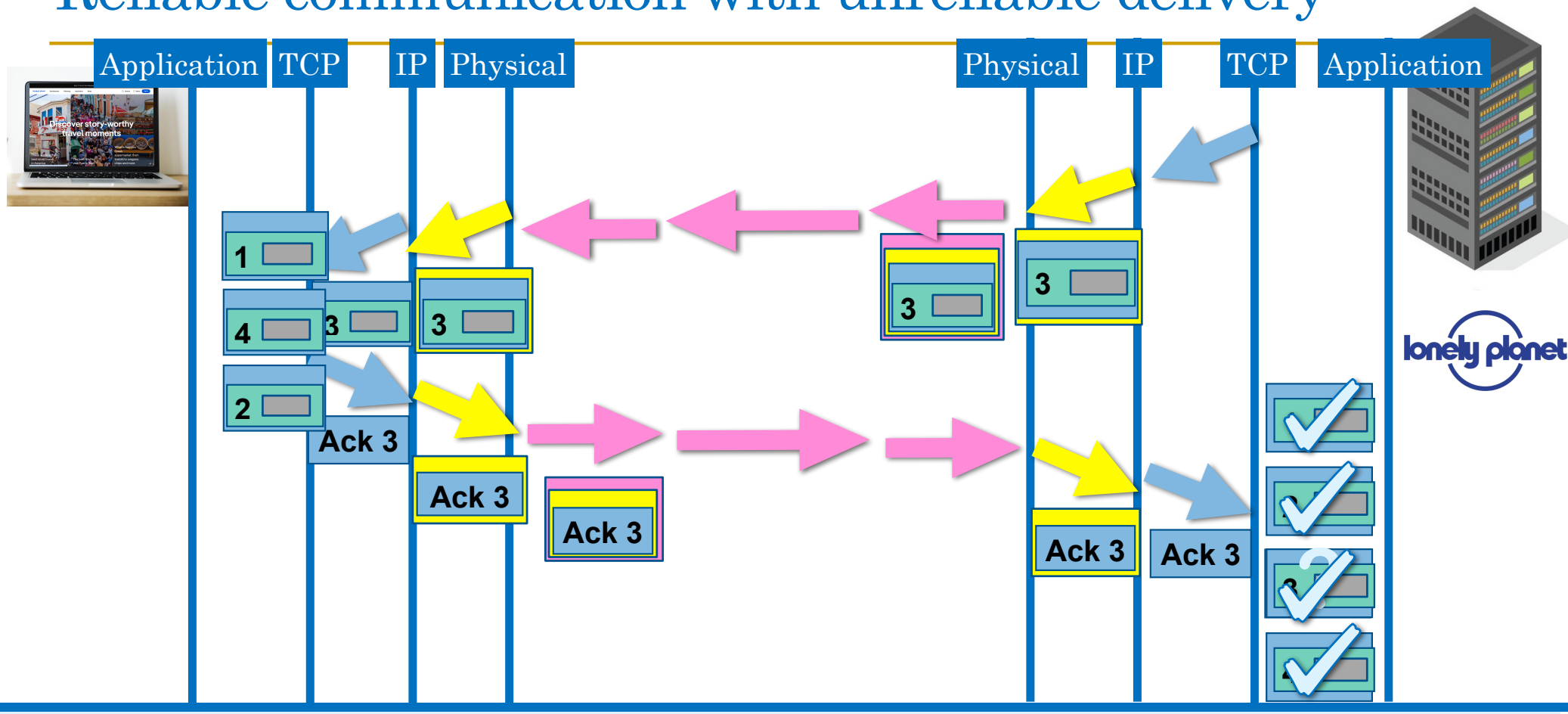


Application TCP IP Physical Physical IP TCP Application

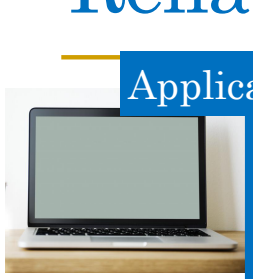
lonely planet

1 4 2 2 2 Ack 2 Ack 2 Ack 2 Ack 2 Ack 2 3

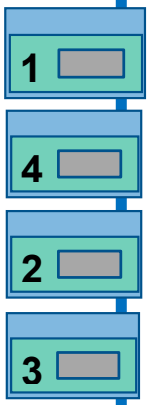
Reliable communication with unreliable delivery

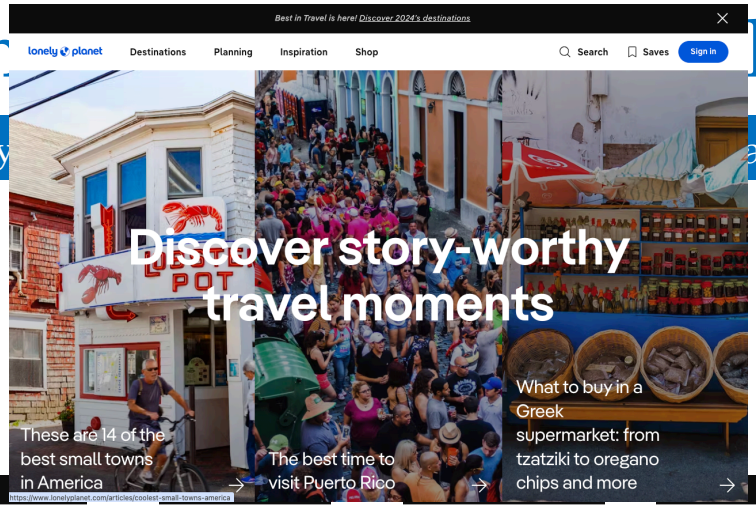


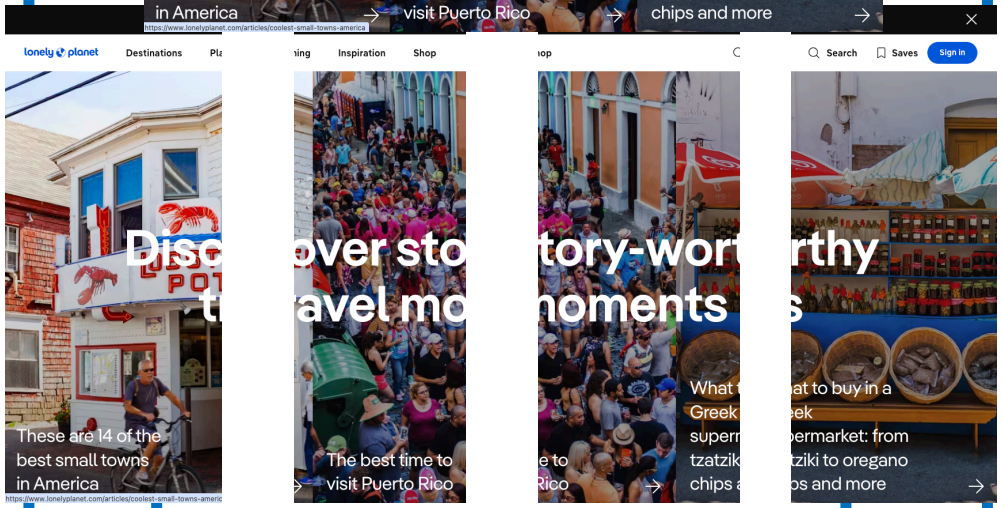
Reliable commun…le delivery



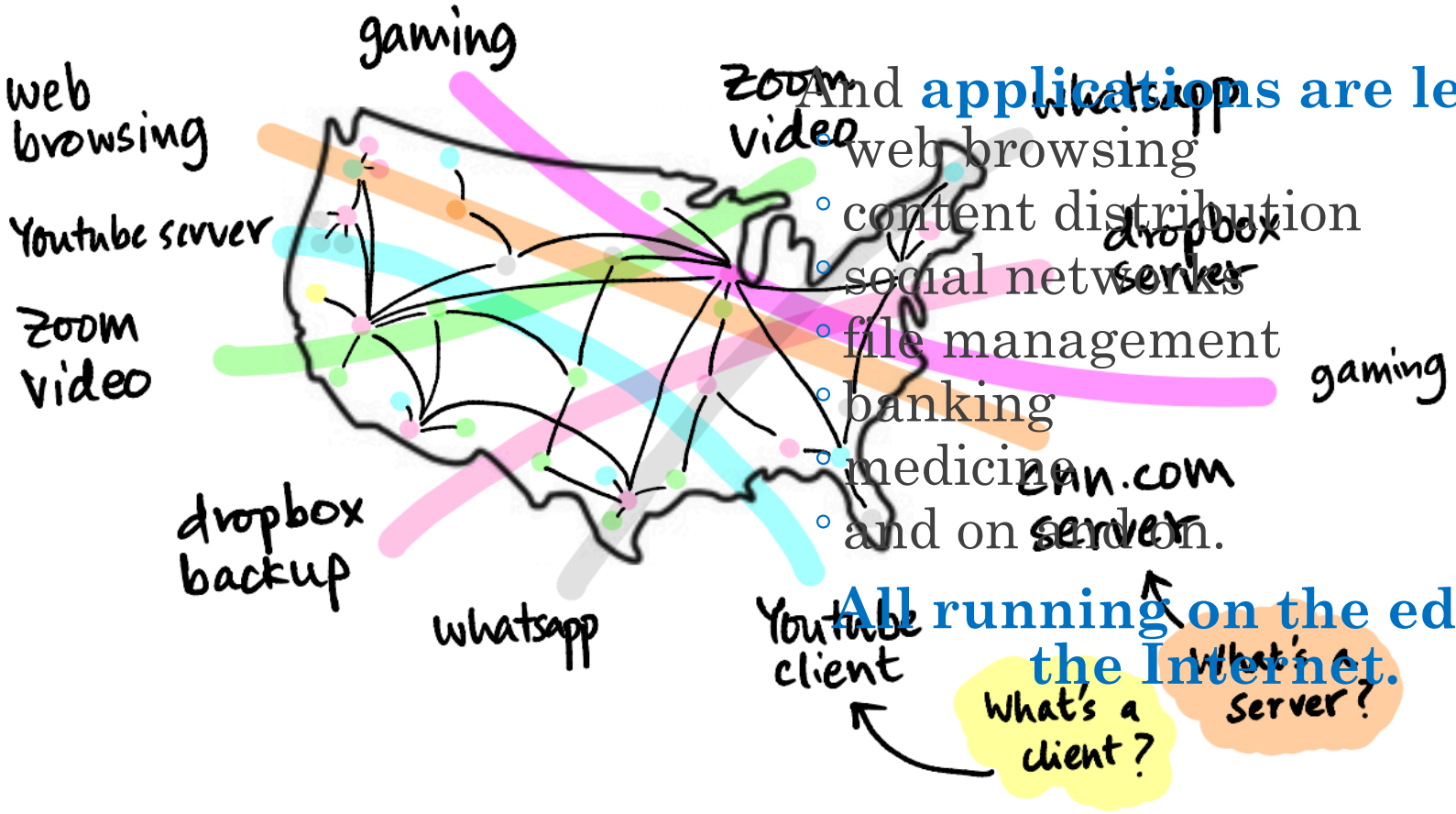
Application TCP IP Phy… …al IP TCP Application







Applications running on the "edge"



And **applications are legion!**

- web browsing
- content distribution
- social networks
- file management
- banking
- medicine
- and on and on.

All running on the edge of the Internet.

Terminology You Should Know from These Slides

- packet of bits
- packet header
- Internet Protocol (IP)
- encapsulation
- protocol stack
- HyperText Transfer Protocol (HTTP)
- Layered architecture
- Transmission Control Protocol (TCP)
- best effort delivery
- connection
- reliable delivery

Concepts You Should Know from These Slides

- uses of packet header: checking for errors, IP addresses, port numbers, protocol commands (example: HTTP GET)
- network protocol layers and their roles in the Internet
- TCP (end-to-end reliable delivery)