

Networking Refresher

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1 IP Addresses

ifconfig bring up networking information.

- `inet`: IPv4 Address in Decimal notation. Made up of 32 bits.
- `inet6`: IPv6 Address in Hexa notation. Made up of 128 bits.

How is it possible that we're using IPv4 but we're out of address space? It's all about NAT: Network Address Translation. What we're doing is assigning private addresses, so we're not taking space from the 4 billion IPv4 addresses. All private addresses are not going to be out in the interweb, it's an IP address that is only known to you. So because we use these private IP addresses we can pass them out through what is called a public IP address.

Network Class	Network Numbers	Network Mask	#Networks	#Hosts per Network
CLASS A	10.0.0.0	255.0.0.0	126	16.646.144
CLASS B	172.16.0.0 to 172.31.0.0	255.255.0.0	16.383	65024
CLASS C	192.168.0.0 to 192.168.255.255	255.255.255.0	2.097.151	254
LOOPBACK	127.0.0.0 to 127.0.0.7	255.255.255.0	-	-

So you probably got all your devices on a class C network, and all of them are talking out of one IP address: your public IP address. You rent it from your ISP, and all this network traffic goes out through this IP.

2 MAC Addresses

This is layer 2. MAC stands for Media Access Control and that is identified in our *ifconfig* as **ether**. This is our physical address and a way that we communicate when we are using switches. This is how switches know what device is what.

Suppose that you have a computer and you're installing a Network Interface Card. You plug that in and you're going to have a MAC Address for that NIC. Anything that's using a NIC is going to have a MAC Address.

If we take the first 3 pairs of a MAC Address, we can identify the manufacturer. E.g. `b0 : c0 : 90`, is from Chicony Electronics Co. Ltd. That way we can identify what we're up against.

3 TCP

TCP stands for Transmission Control Protocol and that is a connection oriented protocol. This one is used when we need high reliability. E.g, websites (HTTP/HTTPS), SSH, FTP.

3.1 The Three-Way Handshake

1. SYN: *You say Hello!*
2. SYN/ACK: *Ey SYN, I Acknowledge you, hello!*
3. ACK: *Cool, let's start the conversation.*

This logic could be extrapolated to ports (an item that we can open in order to communicate with certain protocols, e.g HTTP is port 80, HTTPS is port 443). So, if for example you want to connect to port 80 on a website, first you're going to send a SYN (*Ey, I want to connect to port 80!*). If that port is open and can start a conversation, the reply will be a SYN/ACK (*You can go ahead, connect to me*). Then, if you want to actually establish a connection, you send an ACK packet back.

19	1.178137205	192.168.0.165	216.58.202.35	TCP	74	51916 → 80	[SYN] Seq=0 Win=
20	1.204127977	216.58.202.35	192.168.0.165	TCP	76	80 → 51916	[SYN, ACK] Seq=
21	1.204151354	192.168.0.165	216.58.202.35	TCP	66	51916 → 80	[ACK] Seq=1 Ack=

In this example we can see the three way handshake between the port 51916 from the computer on 192.168.0.165 and the port 80 from the server on 216.58.202.35.

4 UDP

UDP stands for User Datagram Protocol and that is a connection-less protocol. This one is used for example in streaming services, DNS, Voice over IP.

5 Common Ports and Protocols

• TCP

- **FTP (21)**: File transfer protocol. You can log in and put a file or get a file off the server.
- **SSH (22)**: Log into a machine remotely (encrypted).
- **Telnet (23)**: Log into a machine remotely (plain text).
- **SMTP (25)**: Mail.
- **DNS (53)**: Domain Name System: Resolve IP addresses to names.
- **HTTP (80) / HTTPS(443)**: Web sites.
- **POP3 (110)**: Mail.
- **SMB (139 + 445)**: The most common port for pentesters. File shares: think about all the crazy exploits: Wannacry, Eternal Blue, MS17.0.1.0. SMB is open so frequently on networks.
- **IMAP (143)**: Mail

• UDP

- **DNS (53)**: Domain Name System: Resolve IP addresses to names.
- **DHCP (67, 68)**: Associates you with an IP address, kinda random (from a range). The opposite is static IP address.
- **TFTP (69)**: Trivial FTP.
- **SNMP (161)**: Simple Network Management Protocol. When we encounter it there may be information to be gathered. Especially if there are strings being used that are public.

6 OSI Model

Please Do Not Throw Sausage Pizza Away!

- Layer 1. Physical: Data cables, cat6, ...
- Layer 2. Data: Switching, MAC Addresses, ...
- Layer 3. Network: Routing, IP Addresses, ...
- Layer 4. Transport: TCP/UDP, ...
- Layer 5. Session: Session management, ...
- Layer 6. Presentation: WMV, JPEG, MOV (Media), ...
- Layer 7. Application: HTTP, SMTP, ...

When we receive data, it goes from Layer 1 to Layer 7. When we transmit data, it goes out from the Application Layer down to the Physical layer.

When we're troubleshooting, it's always best to start with the physical layer:

1. Is the cable connected? Is there a green light?
2. Let me check the MAC...
3. Let me check the IP...

7 Subnetting

Let's start with an example:

```
root@kali:~# ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.0.58 netmask 255.255.255.0 broadcast 192.168.0.255
```

We have an IPv4 (inet) and a netmask. Each part of them, is made of 8 ones or zeros, and depending on how those ones and zeros are switched on or off, we get different numbers. If we have 8 bits turned on, we get 255. If we have 8 bits turned off, we get 0.

128	64	32	16	8	4	2	1	
1	1	0	0	0	0	0	0	192
1	0	1	0	1	0	0	0	168
0	0	0	0	0	0	0	0	0
0	0	1	1	1	0	1	0	58
1	1	1	1	1	1	1	1	255

So the inet 192.168.0.58 in binary (ones and zeros) is 11000000.10101000.00000000.00111010.

Now, for the 255.255.255.0 netmask: in binary that is 11111111.11111111.11111111.00000000. It is important to note that when we're talking about netmasks, the switch on has to be in order. i.e we can't have ones mixed up with zeros, like for example 11111111.11110011.00001111.00001100.

To simplify all this, we use the CIDR notation, in which we write the IP and then, after a slash ('/'), we write how many ones there are in the netmask. E.g, 192.168.0.58/24.

Subnetting is the process of stealing bits from the HOST part of an IP address in order to divide the larger network into smaller sub-networks called subnets.

7.1 Subnet Address

To calculate the IP Address Subnet you need to perform a bit-wise AND operation ($1+1=1$, $1+0$ or $0+1=0$, $0+0=0$) on the host IP address and subnet mask.

7.2 Hosts

Continuing with the previous netmask, we have 8 bits turned off, and that leads us to calculate how many hosts (devices connected to the network) we can have: $2^8 = 256$. The /24 is one of the most common, because it's used mostly in households and small businesses.

			Subnets			Hosts				
			Class A	Class B	Class C	Class A	Class B	Class C		
Class C Network	Class B Network	Class A Network	/	Netmask	Class A	Class B	Class C	Class A	Class B	Class C
			/8	255.0.0.0	1			16777214		
			/9	255.128.0.0	2			8388606		
			/10	255.192.0.0	4			4194302		
			/11	255.224.0.0	8			2097150		
			/12	255.240.0.0	16			1048574		
			/13	255.248.0.0	32			524286		
			/14	255.252.0.0	64			262142		
			/15	255.254.0.0	128			131070		
			/16	255.255.0.0	256	1		65534	65534	
			/17	255.255.128.0	512	2		32766	32766	
			/18	255.255.192.0	1024	4		16382	16382	
			/19	255.255.224.0	2048	8		8190	8190	
			/20	255.255.240.0	4096	16		4094	4094	
			/21	255.255.248.0	8192	32		2046	2046	
			/22	255.255.252.0	16384	64		1022	1022	
			/23	255.255.254.0	32768	128		510	510	
			/24	255.255.255.0	65536	256	1	254	254	254
			/25	255.255.255.128	131072	512	2	126	126	126
			/26	255.255.255.192	262144	1024	4	62	62	62
			/27	255.255.255.224	524288	2048	8	30	30	30
			/28	255.255.255.240	1048576	4096	16	14	14	14
			/29	255.255.255.248	2097152	8192	32	6	6	6
			/30	255.255.255.252	4194304	16384	64	2	2	2

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			/15	255.254.0.0	128			131070		
			/16	255.255.0.0	256	1		65534	65534	
			/17	255.255.128.0	512	2		32766	32766	
			/18	255.255.192.0	1024	4		16382	16382	
			/19	255.255.224.0	2048	8		8190	8190	
			/20	255.255.240.0	4096	16		4094	4094	
			/21	255.255.248.0	8192	32		2046	2046	
			/22	255.255.252.0	16384	64		1022	1022	
			/23	255.255.254.0	32768	128		510	510	
			/24	255.255.255.0	65536	256	1	254	254	254
			/25	255.255.255.128	131072	512	2	126	126	126
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			/29	255.255.255.248	2097152	8192	32	6	6	6
			/30	255.255.255.252	4194304	16384	64	2	2	2