MIKROTIK ROUTEROS ONLINE TRAINING CLASS – CHAPTER 2

i-BEAM steering ahead

BURMESE VERSION

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TCP/IP BASICS

OSI Model Layer 2 Addressing Layer 3 Addressing IPv4 Subnetting Protocols & Ports

OSI MODEL

• Open Systems Interconnection was developed by ISO in 1977.

• Why a Layered Network Model?

- Reduces complexity
- Standardizes interfaces
- Facilitates modular engineering
- Ensures interoperable technology
- Accelerates evolution
- Simplifies teaching and learning



LAYER 2 – MAC ADDRESS



- Media Access Control Address is a 48-bit length address in Data Link Layer (Layer 2) of the OSI Model.
- MAC Address is physical address, typically burned-in to hardware at the factory and should be unique.
- In a computer, MAC address is usually address of Network Interface Card (NIC) or wireless adaptor.
- Expressed as 6 groups of 2 hexadecimal digits, separated by hyphens (-) or colons (:)
 - The first 6 digits are Organizationally Unique Identifier (OUI), represent the vendor.
 - The rest of the digits are vendor-assigned end-station address for identifying the Ethernet hardware.
 - For example: 02-00-4D-4F-00-50.

Layer 3 – IP Address



- IP (Internet Protocol) address is address in Network Layer (Layer 3) of the OSI model.
- Different from MAC address, IP address is logical and flexible, mean that we can change and adjust it.
- There are 2 kind of IP Address
 - IPv4
 - 32 bits length.
 - Totally 2 ^ 32 = 4,294,967,296 (4.2 billion) addresses.
 - IPv6
 - o 128 bits length.
 - Totally 2 ^ 128 = 340,282,366,920,938,463,374,607,431,768,211,456 (340 decillion) addresses.

IPv4 Addressing



- IPv4 has 32-bit of address length.
- Expressed in dotted decimal notation, divided into 4 pieces of 8-bit (octet):
 - For example: 192.168.1.1
 - Binary: 11000000 10101000 00000001 00000001
 - Each octet's value: 0000000 ~ 11111111 (0 ~ 255)
 - IPv4 range: 0.0.0.0 ~ 255.255.255.255

IPv4 Subnetting



- Subnetting is a way to separate and distribute IP addresses into multiple blocks (subnets):
 - Smaller networks are easier to manage.
 - Overall traffic is reduced.
 - You can more easily apply network security policies.
- Hosts that located in the same subnet can communicate with each other directly without involvement of the router.

IPv4 Subnetting (Cont.)



- Subnet Mask is used to determine the size and IP range of the subnet:
 - Network ID or Network IP is the first IP address of a subnet, used for identifying a network.
 - Broadcast IP is the last IP address of a subnet, used for sending broadcast traffic to all hosts in the subnet.
 - Host IPs are IP addresses that we can actually assign on end hosts, it is between Network ID and Broadcast IP.
- Subnet Mask uses the same notation as IPv4 address:
 - For example: 255.255.255.0
 - Binary: 11111111111111111111111100000000
 - This subnet mask is 24 bits.

CALCULATE AN IP RANGE



• Let's try this example:

- IP Address: 192.168.1.1
- Subnet Mask: 255.255.255.0

• Calculation steps:

- 1. Convert IP Address and Subnet Mask to Binary.
- 2. Count how many "1" in Subnet Mask bits, remain particular number of bits in IP Address unchanged and use them as IP Prefix.
- 3. Replace the rest bits in IP Address to 0 to find Network ID.
- 4. Replace the rest bits in IP Address to 1 to find Broadcast IP.
- 5. Convert Network ID and Broadcast IP back to Decimal.
- 6. Host IPs are between Network ID and Broadcast IP.

DECIMAL TO BINARY CONVERSION



192.168.1.1

_	128	64	32	16	8	4	2	1
	<u>1</u>	<u>1</u>	0	0	0	0	0	0
	<u>1</u>	0	<u>1</u>	0	<u>1</u>	0	0	0
	0	0	0	0	0	0	0	<u>1</u>
	0	0	0	0	0	0	0	<u>1</u>

Result: 11000000 10101000 0000001 0000001

BINARY TO DECIMAL CONVERSION



$11000000 \ 10101000 \ 0000001 \ 0000001$

	128	64	32	16	8	4	2	1
	<u>1</u>	<u>1</u>	0	0	0	0	0	0
\rightarrow	128 +	64 = 192	2					
	<u>1</u>	0	<u>1</u>	0	<u>1</u>	0	0	0
\rightarrow	128 +	32 + 8 =	168					
	0	0	0	0	0	0	0	<u>1</u>
	0	0	0	0	0	0	0	1

Result: 192.168.1.1

CALCULATE AN IP RANGE (CONT.)



• Convert to Binary:

IP Address: 11000000 10101000 00000001 00000001
Subnet Mask: 1111111 1111111111111100000000

• Subnet Mask has 24 "1", so IP Prefix is 24-bit length:

o IP Prefix:11000000 10101000 00000001o Network ID:11000000 10101000 00000001 00000000o Broadcast IP:11000000 10101000 00000001 11111111

• Convert back to Decimal:

- Network ID: 192.168.1.0
- Broadcast IP: 192.168.1.255
- o Host IPs: 192.168.1.1 ~ 192.168.1.254
- o Total Addresses: 256
- Usable Addresses: 256 2 = 254

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IP CALCULATION TOOLS

- Calculator in Windows
 - Use Programmer Mode
- Online IP / Subnet Calculators:
 - http://www.subnet-calculator.com
 - http://www.subnet-calculator.org
 - http://www.subnetmask.info

Calculator										
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IPv4 Classful Addresses



- Network addressing architecture used in the Internet from 1981 until the introduction of CIDR in 1993.
- Defines either a network size or a multicast network.

Class	Number of Networks	Addresses per Network	Default Subnet Mask	Address Range
Class A	128	16,777,216	255.0.0.0 (8 bits)	0.0.0.0 ~ 127.255.255.255
Class B	16,384	65,536	255.255.0.0 (16 bits)	128.0.0.0 ~ 191.255.255.255
Class C	2,097,152	256	255.255.255.0 (24 bits)	192.0.0.0 ~ 223.255.255.255
Class D (Multicast)	-	-	-	224.0.0.0 ~ 239.255.255.255
Class E (Reserved)	-	-	-	240.0.0.0 ~ 255.255.255.255

CIDR



- Classless Inter-Domain Routing was introduced in 1993.
- Slows the growth of internet routing tables.
- Slows the rapid exhaustion of IPv4 addresses.
- Use <IP address>/<Prefix length> notation:
 - For example: 8.8.8.8/24
 - o 24-bit prefix
 - o 8-bit host
 - Binary: 00001000 00001000 00001000
 Start IP: 00001000 00001000 00001000 0000000
 End IP: 00001000 00001000 00001000 1111111
 IP range: 8.8.8.0 ~ 8.8.8.255

• RouterOS uses CIDR notation for all IP configuration.

Private IP



- IP Address also divided into Public IP and Private IP.
- Public IP is used for global internet routing.
- Private IP is used in internal networks:
 - Defined in RFC1918 by IETF in 1996.
 - To delay IPv4 address exhaustion.
 - Commonly used for home, office, and enterprise LANs, when globally routable addresses are not mandatory.
 - Needs to be translated to Public IP by NAT when routing to internet.

RFC1918 Name	Number of Addresses	CIDR	Address Range
24-bit block	16,777,216	10.0.0/8	10.0.0.0 ~ 10.255.255.255
20-bit block	1,048,576	172.16.0.0/12	172.16.0.0 ~ 172.31.255.255
16-bit block	65,536	192.168.0.0/16	192.168.0.0 ~ 192.168.255.255

EXERCISE: CALCULATE IP RANGE



Prefix

11.11.11/26

22.22.22/28

33.33.33.33/25

44.44.44/29

55.55.55/27

66.66.66/28

77.77.77.77/30

88.88.88.88/31

• How many IPs in each prefix?

• Find out following IP addresses:

Network ID

- Broadcast IP
- Host IP Addresses
- What is the subnet mask?

EXERCISE: CALCULATE IP RANGE (ANSWER)



Prefix	IPs	Network ID	Broadcast IP	Host IPs	Subnet Mask
11.11.11.11/26	64	11.11.11.0	11.11.11.63	11.11.11.1 to 11.11.11.62	255.255.255.192
22.22.22.22/28	16	22.22.22.16	22.22.22.31	22.22.22.17 to 22.22.22.30	255.255.255.240
33.33.33.33/25	128	33.33.33.0	33.33.33.127	33.33.33.1 to 33.33.33.126	255.255.255.128
44.44.44.44/29	8	44.44.44.40	44.44.44.47	44.44.44.41 to 44.44.44.46	255.255.255.248
55.55.55.55/27	32	55.55.55.32	55.55.55.63	55.55.55.33 to 55.55.55.62	255.255.255.224
66.66.66.66/28	16	66.66.66.64	66.66.66.79	66.66.66.65 to 66.66.66.78	255.255.255.240
77.77.77.77/30	4	77.77.77.76	77.77.77.79	77.77.77.77, 77.77.77.78	255.255.255.252
88.88.88.88/31	2	88.88.88.88	88.88.88.89	N/A	255.255.255.254

Protocol



- Protocol determines the data transmission procedures.
- Commonly used protocols:
 - Transmission Control Protocol (TCP)
 - File Transfer Protocol (FTP)
 - Hypertext Transfer Protocol (HTTP)
 - Post Office Protocol (POP3)
 - Simple Mail Transfer Protocol (SMTP)
 - User Datagram Protocol (UDP)
 - Domain Name System (DNS)
 - Network Time Protocol (NTP)
 - Real-time communication, such as VoIP, IPTV...etc.
 - Internet Control Message Protocol (ICMP)
 - Ping, Traceroute

Port



- Specifically, a "port" here means a logical port or application port in computer networking.
- A software construct serving as a communications endpoint in a computer's host operating system.
- Identified for each address and protocol by a 16-bit number, commonly known as the port number:
 - Port number range: 0 ~ 65535
 - Well-known ports: 0 ~ 1023
 - Registered ports: 1024 ~ 49151
 - Dynamic, private or ephemeral ports: 49152 ~ 65535

COMMONLY USED PORT NUMBERS



• Well-known applications:

Application	Layer 4 Protocol	Port Number	Use Case
HTTP	ТСР	80	Web browsing
HTTPS	ТСР	443	Web browsing (Secured)
FTP	ТСР	21	File Transfer Protocol
SMTP	ТСР	25	Mail sending
POP3	ТСР	110	Mail receiving
DNS	TCP, UDP	53	Domain Name System
Telnet	ТСР	23	Remote to server/router
SSH	ТСР	22	Remote to server/router (Secured)
SNMP	UDP	161, 162	Simple Network Monitoring Protocol

• More info:

http://en.wikipedia.org/wiki/List_of_TCP_and_UDP_port_numbers

ASK QUESTIONS?



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 - phyo@informationbeam.net

TO BE CONTINUED...

THANKS FOR YOUR ATTENTION!

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