

Internet

The Internet

www.quartomese.com

History & High-Level Tech View

Thomas Aprille, Phd

Internet

Internet

Internet

Internet



You

The Internet ?

The Network ?

The Internet Of Things ?

The Cloud ?



You

The Internet ?

The Network ?

The Internet Of Things ?

The Cloud ?



you

The Internet ?

The Network ?

The Internet Of Things ?

The Cloud ?



The Internet ?

The Network ?

The Internet Of Things ?

The Cloud ?



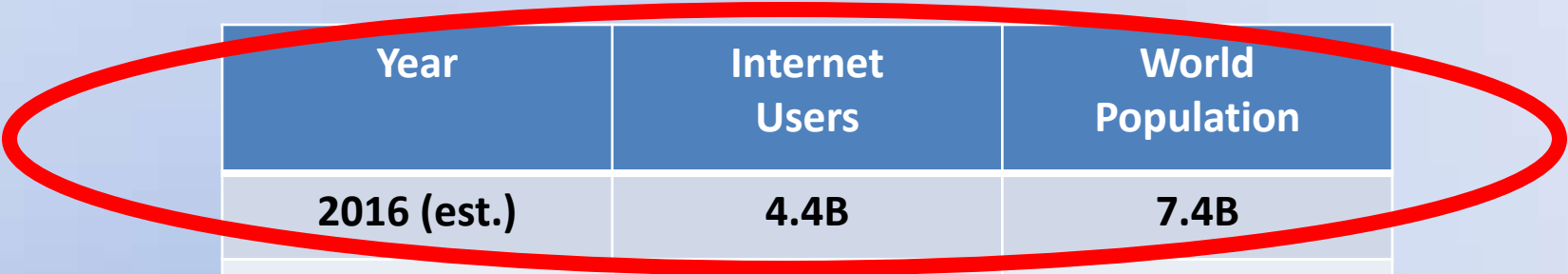
You

Internet Facts

Internet: Network of Networks

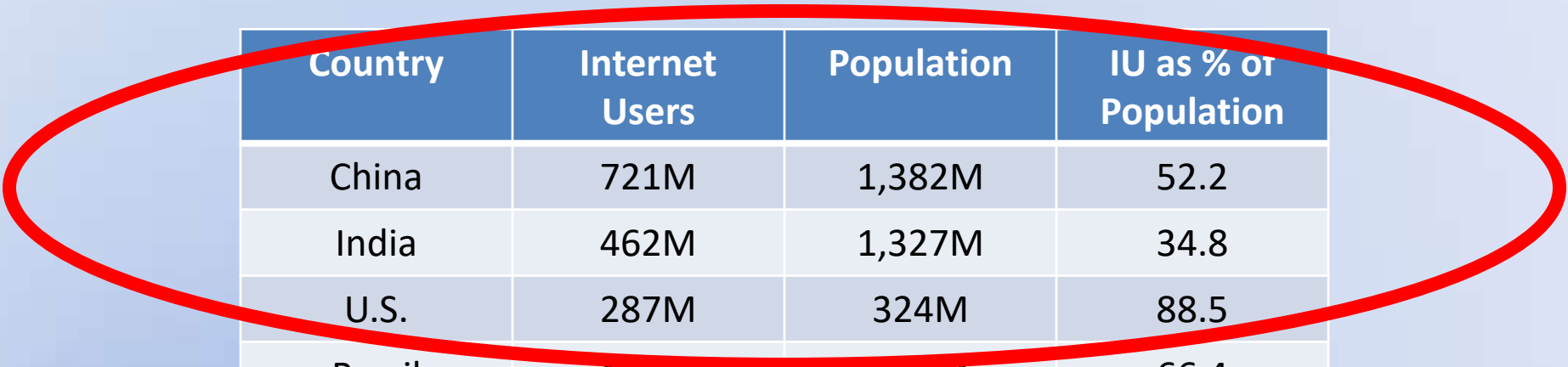
- The Internet links independent networks that are responsible for maintaining themselves
- Each Internet network is an Autonomous System responsible for maintaining its assigned IP addresses
- The Internet consists of hosts and routers that direct packets over transmission/transport facilities
- The infrastructure of the Internet is privately owned
- Internet traffic is exchanged based on commercial agreements among the autonomous networks - with or without compensation

Internet Users



Year	Internet Users	World Population
2016 (est.)	4.4B	7.4B
2013	2.7B	7.2B
2010	2.0B	6.9B
2007	1.4B	6.7B
2004	0.9B	6.4B
2001	0.5B	6.2B

Internet Users by Country (2016)



Country	Internet Users	Population	IU as % of Population
China	721M	1,382M	52.2
India	462M	1,327M	34.8
U.S.	287M	324M	88.5
Brazil	139M	210M	66.4
Japan	115M	126M	91.1
Russia	102M	143M	71.3
Nigeria	86M	187M	46.1
Germany	71M	81M	88.0
U.K.	60M	65M	92.6

Internet History

History - 1

- 1844: Samuel Morse's telegraph
- 1876: Alexander Graham Bell's telephone
- 1958: Bell Telephone Labs' acoustic modem
- 1969: Ted Nelson's hypertext
- 1969: ARPANET computer network is launched
 - DoD contract funds UCLA, UC-SB, Stanford, Uni. Of Utah
 - The first packet-switched computer network was the UK's NPL network, followed closely by the ARPANET
- 1973: Both the NPL and ARPANET networks were interconnected

ARPANET = Advanced Research Projects Agency Network

<http://www.explainthatstuff.com/internet.html>

https://en.wikipedia.org/wiki/Internet_backbone

"Internet Peering and Transit," Anna-Maria Kovacs, April 4, 2012, Available via Google search

History - 2

- 1971: Ray Tomlinson's first email on ARPANET (@ symbol)
- 1973: Robert Metcalfe invents Ethernet
- 1974: Vinton Cerf/Bob Kahn write on Internet & TCP/IP
- 1983: TCP/IP universally used for Internet communications
- 1982-84: Domain Naming System (DNS) developed
 - .com, .gov, .edu, .org
 - IETF formed (Internet Engineering Task Force)
- 1986: National Science Foundation (NSF) creates NSFNET
 - Six sites using 56Kbps (DS-0) links and peering with ARPANET
 - 1987: 13 sites upgraded to 1.536 Mbps (DS-1) links

TCP/IP = Transmission Control Protocol / Internet Protocol

<http://www.explainthatstuff.com/internet.html>

https://en.wikipedia.org/wiki/Internet_backbone

"Internet Peering and Transit," Anna-Maria Kovacs, April 4, 2012, Available via Google search

History - 3

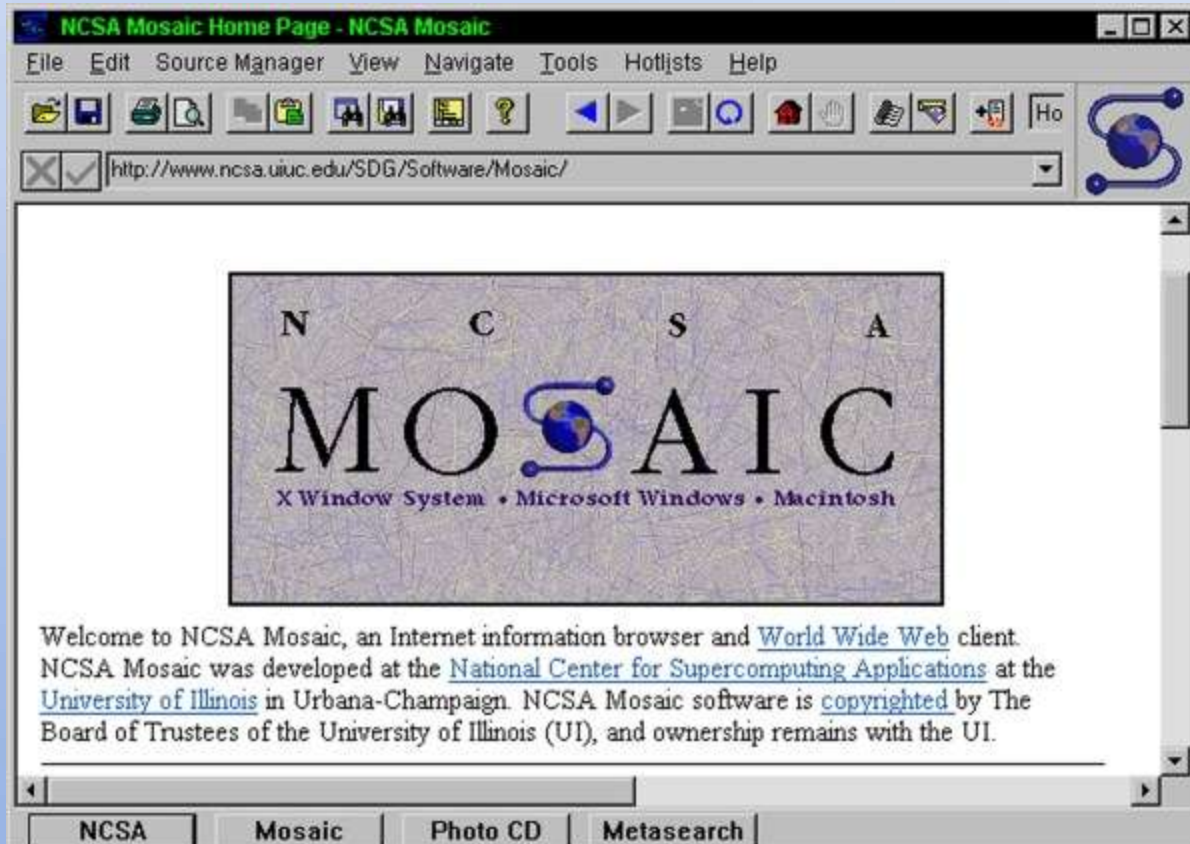
- 1980's Late: The network now called the Internet
- 1989: Tim Berners-Lee defines WWW at CERN
- 1990's: World Wide Web (WWW)
 - Netscape browser appears
 - ARPANET is decommissioned
- 1993: Marc Andreessen (Uni. Of Illinois – Urbana) writes first user-friendly browser Mosaic
- 1995: NSF privatizes the Internet
- 1998: Larry Page/Sergey Brin's search engine Google
- 2000: IPv6 utilized in the backbone network
 - But IPv4 still prevails

History - 3

- 1980's Late: The network peering
- 1989: Tim Berners-Lee
- 1990's: World Wide Web
 - Netscape
 - Apple
- IPv4: 32 bit (4 bytes) addressing
 - 4,294,967,296 addresses
- IPv6: 128 bit (16 bytes) addressing
 - 340,282,366,920,938,463,374,607,431,768,211,456 addresses
- ... (Illinois – Urbana)
- ... browser Mosaic
- ... the Internet
- ... /Sergey Brin's search engine Google
- ... utilized in the backbone network
- ... but IPv4 still prevails

Applications

World Wide Web Application



Application

Get WEB Page

WWW Server



The Internet



You

Application

Get WEB Page

WWW Server



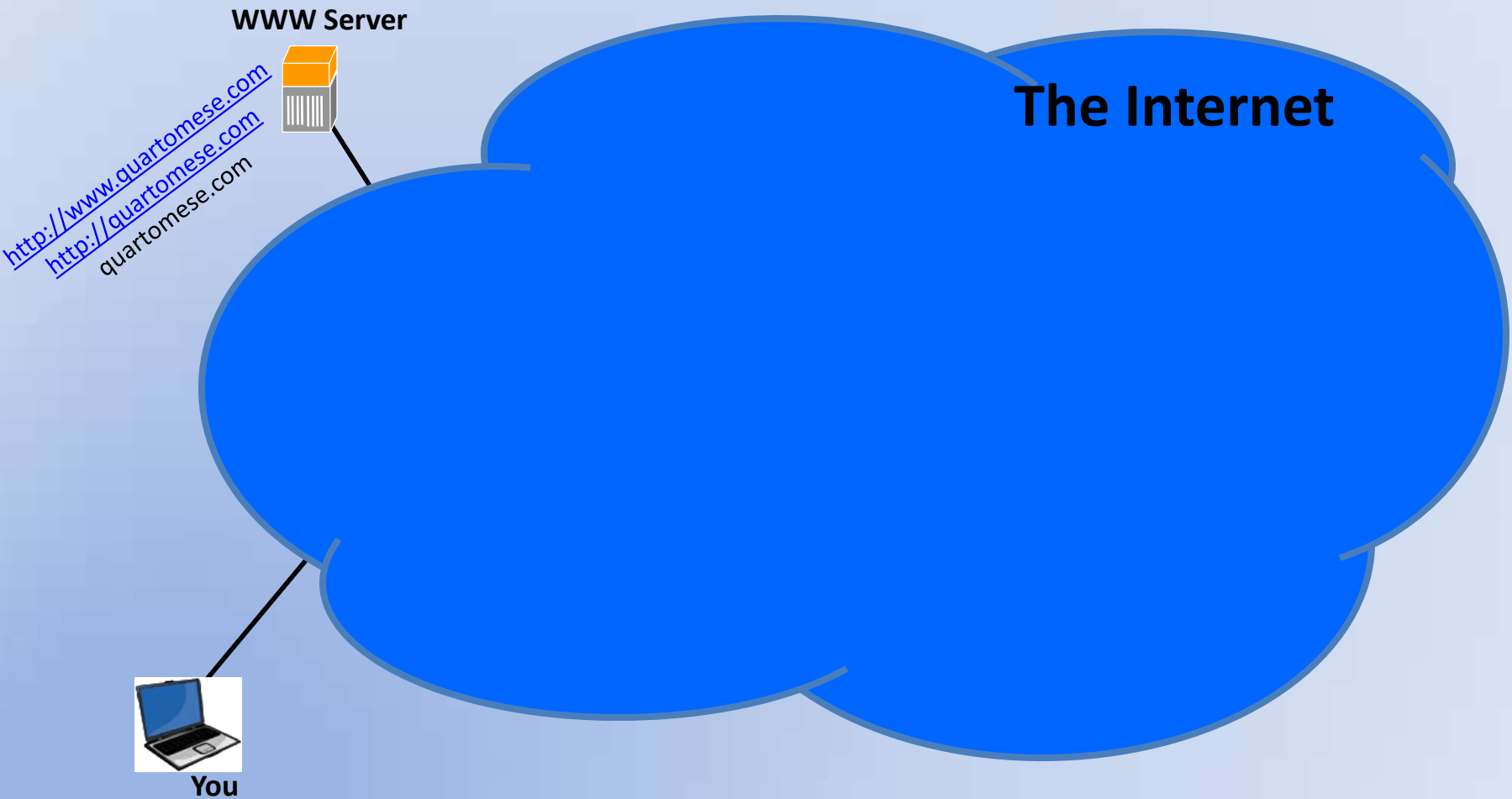
The Internet

WWW Servers attached to or residing in the Internet provide “you “with services – e.g., get web page

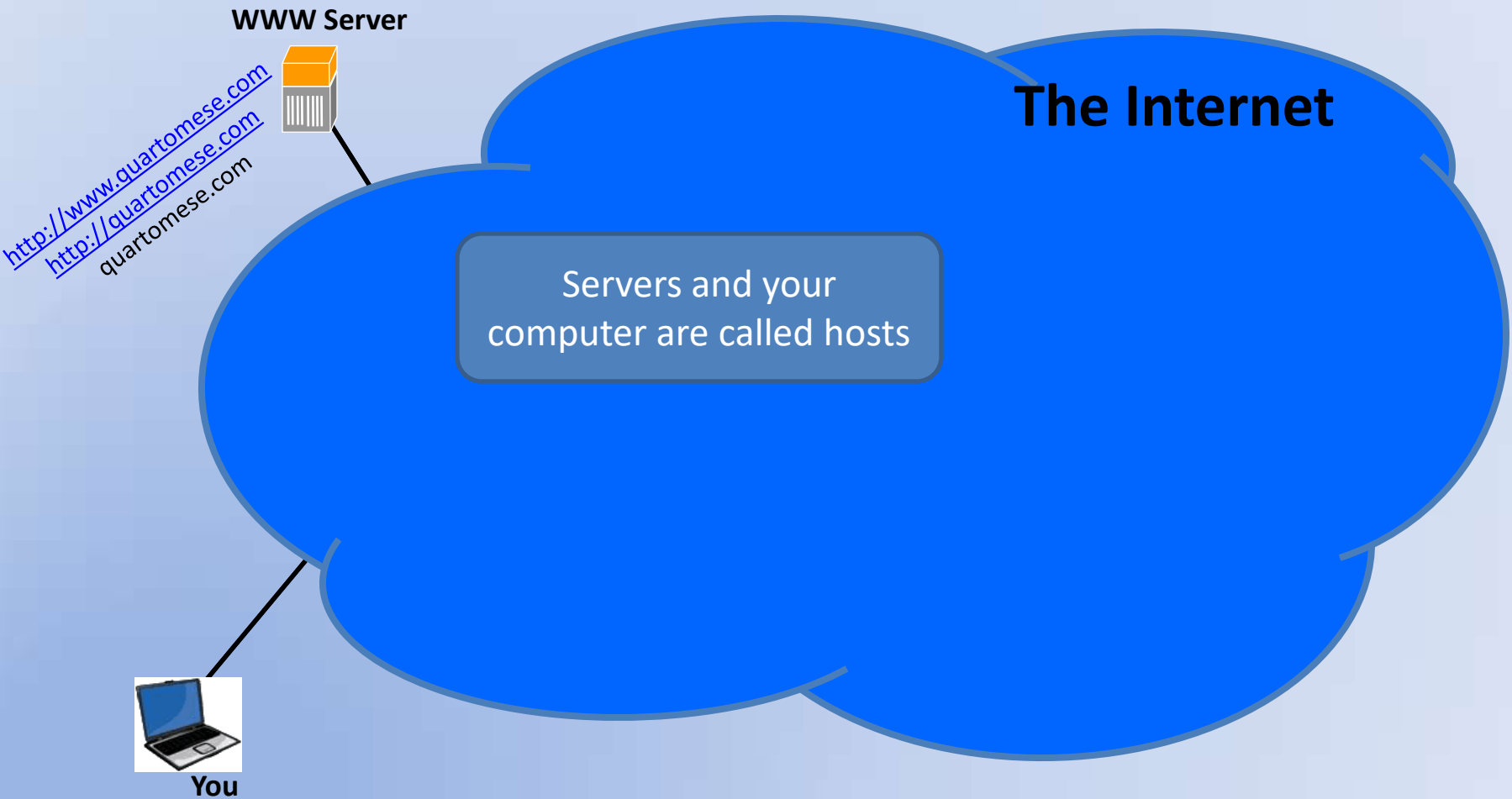


You

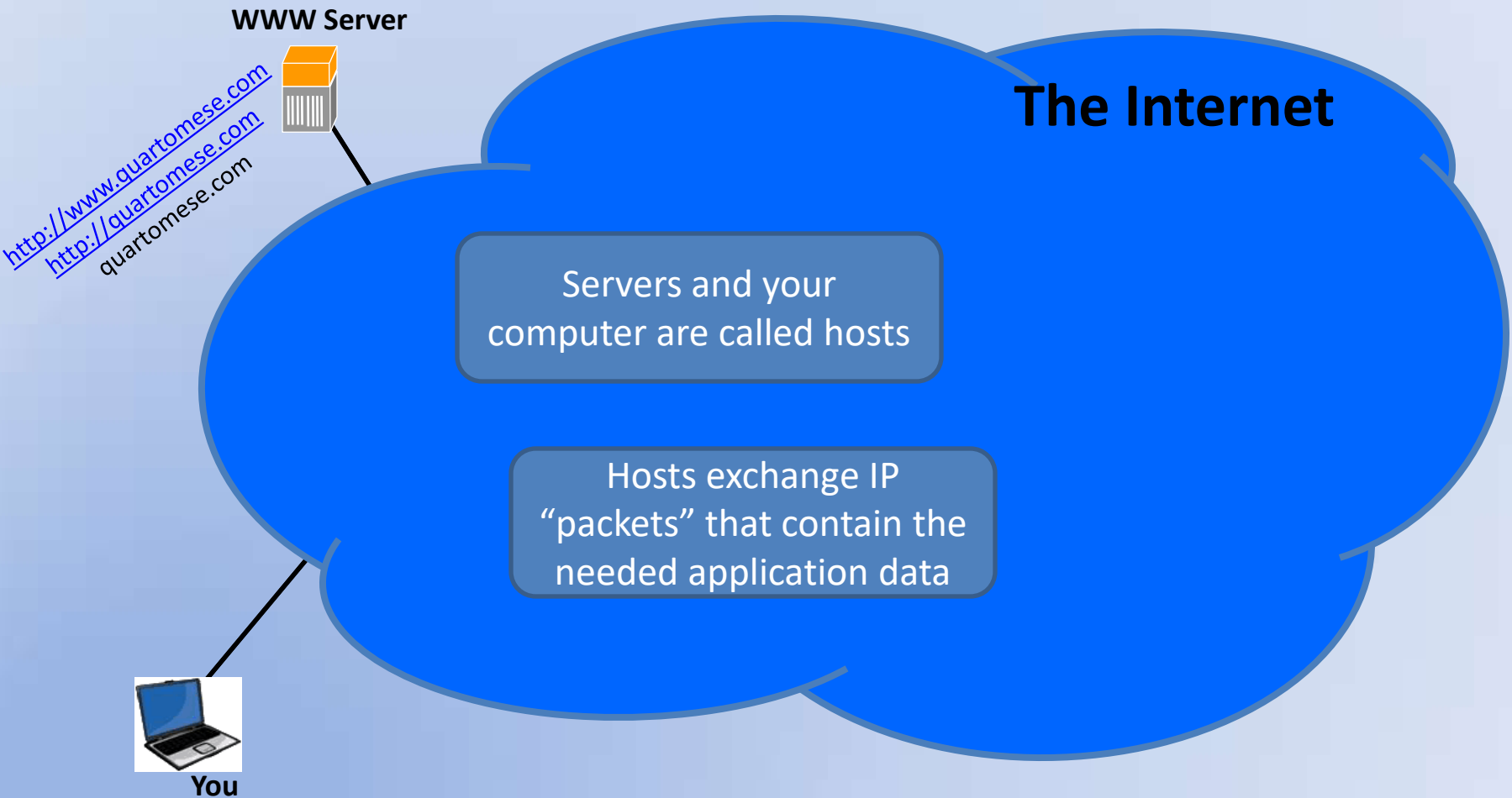
Get WEB Page



Get WEB Page



Get WEB Page



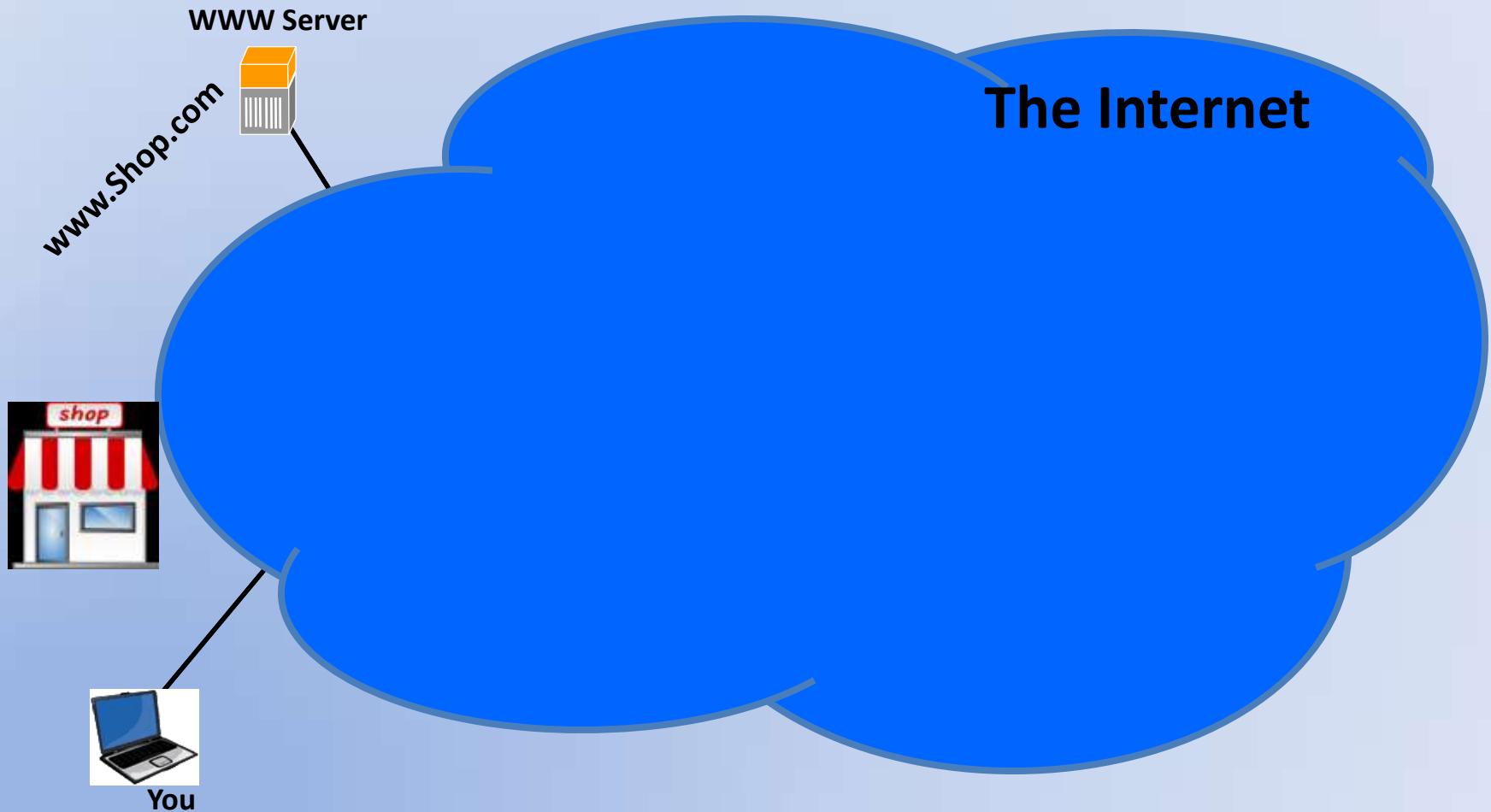
URL - Domain Name - Resource

- URL (Uniform Resource Locator)
 - <http://quartomese.com/Pix/CA/monoLake.php>
 - Protocol identifier: http, https, ftp
 - Domain name: quartomese.com
 - or www.quartomese.com
 - Resource name: /Pix/CA/monoLane.php
 - Another example:
 - /Pix/italy/lazioRomeForum/lazioRomeForum.htm
 - <http://quartomese.com>
 - Resource name defaults:
 - index.html, index.htm, default.html, default.htm



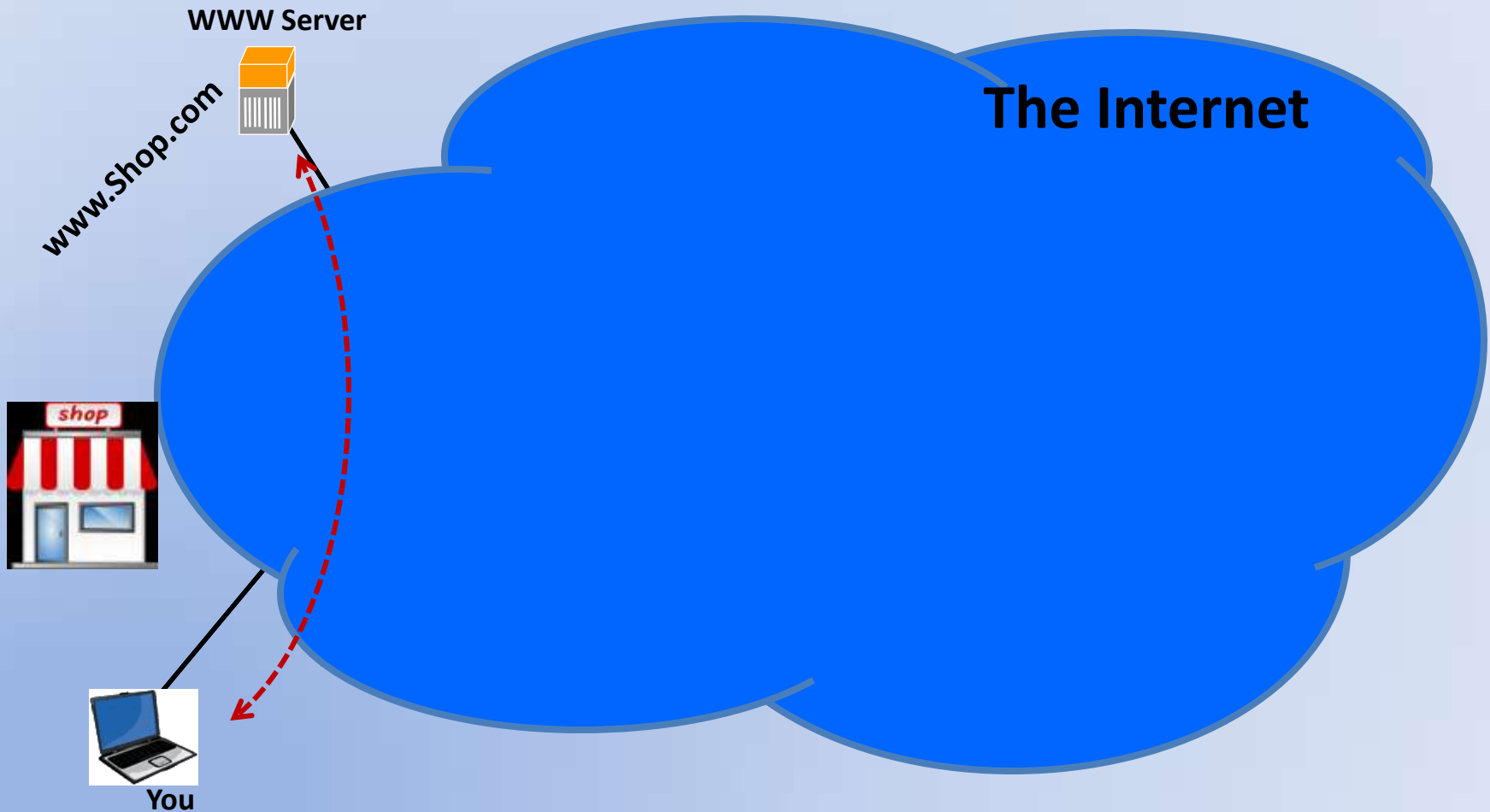
Get WEB Page

You want to visit www.Shop.com



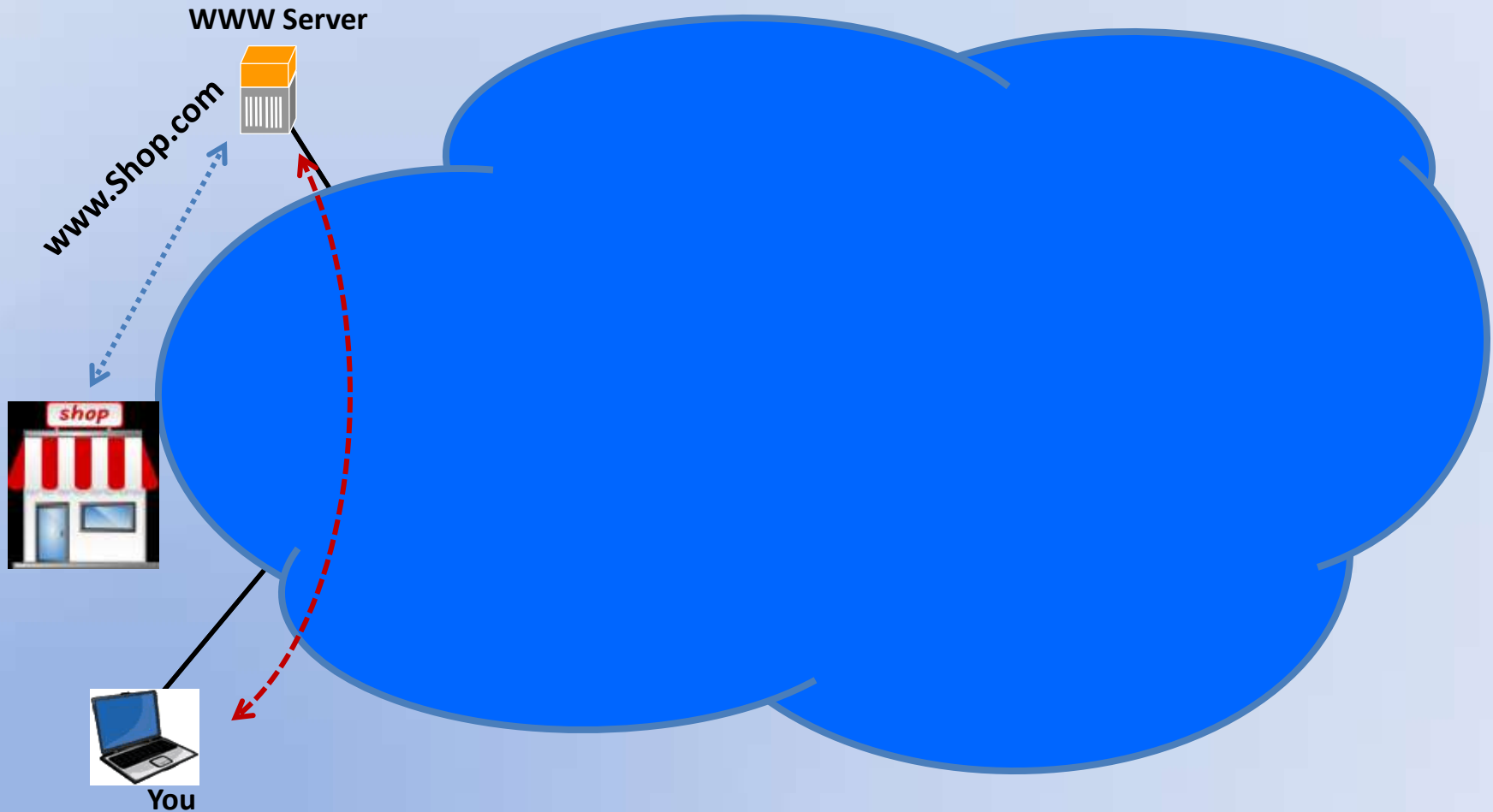
Get WEB Page

Set Browser To www.Shop.com



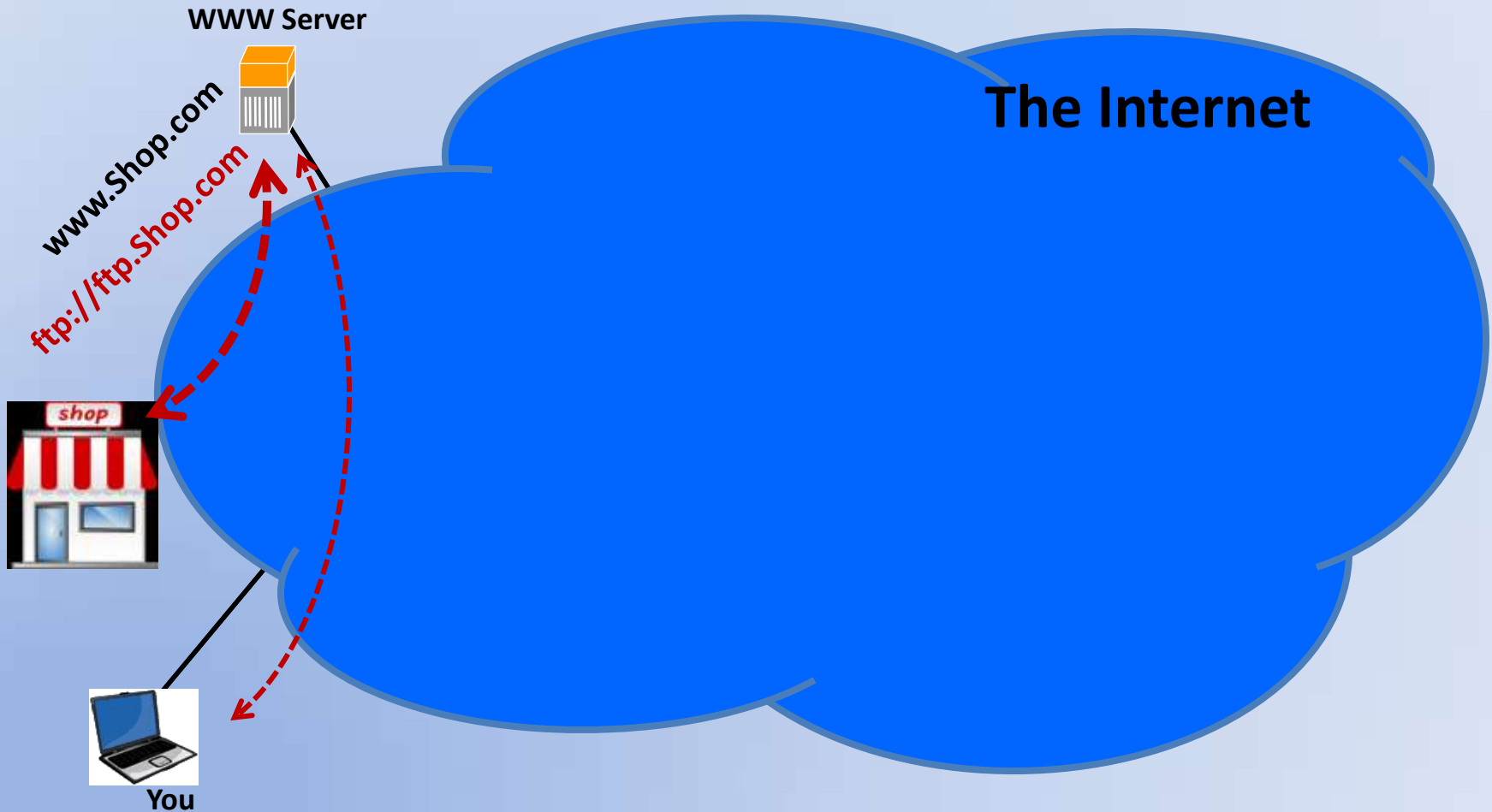
Get WEB Page

Shop Wants To Modify Webpage

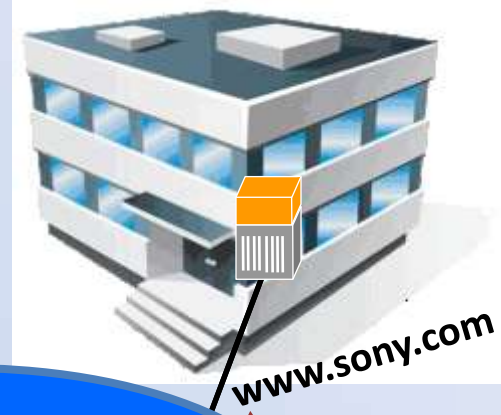


Get WEB Page

Shop Sets Browser To ftp://ftp.Shop.com



Get WEB Page



www.sony.com

WWW Server

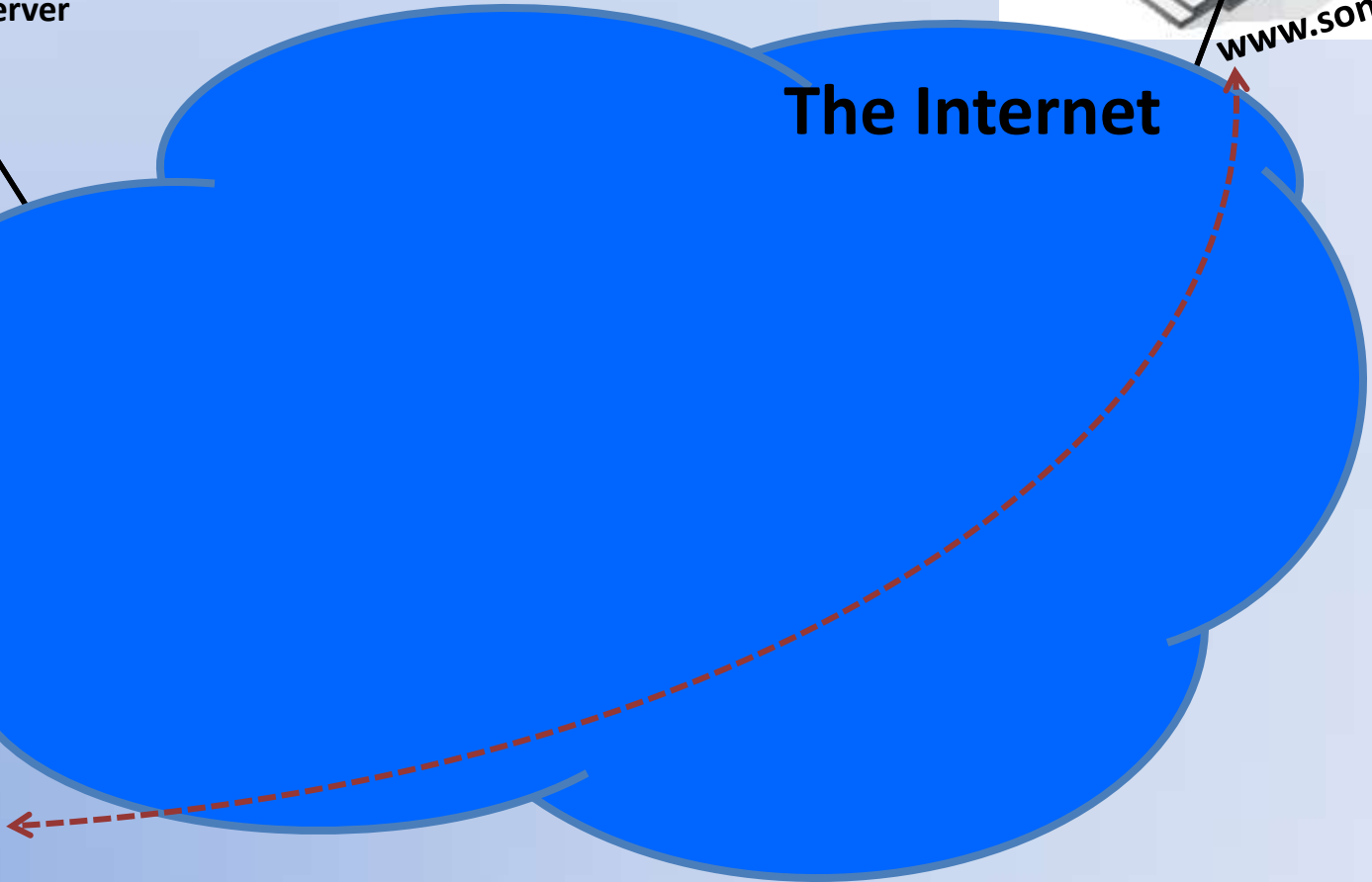


www.Shop.com

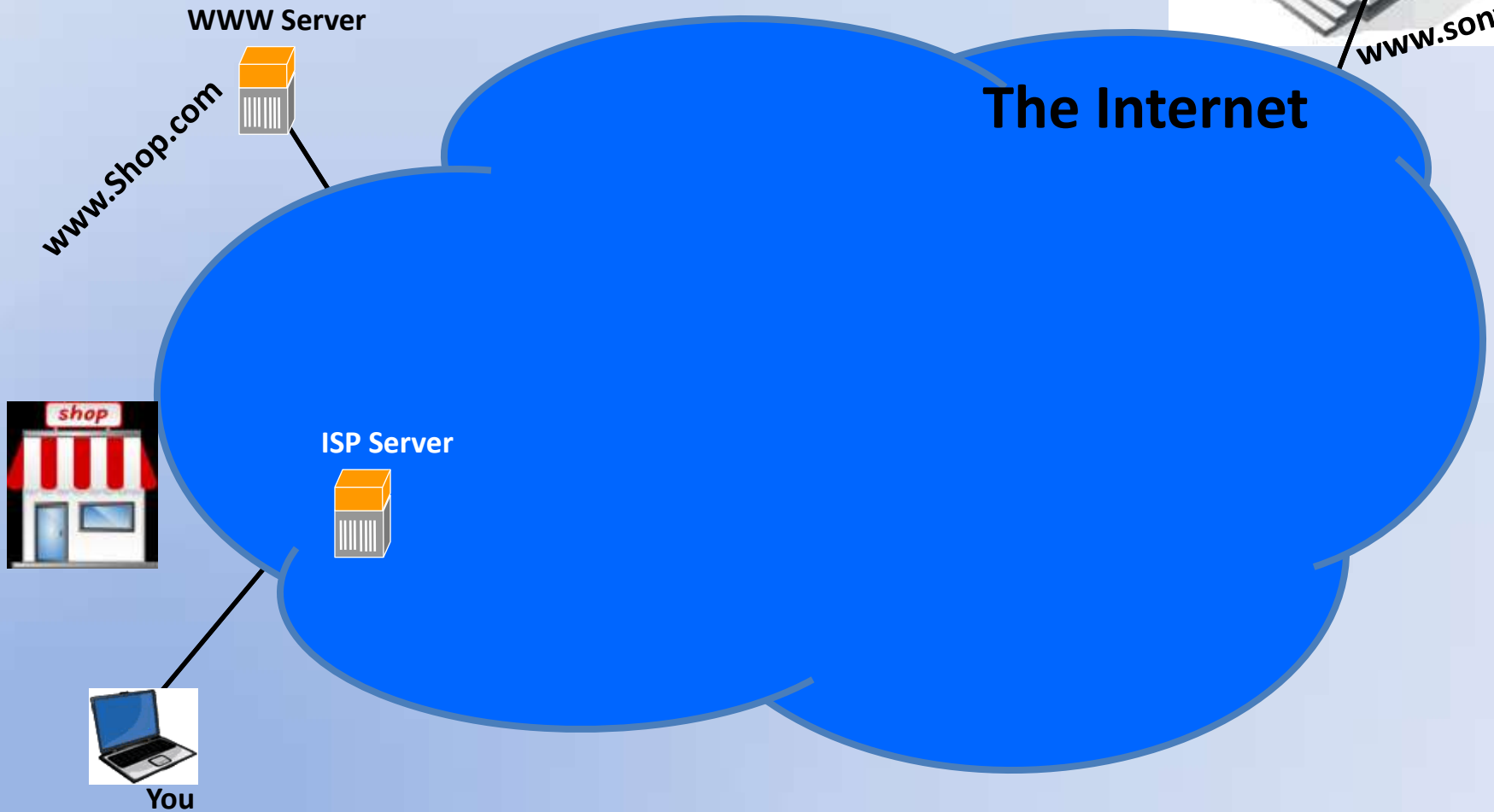
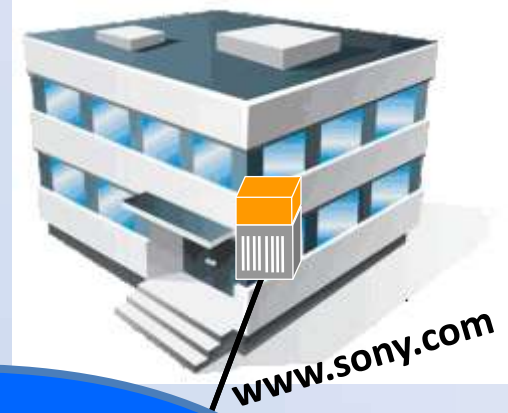


You

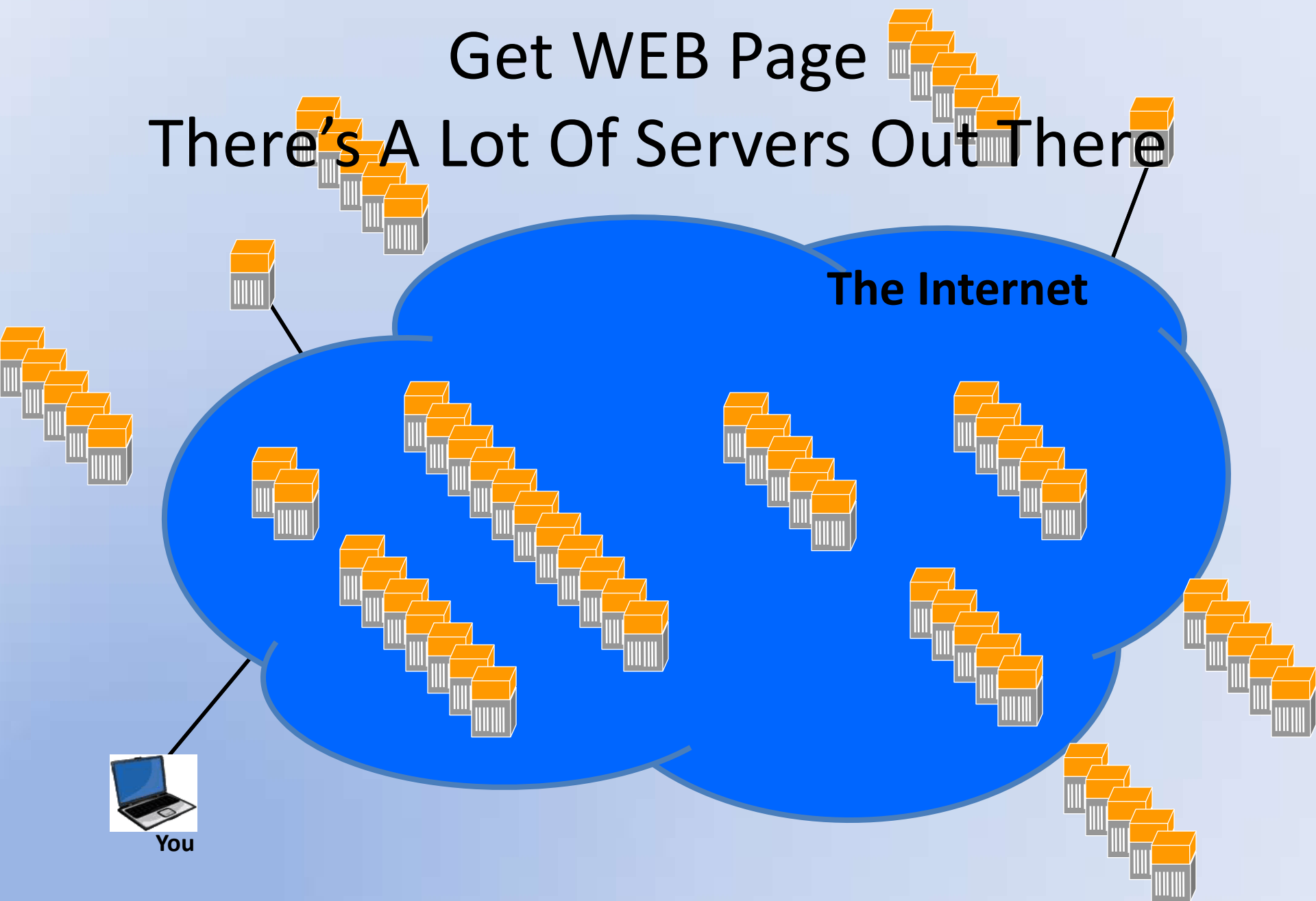
The Internet



Get WEB Page



Get WEB Page There's A Lot Of Servers Out There



Internet Hosts

Date	Host Count (Internet Systems Consortium)
January 2016	1,048,766,623
January 2014	1,010,251,829
January 2012	888,239,420
January 2005	317,646,084
January 2000	72,398,092
January 1995	4,852,000

Number of Hosts advertised in the DNS

Country	Internet Hosts (CIA 2012)
US	505,000,000
Japan	64,453,000
Brazil	26,577,000
Italy	25,662,000
China	20,602,000
Germany	20,043,000
Lots more	

An Internet host is a computer connected directly to the Internet with a unique IP address

Get WEB Page Traffic Engineering



WWW Server



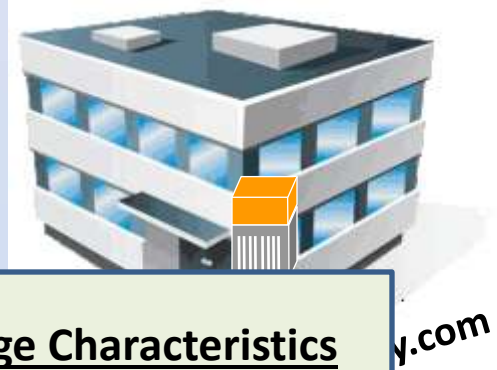
WEB Page Characteristics

y.com



You

Get WEB Page Traffic Engineering



WWW Server



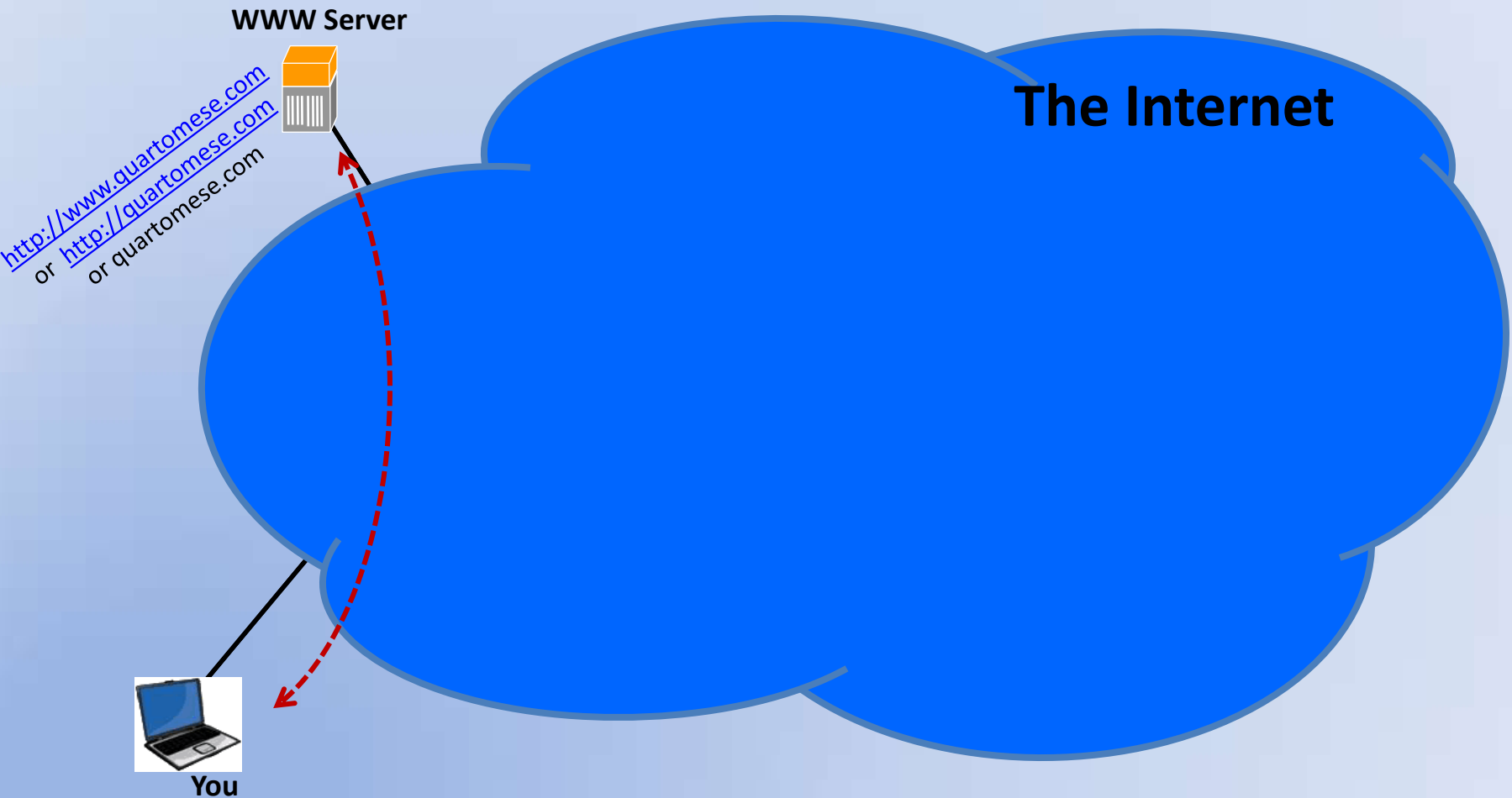
You

WEB Page Characteristics

- Low bandwidth (Early Days)
- Now low-medium bandwidth
- Delay is usually OK

Get WEB Page

HTTP Message Exchanges



Get WEB Page

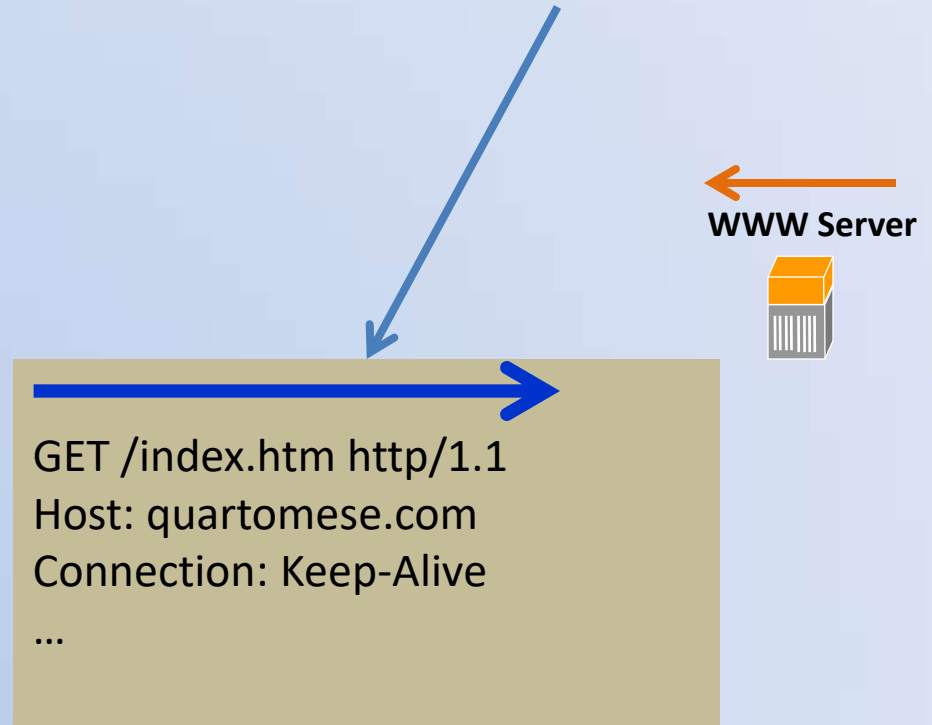
HTTP Client – Server Messages

- Client (You) sends a “Request” to `http://quartomese.com`
 - GET / HTTP/1.1
 - or GET /Pix/CA/monoLake.php HTTP/1.0
 - Host: quartomese.com (used for multi-host servers)
 - Accept-Language: en-US
 -
- Server “Response”
 - HTTP/1.1 200 OK
 - Or HTTP/1.1 404 NOT FOUND
 - Content-Length: 29769
 - Content-Type: text/html
 -
 - <!DOCTYPE html... (the web page `quartomese.com/index.htm`)
- “/” yields `index.html`, `index.htm`, `default.html`, `default.htm`



You

NAME SERVER – CONNECT – SSL/TLS - HTTP



HTTP = Hyper Text Transport Protocol

index.htm, default.htm, index.html, default.html are all default pages

http://www.eventhelix.com/RealtimeMantra/Networking/http_sequence_diagram.pdf

https://www.ntu.edu.sg/home/ehchua/programming/webprogramming/HTTP_Basics.html

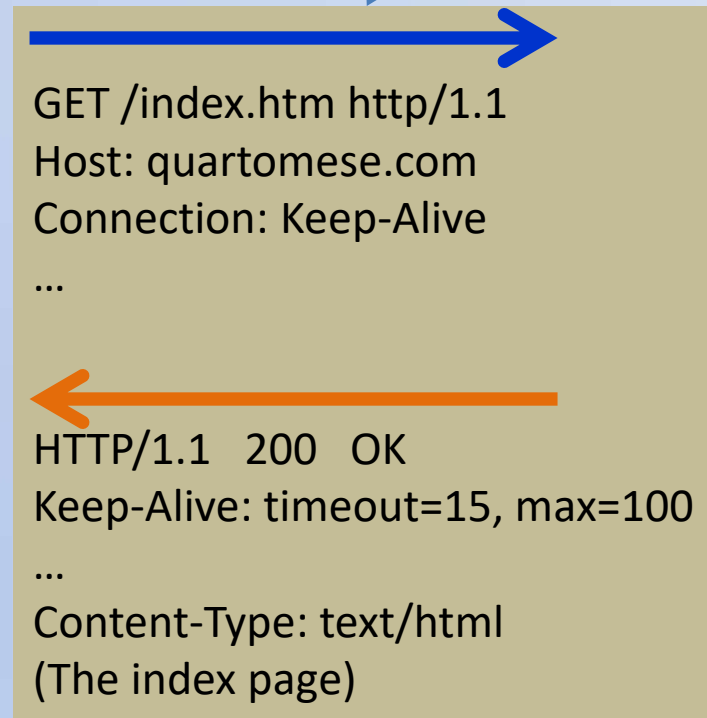
NAME SERVER – CONNECT – SSL/TLS - HTTP



You



WWW Server



HTTP = Hyper Text Transport Protocol

index.htm, default.htm, index.html, default.html are all default pages

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https://www.ntu.edu.sg/home/ehchua/programming/webprogramming/HTTP_Basics.html

NAME SERVER – CONNECT – SSL/TLS - HTTP



You

```
<body style="background-color: #cccccc;">
<!--
Copyright 2004, quartomese.com
-->
<div align="center">
<table border="1" width="100%" cellpadding="1" cellspacing="1" height="100%">
<tr>
<td align="center">

</td>
</tr>
</table>
</div>
<div align="center">
<table border="1" width="100%" style="border-collapse: collapse; height: 50px; cellpadding="5">
<tr>
<td align="center" style="width: 50%; height: 50px; vertical-align: middle">

</td>
<td align="center" style="width: 50%; height: 50px; vertical-align: middle">

</td>
</tr>
</table>
</div>
</body>
```

WWW Server



GET /index.htm http/1.1
Host: quartomese.com
Connection: Keep-Alive
...
HTTP/1.1 200 OK
Keep-Alive: timeout=15, max=100
...
Content-Type: text/html
(The index page)

HTTP = Hyper Text Transport Protocol

index.htm, default.htm, index.html, default.html are all default pages

http://www.eventhelix.com/RealtimeMantra/Networking/http_sequence_diagram.pdf

https://www.ntu.edu.sg/home/ehchua/programming/webprogramming/HTTP_Basics.html

NAME SERVER – CONNECT – SSL/TLS - HTTP



You

```
body style="background-color: #cccccc;
margin: 20px; padding: 20px;
...
div align="center" style="width: 70%; margin: 0 auto; padding: 10px;">


|                                                                                                         |
|---------------------------------------------------------------------------------------------------------|
|                                                                                                         |
| <a href="#">Home</a> <a href="#">Contact Us</a> <a href="#">About Us</a> <a href="#">Privacy Policy</a> |


```

WWW Server



→

GET /index.htm http/1.1
 Host: quartomese.com
 Connection: Keep-Alive
 ...

←

HTTP/1.1 200 OK
 Keep-Alive: timeout=15, max=100
 ...
 Content-Type: text/html
 (The index page)



index.htm, default.htm, index.html, default.html are all default pages

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NAME SERVER – CONNECT – SSL/TLS - HTTP



You

```
body style="background-color: #cccccc;
margin: 20px; padding: 20px;
...
div align="center">
table border="1" width="100%" cellpadding="1" cellspacing="1" height="100%"
...
div align="center">
table border="1" width="70%" style="border-collapse: collapse; height: 50px; cellpadding="5"
...
td align="center" style="width: 50%; height: 50px; vertical-align: middle; text-align: center;">
...
td align="center" style="width: 50%; height: 50px; vertical-align: middle; text-align: center;">
...

```

WWW Server



GET / http/1.1
 Host: quartomese.com
 Connection: Keep-Alive
 ...

HTTP/1.1 200 OK
 Keep-Alive: timeout=15, max=100
 ...
 Content-Type: text/html
 (The index page)



index.htm, default.htm, index.html, default.html are all default pages

Cookies

- A small website-sourced data unit stored on the your computer by your web browser
- Various information can be stored
 - Contents of you shopping cart
 - Pages previously visited on the target website
 - Last logon date
 - Any website desired state information
- The web browser sends these cookies back to the same server on any follow-on visits

Cookies

- Can be created with JavaScript or PHP
 - JavaScript on your webpage
 - PHP on the server
- PHP code on server
 - `setcookie(Name, Value, Expiration Time)`
- To find cookies on Firefox browser
 - Tools → Options → Privacy → remove individual cookies

Application

E-Mail

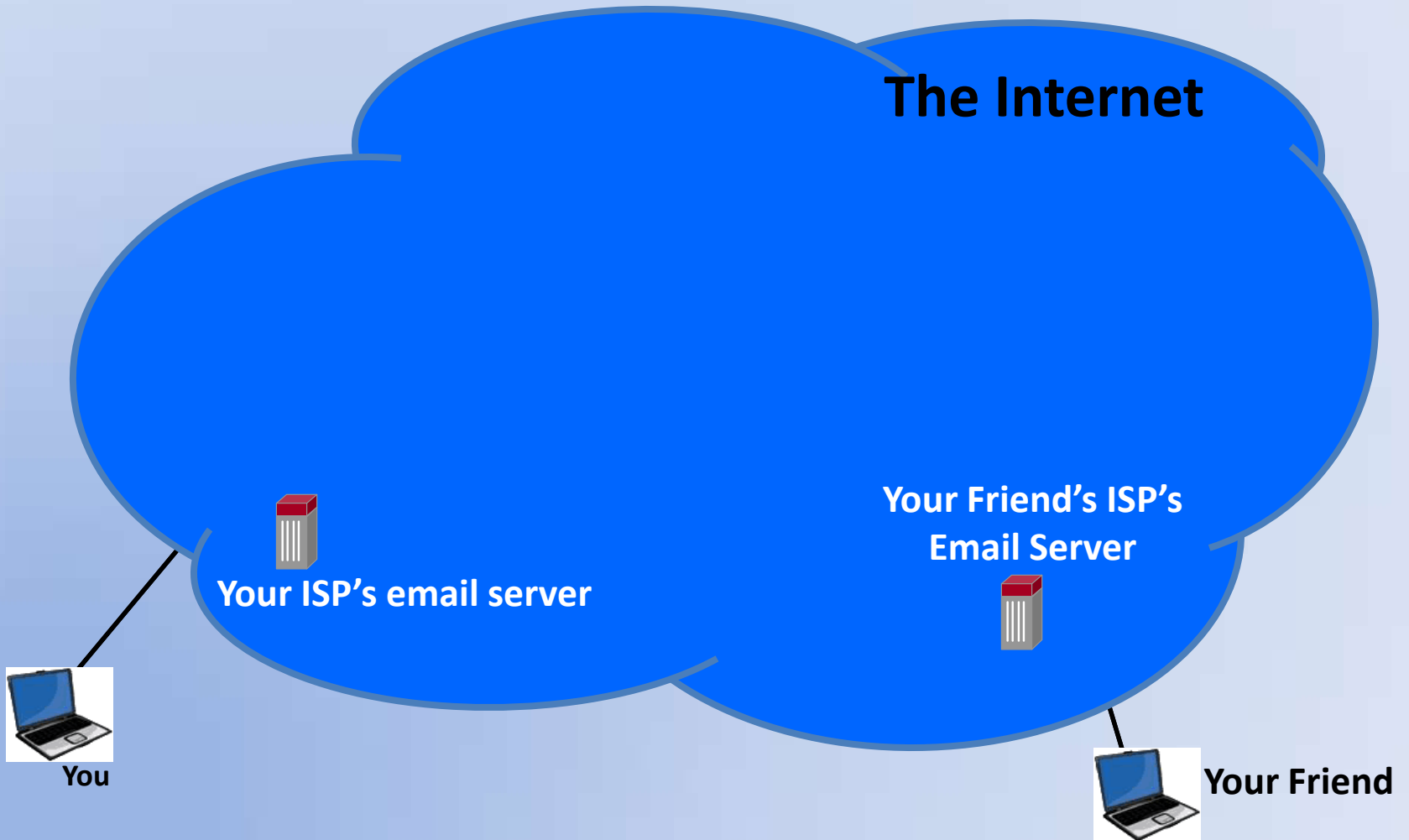
The Internet


Your ISP's email server

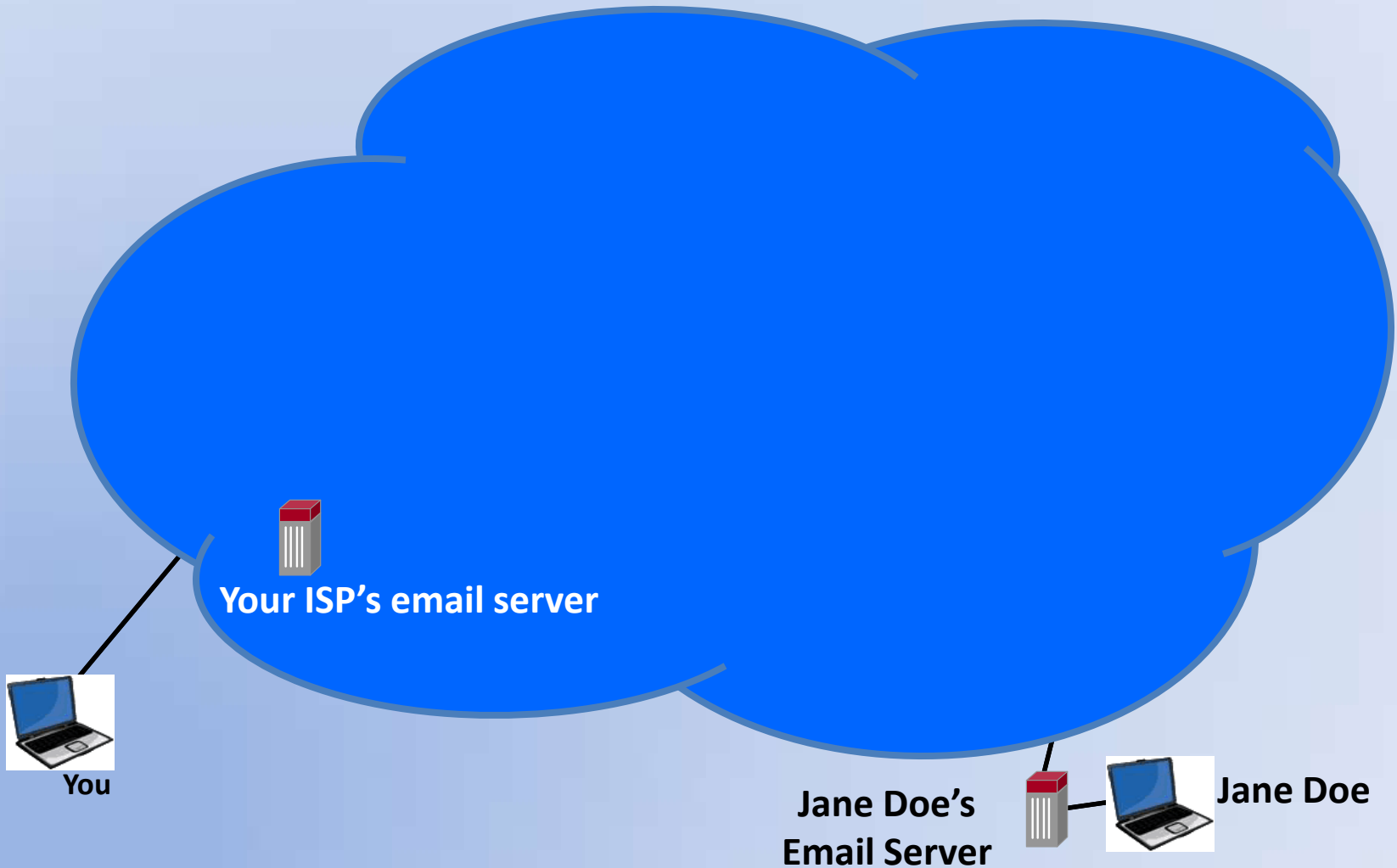


You

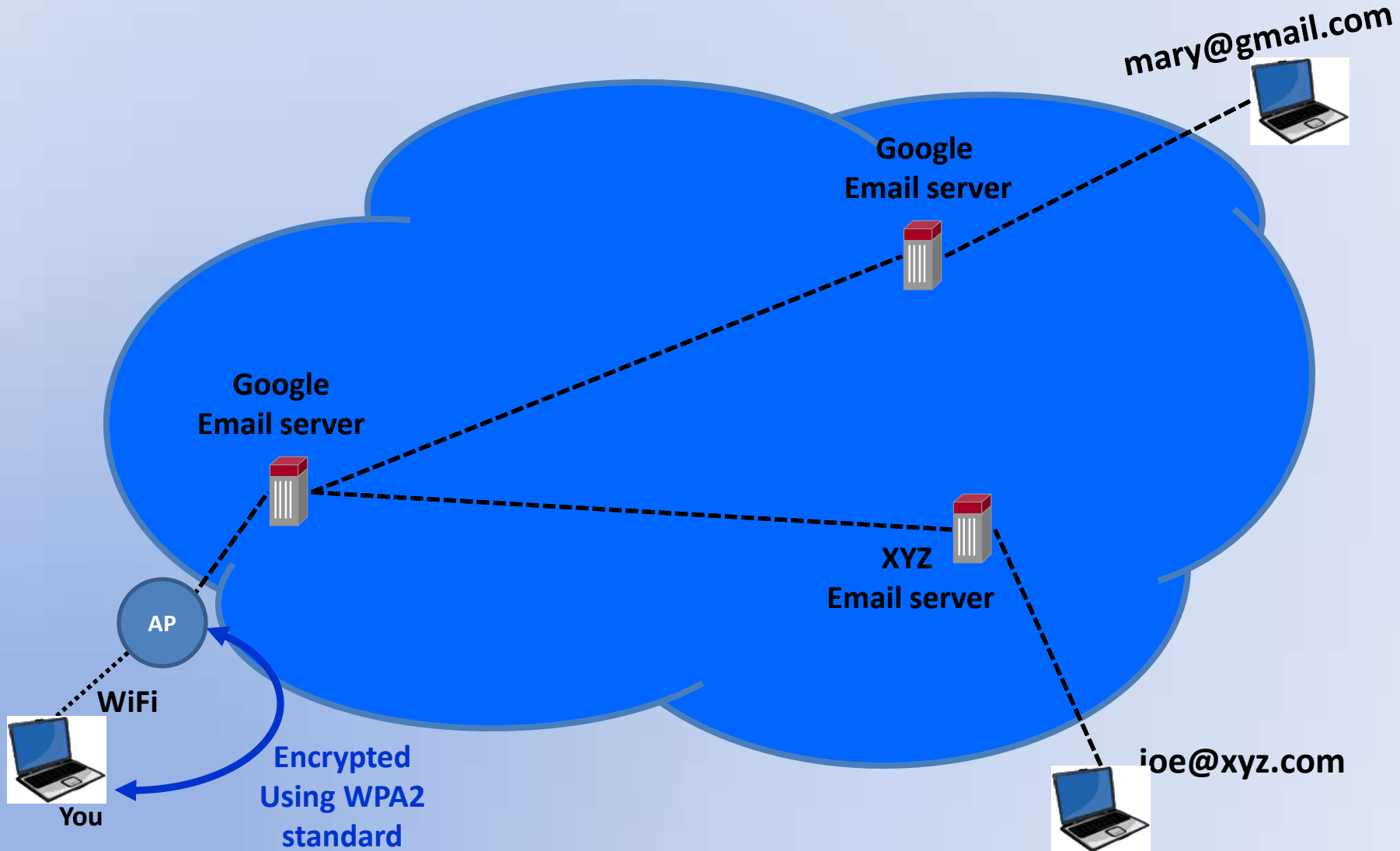
E-Mail



E-Mail

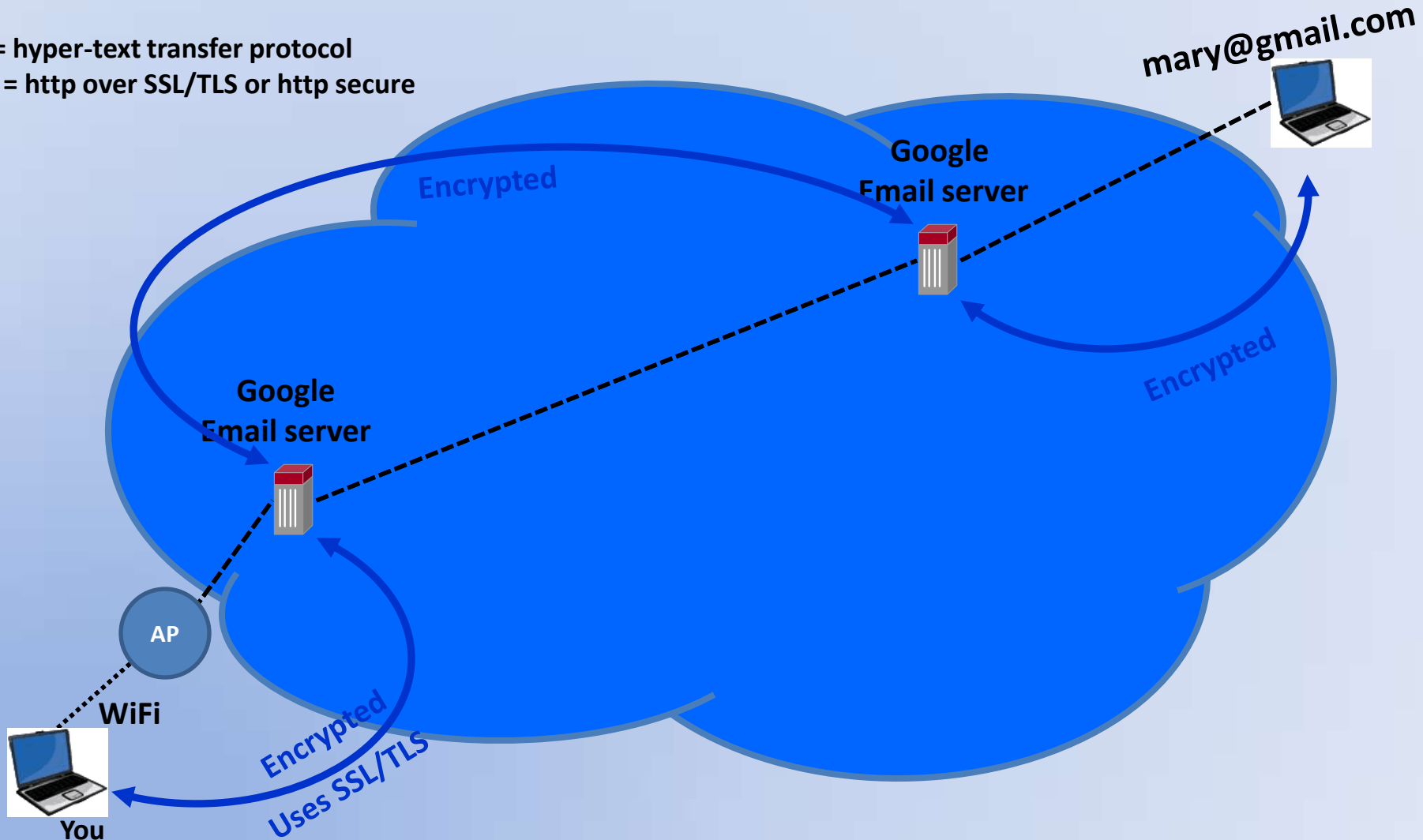


Using WPA2 Encrypted WiFi



Using https Web Access For Gmail

http = hyper-text transfer protocol
https = http over SSL/TLS or http secure



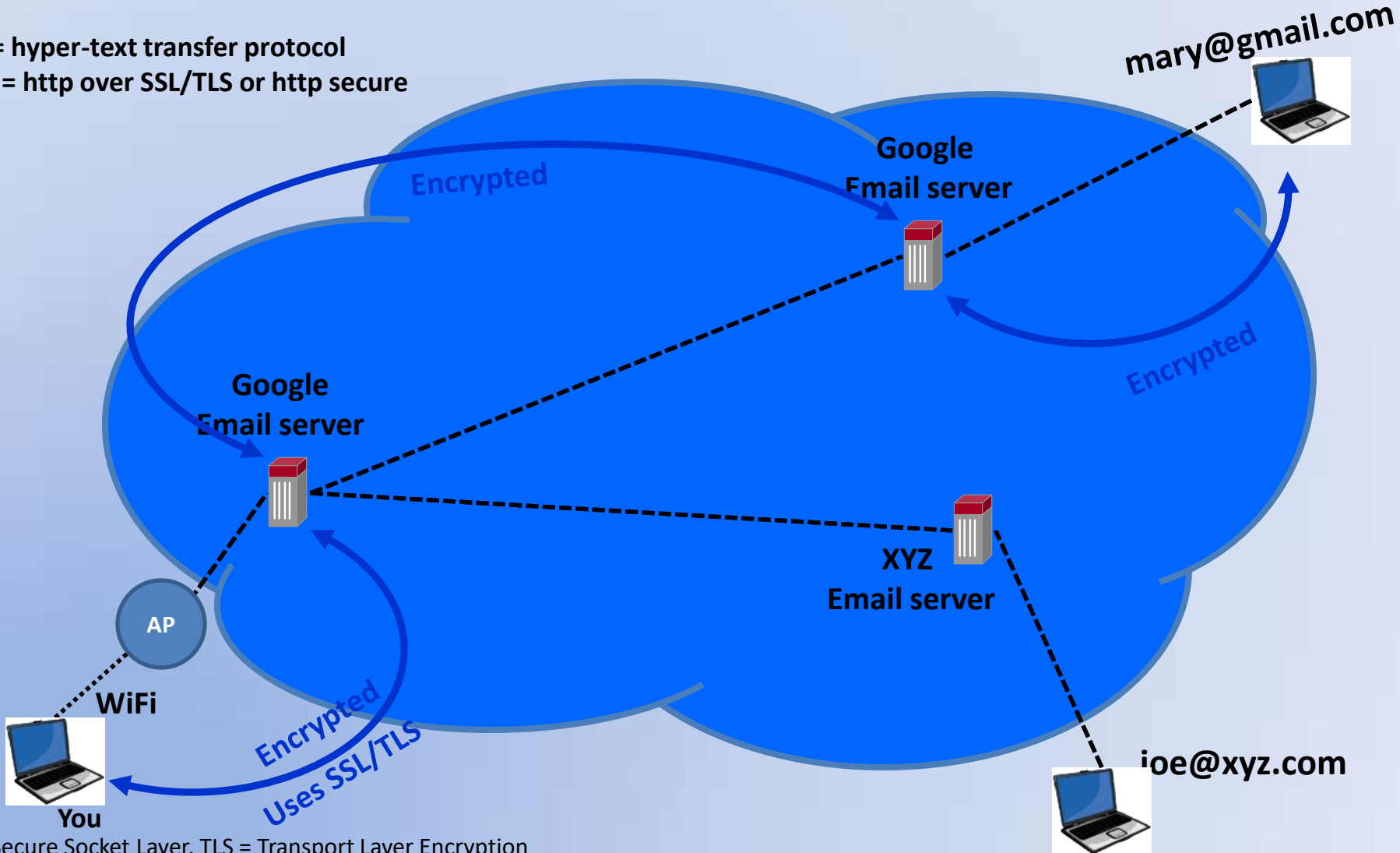
SSL = Secure Socket Layer, TLS = Transport Layer Encryption

<http://thenextweb.com/google/2014/03/20/gmail-now-uses-encrypted-https-connection-check-send-email/>

<https://blog.hartleybrody.com/https-certificates/>

Using https Web Access For Gmail

http = hyper-text transfer protocol
https = http over SSL/TLS or http secure



SSL = Secure Socket Layer, TLS = Transport Layer Encryption

<http://thenextweb.com/google/2014/03/20/gmail-now-uses-encrypted-https-connection-check-send-email/>

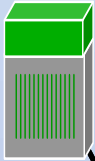
<https://blog.hartleybrody.com/https-certificates/>

Application

Streaming

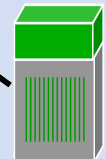
The Internet

NETFLIX



You

YouTube

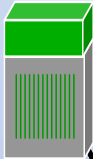


Streaming



Streaming

NETFLIX



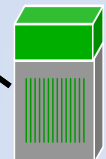
**Streaming:
Pre-encoded audio/video files that begin
playing prior to a full file download**

**Streaming requires a buffer to smooth out
network delays - playback begins only after
the playback buffer is loaded**

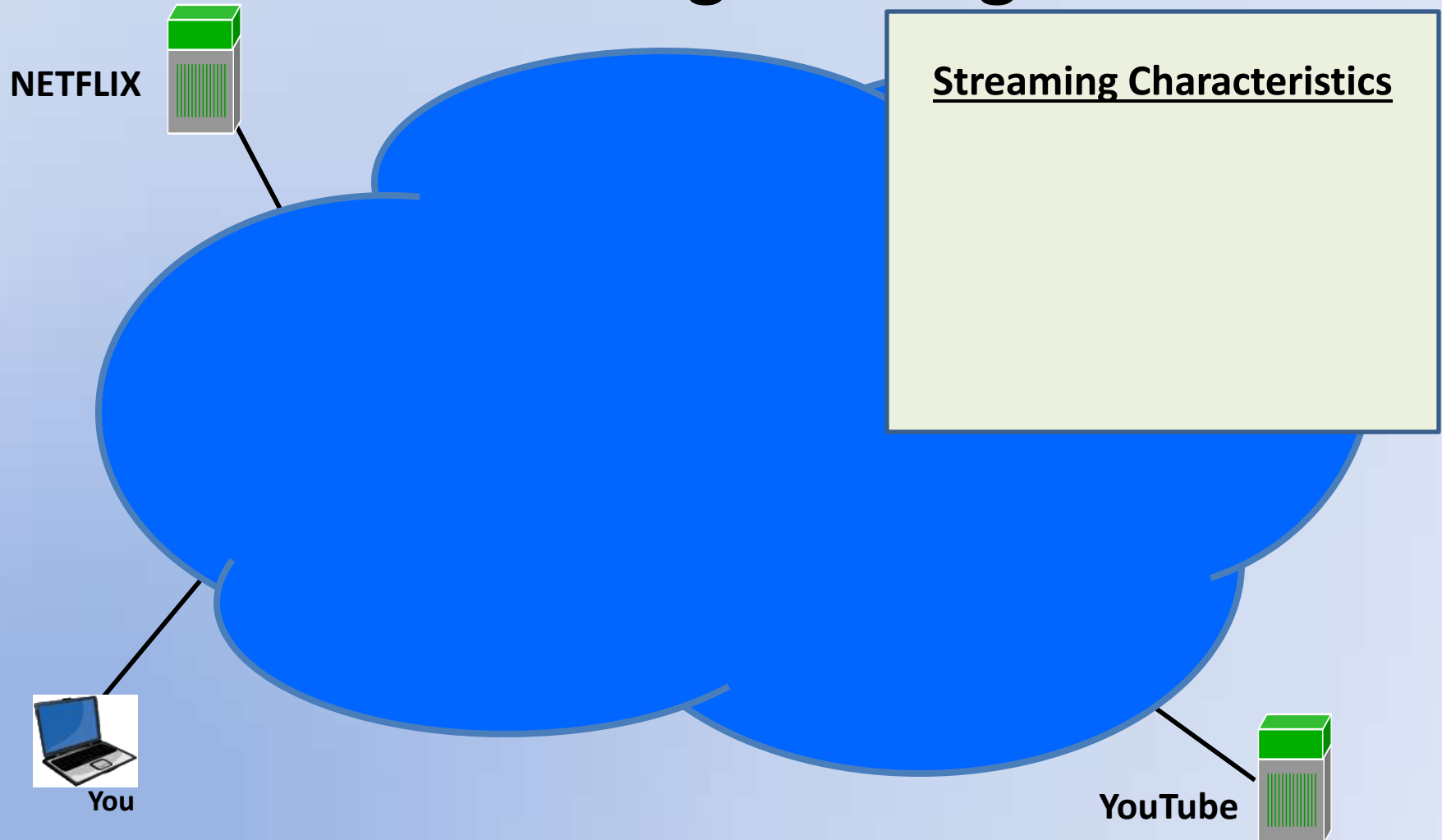


You

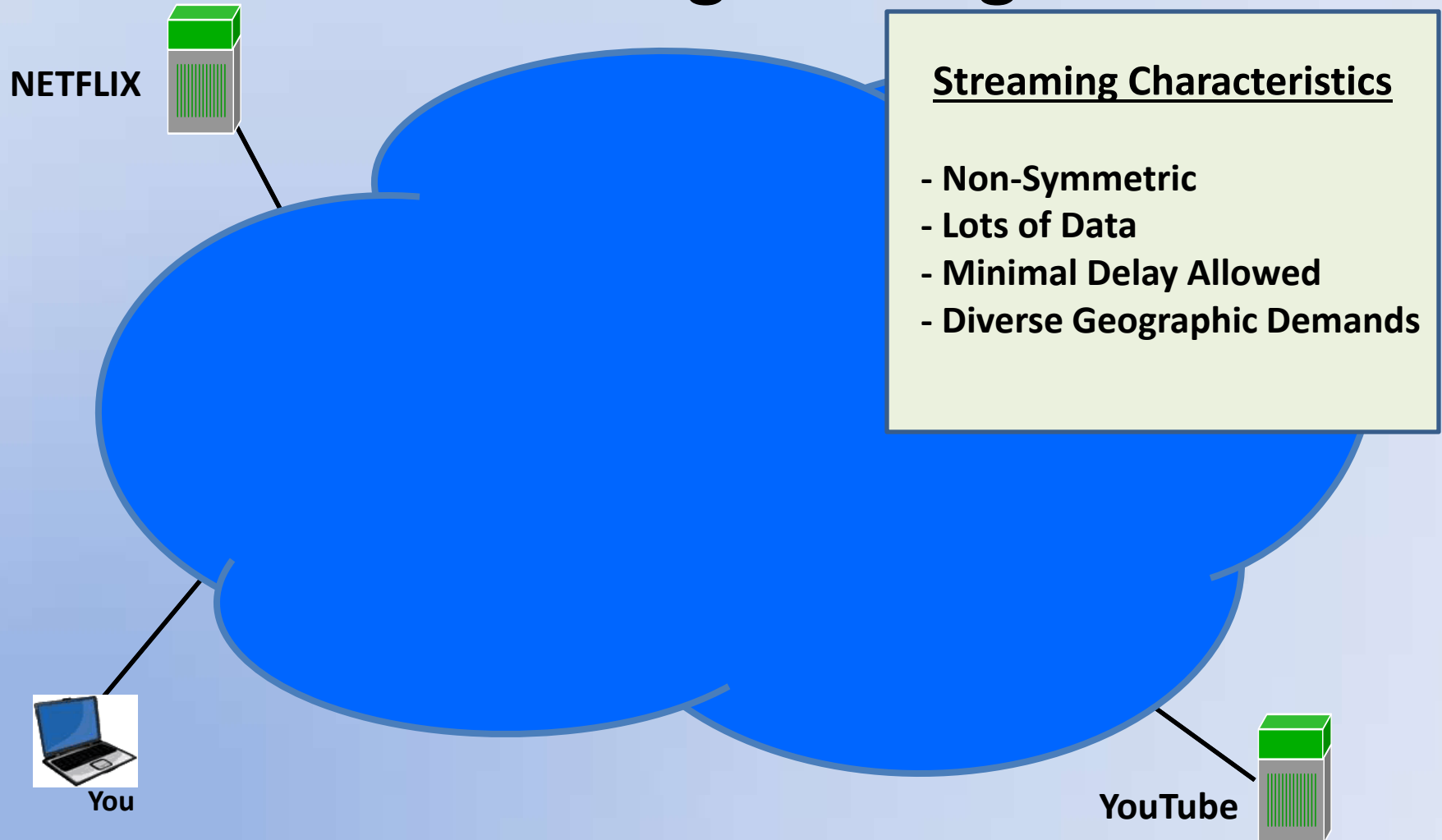
YouTube



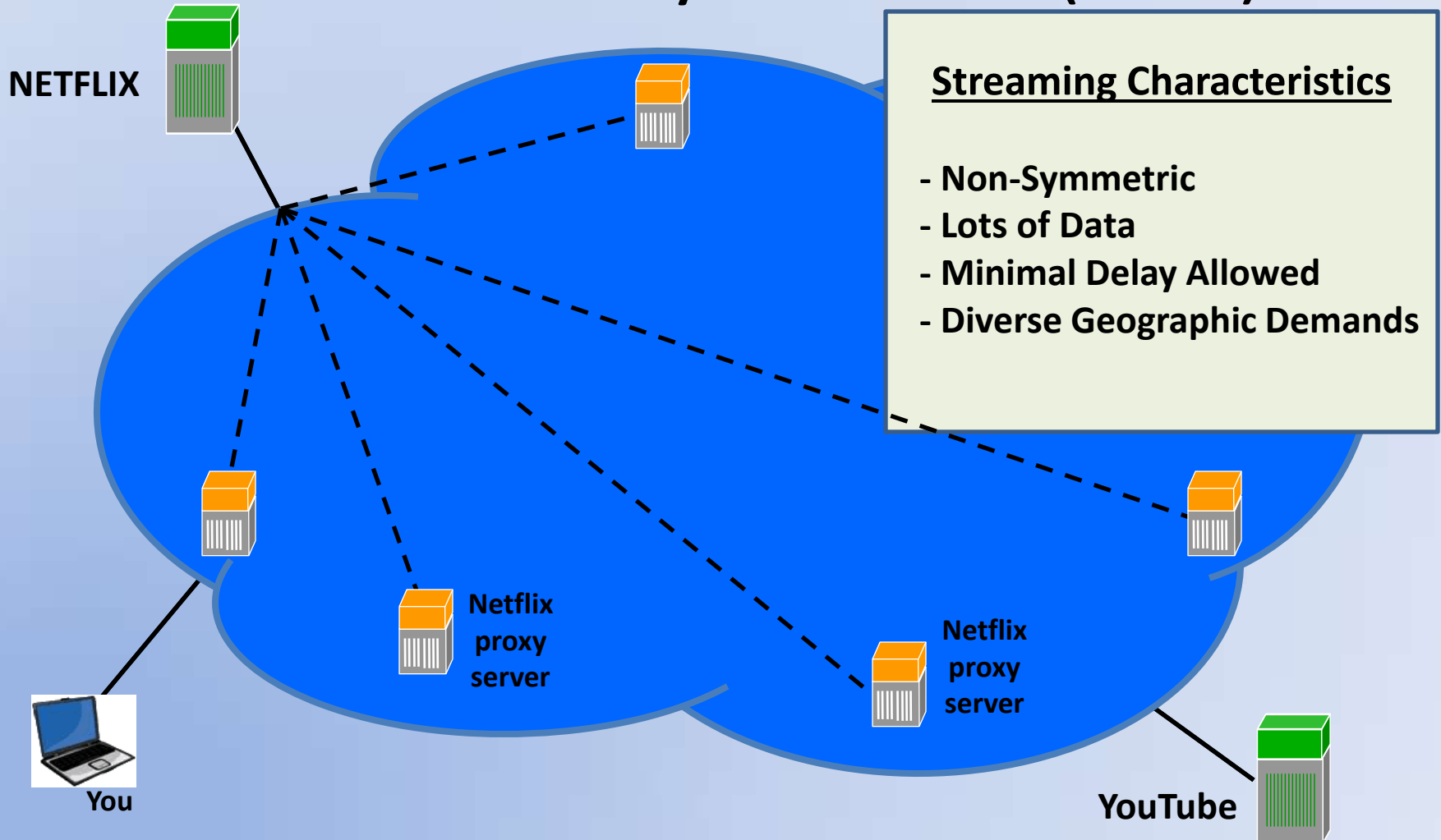
Streaming Traffic Engineering



Streaming Traffic Engineering



Streaming Content Delivery Network (CDN)



Routing the IP packet

WWW Server



You

Internet Protocol Stack

Application Layer 5	HTTP, FTP, SMTP, Telnet, DNS, SSH, etc.
Transport Layer 4	TCP/UDP
Network Layer 3	IPv4, IPv6 addressing/routing
Data Link Layer 2	Ethernet protocol (ARP, ...)
Physical Layer 1	Ethernet media (MAC address, 10BASE-T, ...)

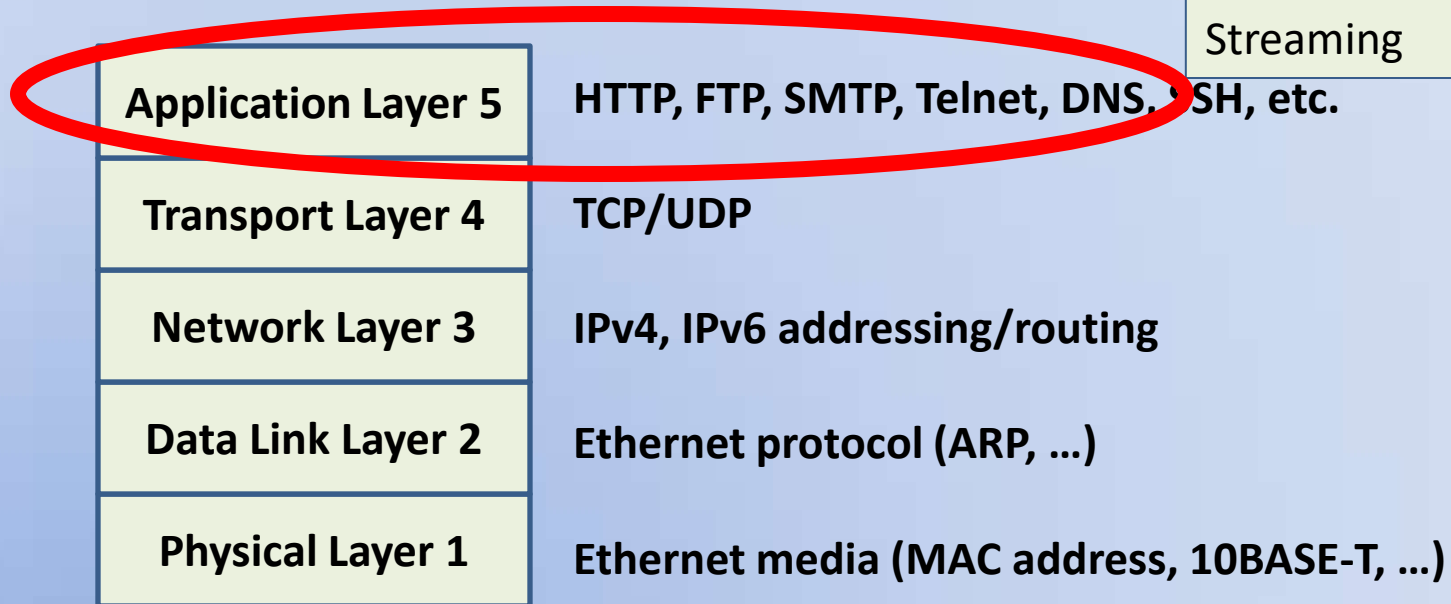
ISO OSI model adds session and presentation layers

IETF = Internet Engineering Task Force

<http://www.thegeekstuff.com/2011/11/tcp-ip-fundamentals/comment-page-1/>

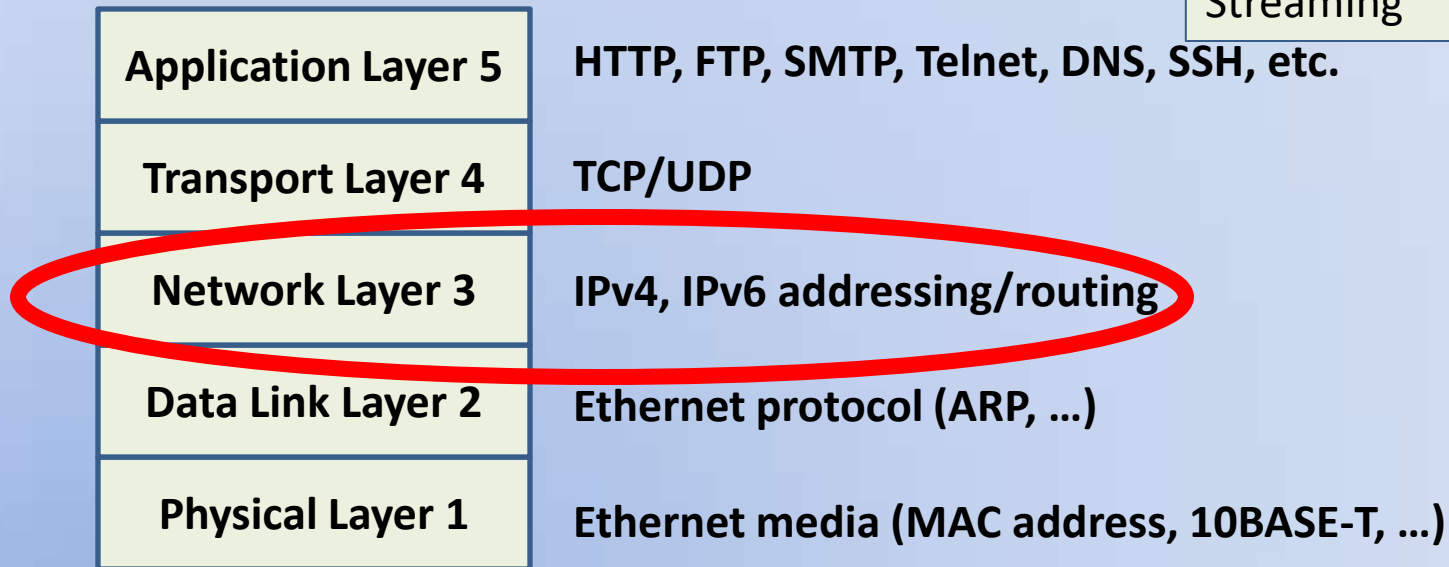
Internet Protocol Stack

Get WEB page
E-mail
Streaming

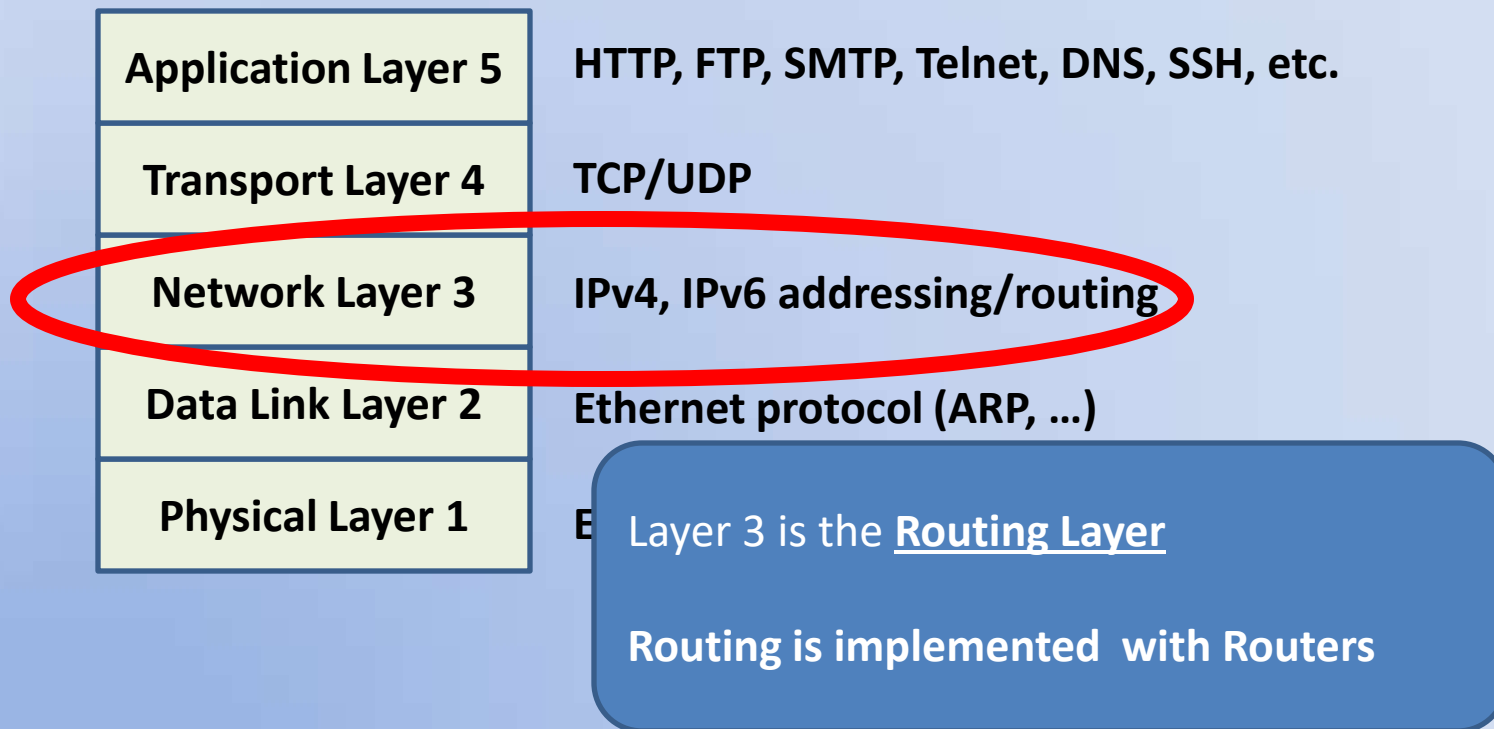


Internet Protocol Stack

Get WEB page
E-mail
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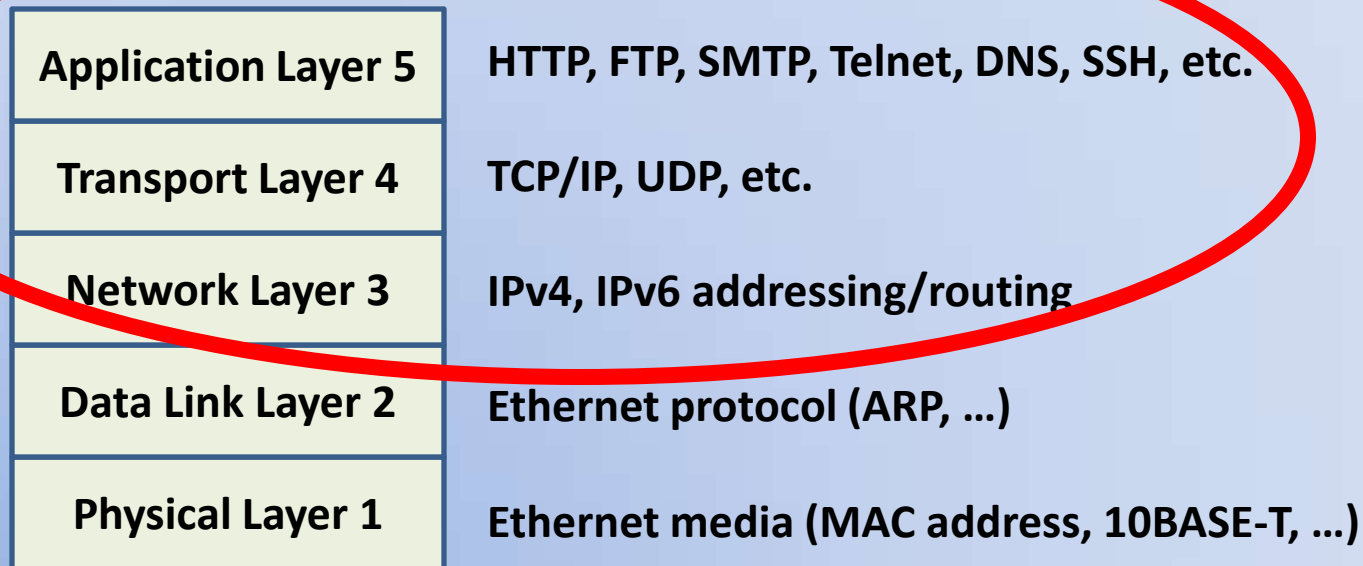


Internet Protocol Stack

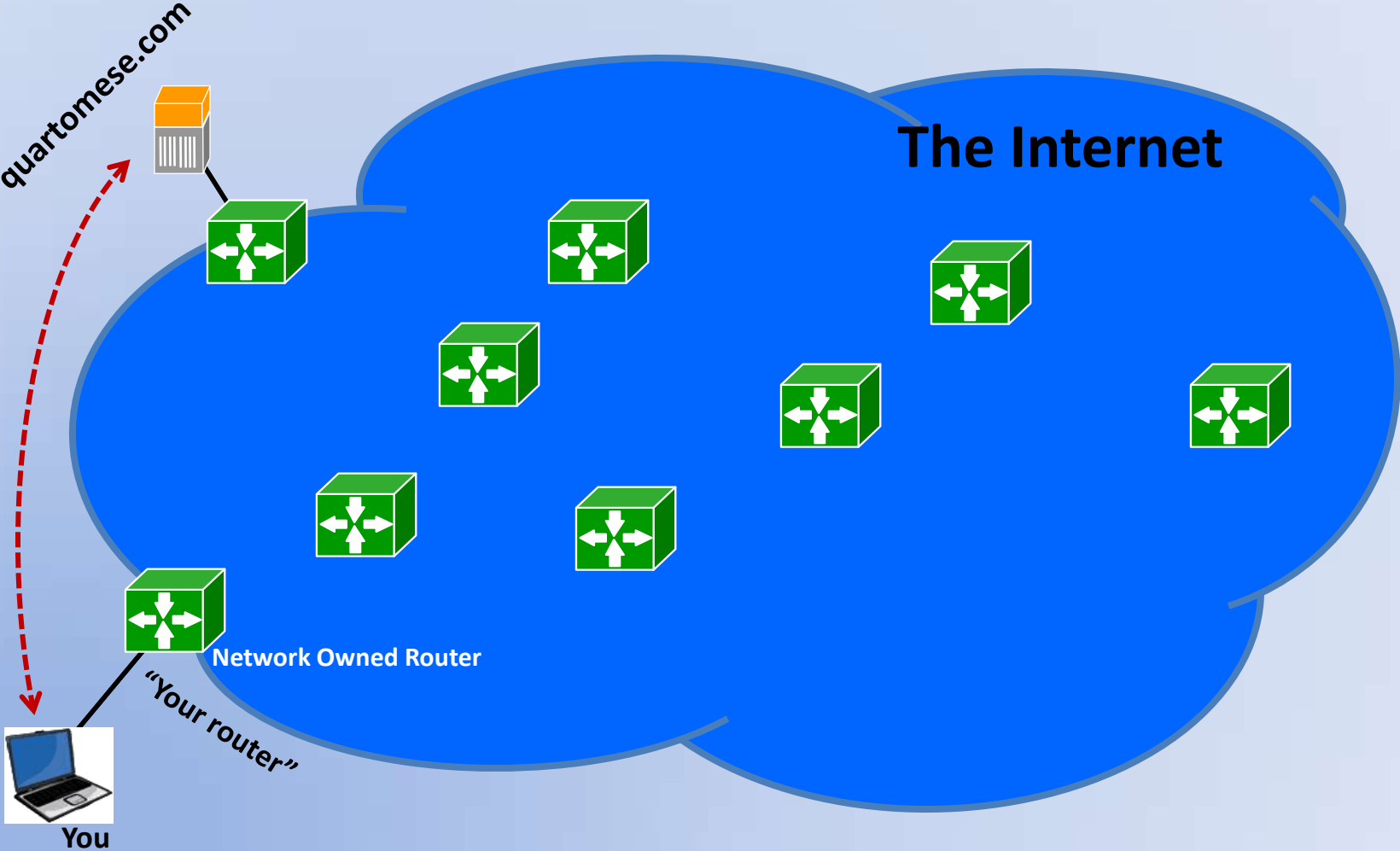


Internet Protocol Stack

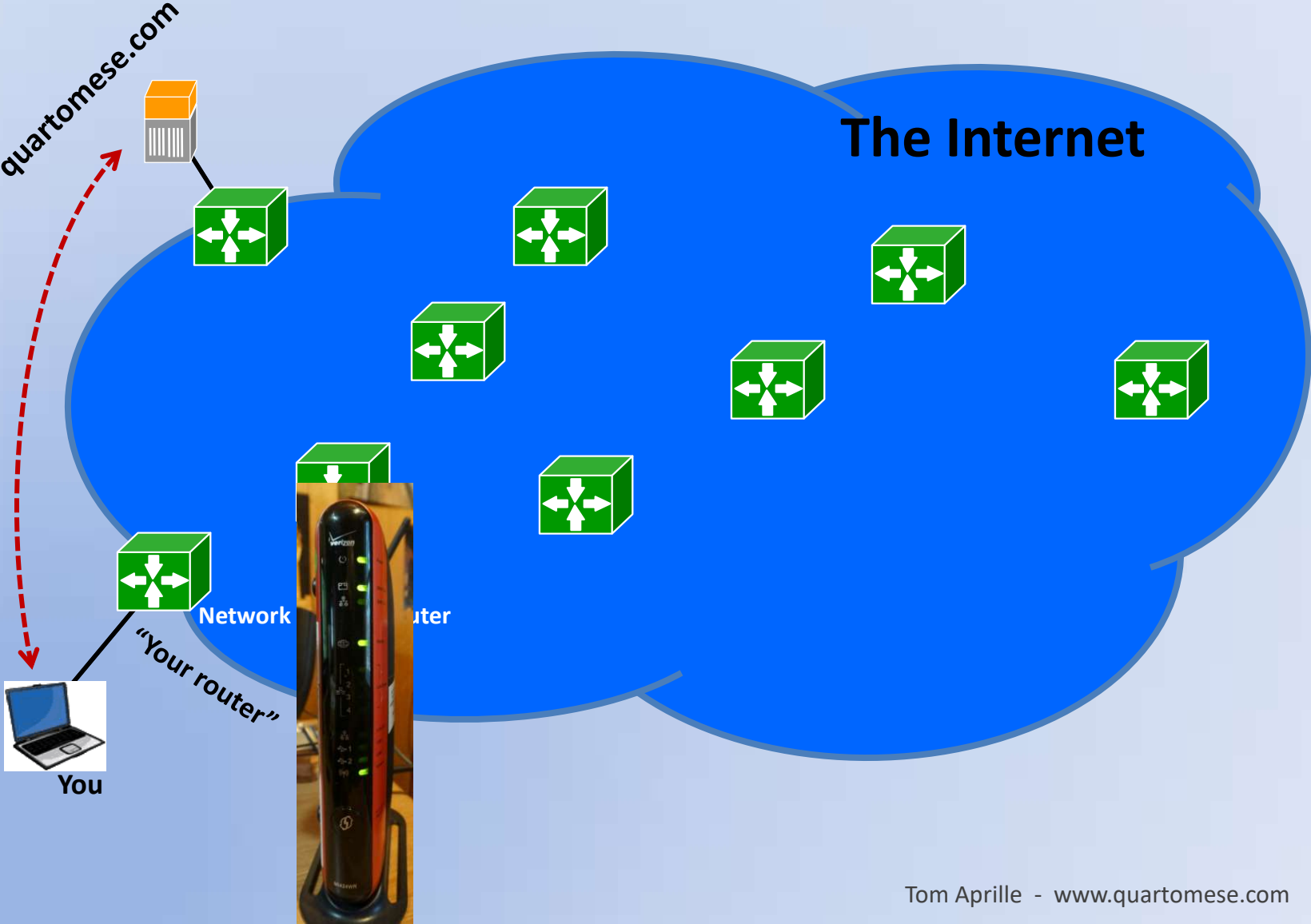
The data bytes that make up Layers 3, 4 & 5 are called an IP packet



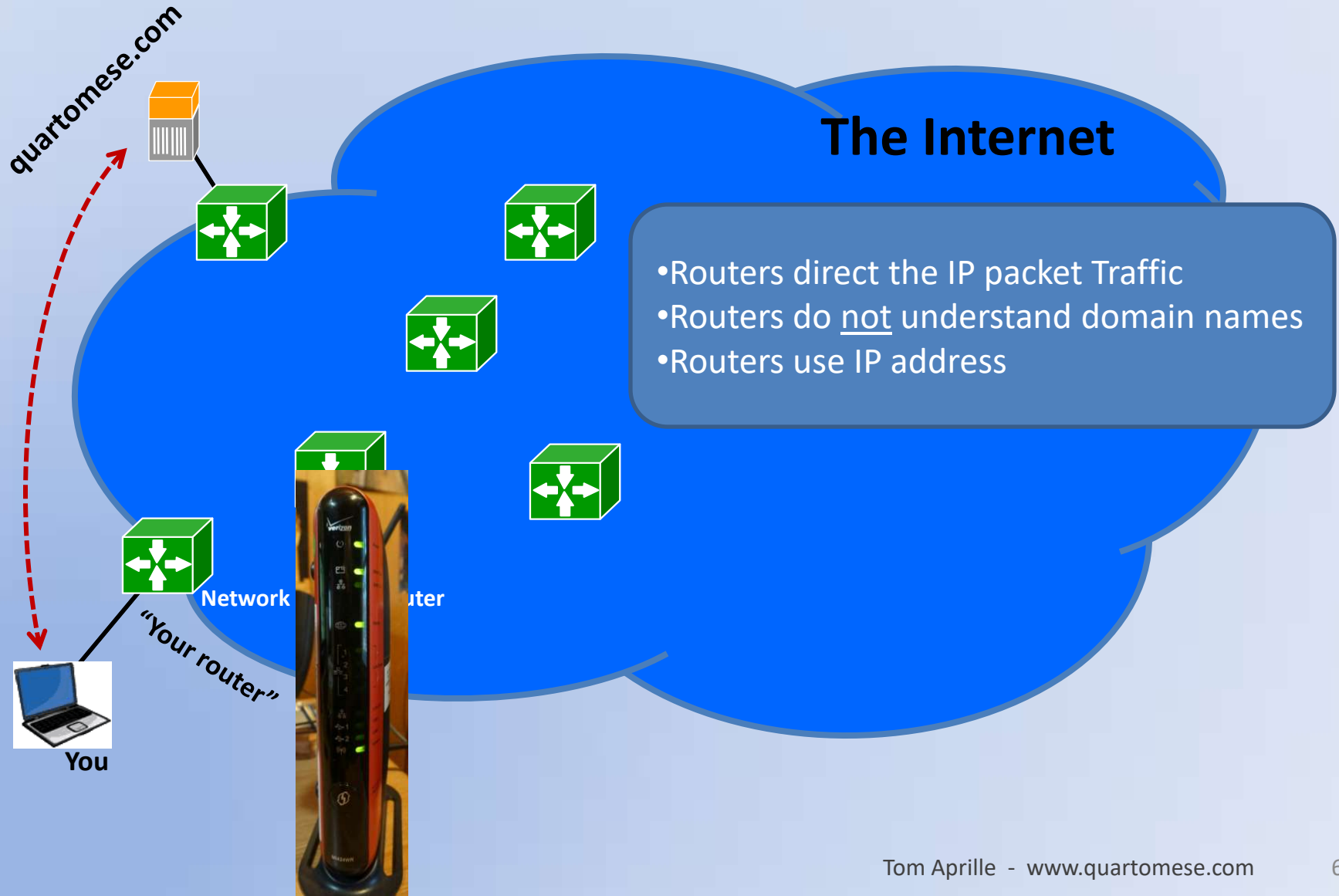
Get WEB Page - Routing



Get WEB Page - Routing



Get WEB Page - Routing



URL - Domain Name → IP Address

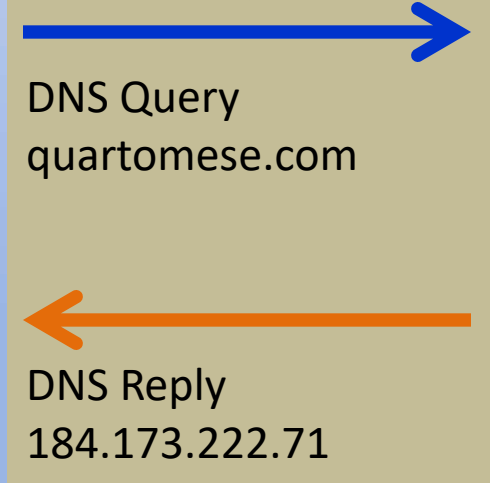
- URL (Uniform Resource Locator)
 - <http://quartomese.com/Pix/CA/monoLake.php>
 - Protocol identifier: http, https, ftp, ftps
 - Domain name: quartomese.com (or www.quartomese.com)
 - Resource name: /Pix/CA/monoLane.php
- Each working domain name has at least one IP address
 - microsoft.com has multiple IP addresses
 - An IP address typically has one domain names
 - It could also have multiple (or no) domain names
 - Shared hosts can have many domain names
- The IP address of the domain name quartomese.com
 - 184.173.222.71
 - 0-255 . 0-255 . 0-255 . 0-255 numbering range



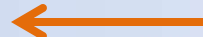
NAME SERVER – CONNECT – SSL/TLS - HTTP



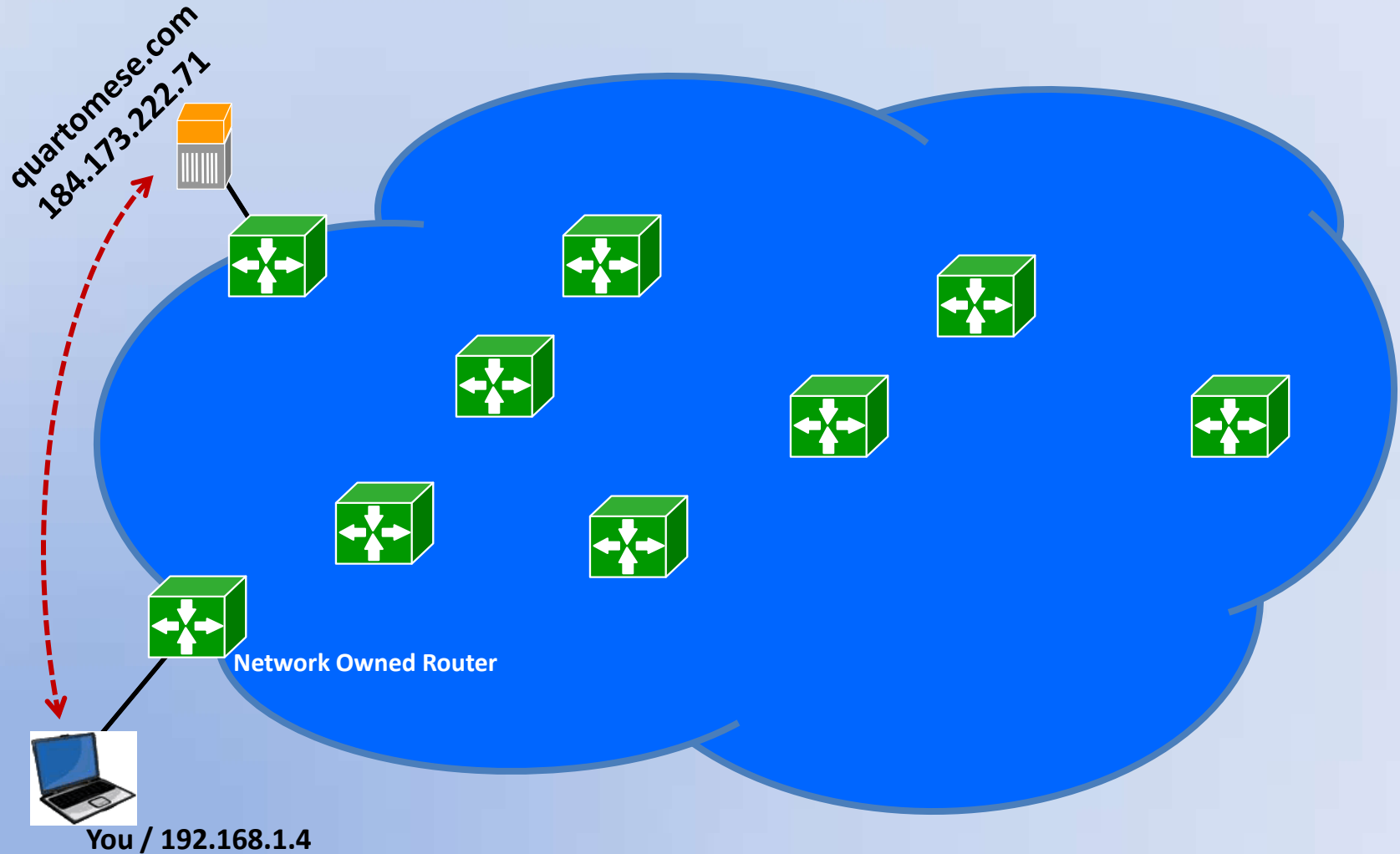
IP addresses are obtained by your browser/OS querying Internet-based DNS servers (DNS = Domain Name System)



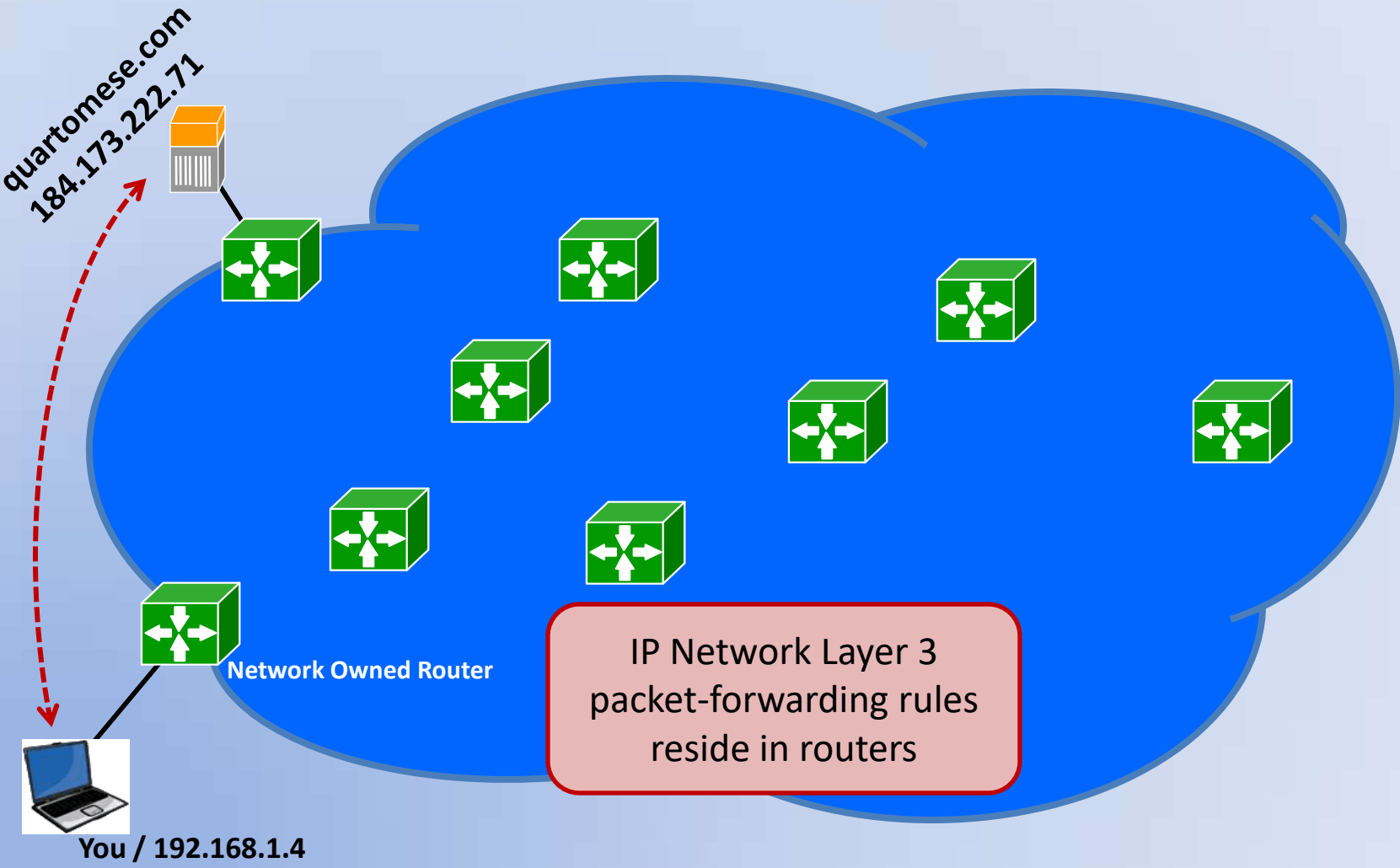
WWW Server



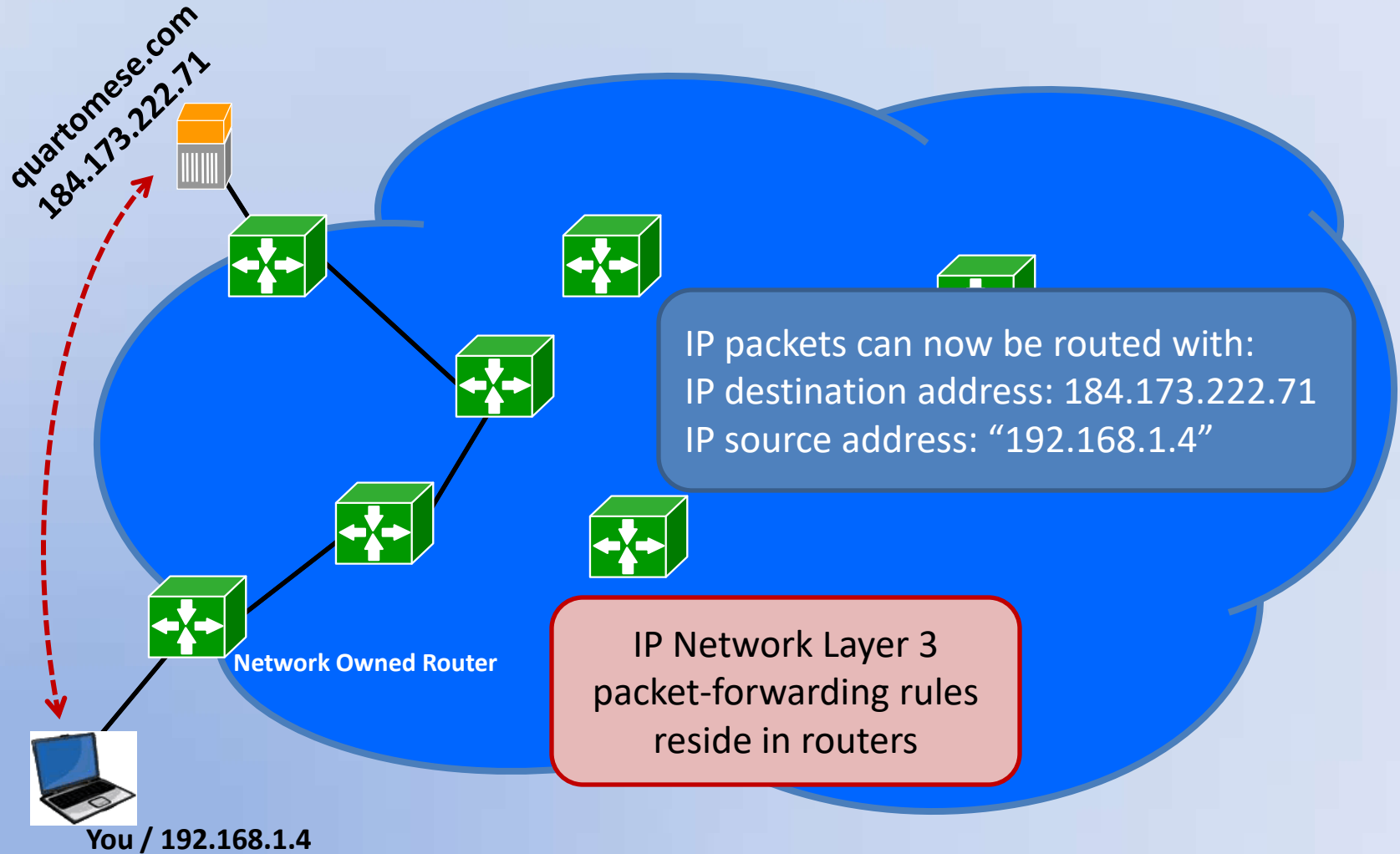
Get WEB Page - Routing



Get WEB Page - Routing



Get WEB Page - Routing

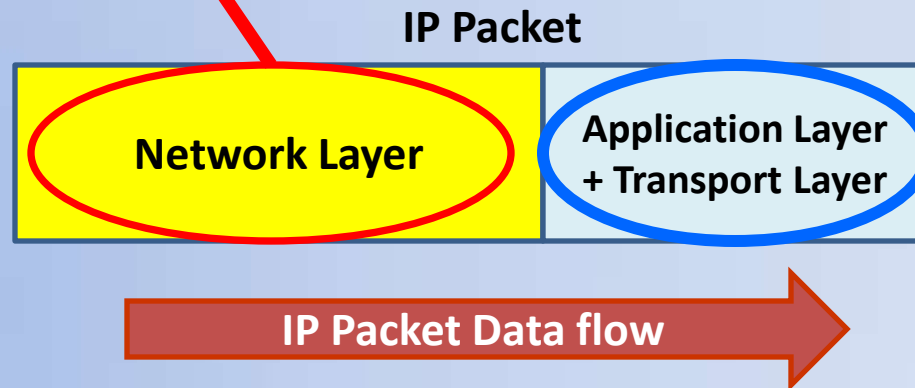
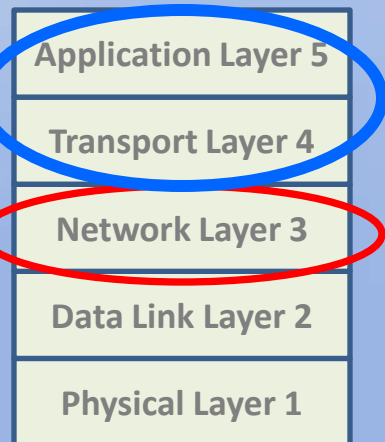


The IP Packet

Destination IP Address			
Source IP Address			
Time To Live	Protocol	Header Checksum	
ID		Flags	Fragment Offset
IP Version	ToS	Total Length	

Network Layer

IP Header = 20 Bytes (IPv4)



Router's Static Route

- 3 components
 - Network ID of destination network
 - IP address of the sub-network to which the destination IP address belongs
 - Subnet mask of destination network
 - The size of the sub-network to which the destination IP address belongs
 - Next hop router's IP address
 - Or the final destination if it is directly connected
 - Uses "Last Resort Router" if IP address not in table

Router's Static Route

- 3 components

- Network ID of destination

- IP address of the router's interface that is connected to the destination network
- IP address of the next hop router

- Subnet mask of destination network

• IP address of the network to which the destination IP

belongs to (router's IP address)

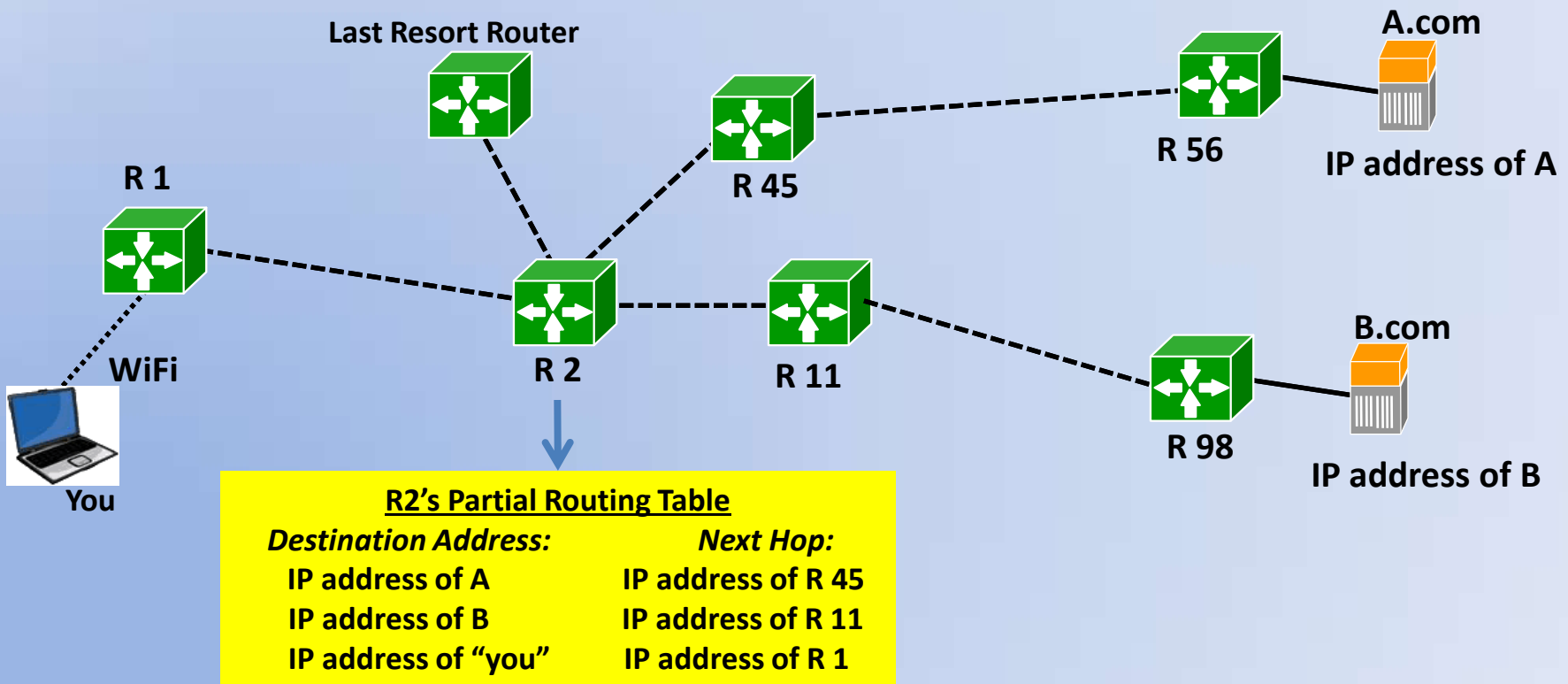
• IP address of the final destination if it is directly connected

- Uses "Last Resort Router" if IP address not in table

In essence, a lookup table with destination IP addresses and associated next hop router IP addresses

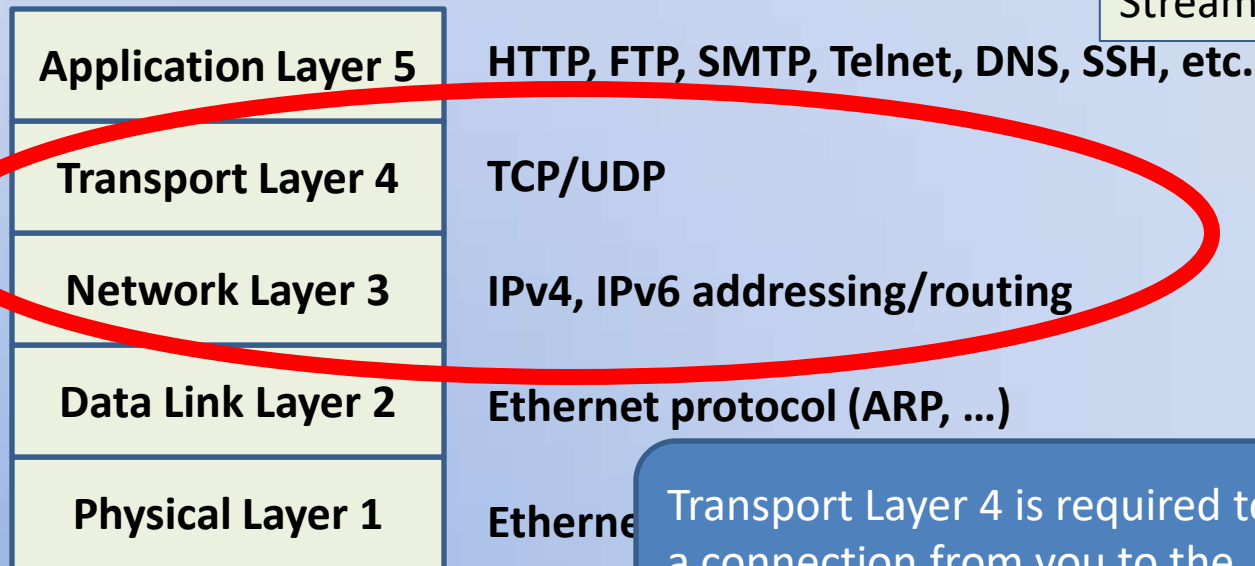
Router's Static Route

- Each router has a look-up routing table that is used to determine the next hop



Internet Protocol Stack

Get WEB page
E-mail
Streaming



Transport Layer 4 is required to set up a connection from you to the destination server

TCP = Transmission Control Protocol

UDP = User Datagram Protocol

<http://www.thegeekstuff.com/2011/11/tcp-ip-fundamentals/comment-page-1/>

NAME SERVER – CONNECT – SSL/TLS - HTTP



You



Blue arrow pointing right

DNS Query
UDP, quartomese.com

Orange arrow pointing left

DNS Reply
UDP, 184.173.222.71

Blue arrow pointing right

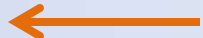
SYN (TCP)
184.173.222.71, port 80
(192.168.1.4, port 3000)

Orange arrow pointing left

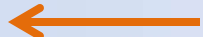
SYN_ACK

Blue arrow pointing right

ACK



WWW Server



DNS Server



<https://gist.github.com/alyssaq/6388253>

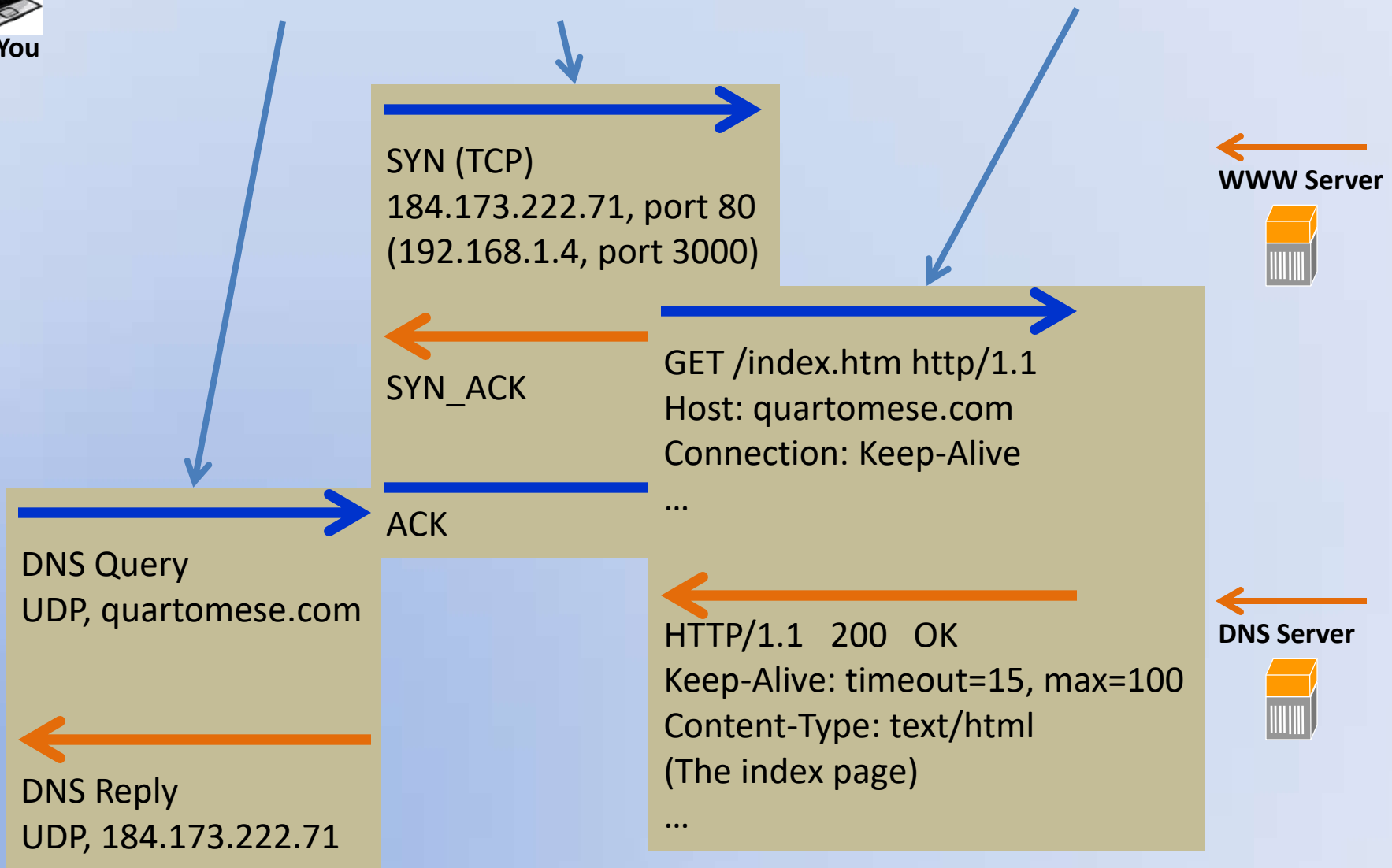
http://www.eventhelix.com/RealtimeMantra/Networking/http_sequence_diagram.pdf

<https://www.objc.io/issues/10-syncing-data/ip-tcp-http/>

NAME SERVER – CONNECT – SSL/TLS - HTTP



You



index.htm, default.htm, index.html, default.html are all default pages

http://www.eventhelix.com/RealtimeMantra/Networking/http_sequence_diagram.pdf

https://www.ntu.edu.sg/home/ehchua/programming/webprogramming/HTTP_Basics.html

NAME SERVER – CONNECT – SSL/TLS - HTTP



You

→

SYN (TCP)
184.173.222.71, port 80
(192.168.1.4, port 3000)

←

WWW Server

In Summary:

1. Your browser/OS get IP address for your desired website
2. Your browser opens a connection to your desired website
3. Your browser make an HTTP document request to your desired website – i.e., the page you wanted in the first place

←

HTTP/1.1 200 OK
Keep-Alive: timeout=15, max=100
Content-Type: text/html
(The index page)
...

←

DNS Server

←

DNS Reply
UDP, 184.173.222.71

NAME SERVER – CONNECT – SSL/TLS - HTTP



You



SYN (TCP)
54.239.25.200, port 443
(192.168.1.4, port 3000)

← SYN_ACK

→ ACK

→ Client "Hello" message
SSL/TLS version options
CipherSuites list
Server name: amazon.com

← Server "Hello" response
SSL/TLS & CipherSuite chosen
Session ID
Server certificate with server public key

→ Client authenticates certificate
Generates pre-master secret (pms) &
send encrypted using server's public key
Generates master keys from pms
Sends "**finished**" using symmetric master keys

← Server decrypts pms using server private key
Generates master keys from pms
Sends "**finished**" using symmetric master keys

← amazon.com



Asymmetric Keys
Text encrypted with a public key can only be decrypted with the associated private key

SSL = Secure Sockets Layer / TLS = Transport Layer Security
<https://blogs.msdn.microsoft.com/kaushal/2013/08/02/ssl-handshake-and-https-bindings-on-iis/>
<http://www.moserware.com/2009/06/first-few-milliseconds-of-https.html>
<http://security.stackexchange.com/questions/20803/how-does-ssl-tls-work>
https://www.ntu.edu.sg/home/ehchua/programming/webprogramming/HTTP_SSL.html
[http://www.ibm.com/support/knowledgecenter/SSFKSJ_7.1.0/com.ibm.mq.doc/sy10660 .htm](http://www.ibm.com/support/knowledgecenter/SSFKSJ_7.1.0/com.ibm.mq.doc/sy10660.htm)

Routing

WWW Server



The ISPs
Internet Service Providers



You

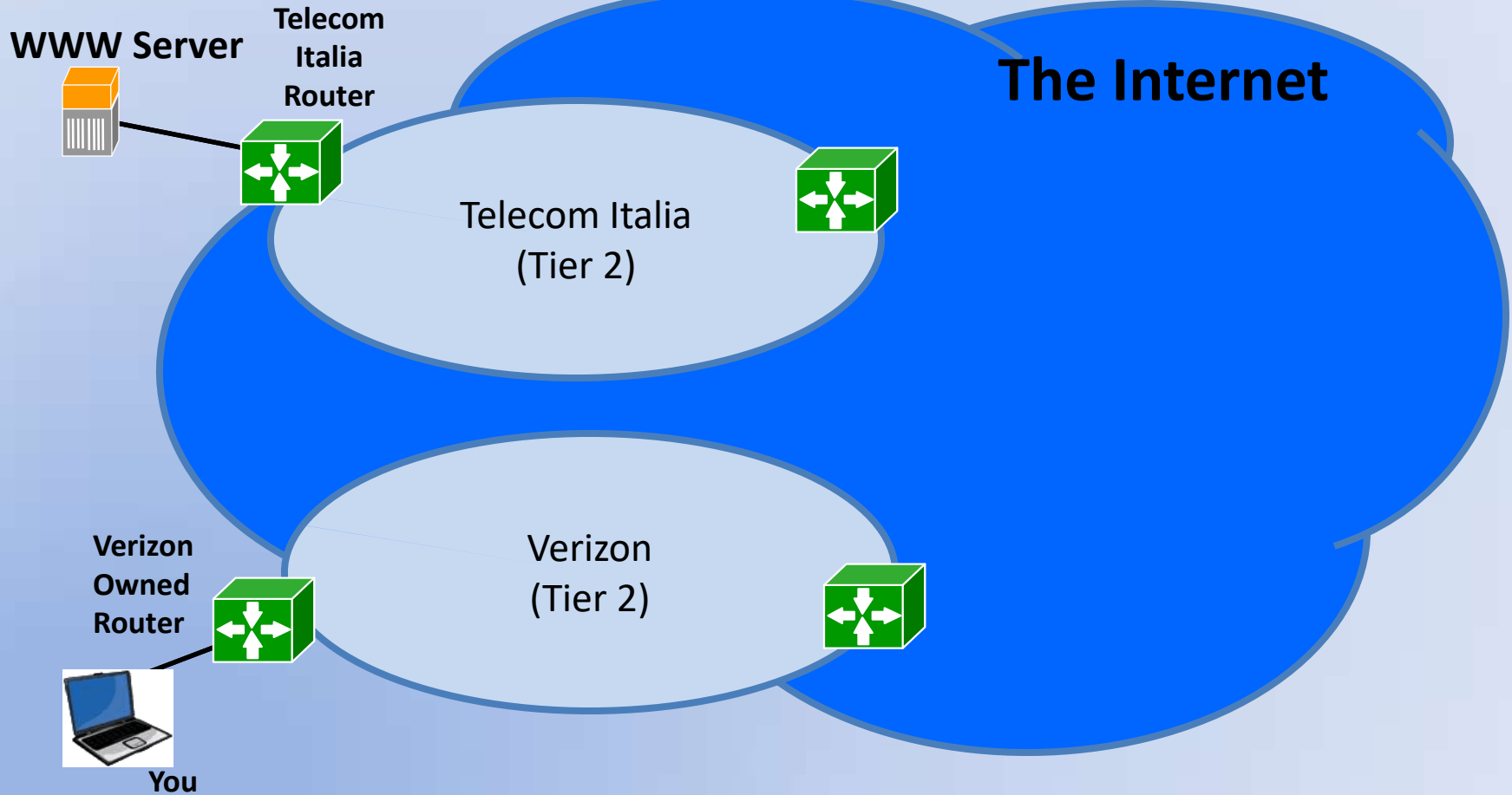
ISPs

- Number of ISPs in US
 - 2,556
- Top 10 ISPs by Number of Internet Customers – Dec. 2011
 - Comcast, AT&T, Time Warner Cable, Century Link, Charter, Verizon, Cox, Optimum, Frontier, Suddenlink

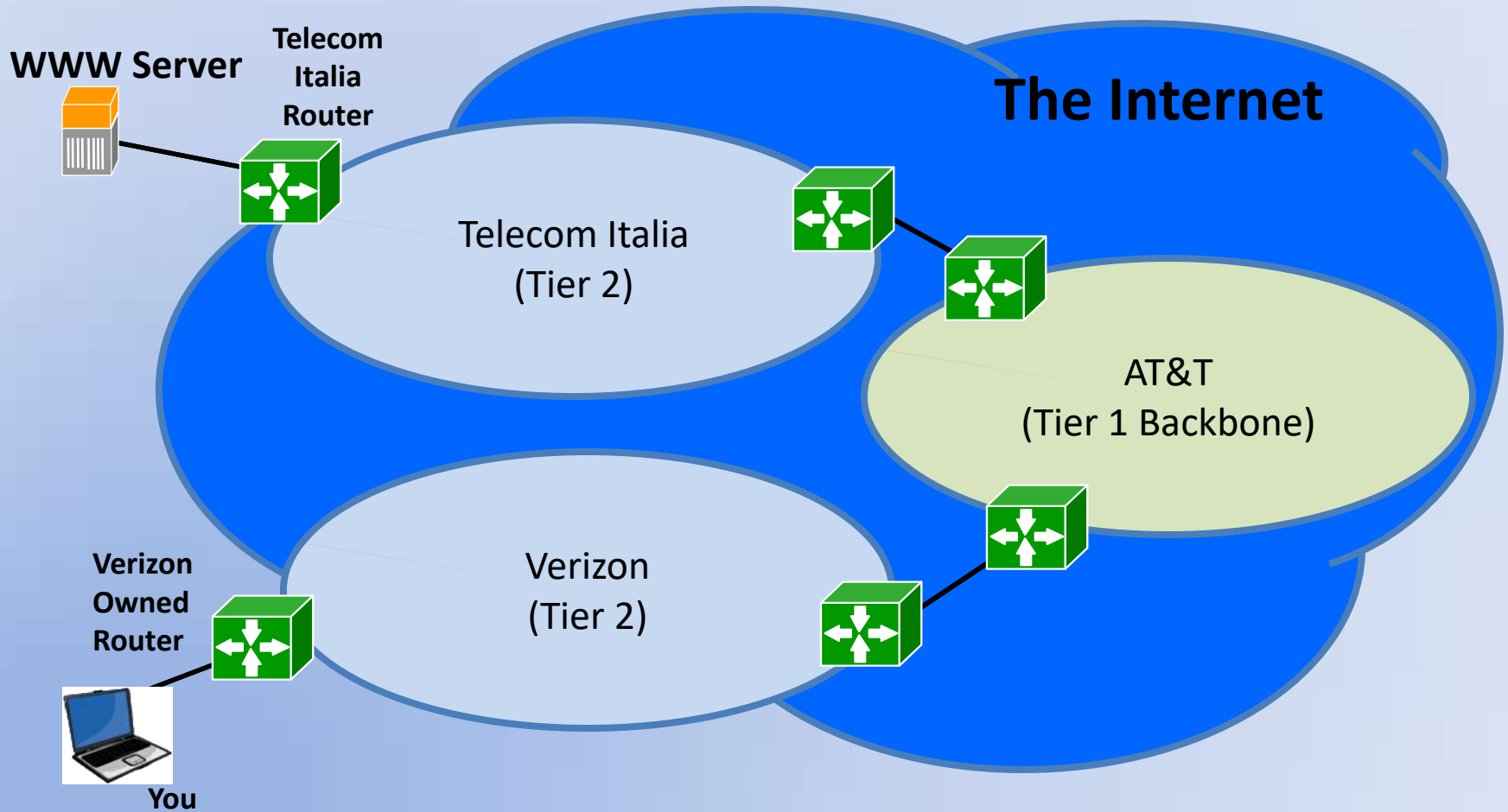
IPv4 Address Allocations (2012)

Country	IP addresses	Population	IP add/1000 pop
US	1,541,605,760	313,847,465	4912
Bogons	875,310,464		
China	330,321,408	1,343,239,923	246
Japan	202,183,168	127,368,088	1,587
UK	123,500,144	63,047,162	1,959
Germany	118,132,104	81,305,856	1,453
South Korea	112,239,104	48,860,500	2,297
France	95,078,032	65,630,692	1,449
Canada	79,989,760	34,300,083	2,332
Italy	50,999,712	61,261,254	833

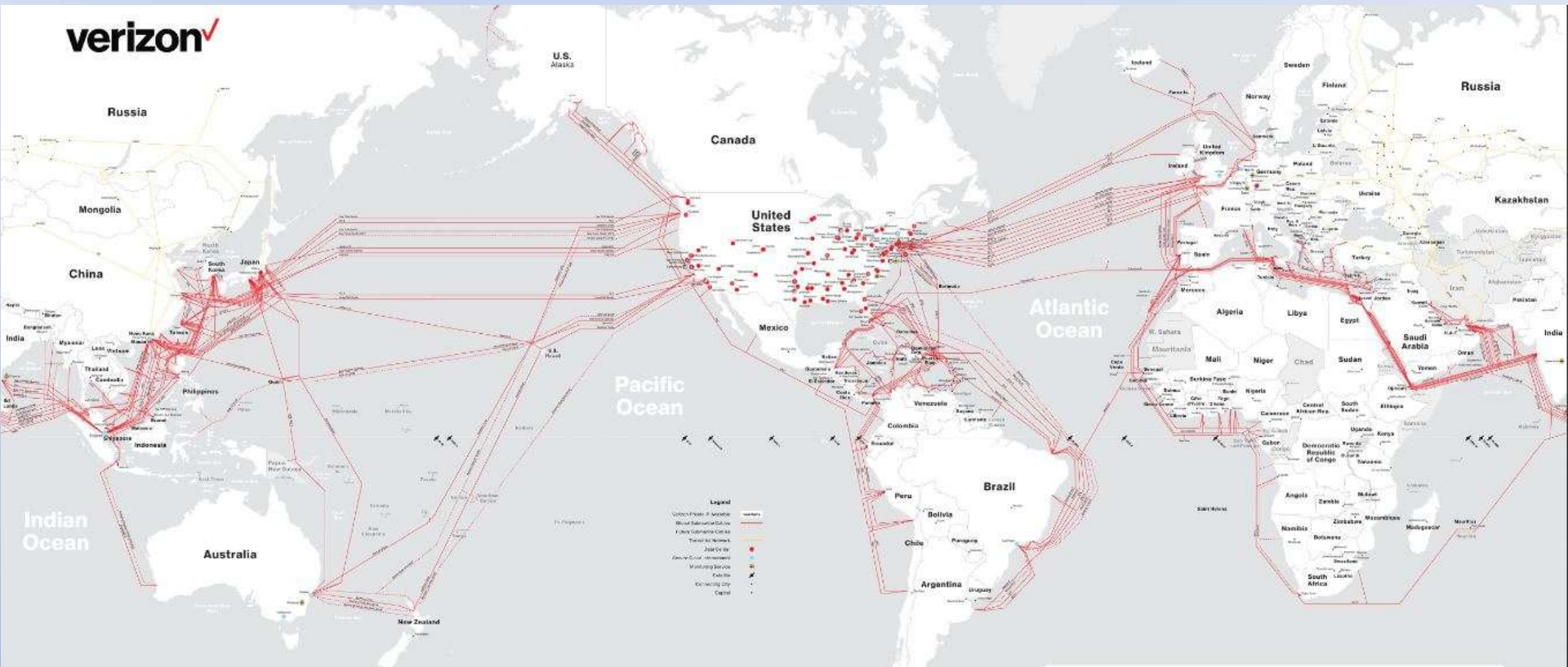
Tier 2 ISPs



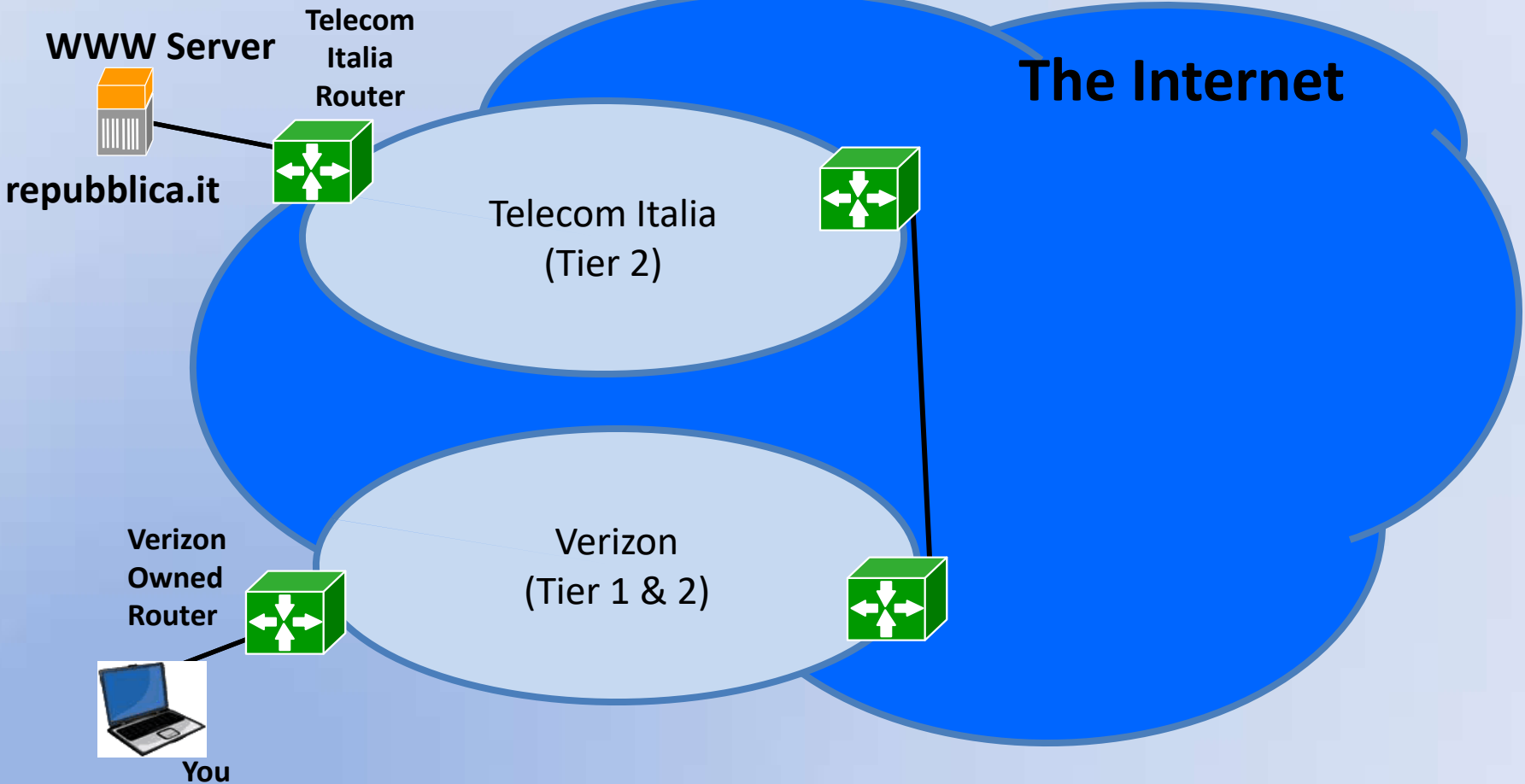
Tier 1 ISPs



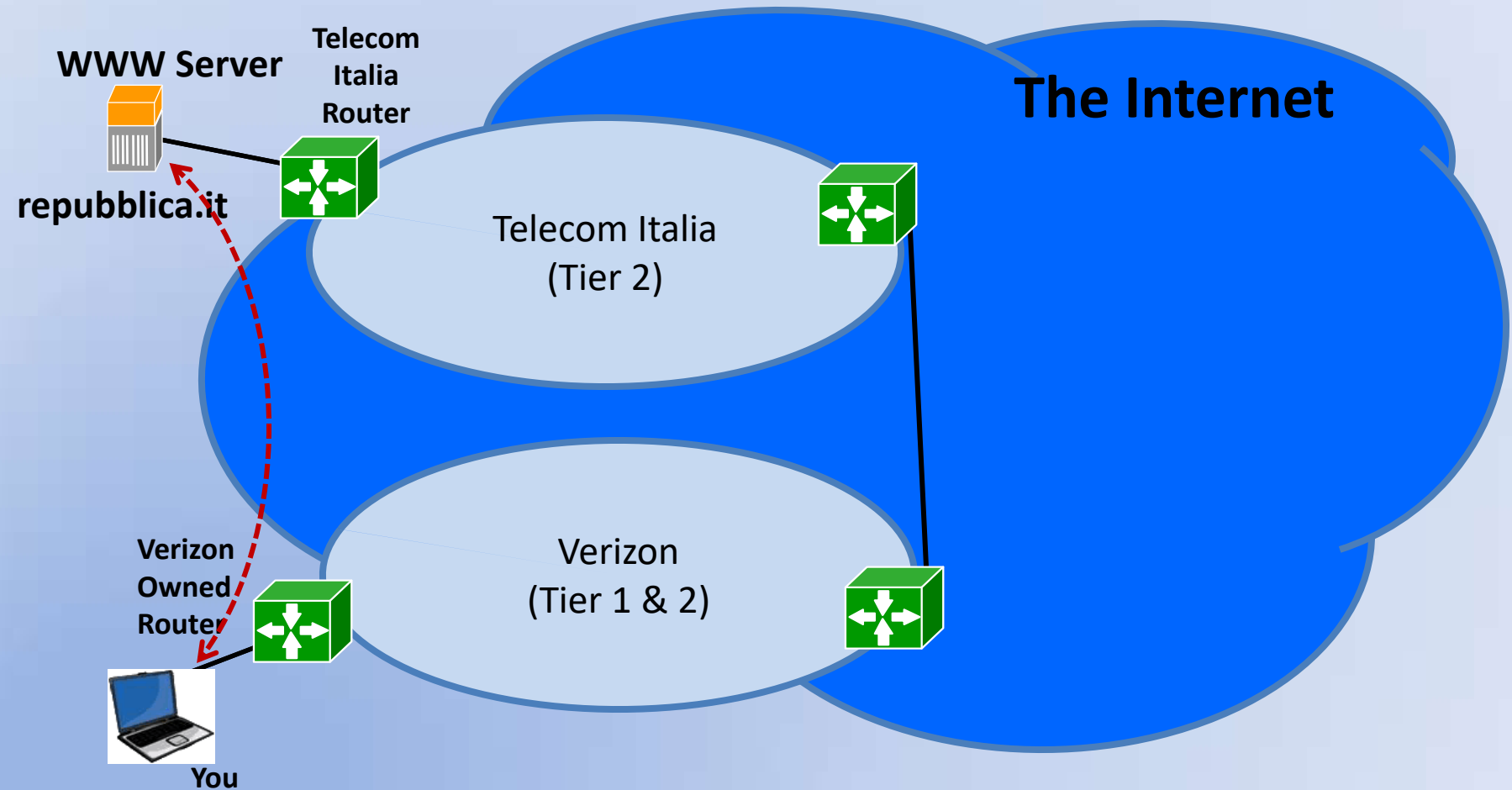
Verizon



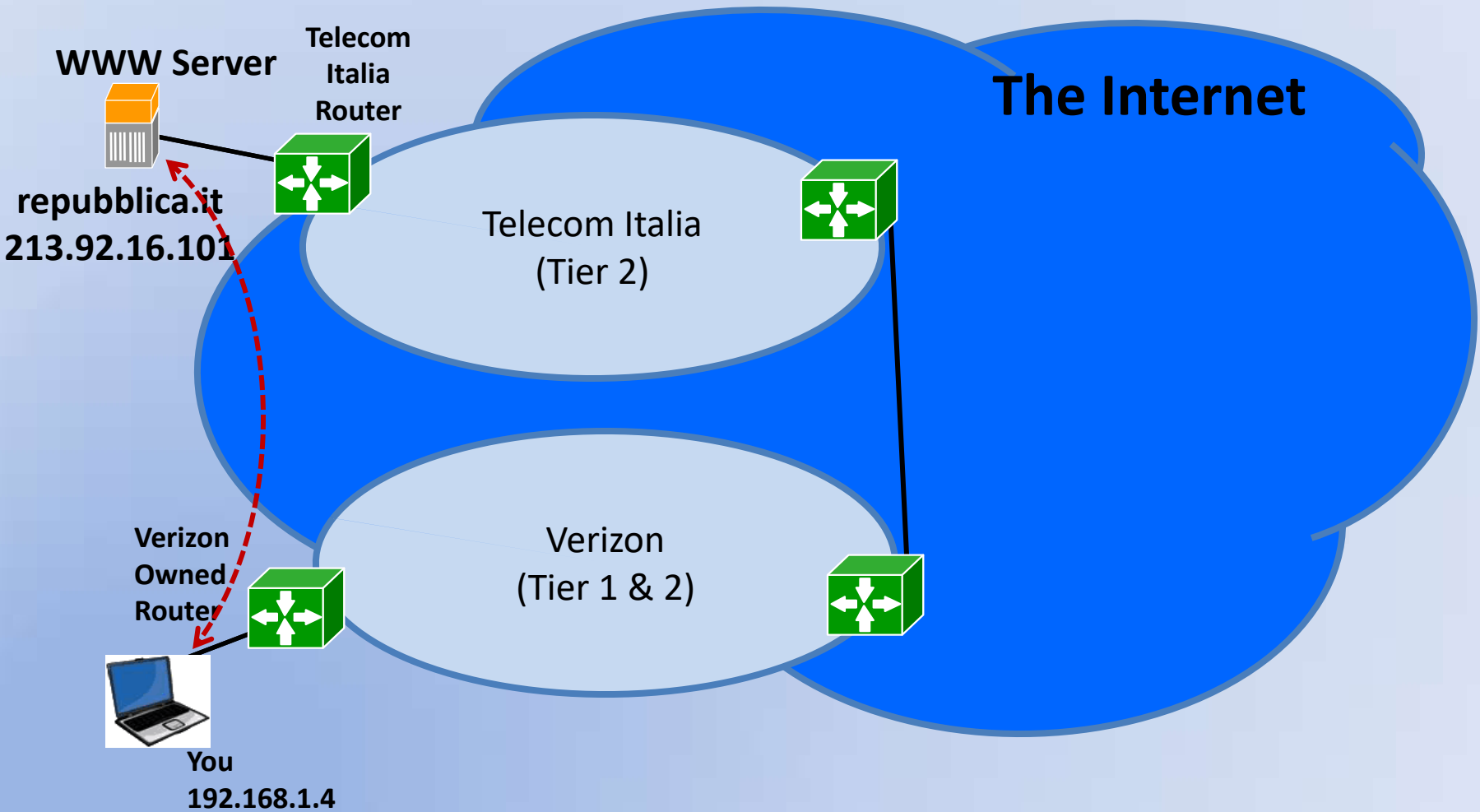
Tier 1 ISP and 2 ISP – More Likely



Get repubblica.it Page



Get repubblica.it Page





Bob Dylan non ritirerà il Nobel "Onorato, ma ho altri impegni"

Lettera all'Accademia dopo mese di silenzio
Cerimonia il 10 dicembre col re di Svezia

RepTv Castaldo: vuole demolire la sua leggenda
Foto Sessant'anni di musica e poesia - **Videoscheda**

Canzoni e strofe memorabili Il primo concerto dopo l'annuncio del premio

8,3mila condivisioni

104 commenti

Disoccupazione, l'annuncio di Renzi: "Nel 2017 decontribuzione totale per chi assume al Sud"

SPORT

SPETTACOLI

MUSICA

BEAUTY



Da Cruyff a Guardiola se il sesso diventa un dilemma

Messi: rinnovo da 50 milioni l'anno
Nazionale: Ventura comincia casting

di NICOLA SELLITTI e FRANCESCO SAVERIO

How To Get The IP Address

Domain Name System - DNS

- Top Level Domains
 - com, gov, edu, it, etc.
- google.com
 - google.com is called the “domain name”
- Name server
 - Computer that translates domain names into IP addresses
 - Authoritative for domains under its control
 - May cache copies of other authoritative name servers

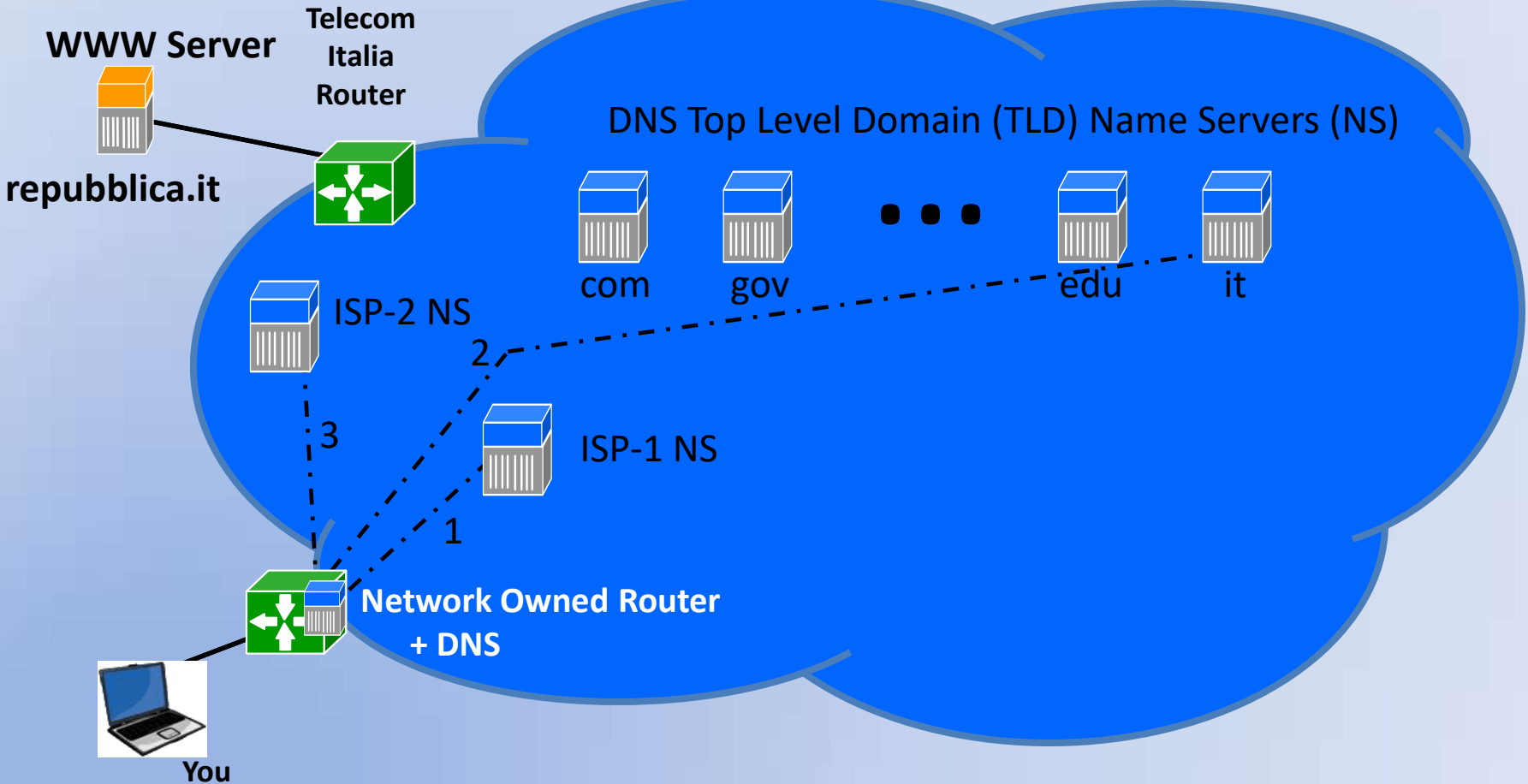
URL: Uniform Resource Locator

<https://www.digitalocean.com/community/tutorials/an-introduction-to-dns-terminology-components-and-concepts>

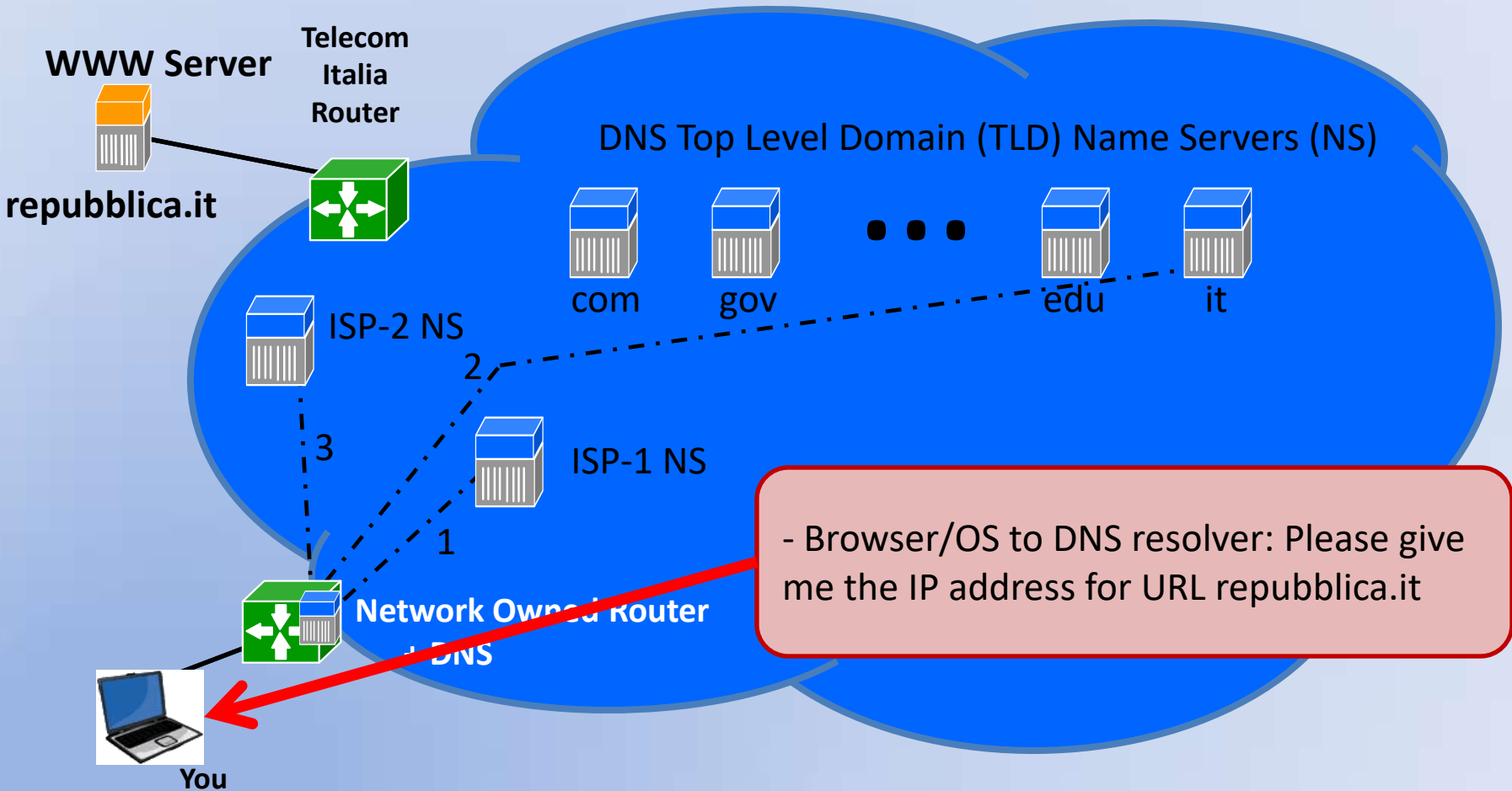
<http://blog.catchpoint.com/2014/07/01/dns-lookup-domain-name-ip-address/>

<http://blog.catchpoint.com/2010/09/17/anatomyhttp/>

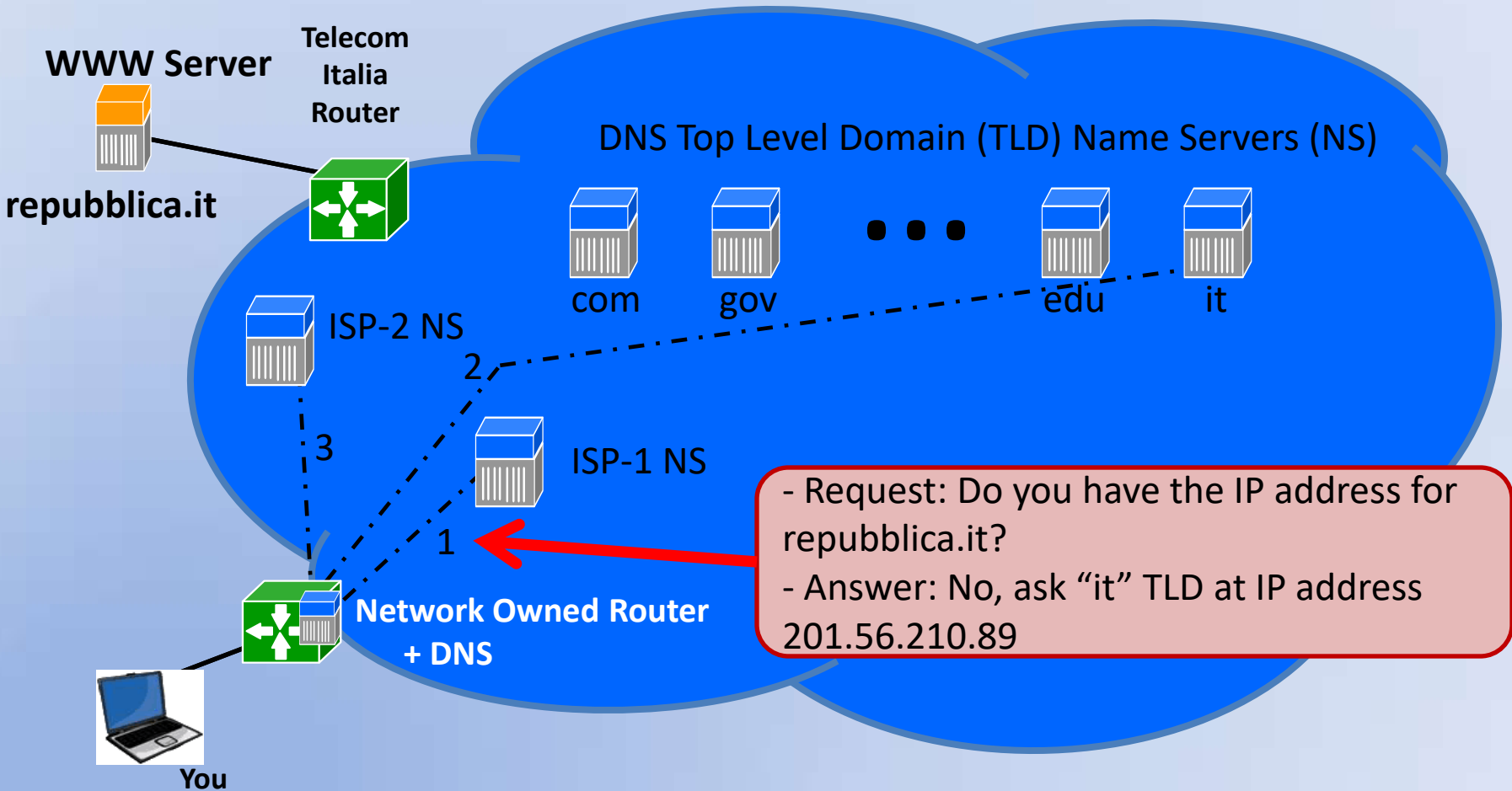
DNS Architecture



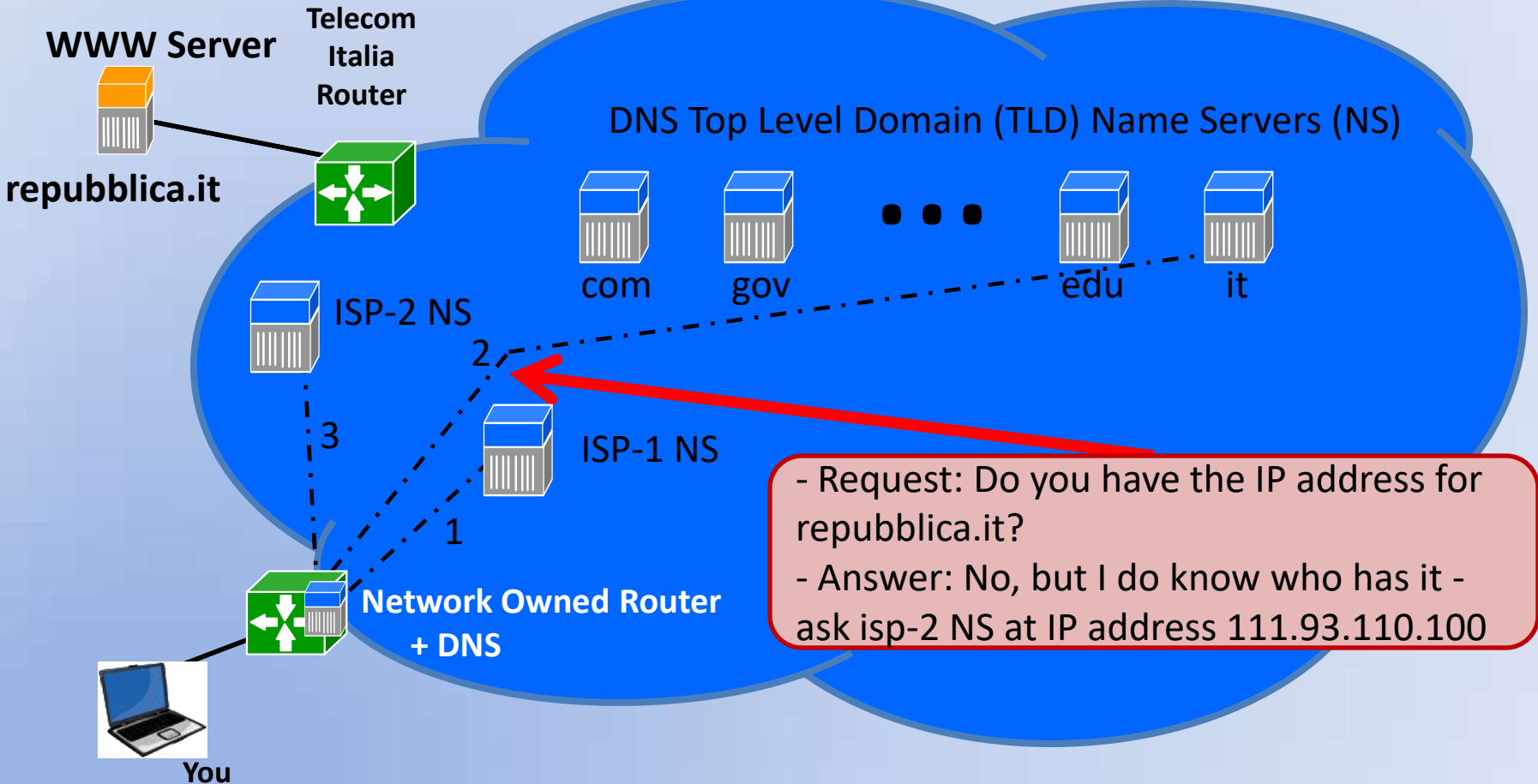
DNS Architecture



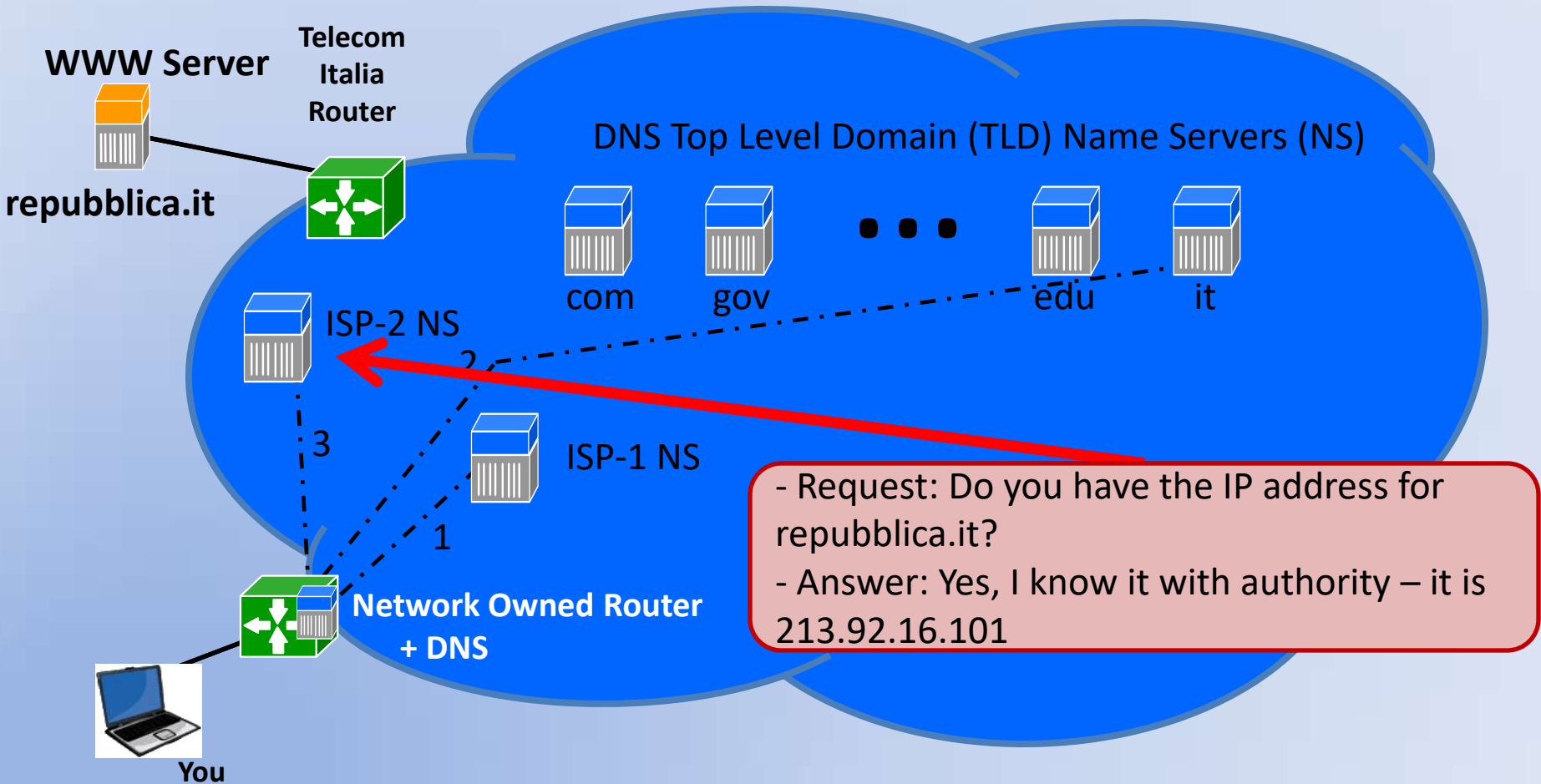
DNS Architecture



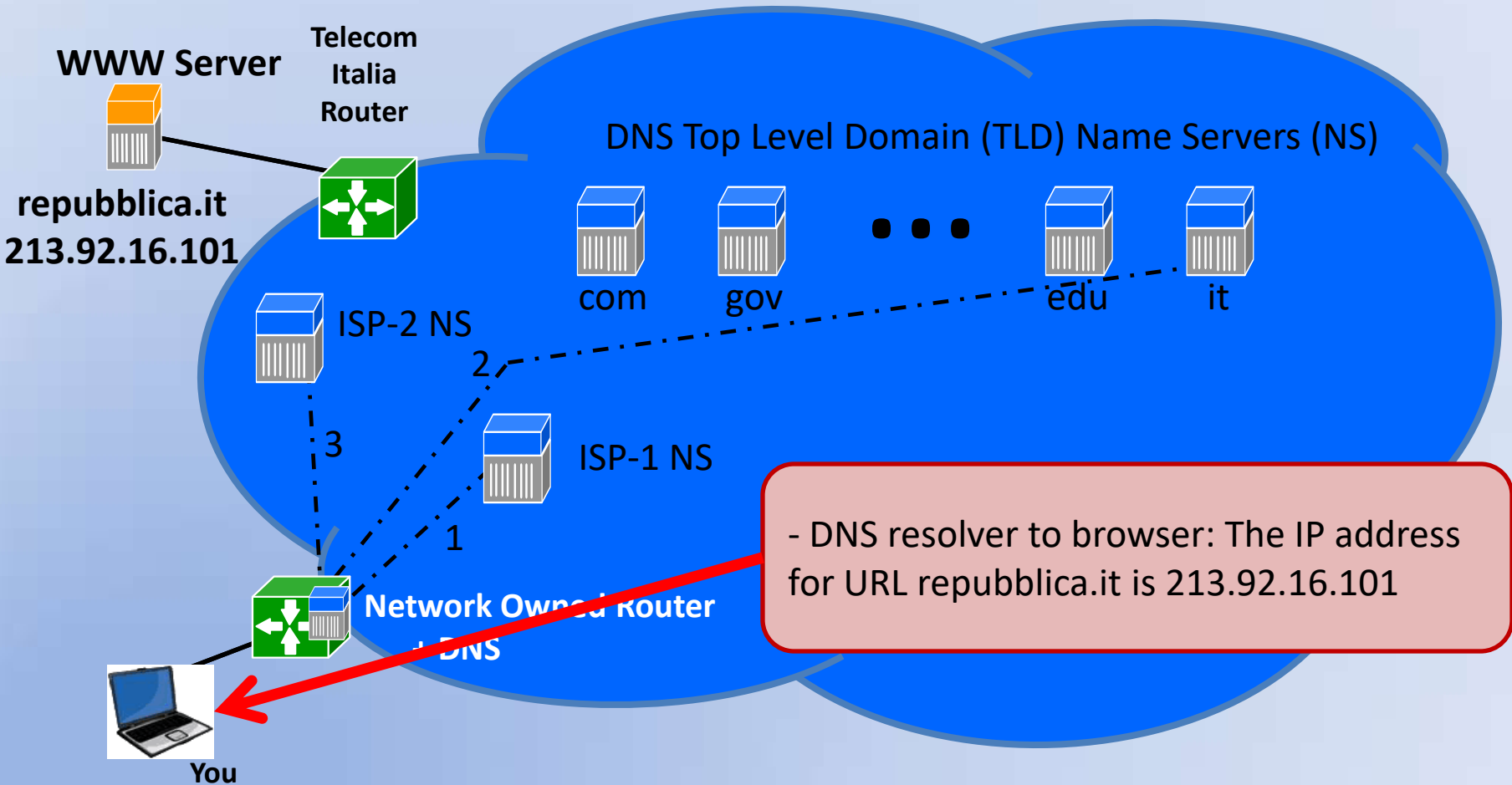
DNS Architecture



DNS Architecture



DNS Architecture



Domain Registration

- ICANN (Internet Corporation for Assigned Names and Numbers)
 - International non-profit organization
 - Responsibilities
 - IP address and domain name management
 - Top level domain servers management
 - Registrars
 - Companies that sell domain names to individuals and organizations
 - US: Belmontdomains.com, Name.com, Register.com, many more

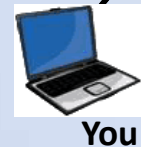
How To Deliver The Packet



You

How Do You Connect

- You connect via
 - Home LAN (Including WiFi)
 - Public WiFi hot spots
 - Smartphones (Mobile network)
 - Acoustic couplers



How Do ISPs Connect To You

- You connect via
 - Home LAN (Including WiFi)
 - Public WiFi hot spots
 - Smartphones (Mobile network)
 - Acoustic couplers
- ISPs connect to you via
 - Router plus WAN
 - DSL
 - Coax cable
 - Fiber
 - Satellite
 - Cell Towers



Router

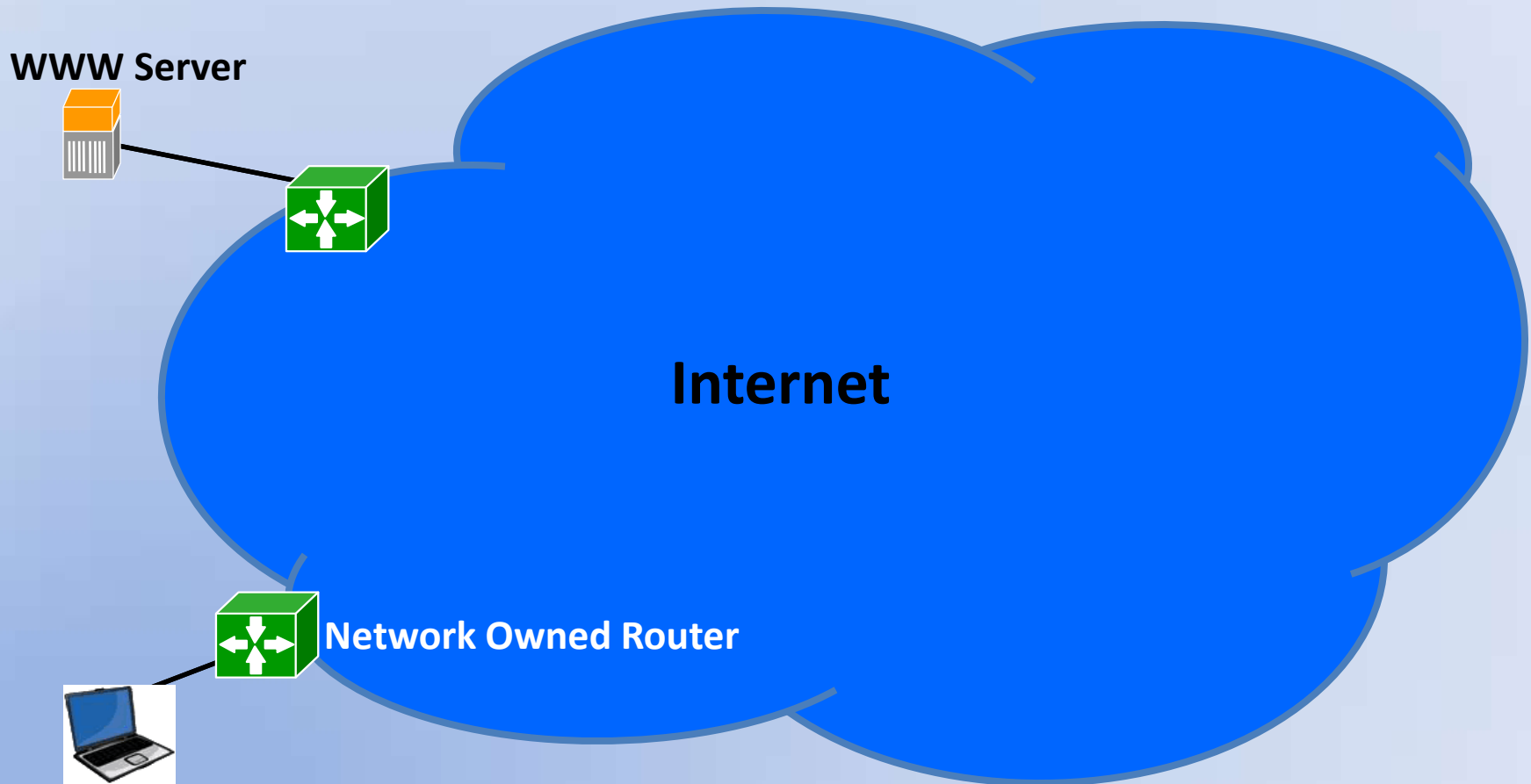
Twisted pair

Coax

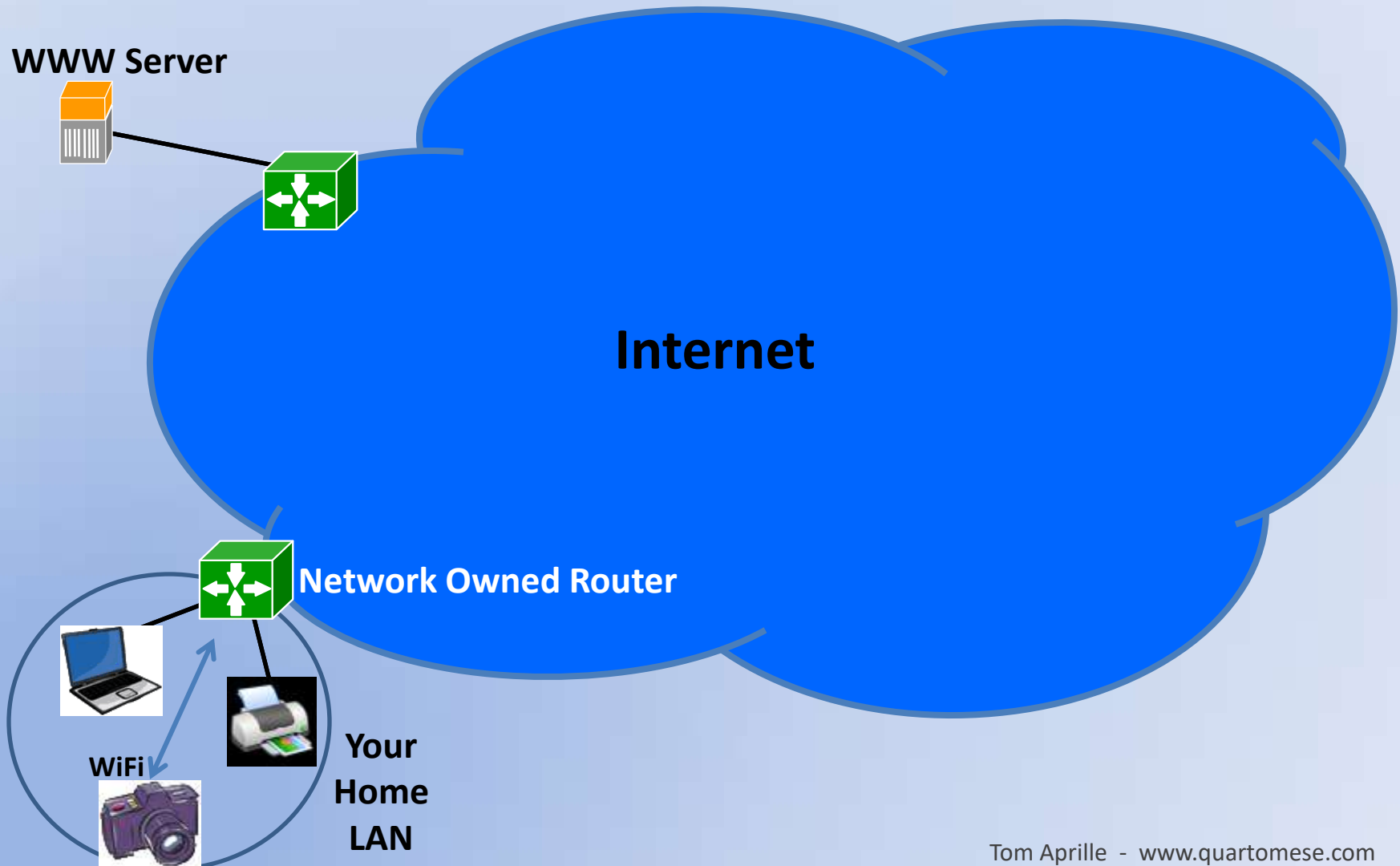
Fiber



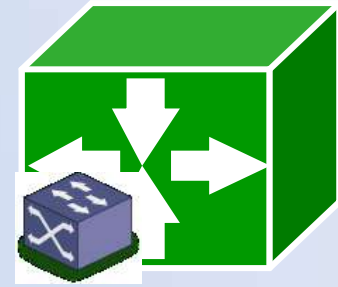
Your Home Local Area Network (LAN)



Your Home Local Area Network (LAN)



ISP Supplied Network Router

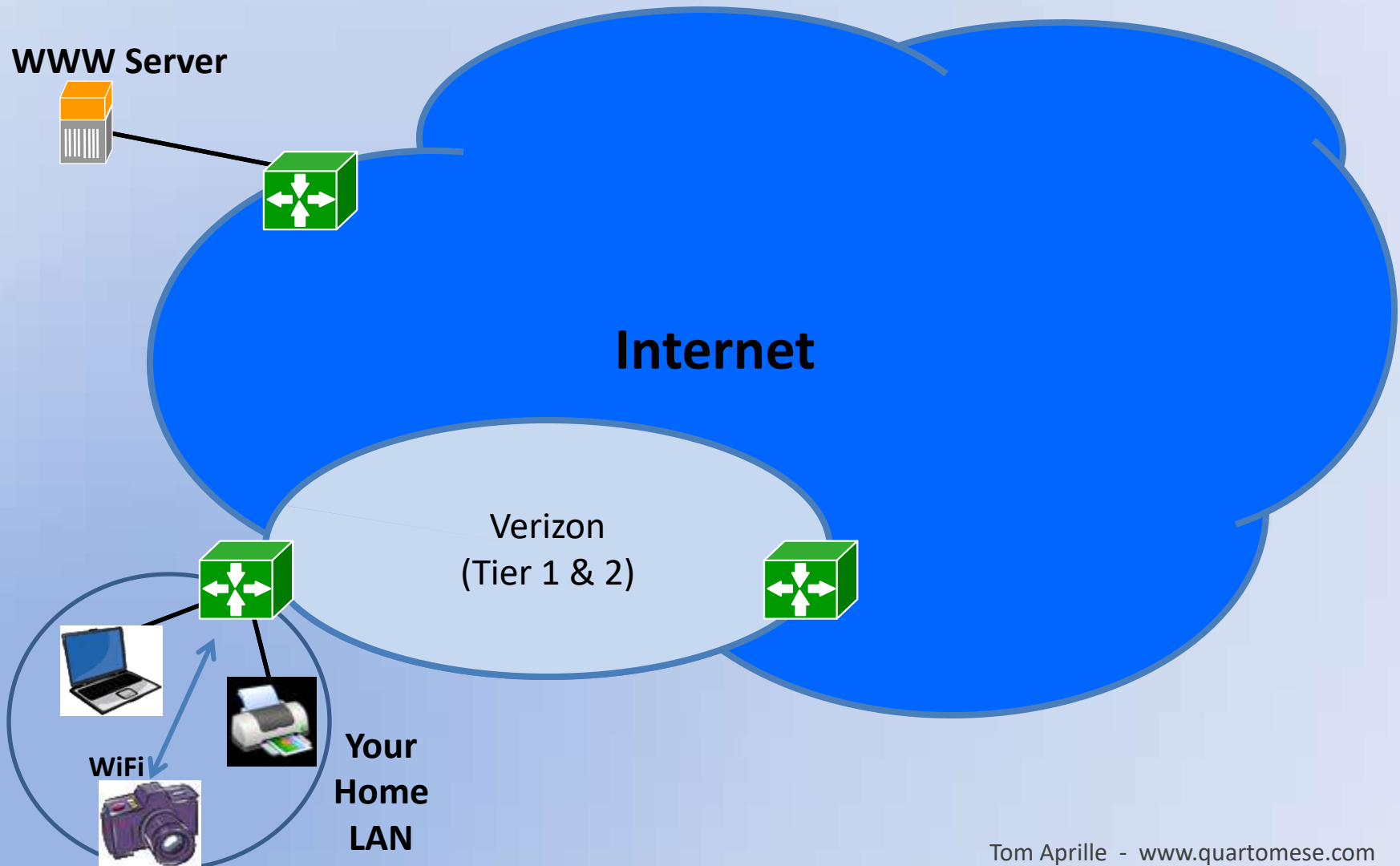


Home router

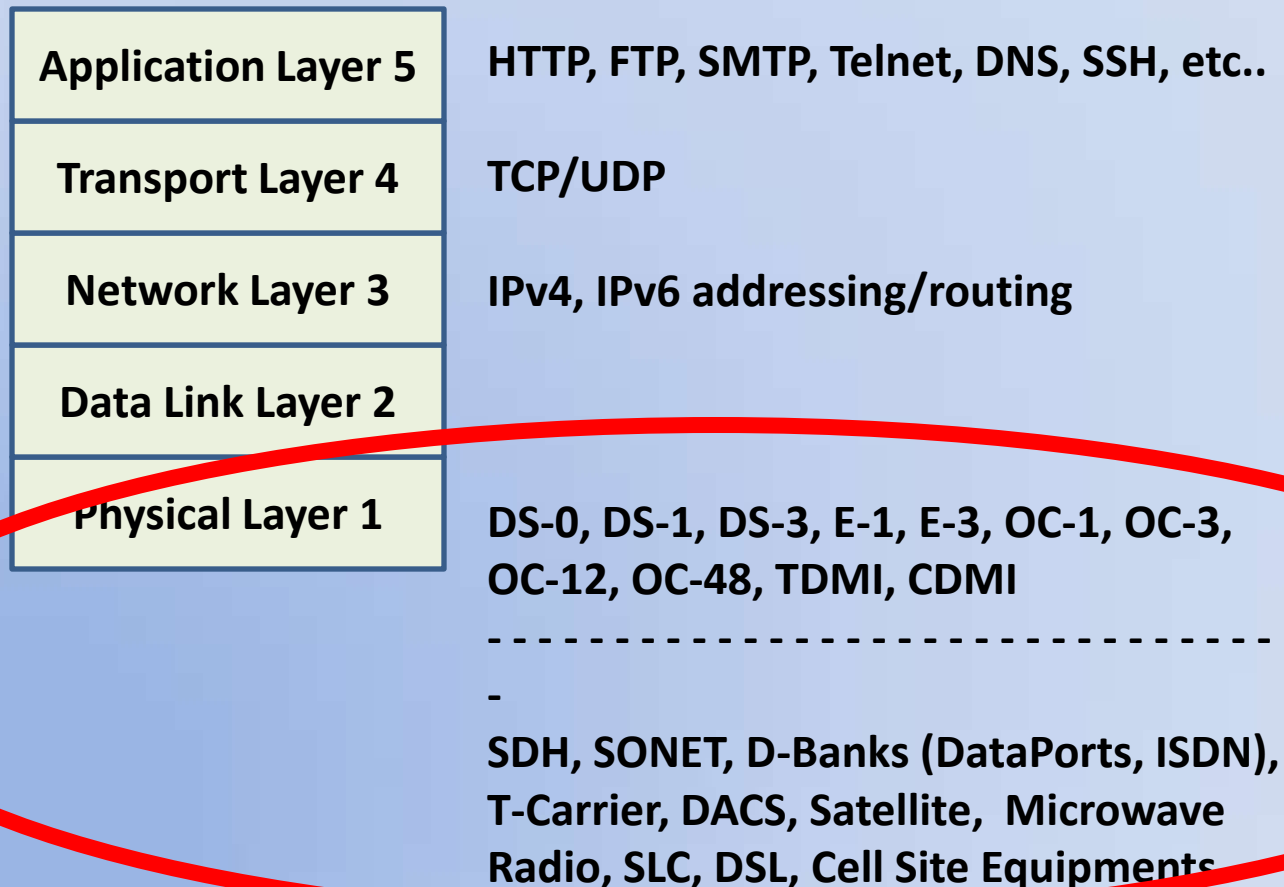
Your Home Local Area Network (LAN)

Application Layer 5	HTTP, FTP, SMTP, Telnet, DNS, SSH, etc.
Transport Layer 4	TCP/UDP
Network Layer 3	IPv4, IPv6 addressing/routing
Data Link Layer 2	Ethernet protocol (ARP. ...)
Physical Layer 1	Ethernet media (MAC address, 10BASE-T, ...)

Your ISP's Wide Area Network (WAN)



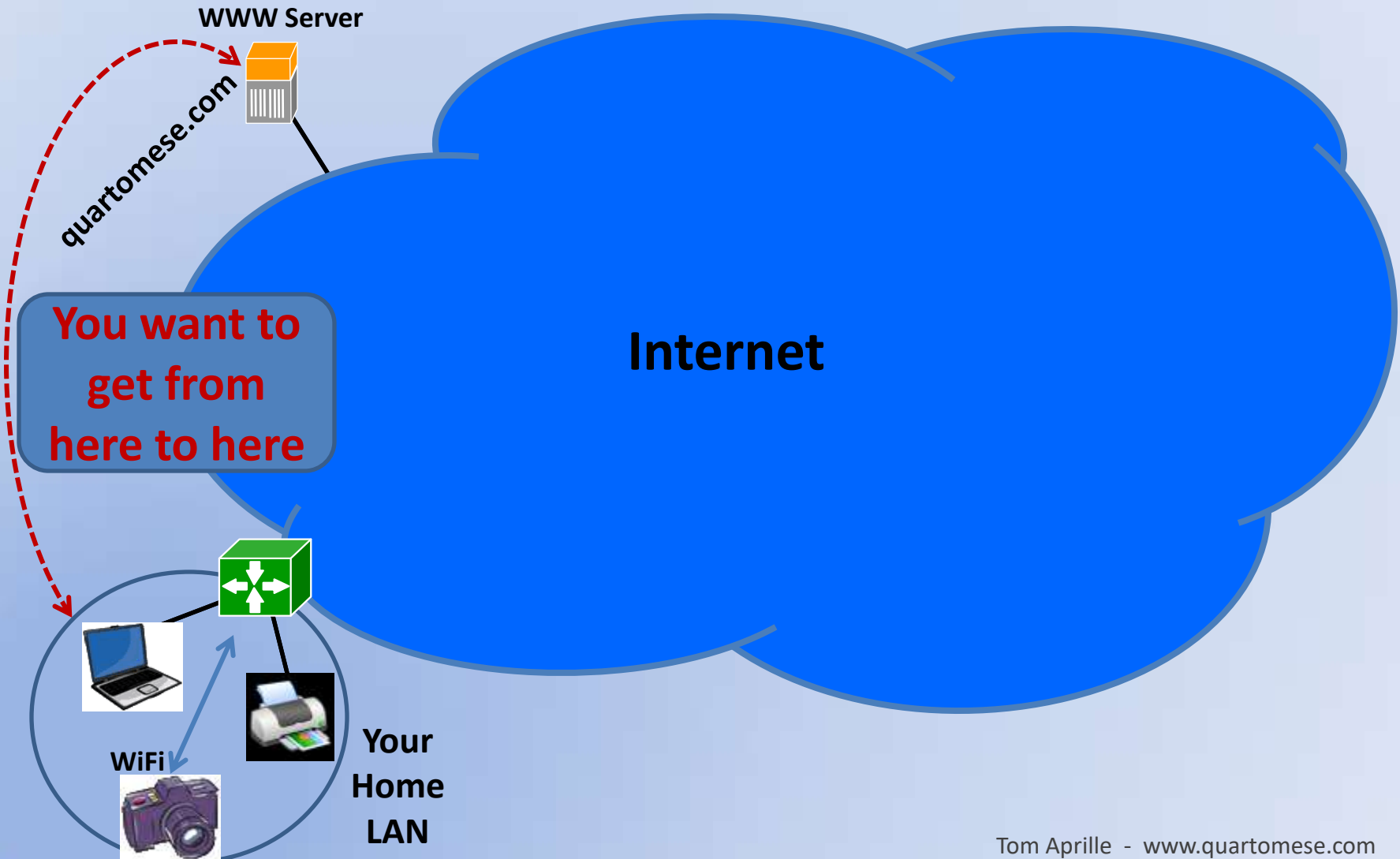
ISP WAN Physical Layer 1



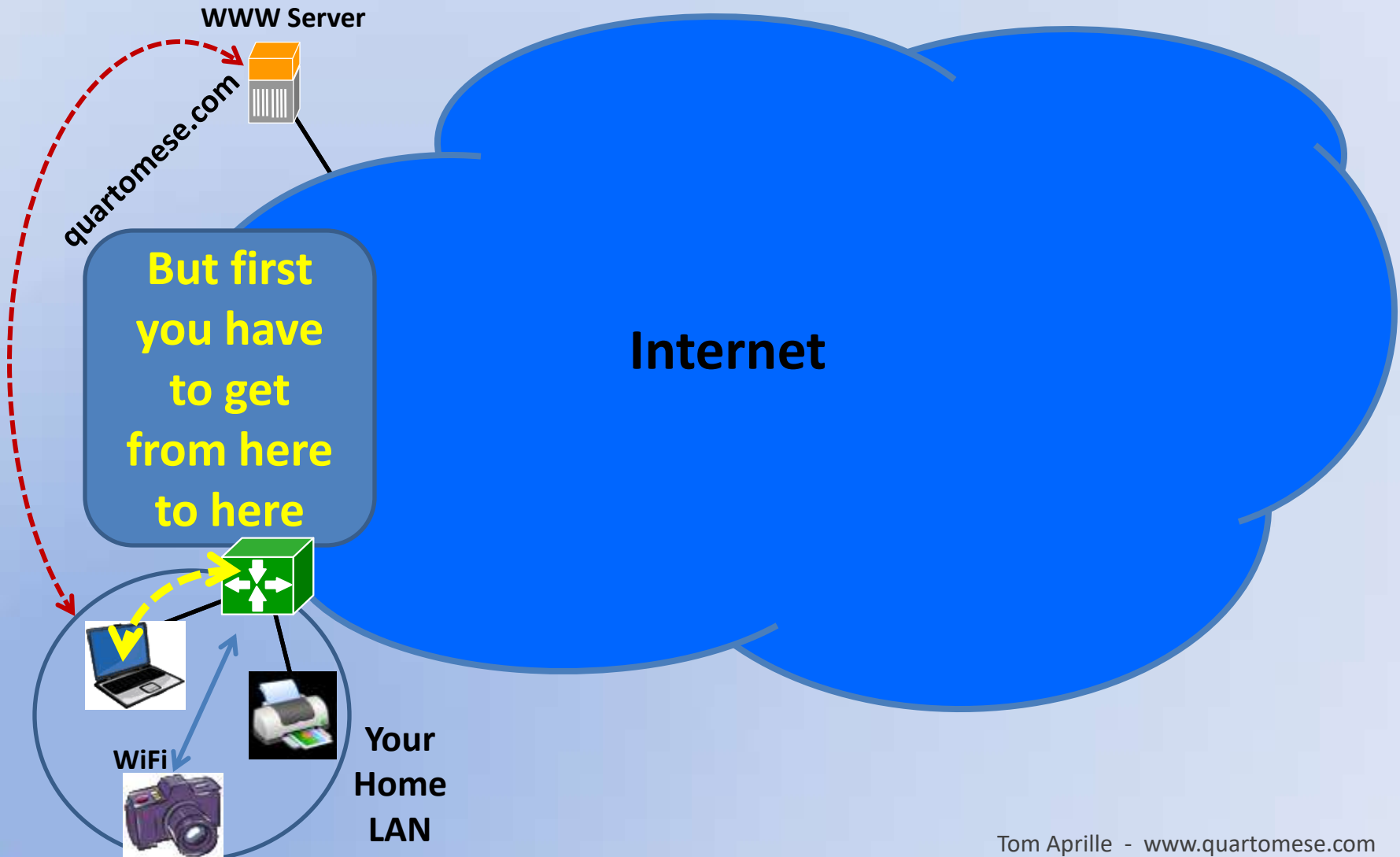
How Does An Ethernet LAN Work



How Does The LAN Work



How Does The LAN Work



How Does The LAN Work

WWW Server

quartomese.com



**But first
you have
to get
from here
to here**

The LAN interface does not understand Domain Names
The LAN interface does not understand IP addresses
The LAN interface only understands MAC addresses
MAC = Media Access Controller



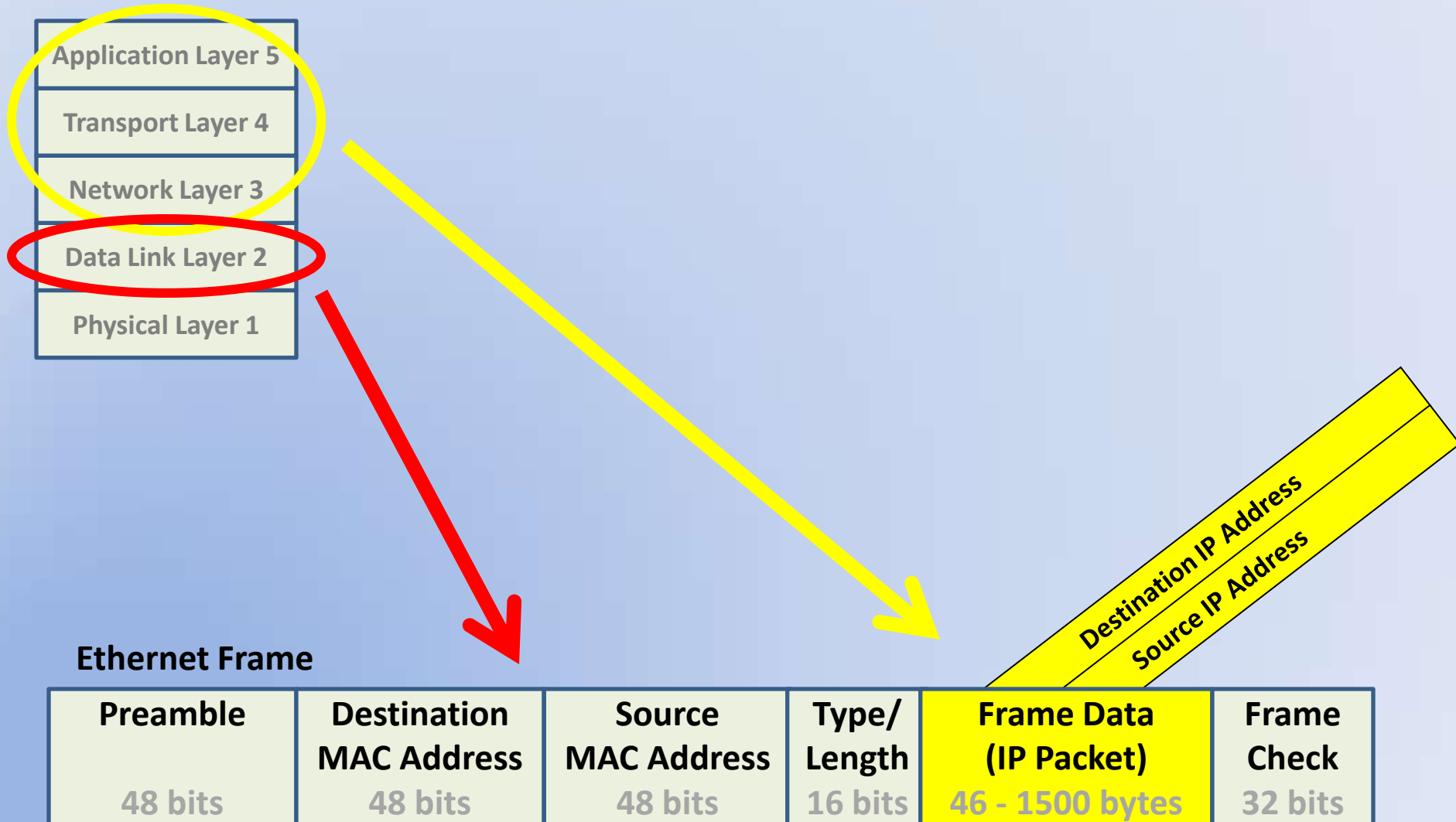
WiFi



Your
Home
LAN

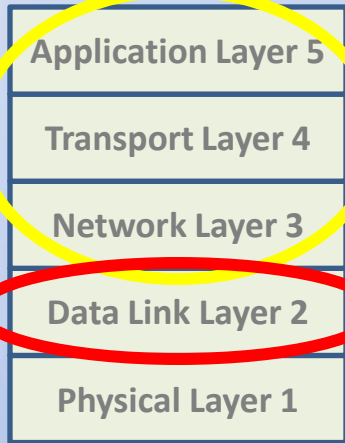
How Does The LAN Work

Ethernet Frame Makeup



How Does The LAN Work

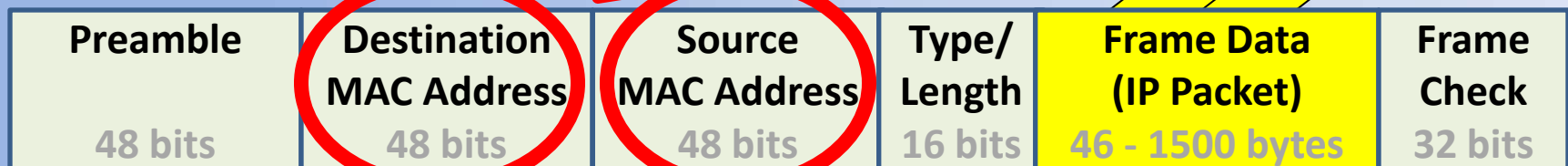
Ethernet Frame Makeup



MAX Equipment Addresses

- 6 bytes long
- Burnt in

Ethernet Frame



How Does The LAN Work

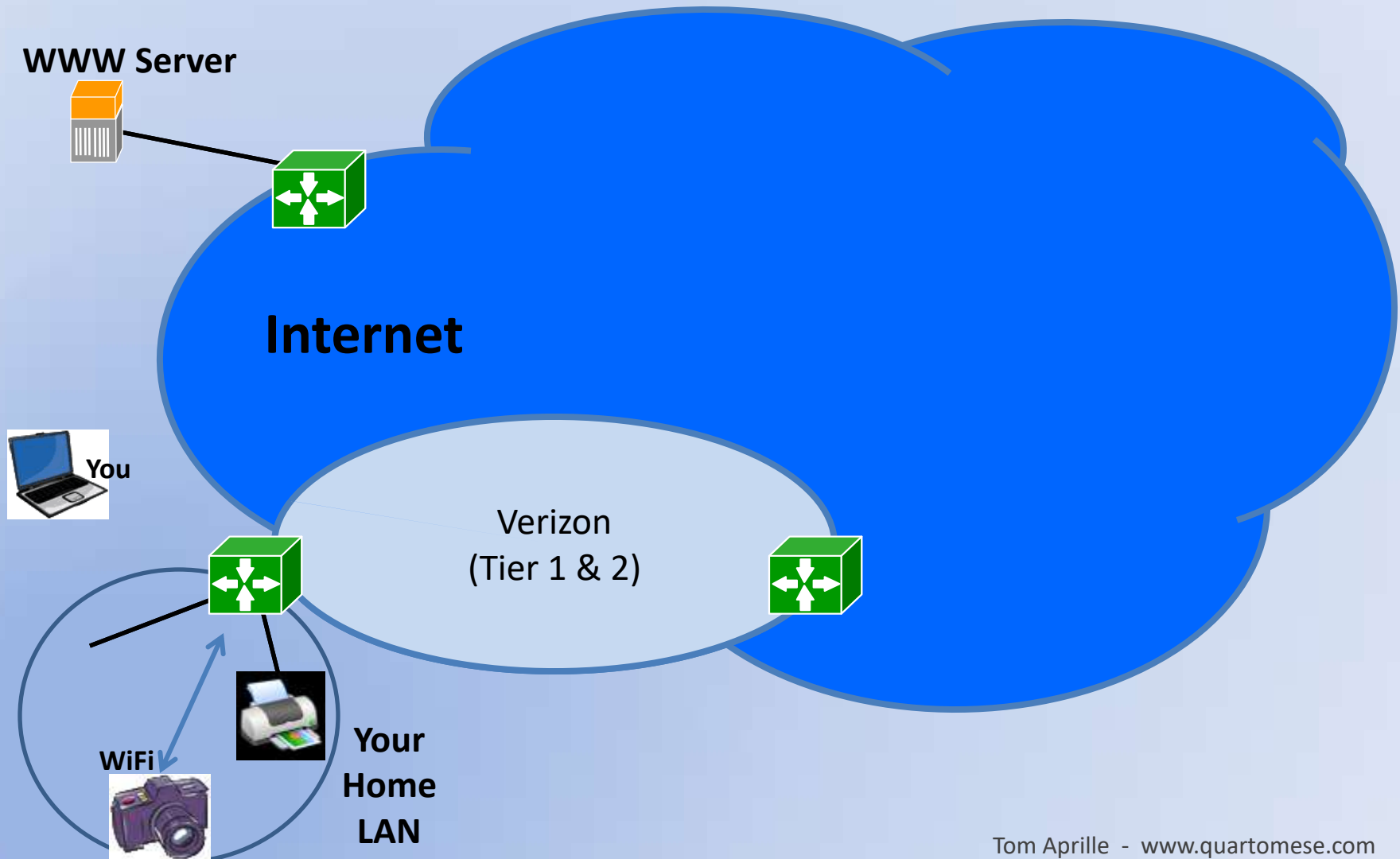
LAN Frame Transport

1. Device 1 checks if Device 2 IP address is on same network as Device 1 IP address
 - A. If Yes
 - a) Device 1 sends local LAN ARP broadcast asking for the MAC address of Device 2
 - b) Device 2 responds to Device 1 with its MAC address
 - c) Device 1 uses the MAC address to send frame to Device 2
 - B. If No
 - a) Device 1 sends local LAN ARP broadcast asking for the MAC address of the default gateway router
 - b) The gateway router responds to Device 1 with its MAC address
 - c) Device 1 uses the MAC address to send frame to the router
 - d) Etc....

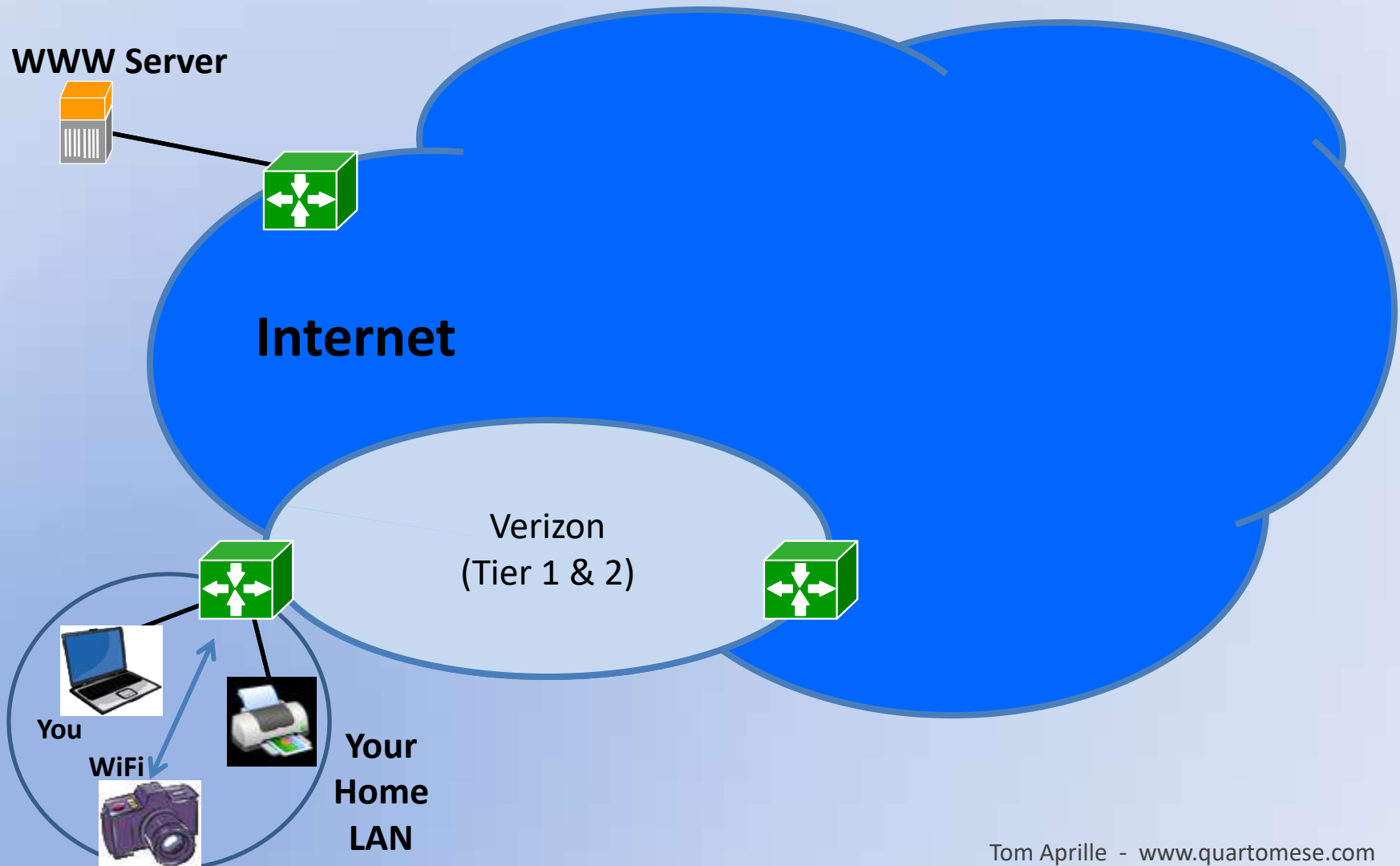
How Does It
All Work Together
In The Beginning ...

Connecting To The Network

Not Connected



Connecting To The Network Connected



Connecting To The Network Hand-Shake

WWW Server



Internet

Router & PC NIC cards recognized - green light
- Via NIC card link layer keep alive signals
PC NIC broadcasts DHCP discover message onto LAN
- Who has the DHCP server
- Somebody give me an IP address
The DHCP server in most all cases is your home router

Verizon
(Tier 1 & 2)



You



WiFi

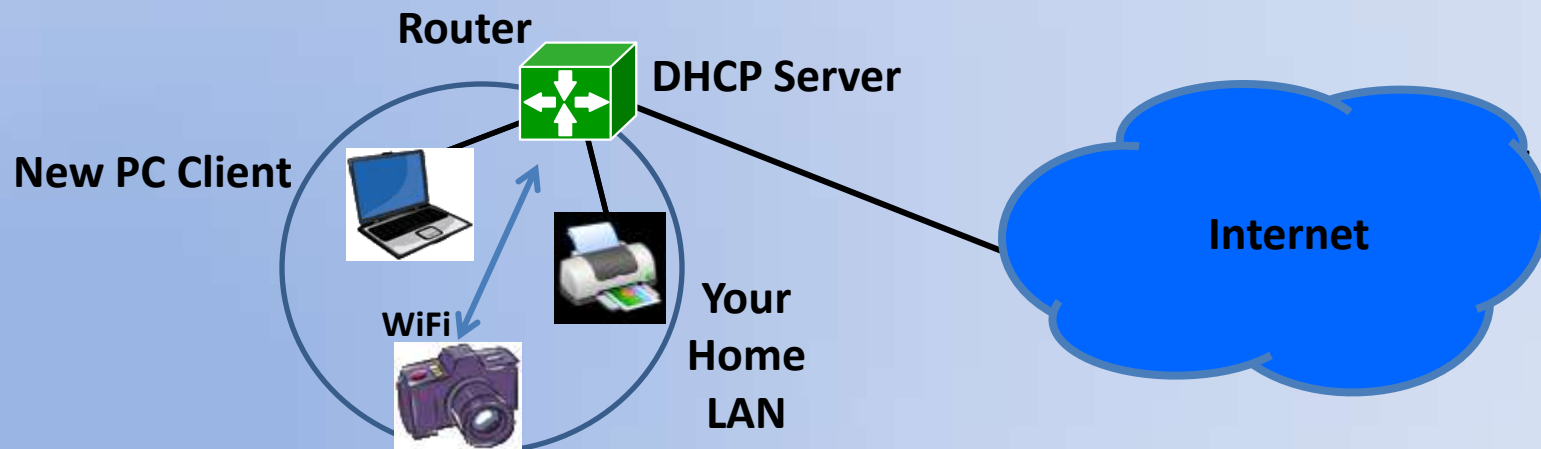


Your
Home
LAN



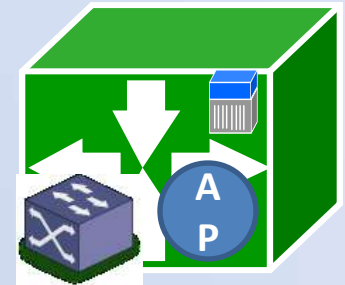
Dynamic Host Configuration Protocol

Source MAC Address	Source IP Address	Destination MAC Address	Destination IP Address	Transaction ID	DHCP Message Type	Function
PC Client	0 . 0 . 0 . 0	Broadcast	255.255.255.255	0x123	DHCP Discover	DHCP Available - I need an IP Address
DHCP Server	DHCP Server	Broadcast	255.255.255.255	0x123	DHCP Offer	How about 192.168.1.8
PC Client	0 . 0 . 0 . 0	Broadcast	255.255.255.255	0x123	DHCP Request	I agree to take 192.168.1.8
DHCP Server	DHCP Server	Broadcast	255.255.255.255	0x123	DHCP ACK	It's yours - goodbye



ISP Supplied Network Router

- Interconnects two networks
 - Your LAN network and the Internet
- 4 - 8 port Ethernet switch
- Integrated WiFi Access Point (AP)
- Network Address Translator
 - Multiple IP Hosts to 1 IP Address, Port Forwarding
- Routing table
- DHCP server
- DNS name server
- Gateway router function
- Firewall



Home router



In Summary

High-Level Internet Architecture

- There are four major IP Networking components
 - Hosts (client computers and server computers)
 - Hosts exchange application data via IP packets
 - Routers
 - Routers point IP packets to the next hop Router/Host
 - LAN/WAN
 - Between a Router/Host and a Router/Host there is a LAN or WAN
 - A LAN/WAN encapsulates the IP packet in a frame format
 - LAN/WAN physically transport frames to and from routers and hosts

The End