REPORT
IP Subnetting Fundamentals

v1.0.0

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REVISION HISTORY

Version	Date	Author	Description of Changes
v1.0.0	08/26/2025	Eldon G.	Initial draft.

EXECUTIVE SUMMARY

This report documents the fundamental principles and practical applications of Internet Protocol (IP) subnetting. It provides a foundational understanding of CIDR notation, subnet masks, and formulas used to calculate network addresses, broadcast addresses, and usable host ranges. The content focuses on practical examples of Class C networks, demonstrating key skills in network administration and cybersecurity.

Disclaimer: This guide is based on my independent practice and understanding of IP subnetting, intended for portfolio demonstration. It is a generic learning resource and not official course material.

1.0 INTRODUCTION TO SUBNETTING

1.1 Subnetting Project Description

Subnetting is the process of dividing a large network into smaller, more efficient subnetworks. This practice conserves IP addresses, reduces network traffic, and enhances security by isolating network segments.

CIDR (Classless Inter-Domain Routing) specifies which part of an IP address represents the network, allowing flexible subnetting. The slash notation (for example, `/24`, `/25`) shows the number of bits reserved for the network part of the IP address.

1.2 Steps for Subnetting

Step 1: Choose IP Address & Subnet Mask

- Example: `192.168.1.0/24` → Subnet Mask `255.255.255.0`

Step 2: Determine Subnet Bits

- Count the number of bits borrowed from the host portion to create subnets.
- Formula: **Total Subnets =** 2^n where *n* = number of subnet bits borrowed.
- Example: Borrow 1 host bit from `/24` → `/25` → $2^1 = 2$ subnets.

Step 3: Calculate Host Per Subnet

- Formula: **Usable Hosts =** $2^h - 2$ where *h* = number of remaining host bits.
- Example: `/25` → 7 host bits → $2^7 - 2 = 126$ usable hosts per subnet.

Step 4: Design Subnet Addressing

- Divide the IP range logically using the subnet increment.
- Example `/25` subnets of `192.168.1.0/24`:
  - Subnet 1: `192.168.1.0` - `192.168.1.127`
  - Subnet 2: `192.168.1.128` - `192.168.1.255`

Step 5: Assign IP to Devices

Assign usable host addresses to devices in each subnet.
Example: For Subnet 1 (`192.168.1.0/25`), usable addresses range from `192.168.1.1 – 192.168.1.126`.

1.3 Private IP Address Ranges

Private IP ranges are reserved for internal networks and are not routable on the public Internet. They are commonly used to manage devices inside organizations:

- **10.0.0.0 – 10.255.255.255** (/8)
- **172.16.0.0 – 172.31.255.255** (/12)
- **192.168.0.0 – 192.168.255.255** (/16)

1.4 IP Address Classes

Class	Left Most Bit	Starting IP Address	Last IP Address
A	0XXX	0.0.0.0	127.255.255.255
B	10XX	128.0.0.0	191.255.255.255
C	110X	192.0.0.0	223.255.255.255
D	1110	224.0.0.0	239.255.255.255
E	1111	240.0.0.0	255.255.255.255

1.5 Binary to Decimal Conversion

Each bit in a byte has a decimal value:

1st Bit	2nd Bit	3rd Bit	4th Bit	5th Bit	6th Bit	7th Bit	8th Bit
128	64	32	16	8	4	2	1

Example: `10011101` → 128 + 16 + 8 + 4 + 1 = **157**

This binary-decimal relationship is fundamental when calculating subnets.

2.0 KEY SUBNETTING CONCEPTS and FORMULAS

- **Total Subnets:** 2^n (where *n* = borrowed bits).
- **Usable Hosts per Subnet:** $2^h - 2$ *where h* = host bits remaining
- **Subnet Increments =** determined by the last significant subnet mask bit.
- **Binary–Decimal Conversion** = essential for calculating ranges.

3.0 IP SUBNET CALCULATIONS

3.1 Subnet Size Reference Table (Class C /24 baseline)

CIDR	Subnet Mask	Total Subnets	Usable Hosts	Subnet Increments
/24	255.255.255.0	1	254	N/A
/25	255.255.255.128	2	126	128
/26	255.255.255.192	4	62	64
/27	255.255.255.224	8	30	32
/28	255.255.255.240	16	14	16
/29	255.255.255.248	32	6	8

3.2 Worked Examples

3.2.1 /25 Subnet — Calculations

- **Starting network:** /24 (255.255.255.0)
- **New subnet:** /25 (255.255.255.128)
- **Subnet Bits**: 25 − 24 = 1
- **Total Subnets**: $2^1 = 2$
- **Host Bits**: 32 − 25 = 7
- **Usable Hosts per Subnet**: $2^7 - 2 = 126$
- **Subnet Increment:** 128

Subnet #	Network Address	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.1.0	192.168.1.1	192.168.1.126	192.168.1.127
2	192.168.1.128	192.168.1.129	192.168.1.254	192.168.1.255

3.2.2 /26 Subnet — Calculations

- **Starting network:** /24 (255.255.255.0)
- **New subnet:** /26 (255.255.255.192)
- **Subnet Bits**: 26 − 24 = 2
- **Total Subnets**: $2^2 = 4$
- **Host Bits:** 32 − 26 = 6
- **Usable Hosts per Subnet**: $2^6 - 2 = 62$
- **Subnet Increment:** 64

Subnet #	Network Address	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.1.0	192.168.1.1	192.168.1.62	192.168.1.63
2	192.168.1.64	192.168.1.65	192.168.1.126	192.168.1.127
3	192.168.1.128	192.168.1.129	192.168.1.190	192.168.1.191
4	192.168.1.192	192.168.1.193	192.168.1.254	192.168.1.255

3.2.3 /27 Subnet — Calculations

- **Starting network:** `/24` (255.255.255.0)
- **New subnet:** `/27` (255.255.255.224)
- **Subnet Bits:** `27 - 24 = 3`
- **Total Subnets**: $2^3 = 8$
- **Host Bits**: `32 - 27 = 5`
- **Usable Hosts:** $2^5 - 2 = 30$
- **Subnet Increment:** `32`

Subnet #	Network Address	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.1.0	192.168.1.1	192.168.1.30	192.168.1.31
2	192.168.1.32	192.168.1.33	192.168.1.62	192.168.1.63
3	192.168.1.64	192.168.1.65	192.168.1.94	192.168.1.95
4	192.168.1.96	192.168.1.97	192.168.1.126	192.168.1.127
5	192.168.1.128	192.168.1.129	192.168.1.158	192.168.1.159
6	192.168.1.160	192.168.1.161	192.168.1.190	192.168.1.191
7	192.168.1.192	192.168.1.193	192.168.1.222	192.168.1.223
8	192.168.1.224	192.168.1.225	192.168.1.254	192.168.1.255

3.2.4 /28 Subnet — Calculations

- **Starting network:** `/24` (255.255.255.0)
- **New subnet:** `/28` (255.255.255.240)
- **Subnet Bits:** `28 - 24 = 4`
- **Total Subnets:** $2^4 = 16$
- **Host Bits:** `32 - 28 = 4`
- **Usable Hosts:** $2^4 - 2 = 14$
- **Subnet Increment:** `16`

Subnet #	Network Address	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.1.0	192.168.1.1	192.168.1.14	192.168.1.15
2	192.168.1.16	192.168.1.17	192.168.1.30	192.168.1.31
3	192.168.1.32	192.168.1.33	192.168.1.46	192.168.1.47
4	192.168.1.48	192.168.1.49	192.168.1.62	192.168.1.63
5	192.168.1.64	192.168.1.65	192.168.1.78	192.168.1.79
6	192.168.1.80	192.168.1.81	192.168.1.94	192.168.1.95
7	192.168.1.96	192.168.1.97	192.168.1.110	192.168.1.111
8	192.168.1.112	192.168.1.113	192.168.1.126	192.168.1.127
9	192.168.1.128	192.168.1.129	192.168.1.142	192.168.1.143
10	192.168.1.144	192.168.1.145	192.168.1.158	192.168.1.159
11	192.168.1.160	192.168.1.161	192.168.1.174	192.168.1.175
12	192.168.1.176	192.168.1.177	192.168.1.190	192.168.1.191
13	192.168.1.192	192.168.1.193	192.168.1.206	192.168.1.207
14	192.168.1.208	192.168.1.209	192.168.1.222	192.168.1.223
15	192.168.1.224	192.168.1.225	192.168.1.238	192.168.1.239
16	192.168.1.240	192.168.1.241	192.168.1.254	192.168.1.255

3.2.5 /29 Subnet — Calculations

- **Starting network:** `/24` (255.255.255.0)
- **New subnet:** `/29` (255.255.255.248)
- **Subnet Bits:** `29 - 24 = 5`
- **Total Subnets:** $2^5 = 32$
- **Host Bits:** `32 - 29 = 3`
- **Usable Hosts:** $2^3 - 2 = 6$
- **Subnet Increment:** `8`

Subnet #	Network Address	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.1.0	192.168.1.1	192.168.1.6	192.168.1.7
2	192.168.1.8	192.168.1.9	192.168.1.14	192.168.1.15
3	192.168.1.16	192.168.1.17	192.168.1.22	192.168.1.23
4	192.168.1.24	192.168.1.25	192.168.1.30	192.168.1.31
5	192.168.1.32	192.168.1.33	192.168.1.38	192.168.1.39
6	192.168.1.40	192.168.1.41	192.168.1.46	192.168.1.47
7	192.168.1.48	192.168.1.49	192.168.1.54	192.168.1.55
8	192.168.1.56	192.168.1.57	192.168.1.62	192.168.1.63
9	192.168.1.64	192.168.1.65	192.168.1.70	192.168.1.71
10	192.168.1.72	192.168.1.73	192.168.1.78	192.168.1.79
11	192.168.1.80	192.168.1.81	192.168.1.86	192.168.1.87
12	192.168.1.88	192.168.1.89	192.168.1.94	192.168.1.95
13	192.168.1.96	192.168.1.97	192.168.1.102	192.168.1.103
14	192.168.1.104	192.168.1.105	192.168.1.110	192.168.1.111
15	192.168.1.112	192.168.1.113	192.168.1.118	192.168.1.119
16	192.168.1.120	192.168.1.121	192.168.1.126	192.168.1.127
17	192.168.1.128	192.168.1.129	192.168.1.134	192.168.1.135
18	192.168.1.136	192.168.1.137	192.168.1.142	192.168.1.143
19	192.168.1.144	192.168.1.145	192.168.1.150	192.168.1.151
20	192.168.1.152	192.168.1.153	192.168.1.158	192.168.1.159
21	192.168.1.160	192.168.1.161	192.168.1.166	192.168.1.167
22	192.168.1.168	192.168.1.169	192.168.1.174	192.168.1.175
23	192.168.1.176	192.168.1.177	192.168.1.182	192.168.1.183
24	192.168.1.184	192.168.1.185	192.168.1.190	192.168.1.191
25	192.168.1.192	192.168.1.193	192.168.1.198	192.168.1.199

26	192.168.1.200	192.168.1.201	192.168.1.206	192.168.1.207
27	192.168.1.208	192.168.1.209	192.168.1.214	192.168.1.215
28	192.168.1.216	192.168.1.217	192.168.1.222	192.168.1.223
29	192.168.1.224	192.168.1.225	192.168.1.230	192.168.1.231
30	192.168.1.232	192.168.1.233	192.168.1.238	192.168.1.239
31	192.168.1.240	192.168.1.241	192.168.1.246	192.168.1.247
32	192.168.1.248	192.168.1.249	192.168.1.254	192.168.1.255

5.0 CYBERSECURITY APPLICATIONS OF SUBNETTING

5.1 Segmentation for Access Control

Example: /25 Subnets (2 subnets, 126 hosts each)

- HR could occupy one /25 subnet and Finance the other.
- Each department's traffic is isolated, reducing exposure of sensitive data.
- Limits lateral movement if a host is compromised.

Example: /26 Subnets (4 subnets, 62 hosts each)

- Smaller teams or critical servers can be segmented further.
- IT and network devices could occupy separate /26 subnets, ensuring **management traffic** stays isolated.

5.2 Reduced Attack Surface

Example: /27 Subnets (8 subnets, 30 hosts each)

- Isolates smaller groups, like lab environments or guest networks.
- Smaller broadcast domains reduce the risk of malware spreading or accidental network floods.

Example: /28 Subnets (16 subnets, 14 hosts each)

- Perfect for highly sensitive systems, e.g., servers storing confidential data.
- Only a few hosts per subnet reduces the number of potential targets for attackers.

5.3 Firewall and IDS/IPS Rules

Example: /29 Subnets (32 subnets, 6 hosts each)

- Ideal for **point-to-point links** or tightly controlled server access.
- Each subnet can have **individual firewall rules** and IDS/IPS monitoring.
- Allows precise management of access to sensitive systems

5.4 Network Monitoring & Anomaly Detection

- Clear boundaries of subnets (/25–/29) allow **easier detection of unusual traffic**.
- Security teams can assign monitoring thresholds per subnet.
- Smaller subnets make deviations in traffic patterns stand out immediately, helping SOC analysts identify threats faster.

6.0 CONCLUSION

Subnetting is a **core skill** for cybersecurity professionals and network administrators. Beyond efficient IP address management, it:

- Enables **secure network design** through segmentation.
- Supports **scalable monitoring and defense strategies**.
- Provides the foundation for applying **zero-trust principles** in enterprise environments.

Developing strong subnetting skills ensures **resilient network architecture** and directly contributes to stronger cybersecurity postures.

Appendix A: Class C Subnet Address Ranges (/25–/29)

Subnet #	Network Address	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.1.0	192.168.1.1	192.168.1.126	192.168.1.127
2	192.168.1.128	192.168.1.129	192.168.1.254	192.168.1.255
1	192.168.1.0	192.168.1.1	192.168.1.62	192.168.1.63
2	192.168.1.64	192.168.1.65	192.168.1.126	192.168.1.127
3	192.168.1.128	192.168.1.129	192.168.1.190	192.168.1.191
4	192.168.1.192	192.168.1.193	192.168.1.254	192.168.1.255
1	192.168.1.0	192.168.1.1	192.168.1.30	192.168.1.31
2	192.168.1.32	192.168.1.33	192.168.1.62	192.168.1.63
3	192.168.1.64	192.168.1.65	192.168.1.94	192.168.1.95
4	192.168.1.96	192.168.1.97	192.168.1.126	192.168.1.127
5	192.168.1.128	192.168.1.129	192.168.1.158	192.168.1.159
6	192.168.1.160	192.168.1.161	192.168.1.190	192.168.1.191
7	192.168.1.192	192.168.1.193	192.168.1.222	192.168.1.223
8	192.168.1.224	192.168.1.225	192.168.1.254	192.168.1.255
1	192.168.1.0	192.168.1.1	192.168.1.14	192.168.1.15
2	192.168.1.16	192.168.1.17	192.168.1.30	192.168.1.31
3	192.168.1.32	192.168.1.33	192.168.1.46	192.168.1.47
4	192.168.1.48	192.168.1.49	192.168.1.62	192.168.1.63
5	192.168.1.64	192.168.1.65	192.168.1.78	192.168.1.79
6	192.168.1.80	192.168.1.81	192.168.1.94	192.168.1.95
7	192.168.1.96	192.168.1.97	192.168.1.110	192.168.1.111
8	192.168.1.112	192.168.1.113	192.168.1.126	192.168.1.127
9	192.168.1.128	192.168.1.129	192.168.1.142	192.168.1.143
10	192.168.1.144	192.168.1.145	192.168.1.158	192.168.1.159
11	192.168.1.160	192.168.1.161	192.168.1.174	192.168.1.175
12	192.168.1.176	192.168.1.177	192.168.1.190	192.168.1.191
13	192.168.1.192	192.168.1.193	192.168.1.206	192.168.1.207
14	192.168.1.208	192.168.1.209	192.168.1.222	192.168.1.223
15	192.168.1.224	192.168.1.225	192.168.1.238	192.168.1.239
16	192.168.1.240	192.168.1.241	192.168.1.254	192.168.1.255
1	192.168.1.0	192.168.1.1	192.168.1.6	192.168.1.7
2	192.168.1.8	192.168.1.9	192.168.1.14	192.168.1.15

3	192.168.1.16	192.168.1.17	192.168.1.22	192.168.1.23
4	192.168.1.24	192.168.1.25	192.168.1.30	192.168.1.31
5	192.168.1.32	192.168.1.33	192.168.1.38	192.168.1.39
6	192.168.1.40	192.168.1.41	192.168.1.46	192.168.1.47
7	192.168.1.48	192.168.1.49	192.168.1.54	192.168.1.55
8	192.168.1.56	192.168.1.57	192.168.1.62	192.168.1.63
9	192.168.1.64	192.168.1.65	192.168.1.70	192.168.1.71
10	192.168.1.72	192.168.1.73	192.168.1.78	192.168.1.79
11	192.168.1.80	192.168.1.81	192.168.1.86	192.168.1.87
12	192.168.1.88	192.168.1.89	192.168.1.94	192.168.1.95
13	192.168.1.96	192.168.1.97	192.168.1.102	192.168.1.103
14	192.168.1.104	192.168.1.105	192.168.1.110	192.168.1.111
15	192.168.1.112	192.168.1.113	192.168.1.118	192.168.1.119
16	192.168.1.120	192.168.1.121	192.168.1.126	192.168.1.127
17	192.168.1.128	192.168.1.129	192.168.1.134	192.168.1.135
18	192.168.1.136	192.168.1.137	192.168.1.142	192.168.1.143
19	192.168.1.144	192.168.1.145	192.168.1.150	192.168.1.151
20	192.168.1.152	192.168.1.153	192.168.1.158	192.168.1.159
21	192.168.1.160	192.168.1.161	192.168.1.166	192.168.1.167
22	192.168.1.168	192.168.1.169	192.168.1.174	192.168.1.175
23	192.168.1.176	192.168.1.177	192.168.1.182	192.168.1.183
24	192.168.1.184	192.168.1.185	192.168.1.190	192.168.1.191
25	192.168.1.192	192.168.1.193	192.168.1.198	192.168.1.199
26	192.168.1.200	192.168.1.201	192.168.1.206	192.168.1.207
27	192.168.1.208	192.168.1.209	192.168.1.214	192.168.1.215
28	192.168.1.216	192.168.1.217	192.168.1.222	192.168.1.223
29	192.168.1.224	192.168.1.225	192.168.1.230	192.168.1.231
30	192.168.1.232	192.168.1.233	192.168.1.238	192.168.1.239
31	192.168.1.240	192.168.1.241	192.168.1.246	192.168.1.247
32	192.168.1.248	192.168.1.249	192.168.1.254	192.168.1.255