





Ardabil University of Medical Sciences



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Do we need information about computer networks?



Introduction to computer network science



SYBEX

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TODD LAMMLE

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The purpose of creating a network

Sharing resources including:

Data and Hardware





The simplest computer network



Two Computer Connected Back to Back



The simplest computer network



But our goal is to share resources on a larger scale



How are networks created?



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How are networks connected?



Answer: By ROUTERS

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Physical Networks Topologies

- Bus
- Ring
- Mesh
- Point- to- point
- Point- to- multipoint
- Hybrid
- Star









Network types in terms of scale

- PAN (Personal Area Network)
- LAN (Local Area Network)
- MAN (Metropolitan Area Network)
- WAN (Wide Area Network)







Network Physical Medias

























Physical Media



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Physical Media







Cat 5e Cat 6 Cat 6e









Physical Media



Physical Media











Network Connectivity Devices





NIC

Network Interface Card



Ethernet Adapter



Network Interface Card





Network Interface Card









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Network Interface Card

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Network Interface Card

Each of NICs have a MAC Address (Physical Address)

e.g.: 7F:D2:68:71:4E:FF

e.g.: 00-5A-0C-B9-DA-8F

it contains 48 bit or 6 byte

Network Interface Card

00-5A-0C-B9-DA-8F

it contains 48 bit or 6 byte

(a 48-bit address space with 2 possible values for each positio n (either 0 or 1) gives you 2⁴⁸, or 281 thousands billion).


Network Interface Card



In Windows:

Control Panel -- Network and Internet -- Network Connections Double Click on NIC – Details – Physical Address

Network Interface Card

Network & internet Wi-Fi 4 4 H-300 Connected Wi-Fi Use Wi-Fi H-300 H-300 Mobile network Forget Connected Data usage eastdelhiupdate 0 474 MB used on Wi-Fi Signal strength Excellent BSB.NET 9 Frequency Hotspot & tethering 2.4 GHz 0 Off DIRECT-vF-BRAVIA 8 Security WPA2 PSK SIM cards Add network Metered \$ Detect automatically Advanced V Wi-Fi preferences Airplane mode, VPN, Private DNS Wi-Fi turns back on automatically Network details Saved networks MAC address d8:d1:f9 3 networks **IP** address iTechHacks Gateway

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Network Interface Card

	Settings		Settings General		General	About
8	Control Center	5			Videos	129
C	Do Not Disturb	5	About	2	Photos	5,151
-			Software Update	>	Applications	106
0	General	>	A204.14		Applications	100
AA	Display & Brightness	>	AirDrop	>	Capacity	256 GB
	Wollnapor	~	Handoff	>	Available	181.61 GB
1990	waipapei		CarPlay	×	Version	11.2.1 (15C153)
-0	Sounds & Haptics	>			Carrier	Vodafone India 31.0
8	Siri & Search	>	Accessibility	>	Model	MQCN2LL/A
Ľ	Face ID & Passcode	>			Carial Number	DNDVARNU IOLA
505	Emergency SOS	>	iPhone Storage	>	Serial Number	DNPVMBNLJCLO
-	Battery	5	Background App Refresh	2	Wi-Fi Address	34:08:BC:19:7D:CA
-	building				Bluetooth	34:08:BC:19:7D:CB
U	Privacy	2	Restrictions	On >	IMEI	35 672708 253318 1











Switch





Switch





What is difference between Hub and Switch?



Switch



The hubs broadcasts



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Switch



But the switch does unicast

- Each of NICs has a MAC address (physical address).
- The switch reads the physical addresses that connected to each port.
- Switch make a MAC address table.

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Switch

Switch#show mac-add Switch#show mac-address-table Mac Address Table

lan	Mac Address	Туре	Ports
1	0007.8580.7456	DYNAMIC	Fa0/1
1	000d.6516.d692	DYNAMIC	Fa0/3
1	1000d.bcef.ae82	DYNAMIC	Fa0/4
1	000e.83f6.32da	DYNAMIC	Fa0/2
lotal	Mac Addresses for	this criter	ion: 4
wite	h#		



Network Layers (OSI Ref. Model)









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Wait..., let me see again

We have here an Address

MAC Address

What is difference between IP & MAC

- Local identification vs Global identification
- Layer 2 vs Layer 3 operation
- Physical address vs logical address
- Number of bits
- Address assignment and permanence
- Address formatting

- An IPv4 address consists of 32 bits of information
- These bits are divided into 4 sections, referred to as octets or bytes
- Four octets sum up to 32 bits $(8 \times 4 = 32)$

Every octet can be 0~255 in decimal base



Decimal: 172 . 16 . 30 . 56

Binary: 10101100.00010000.00011110.00111000



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IP Addressing

Decimal: 1 . 0 . 0 . 0

Decimal: 254 . 255 . 255 . 255

Binary: 11111110. 1111111. 11111111. 1111111

Namely, 4.3 billion (a 32-bit address space with 2 possible values for

each position (either 0 or 1) gives you 2^{32} , or 4,294,967,296).

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Depending on how many bits of IPv4 are fixed in the network, we have

three **Classes** of addresses



Address Class	RANGE	Default Subnet Mask
Α	1.0.0.0 to 126.255.255.255	255.0.0.0
в	128.0.0.0 to 191.255.255.255	255.255.0.0
С	192.0.0.0 to 223.255.255.255	255.255.255.0
D	224.0.0.0 to 239.255.255.255	Reserved for Multicasting
E	240.0.0.0 to 254.255.255.255	Experimental

Note: Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback testing.

In your opinion

Is the number of IPv4s **enough** for our world today?





Communication Devices, Servers, Storages, Computers, Portable Devices, TVs, Homs, Organizations,



What is the solution?

Private & Public IP

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2	Private address range			
Class	start address	finish address		
A	10.0.0.0	10.255.255.255		
В	172.16.0.0	172.31.255.255		
С	192.168.0.0	192.168.255.255		

	Public address range			
Class	start address	finish address		
A	0.0.0	126.255.255.255		
В	128.0.0.0	191.255.255.255		
C	192.0.0.0	223.255.255.255		
D	224.0.0.0	239.255.255.255		
	240.0.0.0	254.255.255.255		

IP Addressing Private & Public IP



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Private IPs in edge of network translate to Public IPs



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Private IPs in edge of network translate to Public IPs



Private IPs in edge of network translate to Public IPs



Network Address Translation (NAT)





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What is the solution for

IPv4 running out problem?

IP Addressing IPv6

- IPv6 was developed by Internet Engineering Task Force (IETF) in 1998
- IPv6 is a 128-bits address
- IPv6 use Hexa-Decimal format separated by colon :
- There are 8 groups and each group represents 2 Bytes (16-bits)

FE80:CD00:0000:0CDE:1257:0000:211E:729C





IP Addressing IPv6

IPv4

Deployed 1981

32-bit IP address

4.3 billion addresses Addresses must be reused and masked

> Numeric dot-decimal notation 192.168.5.18

DHCP or manual configuration

Deployed 1998

IPv6

128-bit IP address

7.9x10²⁸ addresses Every device can have a unique address

Alphanumeric hexadecimal notation 50b2:6400:0000:0000:6c3a:b17d:0000:10a9 (Simplified - 50b2:6400::6c3a:b17d:0:10a9)

Supports autoconfiguration

IP Addressing IPv6 Advantages of IPv6

- No more NAT (Network Address Translation)
- Auto-configuration
- No more private address collisions
- Better multicast routing
- Simpler header format
- Simplified, more efficient routing
- True quality of service (QoS), also called "flow labeling"
 - Built-in authentication and privacy support

IP Addressing IPv6

On March 2023, Google's statistics show IPv6 availability of its global user base at around

39 – 43%

depending on the day of the week. (greater on weekends)

Public IPs



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IP Addressing

Public IPs

- ARIN Canada, USA, and some Caribbean Islands
- APNIC Asia/Pacific Region
- RIPE NCC Europe, the Middle East, and Central Asia
- LACNIC Latin America and some Caribbean Islands
- AFRINIC Africa Region

IP Addressing

Public IPs



Figure 1. Internet Registry System structure

Public IPs

IP Addressing

- https://ipshu.com
- <u>https://lite.ip2location.com/ip-address-ranges-by-country</u>
- <u>https://www.iana.org/numbers</u>



IP Addressing

Private IPv4s

Class	Private IP address range	Subnet mask
А	10.0.0.0 - 10.255.255.255	255.0.0.0
В	172.16.0.0 - 172.16.31.255	255.255.0.0
С	192.168.0.0 - 192.168.255.255	255.255.255.0

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Ooh!!

What does this Subnet Mask say?

Don't worry!!

Its Only says that how many devices can be

in our network?

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Is the subnet mask immutable?

Of course not!!

You can change it and make your network bigger or smaller

Subnetting or Superneting



Subnet Mask **IP Addressing** The subnet mask determines whether two IPs are in the same range or not 172.16.40.25 172.16.10.25 255.255.0.0 255.255.0.0 Is in same range 192.168.1.10 192.168.40.220 80 255.255.255.0 255.255.255.0 Isn't in same range







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IP Addressing

Subnet Mask

Default Subnet Mask	Network / Host	Number of networks	Maximum nodes in a network
255.0.0.0	N.H.H.H	126	16,777,214
255.255.0.0	N.N.H.H	16,384	65,534
255.255.255.0	N.N.N.H	2,097,152	254

Maximum nodes in a network = (2ⁿ)-2

n= Number of host bit

IP Addressing

Subnet Mask

CIDR (Classless Inter-Domain Routing) Table

No. of bits within the		No. of hosts	Newtwork mask		No. of equivalent c addressing netw		classful twork
Prefix Host ID		per	Prefix	Dotted decima	Class A	Charles D	Class C
		network	notation	notation	Class A	Class B	
1	31	2147483646	/1	128.0.0.0	128	2 ⁻¹⁵	2 ²³
2	30	1073741822	/2	192.0.0.0	64	2 ⁻¹⁴	2 ²²
3	29	536870910	/3	224.0.0.0	32	2 ⁻¹³	2 ²¹
4	28	268435454	/4	240.0.0.0	16	4096	2 ²⁰
5	27	134217726	/5	248.0.0.0	8	2048	2 ¹⁹
6	26	67108862	/6	252.0.0.0	4	1024	2 ¹⁸
7	25	33554430	17	254.0.0.0	2	512	2 ¹⁷
8	24	16777214	/8	255.0.0.0	1	256	2 ¹⁶
9	23	8388606	/9	255.128.0.0	1/2	128	2 ¹⁵
10	22	4194302	/10	255 192 0 0	1/4	64	2 ¹⁴
11	21	2097150	/11	255.224.0.0	1/8	32	2 ¹³
12	20	1048574	/12	255.240.0.0	1/16	16	4096
13	19	524286	/13	255.248.0.0	1/32	8	2048
14	18	262142	/14	255.252.0.0	1/64	4	1024
15	17	131070	/15	255.254.0.0	1/128	2	512
16	16	65534	/16	255.255.0.0	1/256	1	256
17	15	32766	/17	255.255.128.0	1/512	1/2	128
18	14	16382	/18	255.255.192.0	1/1024	1/4	64
19	13	8190	/19	255,255,224,0	1/2048	1/8	32
20	12	4094	/20	255,255,240,0	1/4096	1/16	16
21	11	2046	/21	255,255,248,0	2 ⁻¹³	1/32	8
22	10	1022	/22	255.255.252.0	2-14	1/64	4
23	9	510	/23	255.255.254.0	2 ⁻¹⁵	1/128	2
24	8	254	/24	255.255.255.0	2-16	1/256	1
25	7	126	/25	255,255,255,128	2 ⁻¹⁷	1/512	1/2
26	6	62	/26	255 255 255 192	2 ⁻¹⁸	1/1024	1/4
27	5	30	/27	255.255.255.224	2 ⁻¹⁹	1/2048	1/8
28	4	14	/28	255 255 255 240	2 ⁻²⁰	1/4096	1/16
29	3	6	/29	255.255.255.248	2 ⁻²¹	2 ⁻¹³	1/32
30	2	2	/30	255.255.255.252	2 ⁻²²	2 ⁻¹⁴	1/64

IP Addressing

		Wi-Fi	-	
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator		Wi-Fi preferences	Forget this	Network
for the appropriate IP settings.		SLT-LTE-WiFi-78DE	ID Addresse	
Obtain an IP address auto	matically	IP settings	IF Address	
• Use the following IP addre	SS:	Static	DHCP Boo	tD Statio
IP address:	192 . 168 . 10 . 10	IP address	DHOP DOU	Static
Subpet mask:	255 255 255 0	192.168.1.128		
	233 . 233 . 233 . 0	Gateway	ID Address	100 100 1 0
Default gateway:		192.168.1.1	IP Address	192.106.1.0
Obtain DNS server addres	s automatically	Network prefix length	Cubrat Maak	OFF DEE OFF D
Use the following DNS server	ver addresses:	24	Subnet mask	200.200.200.0
Preferred DNS server		DNS 1	Doutor	400 420 4 4
ile in and		8.8.8.8	Houter	192.108.1.1
Iternate DNS server:	· · ·	DNS 2	5110	300000000000000
		8.8.4.4	DNS	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Ulidate settings upon ex	t Advanced	CANCEL SAVE	Search Domains	
	0% 0l		ooaron pomano	
	OK Cancel	\triangleleft \bigcirc \Box		

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When an address is inside the network, it is routed by the **Switch**.

But when an out-of-network address is requested, it is delivered to **Gateway (Router)** to continue the route.

Whether an address is inside the network or not is determined by **ANDing** the IP address with the subnet mask.

A router is a physical or virtual appliance that passes information between two or more networks.

A router inspects a given data packet's destination IP address, calculates the best way for it to reach its destination and then forwards it accordingly.

There are several types of routers, routers packets between 2 Local network or routers pass data between LANs and WANs

Routers can configured by Static Routes or Dynamic Route

Modem Router

A modulator-demodulator or (modem) is a device that converts data from a digital format into a format suitable for an analog transmission medium such as telephone or radio.

Gateway & Routing How are networks created?

Gateway & Routing How are networks connected?

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1- Ping

Ping is used to testing a network connect with another host

Select Command Prompt

C:\Users\Admin>ping 10.2.40.4

```
Pinging 10.2.40.4 with 32 bytes of data:
Reply from 10.2.40.4: bytes=32 time=1ms TTL=128
Reply from 10.2.40.4: bytes=32 time<1ms TTL=128
Reply from 10.2.40.4: bytes=32 time<1ms TTL=128
Reply from 10.2.40.4: bytes=32 time<1ms TTL=128
```

```
Ping statistics for 10.2.40.4:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

C:\Users\Admin>ping arums.ac.ir

```
Pinging arums.ac.ir [192.168.10.142] with 32 bytes of data:
Reply from 192.168.10.142: bytes=32 time=89ms TTL=62
Reply from 192.168.10.142: bytes=32 time=1ms TTL=62
Reply from 192.168.10.142: bytes=32 time=3ms TTL=62
Reply from 192.168.10.142: bytes=32 time=1ms TTL=62
```

```
Ping statistics for 192.168.10.142:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 1ms, Maximum = 89ms, Average = 23ms
```

C:\Users\Admin>_

2- Ipconfig To display basic details about the device's (NICs) IP address

Select Command Prompt

Microsoft Windows [Version 10.0.19045.3570] (c) Microsoft Corporation. All rights reserved.

C:\Users\Admin>ipconfig

Windows IP Configuration

Unknown adapter HotspotShield Network Adapter:

Media State Media disconnected Connection-specific DNS Suffix . :

Ethernet adapter vEthernet (Default Switch):

Connection-specific DNS Suffix .: Link-local IPv6 Address : fe80::6be0:884f:b63b:9018%39 IPv4 Address : 172.28.240.1 Subnet Mask : 255.255.240.0 Default Gateway :

Ethernet adapter Ethernet 3:

Connection-specific DNS Suffix . : arums.ac.ir Link-local IPv6 Address : fe80::123:9182:ef82:a2f8%21 IPv4 Address. : 10.2.40.25 Subnet Mask : 255.255.255.0 Default Gateway : 10.2.40.1

C:\Users\Admin>

3- Arp /a

ARP stands for Address Resolution Protocol. Although network communications can readily be thought of as an IP address, the packet delivery depends ultimately on the media access control (MAC)

Proot@kali: /home/webimprints					- o ×
Currently s	canning:	Finished!	Screen	View: (Unique Hosts
8 Captured	ARP Req/F	Rep packets,	from 7 hos	ts. To	otal size: 480
IP	At M	Address	Count	Len	MAC Vendor / Hostname
192.168.1.1	0c:d	12:b5:32:57:e	4 1	60	Binatone Telecommunication P
192.168.1.1	00 b8:8	31:98:e6:0d:1	1 2	120	Intel Corporate
192.168.1.1	04 00:1	c:26:ba:65:2	d 1	60	Hon Hai Precision Ind. Co.,L
192.168.1.1	05 00:2	27:15:79:45:2	c 1	60	Rebound Telecom. Co., Ltd
192.168.1.1	01 40:h	0:76:65:d1:2	2 1	60	ASUSTek COMPUTER INC.
192.168.1.1	06 9c:6	6b:72:75:1f:7	9 1	60	Unknown vendor
192.168.1.2	40 14:0	07:08:5a:5d:5	a 1	60	Private

4- Tracert

is used to get the network packet being sent and received and the number of hops required for that packet to reach to target.

Microsoft Windows [Version 10.0.14393] (c) 2016 Microsoft Corporation. All rights reserved. C:\Users\Ease >tracert 8.8.8.8 Tracing route to google-public-dns-a.google.com [8.8.8.8] over a maximum of 30 hops: <1 ms <1 ms <1 ms 192.168.10.254 1 1 ms n4l-akl-internet.mdr-bng1.as45177.net.nz [14.1.43.222] 2 4 ms 7 ms 1 ms ae3-1303.mdr-cr1.as45177.net.nz [120.136.0.131] 1 ms 1 ms 4 25 ms xe-4-0-1-0.sy3-cr1.as45177.net.au [120.136.0.118] 24 ms 24 ms 24 ms 24 ms 24 ms as15169-ip-119.cust.sy3-cr1.as45177.net.au [120.136.0.119] 25 ms 25 ms 216.239.40.233 6 25 ms 25 ms 25 ms 216.239.40.255 25 ms 25 ms google-public-dns-a.google.com [8.8.8.8] 8 25 ms 25 ms Trace complete. C:\Users\

Dynamic Host Configuration Protocol (DHCP) is a client/server protocol (Service) that automatically provides an Internet Protocol (IP) host with its IP address and other related configuration information such as the subnet mask and default gat eway.

DHCP Service has a Lease Duration. For example: 10 Days

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You can get IP settings assigned au this canability. Otherwise, you need	tomatically if your network supports	Wi-Fi preferences
for the appropriate IP settings.		SLT-LTE
Obtain an IP address automat	ically	IP settings
• Use the following IP address:		Static
IP address:	192 . 168 . 10 . 10	IP address
Subnet mask:	255.255.255.0	192.168.1.128
Default gateway:		Gateway
Obtain DNS server address au	tomatically	Network prefix length
Use the following DNS server	addresses:	DNR 1
Preferred DNS server:		8.8.8.8
Alternate DNS server:		DNS 2
		8.8.4.4
Validate settings upon exit	Advanced	CANCEL
	OK Creat	

Forge	et this Netw	ork
IP Address		
DHCP	BootP	Static
IP Address		192.168.1.6
Subnet Mask	(25	5.255.255.0
Router		192.168.1.1
DNS	xx	x, xxx, xxx, xxx
Search Dom	ains	

Automatic IP

Dynamic IP

DHCP

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DHCP Servers

Microsoft Windows Server

Server Manager (VMWARE-W2K	8)	Scope Options			
Roles Active Directory Demain Service		Option Name	Vendor	Value	Class
DHCP Server	ear.local 50.0.0] NETGEAR Pool Leases tions Plia Configure Opt	006 DNS Servers 015 DNS Domain Name	Standard Standard	10.250.0.7 mateusz.local	None
Filters	View	•			
DNS Server File Services	Refresh Export List				
Features Help					

DHCP Servers

Linux Server

File Edit View Search Terminal Help GNU nano 4.8 /etc/dhcp/dhcpd.conf Modified Fine dynamic-bootp 10.254.239.40 10.254.239.60; option broadcast-address 10.254.239.31;
GNU nano 4.8 /etc/dhcp/dhcpd.conf Modified range dynamic-bootp 10.254.239.40 10.254.239.60; option broadcast-address 10.254.239.31;
<pre>range dynamic-bootp 10.254.239.40 10.254.239.60; option broadcast-address 10.254.239.31; option broadcast-address 10.254.239.31;</pre>
option proadcast-address 10.254.239.31;
ubnet 192.168.114.0 netmask 255.255.255.0 {
range 192.168.114.20 192.168.114.254;
option domain-name-servers server.example.org;
option domain-name "example.org"; option subpet-mask 255 255 0;
option routers 192.168.114.1:
option broadcast-address 192.168.137.255;
default-lease-time 600;
max-lease-time 7200;
G Get Help <u>^O</u> Write Out <u>^W</u> Where Is <u>^K</u> Cut Text <u>^l</u> lustify
X Exit AR Read File ^\ Replace ^U Paste Text^T To Spell

DHCP Servers

DHCP Networks Leases Options Option Sets Alerts

T DHCP Config DHCP Setup

8.8.8.8

Back

DNS Servers: 1.1.1.1

Add AR.

\$

\$

Next Cancel

+

+ ok

Cancel

Apply

Static

Cache

admin@00:0C:42:F9:72:78 (MikroTik) - WinBox v6.43 on RB751U-2HnD (mipsbe)

Session: 00:0C:42:F9:72:78

NS Settings

Servers:

8.8.8.8

Allow Remote Requests

Dynamic Servers: 1.1.1.1

Max UDP Packet Size: 4096

Query Server Timeout: 2.000

Max. Concurrent Queries: 100

Max. Concurrent TCP Sessions: 20

Query Total Timeout: 10.000

Cache Size: 2048

Cache Max TTL: 7d 00:00:00 Cache Used: 10 KiB

Session Settings Dashboard

Capedia Capedia Capedia
Capedia
Capedia
Interfaces
Capedia
Ca

OpenFlow

Routing

illi System

Queues

Log

Files

Radius

X Tools

TR069

Partition

🕜 Manual

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S New WinBox

👃 Make Supout.rif

Mew Termina

	BAPINS BA
Find T	E .

DHCP Servers

Router≻enable Router#configure terminal Router#ip dhcp excluded-address 10.0.0.1 10.0.0.10 Router(config)#ip dhcp pool mypool Router(dhcp-config)#network 10.0.0.0 255.255.255.0 Router(dhcp-config)#default-router 10.0.0.1 Router(dhcp-config)#default-router 10.0.0.2 Router(dhcp-config)#lease 3 0 0 Router(dhcp-config)#end Router(dhcp-config)#end Router#write memory

Cisco Switch and Routers

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Modem-Router

DHCP

DHCP Servers

Product: DSL-3580L					Firmware Version: EU_1.01
D-Lin	k				
DSL-3580L	SETUP	ADVANCED	MAINTENANCE	STATUS	HELP
Wizard	LAN SETUP				Helpful Hints
WAN Setup Wireless Setup	This section allows you to optional and you should r	o configure the local network s not need to change any of the	ettings of your router. Please r settings here to get your netw	note that this section is vork up and running.	If you already have a DHCP server on your network or are using
LAN Setup	ROUTER SETTING	s			the devices on your
Time and Date IPv6 Setup USB Setup	Use this section to config is the IP Address that yo here, you may need to a	ure the local network settings u use to access the Web-base djust your PC's network settin	of your router. The IP Address d management interface. If yo gs to access the network again	that is configured here u change the IP Address	DHCP Server to disable this feature.
Mydlink TM Settings		Router IP Address : Subnet Mask :	192.168.0.1 255.255.255.0		always have fixed IP addresses, add a DHCP Reservation for each
English - Reboot	DHCP SERVER SE Use this section to config network.	TTINGS (OPTIONAL) ure the built-in DHCP Server t Enable DHCP Server : DHCP IP Address Range :	D assign IP addresses to the co	mputers on your 192.168.0.254	such device. More
		DHCP Lease Time : DHCP Relay : DHCP Server IP :	24 (hours)		
	L	Save S	ettings		

DNS

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A Domain Name Service (DNS) server is one of the most important servers in your network and on the Internet as well.

Why?

Because without a DNS server, you would have to

type <u>https://94.182.113.53</u> for entering <u>http://www.varzesh3.com</u> Or type <u>https://185.188.104.10</u> for entering <u>https://www.digikala.com</u>

DNS system as the **phone book** of the Internet.

DNS



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Root server

There are 13 root domain name servers in the world, one of which is the main root server in the United States, operated by Network Solu tions, an American Internet agency.

The other 12 are secondary root servers, 9 of which are in the US, 2 in Europe (located in the UK and Sweden), and 1 in Asia (located in Japan).

If there is no cache response, the resolver initiates a query request t o the root server. The root server registers the top-level domain na me (.com, .net, .org, etc.) and the corresponding host. After the recu rsive resolver receives the initial response, it sends another request t o the TLD name server.



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DNS can assign by DHCP Service on client. Also can set manually, independent IP, Subnet Mask and Default Gateway.





Best Global Public DNS Servers

Google 8.8.4.4 8.8.8.8 Cloudflare 1.1.1.1 1.0.0.1 **Open DNS**

208.67.222.222 208.67.220.220



Other Network Protocols



Firewall

A Firewall is a network security device or a software that mon itors and filters incoming and outgoing network traffic based on an organization's previously established security policies.

At its most basic, a firewall is essentially the barrier that sits between a private internal network and the public Internet.

Home Network





Virtual Private Network

A VPN establishes a secure and encrypted connection between your computer and the Internet and provides a private tunnel f or your data and communications when using public networks.



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Virtual Private Network

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Wireless Networks

Wired vs Wireless Network

A wired network keeps devices connected to a network by wires. In a Wireless network, the media (Air) is a shared resource.

This has several implications:

- Unlike a wired network, wireless can't both talk and listen at the same time, it is "half duplex"
- All users are sharing the same space must take turns to talk
- Everyone can 'hear' all traffic going on.

Types of Wireless Network Connections

- WWAN: A wide-area network covers a very large area, Such as m obile cellular networks (MCI net, MTN Irancell, ...)
- WMAN: A metropolitan-area network is a computer network tha t spans across a city or small geographical area such as Wimax.
- WLAN: Wireless network that exists at a single site, such as an off ice building or in your home.
- WPAN: Bluetooth or IR Networks that work in 10 meters.

Wi-Fi Network Connection Modes

• Infrastructure: With infrastructure mode, you need an access point that serves as the primary connection device for clients.

 Ad hoc: Ad hoc mode is also referred to as peer-to-peer mode because it does not involve an access point, but is instead made up of multiple client devices. The devices, acting as "peers" with in the network, connect to each other directly. Such as 'Wireless Sensor Networks (WSNs)'

Waves Frequency and Radio Range



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Waves Frequency and Radio Range



National Table of Frequency Allocation



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National Table of Frequency Allocation



Wireless IEEE Standards

Name of the Standard	Went Live	Bands	Max Network Bandwidth	Remarks
802.11be (WiFi 7) Extremely High Throughput (EHT)	Currently in works	2.4 GHz, 5 GHz, and new 6 GHz band	30 Gbps (Theoretically)	 Based on draft 802.11be standard drafted in 2021. The WiFi 7 standard is backward compatible with 2.4 GHz and 5 GHz devices. The 6 GHz band yields drastically less interference as compared to the 2.4 and 5 GHz bands.
802.11ax (WiFi 6) High-Efficiency Wireless (HEW)	2019		10 Gbps	 Will replace 802.11ac as a de-facto wireless standard. Uses less power more reliable in congested environments. Supports better security.
802.11ac (WiFi 5)	2014	5 GHz band	1300 Mbps (5 GHz Band) 450 Mbps (2.4 GHz Band)	 Uses dual-band wireless technology, supporting simultaneous connections on both 2.4 GHz and 5 GHz WiFi devices. Most wireless routers are compliant with this standard. Most expensive to implement.
802.11n (WiFi 4)	2009	2.4 GHz, and 5 GHz bands	600 Mbps	 Uses MIMO technology. Supports a better range over WiFi standards due to its increased signal intensity. Significant bandwidth improvement over earlier standards. More expensive to implement over 802.11g (WiFi 3)
802.11g (WiFi 3)	2002-2003	2.4 GHz bands	Up to 54 Mbps	 Uses the 2.4 GHz range. Combines best of 802.11a and 802.11b. 802.11g access points work with 802.11b wireless network adaptors and vice versa. Least expensive. Supported by all wireless devices.
802.11a (WiFi 2)	1999	5 GHz band	upto 54 Mbps (5 GHz Band)	 802.11a and 802.11b use different frequencies and hence are incompatible.
802.11b (WiFi 1)	July 1999	2.4 GHz band	2 Mbps (TCP) 3 Mbps (UDP)	 Unregulated. An issue with interference from microwave ovens and other appliances using the 2.4 GHz range.



Configuration an ADSL Modem-Router





Thank you

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