NETWORK FUNDAMENTALS

Введение в системную инженерию(DevOps)

Author:

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2. Routing and Switching
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1. **GNS3**
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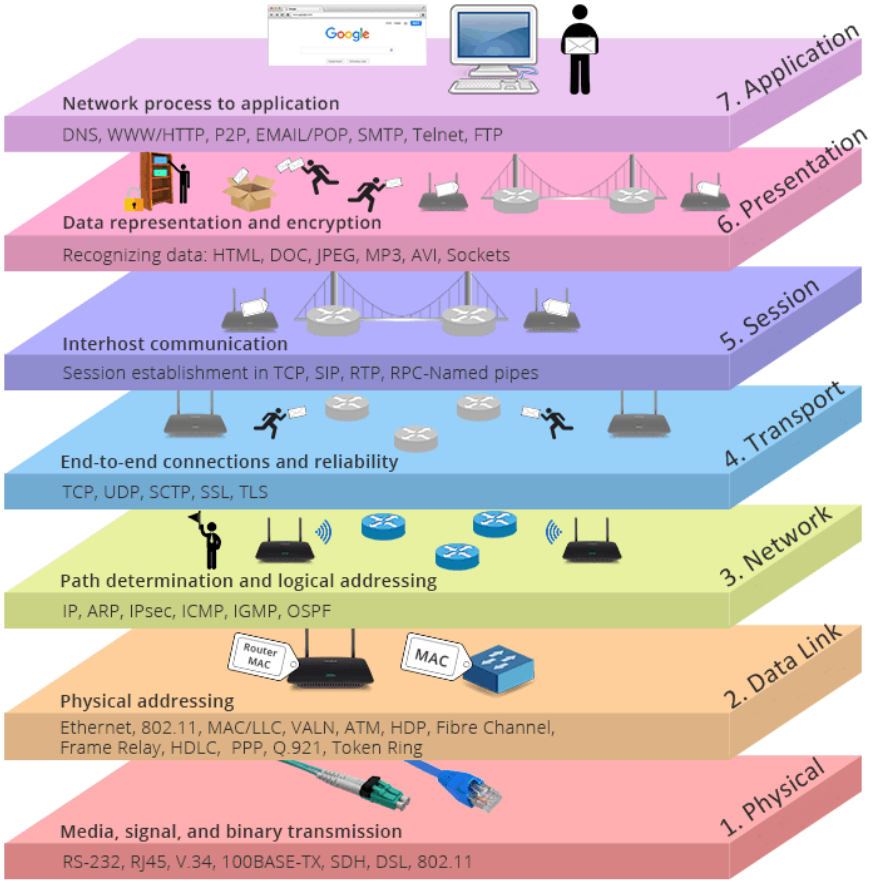
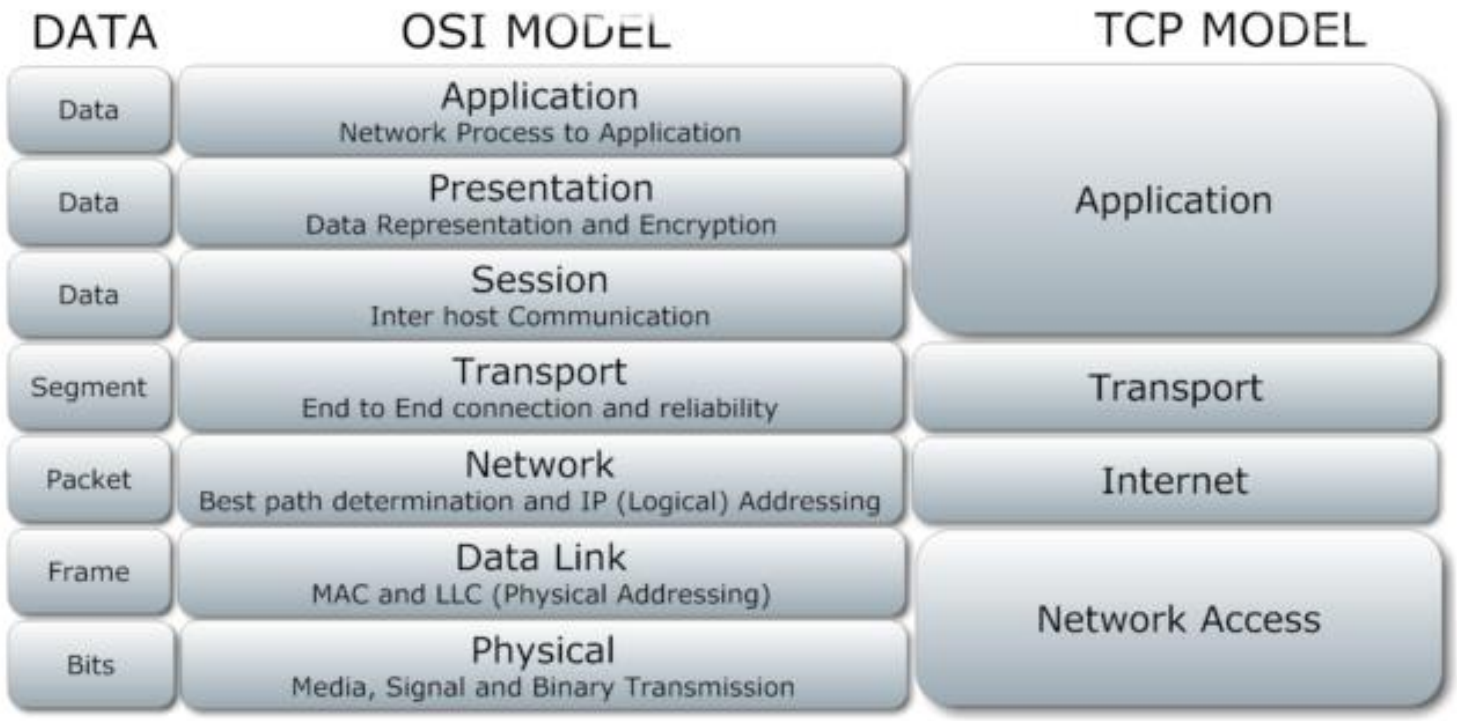
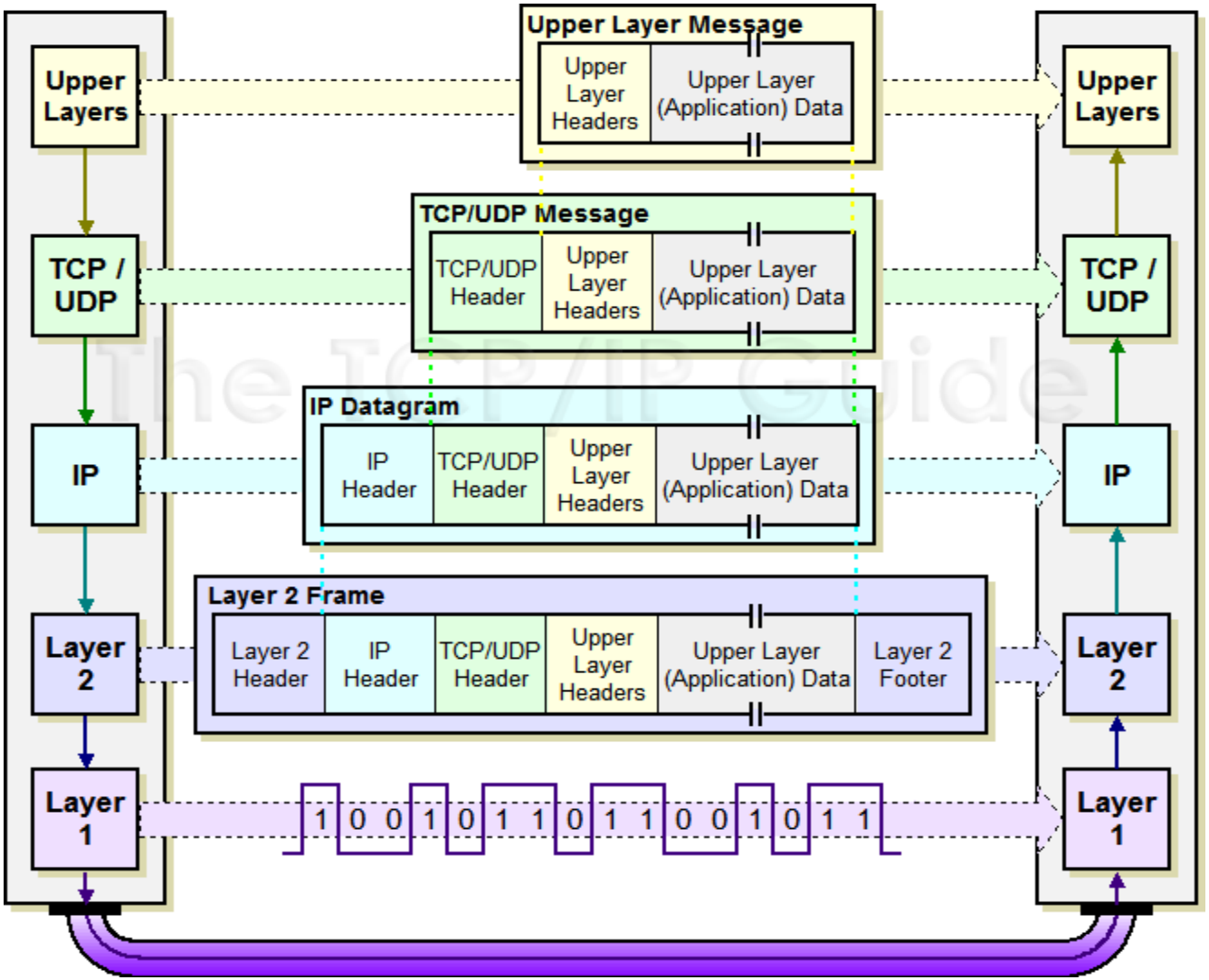
OSI Model



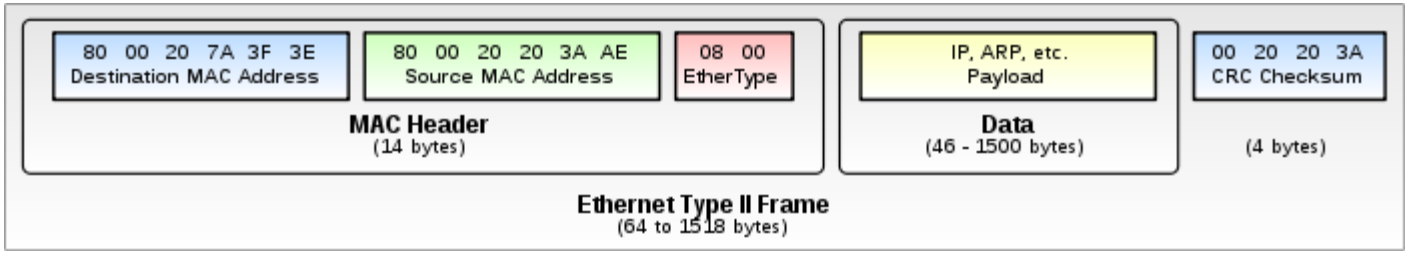
TCP/IP Model

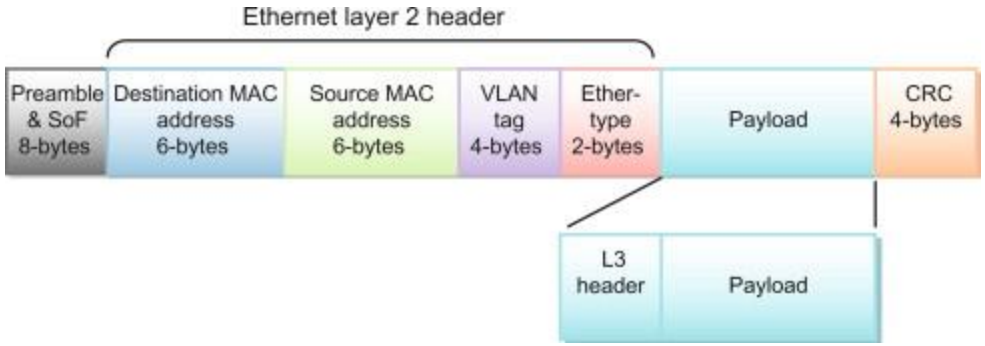


TCP/IP Model

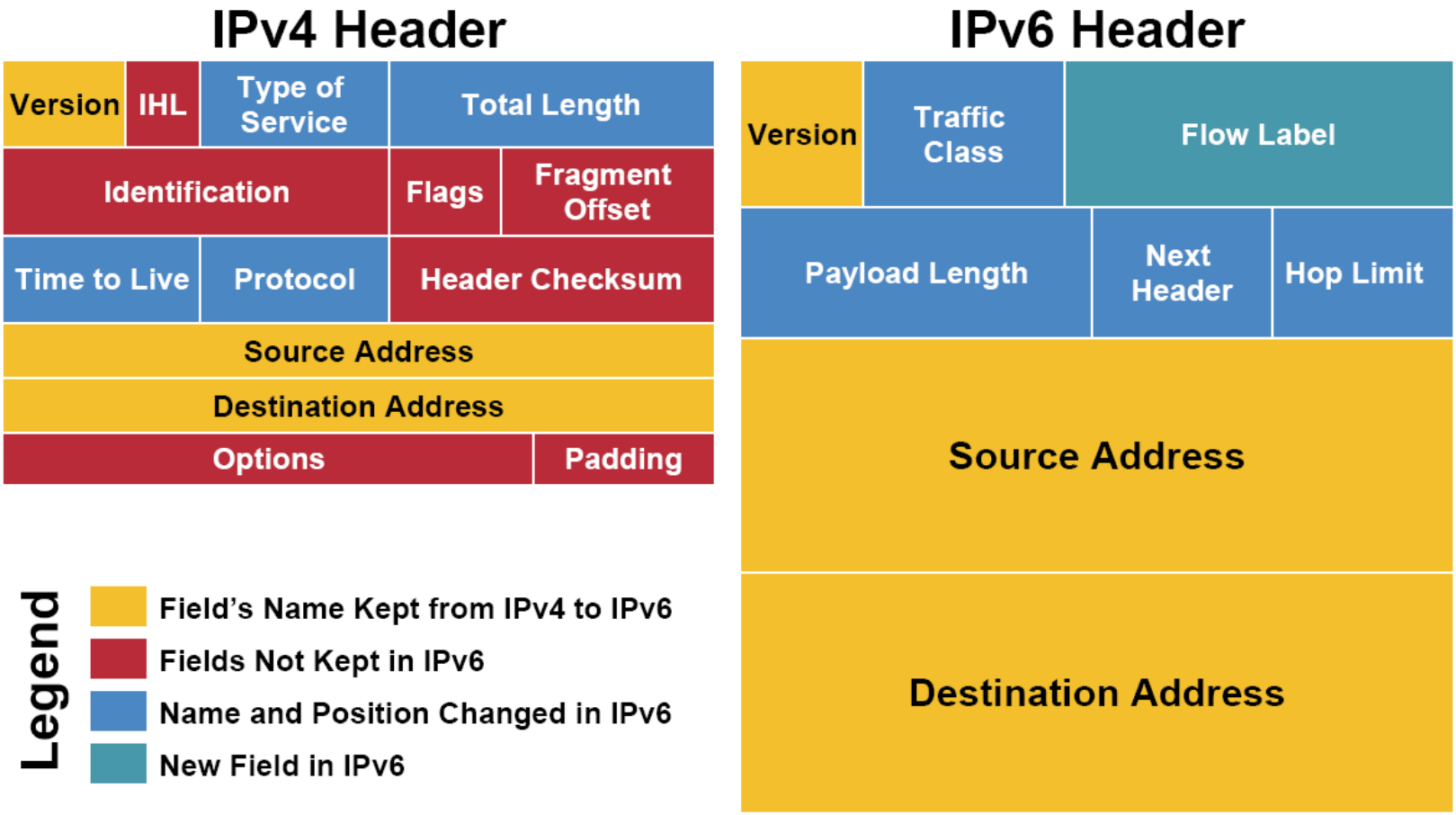


Ethernet Frame





IPv4/v6 Packet



TCP/UDP Packet

TCP Segment Header Format

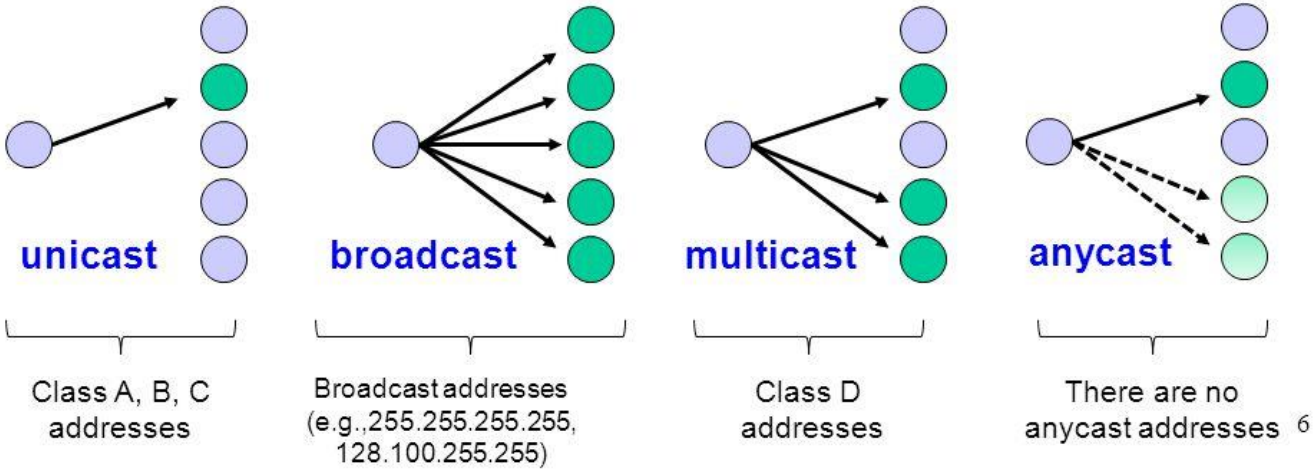
Bit #	0 – 7	8 – 15	16 – 23	24 – 31
0	Source Port		Destination Port	
32	Sequence Number			
64	Acknowledgment Number			
96	Data Offset	Res	Flags	Window Size
128	Header and Data Checksum		Urgent Pointer	
160…	Options			

UDP Datagram Header Format

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

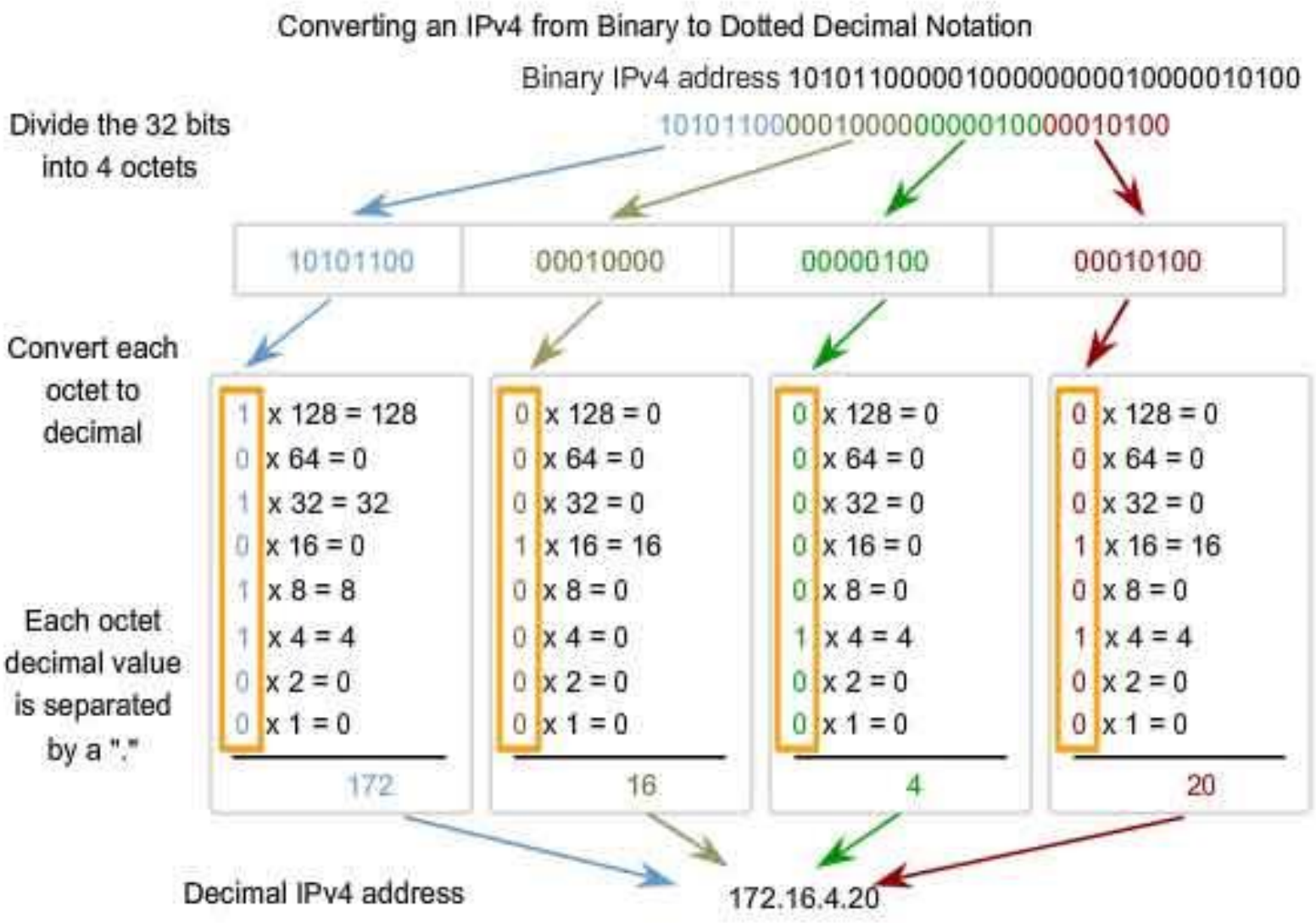
Delivery modes

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

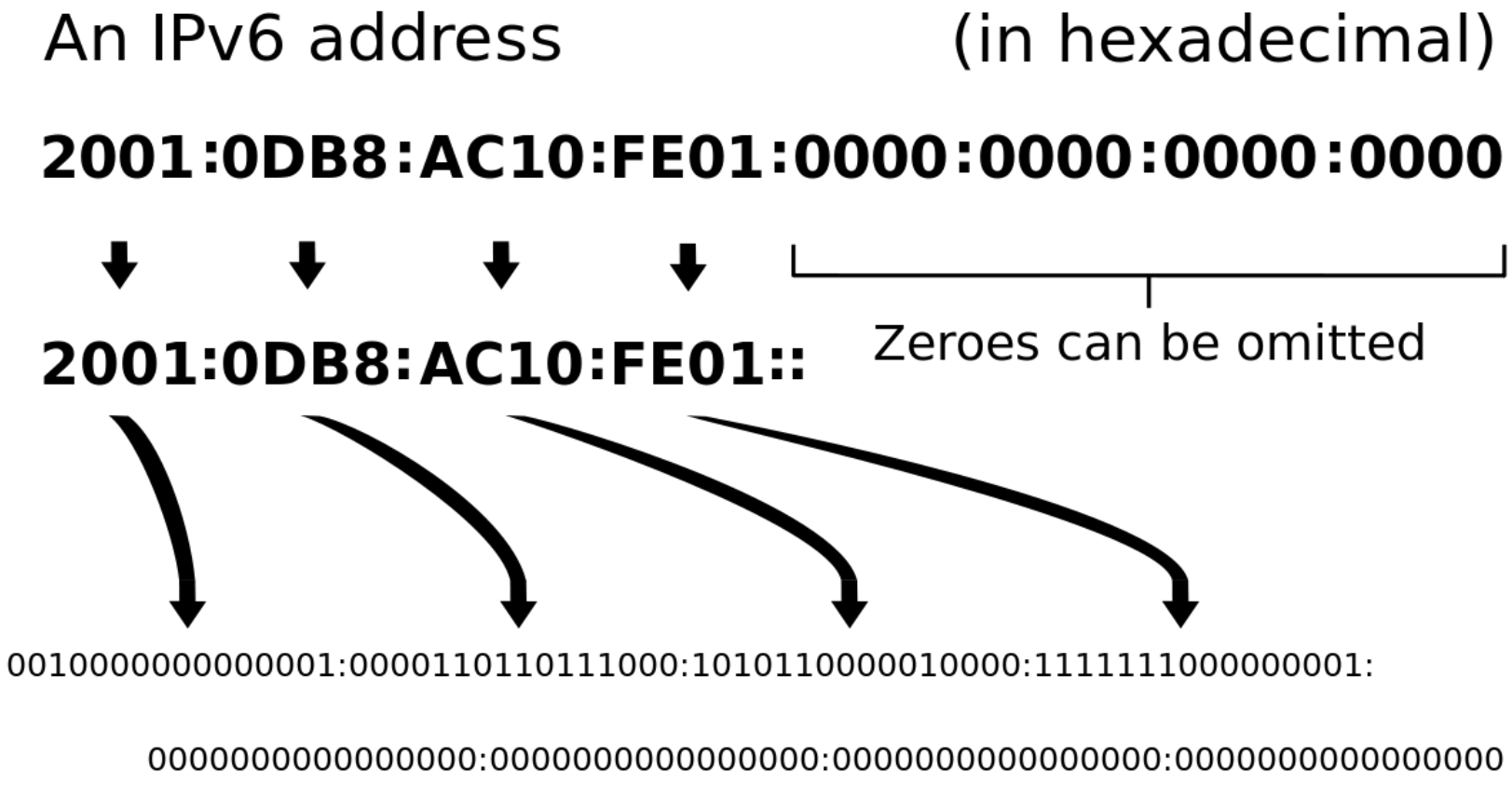


6

IPv4 structure

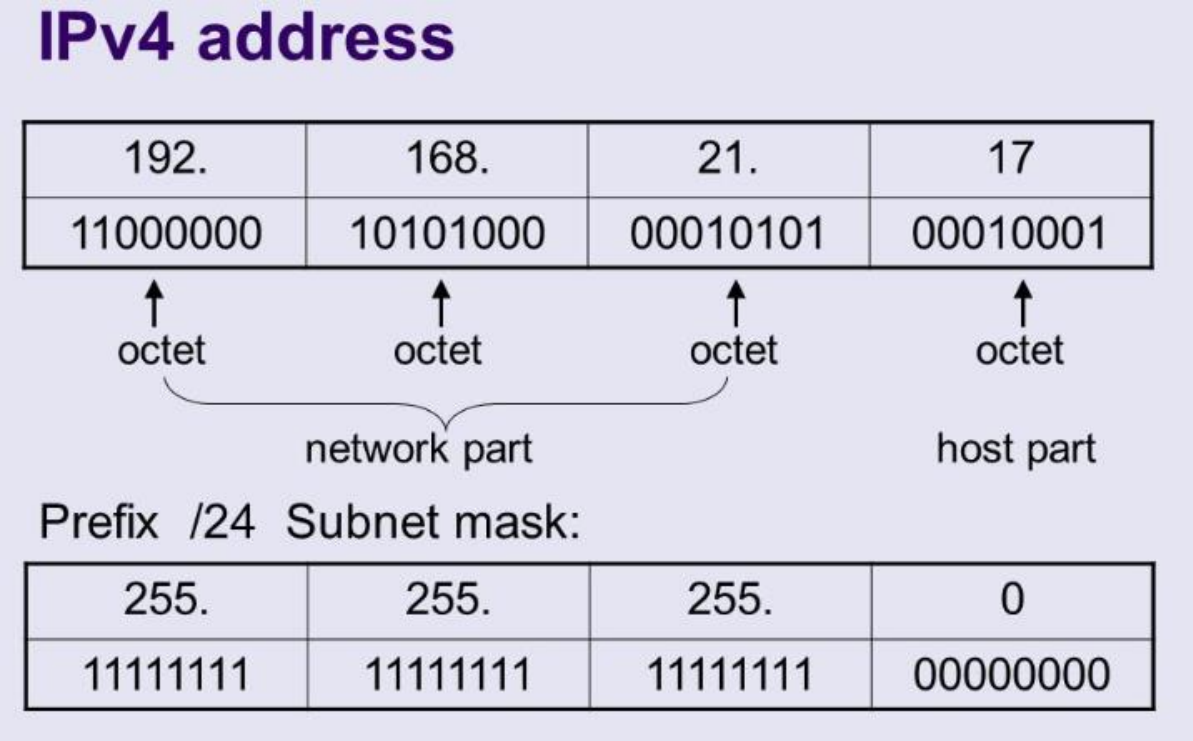


IPv6 structure



Ip subnet structure

192.168.21.17/24



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)
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	224 - 239	N/A	N/A
E	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

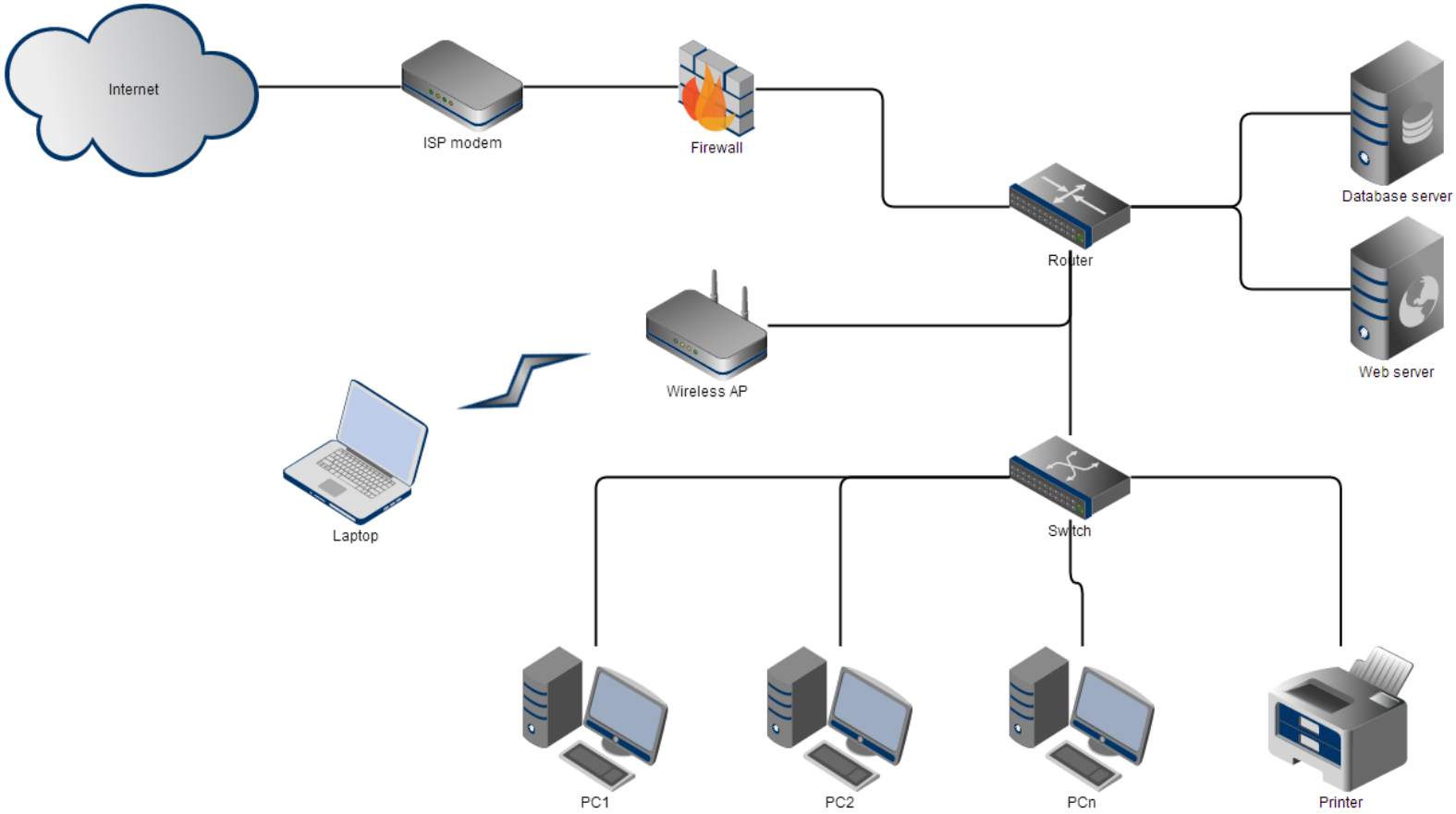
Special IPv4 addresses

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.[1][11]
240.0.0.0/4	240.0.0.0–255.255.255.254	268 435 456	Internet	Reserved for future use.[10] (Former Class E network).
224.0.0.0/4	224.0.0.0–239.255.255.255	268 435 456	Internet	In use for IP multicast.[9] (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.[5]
198.51.100.0/24	198.51.100.0–198.51.100.255	256	Documentation	Assigned as TEST-NET-2, documentation and examples.[5]
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.[8]
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.[2]
192.88.99.0/24	192.88.99.0–192.88.99.255	256	Internet	Reserved.[6] Formerly used for IPv6 to IPv4 relay[7] (included IPv6 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.[5]
192.0.0.0/24	192.0.0.0–192.0.0.255	256	Private network	IETF Protocol Assignments.[1]
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.[2]
169.254.0.0/16	169.254.0.0–169.254.255.255	65 536	Subnet	Used for link-local addresses[4] between two hosts on a single link when no IP address is otherwise specified, such as would have normally been retrieved from a DHCP server.
127.0.0.0/8	127.0.0.0–127.255.255.255	16 777 216	Host	Used for loopback addresses to the local host.[1]
100.64.0.0/10	100.64.0.0–100.127.255.255	4 194 304	Private network	Shared address space[3] for communications between a service provider and its subscribers when using a carrier-grade NAT.
10.0.0.0/8	10.0.0.0–10.255.255.255	16 777 216	Private network	Used for local communications within a private network.[2]
0.0.0.0/8	0.0.0.0–0.255.255.255	16 777 216	Software	Current network[1] (only valid as source address).

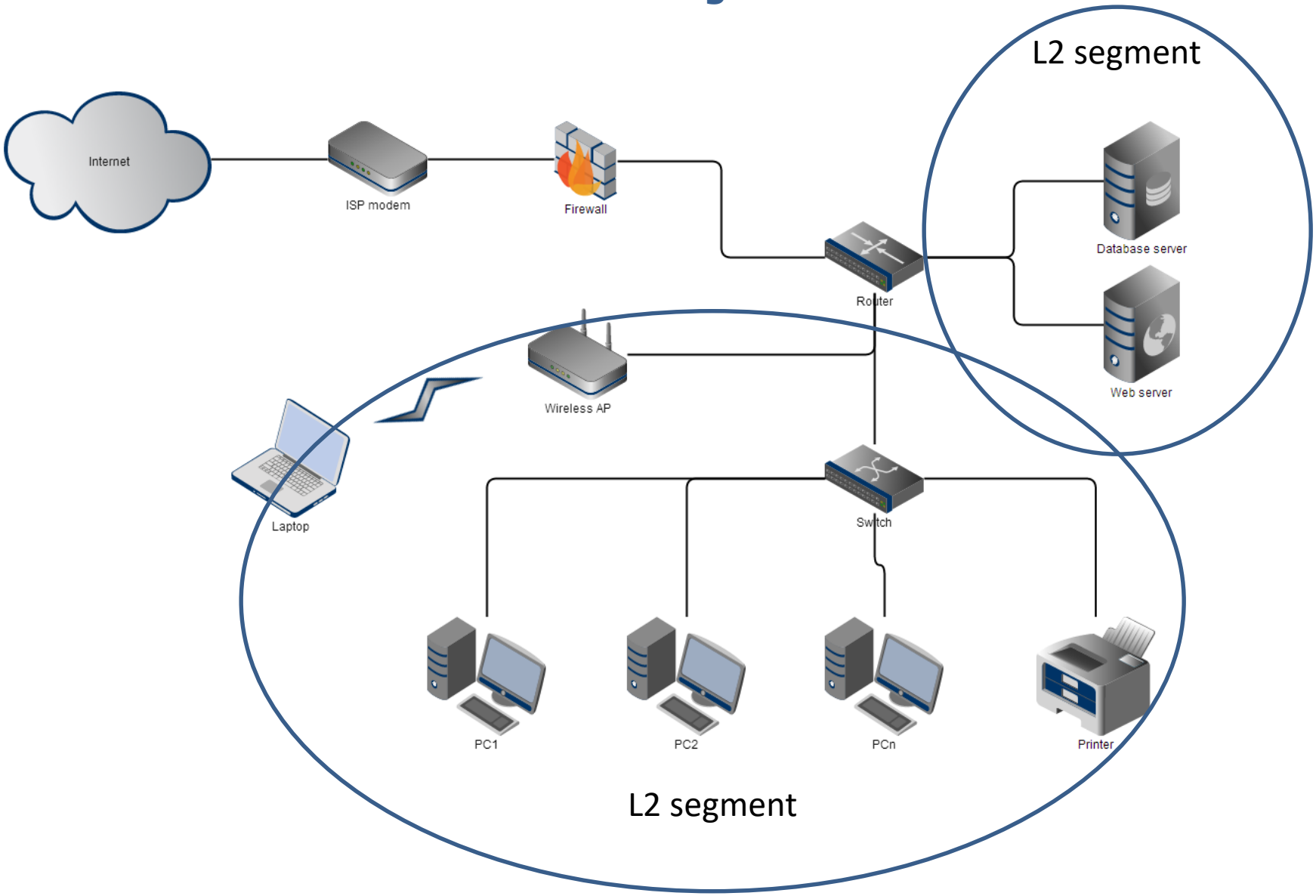
Private Ranges

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	Loopback address 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.[12]
100::/64	100::	100::ffff:ffff:ffff:ffff	2^{64}	Routing	Discard prefix.[13]
2001::/32	2001::	2001::ffff:ffff:ffff:ffff:ffff:ffff	2^{96}	Global Internet	Teredo tunneling.
2001:20::/28	2001:20::	2001:2f:ffff:ffff:ffff:ffff:ffff:ffff	2^{100}	Software	ORCHIDv2.[14]
2001:db8::/32	2001:db8::	2001:db8:ffff:ffff:ffff:ffff:ffff:ffff	2^{96}	Documentation	Addresses used in documentation and example source code.[15]
2002::/16	2002::	2002:ffff:ffff:ffff:ffff:ffff:ffff:ffff	2^{112}	Global Internet	The 6to4 addressing scheme (now deprecated).[6]
fc00::/7	fc00::	fdff:ffff:ffff:ffff:ffff:ffff:ffff:ffff	2^{121}	Private network	Unique local address.[16]
fe80::/10	fe80::	febf:ffff:ffff:ffff:ffff:ffff:ffff:ffff	2^{118}	Link	Link-local address.
ff00::/8	ff00::	ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff	2^{120}	Global Internet	Multicast address.

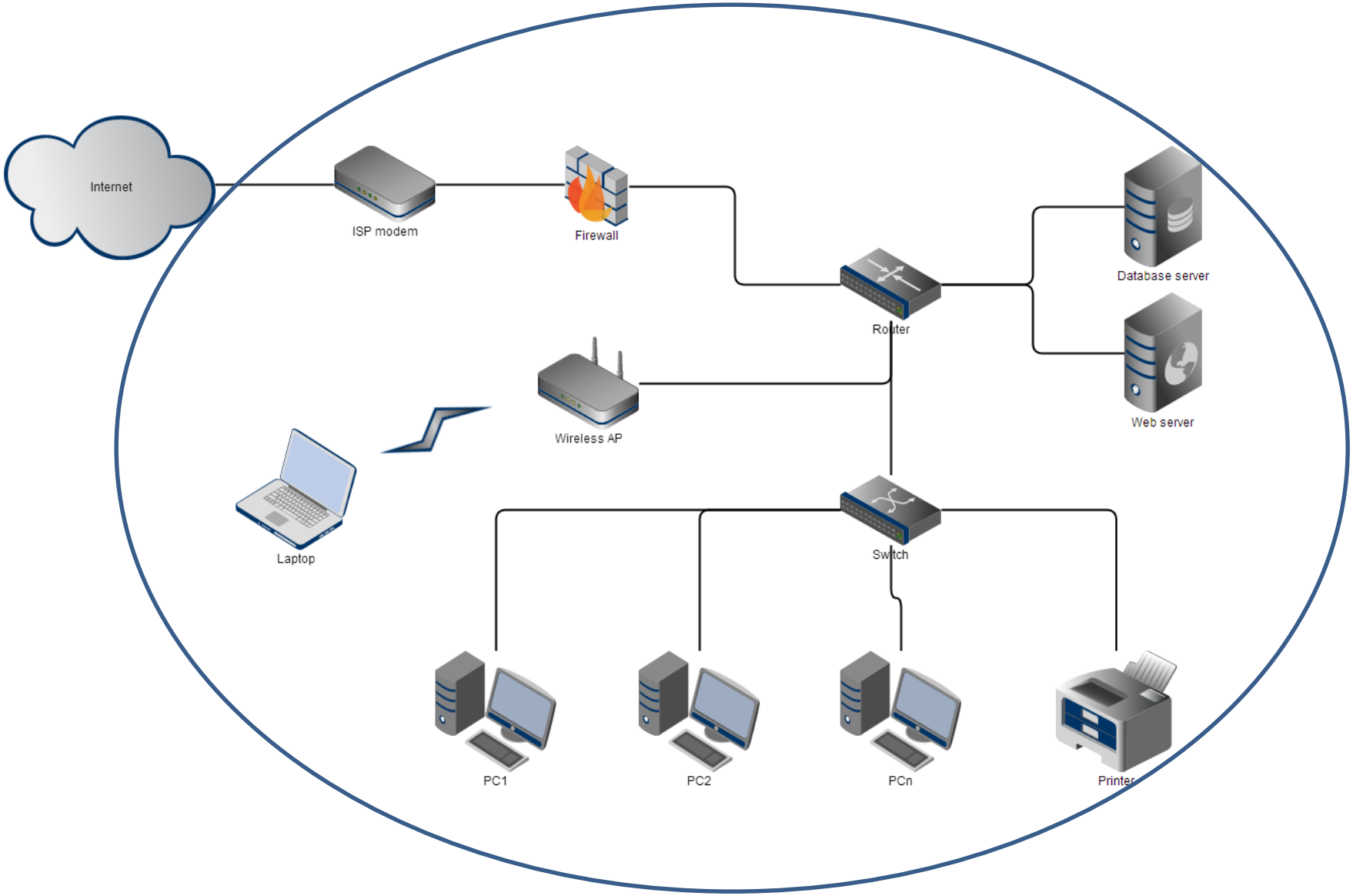
Routing and Switching



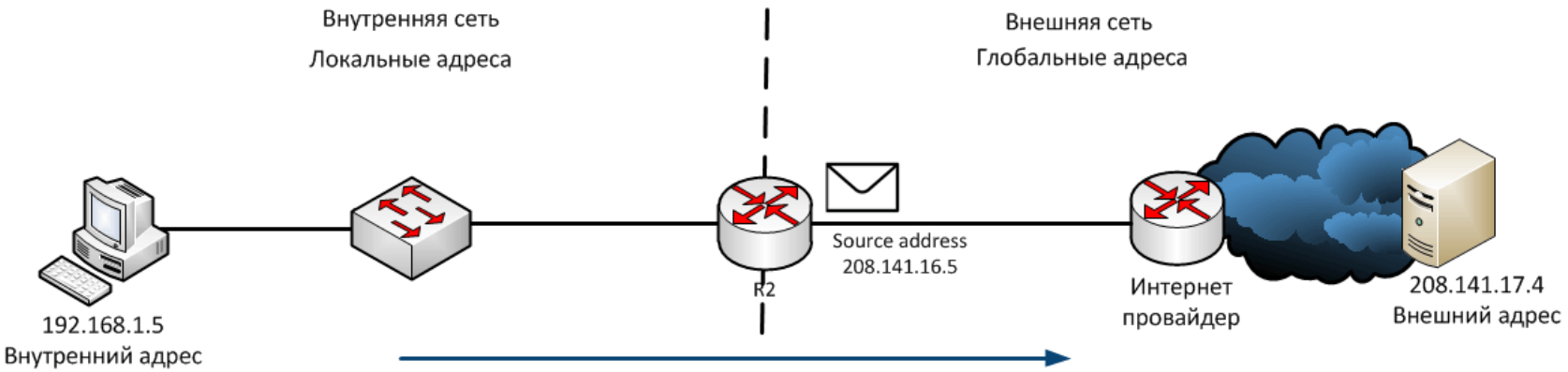
L2 Switching



L3 Switching



NAT



Source Address Inside Local 192.168.1.5	Destination Address Outside Local 208.141.17.4

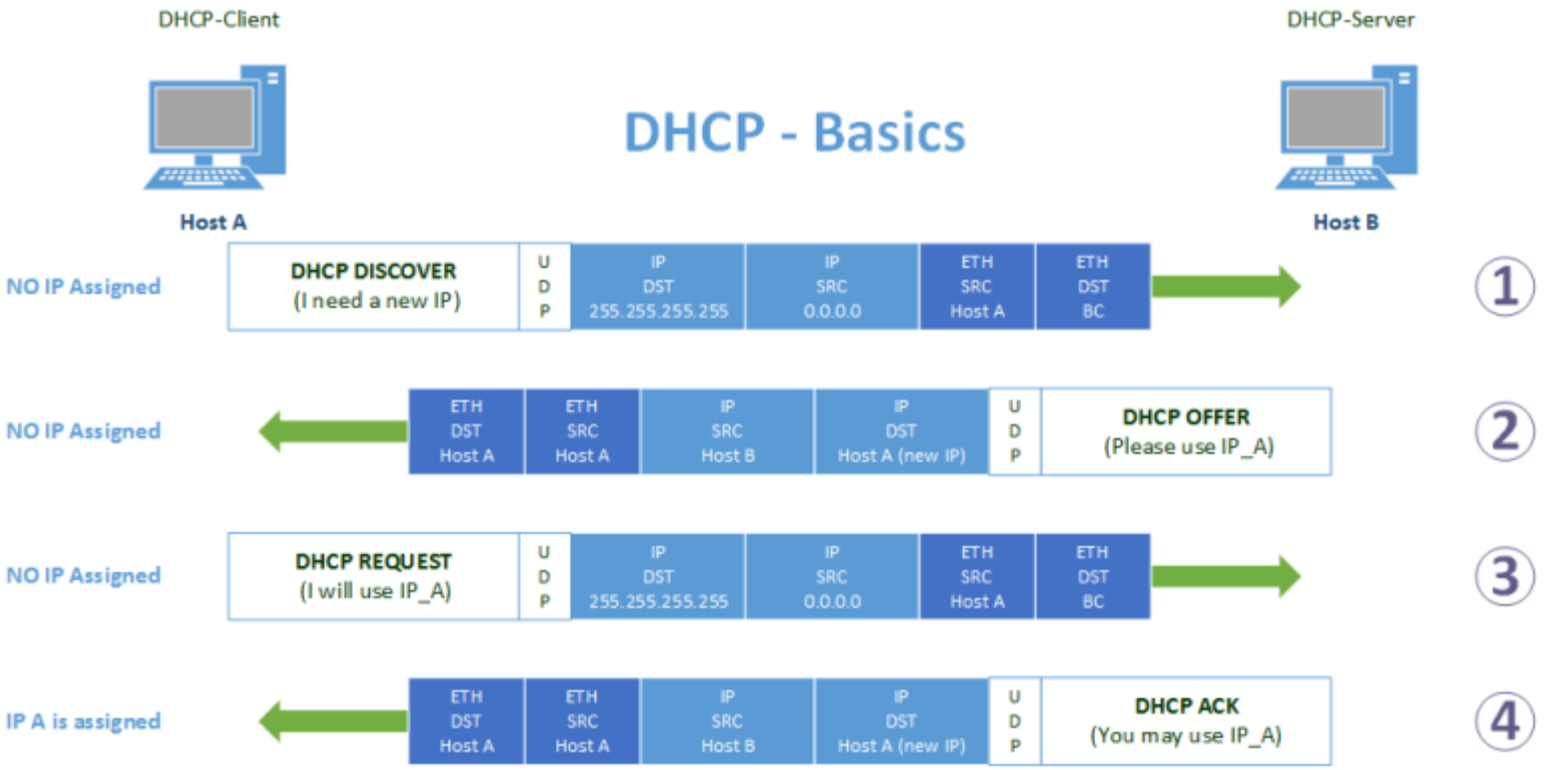
Source Address Inside Global 208.141.16.5	Destination Address Outside Global 208.141.17.4

Destination Address Inside Local 192.168.1.5	Source Address Outside Local 208.141.17.4

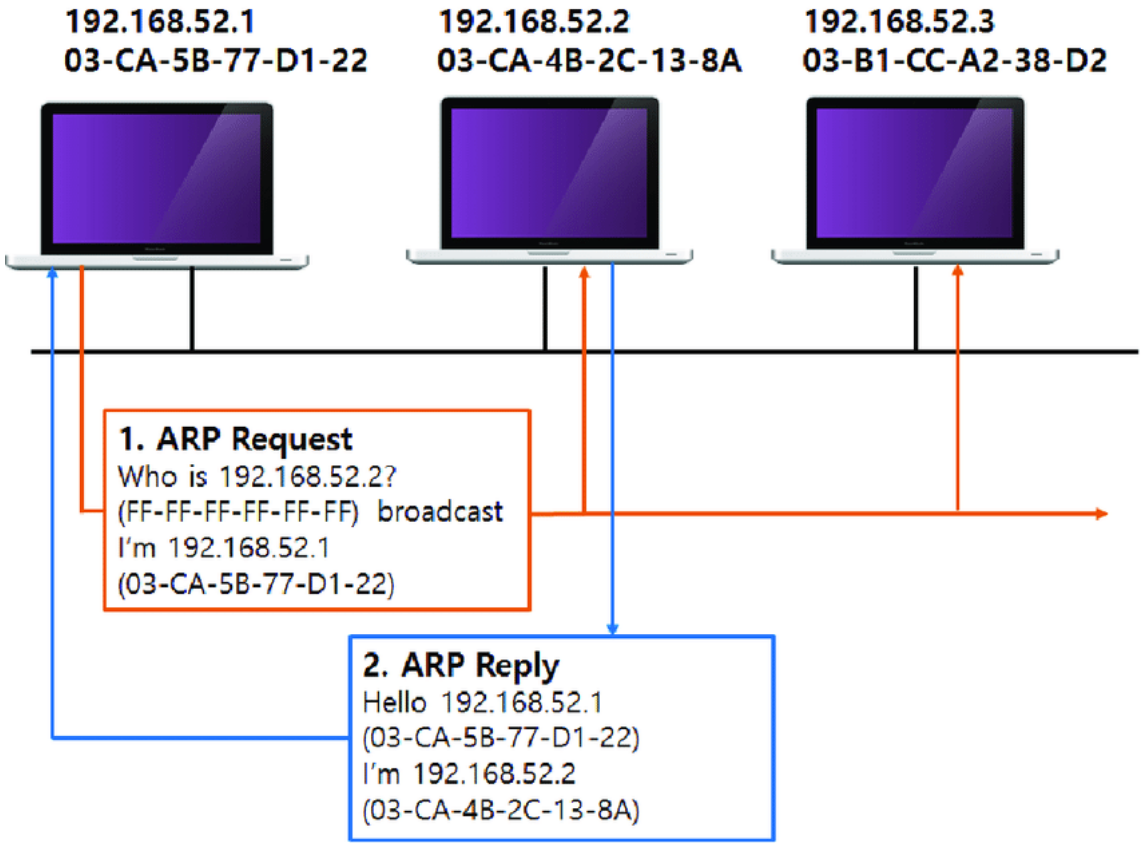
Destination Address Inside Global 208.141.16.5	Source Address Outside Global 208.141.17.4

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


DHCP-Client
DHCP-Server
DHCP - Basics
Host A
Host B
NO IP Assigned
DHCP DISCOVER
(I need a new IP)
UDP
IP DST 255.255.255.255
IP SRC 0.0.0.0
ETH SRC Host A
ETH DST BC
1
NO IP Assigned
ETH DST Host A
ETH SRC Host A
IP SRC Host B
IP DST Host A (new IP)
UDP
DHCP OFFER
(Please use IP_A)
2
NO IP Assigned
DHCP REQUEST
(I will use IP_A)
UDP
IP DST 255.255.255.255
IP SRC 0.0.0.0
ETH SRC Host A
ETH DST BC
3
IP A is assigned
ETH DST Host A
ETH SRC Host A
IP SRC Host B
IP DST Host A (new IP)
UDP
DHCP ACK
(You may use IP_A)
4

ARP(Address Resolution Protocol)

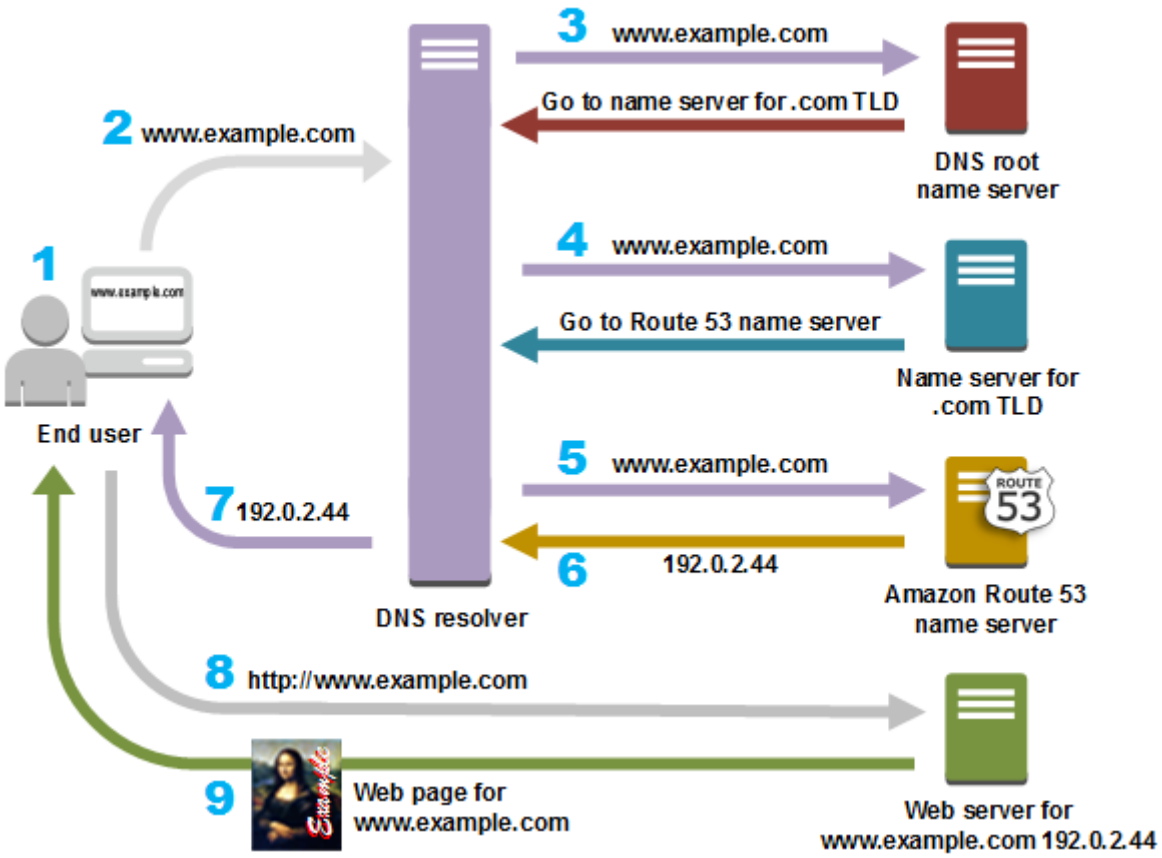


arp –a - show all entries

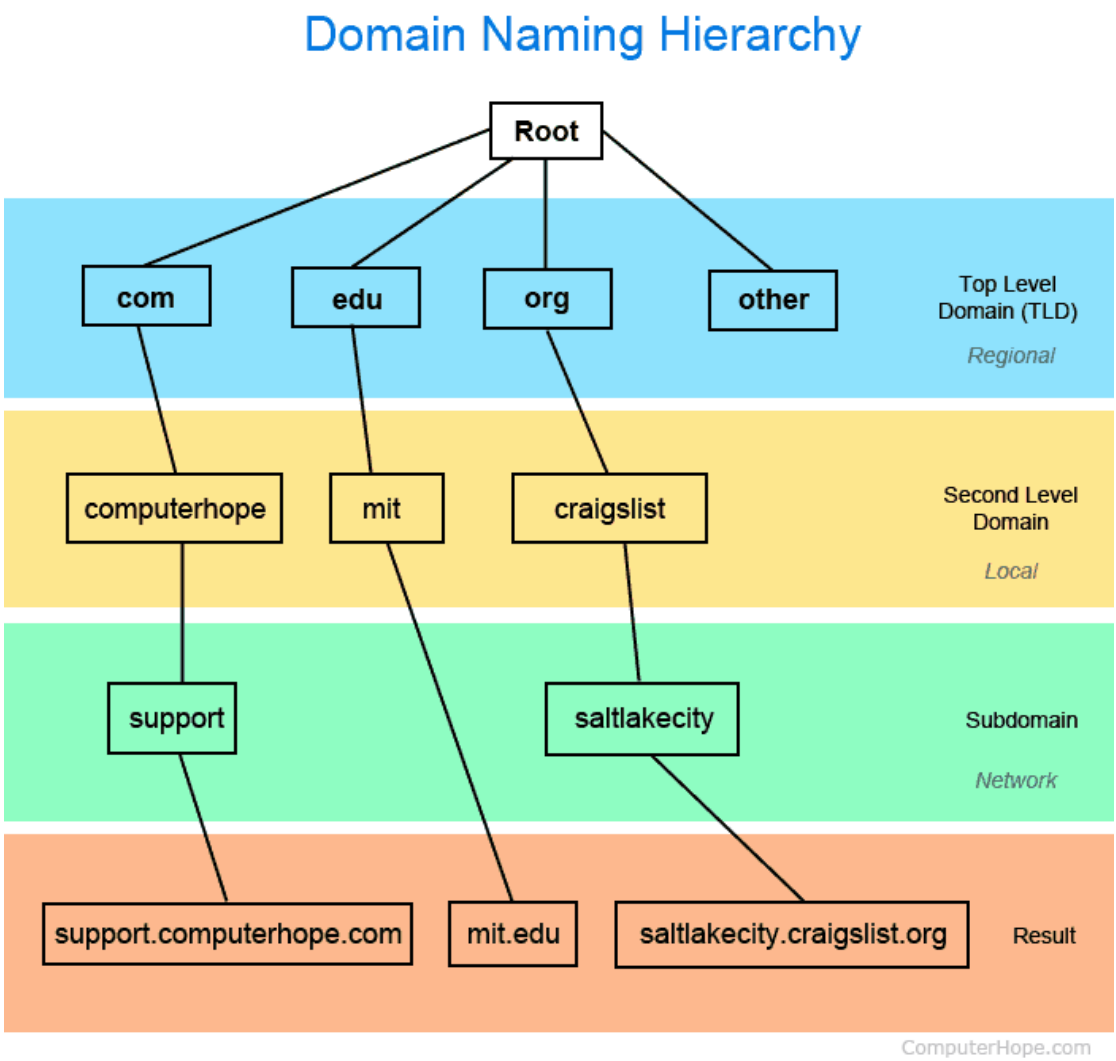
arp –d - clear all entries

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

DNS


1
www.example.com
End user
2 www.example.com
3 www.example.com
Go to name server for .com TLD
DNS root name server
4 www.example.com
Go to Route 53 name server
Name server for .com TLD
5 www.example.com
6 192.0.2.44
Amazon Route 53 name server
7 192.0.2.44
DNS resolver
8 http://www.example.com
9
Web page for www.example.com
Web server for www.example.com 192.0.2.44

DNS


Domain Naming Hierarchy
Root
com
edu
org
other
Top Level Domain (TLD)
Regional
computerhope
mit
craigslist
Second Level Domain
Local
support
saltlakecity
Subdomain
Network
support.computerhope.com
mit.edu
saltlakecity.craigslist.org
Result
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?

NETWORK FUNDAMENTALS

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