

# NETWORK FUNDAMENTALS

Введение в системную инженерию(DevOps)

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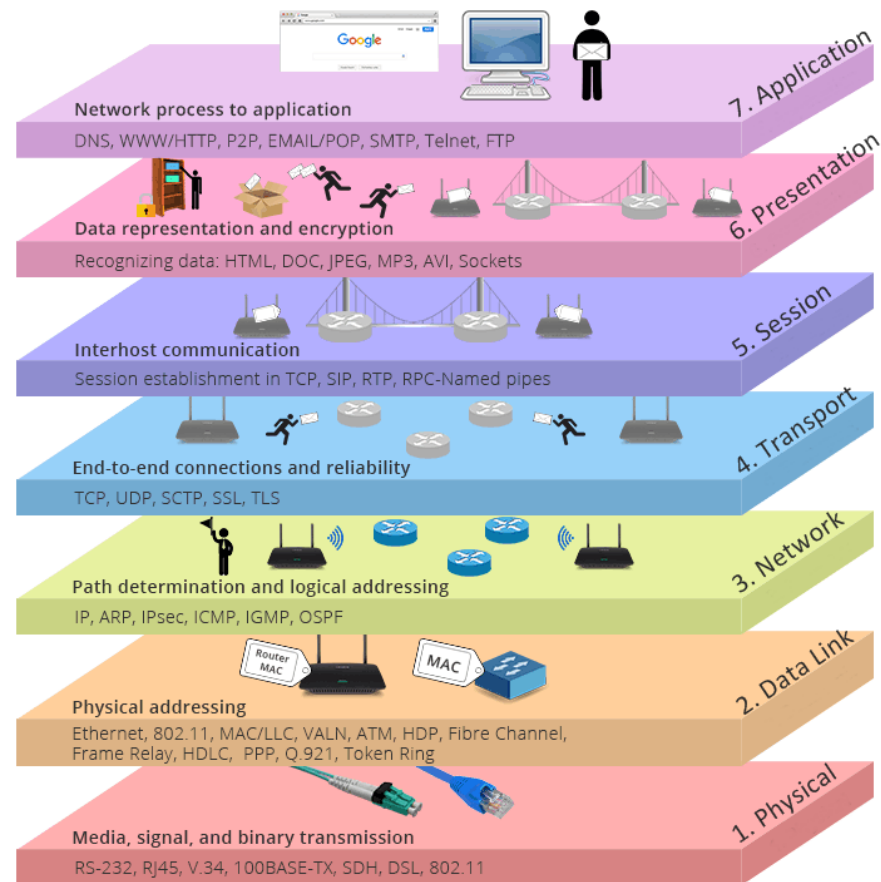
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1. OSI Model
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3. Protocols
4. Utilities

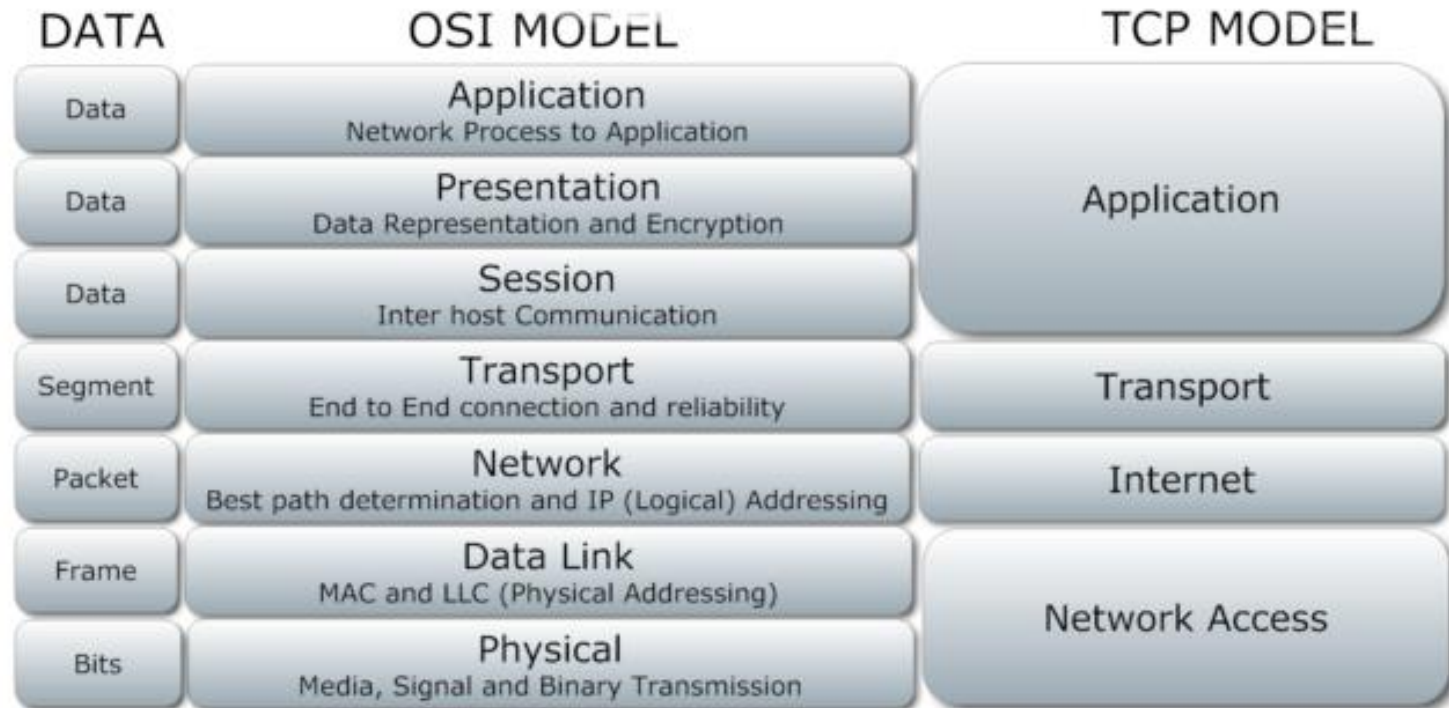
# Software

1. GNS3
2. Windows

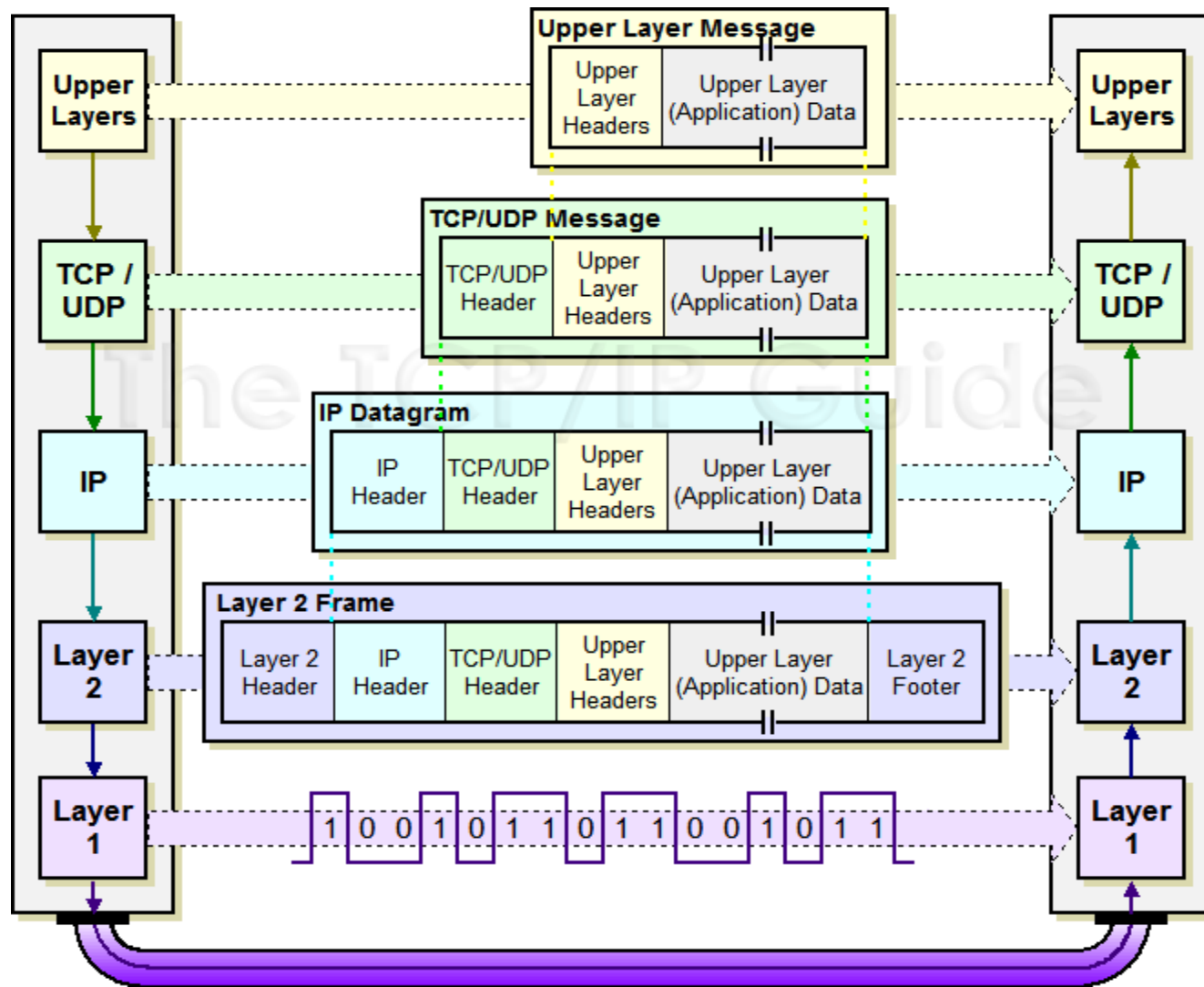
# OSI Model



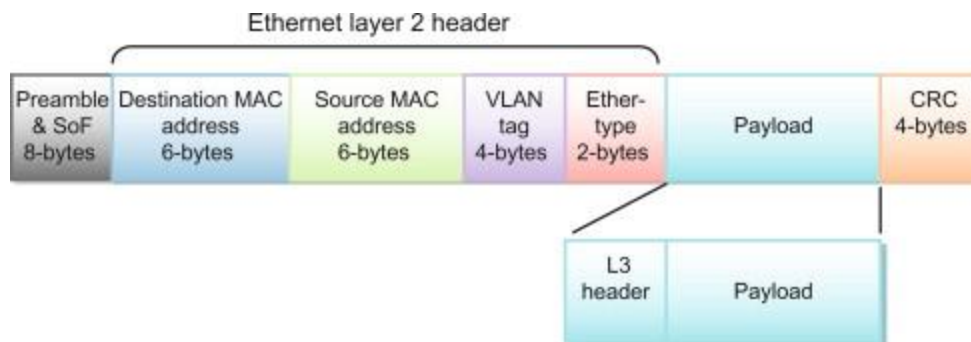
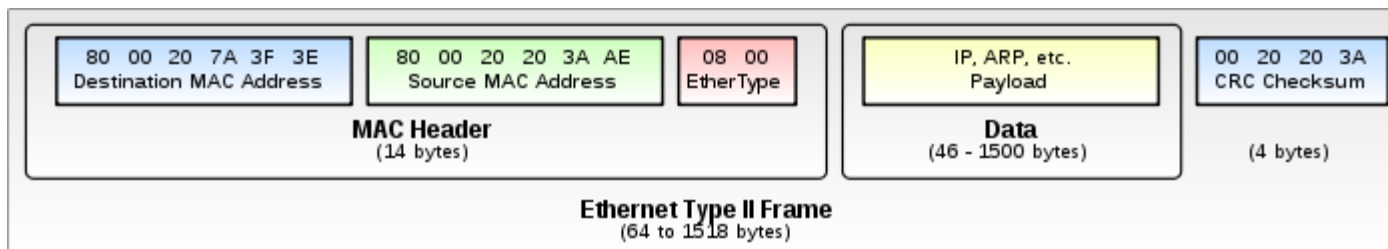
# TCP/IP Model



# TCP/IP Model

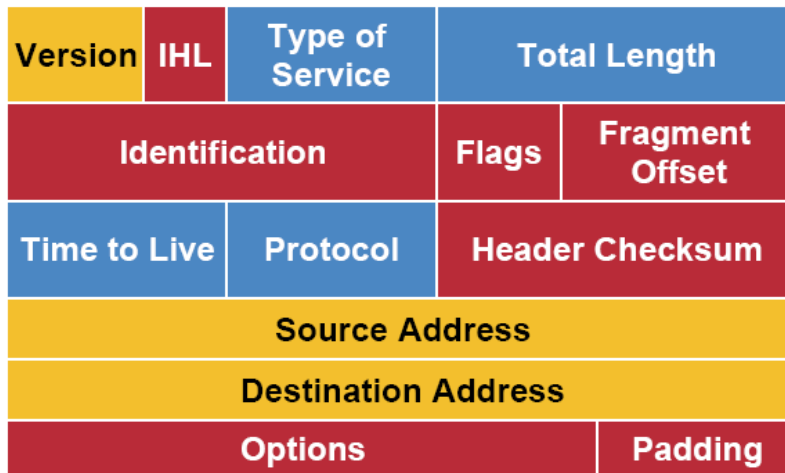


# Ethernet Frame



# IPv4/v6 Packet

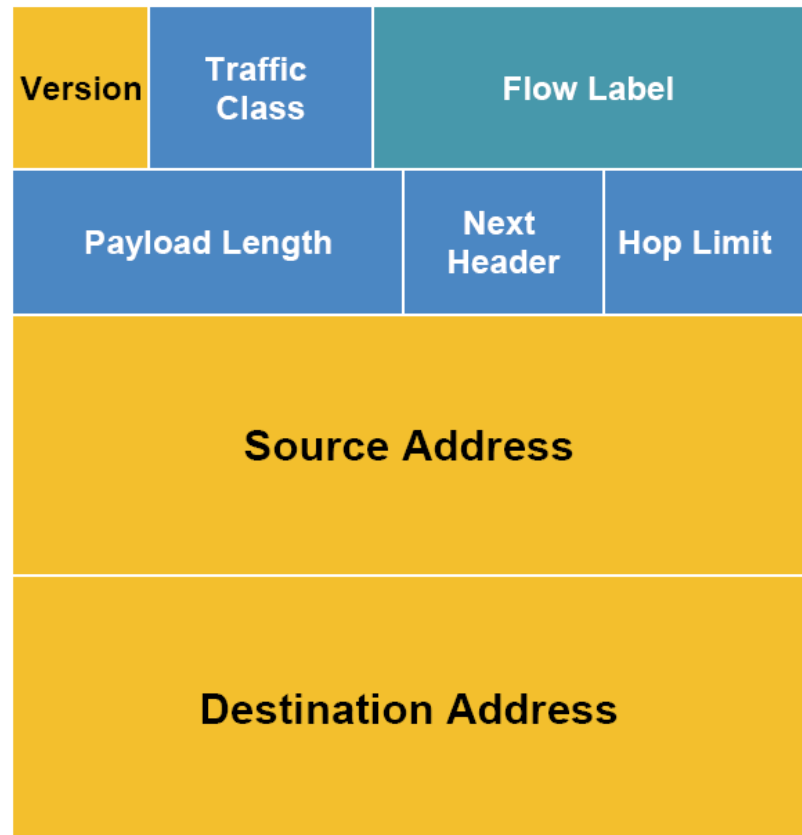
## IPv4 Header



### Legend

- Field's Name Kept from IPv4 to IPv6
- Fields Not Kept in IPv6
- Name and Position Changed in IPv6
- New Field in IPv6

## IPv6 Header





# TCP/UDP Packet

## TCP Segment Header Format

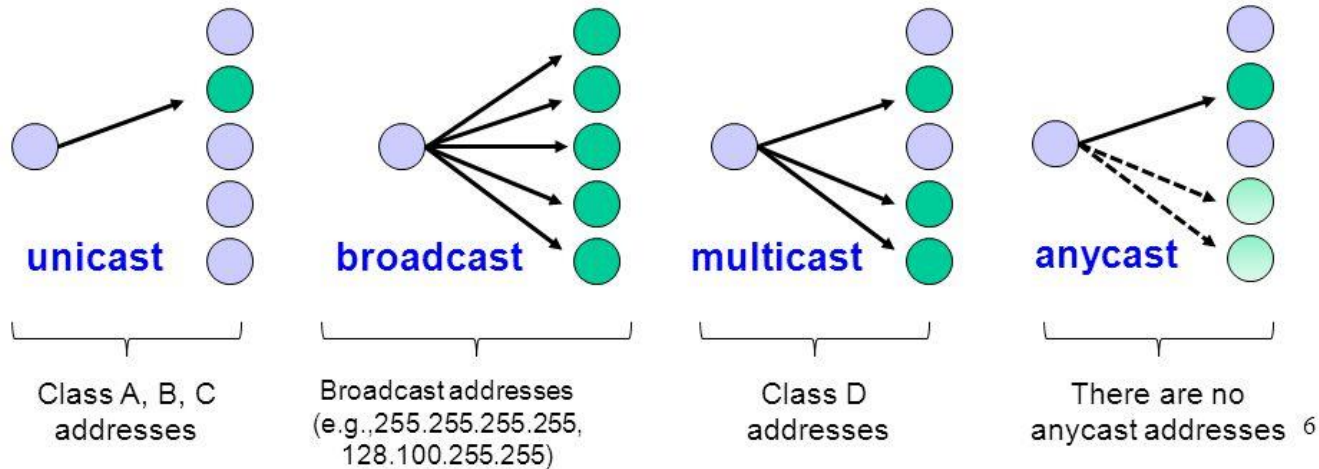
Bit #	0	7	8	15	16	23	24	31
0	Source Port				Destination Port			
32	Sequence Number							
64	Acknowledgment Number							
96	Data Offset	Res	Flags		Window Size			
128	Header and Data Checksum				Urgent Pointer			
160...	Options							

## UDP Datagram Header Format

Bit #	0	7	8	15	16	23	24	31
0	Source Port				Destination Port			
32	Length				Header and Data Checksum			

## Delivery modes

- Supported by IPv4
  - one-to-one (unicast)
  - one-to-all (broadcast)
  - one-to-many (multicast)
- Not supported by IPv4:
  - one-to-any (anycast)

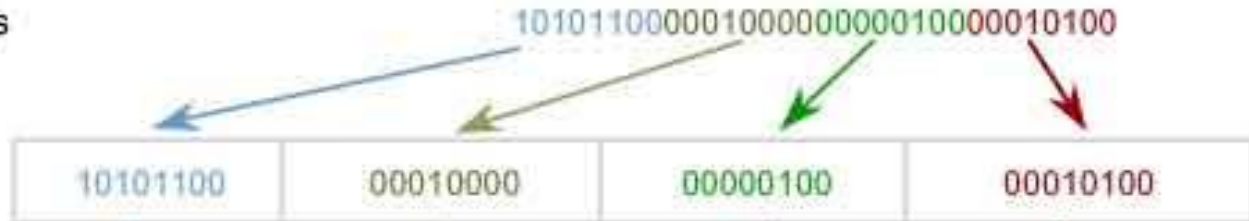


# IPv4 structure

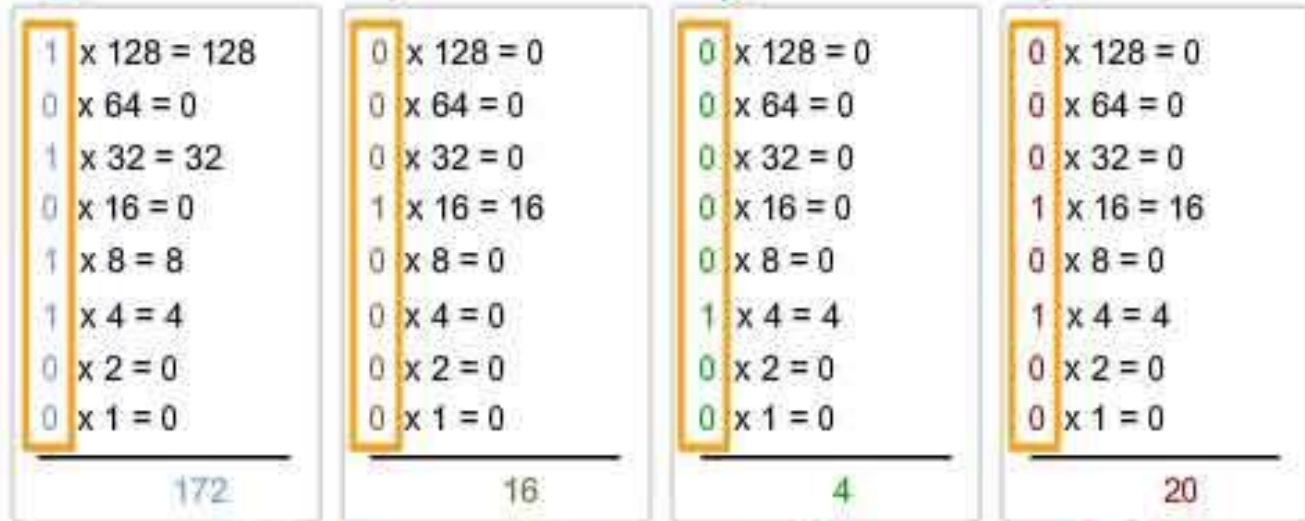
## Converting an IPv4 from Binary to Dotted Decimal Notation

Binary IPv4 address 10101100000100000000010000010100

Divide the 32 bits  
into 4 octets



Convert each  
octet to  
decimal



Each octet  
decimal value  
is separated  
by a "."

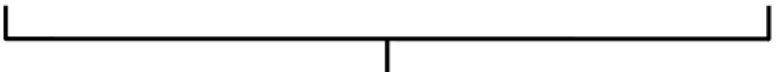
Decimal IPv4 address

172.16.4.20


## IPv6 structure

An IPv6 address (in hexadecimal)

**2001:0DB8:AC10:FE01:0000:0000:0000:0000**

↓ ↓ ↓ ↓  Zeroes can be omitted

**2001:0DB8:AC10:FE01::**



0010000000000001:0000110110111000:1010110000010000:1111110000000001:  
0000000000000000:0000000000000000:0000000000000000:0000000000000000

## Ip subnet structure

192.168.21.17/24

### IPv4 address

192.	168.	21.	17
11000000	10101000	00010101	00010001
↑ octet	↑ octet	↑ octet	↑ octet
network part			host part

Prefix /24 Subnet mask:

255.	255.	255.	0
11111111	11111111	11111111	00000000

192.168.21.0 - network

192.168.21.255 - broadcast

## Subnets before CIDR

Address Class	Value in First Octet	Classful Mask (dotted decimal)	Classful Mask (prefix notation)
<b>A</b>	1 - 126	255.0.0.0	/8
<b>B</b>	128 - 191	255.255.0.0	/16
<b>C</b>	192 - 223	255.255.255.0	/24
<b>D</b>	224 - 239	N/A	N/A
<b>E</b>	240 - 255	N/A	N/A

## Subnet Mask Hierarchy

Subnet Mask	CIDR	Binary Notation	Available Addresses Per Subnet
255.255.255.255	/32	11111111.11111111.11111111.11111111	1
255.255.255.254	/31	11111111.11111111.11111111.11111110	2
255.255.255.252	/30	11111111.11111111.11111111.11111100	4
255.255.255.248	/29	11111111.11111111.11111111.11111000	8
255.255.255.240	/28	11111111.11111111.11111111.11110000	16
255.255.255.224	/27	11111111.11111111.11111111.11100000	32
255.255.255.192	/26	11111111.11111111.11111111.11000000	64
255.255.255.128	/25	11111111.11111111.11111111.10000000	128
255.255.255.0	/24	11111111.11111111.11111111.00000000	256
255.255.254.0	/23	11111111.11111111.11111110.00000000	512
255.255.252.0	/22	11111111.11111111.11111100.00000000	1024
255.255.248.0	/21	11111111.11111111.11111000.00000000	2048
255.255.240.0	/20	11111111.11111111.11110000.00000000	4096
255.255.224.0	/19	11111111.11111111.11100000.00000000	8192
255.255.192.0	/18	11111111.11111111.11000000.00000000	16384
255.255.128.0	/17	11111111.11111111.10000000.00000000	32768
255.255.0.0	/16	11111111.11111111.00000000.00000000	65536
255.254.0.0	/15	11111111.11111110.00000000.00000000	131072
255.252.0.0	/14	11111111.11111100.00000000.00000000	262144
255.248.0.0	/13	11111111.11111000.00000000.00000000	524288
255.240.0.0	/12	11111111.11110000.00000000.00000000	1048576
255.224.0.0	/11	11111111.11100000.00000000.00000000	2097152
255.192.0.0	/10	11111111.11000000.00000000.00000000	4194304
255.128.0.0	/9	11111111.10000000.00000000.00000000	8388608
255.0.0.0	/8	11111111.00000000.00000000.00000000	16777216

## Subnet Blocks

Binary	Decimal
$2^8 - 2^0$	255
$2^8 - 2^1$	254
$2^8 - 2^2$	252
$2^8 - 2^3$	248
$2^8 - 2^4$	240
$2^8 - 2^5$	224
$2^8 - 2^6$	192
$2^8 - 2^7$	128

Number of valid hosts is always two less than the subnet block



## Private Ranges

Class	Private IP address range	Subnet mask	No. of hosts
A	10.0.0.0 – 10.255.255.255	255.0.0.0	16,777,212
B	172.16.0.0 – 172.16.31.255	255.255.0.0	8190
C	192.168.0.0 – 192.168.255.255	255.255.255.0	65,534

Private IP Addresses



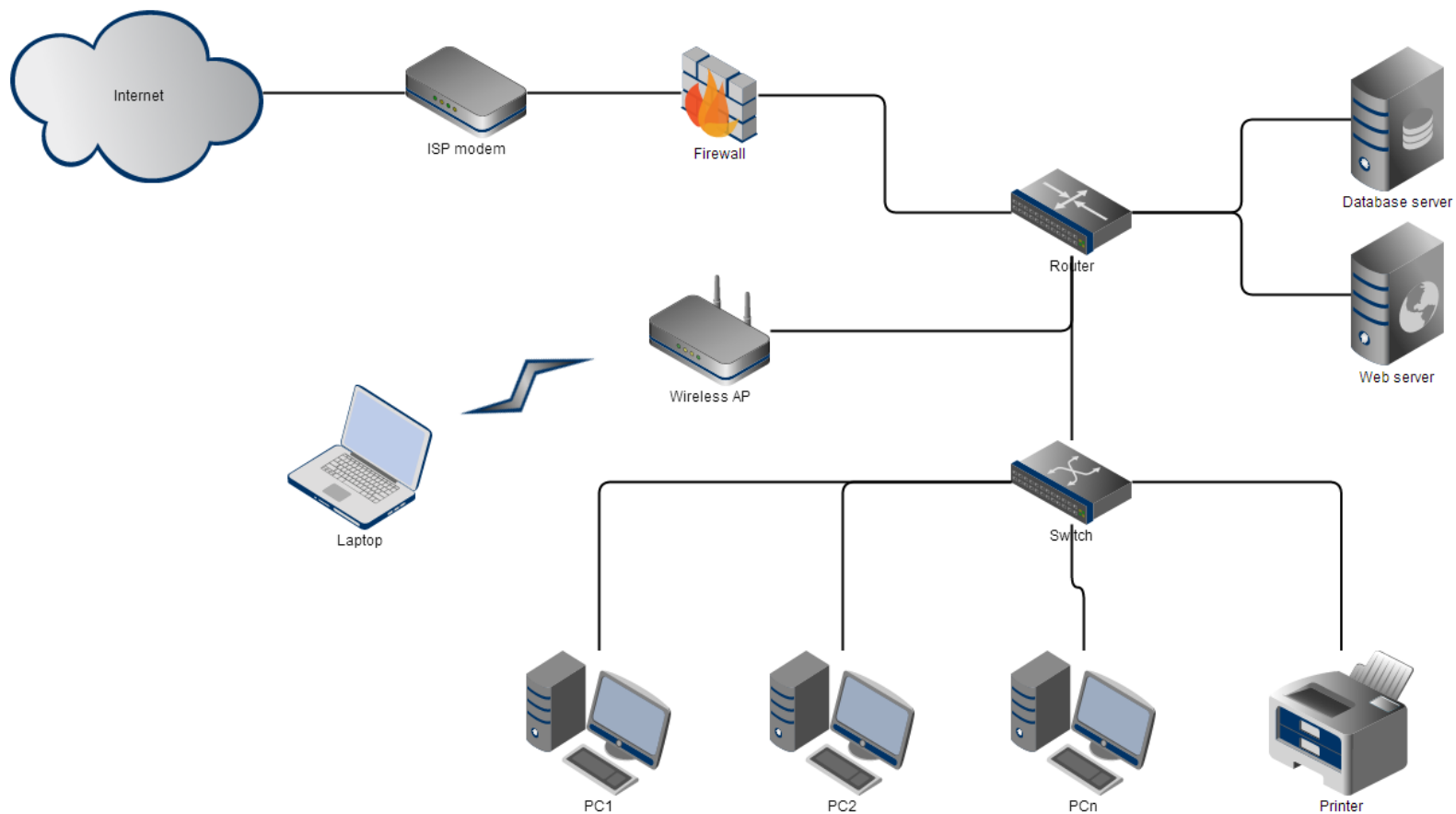
# Special IPv4 addresses

Address block ▾	Address range ↕	Number of addresses ↕	Scope ↕	Description ↕
255.255.255.255/32	255.255.255.255	1	Subnet	Reserved for the "limited broadcast" destination address. <sup>[1][11]</sup>
240.0.0.0/4	240.0.0.0–255.255.255.254	268 435 456	Internet	Reserved for future use. <sup>[10]</sup> (Former Class E network).
224.0.0.0/4	224.0.0.0–239.255.255.255	268 435 456	Internet	In use for <a href="#">IP multicast</a> . <sup>[9]</sup> (Former Class D network).
203.0.113.0/24	203.0.113.0–203.0.113.255	256	Documentation	Assigned as TEST-NET-3, documentation and examples. <sup>[5]</sup>
198.51.100.0/24	198.51.100.0–198.51.100.255	256	Documentation	Assigned as TEST-NET-2, documentation and examples. <sup>[5]</sup>
198.18.0.0/15	198.18.0.0–198.19.255.255	131 072	Private network	Used for benchmark testing of inter-network communications between two separate subnets. <sup>[8]</sup>
192.168.0.0/16	192.168.0.0–192.168.255.255	65 536	Private network	Used for local communications within a private network. <sup>[2]</sup>
192.88.99.0/24	192.88.99.0–192.88.99.255	256	Internet	Reserved. <sup>[6]</sup> Formerly used for <a href="#">IPv6 to IPv4 relay</a> <sup>[7]</sup> (included <a href="#">IPv6</a> address block 2002::/16).
192.0.2.0/24	192.0.2.0–192.0.2.255	256	Documentation	Assigned as TEST-NET-1, documentation and examples. <sup>[5]</sup>
192.0.0.0/24	192.0.0.0–192.0.0.255	256	Private network	IETF Protocol Assignments. <sup>[1]</sup>
172.16.0.0/12	172.16.0.0–172.31.255.255	1 048 576	Private network	Used for local communications within a private network. <sup>[2]</sup>
169.254.0.0/16	169.254.0.0–169.254.255.255	65 536	Subnet	Used for <a href="#">link-local addresses</a> <sup>[4]</sup> between two hosts on a single link when no IP address is otherwise specified, such as would have normally been retrieved from a <a href="#">DHCP</a> server.
127.0.0.0/8	127.0.0.0–127.255.255.255	16 777 216	Host	Used for <a href="#">loopback addresses</a> to the local host. <sup>[1]</sup>
100.64.0.0/10	100.64.0.0–100.127.255.255	4 194 304	Private network	<a href="#">Shared address space</a> <sup>[3]</sup> for communications between a service provider and its subscribers when using a <a href="#">carrier-grade NAT</a> .
10.0.0.0/8	10.0.0.0–10.255.255.255	16 777 216	Private network	Used for local communications within a <a href="#">private network</a> . <sup>[2]</sup>
0.0.0.0/8	0.0.0.0–0.255.255.255	16 777 216	Software	Current network <sup>[1]</sup> (only valid as source address).

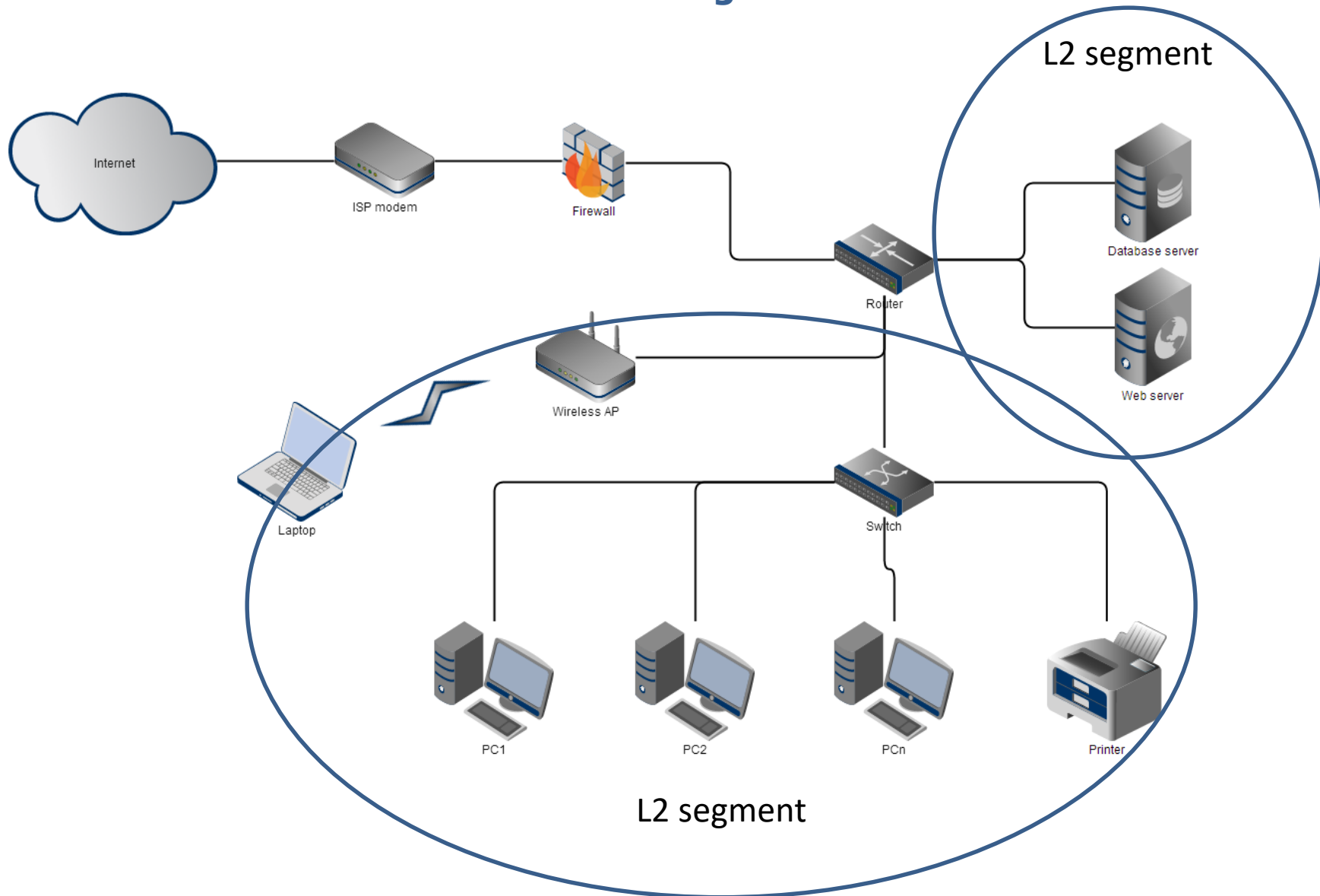
# Private Ranges

Address block (CIDR)	First address	Last address	Number of addresses	Usage	Purpose
::/0	::	ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff	$2^{128}$	Routing	Default route.
::/128	::		1	Software	Unspecified address.
::1/128	::1		1	Host	<a href="#">Loopback address</a> to the local host.
::ffff:0:0/96	::ffff:0:0:0:0	::ffff:255.255.255.255	$2^{128-96} = 2^{32} = 4\,294\,967\,296$	Software	IPv4 mapped addresses.
::ffff:0:0:0/96	::ffff:0:0:0:0:0	::ffff:0:255.255.255.255	$2^{32}$	Software	IPv4 translated addresses.
64:ff9b::/96	64:ff9b::0:0:0:0	64:ff9b::255.255.255.255	$2^{32}$	Global Internet	IPv4/IPv6 translation. <sup>[12]</sup>
100::/64	100::	100::ffff:ffff:ffff:ffff	$2^{64}$	Routing	Discard prefix. <sup>[13]</sup>
2001::/32	2001::	2001::ffff:ffff:ffff:ffff:ffff:ffff	$2^{96}$	Global Internet	<a href="#">Teredo tunneling</a> .
2001:20::/28	2001:20::	2001:2f:ffff:ffff:ffff:ffff:ffff:ffff	$2^{100}$	Software	<a href="#">ORCHIDv2</a> . <sup>[14]</sup>
2001:db8::/32	2001:db8::	2001:db8:ffff:ffff:ffff:ffff:ffff:ffff	$2^{96}$	Documentation	Addresses used in documentation and example source code. <sup>[15]</sup>
2002::/16	2002::	2002:ffff:ffff:ffff:ffff:ffff:ffff:ffff	$2^{112}$	Global Internet	The <a href="#">6to4</a> addressing scheme (now deprecated). <sup>[6]</sup>
fc00::/7	fc00::	fdff:ffff:ffff:ffff:ffff:ffff:ffff:ffff	$2^{121}$	Private network	<a href="#">Unique local address</a> . <sup>[16]</sup>
fe80::/10	fe80::	febf:ffff:ffff:ffff:ffff:ffff:ffff:ffff	$2^{118}$	Link	<a href="#">Link-local address</a> .
ff00::/8	ff00::	ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff	$2^{120}$	Global Internet	<a href="#">Multicast address</a> .

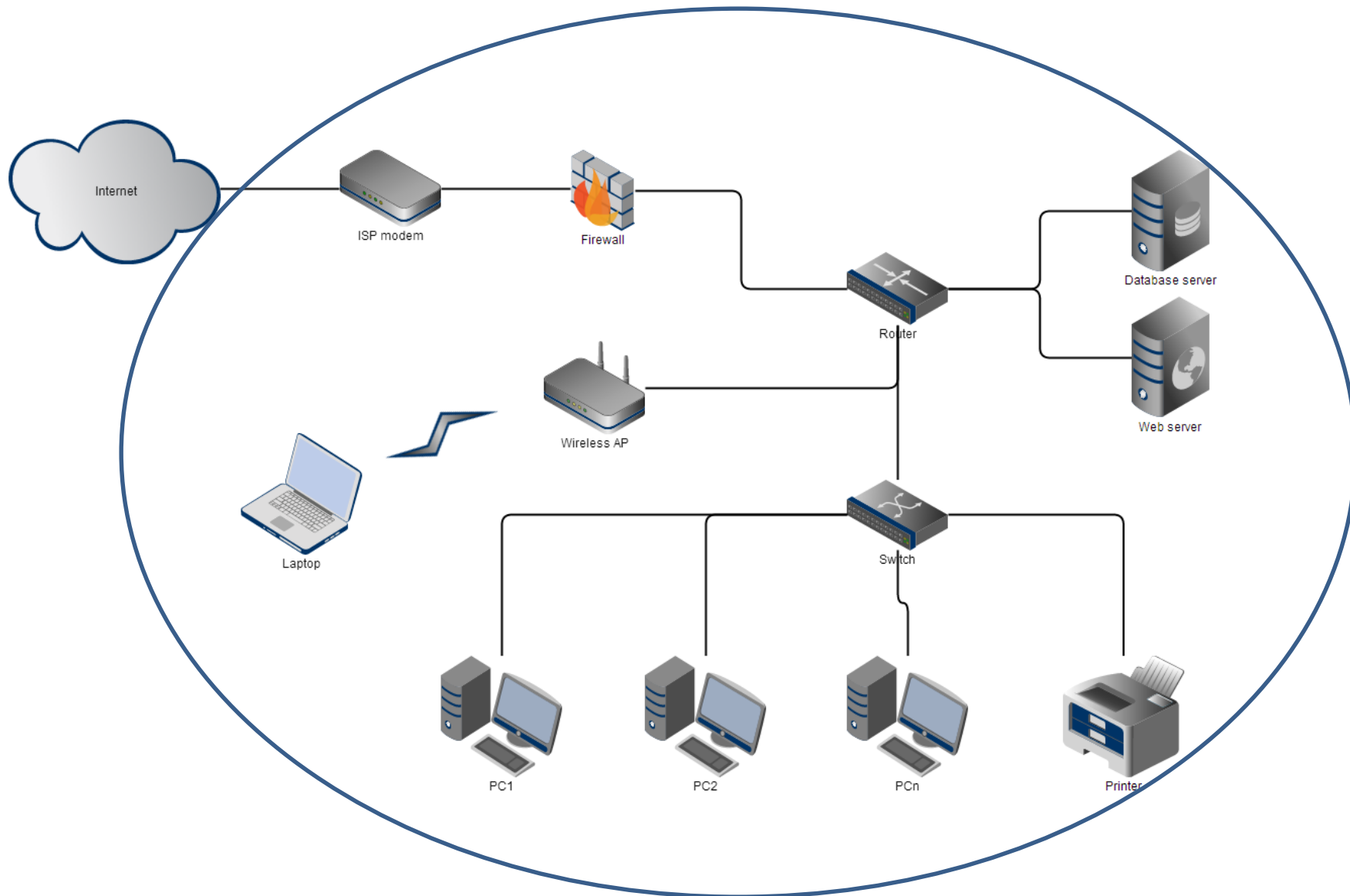
# Routing and Switching



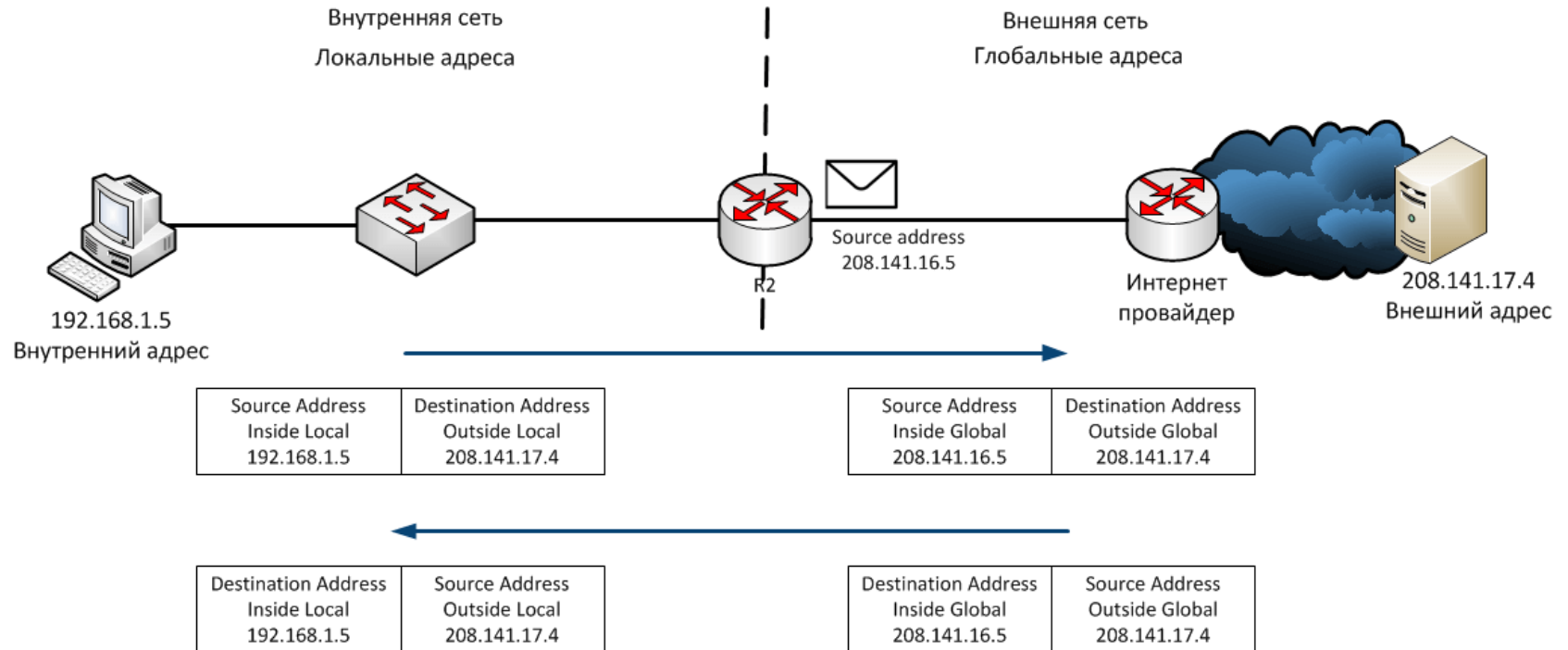
# L2 Switching



# L3 Switching

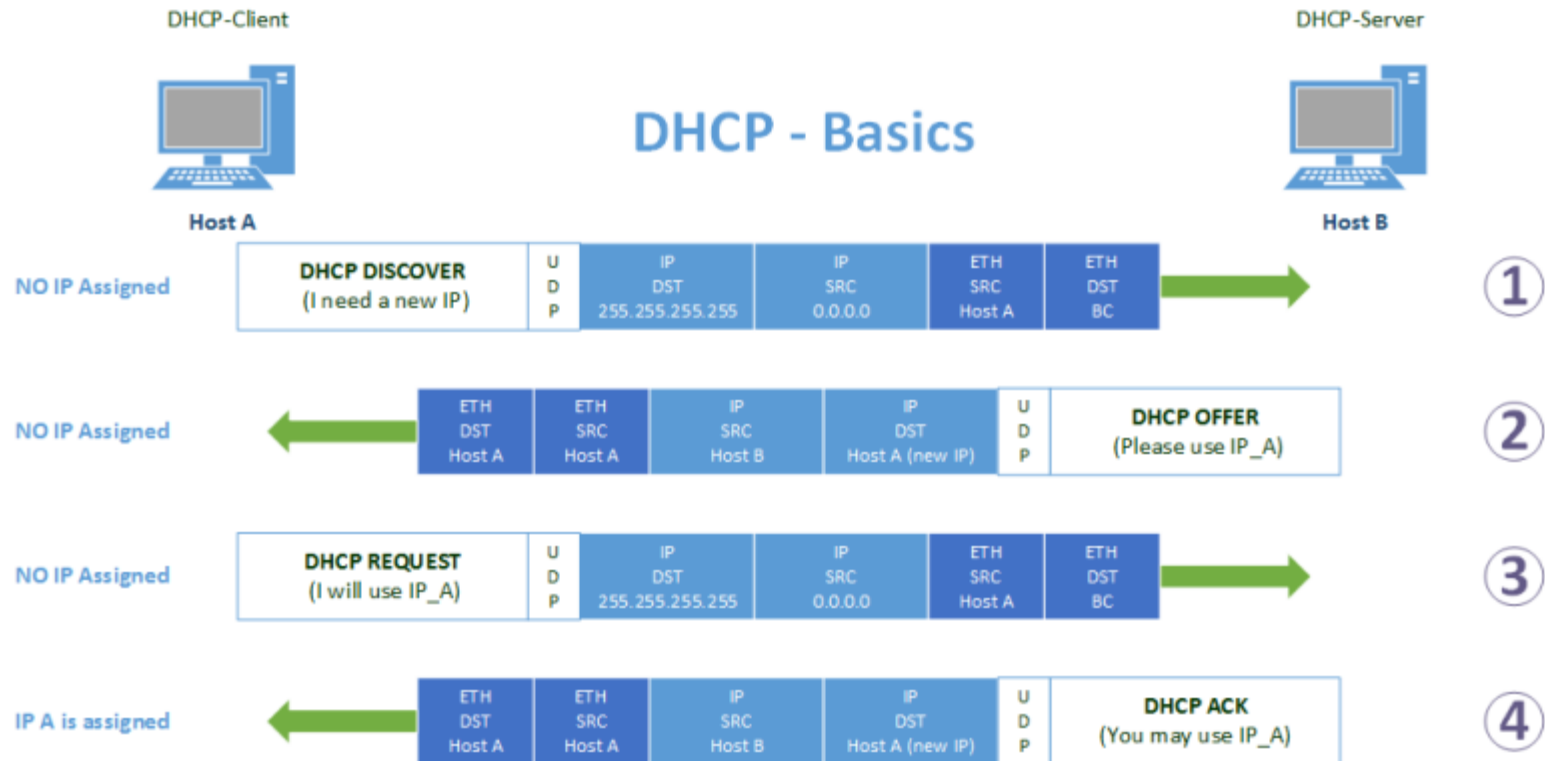


# NAT

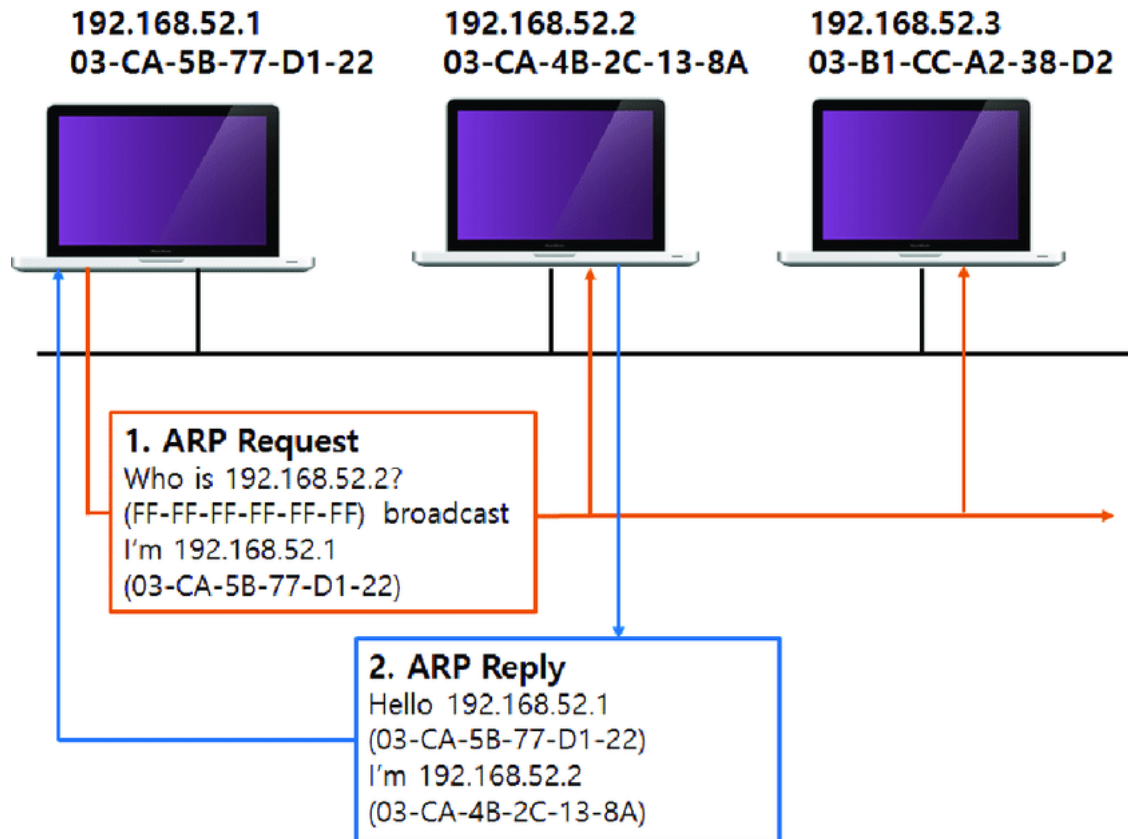


NAT таблица маршрутизатора			
ПК		Веб-сервер	
Inside Global	Inside Local	Outside Local	Outside Global
208.141.17.4	192.168.1.5	208.141.16.5	208.141.16.5

# DHCP



# ARP(Address Resolution Protocol)



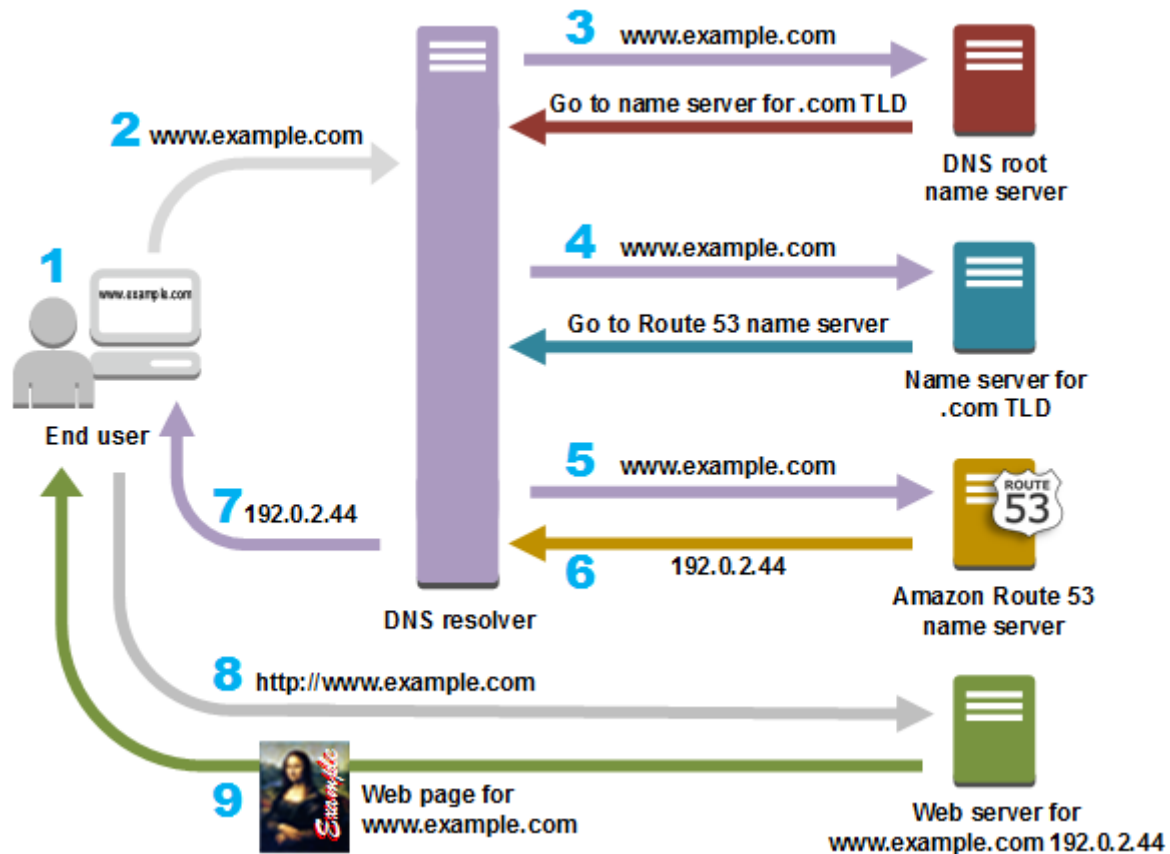
arp -a - show all entries

arp -d - clear all entries

arp -s 157.55.85.212 00-aa-00-62-c6-09 – add entry

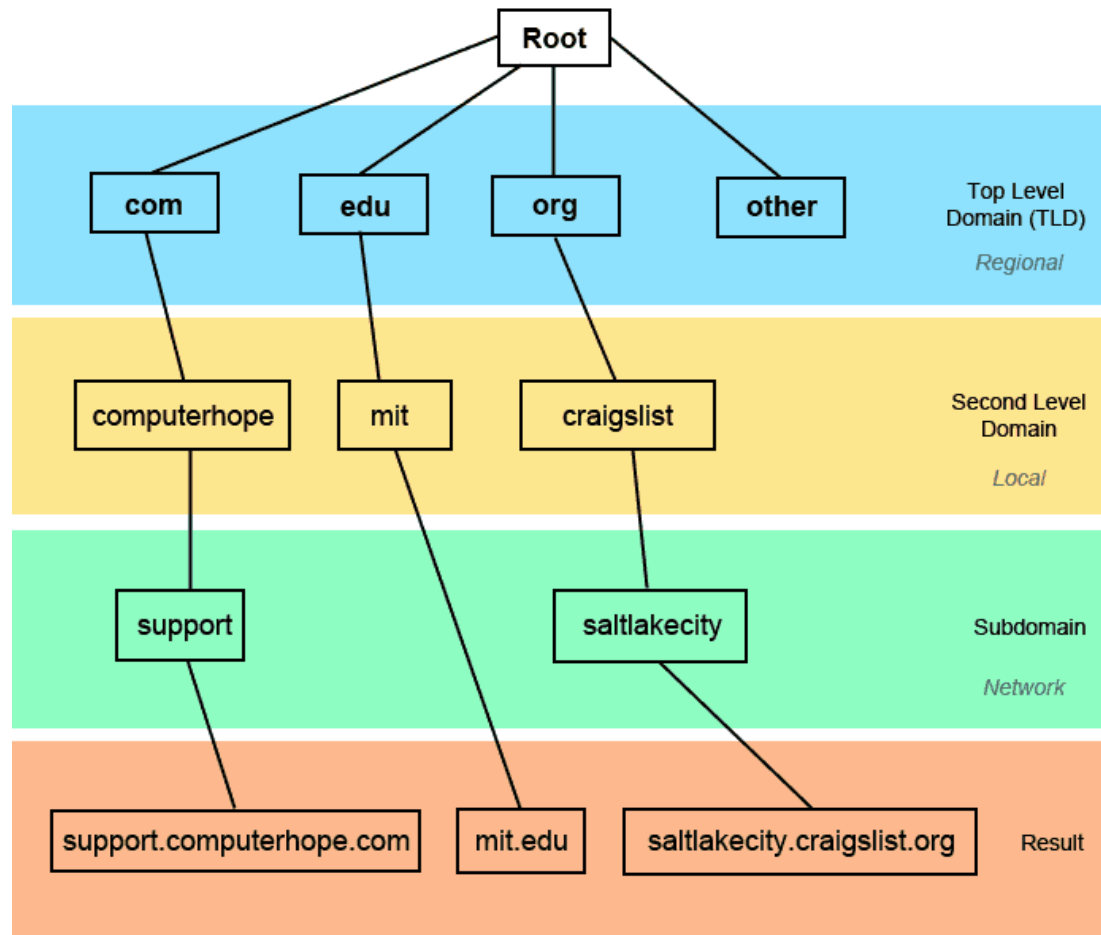


# DNS



# DNS

## Domain Naming Hierarchy



ComputerHope.com

# DNS

```
dig google.com
```

```
; <<>> DiG 9.11.3-1ubuntu1.7-Ubuntu <<>> google.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 43643
;; flags: qr rd ra; QUERY: 1, ANSWER: 6, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags::; udp: 4000
;; QUESTION SECTION:
;google.com.                IN      A

;; ANSWER SECTION:
google.com.                 44      IN      A      173.194.222.102
google.com.                 44      IN      A      173.194.222.113
google.com.                 44      IN      A      173.194.222.138
google.com.                 44      IN      A      173.194.222.139
google.com.                 44      IN      A      173.194.222.100
google.com.                 44      IN      A      173.194.222.101

;; Query time: 1 msec
;; SERVER: 10.18.0.2#53(10.18.0.2)
;; WHEN: Tue Sep 03 17:19:35 +04 2019
;; MSG SIZE rcvd: 13
```

# Links

# Thanks for Your Attention

## Questions?

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