Networking

CIDR & VSLM Subnetting

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- Guiding Question: How do CIDR and VSLM improve network efficiency and IP address management in modern networks?

- Students will:
  - Explain the purpose of subnetting and how it reduces network congestion and improves security.
  - Differentiate between classful and classless addressing, identifying the benefits of CIDR.
  - Calculate subnet sizes and the number of available hosts using CIDR notation.

IPv4 Addresses

- An IP address is a 32 bit number that identifies a host.
- Every IP address comes with a subnet mask.
  - A 32 bit number used to block out a part of the IP address to distinguish the Network portion from the Host portion. This tells us what network the IP address belongs to.
- Devices use the subnet mask to look at packets and identify whether the destination host's IP address is located on a local network or a remote network.

IP Address	192.168.12.204
Decimal Subnet	255.255.255.0
Binary Subnet	11111111 . 11111111 . 11111111 . 00000000

Classful Addressing

- The subnet determines the number of host addresses available in a network.
- The more host bits in the subnet mask means the more hosts in the network.
- PROBLEM: A and B are too big, C is too small

Class	1st Octet Range	Default Subnet Mask	# of Hosts Addresses
A	1 - 126	255.0.0.0	16,777,214
B	128 - 191	255.255.0.0	64,534
C	192 - 223	255.255.255.0	254

Classless IP Addressing

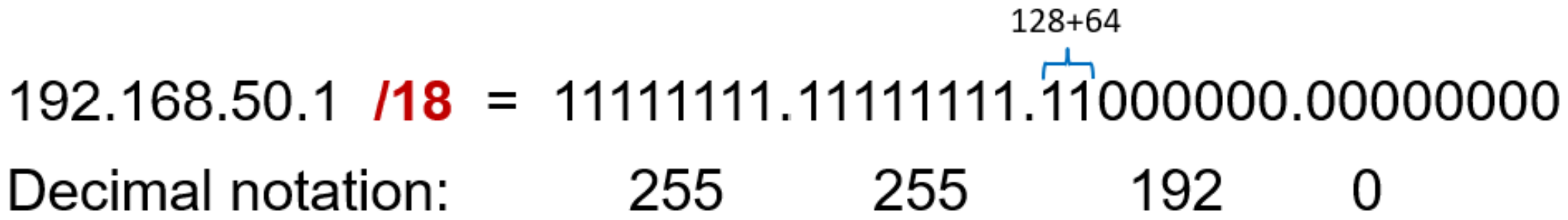
Subnet masks do not have to end on “natural octet boundaries” SO it is possible to customize them.

- Value of first octet does NOT determine class, or subnet mask.
- Classless IP addressing doesn’t use default subnet mask.
  - Instead, we create a custom subnet mask based on the desired size of the network.
- Formal name = Classless Inter-Domain Routing (CIDR)
- CIDR IP addressing is what is used on the Internet and in most internal networks.

CIDR Notation

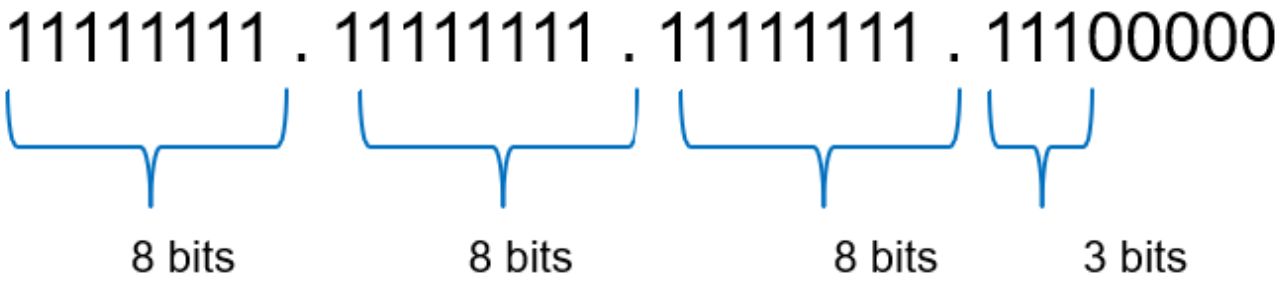
CIDR notation is a compact way to represent an IP address and its subnet mask, allowing for more efficient and flexible IP address allocation.

- In CIDR notation we count the number of bits in the network portion and put a slash in front.
- Example: /16 – Number of subnet bits are set to 1's.
- To get the decimal notation equivalent, add the value of the bits in each octet.



CIDR Notation **192.168.50.0** */27*

- To go from CIDR format notation to dotted decimal notation you simply convert the bits in each octet to their decimal number.
- 27 is the number of 1 bits in the subnet mask.



- So, the subnet mask in decimal is: **255.255.255.224**

CIDR Format Practice

IP Address	/Subnet	Decimal Subnet
177.100.18.4	/18	
10.10.250.1	/13	
193.100.77.83	/28	
95.250.91.99	/22	
189.210.50.1	/17	
220.90.130.45	/27	

CIDR Format Practice

IP Address	/Subnet	Decimal Subnet
177.100.18.4	/18	255.255.192.0
10.10.250.1	/13	255.248.0.0
193.100.77.83	/28	255.255.255.240
95.250.91.99	/22	255.255.252.0
189.210.50.1	/17	255.255.128.0
220.90.130.45	/27	255.255.255.224

Custom Subnetting

Custom Subnetting involves dividing a network address block into smaller subnets by borrowing bits from the host portion of the IP address to create a larger network address space.

- Imagine that a school is built as one big building with just 4 exterior walls.
- Everything that happens in the school is mixed up all together. The balls from PE classes keep getting into the lunch food and all the noise makes it very hard to hear the teachers.
- Subnetting is when we build interior walls to make rooms. PE equipment stays in the gym, food stays in the cafeteria and learning happens in classrooms.

Why Subnet?

- **Network traffic:** Too many devices trying to send packets at the same time in one network can lead to collisions and delays.
- **Security:** Can separate departments. A single network allows all hosts to access each other - but what if they shouldn't be sharing data?
- **Address space:** Reduce waste of unused addresses. Most networks do not need a Classful A network with 16 million addresses, so the extra addresses are going to waste.

Custom Subnetting

- CIDR says we can get rid of Classes - which also means we don’t have to stick to the default subnets.
- By changing the subnet mask, it will change the number of networks AND the number of hosts.
- We can take one 256 host network and chop it up into smaller networks. We can customize!
  - 2 nets x 128 hosts
  - 4 nets x 64 hosts
  - 8 nets x 32 hosts
  - 16 nets x 16 hosts

Formulas For Custom Subnetting

CIDR Subnet Mask **192.168.2.0** **/25**

11111111.11111111.11111111.**1**0000000

- Number of networks?
  - **2** (number of added bits)
- How many bits did we add?
  - **1** so → 2^1 = 2 networks
- Number of hosts addresses?
  - **Value of last bit added.**
- What is the binary value of the last bit we added?
  - **128 hosts per network.**

1 0 0 0 0000

128	64	32	16	8	4	2	1

Knowledge Check

- What will the decimal subnet mask be for **192.168.2.0 /25**?

Network #1
Start: 192.168.2.0
End: 192.168.2.127

Network #2
Start: 192.168.2.128
End: 192.168.2.255

- What network will IP Address 192.168.0.154 belong to?
- What is the broadcast address of Network #1?

VLSM Variable Length Subnet Masking

- We can ignore classes with CIDR when creating subnets BUT sometimes we don't want all subnets to have an equal number of hosts.
- With VLSM (Variable Length Subnet Masking) we can divide a larger networks into subnets of different sizes.
- **Example:**
  - 50 Employees in the IT Department.
  - 20 in Human Resources.
  - 10 in Finance.
- We don't want to waste addresses by making several subnets all with 50 hosts just so it will fit Finance.

VSLM Variable Length Subnet Mask

- VLSM allows each subnet to use a different subnet mask.
- **Example:**

Department	Hosts Needed	Subnet Mask	Address Range
IT (Large)	50	/26 (64 addresses)	192.168.1.0 - 192.168.1.63
HR (Medium)	20	/27 (32 addresses)	192.168.1.64 - 192.168.1.95
Finance (Small)	10	/28 (16 addresses)	192.168.1.96 - 192.168.1.111

Activity

- Practice Subnet Math Worksheet.

APPENDIX: Binary System

- Binary math is foundational for learning about IP address subnetting. These slides can be used to go over the basics or to review prior learning
- **Binary** number system = **Base 2** because there are 2 possible digits that can be used: **0** or **1**
- To make numbers larger than 1 we use the position of a digit to determine its value. Each position a multiple of 2.

8's	**4's**	**2's**	**1's**
0	**1**	**1**	**0**
0x8	1x4	1x2	0x1

= 6

Binary System (cont'd)

- Remember, a byte has 8 bits – so binary numbers use these 8 position values.
- By placing the values into a conversion table, we easily convert from binary to decimal numbers.

128	64	32	16	8	4	2	1

Binary to Decimal: Example #1

- Convert the number: 01001101
- Use the place values for 8 bits to create a conversion table and fill in the same binary number.
- If there is a binary zero, then bring down a zero.
- If there is a binary 1, then bring down the place value.

128	64	32	16	8	4	2	1
0	1	0	0	1	1	0	1
↓	↓	↓	↓	↓	↓	↓	↓

Add up the values: _____

Binary to Decimal: Example #2

- Convert the number: 10000110
- Use the place values for 8 bits to create a conversion table and fill in the same binary number.
- If there is a binary zero, then bring down a zero.
- If there is a binary 1, then bring down the place value.

128	64	32	16	8	4	2	1
1	0	0	0	0	1	1	0
↓	↓	↓	↓	↓	↓	↓	↓

Add up the values: _____