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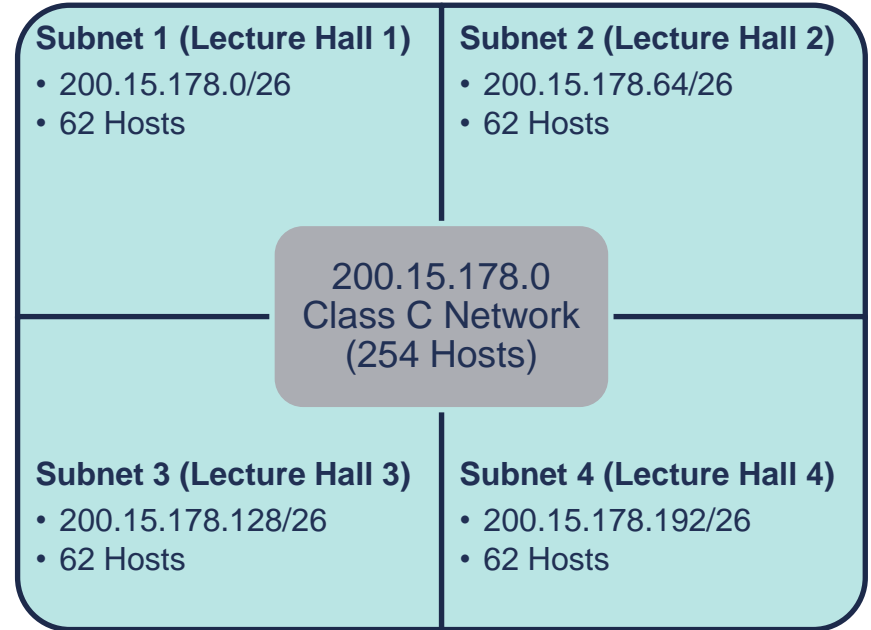# *Introduction to Subnetting*

# Why Subnet?

- Using default Class A, B and C subnets (called Classful IP Addressing) is inefficient:

  o Wastes unused IP Addresses (Public IP Addresses)

- Allows you to create multiple logical networks that exist within a single Class A, B, or C network.

  o Breaks up larger networks into multiple smaller sub-networks, which are called subnets

- Allows for more efficient routing via router summarization.

- Increased network security!

# *Fixed Length Subnetting*

- We will be learning about fixed-length subnetting, known as a fixed-length subnet mask (FLSM).

- There is also variable-length subnetting (VLSM), which is beyond the scope of this beginner's course.

# Class C Subnetting Example

- You're the network administrator for the Computer Science department at a university.

- You're setting up four new lecture halls that must have their own 60-person wireless network.

- You've been assigned the 200.15.178.0 Class C Network by the university, that supports 254 hosts per network by default.

- How do you break up this one Class C network into 4 smaller networks that support 60 host IP addresses per network?

- You subnet it.

- Subnetting allows your to breakup a larger network into smaller networks (subnets).

**Subnet 1 (Lecture Hall 1)**
- 200.15.178.0/26
- 62 Hosts

**Subnet 2 (Lecture Hall 2)**
- 200.15.178.64/26
- 62 Hosts

200.15.178.0
Class C Network
(254 Hosts)

**Subnet 3 (Lecture Hall 3)**
- 200.15.178.128/26
- 62 Hosts

**Subnet 4 (Lecture Hall 4)**
- 200.15.178.192/26
- 62 Hosts

# Process of Subnetting

- We borrow host bits to create more sub-networks (subnets) from a Class A, B, or C network.

- When you borrow hosts bits:
  - You create additional sub-networks, i.e., subnets
  - You also decrease the amount of host IP addresses available to use

|  | 8 bits | 8 bits | 8 bits | 8 bits |
|---|---|---|---|---|
| **Class A:** | Network = 8 Bits | Hosts = 24 Bits = $2^{24} - 2$ = 16,777,214 | | |
| **Class B:** | Network = 16 Bits | | Hosts = 16 Bits = $2^{16} - 2$ = 65,534 | |
| **Class C:** | Network = 24 Bits | | | Hosts = 8 Bits = $2^{8} - 2$ = 254 |

# How to Create Subnets

- Borrow bits from the host portion of an IP address
  - Each bit we borrow is equal to $2^1$ Subnets
    - Borrow 1 Host Bit = $2^1$ = 2
    - Borrow 2 Host Bits = $2^2$ = 4
    - Borrow 3 Host Bits = $2^3$ = 8
    - Borrow 4 Host Bits = $2^4$ = 16
    - Etc.

# Creating Subnets Visualized



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# *Subnetting Questions*

- To Create a Subnet, Answer the Following Questions:
  - How many subnets are needed?
  - How many hosts do you need per subnet?

# Class C Possible Subnets

| Binary (N.N.N.H) | Decimal | CIDR | # Subnets ($2^x$) | Block Size ($2^y$) | # Hosts ($2^y$ - 2) |
|---|---|---|---|---|---|
| N.N.N.00000000 | 255.255.255.0 | /24 | $2^0 = 1$ | $2^8 = 256$ | $2^8 - 2 = 254$ |
| N.N.N.10000000 | 255.255.255.128 | /25 | $2^1 = 2$ | $2^7 = 128$ | $2^7 - 2 = 126$ |
| N.N.N.11000000 | 255.255.255.192 | /26 | $2^2 = 4$ | $2^6 = 64$ | $2^6 - 2 = 62$ |
| N.N.N.11100000 | 255.255.255.224 | /27 | $2^3 = 8$ | $2^5 = 32$ | $2^5 - 2 = 30$ |
| N.N.N.11110000 | 255.255.255.240 | /28 | $2^4 = 16$ | $2^4 = 16$ | $2^4 - 2 = 14$ |
| N.N.N.11111000 | 255.255.255.248 | /29 | $2^5 = 32$ | $2^3 = 8$ | $2^3 - 2 = 6$ |
| N.N.N.11111100 | 255.255.255.252 | /30 | $2^6 = 64$ | $2^2 = 4$ | $2^2 - 2 = 2$ |

## Number of Subnets ($2^x$)

- X = number of host bits we borrow to create subnets

## Block Size ($2^y$)

- Y = number of remaining host bits left that are used for the subnet IP addresses

## Hosts per Subnet ($2^y - 2$)

- There are two addresses per network (or subnet) that we cannot use to assign to hosts on that network:
  - **Network Address**: This is the address used to uniquely identify the network (or subnet).
  - **Broadcast Address**: Address reserved for broadcast communication on the network.

# Class B Possible Subnets

| Binary (N.N.H.H) | Decimal | CIDR | # Subnets ($2^x$) | Block Size ($2^y$) | # Hosts ($2^y$ - 2) |
|---|---|---|---|---|---|
| N.N.00000000.00000000 | 255.255.0.0 | /16 | $2^0 = 1$ | $2^{16} = 65,536$ | $2^{16} - 2 = 65,534$ |
| N.N.10000000.00000000 | 255.255.128.0 | /17 | $2^1 = 2$ | $2^{15} = 32,768$ | $2^{15} - 2 = 32,766$ |
| N.N.11000000.00000000 | 255.255.192.0 | /18 | $2^2 = 4$ | $2^{14} = 16,384$ | $2^{14} - 2 = 16,382$ |
| N.N.11100000.00000000 | 255.255.224.0 | /19 | $2^3 = 8$ | $2^{13} = 8,192$ | $2^{13} - 2 = 8,190$ |
| N.N.11110000.00000000 | 255.255.240.0 | /20 | $2^4 = 16$ | $2^{12} = 4,096$ | $2^{12} - 2 = 4,094$ |
| N.N.11111000.00000000 | 255.255.248.0 | /21 | $2^5 = 32$ | $2^{11} = 2,048$ | $2^{11} - 2 = 2,046$ |
| N.N.11111100.00000000 | 255.255.252.0 | /22 | $2^6 = 64$ | $2^{10} = 1,024$ | $2^{10} - 2 = 1,022$ |
| N.N.11111110.00000000 | 255.255.254.0 | /23 | $2^7 = 128$ | $2^9 = 512$ | $2^9 - 2 = 510$ |
| N.N.11111111.00000000 | 255.255.255.0 | /24 | $2^8 = 256$ | $2^8 = 256$ | $2^8 - 2 = 254$ |
| N.N.11111111.10000000 | 255.255.255.128 | /25 | $2^9 = 512$ | $2^7 = 128$ | $2^7 - 2 = 126$ |
| N.N.11111111.11000000 | 255.255.255.192 | /26 | $2^{10} = 1,024$ | $2^6 = 64$ | $2^6 - 2 = 62$ |
| N.N.11111111.11100000 | 255.255.255.224 | /27 | $2^{11} = 2,048$ | $2^5 = 32$ | $2^5 - 2 = 30$ |
| N.N.11111111.11110000 | 255.255.255.240 | /28 | $2^{12} = 4,096$ | $2^4 = 16$ | $2^4 - 2 = 14$ |
| N.N.11111111.11111000 | 255.255.255.248 | /29 | $2^{13} = 8,192$ | $2^3 = 8$ | $2^3 - 2 = 6$ |
| N.N.11111111.11111100 | 255.255.255.252 | /30 | $2^{14} = 16,384$ | $2^2 = 4$ | $2^2 - 2 = 2$ |

# Class A Possible Subnets

| Binary (N.H.H.H) | Decimal | CIDR | # Subnets ($2^x$) | Block Size ($2^y$) | # Hosts ($2^y - 2$) |
|---|---|---|---|---|---|
| N.00000000.00000000.00000000 | 255.0.0.0 | /8 | $2^0 = 1$ | $2^{22} = 16{,}777{,}216$ | $2^{22} - 2 = 16{,}777{,}214$ |
| N.10000000.00000000.00000000 | 255.128.0.0 | /9 | $2^1 = 2$ | $2^{23} = 8{,}388{,}608$ | $2^{23} - 2 = 8{,}388{,}606$ |
| N.11000000.00000000.00000000 | 255.192.0.0 | /10 | $2^2 = 4$ | $2^{22} = 4{,}194{,}304$ | $2^{22} - 2 = 4{,}194{,}302$ |
| N.11100000.00000000.00000000 | 255.224.0.0 | /11 | $2^3 = 8$ | $2^{21} = 2{,}097{,}152$ | $2^{21} - 2 = 2{,}097{,}150$ |
| N.11110000.00000000.00000000 | 255.240.0.0 | /12 | $2^4 = 16$ | $2^{20} = 1{,}048{,}576$ | $2^{20} - 2 = 1{,}048{,}574$ |
| N.11111000.00000000.00000000 | 255.248.0.0 | /13 | $2^5 = 32$ | $2^{19} = 524{,}288$ | $2^{19} - 2 = 524{,}286$ |
| N.11111100.00000000.00000000 | 255.252.0.0 | /14 | $2^6 = 64$ | $2^{18} = 262{,}144$ | $2^{18} - 2 = 262{,}142$ |
| N.11111110.00000000.00000000 | 255.254.0.0 | /15 | $2^7 = 128$ | $2^{17} = 131{,}072$ | $2^{17} - 2 = 131{,}070$ |
| N.11111111.00000000.00000000 | 255.255.0.0 | /16 | $2^8 = 256$ | $2^{16} = 65{,}536$ | $2^{16} - 2 = 65{,}534$ |
| N.11111111.10000000.00000000 | 255.255.128.0 | /17 | $2^9 = 512$ | $2^{15} = 32{,}768$ | $2^{15} - 2 = 32{,}766$ |
| N.11111111.11000000.00000000 | 255.255.192.0 | /18 | $2^{10} = 1{,}024$ | $2^{14} = 16{,}384$ | $2^{14} - 2 = 16{,}382$ |
| N.11111111.11100000.00000000 | 255.255.224.0 | /19 | $2^{11} = 2{,}048$ | $2^{13} = 8{,}192$ | $2^{13} - 2 = 8{,}190$ |
| N.11111111.11110000.00000000 | 255.255.240.0 | /20 | $2^{12} = 4{,}096$ | $2^{12} = 4{,}096$ | $2^{12} - 2 = 4{,}094$ |
| N.11111111.11111000.00000000 | 255.255.248.0 | /21 | $2^{13} = 8{,}192$ | $2^{11} = 2{,}048$ | $2^{11} - 2 = 2{,}046$ |
| N.11111111.11111100.00000000 | 255.255.252.0 | /22 | $2^{14} = 16{,}384$ | $2^{10} = 1{,}024$ | $2^{10} - 2 = 1{,}022$ |
| N.11111111.11111110.00000000 | 255.255.254.0 | /23 | $2^{15} = 32{,}768$ | $2^9 = 512$ | $2^9 - 2 = 510$ |
| N.11111111.11111111.00000000 | 255.255.255.0 | /24 | $2^{16} = 65{,}536$ | $2^8 = 256$ | $2^8 - 2 = 254$ |
| N.11111111.11111111.10000000 | 255.255.255.128 | /25 | $2^{17} = 131{,}072$ | $2^7 = 128$ | $2^7 - 2 = 126$ |
| N.11111111.11111111.11000000 | 255.255.255.192 | /26 | $2^{18} = 262{,}144$ | $2^6 = 64$ | $2^6 - 2 = 62$ |
| N.11111111.11111111.11100000 | 255.255.255.224 | /27 | $2^{19} = 524{,}288$ | $2^5 = 32$ | $2^5 - 2 = 30$ |
| N.11111111.11111111.11110000 | 255.255.255.240 | /28 | $2^{20} = 1{,}048{,}576$ | $2^4 = 16$ | $2^4 - 2 = 14$ |
| N.11111111.11111111.11111000 | 255.255.255.248 | /29 | $2^{21} = 2{,}097{,}152$ | $2^3 = 8$ | $2^3 - 2 = 6$ |
| N.11111111.11111111.11111100 | 255.255.255.252 | /30 | $2^{22} = 4{,}194{,}304$ | $2^2 = 4$ | $2^2 - 2 = 2$ |

# Subnet Calculation Table ($2^x$)

| Host Bits Borrowed | $2^x$ | Number of Subnets Created |
|:---:|:---:|:---:|
| 1 | $2^1$ | 2 |
| 2 | $2^2$ | 4 |
| 3 | $2^3$ | 8 |
| 4 | $2^4$ | 16 |
| 5 | $2^5$ | 32 |
| 6 | $2^6$ | 64 |
| 7 | $2^7$ | 128 |
| 8 | $2^8$ | 256 |
| 9 | $2^9$ | 512 |
| 10 | $2^{10}$ | 1,024 |
| 11 | $2^{11}$ | 2,048 |
| 12 | $2^{12}$ | 4,096 |
| Etc.… | | |

# Subnet Hosts & Addresses Calculation Table ($2^y$)

| Host Bits Left | $2^y$ | Addresses per Subnet ($2^y$) | Hosts per Subnet ($2^y - 2$) |
|:---:|:---:|:---:|:---:|
| ~~1~~ | ~~$2^1$~~ | ~~2~~ | ~~0~~ |
| 2 | $2^2$ | 4 | 2 |
| 3 | $2^3$ | 8 | 6 |
| 4 | $2^4$ | 16 | 14 |
| 5 | $2^5$ | 32 | 30 |
| 6 | $2^6$ | 64 | 62 |
| 7 | $2^7$ | 128 | 126 |
| 8 | $2^8$ | 256 | 254 |
| 9 | $2^9$ | 512 | 510 |
| 10 | $2^{10}$ | 1,024 | 1,022 |
| 11 | $2^{11}$ | 2,048 | 2,046 |
| 12 | $2^{12}$ | 4,096 | 4,094 |

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# Subnetting Reference Tables

## POWER OF 2'S TABLE

| | |
|---|---|
| $2^1 = 2$ | $2^9 = 512$ |
| $2^2 = 4$ | $2^{10} = 1,024$ |
| $2^3 = 8$ | $2^{11} = 2,048$ |
| $2^4 = 16$ | $2^{12} = 4,096$ |
| $2^5 = 32$ | $2^{13} = 8,192$ |
| $2^6 = 64$ | $2^{14} = 16,384$ |
| $2^7 = 128$ | $2^{15} = 32,768$ |
| $2^8 = 256$ | $2^{16} = 65,536$ |

## DEFAULT SUBNET MASK

| Class | Format | Default Subnet Mask |
|---|---|---|
| A | network.host.host.host | 255.0.0.0 |
| B | network.network.host.host | 255.255.0.0 |
| C | network.network.network.host | 255.255.255.0 |

## BINARY MATH TABLE

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## SUBNET MASK TABLE

| Binary | Decimal |
|---|---|
| 00000000 | 0 |
| 10000000 | 128 |
| 11000000 | 192 |
| 11100000 | 224 |
| 11110000 | 240 |
| 11111000 | 248 |
| 11111100 | 252 |

## SUBNET CALCULATION TABLE ($2^X$)

| Host Bits Borrowed | $2^x$ | Number of Subnets Created |
|---|---|---|
| 1 | $2^1$ | 2 |
| 2 | $2^2$ | 4 |
| 3 | $2^3$ | 8 |
| 4 | $2^4$ | 16 |
| 5 | $2^5$ | 32 |
| 6 | $2^6$ | 64 |
| 7 | $2^7$ | 128 |
| 8 | $2^8$ | 256 |
| 9 | $2^9$ | 512 |
| 10 | $2^{10}$ | 1,024 |
| 11 | $2^{11}$ | 2,048 |
| 12 | $2^{12}$ | 4,096 |

## SUBNET HOSTS & ADDRESSES CALCULATION TABLE ($2^Y$)

| Host Bits Left | $2^y$ | Hosts per Subnet ($2^y - 2$) | Addresses per Subnet ($2^y$) |
|---|---|---|---|
| ~~1~~ | ~~$2^1$~~ | ~~0~~ | ~~2~~ |
| 2 | $2^2$ | 2 | 4 |
| 3 | $2^3$ | 6 | 8 |
| 4 | $2^4$ | 14 | 16 |
| 5 | $2^5$ | 30 | 32 |
| 6 | $2^6$ | 62 | 64 |
| 7 | $2^7$ | 126 | 128 |
| 8 | $2^8$ | 254 | 256 |
| 9 | $2^9$ | 510 | 512 |
| 10 | $2^{10}$ | 1,022 | 1,024 |
| 11 | $2^{11}$ | 2,046 | 2,048 |
| 12 | $2^{12}$ | 4,094 | 4,096 |

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## CLASS C POSSIBLE SUBNET MASKS

| Binary (N.N.N.H) | Decimal | CIDR | # Subnets ($2^x$) | Block Size ($2^y$) | # Hosts ($2^y$ - 2) |
|---|---|---|---|---|---|
| N.N.N.00000000 | 255.255.255.0 | /24 | $2^0 = 1$ | $2^8 = 256$ | $2^8 - 2 = 254$ |
| N.N.N.10000000 | 255.255.255.128 | /25 | $2^1 = 2$ | $2^7 = 128$ | $2^7 - 2 = 126$ |
| N.N.N.11000000 | 255.255.255.192 | /26 | $2^2 = 4$ | $2^6 = 64$ | $2^6 - 2 = 62$ |
| N.N.N.11100000 | 255.255.255.224 | /27 | $2^3 = 8$ | $2^5 = 32$ | $2^5 - 2 = 30$ |
| N.N.N.11110000 | 255.255.255.240 | /28 | $2^4 = 16$ | $2^4 = 16$ | $2^4 - 2 = 14$ |
| N.N.N.11111000 | 255.255.255.248 | /29 | $2^5 = 32$ | $2^3 = 8$ | $2^3 - 2 = 6$ |
| N.N.N.11111100 | 255.255.255.252 | /30 | $2^6 = 64$ | $2^2 = 4$ | $2^2 - 2 = 2$ |

## CLASS B POSSIBLE SUBNET MASKS

| Binary (N.N.H.H) | Decimal | CIDR | # Subnets ($2^x$) | Block Size ($2^y$) | # Hosts ($2^y$ - 2) |
|---|---|---|---|---|---|
| N.N.00000000.00000000 | 255.255.0.0 | /16 | $2^0 = 1$ | $2^{16} = 65,536$ | $2^{16} - 2 = 65,534$ |
| N.N.10000000.00000000 | 255.255.128.0 | /17 | $2^1 = 2$ | $2^{15} = 32,768$ | $2^{15} - 2 = 32,766$ |
| N.N.11000000.00000000 | 255.255.192.0 | /18 | $2^2 = 4$ | $2^{14} = 16,384$ | $2^{14} - 2 = 16,382$ |
| N.N.11100000.00000000 | 255.255.224.0 | /19 | $2^3 = 8$ | $2^{13} = 8,192$ | $2^{13} - 2 = 8,190$ |
| N.N.11110000.00000000 | 255.255.240.0 | /20 | $2^4 = 16$ | $2^{12} = 4,096$ | $2^{12} - 2 = 4,094$ |
| N.N.11111000.00000000 | 255.255.248.0 | /21 | $2^5 = 32$ | $2^{11} = 2,048$ | $2^{11} - 2 = 2,046$ |
| N.N.11111100.00000000 | 255.255.252.0 | /22 | $2^6 = 64$ | $2^{10} = 1,024$ | $2^{10} - 2 = 1,022$ |
| N.N.11111110.00000000 | 255.255.254.0 | /23 | $2^7 = 128$ | $2^9 = 512$ | $2^9 - 2 = 510$ |
| N.N.11111111.00000000 | 255.255.255.0 | /24 | $2^8 = 256$ | $2^8 = 256$ | $2^8 - 2 = 254$ |
| N.N.11111111.10000000 | 255.255.255.128 | /25 | $2^9 = 512$ | $2^7 = 128$ | $2^7 - 2 = 126$ |
| N.N.11111111.11000000 | 255.255.255.192 | /26 | $2^{10} = 1,024$ | $2^6 = 64$ | $2^6 - 2 = 62$ |
| N.N.11111111.11100000 | 255.255.255.224 | /27 | $2^{11} = 2,048$ | $2^5 = 32$ | $2^5 - 2 = 30$ |
| N.N.11111111.11110000 | 255.255.255.240 | /28 | $2^{12} = 4,096$ | $2^4 = 16$ | $2^4 - 2 = 14$ |
| N.N.11111111.11111000 | 255.255.255.248 | /29 | $2^{13} = 8,192$ | $2^3 = 8$ | $2^3 - 2 = 6$ |
| N.N.11111111.11111100 | 255.255.255.252 | /30 | $2^{14} = 16,384$ | $2^2 = 4$ | $2^2 - 2 = 2$ |

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## CLASS A POSSIBLE SUBNET MASKS

| Binary (N.H.H.H) | Decimal | CIDR | # Subnets ($2^x$) | Block Size ($2^y$) | # Hosts ($2^y$ - 2) |
|---|---|---|---|---|---|
| N.00000000.00000000.00000000 | 255.0.0.0 | /8 | $2^0 = 1$ | $2^{22} = 16,777,216$ | $2^{22} - 2 = 16,777,214$ |
| N.10000000.00000000.00000000 | 255.128.0.0 | /9 | $2^1 = 2$ | $2^{23} = 8,388,608$ | $2^{23} - 2 = 8,388,606$ |
| N.11000000.00000000.00000000 | 255.192.0.0 | /10 | $2^2 = 4$ | $2^{22} = 4,194,304$ | $2^{22} - 2 = 4,194,302$ |
| N.11100000.00000000.00000000 | 255.224.0.0 | /11 | $2^3 = 8$ | $2^{21} = 2,097,152$ | $2^{21} - 2 = 2,097,150$ |
| N.11110000.00000000.00000000 | 255.240.0.0 | /12 | $2^4 = 16$ | $2^{20} = 1,048,576$ | $2^{20} - 2 = 1,048,574$ |
| N.11111000.00000000.00000000 | 255.248.0.0 | /13 | $2^5 = 32$ | $2^{19} = 524,288$ | $2^{19} - 2 = 524,286$ |
| N.11111100.00000000.00000000 | 255.252.0.0 | /14 | $2^6 = 64$ | $2^{18} = 262,144$ | $2^{18} - 2 = 262,142$ |
| N.11111110.00000000.00000000 | 255.254.0.0 | /15 | $2^7 = 128$ | $2^{17} = 131,072$ | $2^{17} - 2 = 131,070$ |
| N.11111111.00000000.00000000 | 255.255.0.0 | /16 | $2^8 = 256$ | $2^{16} = 65,536$ | $2^{16} - 2 = 65,534$ |
| N.11111111.10000000.00000000 | 255.255.128.0 | /17 | $2^9 = 512$ | $2^{15} = 32,768$ | $2^{15} - 2 = 32,766$ |
| N.11111111.11000000.00000000 | 255.255.192.0 | /18 | $2^{10} = 1,024$ | $2^{14} = 16,384$ | $2^{14} - 2 = 16,382$ |
| N.11111111.11100000.00000000 | 255.255.224.0 | /19 | $2^{11} = 2,048$ | $2^{13} = 8,192$ | $2^{13} - 2 = 8,190$ |
| N.11111111.11110000.00000000 | 255.255.240.0 | /20 | $2^{12} = 4,096$ | $2^{12} = 4,096$ | $2^{12} - 2 = 4,094$ |
| N.11111111.11111000.00000000 | 255.255.248.0 | /21 | $2^{13} = 8,192$ | $2^{11} = 2,048$ | $2^{11} - 2 = 2,046$ |
| N.11111111.11111100.00000000 | 255.255.252.0 | /22 | $2^{14} = 16,384$ | $2^{10} = 1,024$ | $2^{10} - 2 = 1,022$ |
| N.11111111.11111110.00000000 | 255.255.254.0 | /23 | $2^{15} = 32,768$ | $2^9 = 512$ | $2^9 - 2 = 510$ |
| N.11111111.11111111.00000000 | 255.255.255.0 | /24 | $2^{16} = 65,536$ | $2^8 = 256$ | $2^8 - 2 = 254$ |
| N.11111111.11111111.10000000 | 255.255.255.128 | /25 | $2^{17} = 131,072$ | $2^7 = 128$ | $2^7 - 2 = 126$ |
| N.11111111.11111111.11000000 | 255.255.255.192 | /26 | $2^{18} = 262,144$ | $2^6 = 64$ | $2^6 - 2 = 62$ |
| N.11111111.11111111.11100000 | 255.255.255.224 | /27 | $2^{19} = 524,288$ | $2^5 = 32$ | $2^5 - 2 = 30$ |
| N.11111111.11111111.11110000 | 255.255.255.240 | /28 | $2^{20} = 1,048,576$ | $2^4 = 16$ | $2^4 - 2 = 14$ |
| N.11111111.11111111.11111000 | 255.255.255.248 | /29 | $2^{21} = 2,097,152$ | $2^3 = 8$ | $2^3 - 2 = 6$ |
| N.11111111.11111111.11111100 | 255.255.255.252 | /30 | $2^{22} = 4,194,304$ | $2^2 = 4$ | $2^2 - 2 = 2$ |

# Subnetting a Class C Network #1

# Subnetting a Class C Network #1

## Details & Requirements

You've been assigned a 192.168.1.0/24 Class C network, and you need to create two subnets from it.

## How many host bit do we need to borrow?

1 host bit, $2^1$ = 2 Subnets

## How many host addresses per subnet?

7 host bits left, $2^7$ = 128 Addresses / Subnet

$2^7$ - 2= 126 Addresses / Subnet

## What are the valid subnets?

192.168.1.0 and 192.168.1.128

## New Subnet Mask?

11111111.11111111.11111111.10000000

255.255.255.128  or  /25

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

| Binary (N.N.N.H) | Decimal | CIDR | # Subnets ($2^x$) | Block Size ($2^y$) | # Hosts ($2^y$ - 2) |
|---|---|---|---|---|---|
| N.N.N.00000000 | 255.255.255.0 | /24 | $2^0$ = 1 | $2^8$ = 256 | $2^8 - 2$ = 254 |
| N.N.N.10000000 | 255.255.255.128 | /25 | $2^1$ = 2 | $2^7$ = 128 | $2^7 - 2$ = 126 |
| N.N.N.11000000 | 255.255.255.192 | /26 | $2^2$ = 4 | $2^6$ = 64 | $2^6 - 2$ = 62 |
| N.N.N.11100000 | 255.255.255.224 | /27 | $2^3$ = 8 | $2^5$ = 32 | $2^5 - 2$ = 30 |
| N.N.N.11110000 | 255.255.255.240 | /28 | $2^4$ = 16 | $2^4$ = 16 | $2^4 - 2$ = 14 |
| N.N.N.11111000 | 255.255.255.248 | /29 | $2^5$ = 32 | $2^3$ = 8 | $2^3 - 2$ = 6 |
| N.N.N.11111100 | 255.255.255.252 | /30 | $2^6$ = 64 | $2^2$ = 4 | $2^2 - 2$ = 2 |

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**Details & Requirements**
- Network Address: 192.168.1.0
- Default Subnet Mask: 255.255.255.0
- Requires 2 Subnets

**How many host bit do we need to borrow?**
- 1 host bit, $2^1$ = 2 Subnets

**How many addresses hosts per subnet?**
- 7 host bits left, $2^7$ = 128 Addresses / Subnet
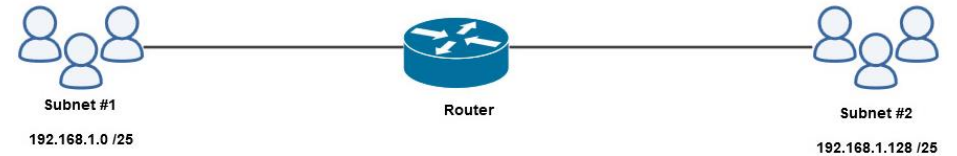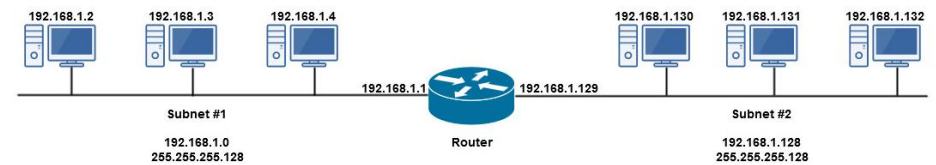- $2^7$ - 1 = 126 Addresses / Subnet

**What are the valid subnets?**
- 192.168.1.0 and 192.168.1.128

**New Subnet Mask?**
- 11111111.11111111.11111111.10000000
- 255.255.255.128 or /25

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

**Default Class C Network (8 Host Bits): 192.168.1.0 /24 Network**

1 Host Bits Borrowed = $2^1$ = Subnetted into 2 Subnets

| Subnet #1: 192.168.1.0 /25 | Subnet #2: 192.168.1.128 /25 |
|---|---|

**CLASS C POSSIBLE SUBNET MASKS**

| Binary (N.N.N.H) | Decimal | CIDR | # Subnets ($2^x$) | Block Size ($2^y$) | # Hosts ($2^y$ - 2) |
|---|---|---|---|---|---|
| N.N.N.00000000 | 255.255.255.0 | /24 | $2^0$ = 1 | $2^8$ = 256 | $2^8 - 2$ = 254 |
| N.N.N.10000000 | 255.255.255.128 | /25 | $2^1$ = 2 | $2^7$ = 128 | $2^7 - 2$ = 126 |
| N.N.N.11000000 | 255.255.255.192 | /26 | $2^2$ = 4 | $2^6$ = 64 | $2^6 - 2$ = 62 |
| N.N.N.11100000 | 255.255.255.224 | /27 | $2^3$ = 8 | $2^5$ = 32 | $2^5 - 2$ = 30 |
| N.N.N.11110000 | 255.255.255.240 | /28 | $2^4$ = 16 | $2^4$ = 16 | $2^4 - 2$ = 14 |
| N.N.N.11111000 | 255.255.255.248 | /29 | $2^5$ = 32 | $2^3$ = 8 | $2^3 - 2$ = 6 |
| N.N.N.11111100 | 255.255.255.252 | /30 | $2^6$ = 64 | $2^2$ = 4 | $2^2 - 2$ = 2 |

## Network Simplified View



Subnet #1
192.168.1.0 /25

Router

Subnet #2
192.168.1.128 /25

## Network Detailed View



192.168.1.2  192.168.1.3  192.168.1.4

192.168.1.130  192.168.1.131  192.168.1.132

192.168.1.1        192.168.1.129

Subnet #1
192.168.1.0
255.255.255.128

Router

Subnet #2
192.168.1.128
255.255.255.128

# *Subnetting a Class C Network #2*

# Subnetting a Class C Network #2

## Details & Requirements

You've been assigned a 192.168.1.0/24 Class C network, and you need to create four subnets from it.

**How many host bit do we need to borrow?**

2 host bits, $2^2$ = 4 Subnets

**How many host addresses per subnet?**

6 host bits left, $2^6$ = 64 Addresses / Subnet

$2^6$ - 2= 62 Addresses / Subnet

**What are the valid subnets?**

192.168.1.**0**, 192.168.1.**64**,
192.168.1.**128**, 192.168.1.**192**

**New Subnet Mask?**

11111111.11111111.11111111.**11**000000

255.255.255.192  or  /26

| Subnet | Network /Subnet Address | Host IP Addresses | Broadcast Address |
|--------|-------------------------|-------------------|-------------------|
| 1 | 192.168.1.**0** | 1 thru 62 | 192.168.1.**63** |
| 2 | 192.168.1.**64** | 65 thru 126 | 192.168.1.**127** |
| 3 | 192.168.1.**128** | 129 thru 190 | 192.168.1.**191** |
| 4 | 192.168.1.**192** | 193 thru 254 | 192.168.1.**255** |

| Binary (N.N.N.H) | Decimal | CIDR | # Subnets ($2^x$) | Block Size ($2^y$) | # Hosts ($2^y$ - 2) |
|------------------|---------|------|----------------|----------------|------------------|
| N.N.N.**00000000** | 255.255.255.0 | /24 | $2^0$ = 1 | $2^8$ = 256 | $2^8 - 2 = 254$ |
| N.N.N.**10000000** | 255.255.255.128 | /25 | $2^1$ = 2 | $2^7$ = 128 | $2^7 - 2 = 126$ |
| N.N.N.**11000000** | 255.255.255.192 | /26 | $2^2$ = 4 | $2^6$ = 64 | $2^6 - 2 = 62$ |
| N.N.N.**11100000** | 255.255.255.224 | /27 | $2^3$ = 8 | $2^5$ = 32 | $2^5 - 2 = 30$ |
| N.N.N.**11110000** | 255.255.255.240 | /28 | $2^4$ = 16 | $2^4$ = 16 | $2^4 - 2 = 14$ |
| N.N.N.**11111000** | 255.255.255.248 | /29 | $2^5$ = 32 | $2^3$ = 8 | $2^3 - 2 = 6$ |
| N.N.N.**11111100** | 255.255.255.252 | /30 | $2^6$ = 64 | $2^2$ = 4 | $2^2 - 2 = 2$ |

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## Details & Requirements
– Network Address: 192.168.1.0
– Default Subnet Mask: 255.255.255.0
– Requires 4 Subnets

## How many host bit do we need to borrow?
– 2 host bit, $2^2$ = 4 Subnets

## How many addresses hosts per subnet?
– 6 host bits left, $2^6$ = 64 Addresses / Subnet
– $2^6$ - 1 = 62 Addresses / Subnet

## What are the valid subnets?
– 192.168.1.**0**, 192.168.1.**64**, 192.168.1.**128**, 192.168.1.**192**

## New Subnet Mask?
– 11111111.11111111.11111111.**11**000000
– 255.255.255.192 or /26

| Subnet | Network Address | Host IP Addresses | Broadcast Address |
|--------|-----------------|-------------------|-------------------|
| 1 | .0 | .1 to .62 | .63 |
| 2 | .64 | .65 to .126 | .127 |
| 3 | .128 | .129 to .190 | .191 |
| 4 | .192 | .193 to .254 | .255 |

| Default Class C Network (8 Host Bits) | | | |
|---|---|---|---|

2 Host Bits Borrowed = $2^2$ = Subnetted into 4 Subnets

| 1 | 2 | 3 | 4 |
|---|---|---|---|

## CLASS C POSSIBLE SUBNET MASKS

| Binary (N.N.N.H) | Decimal | CIDR | # Subnets ($2^x$) | Block Size ($2^y$) | # Hosts ($2^y$ - 2) |
|---|---|---|---|---|---|
| N.N.N.00000000 | 255.255.255.0 | /24 | $2^0$ = 1 | $2^8$ = 256 | $2^8 - 2$ = 254 |
| N.N.N.10000000 | 255.255.255.128 | /25 | $2^1$ = 2 | $2^7$ = 128 | $2^7 - 2$ = 126 |
| N.N.N.11000000 | 255.255.255.192 | /26 | $2^2$ = 4 | $2^6$ = 64 | $2^6 - 2$ = 62 |
| N.N.N.11100000 | 255.255.255.224 | /27 | $2^3$ = 8 | $2^5$ = 32 | $2^5 - 2$ = 30 |
| N.N.N.11110000 | 255.255.255.240 | /28 | $2^4$ = 16 | $2^4$ = 16 | $2^4 - 2$ = 14 |
| N.N.N.11111000 | 255.255.255.248 | /29 | $2^5$ = 32 | $2^3$ = 8 | $2^3 - 2$ = 6 |
| N.N.N.11111100 | 255.255.255.252 | /30 | $2^6$ = 64 | $2^2$ = 4 | $2^2 - 2$ = 2 |

## Network Simplified & Detail Views



Subnet #1
192.168.1.0 /26

Subnet #2
192.168.1.64 /26

Router

Subnet #3
192.168.1.128 /26

Subnet #4
192.168.1.192 /26

192.168.1.2  192.168.1.3  192.168.1.4  192.168.1.66  192.168.1.67  192.168.1.68

Router

192.168.1.1  192.168.1.65

Subnet #1
192.168.1.0
255.255.255.192

192.168.1.129  192.168.1.193

Subnet #2
192.168.1.64
255.255.255.192

192.168.1.130  192.168.1.131  192.168.1.194  192.168.1.195

Subnet #3
192.168.1.128
255.255.255.192

Subnet #4
192.168.1.192
255.255.255.192