

Common Network Configuration Concepts



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Overview



Network configuration concepts

- IP Addressing
- DNS
- DHCP

Network ports and protocols

- TCP vs UDP



Network Configuration Concepts



Network Configuration Concepts

IP address

Subnet mask

Gateway

DNS

DHCP



IP Addressing

An Internet Protocol address (IP address) is a logical numeric address that is assigned to every single computer, printer, switch, router or any other device that is part of a TCP/IP-based network.



IP Addressing

IPv4

IPv6



IPv4 Address Basics

**Defined in RFC 791
(1981)**

**Internet Assigned
Numbers Authority
(IANA)**

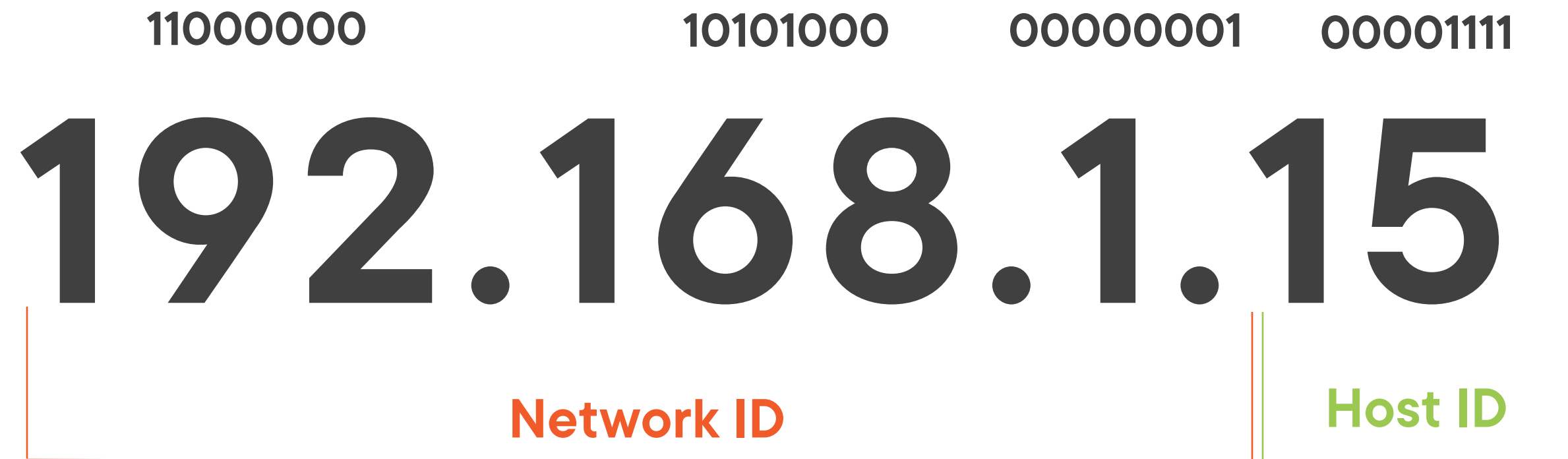
32 bits

4.2 billion addresses

**Public address pool
is exhausted**



IPv4 Structure



IPv4 Structure

192.168.1.15

11000000

10101000

00000001

00001111

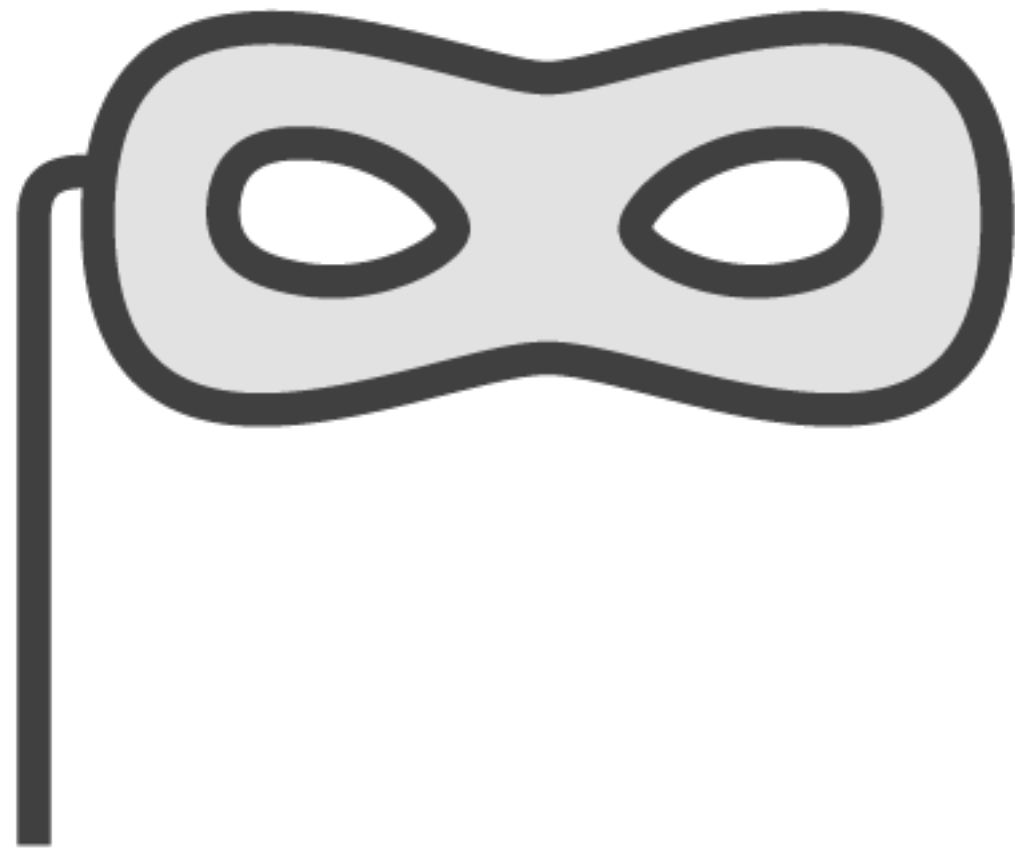
8 bits / 1 byte / 1 octet

32 bits / 4 bytes

$$(11111111)_2 = (255)_{10}$$



Subnet Mask



Used to determine what subnet a host is on
– **Sub network**

Parts of the IP address used for network and host are not fixed

Subnet mask is a 32-bit number



Subnet Mask Example

IP address - **192.168.123.132** - 11000000.10101000.01111011.10000100

Subnet mask **255.255.255.0** - 11111111.11111111.11111111.00000000

Network address **192.168.123.0** - 11000000.10101000.01111011.00000000

Host address **000.000.000.132** - 00000000.00000000.00000000.10000100



IPv4 Network Classes

Class	First Octet	Subnet Mask	Example IP
A	1-126	255.0.0.0	10.52.36.11
B	128-191	255.255.0.0	172.16.52.63
C	192-223	255.255.255.0	192.168.123.132
D	Multicast IP addresses		
E			
	Experimental IP addresses		



CIDR (Classless Inter-Domain Routing)

Class	First Octet	Subnet Mask	CIDR Mask
A	1-126	255.0.0.0	/8
B	128-191	255.255.0.0	/16
C	192-223	255.255.255.0	/24
D	Multicast IP addresses		
E			
	Experimental IP addresses		

Classless addressing: *Network break at any bit boundary*

192.168.0.0 /19 (255.255.224.0)

8 subnets with 8,190 hosts per subnet



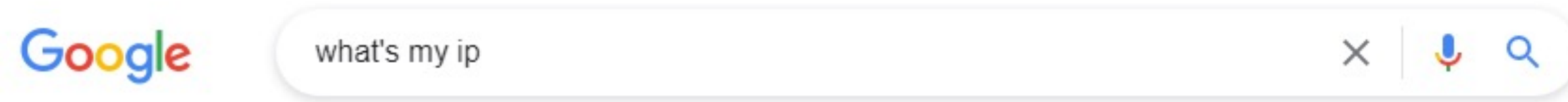
Private Addresses

RFC1918 Name	IP Address Range	Number of Addresses	Largest CIDR Block (Subnet Mask)
24-bit block	10.0.0.0 – 10.255.255.255	16,777,216	10.0.0.0/8 (255.0.0.0)
20-bit block	172.16.0.0 – 172.31.255.255	1,048,576	172.16.0.0/12 (255.240.0.0)
16-bit block	192.168.0.0 – 192.168.255.255	65,536	192.168.0.0/16 (255.255.0.0)

Network address translation (NAT) on router will remap (translate) to a public IP Address as we go on the internet



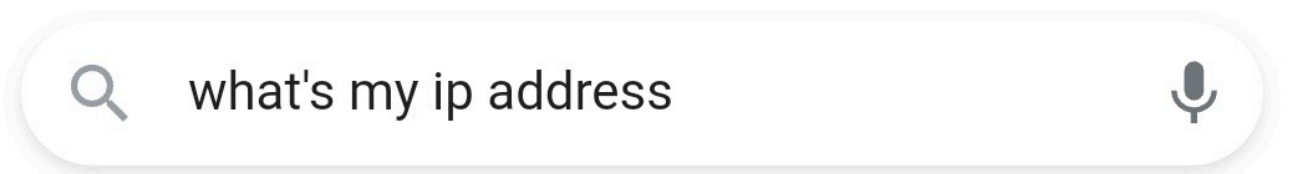
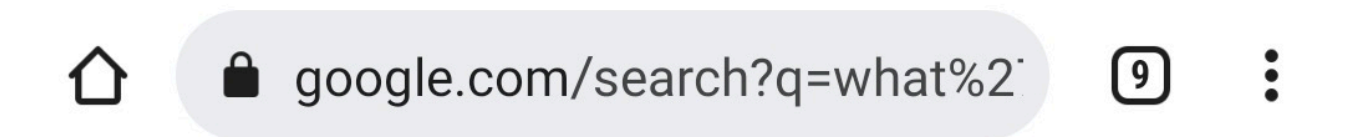
Test It Out – Your Public Address



[All](#) [News](#) [Maps](#) [Shopping](#) [Videos](#) [More](#) [Tools](#)

About 1,780,000,000 results (0.54 seconds)

What's my IP	⋮
184.163.0.88 Your public IP address	
→ Learn more about IP addresses	



[All](#) [News](#) [Shopping](#) [Videos](#) [Images](#) [Maps](#) [B](#)

What's my IP ⋮

184.163.0.88
Your public IP address

→ Learn more about IP addresses

IPv6

128 bits

**340,282,366,920,938,463,463,374,607,431,
768,211,456 addresses**

**Represented in
hexadecimals**

Co-exists with IPv4



IPv6 Structure

001000000000000001 000000000000000000 0011001000111000 110111111100001 00000000001100011
000000000000000000 000000000000000000 111111011111011

2001:0000:3238:DFE1:0063:0000:0000:FEFB

First discard leading Zero(es):

2001:0000:3238:DFE1:63:0000:0000:FEF

Then replace consecutive zeroes with double colon sign

2001:0000:3238:DFE1:63::FEF

Replace blocks of zero with a single zero

2001:0:3238:DFE1:63::FEF

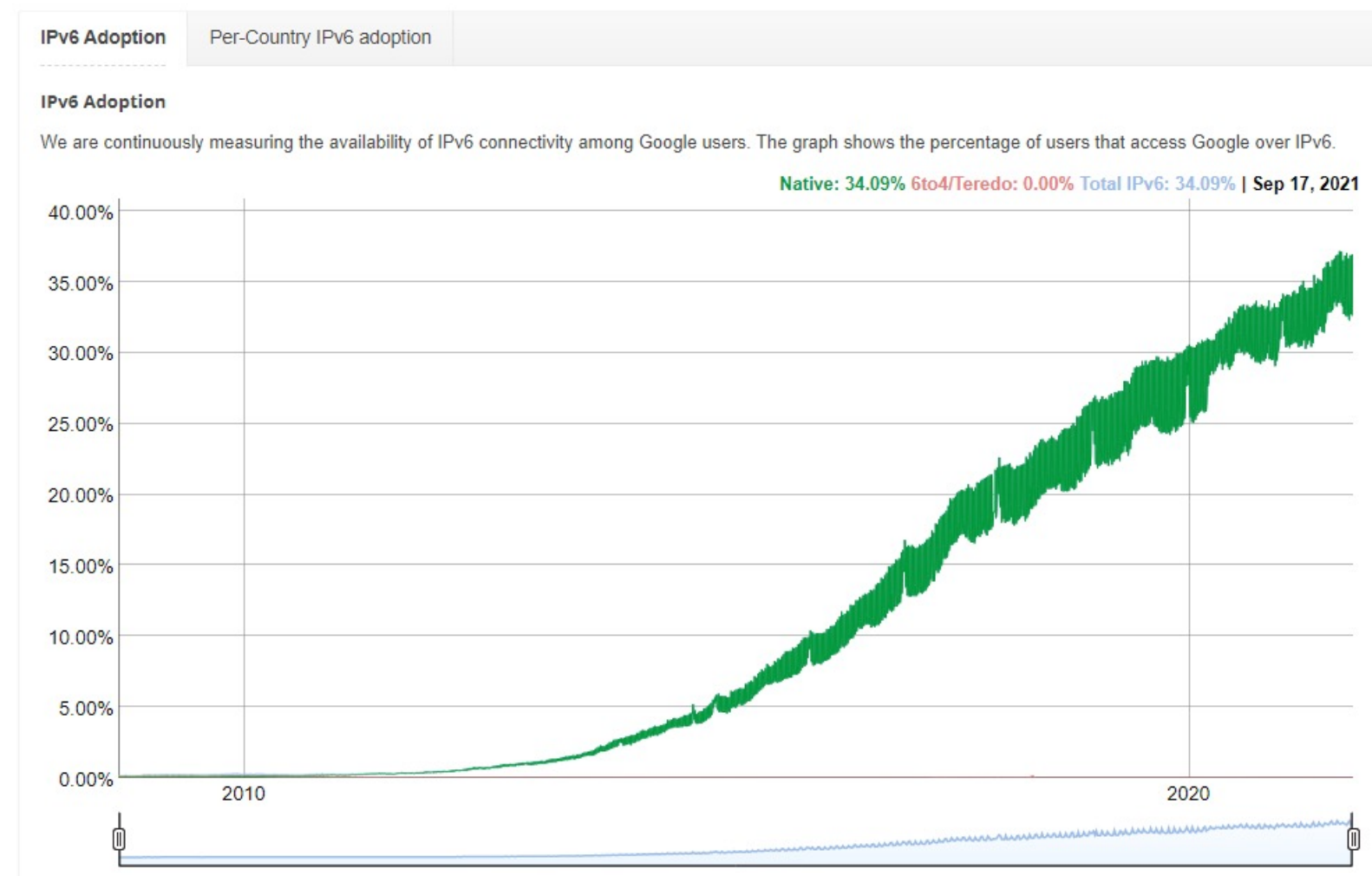


IPv6 Adoption – September 2021

Google IPv6

Statistics

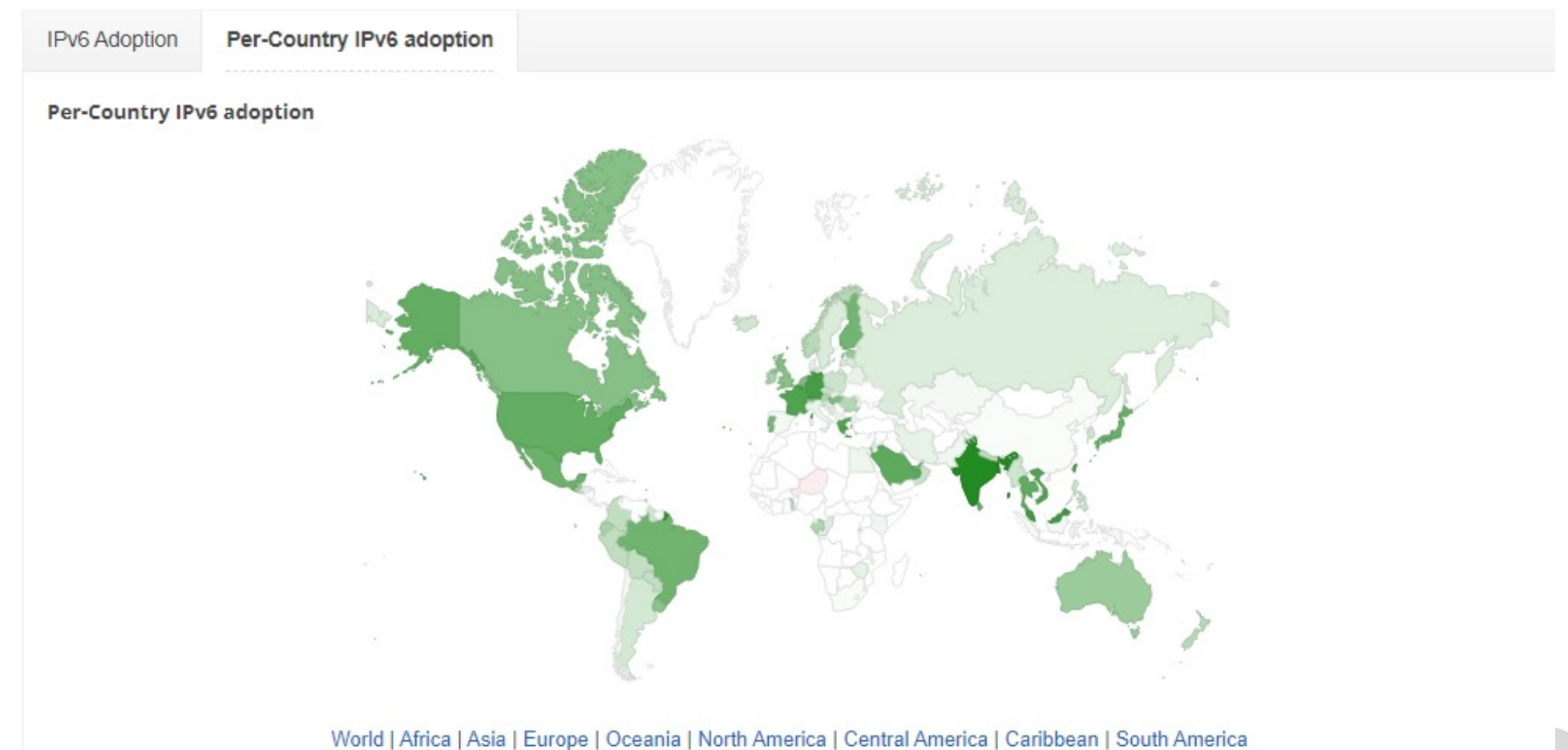
Google collects statistics about IPv6 adoption in the Internet on an ongoing basis. We hope that publishing this information will help Internet providers, website owners, and policy makers as the industry rolls out IPv6.



Google IPv6

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<https://www.google.com/intl/en/ipv6/statistics.html>



Getting an IP Address

The screenshot shows the 'Internet Protocol Version 4 (TCP/IPv4) Properties' dialog box with the 'General' tab selected. The 'Obtain an IP address automatically' radio button is unselected, and the 'Use the following IP address:' radio button is selected. The IP address field is filled with '192 . 168 . 2 . 89', the subnet mask with '255 . 255 . 255 . 0', and the default gateway with '192 . 168 . 2 . 1'. The 'Obtain DNS server address automatically' radio button is unselected, and the 'Use the following DNS server addresses:' radio button is selected. The preferred DNS server field is filled with '192 . 168 . 2 . 1', and the alternate DNS server field is empty. The 'Validate settings upon exit' checkbox is unchecked. The 'Advanced...' button is visible at the bottom right of the dialog box.

Static

The screenshot shows the 'Internet Protocol Version 4 (TCP/IPv4) Properties' dialog box with the 'Alternate Configuration' tab selected. The 'Obtain an IP address automatically' radio button is selected, and the 'Use the following IP address:' radio button is unselected. The IP address, subnet mask, and default gateway fields are empty. The 'Obtain DNS server address automatically' radio button is selected, and the 'Use the following DNS server addresses:' radio button is unselected. The preferred DNS server and alternate DNS server fields are empty. The 'Validate settings upon exit' checkbox is unchecked. The 'Advanced...' button is visible at the bottom right of the dialog box.

Dynamic



Dynamic Host Configuration Protocol (DHCP)



Every time a device connects to a network it gets an IP address

The IP address assignment expires after a set amount of time

The IP address gets assigned back to the pool of available addresses

DHCP Example – Home Router

DHCP

DHCP

ON

OFF

Router IP address:

192

.

168

.

2

.

1

Subnet mask:

255

.

255

.

255

.

0

↕

IP address range:

Start:

192

.

168

.

2

.

10

End:

192

.

168

.

2

.

254

Lease (DD:HH:MM):

3

↕

0

↕

0

↕

DHCP lease table

Clear all

Lease: 2:20:19

?

Unknown Device - 61

MAC: 18:b4:30:37:

IP: 192.168.2.44

Lease: 2:04:10

?

Unknown Device - 77

MAC: 3C:28:6D:03:

IP: 192.168.2.91

Lease: 1:11:54

🖨

VladQ

MAC: 1C:87:2C:B7:

IP: 192.168.2.89

Lease: 2:19:22

Cancel

Save

Cancel

Save



Automatic Private IP Addressing (APIPA)



Assign an IP address if DHCP is not available

- Also called Link-local address**

Can communicate on local network

- Not outside**

IPV4 – 169.254.0.0/16 (255.255.0.0)

- 169.254.0.1 – 169.254.255.254**

IPV6 – fe80::/64

Domain Name Server (DNS)

Core component of every network
Even the internet!

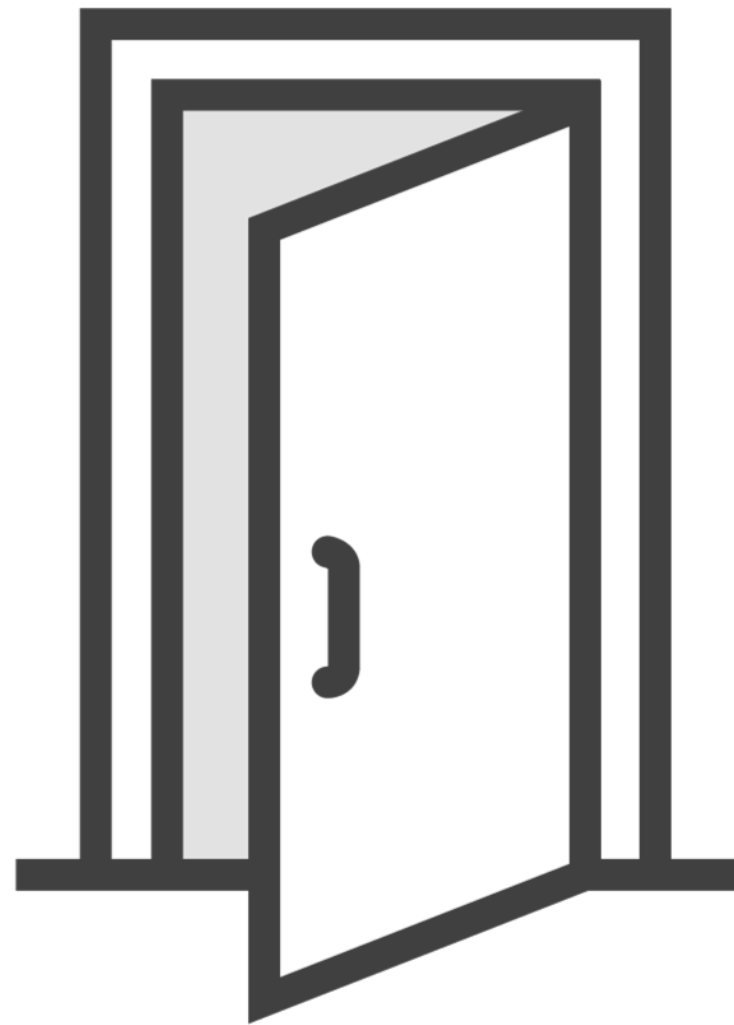
Translate domain names to IP addresses

Pluralsight.com > 35.161.255.88

**https://intranet.globomantics.org >
192.168.0.15**



Gateway



Device located at the boundary of a network

Transfers communications between your local network

– And the Internet

The router on a home network



Try It Yourself

IP Address

Subnet Mask

DHCP

DNS

Gateway

```
C:\Users\vlad>ipconfig

Wireless LAN adapter Wi-Fi 2:

    Connection-specific DNS Suffix . : home
    Description . . . . . : ASUS PCE-AC68 802.11ac Network Adapter
    Physical Address. . . . . : 1C-87-2C-B7-BD-70
    DHCP Enabled. . . . . : Yes
    Autoconfiguration Enabled . . . . : Yes
    IPv4 Address. . . . . : 192.168.2.89(Preferred)
    Subnet Mask . . . . . : 255.255.255.0
    Lease Obtained. . . . . : Monday, December 24, 2018 11:59:06 AM
    Lease Expires . . . . . : Thursday, December 27, 2018 11:59:25 AM
    Default Gateway . . . . . : 192.168.2.1
    DHCP Server . . . . . : 192.168.2.1
    DNS Servers . . . . . : 192.168.2.1
                           207.164.234.193
    NetBIOS over Tcpip. . . . . : Enabled
```



Network Ports and Protocols



TCP & UDP Protocols

TCP

Transmission Control Protocol

UDP

User Datagram Protocol

Send Information from one device to another

TCP/IP

UDP/IP



Transmission Control Protocol



Connection-oriented protocol

Establish a connection

- Data can be sent both ways

TCP is all about reliability

- Built-in systems to check for errors
- Guarantee data will be delivered in the right order

TCP is perfect for

- Images
- Data files
- Web Pages
- E-mails



User Datagram Protocol

Connectionless protocol

Data is continuously sent to the recipient

Whether or not they receive it

No error checking or confirmation

Great for real-time communications

Live Broadcast

Online multiplayer games



TCP & UDP Protocols

TCP

Requires an established connection to transmit data (which should be closed after transmission is complete)

Can guarantee delivery of data

Able to retransmit lost packets

Extensive error checking capabilities

Slower

UDP

Connectionless protocol with no requirements for opening, maintaining, or terminating a connection

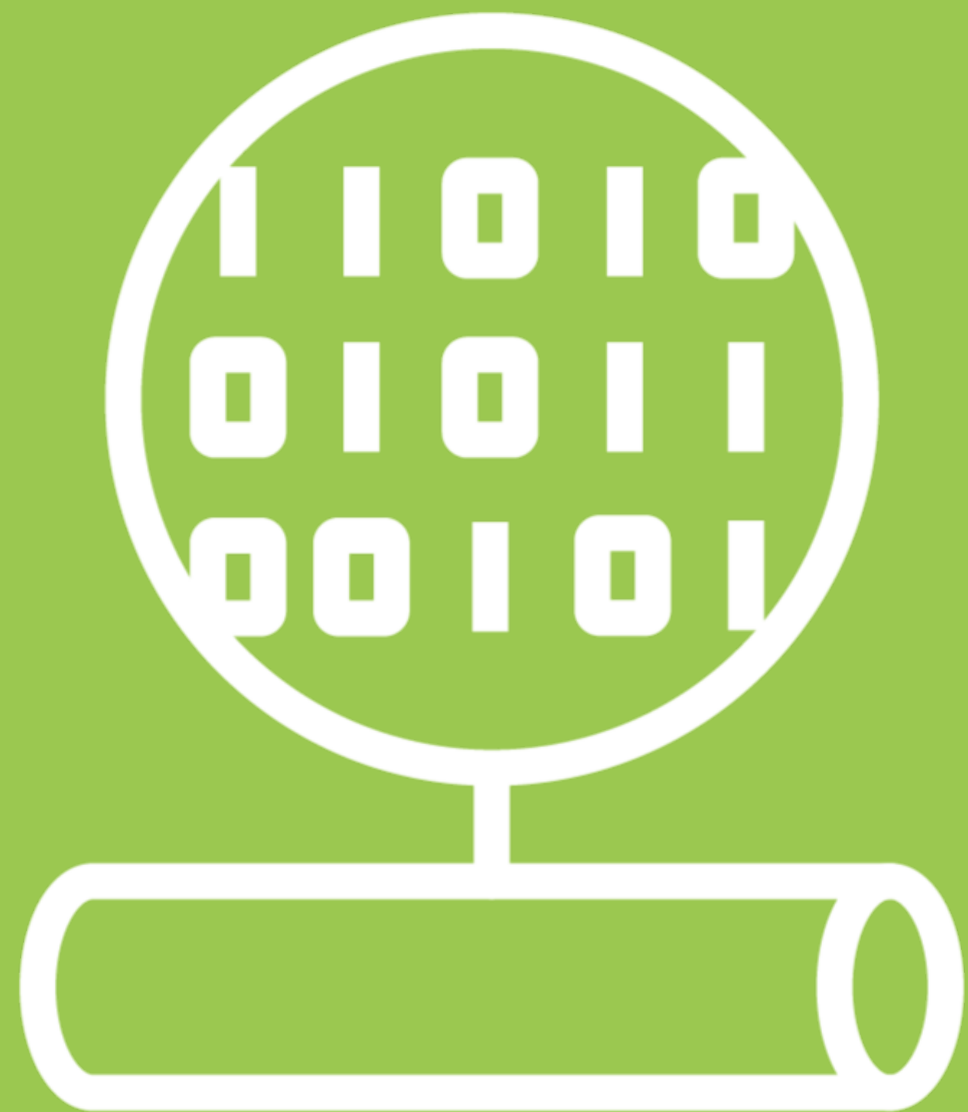
Cannot guarantee delivery of data

No retransmission of lost packets

Basic error checking capabilities

Faster





Common Protocols and The TCP / UDP Ports They Use



Network Ports

A network port is a process-specific or an application-specific software construct serving as a communication endpoint, which is used by the Transport Layer protocols of Internet Protocol suite, such as User Datagram Protocol (UDP) and Transmission Control Protocol (TCP).



File Transfer Protocol (**FTP**)

One of the most used file transfer protocols

Move files from one system to another

Uses TCP 20/21



**Secure management of network devices at
the command level**

Uses TCP port 22

Secure Shell
(SSH)



Telnet

Management of network devices at the command level

Only provides an unsecured connection

Not recommended over public networks

Uses TCP port 23



Used to transfer e-mail between mail servers

Used when end-users send an e-mail to a mail system

Uses TCP port 25

Simple Mail Transfer Protocol (SMTP)



Domain Name System (**DNS**)

Translate domain names to IP addresses

Used on public and private networks

Uses TCP/UDP port 53



Used to assign an IP to devices

Uses ports UDP 67/68

Dynamic Host Configuration Protocol **(DHCP)**



Hypertext Transfer Protocol (**HTTP**)

Used to display web pages

– **http://<yoursite>.com**

Data transfer is unsecured / unencrypted

Uses TCP port 80



Also used to by browsers to display pages

<https://Pluralsight.com>

Encryption done via SSL or TLS

Uses TCP port 443

Hypertext
Transfer Protocol
Secure
(HTTPS)



Post Office Protocol (**POP**) version 3

Used to retrieve emails from a server

Uses TCP port 110



Used to retrieve email from a server

Supports a wider array of remote mailbox operations

Uses TCP port 143

Internet Message
Access Protocol
(IMAP)



Simple Network Management Protocol (**SNMP**)

Collecting and organizing information about managed devices

Uses TCP/UDP Ports 161 and 162



**Central protocol used to interconnect
Microsoft Windows devices**

**Communicates on TCP/UDP Ports
137/138/139**

NetBIOS over
TCP/IP
(NetBT)



Lightweight Directory Access Protocol (LDAP)

**Mechanism for accessing and maintaining
distributed directory information**

Uses TCP/UDP Port 389



Foundation of Microsoft's Windows
networking capability

Common Internet File System (CIFS)

Uses TCP port 445

Server Message
Block
(**SMB**)



Remote Desktop Protocol (RDP)

**View the remote desktop of a device across
the network**

Uses TCP port 3389



TCP & UDP Ports Cheat Sheet



Files

TCP 20 - FTP

TCP 21 - FTP

TCP 445 - SMB / CIFS



E-mail

TCP 25 - SMTP

TCP 110 - POP3

TCP 143 - IMAP



Web

TCP 80 - HTTP

TCP 443 - HTTPS



Management

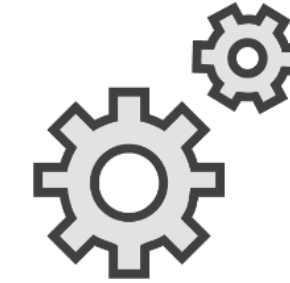
TCP 22 - SSH

TCP 23 - Telnet

TCP/UDP 161 - SNMP

TCP/UDP 162 - SNMP

TCP 3389 - RDP



Utilities

TCP/UDP 53 - DNS

UDP 67 - DHCP

UDP 68 - DHCP

TCP/UDP 137 - NetBIOS

TCP/UDP 138 - NetBIOS

TCP/UDP 139 - NetBIOS

TCP/UDP 389 - LDAP



Conclusion



Network configuration concepts

- IP Addressing
 - IPv4
 - IPv6
- Subnet Mask
- DNS
- DHCP

Network ports and protocols

- TCP & UDP



Up Next:
Common Networking Hardware

