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SUBNETTING
MADE PRACTICAL

A hands-on, beginner-friendly guide to IPv4 addressing and subnetting Class C, Class B, and Class A

Includes

Worked examples • Cheat-sheet tables • Practice exercises • Full answer key

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Chapter 1 What Is an IP Address?

Every device on a network   a laptop, a phone, a server, a printer   needs a unique address so that other devices know where to send information. That address is called an IP address (Internet Protocol address). Think of it like a street address for a house: without it, the postal service (the network) has no idea where to deliver your mail (your data).

This guide focuses on IPv4, the most widely used addressing system. An IPv4 address is a 32-bit number, but writing out 32 ones and zeros is painful for humans, so we split it into four groups of 8 bits called octets, and write each octet as a decimal number (0–255), separated by dots. This is called dotted-decimal notation.

1.1 Binary and Decimal: The Same Address, Two Views

Take the address 192.168.1.10. It looks simple, but underneath it is pure binary. Each octet converts like this:

Decimal Octet	Binary (8 bits)	Position
192	1 1 0 0 0 0 0 0	1st octet
168	1 0 1 0 1 0 0 0	2nd octet
1	0 0 0 0 0 0 0 1	3rd octet
10	0 0 0 0 1 0 1 0	4th octet

Full binary address: 11000000.10101000.00000001.00001010

Each bit in an octet has a place value, exactly like decimal place values (hundreds, tens, ones). In an 8-bit octet the place values are:

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

Add up the place values where there's a 1: 128 + 64 = 192. That's exactly how the computer reads the first octet of our example address. You will use this exact skill constantly once we start subnetting, so it's worth practicing until it's automatic.

Quick Tip

Memorize these 8 place values in order: 128, 64, 32, 16, 8, 4, 2, 1. Almost every subnetting shortcut in this guide is built on this single list.

1.2 Network Portion vs. Host Portion

Every IP address is really made up of two parts glued together: the network portion, which identifies which network the device belongs to, and the host portion, which identifies the specific device within that network. Subnetting is entirely about deciding where the line between these two parts falls and moving that line is the whole trick.

1.3 Public vs. Private IP Addresses

Not all IP addresses are reachable from the public internet. Certain ranges are reserved for private, internal use these are the addresses you'll see on almost every home and office network:

Class	Private Range	Default Mask	Typical Use
A	10.0.0.0 – 10.255.255.255	255.0.0.0	Large enterprise / ISP networks
B	172.16.0.0 – 172.31.255.255	255.255.0.0	Medium-to-large campus networks
C	192.168.0.0 – 192.168.255.255	255.255.255.0	Home & small office networks

Everything outside these ranges is generally a public, internet-routable address, assigned by an Internet Registry (like ARIN, RIPE, or APNIC) to ISPs and organizations.

Chapter 2 IP Address Classes

In the early design of IPv4, addresses were split into five classes (A through E), based on the value of the very first octet. Classes A, B, and C are used for normal host addressing (and are the focus of this guide); Class D is reserved for multicast; Class E is reserved for research/experimental use.

Class	1st Octet Range	Default Mask	CIDR	Networks	Hosts / Network
A	1 – 126	255.0.0.0	/8	126	16,777,214
B	128 – 191	255.255.0.0	/16	16,384	65,534
C	192 – 223	255.255.255.0	/24	2,097,152	254
D	224 – 239	(multicast)	n/a		
E	240 – 255	(experimental)	n/a		

Why this matters

The first octet instantly tells you the class, and the class tells you the default subnet mask before you even start subnetting. 192.168.1.5 starts with 192 → Class C → default mask 255.255.255.0 (/24). This is your starting point for every subnetting problem get it right first, every single time.

Note: 127.x.x.x is reserved for loopback testing (127.0.0.1 = "localhost") and is not used as a real Class A network.

Chapter 3 The Subnet Mask, Explained

A subnet mask is a 32-bit number that sits next to an IP address and tells every device exactly where the network portion ends and the host portion begins. Wherever the mask has a binary 1, that bit belongs to the network. Wherever it has a binary 0, that bit belongs to the host.

3.1 Default Masks by Class

Class	Default Mask (Decimal)	Default Mask (Binary)	CIDR Notation
A	255.0.0.0	11111111.00000000.00000000.00000000	/8
B	255.255.0.0	11111111.11111111.00000000.00000000	/16
C	255.255.255.0	11111111.11111111.11111111.00000000	/24

3.2 CIDR Notation

CIDR (Classless Inter-Domain Routing) notation is just a shortcut: instead of writing out the full mask, we write a slash followed by the number of network bits. 192.168.1.0/24 means "the mask has 24 network bits", which is exactly 255.255.255.0. This is the notation we'll use throughout the rest of this guide because it's faster to read and calculate with.

3.3 How to Read Any Mask Instantly

You only need to memorize one row of numbers the value each bit contributes when it's turned on, from left to right in an octet:

128	192	224	240	248	252	254	255
1 bit	2 bits	3 bits	4 bits	5 bits	6 bits	7 bits	8 bits

This single table is the master key to subnetting. Every mask value you will ever see in an octet (128, 192, 224, 240, 248, 252, 254, or 255) appears in this list, and the number below it tells you how many bits are borrowed in that octet. Bookmark this page you'll come back to it constantly.

🎯 Core Formulas memorize these

Number of subnets = 2^n

Number of usable hosts per subnet = $2^h - 2$

Block size (the jump between each subnet) = 256 − mask value in the interesting octet

Chapter 4 Why Do We Subnet?

- Efficient use of address space instead of wasting an entire Class C block on a 5-device office, carve out only what's needed.
- Smaller broadcast domains fewer devices per segment means less broadcast traffic and better performance.
- Security & isolation separate departments (HR, Finance, Guest Wi-Fi) into their own subnets and control traffic between them with firewalls.
- Organizational clarity floors, buildings, or branch offices can each get a logical, easy-to-manage block.

🔧 The Big Idea

Subnetting means borrowing bits from the host portion of an address and giving them to the network portion. Borrowing bits creates more, smaller networks each with fewer usable hosts. That trade-off more networks vs. fewer hosts per network is the entire game of subnetting.

Chapter 5 Subnetting Class C Networks (Start Here)

We start with Class C because it's the simplest: the default mask is /24 (255.255.255.0), which means only the last octet is available for subnetting. All the borrowing and math happens in one octet, making it the easiest place to build your confidence.

5.1 The Class C Cheat Sheet

Here is every possible way to subnet a Class C network, from borrowing 1 bit to borrowing 6 bits (you must leave at least 2 host bits for any usable subnet):

Bits Borrowed	CIDR	Mask (last octet)	Block Size	# Subnets	Usable Hosts/Subnet
1	/25	128	128	2	126
2	/26	192	64	4	62
3	/27	224	32	8	30
4	/28	240	16	16	14
5	/29	248	8	32	6
6	/30	252	4	64	2

5.2 Worked Example: "I need 4 subnets"

Scenario: ZolaxTech has been given the block 192.168.10.0/24 and needs to split it into 4 separate departmental subnets.

1. How many bits do we need to borrow to get at least 4 subnets? $2^1=2$ (not enough), $2^2=4$ (exactly enough). Borrow 2 bits.
2. New CIDR = /24 + 2 = /26. New mask = 255.255.255.192 (from our master table: 2 bits borrowed → 192).
3. Block size = 256 − 192 = 64. Each subnet jumps by 64 in the last octet.
4. List the subnets by simply counting up in blocks of 64, starting at 0.

Subnet #	Network ID	First Usable	Last Usable	Broadcast
1	192.168.10.0	192.168.10.1	192.168.10.62	192.168.10.63
2	192.168.10.64	192.168.10.65	192.168.10.126	192.168.10.127
3	192.168.10.128	192.168.10.129	192.168.10.190	192.168.10.191
4	192.168.10.192	192.168.10.193	192.168.10.254	192.168.10.255

✓ How to double-check yourself

The Network ID is always the block-size multiple (0, 64, 128, 192…). The Broadcast is always one less than the next network ID. Everything in between is usable. If your numbers don't line up like this, recheck your block size.

5.3 Worked Example: "I need at least 25 hosts per subnet"

Scenario: ZolaxTech's design team needs a subnet that supports at least 25 devices, carved from 192.168.20.0/24.

5. Find the smallest host block ≥ 25 using $2^h - 2$: $2^4-2=14$ (too few), $2^5-2=30$ (enough). We need 5 host bits.
6. Total bits in an octet = 8, so bits borrowed = 8 − 5 = 3. CIDR = /27.

7. Mask (last octet) = 224. Block size = 256 − 224 = 32.
8. First subnet: 192.168.20.0/27 → usable range .1 to .30, broadcast .31.

5.4 Practice Exercises: Class C

Exercise 1

You are given 192.168.5.0/24. Subnet it to create exactly 8 subnets. What is the new CIDR, subnet mask, and block size?

Exercise 2

Using 192.168.5.0/24 subnetted into 8 equal parts, list the Network ID, first usable host, last usable host, and broadcast address for the 3rd subnet.

Exercise 3

Your ISP gives you 192.168.100.0/24. You need at least 50 hosts per subnet, and as many subnets as possible. What CIDR should you use, and how many usable hosts does each subnet actually get?

Exercise 4

A host has the address 192.168.1.77/27. What is the Network ID, broadcast address, and range of usable hosts for this subnet?

Exercise 5

You need 60 separate point-to-point links, each needing only 2 usable host addresses. What CIDR minimizes wasted addresses, and how many total addresses does ZolaxTech need to reserve?

Chapter 6 Subnetting Class B Networks

Class B networks default to a /16 mask (255.255.0.0), which means the 3rd and 4th octets   16 whole bits are available for subnetting. This is exactly like Class C, just with twice as many bits to play with. The same formulas apply; we only need to track which octet the borrowed bits land in.

6.1 The Key Difference From Class C

In Class C, all borrowed bits live in the 4th octet. In Class B, the first 8 borrowed bits land in the 3rd octet, and if you need more than 8 bits, borrowing spills into the 4th octet. Everything else   the formulas, the block-size logic   works exactly the same way.

Bits Borrowed	CIDR	Mask	# Subnets	Usable Hosts/Subnet
2	/18	255.255.192.0	4	16,382

Bits Borrowed	CIDR	Mask	# Subnets	Usable Hosts/Subnet
4	/20	255.255.240.0	16	4,094
6	/22	255.255.252.0	64	1,022
8	/24	255.255.255.0	256	254
10	/26	255.255.255.192	1,024	62
12	/28	255.255.255.240	4,096	14

6.2 Worked Example: "I need 16 subnets"

Scenario: ZolaxTech owns 172.16.0.0/16 and needs 16 subnets for 16 branch offices.

9. $2^4 = 16$, so we borrow 4 bits. New CIDR = /16 + 4 = /20.
10. Since we're borrowing only 4 bits, they all land inside the 3rd octet. Mask (3rd octet) = 240 → full mask 255.255.240.0.
11. Block size in the 3rd octet = 256 − 240 = 16. So the 3rd octet counts up in steps of 16: 0, 16, 32, 48…

Subnet #	Network ID	First Usable	Last Usable	Broadcast
1	172.16.0.0	172.16.0.1	172.16.15.254	172.16.15.255
2	172.16.16.0	172.16.16.1	172.16.31.254	172.16.31.255
3	172.16.32.0	172.16.32.1	172.16.47.254	172.16.47.255

Notice that within each subnet, the 4th octet still runs the full 0–255 range the borrowed bits only affect the 3rd octet in this example, so the 4th octet is entirely host space.

6.3 Worked Example: Borrowing Into the 4th Octet

Scenario: ZolaxTech needs ~500 subnets from 172.20.0.0/16 for a very large campus rollout.

12. $2^9 = 512 \geq 500$, so we borrow 9 bits. New CIDR = /16 + 9 = /25.
13. The first 8 borrowed bits fill the entire 3rd octet (mask = 255). The 9th bit spills into the 4th octet (mask = 128).
14. Full mask = 255.255.255.128. Block size in the 4th octet = 256 − 128 = 128.
15. Subnets step through both octets: 172.20.0.0/25, 172.20.0.128/25, 172.20.1.0/25, 172.20.1.128/25 … and so on.

Quick Tip

Whenever the mask value in an octet is 255, that whole octet is 100% network nothing to calculate. Only the one octet whose mask value is between 1 and 254 is the "interesting octet" where the block-size math happens.

6.4 Practice Exercises: Class B

Exercise 6

You have 172.16.0.0/16 and need exactly 64 subnets. What CIDR do you use, what is the mask, and how many usable hosts does each subnet get?

Exercise 7

Using the /20 subnetting from section 6.2, what are the Network ID and broadcast address of the 5th subnet?

Exercise 8

A host has the address 172.25.14.9/21. Identify the Network ID and broadcast address.

Exercise 9

ZolaxTech needs 300 subnets from 172.30.0.0/16, each with as many hosts as possible. What CIDR should be used, and how many usable hosts land in each subnet?

Chapter 7 Subnetting Class A Networks

Class A networks default to a /8 mask (255.0.0.0) meaning a staggering 24 bits (three whole octets) are available for subnetting. This is the same game as Class B, just with one more octet of room. Large ISPs and huge enterprises are the typical owners of Class A space.

7.1 The Class A Cheat Sheet (selected values)

Bits Borrowed	CIDR	Mask	# Subnets	Usable Hosts/Subnet
2	/10	255.192.0.0	4	4,194,302
8	/16	255.255.0.0	256	65,534
12	/20	255.255.240.0	4,096	4,094
16	/24	255.255.255.0	65,536	254
20	/28	255.255.255.240	1,048,576	14

7.2 Worked Example: "I need 500 subnets"

Scenario: ZolaxTech's ISP division owns 10.0.0.0/8 and needs at least 500 regional subnets, each with as many hosts as possible.

16. $2^9 = 512 \geq 500$, so borrow 9 bits. New CIDR = /8 + 9 = /17.

17. The first 8 bits fill the 2nd octet completely (mask = 255). The 9th bit spills into the 3rd octet (mask = 128).
18. Full mask = 255.255.128.0. Block size in the 3rd octet = 256 − 128 = 128.
19. The 4th octet remains entirely untouched host space (0–255).

Subnet #	Network ID	First Usable	Last Usable	Broadcast
1	10.0.0.0	10.0.0.1	10.0.127.254	10.0.127.255
2	10.0.128.0	10.0.128.1	10.0.255.254	10.0.255.255
3	10.1.0.0	10.1.0.1	10.1.127.254	10.1.127.255

7.3 Worked Example: A Small Slice of a Huge Network

Scenario: A single branch office only needs 100 hosts, carved out of 10.5.0.0/16 (already a /16 slice handed down from the /8).

20. $2^7-2 = 126 \geq 100$, so we need 7 host bits, meaning we borrow 32 − 8(net) ... let's count directly: total host bits available at /16 = 16. We need 7 of them for hosts, so borrow 16 − 7 = 9 bits from the host space.
21. New CIDR = /16 + 9 = /25. Mask = 255.255.255.128 (8 bits fill the 3rd octet, 1 bit value 128 lands in the 4th).
22. Block size in the 4th octet = 256 − 128 = 128. First subnet: 10.5.0.0/25 (usable .1–.126), second: 10.5.0.128/25 (usable .129–.254).

📌 The pattern that ties every class together

No matter the class, the process never changes: (1) find the default mask from the class, (2) decide how many bits to borrow based on subnets or hosts needed, (3) find the new mask and block size in whichever octet is 'interesting', (4) count up in block-size steps to list every subnet. Master this four-step loop once and it works for A, B, and C alike.

7.4 Practice Exercises: Class A

Exercise 10

You are given 10.0.0.0/8 and need exactly 1,024 subnets. What CIDR do you use, and how many usable hosts does each subnet get?

Exercise 11

A device has the IP address 10.20.35.9/14. What is the Network ID and broadcast address of its subnet?

Exercise 12

ZolaxTech wants to give every department across 50 offices its own /24 (254 hosts) subnet, carved from 10.0.0.0/8. What CIDR range accomplishes this, and how many total /24 subnets does a /8 actually contain?

Exercise 13

Using the worked example in 7.3, what would the 4th subnet's Network ID and broadcast address be?

Chapter 8 Master Cheat Sheet (All Classes)

Keep this table handy   it condenses everything in this guide into one page.

Mask Value	CIDR add-on	Binary	Hosts if this is the last octet
128	/1	10000000	126
192	/2	11000000	62
224	/3	11100000	30
240	/4	11110000	14
248	/5	11111000	6
252	/6	11111100	2
254	/7	11111110	0 (P2P edge case, RFC 3021)
255	/8	11111111	0 (fully network)

Class	Default CIDR	Octets Available to Borrow	Max Practical Subnets
C	/24	4th octet only (8 bits)	64 (/30)
B	/16	3rd + 4th octets (16 bits)	16,384 (/30)
A	/8	2nd, 3rd + 4th octets (24 bits)	4,194,304 (/30)

Chapter 9 Answer Key

Class C Answers

- 1. Need 8 subnets → $2^3=8$ → borrow 3 bits → CIDR /27, mask 255.255.255.224, block size 32.
- 2. 3rd subnet (0–31, 32–63, 64–95…): Network 192.168.5.64, usable .65–.94, broadcast .95.
- 3. Need ≥50 hosts → $2^6-2=62$ works → 2 host bits left over means CIDR /26, mask 255.255.255.192, giving 62 usable hosts per subnet (4 subnets total).
- 4. /27 → block size 32 → 192.168.1.77 falls in block 64–95 → Network 192.168.1.64, broadcast 192.168.1.95, usable .65–.94.
- 5. Need only 2 hosts per link → $2^2-2=2$ → CIDR /30, block size 4. 60 links × 4 addresses = 240 addresses reserved (fits inside one /24 easily).

Class B Answers

- 6. Need 64 subnets → $2^6=64$ → borrow 6 bits → CIDR /22, mask 255.255.252.0, hosts = $2^{10}-2$ = 1,022.
- 7. /20 block size = 16 (3rd octet). 5th subnet (0,16,32,48,64…): Network 172.16.64.0, broadcast 172.16.79.255.
- 8. /21 → mask 255.255.248.0, block size 8 in 3rd octet. 172.25.14.9 → 14 falls in block 8–15 → Network 172.25.8.0, broadcast 172.25.15.255.
- 9. Need 300 subnets → $2^9=512 \geq 300$ → borrow 9 bits → CIDR /25, mask 255.255.255.128, hosts = 2^7-2 = 126 usable per subnet.

Class A Answers

- 10. Need 1,024 subnets → 2^{10}=1,024 → borrow 10 bits → CIDR /18, mask 255.255.192.0, hosts = $2^{14}-2$ = 16,382.
- 11. /14 → mask 255.252.0.0, block size 4 in 2nd octet. 10.20.35.9 → 20 falls in block 20–23 → Network 10.20.0.0, broadcast 10.23.255.255.
- 12. Need /24 subnets from a /8: 24 − 8 = 16 bits borrowed → CIDR /24 gives 2^{16} = 65,536 total /24 subnets available (far more than the 50 needed).
- 13. Block size 128 in 4th octet, starting 10.5.0.0/25: 4th subnet = 10.5.1.128 → Network 10.5.1.128, broadcast 10.5.1.255.

Chapter 10 Final Tips & Next Steps

- Practice the 4-step loop until it's automatic: find default mask → decide bits to borrow → find new mask/block size → list subnets.
- Always double-check with the broadcast rule: broadcast = next network ID minus 1.
- Try re-working every exercise in this guide without looking at the answer key, then check yourself.
- Once comfortable, practice VLSM (Variable Length Subnet Masking) subnetting a network into unequal-sized pieces to match real-world host requirements exactly.

🚀 About ZolaxTech

This guide was built by ZolaxTech to make networking fundamentals practical and approachable for beginners. Visit www.zolaxtech.com for more hands-on guides on networking, security, and IT fundamentals.