IPv4 Subnetting – Sections

Section 1: Analyzing Individual Subnets

Section 2: Converting Subnet Masks

Section 3: Analyzing IP Networks

Section 4: Identifying the Subnets of a Network

Section 5: Analyzing Designs Using Masks

Section 6: Subnetting and the Exam

Self-Evaluation Time!

Subnetting Processes	Book Speed Goals	Your Speed Goal	Your Current Speed	Your Stage Goal During Class	Your Current Stage
Find Classful Network Facts *	10				
Convert Mask Formats *	10				
Find Subnet Facts	30				
Interpret Design w/ Mask	15				
Choose One Mask	15				
Find All Subnet IDs *	45				

* These Time Estimates Do Not Include the Time to Write/Type the Answers

Until 20 Minutes After the Hour…

- Office Hours – I am Here to Answer Your Questions!

- **QA Panel**
  - Ask Wendell Questions
  - Be specific
  - If a Practice Problem, Mention Section and Number

- **Chat Panel**
  - Student-to-Student
  - I will Watch as Well

Course Outline

Day 1

Section 1: Analyzing Existing Subnets
Section 2: Converting Subnet Masks
Section 3: Analyzing IP Networks

Day 2

Office Hours (QA for the First 20 Minutes)
Section 4: Finding All Subnets in a Network
Section 5: Analyzing Designs Using Masks
Section 6: Subnetting and the Exam

IPv4 Subnetting – Sections

Section 1: Analyzing Individual Subnets

Section 2: Converting Subnet Masks

Section 3: Analyzing IP Networks

Section 4: Identifying the Subnets of a Network

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IPv4 Subnetting – Section 4

Noticing Patterns in Subnet IDs

Finding All Subnets: Network and Host Octets

* Finding All Subnets: 1 Subnet Octet
* Finding All Subnets: >1 Subnet Octet

In This Lesson...

Subnetting a Classful Network

- **Simple Subnet ID Patterns when Using One Simple Mask**
- Less Obvious Subnet ID Patterns when Using One Difficult Mask
- Classful Addressing Analysis to Find the Number of Subnets
- Summary and Terms

Defining “Subnet”

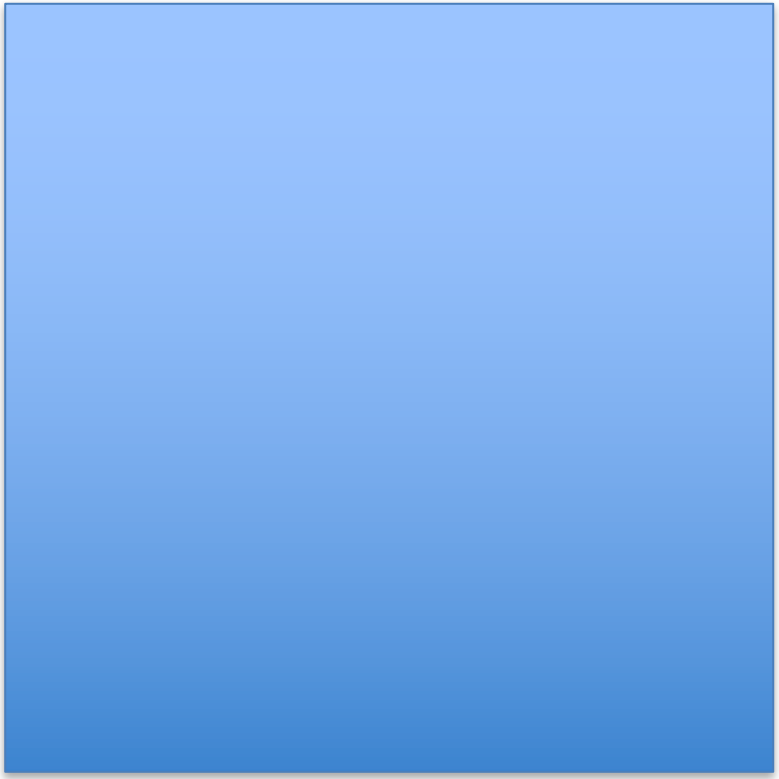
Subnet (Noun)

1. A Predictable Set of Consecutive Numbers
   A. Numbers are 32-bits, Written in DDN Format for Convenience
   B. Predictable Lowest Number in the Subnet (Subnet ID)
   C. A Predictable Size: 2^H (H is Based on the Subnet Mask)
2. Most Numbers are IP Addresses, Some are Reserved

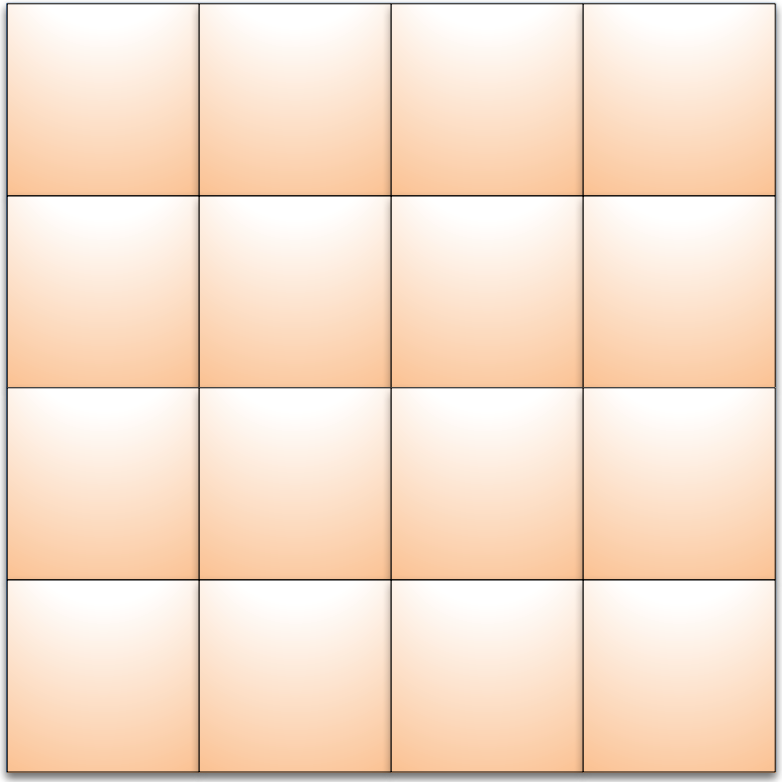
Subnet (Verb)

1. To Subdivide a Larger Set of IPv4 Addresses into Multiple Smaller Sets
2. To Subdivide a Set of Size 2^N into Smaller Sets of Size 2^X, in Which X<N
3. To Follow the Rules of IP Addressing and Subnetting to Subdivide a Network

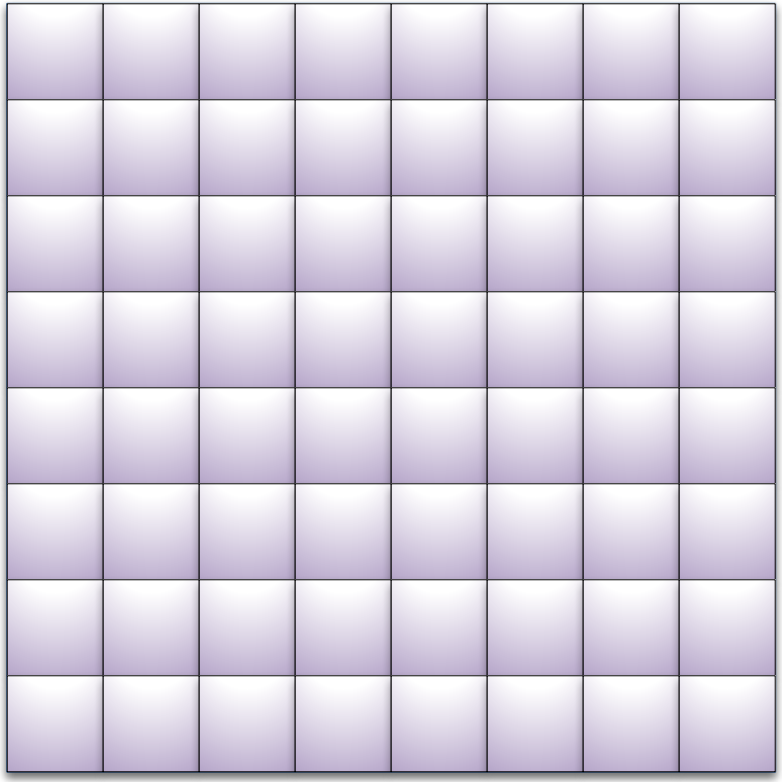
Idea: One Network



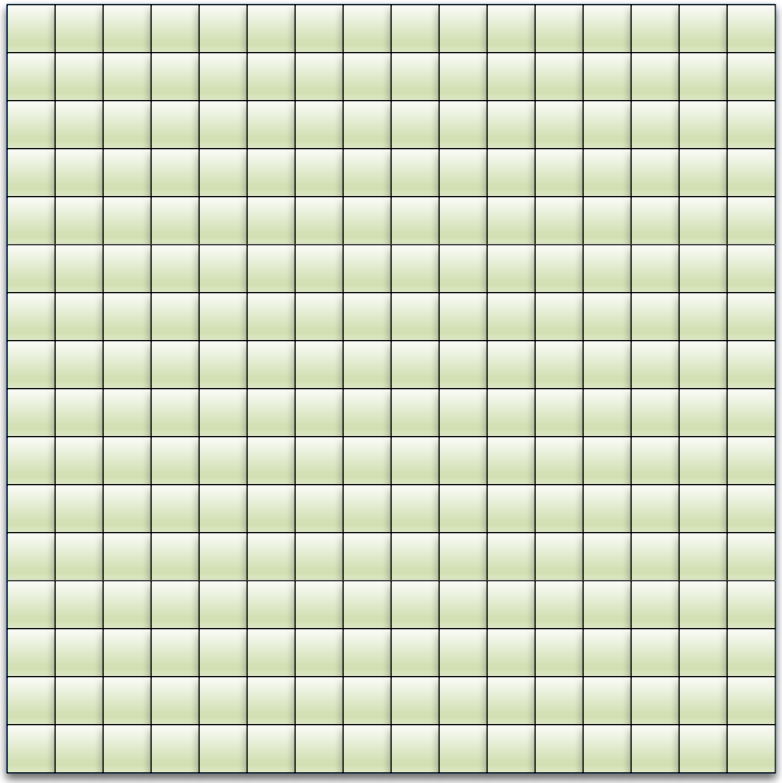
Idea: 16 Subnets of that Network



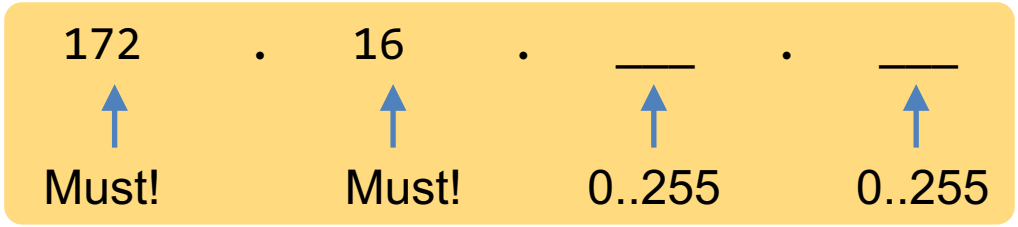
Idea: 64 Subnets of that Network



Idea: 256 Subnets of that Network

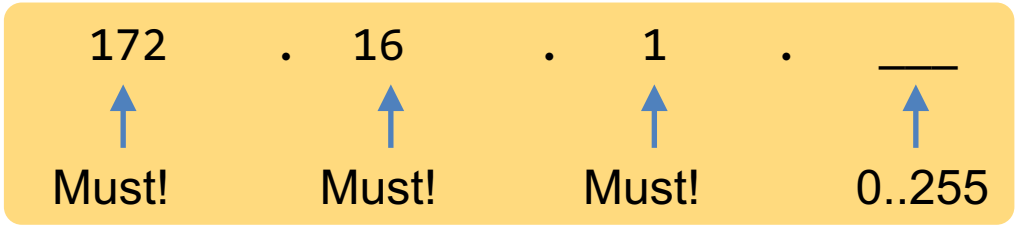


Example: Class B Network 172.16.0.0

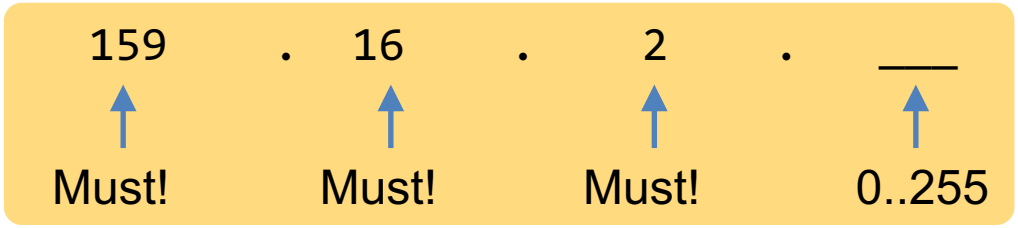


One Group:
All that Begin 172.16

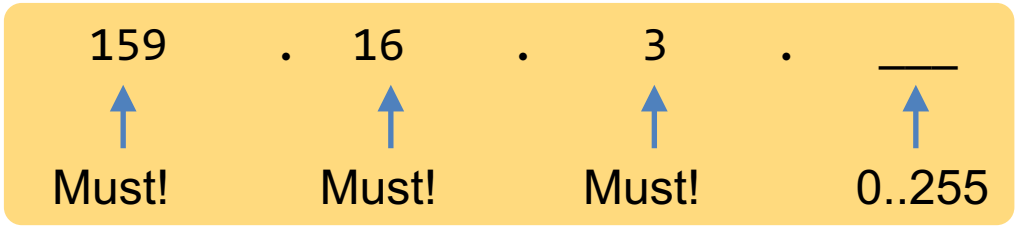
Example Subnets of Network 172.16.0.0 w/ /24



A Subset (Subnet):
All that Begin 172.16.1

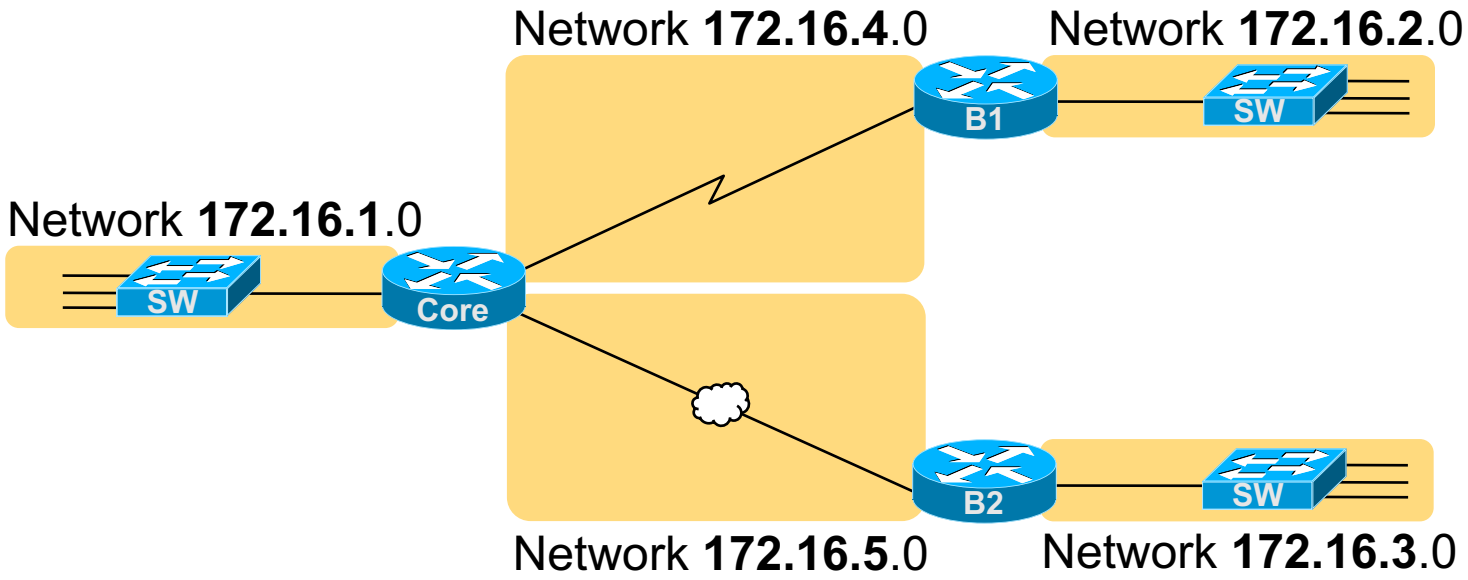


A Subset (Subnet):
All that Begin 172.16.2



A Subset (Subnet):
All that Begin 172.16.3

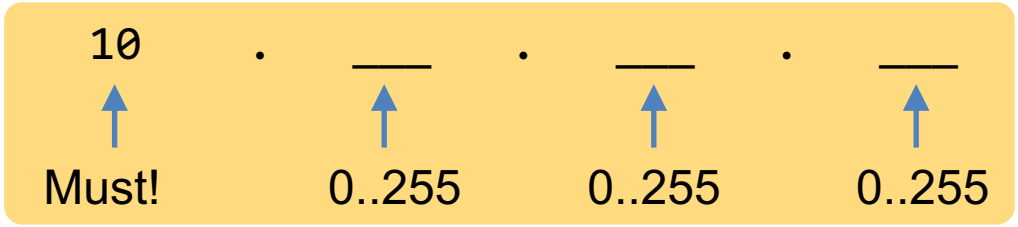
Five Subnets, All from Same Class B Network



Pattern of Subnets of 172.16.0.0 with /24

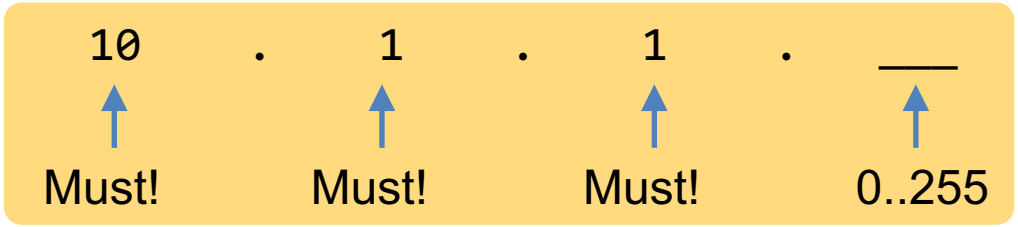
172.16. 0.__		
172.16. 1.__	172.16. 21.__	
172.16. 2.__	172.16. 22.__	172.16.237.__
172.16. 3.__	172.16. 23.__	172.16.238.__
172.16. 4.__	172.16. 24.__	172.16.239.__
172.16. 5.__	172.16. 25.__	172.16.240.__
172.16. 6.__	172.16. 26.__	172.16.241.__
172.16. 7.__	172.16. 27.__	172.16.242.__
172.16. 8.__	172.16. 28.__	172.16.243.__
172.16. 9.__	172.16. 29.__	172.16.244.__
172.16. 10.__	172.16. 30.__	172.16.245.__
172.16. 11.__	172.16. 31.__	172.16.246.__
172.16. 12.__	172.16. 32.__	172.16.247.__
172.16. 13.__	172.16. 33.__	172.16.248.__
172.16. 14.__	172.16. 34.__	172.16.249.__
172.16. 15.__	172.16. 35.__	172.16.250.__
172.16. 16.__	172.16. 36.__	172.16.251.__
172.16. 17.__	172.16. 37.__	172.16.252.__
172.16. 18.__	172.16. 38.__	172.16.253.__
172.16. 19.__	172.16. 39.__	172.16.254.__
172.16. 20.__	172.16. 40.__	172.16.255.__

Example: Class A Network 10.0.0.0

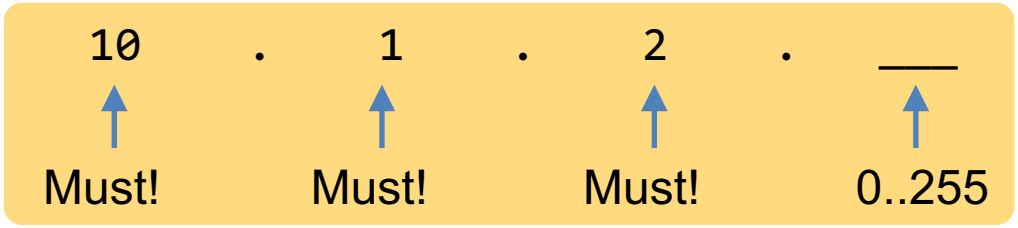


One Group:
All that Begin 10

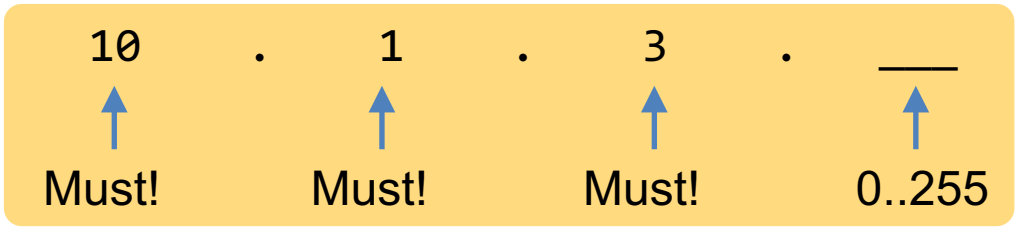
Example Subnets of Network 10.0.0.0 w/ /24



A Subset (Subnet):
All that Begin 10.1.1

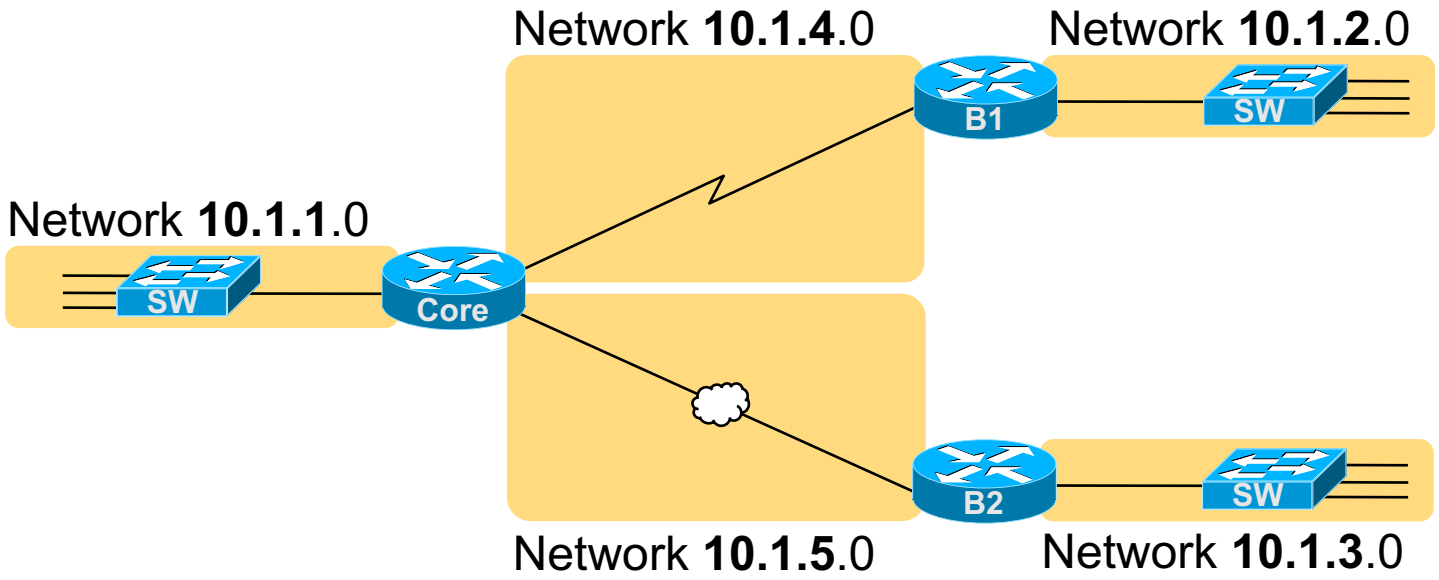


A Subset (Subnet):
All that Begin 10.1.2



A Subset (Subnet):
All that Begin 10.1.3

Five Subnets, All from Same Class A Network



Patterns of Subnets of Network 10.0.0.0 with /24

10. 0. 0.__	10. 1. 0.__	10. 2. 0.__
10. 0. 1.__	10. 1. 1.__	10. 2. 1.__
10. 0. 2.__	10. 1. 2.__	10. 2. 2.__
10. 0. 3.__	10. 1. 3.__	10. 2. 3.__
10. 0. 4.__	10. 1. 4.__	10. 2. 4.__
10. 0. 5.__	10. 1. 5.__	10. 2. 5.__
10. 0. 6.__	10. 1. 6.__	10. 2. 6.__
10. 0. 7.__	10. 1. 7.__	10. 2. 7.__
10. 0. 8.__	10. 1. 8.__	10. 2. 8.__
10. 0. 9.__	10. 1. 9.__	10. 2. 9.__
10. 0. 10.__	10. 1. 10.__	10. 2. 10.__
…	…	…
10. 0.249.__	10. 1.249.__	10. 2.249.__
10. 0.250.__	10. 1.250.__	10. 2.250.__
10. 0.251.__	10. 1.251.__	10. 2.251.__
10. 0.252.__	10. 1.252.__	10. 2.252.__
10. 0.253.__	10. 1.253.__	10. 2.253.__
10. 0.254.__	10. 1.254.__	10. 2.254.__
10. 0.255.__	10. 1.255.__	10. 2.255.__

10.254. 0.__	10.255. 0.__
10.254. 1.__	10.255. 1.__
10.254. 2.__	10.255. 2.__
10.254. 3.__	10.255. 3.__
10.254. 4.__	10.255. 4.__
10.254. 5.__	10.255. 5.__
10.254. 6.__	10.255. 6.__
10.254. 7.__	10.255. 7.__
10.254. 8.__	10.255. 8.__
10.254. 9.__	10.255. 9.__
10.254. 10.__	10.255. 10.__
…	…
10.254.249.__	10.255.249.__
10.254.250.__	10.255.250.__
10.254.251.__	10.255.251.__
10.254.252.__	10.255.252.__
10.254.253.__	10.255.253.__
10.254.254.__	10.255.254.__
10.254.255.__	10.255.255.__

In This Lesson...

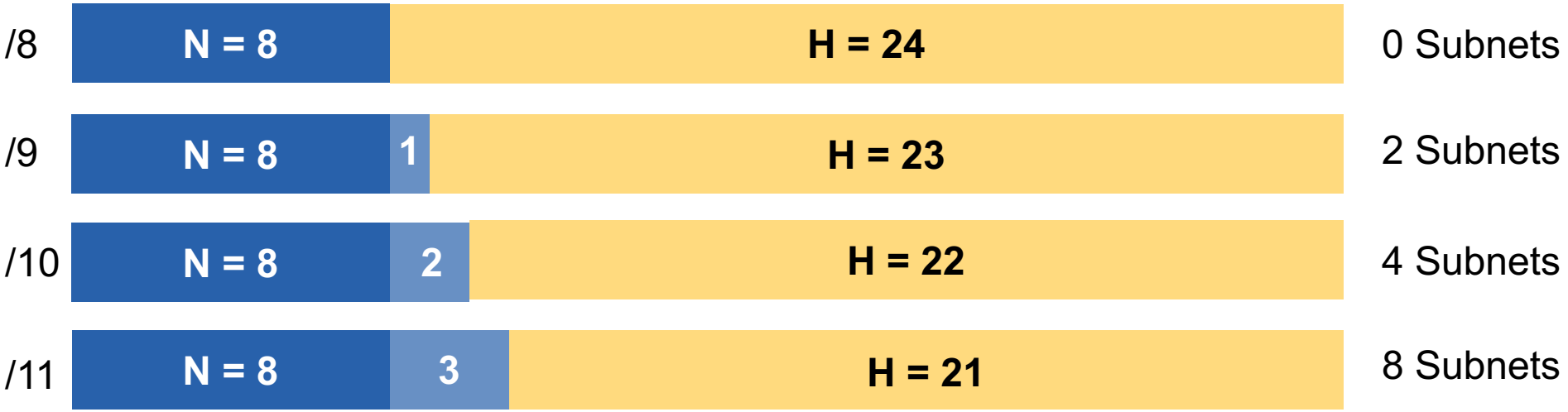
Subnetting a Classful Network

- Simple Subnet ID Patterns when Using One Simple Mask
- **Less Obvious Subnet ID Patterns when Using One Difficult Mask**
- Classful Addressing Analysis to Find the Number of Subnets
- Summary and Terms

Comparing Mask Choices for Class A

DDN Mask	Prefix Length	Network (N) Bits	Subnet (S) Bits	# Subnets	Host (H) Bits	# Hosts Per Subnet
255.0.0.0	/8	8	0	0	24	$2^{24} - 2$
255.128.0.0	/9	8	1	$2^1 = 2$	23	$2^{23} - 2$
255.192.0.0	/10	8	2	$2^2 = 4$	22	$2^{22} - 2$
255.224.0.0	/11	8	3	$2^3 = 8$	21	$2^{21} - 2$
255.240.0.0	/12	8	4	$2^4 = 16$	20	$2^{20} - 2$
255.248.0.0	/13	8	5	$2^5 = 32$	19	$2^{19} - 2$
255.252.0.0	/14	8	6	$2^6 = 64$	18	$2^{18} - 2$
255.254.0.0	/15	8	7	$2^7 = 128$	17	$2^{17} - 2$
255.255.0.0	/16	8	8	$2^8 = 256$	16	$2^{16} - 2$

The First Few Masks



Class A 10.0.0.0, Mask 255.0.0.0 (S=0)

Network ID	Address Range	Broadcast Address
10.0.0.0	10.0.0.1 - 10.255.255.254	10.255.255.255

Class A 10.0.0.0, Mask 255.128.0.0 (S=1)

Subnet IDs	Address Ranges	Broadcast
10. 0.0.0	10.0.0.1 - 10.127.255.254	10.127.255.255
10.128.0.0	10.128.0.1 - 10.255.255.254	10.255.255.255

Class A 10.0.0.0, Mask 255.192.0.0 (S=2)

Subnet IDs	Address Ranges	Broadcast
10. 0.0.0	10. 0.0.1 – 10. 63.255.254	10. 63.255.255
10. 64.0.0	10. 64.0.1 – 10.127.255.254	10.127.255.255
10.128.0.0	10.128.0.1 – 10.191.255.254	10.191.255.255
10.192.0.0	10.192.0.1 – 10.255.255.254	10.255.255.255

Class A 10.0.0.0, Mask 255.224.0.0 (S=3)

Subnet IDs	Address Ranges	Broadcast
10. 0.0.0	10. 0.0.1 - 10. 31.255.254	10. 31.255.255
10. 32.0.0	10. 32.0.1 - 10. 63.255.254	10. 63.255.255
10. 64.0.0	10. 64.0.1 - 10. 95.255.254	10. 95.255.255
10. 96.0.0	10. 96.0.0 - 10.127.255.254	10.127.255.255
10.128.0.0	10.128.0.1 - 10.159.255.254	10.159.255.255
10.160.0.0	10.160.0.1 - 10.191.255.254	10.191.255.255
10.192.0.0	10.192.0.1 - 10.223.255.254	10.223.255.255
10.224.0.0	10.224.0.1 - 10.255.255.254	10.255.255.255

Subnet ID Patterns When Using 1 Mask

/9 255.**128**.0.0 By 128's	/10 255.**192**.0.0 By 64's	/11 255.**224**.0.0 By 32's	/12 255.**240**.0.0 By 16's
10. **0**.0.0	10. **0**.0.0	10. **0**.0.0	10. **0**.0.0
		10. **32**.0.0	10. **16**.0.0
	10. **64**.0.0	10. **64**.0.0	10. **32**.0.0
		10. **96**.0.0	10. **48**.0.0
10.**128**.0.0	10.**128**.0.0	10.**128**.0.0	10. **64**.0.0
		10.**160**.0.0	10. **80**.0.0
	10.**192**.0.0	10.**192**.0.0	10. **96**.0.0
		10.**224**.0.0	10.**112**.0.0
			.
			.

Subnet ID Patterns

/13 255.**248**.0.0 By 8's	/14 255.**252**.0.0 By 4's	/15 255.**254**.0.0 By 2's	/16 255.**255**.0.0 By 1's
10. **0**.0.0	10. **0**.0.0	10. **0**.0.0	10. **0**.0.0
10. **8**.0.0	10. **4**.0.0	10. **2**.0.0	10. **1**.0.0
10. **16**.0.0	10. **8**.0.0	10. **4**.0.0	10. **2**.0.0
10. **24**.0.0	10. **12**.0.0	10. **6**.0.0	10. **3**.0.0
10. **32**.0.0	10. **16**.0.0	10. **8**.0.0	10. **4**.0.0
10. **40**.0.0	10. **20**.0.0	10. **10**.0.0	10. **5**.0.0
10. **48**.0.0	10. **24**.0.0	10. **12**.0.0	10. **6**.0.0
10. **56**.0.0	10. **28**.0.0	10. **14**.0.0	10. **7**.0.0
.	.	.	.
.	.	.	.

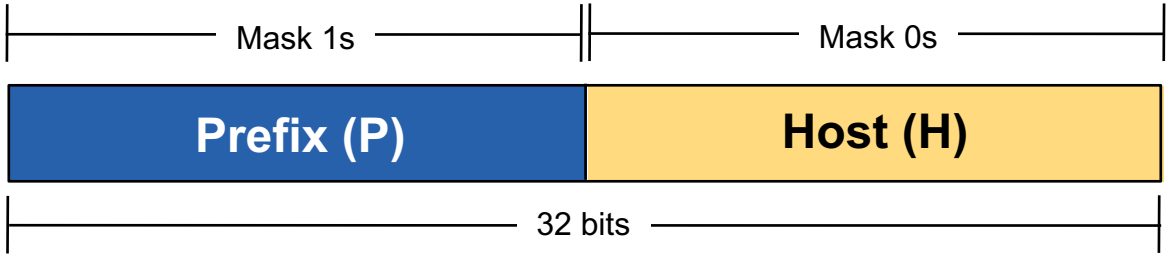
In This Lesson...

Subnetting a Classful Network

- Simple Subnet ID Patterns when Using One Simple Mask
- Less Obvious Subnet ID Patterns when Using One Difficult Mask
- **Classful Addressing Analysis to Find the Number of Subnets**
- Summary and Terms

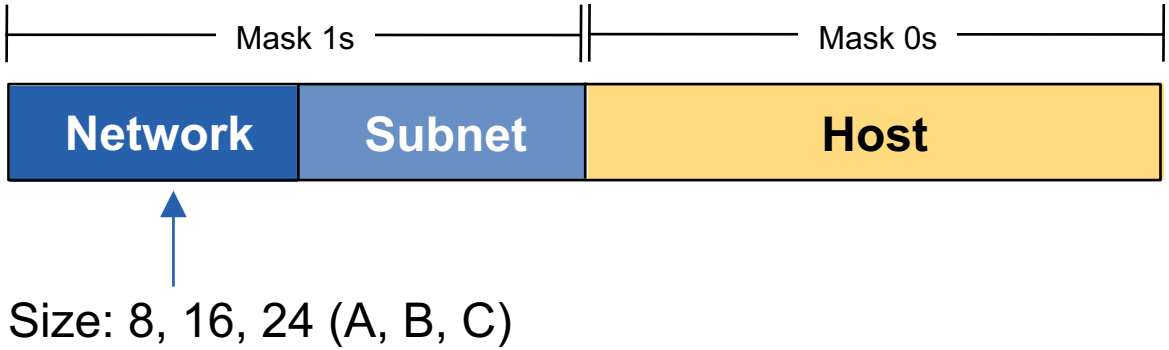
Basic Math: Classless Addressing

P + H = 32



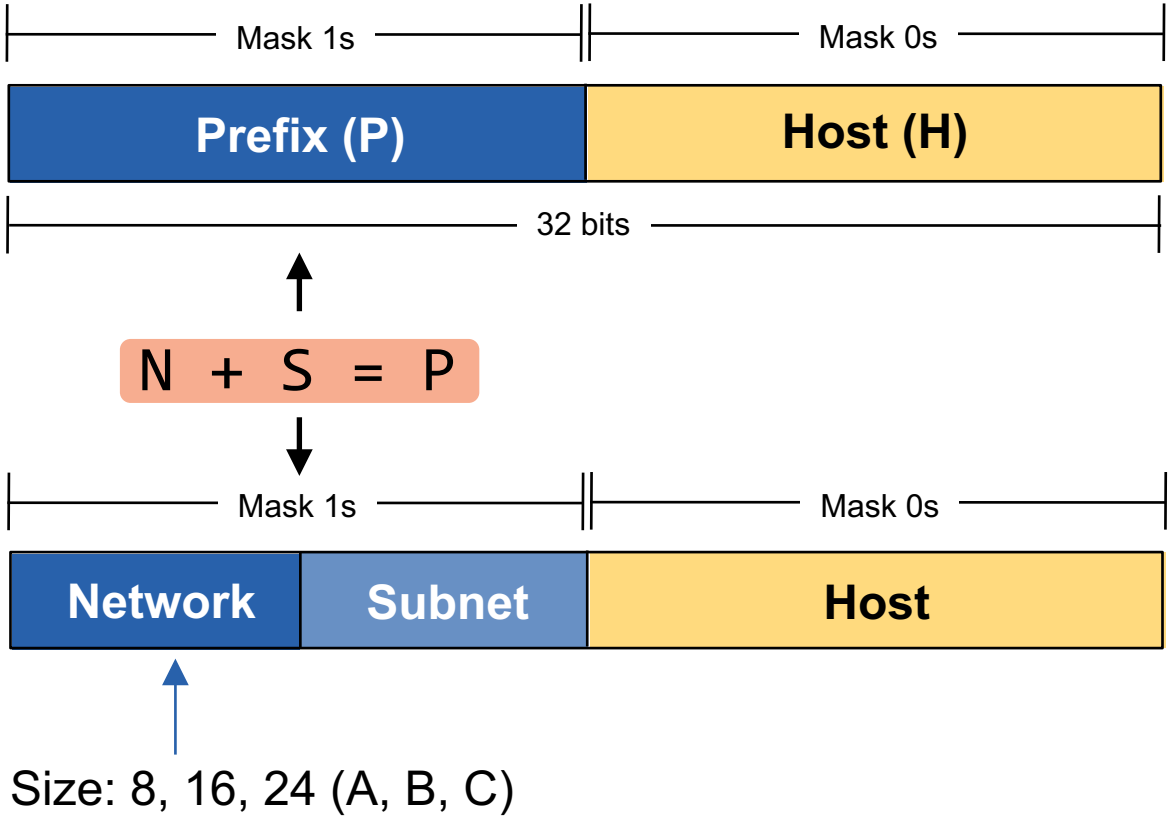
Basic Math: Classful Addressing

N + S + H = 32



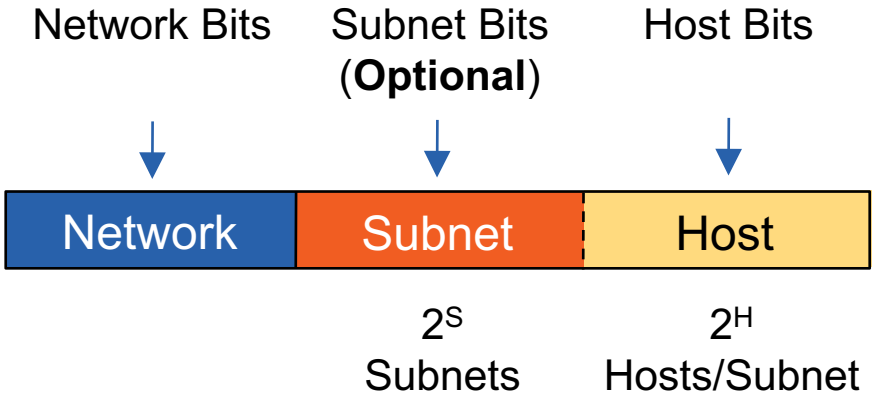
Basic Math: Classless and Classful

P + H = 32



N + S + H = 32

Classful Structure of a Network



Classful Rules to Analyze Any Mask

Rules:

1. # Network Bits (N) Always Exist at Beginning, with # Based on Class:
   - Class A: 8
   - Class B: 16
   - Class C: 24
2. # Host Bits (H) Always Exist at the End, with # Based on # of Binary 0s
3. # Subnet Bits (S) May or May Not Exist!
   - S has a Value so that N + S + H = 32 (the # Bits in a Mask)
   - If S = 0, the Mask is the Default Mask for the Class
   - If S > 0, the Mask is Not the Default Mask

In This Lesson...

Subnetting a Classful Network

- Simple Subnet ID Patterns when Using One Simple Mask
- Less Obvious Subnet ID Patterns when Using One Difficult Mask
- Classful Addressing Analysis to Find the Number of Subnets
- **Summary and Terms**

Summary

Subnet (Noun)

1. If Using 1 Mask to Subnet 1 Network:
   A. # of Subnets is Predictable 2^S
   B. Subnet IDs are Predictable
   C. A Predictable Size: 2^H (H is Based on the Subnet Mask)
2. Concepts Only Valid when Not Using VLSM
   A. VLSM: Variable Length Subnet Masks
   B. VLSM: Means **>1 Mask** in 1 Network
3. Classful Addressing:
   A. A Way to Think About Addresses
   B. Reveals 3-Part Structure, Allowing 2^S Calculation

Terms from this Topic

Masks:
Subnet
Default Mask
Network Bits
Subnet Bits
Host Bits

Ideas:
Classless Addressing
Classful Addressing
Variable Length Subnet Masks (VLSM)

IPv4 Subnetting – Sections

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IPv4 Subnetting – Section 4

Noticing Patterns in Subnet IDs

Finding All Subnets: Network and Host Octets

* Finding All Subnets: 1 Subnet Octet

* Finding All Subnets: >1 Subnet Octet

In This Lesson...

Finding All Subnets: Network and Host Octets

- **The Big Ideas: Finding All Subnets**
- Class B Examples
- Formal Rules
- Class A Examples
- Class C Examples
- Summary and Terms

Facts about Subnets of a Network

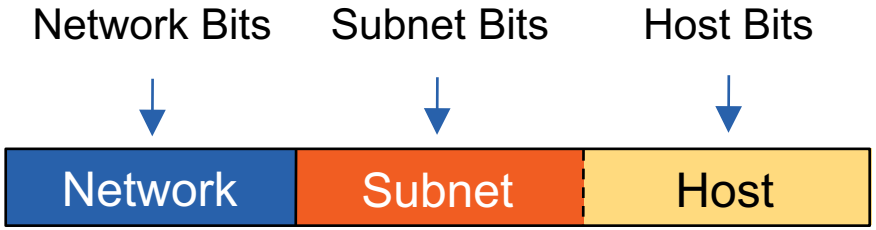
The Context:

List All Subnet IDs…
Of One Classful Network…
One Mask by All

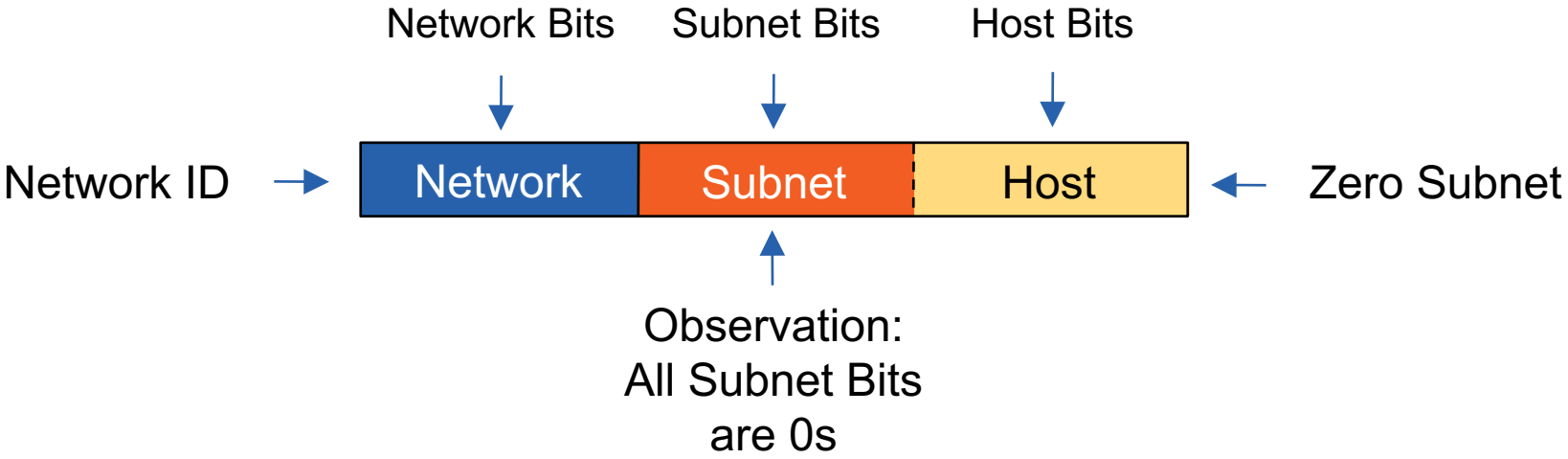
The Binary Facts about All Subnet IDs of Any Network:

Network Bits:	Equal to Network ID
Host Bits	Equal to Network ID (Also 0's)
Subnet Bits:	Different for Each Subnet ID

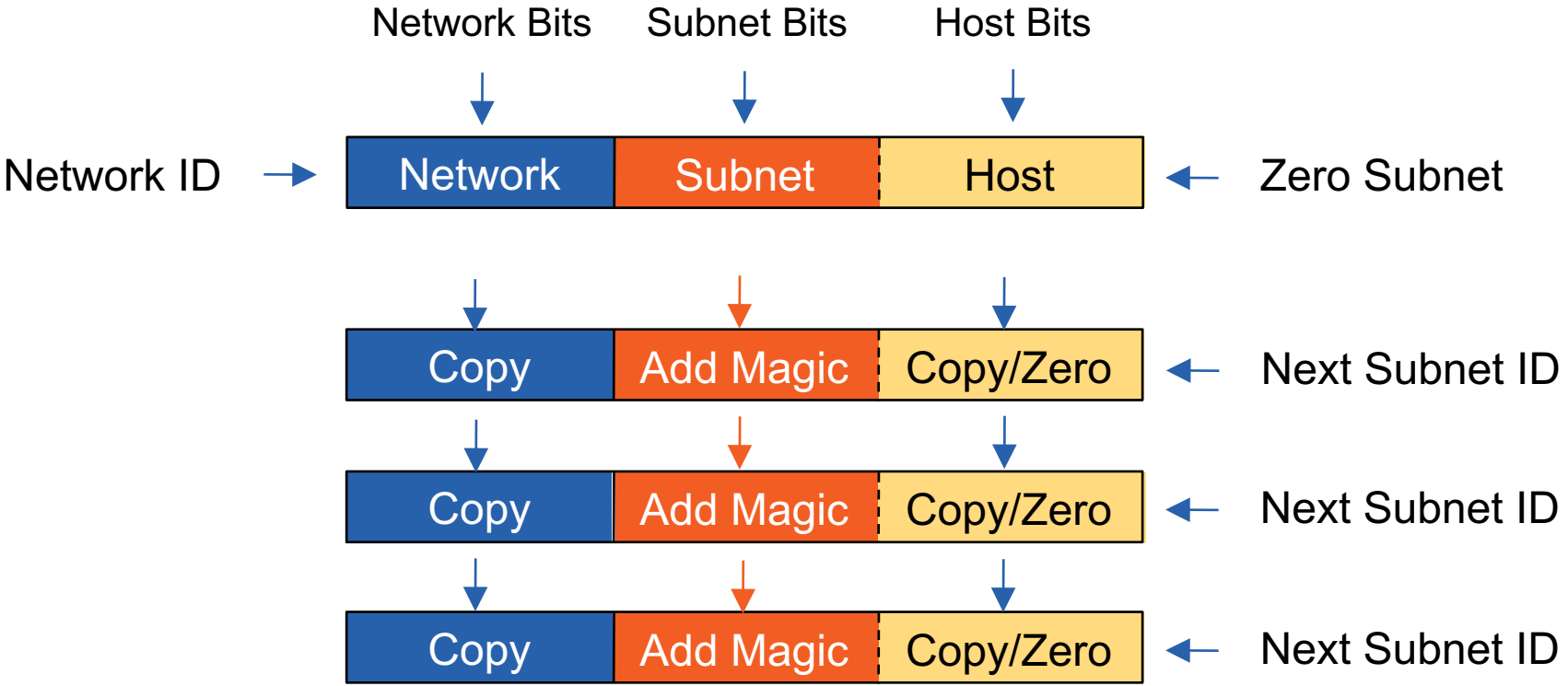
Classful Structure of a Network, One Mask



The Zero Subnet



Predicting All Subnet IDs



In This Lesson...

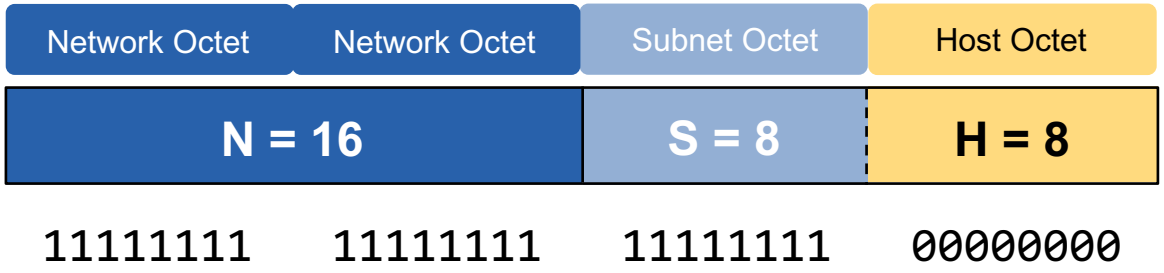
Finding All Subnets: Network and Host Octets

- The Big Ideas: Finding All Subnets
- **Class B Examples**
- Formal Rules
- Class A Examples
- Class C Examples
- Summary and Terms

Example 1: Class B with /24

Example:

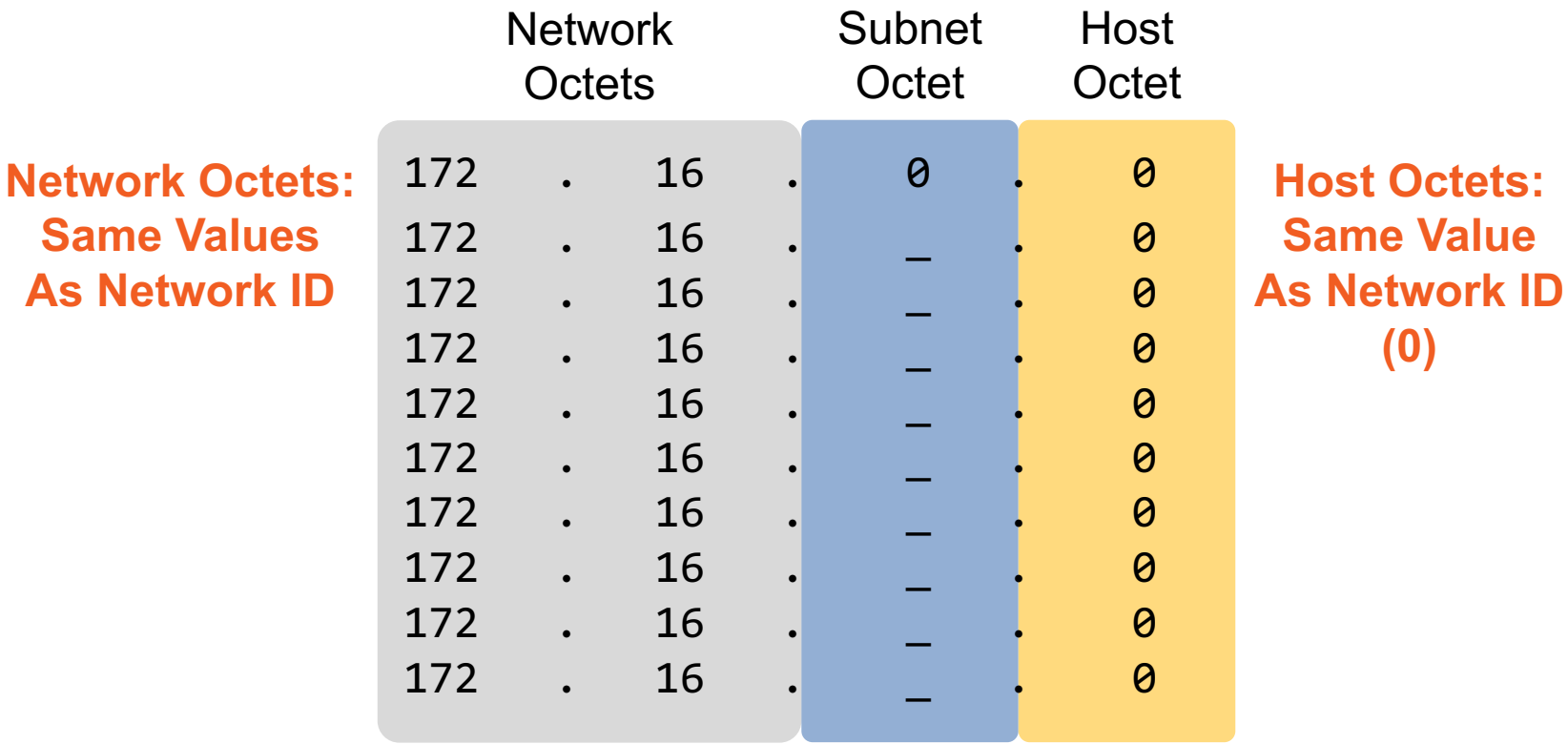
172.16.0.0
255.255.255.0



Rules:

1. N: Subnetting Class B Network 172.16.0.0, so N = 16.
2. H: Binary Mask Ends with 8 Binary 0s, so H = 8.
3. S: Number so that N + S + H = 32, so S = 8.

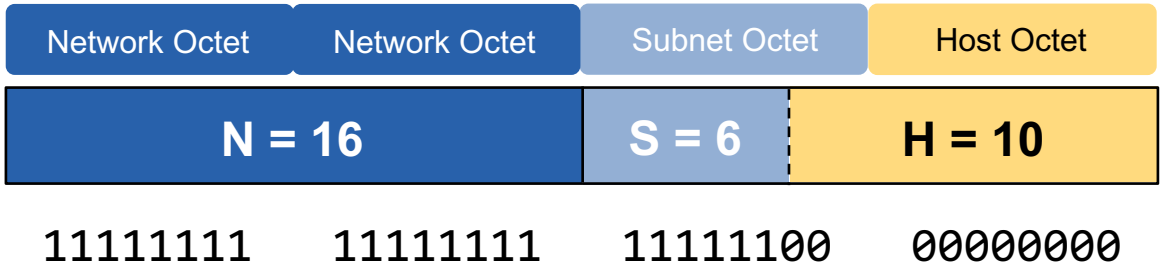
Example 1: List of Subnet IDs (Incomplete)



Example 2: Class B with /22

Example:

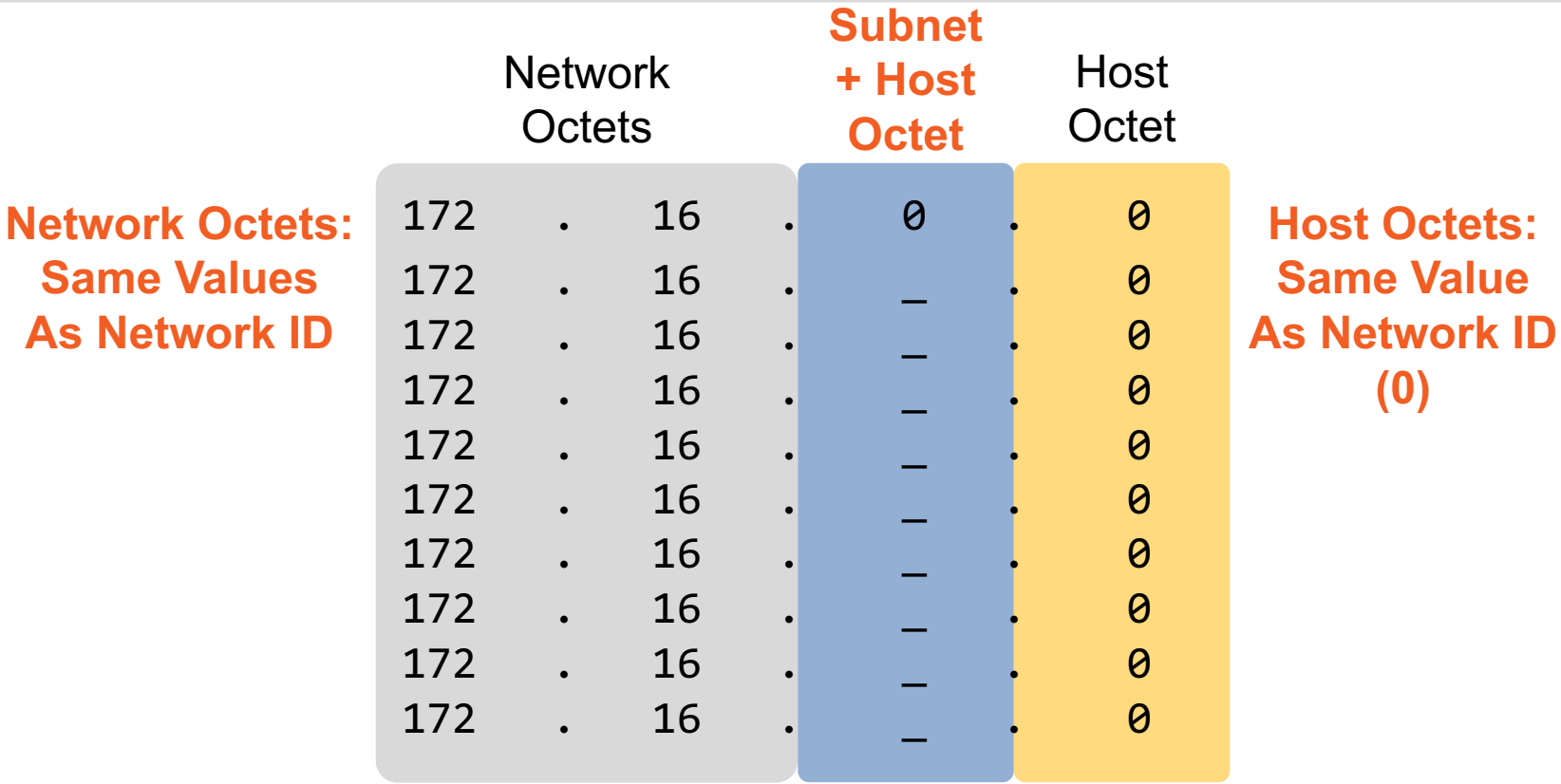
172.16.0.0
255.255.252.0



Rules:

1. N: Subnetting Class B Network 172.16.0.0, so N = 16.
2. H: Binary Mask Ends with 10 Binary 0s, so H = 10.
3. S: Number so that N + S + H = 32, so S = 6.

Example 2: List of Subnet IDs (Incomplete)



In This Lesson...

Finding All Subnets: Network and Host Octets

- The Big Ideas: Finding All Subnets
- Class B Examples
- **Formal Rules**
- Class A Examples
- Class C Examples
- Summary and Terms

Text Rules: Finding All Subnets (Partial)

1. **Set Up the Problem:**
   - Write the Mask First, Followed by Network ID
   - Leave Space for More Subnet ID's Below
2. **Identify and Process Network (Only) Octets**
   - Apply Class A, B, or C, Rules to Determine 1, 2, or 3 Network Octets
   - Copy Network ID to ALL Subnet IDs for All Network Octets
3. **Identify and Process Host (Only) Octets**
   - Octets with DDN Mask Octet = 0 are Host Only Octets
   - Copy Network ID to Subnet IDs for All Host Octets
   - (Also... Host Octet Values of Subnet IDs Will be 0)
4. **Process Octets w/ at Least Some Subnet Bits**
   - Details to be Determined

Visual Rules: Network and Host Only Octets

Network (Only) Octet(s)	Subnet (Only) Octets	Subnet + Host Octet	Host (Only) Octet(s)
			
Copy Network ID	**TBD**	**TBD**	**Copy Network ID (Always 0)**

In This Lesson...

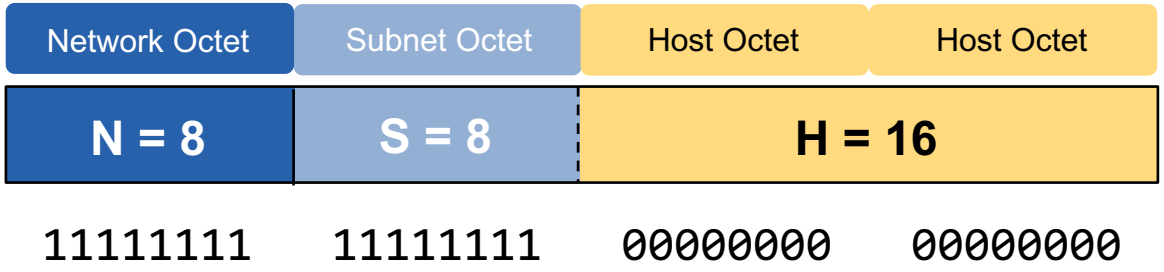
Finding All Subnets: Network and Host Octets

- The Big Ideas: Finding All Subnets
- Class B Examples
- Formal Rules
- **Class A Examples**
- Class C Examples
- Summary and Terms

Example 3: Class A with /16

Example:

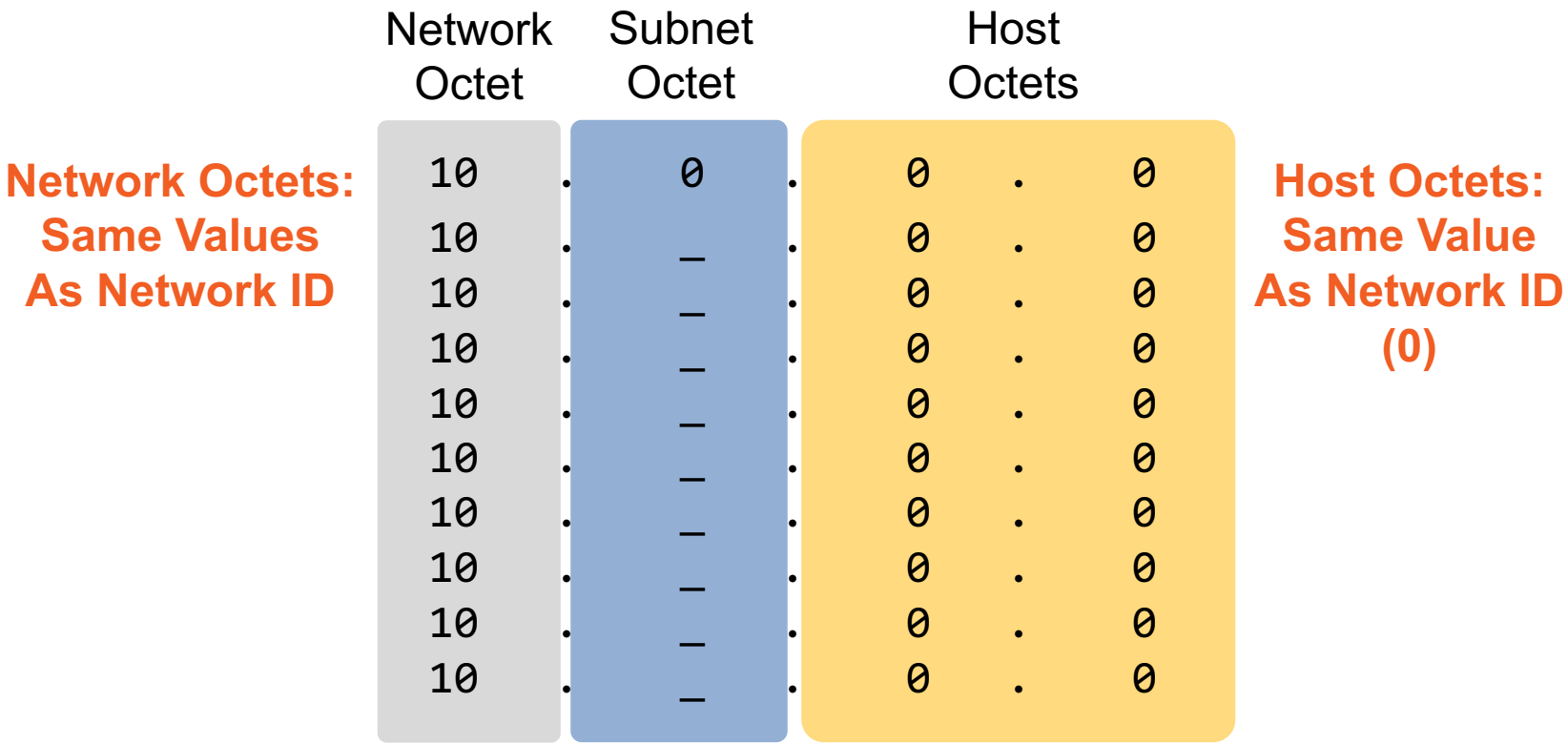
```
10.0.0.0
255.255.0.0
```



Rules:

1. N: Subnetting Class A Network 10.0.0.0, so N = 8.
2. H: Binary Mask Ends with 16 Binary 0s, so H = 16.
3. S: Number so that N + S + H = 32, so S = 8.

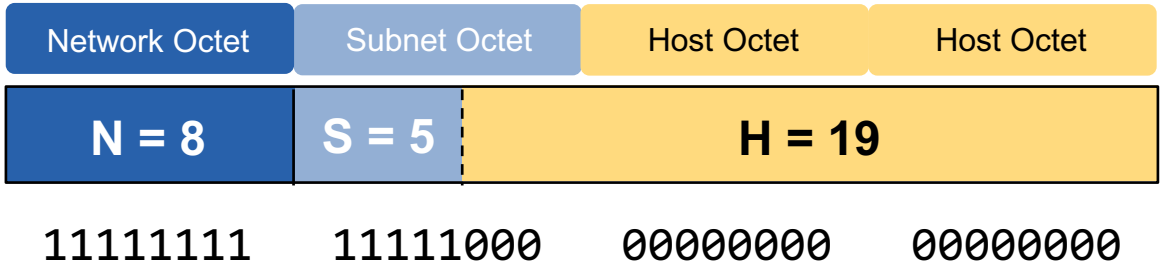
Example 3: List of Subnet IDs (Incomplete)



Example 4: Class A with /13

Example:

```
10.0.0.0
255.248.0.0
```

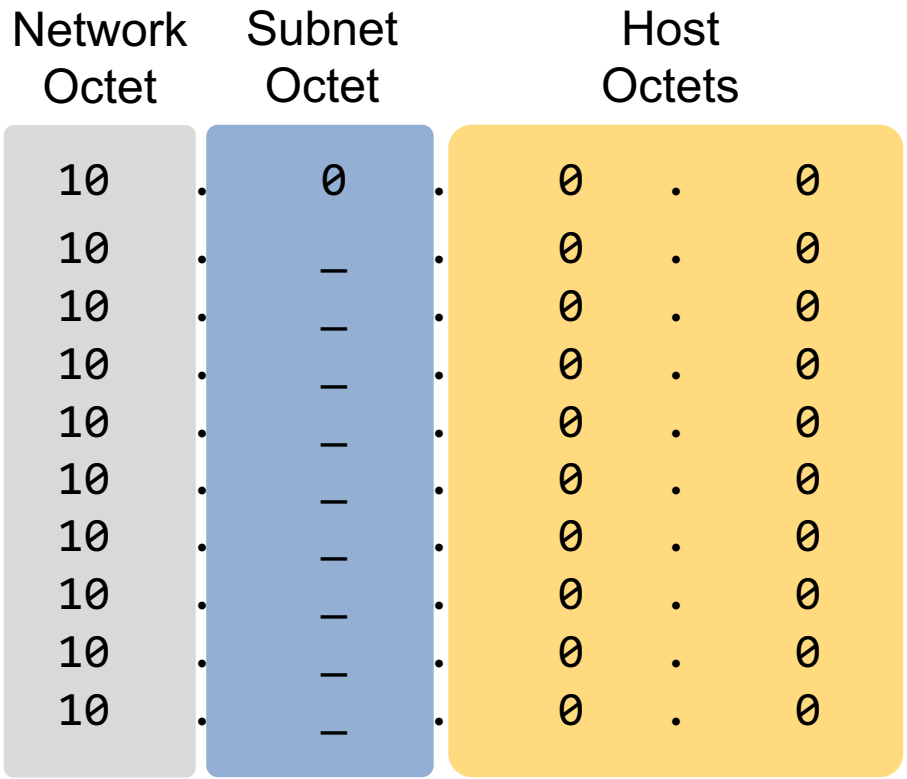


Rules:

1. N: Subnetting Class A Network 10.0.0.0, so N = 8.
2. H: Binary Mask Ends with 19 Binary 0s, so H = 19.
3. S: Number so that N + S + H = 32, so S =5.

Example 4: List of Subnet IDs (Incomplete)

Network Octets: Same Values As Network ID



Host Octets: Same Value As Network ID (0)

In This Lesson...

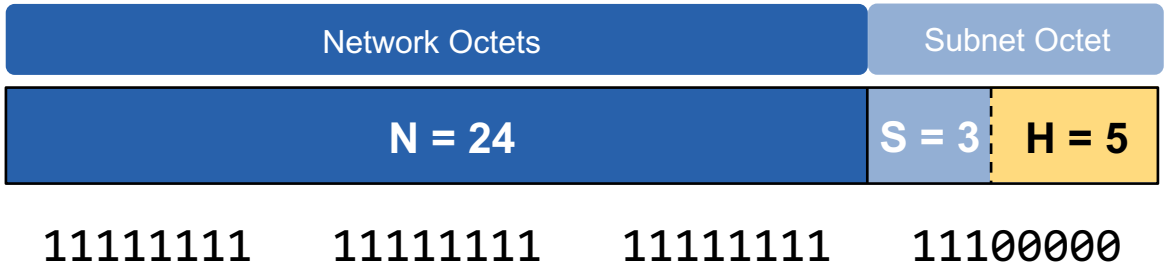
Finding All Subnets: Network and Host Octets

- The Big Ideas: Finding All Subnets
- Class B Examples
- Formal Rules
- Class A Examples
- **Class C Examples**
- Summary and Terms

Example 5: Class C with /27

Example:

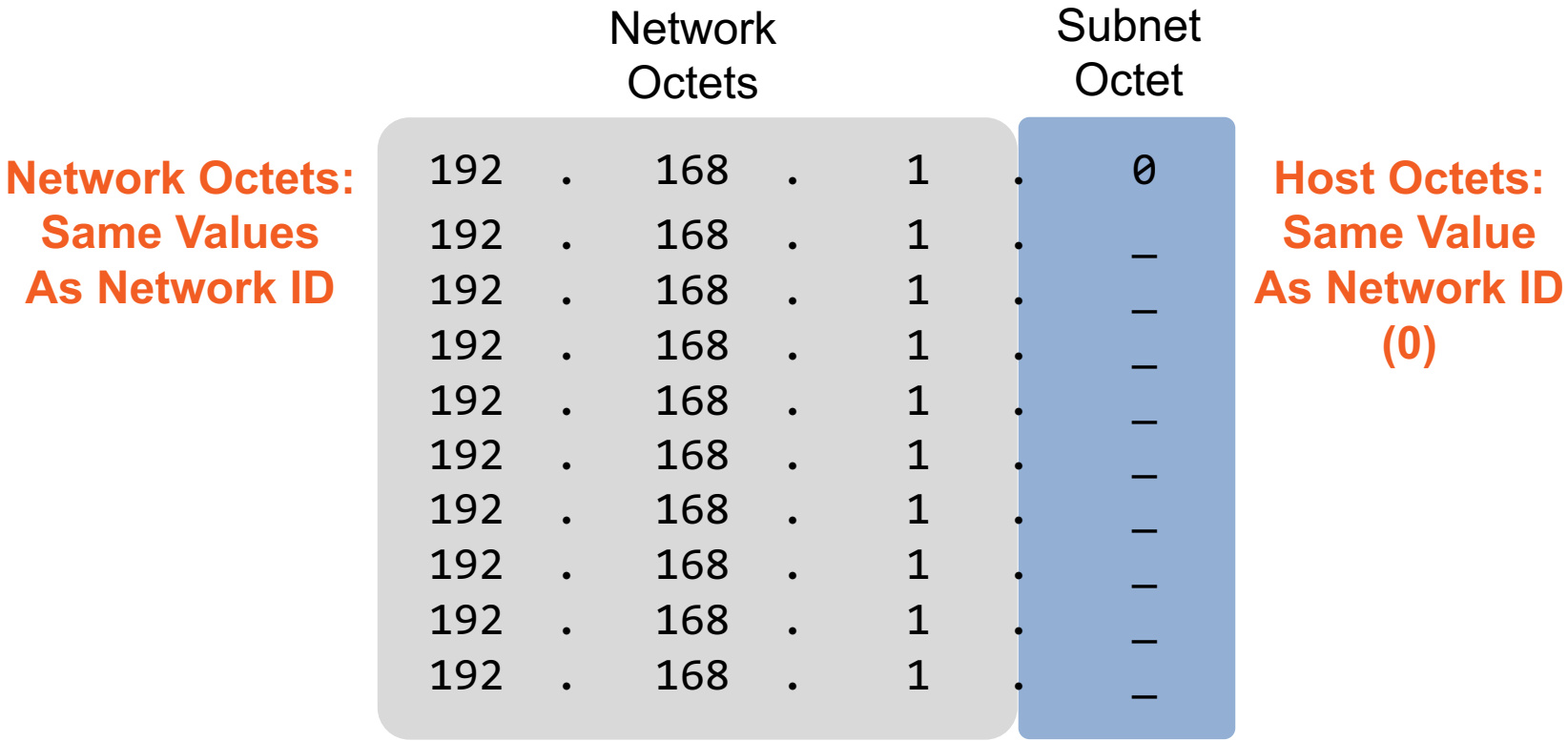
192.168.1.0
255.255.255.224



Rules:

1. N: Subnetting Class C Network 10.0.0.0, so N = 24.
2. H: Binary Mask Ends with 5 Binary 0s, so H = 5.
3. S: Number so that N + S + H = 32, so S = 3.

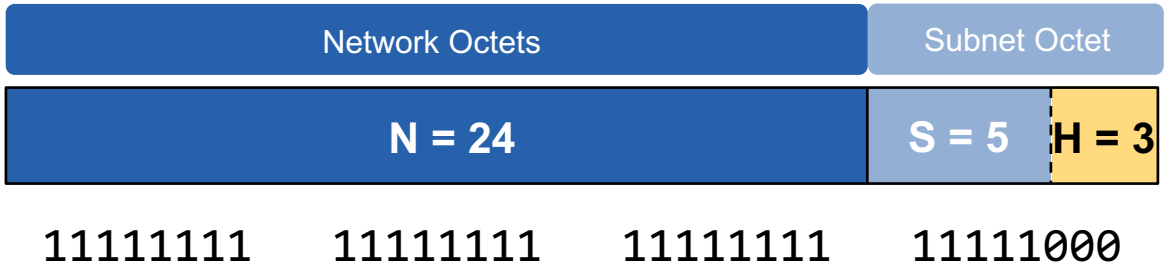
Example 5: List of Subnet IDs (Incomplete)



Example 6: Class C with /29

Example:

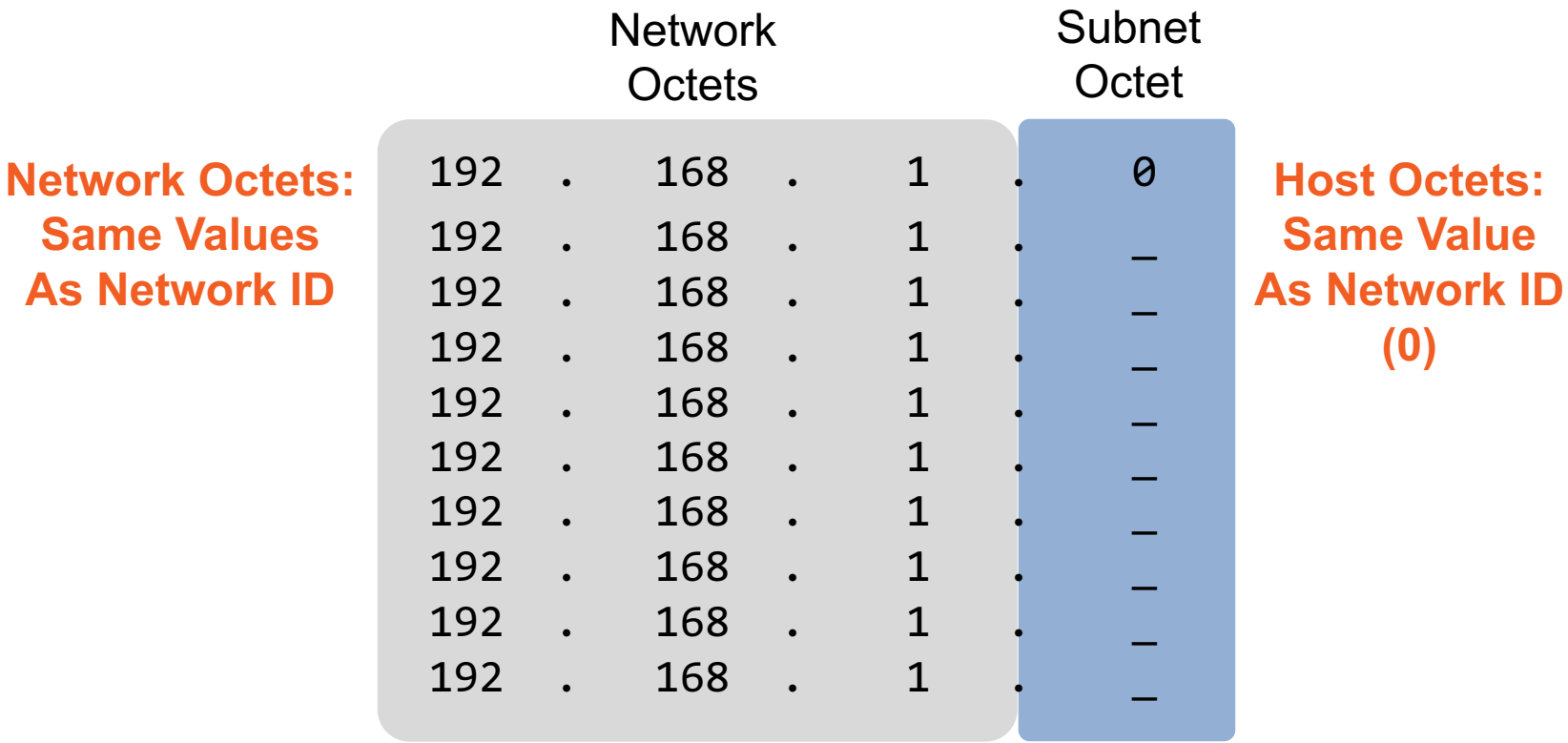
192.168.1.0
255.255.255.248



Rules:

1. N: Subnetting Class C Network 10.0.0.0, so N = 24.
2. H: Binary Mask Ends with 3 Binary 0s, so H = 3.
3. S: Number so that N + S + H = 32, so S = 5.

Example 6: List of Subnet IDs (Incomplete)



In This Lesson...

Finding All Subnets: Network and Host Octets

- The Big Ideas: Finding All Subnets
- Class B Examples
- Formal Rules
- Class A Examples
- Class C Examples
- **Summary and Terms**

Terms from this Topic

Classful Addressing:
Classful Network
Network Bits/Part
Subnet Bits/Part
Host Bits/Part

Special Subnets:
Subnet ID
Zero Subnet
Subnet Zero (Synonym)

Broadcast Subnet

Terms Used in this Course:
Subnet Octet
All Subnet Octet
Partial Subnet Octet

Rules so Far

Network (Only) Octet(s)	Subnet (Only) Octets	Subnet + Host Octet	Host (Only) Octet(s)
			
Copy Network ID	**TBD**	**TBD**	**Copy Network ID (Always 0)**

IPv4 Subnetting – Sections

Section 1: Analyzing Individual Subnets

Section 2: Converting Subnet Masks

Section 3: Analyzing IP Networks

Section 4: Identifying the Subnets of a Network

Section 5: Analyzing Designs Using Masks

Section 6: Subnetting and the Exam

IPv4 Subnetting – Section 4

Noticing Patterns in Subnet IDs

Finding All Subnets: Network and Host Octets

*** Finding All Subnets: 1 Subnet Octet**

* Finding All Subnets: >1 Subnet Octet

In This Lesson...

Finding All Subnets: 1 Subnet Octet

- **Process: Class B with 8 Subnet Bits**
- Process: Class B with <8 Subnet Bits
- Process: Class A with 8 Subnet Bits
- Process: Class A with <8 Subnet Bits
- Process: Class C with <8 Subnet Bits
- Learning Stages and Practice

Can You Do These Exercises Already?

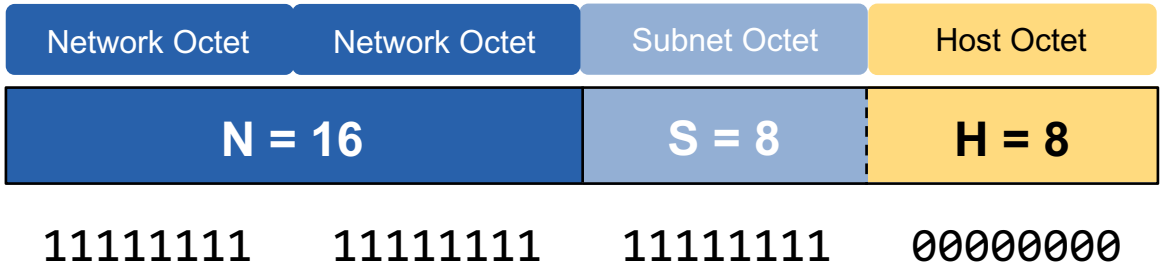
- **List All Subnet IDs** for These Networks
- One Mask Used for All Subnets

1. 172.16.0.0, 255.255.255.0
2. 172.30.0.0, 255.255.255.0
3. 10.0.0.0, 255.255.0.0

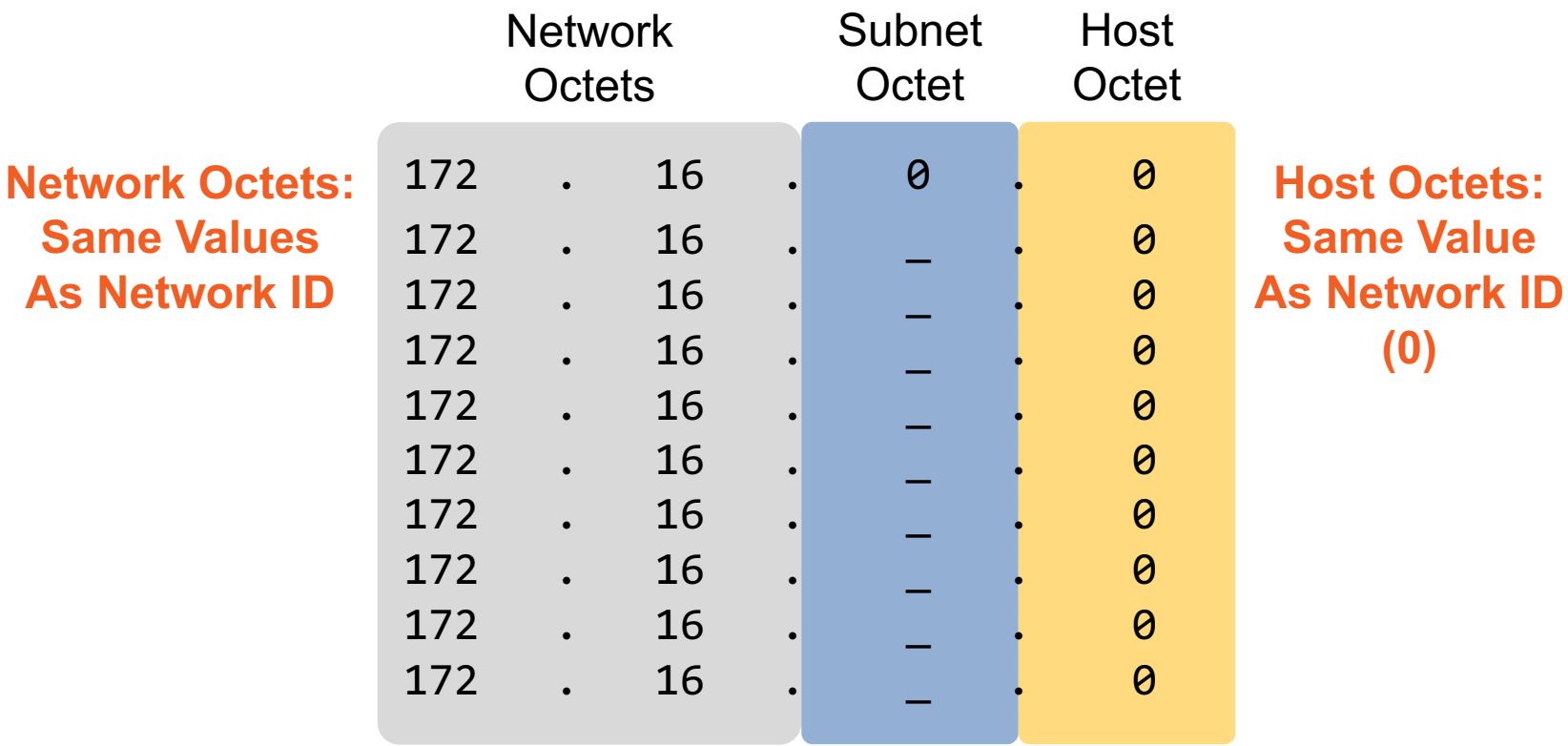
Example 1: Class B with /24

Example:

172.16.0.0
255.255.255.0



Example 1: List of Subnet IDs (3 Octets)



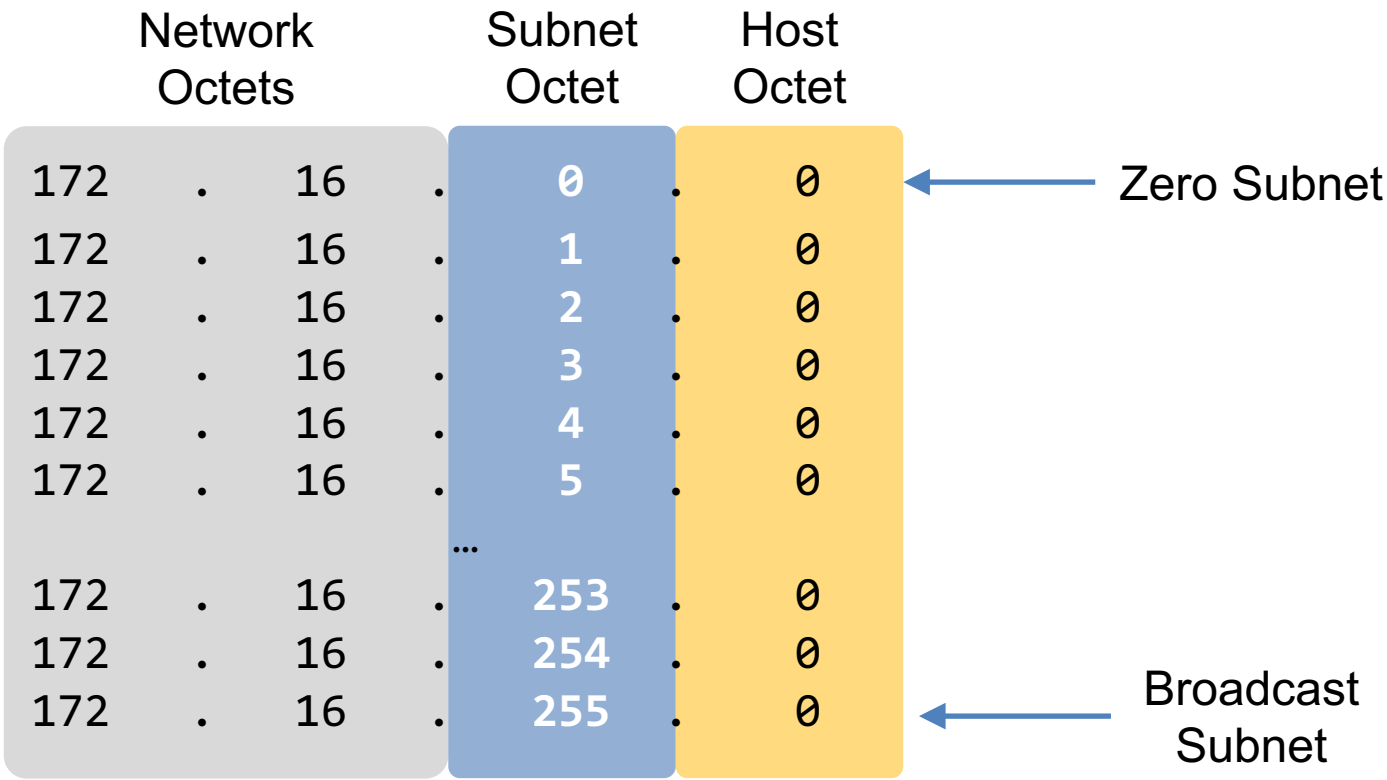
Finding the Values in the Subnet Octet

Example:

172.16.0.0
255.255.255.0

Subnet Octet:
Count by Magic #
Start at 0
All < 256

Magic:
256
-255
1



Pattern of Subnets of 172.16.0.0 /24

172.16. 0.__
172.16. 1.__
172.16. 2.__
172.16. 3.__
172.16. 4.__
172.16. 5.__
172.16. 6.__
172.16. 7.__
172.16. 8.__
172.16. 9.__
172.16. 10.__
172.16. 11.__
172.16. 12.__
172.16. 13.__
172.16. 14.__
172.16. 15.__
172.16. 16.__
172.16. 17.__
172.16. 18.__
172.16. 19.__
172.16. 20.__

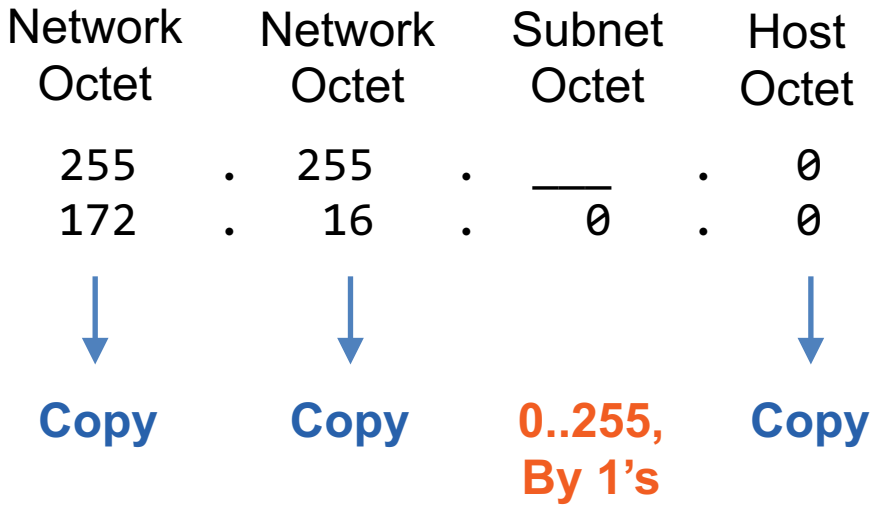
172.16. 21.__
172.16. 22.__
172.16. 23.__
172.16. 24.__
172.16. 25.__
172.16. 26.__
172.16. 27.__
172.16. 28.__
172.16. 29.__
172.16. 30.__
172.16. 31.__
172.16. 32.__
172.16. 33.__
172.16. 34.__
172.16. 35.__
172.16. 36.__
172.16. 37.__
172.16. 38.__
172.16. 39.__
172.16. 40.__

172.16.237.__
172.16.238.__
172.16.239.__
172.16.240.__
172.16.241.__
172.16.242.__
172.16.243.__
172.16.244.__
172.16.245.__
172.16.246.__
172.16.247.__
172.16.248.__
172.16.249.__
172.16.250.__
172.16.251.__
172.16.252.__
172.16.253.__
172.16.254.__
172.16.255.__

Text Rules: Finding Values in Subnet Octet

1. **In Any "Subnet Octet" (an Octet That Contains Subnet Bits):**
   A. Start with 0 (Zero Subnet)
   B. Calculate Magic Number for that Octet
   C. Add Magic Number to Previous Subnet ID to Find Next Subnet ID
   D. Only Numbers <256

Visual Rules: Subnetting Class B with /24



In This Lesson...

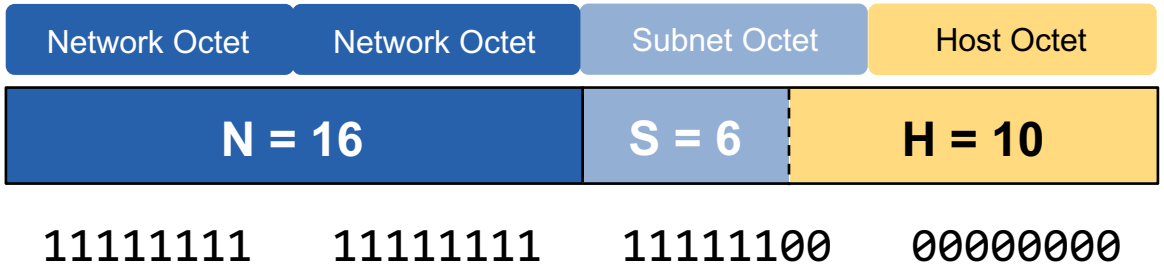
Finding All Subnets: 1 Subnet Octet

- Process: Class B with 8 Subnet Bits
- **Process: Class B with <8 Subnet Bits**
- Process: Class A with 8 Subnet Bits
- Process: Class A with <8 Subnet Bits
- Process: Class C with <8 Subnet Bits
- Learning Stages and Practice

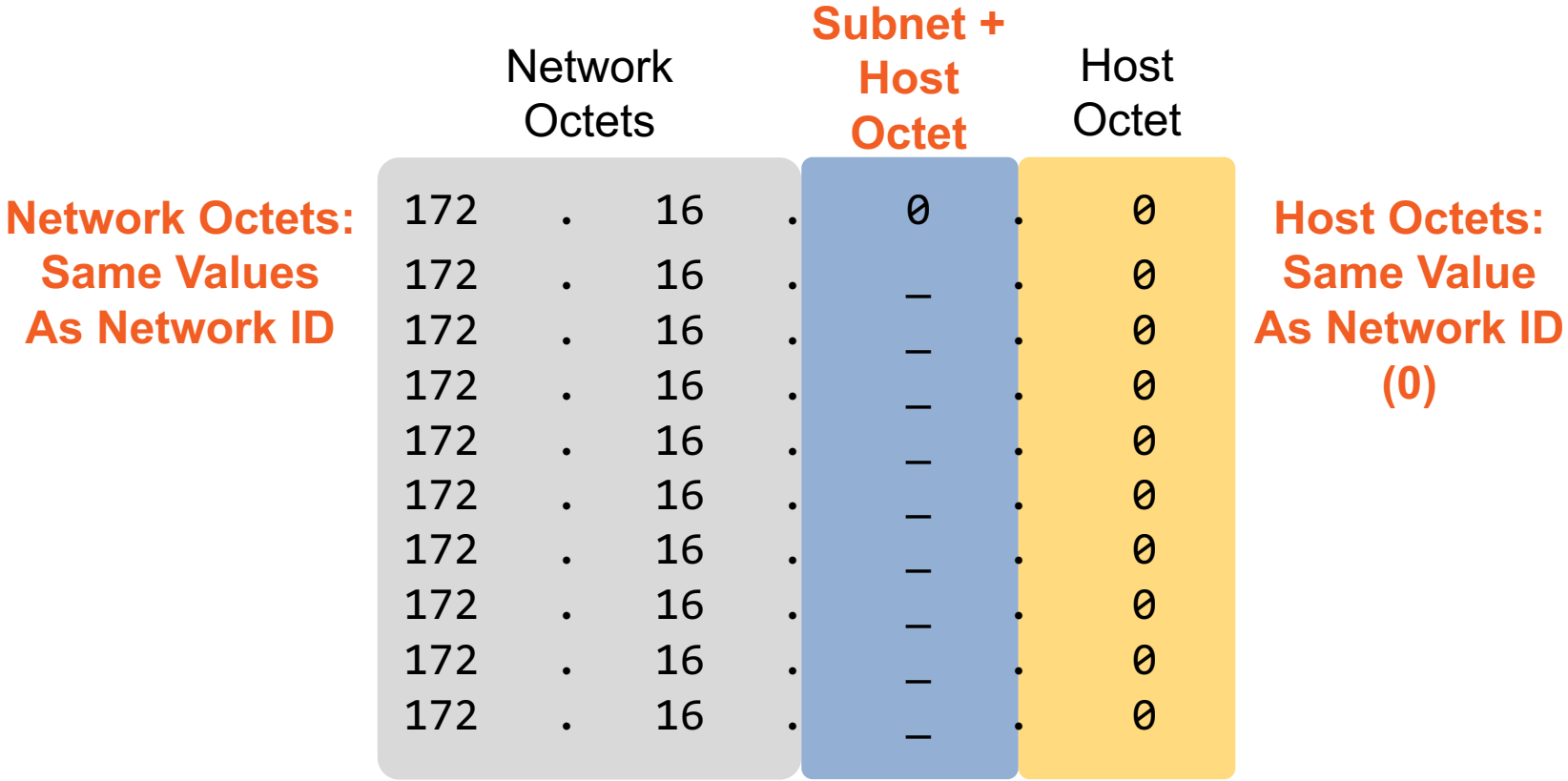
Example 2: Class B with /22

Example:

172.16.0.0
255.255.252.0



Example 2: List of Subnet IDs (3 Octets)



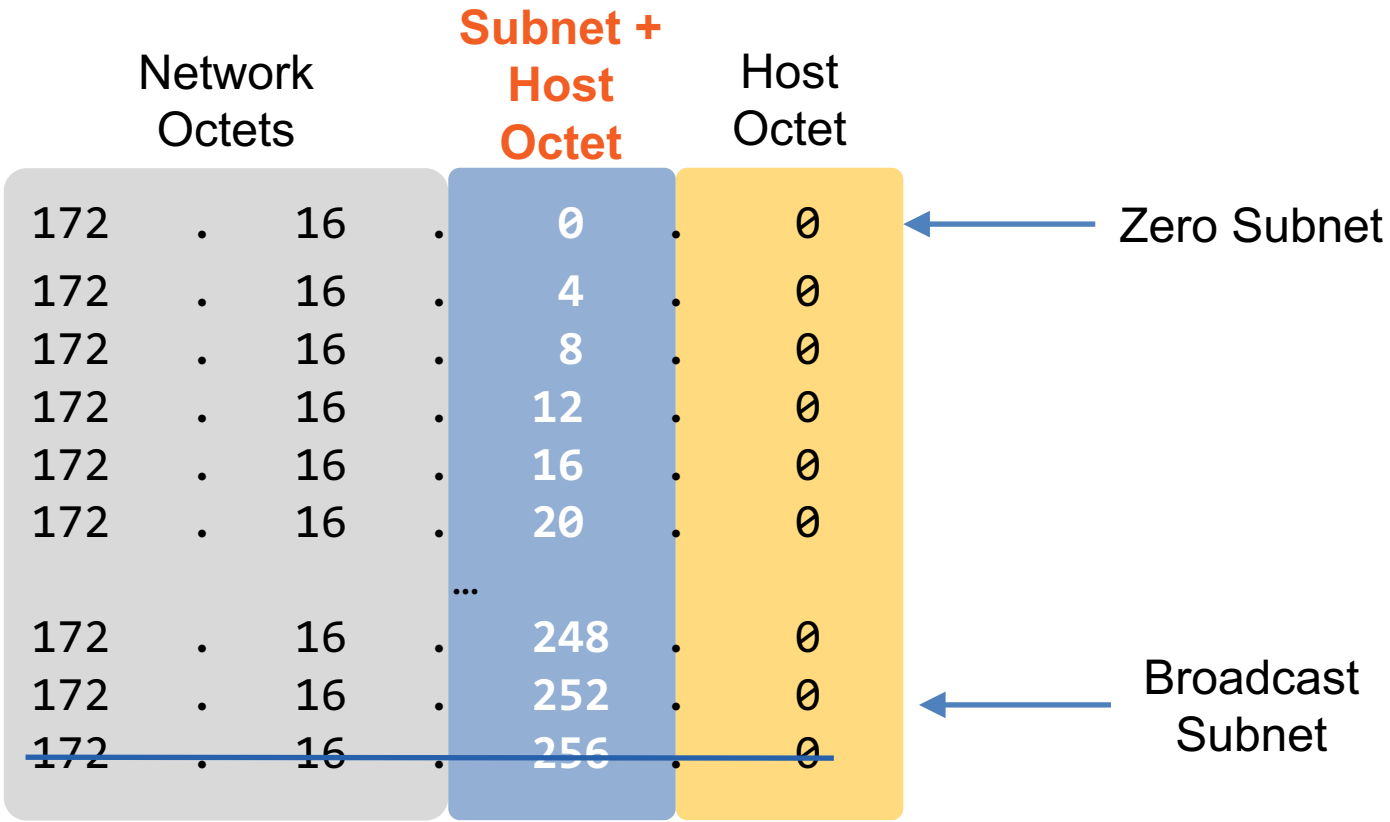
Finding the Values in the Subnet Octet

Example:

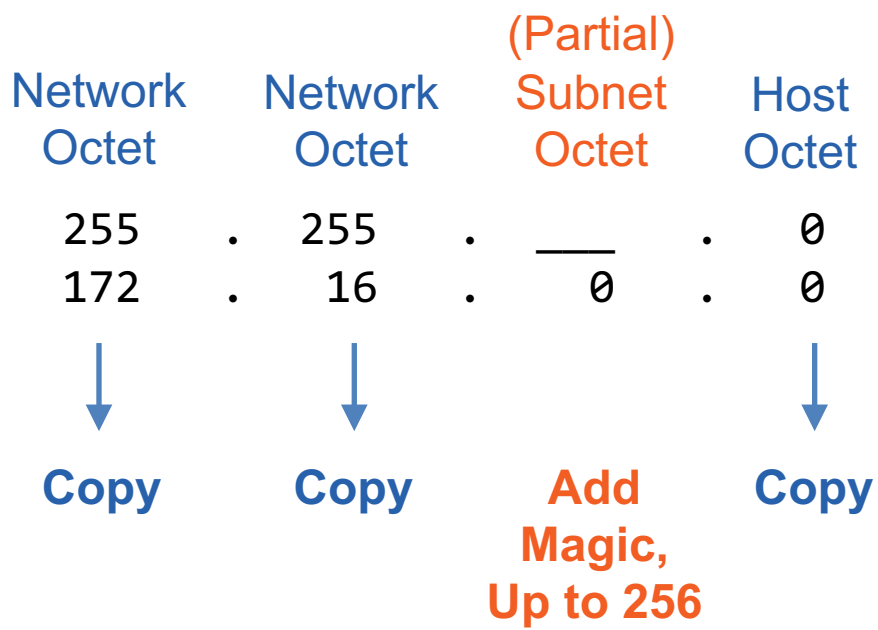
172.16.0.0
255.255.252.0

Subnet Octet:
Count by Magic #
Start at 0
All < 256

Magic:
256
-252
4



Visual Review of Subnetting Class B, /17 - /24



Magic Numbers and Multiples

DDN Mask	Magic #, 3rd Octet	First Few Multiples Within 0 - 255
255.255.128.0	256 – 128 = 128	0, 128
255.255.192.0	256 – 192 = 64	0, 64, 128, 192
255.255.224.0	256 – 224 = 32	0, 32, 64, 96, 128, 160, 192, 224
255.255.240.0	256 – 240 = 16	0, 16, 32, 48, 64, 80, 96, 112, 128, 144... 240
255.255.248.0	256 – 248 = 8	0, 8, 16, 24, 32, 40, 48, 56, 64, 72, 80, 88... 248
255.255.252.0	256 – 252 = 4	0, 4, 8, 12, 16, 20, 24, 28... 252
255.255.254.0	256 – 254 = 2	0, 2, 4... 254 (all even numbers)

In This Lesson...

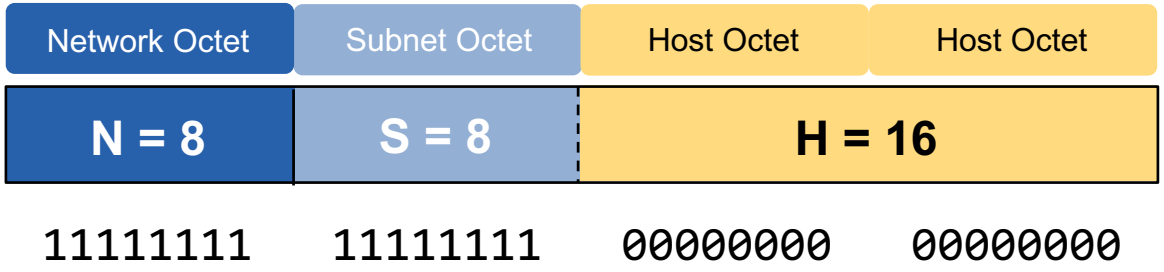
Finding All Subnets: 1 Subnet Octet

- Process: Class B with 8 Subnet Bits
- Process: Class B with <8 Subnet Bits
- **Process: Class A with 8 Subnet Bits**
- Process: Class A with <8 Subnet Bits
- Process: Class C with <8 Subnet Bits
- Learning Stages and Practice

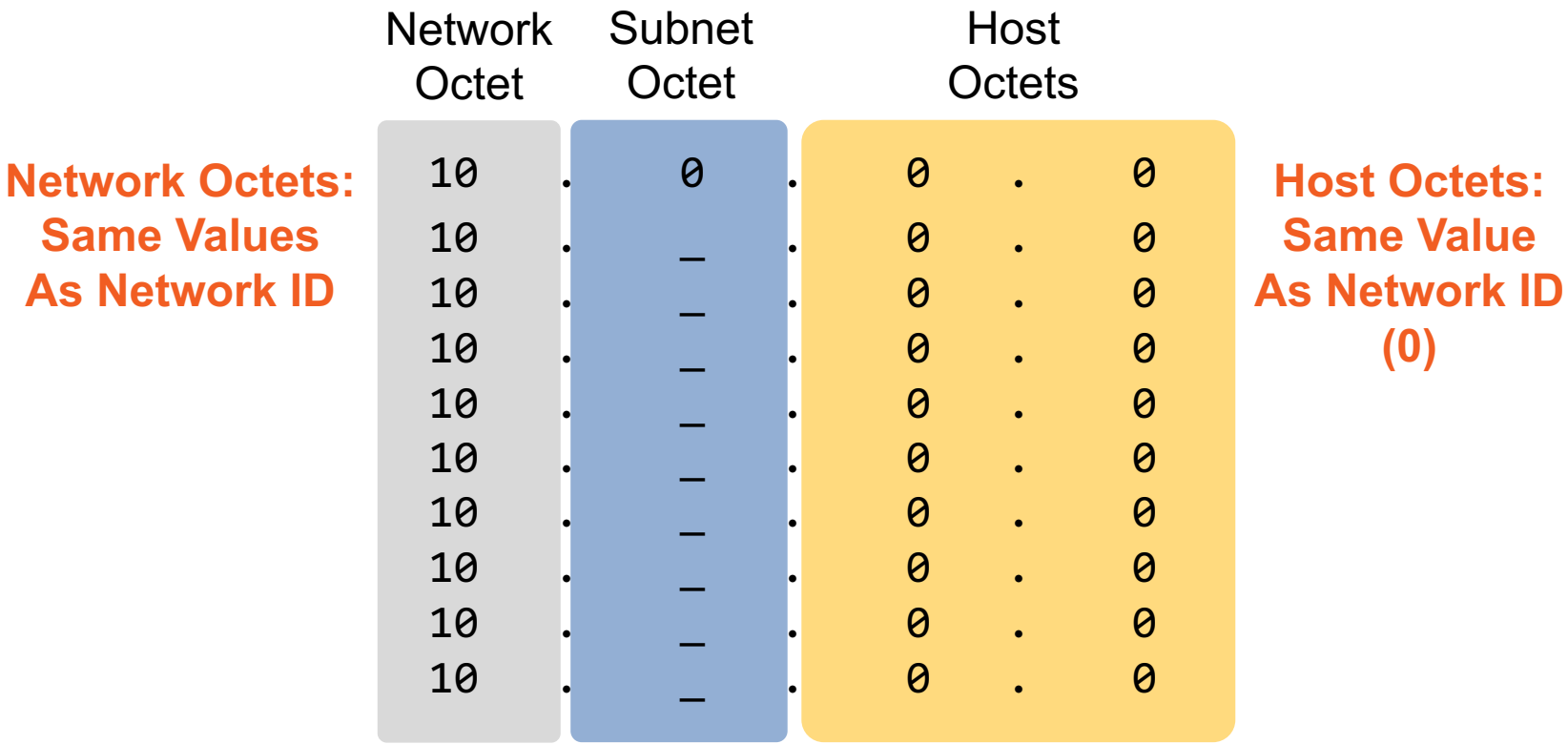
Example 3: Class A with /16

Example:

10.0.0.0
255.255.0.0



Example 3: List of Subnet IDs (Incomplete)



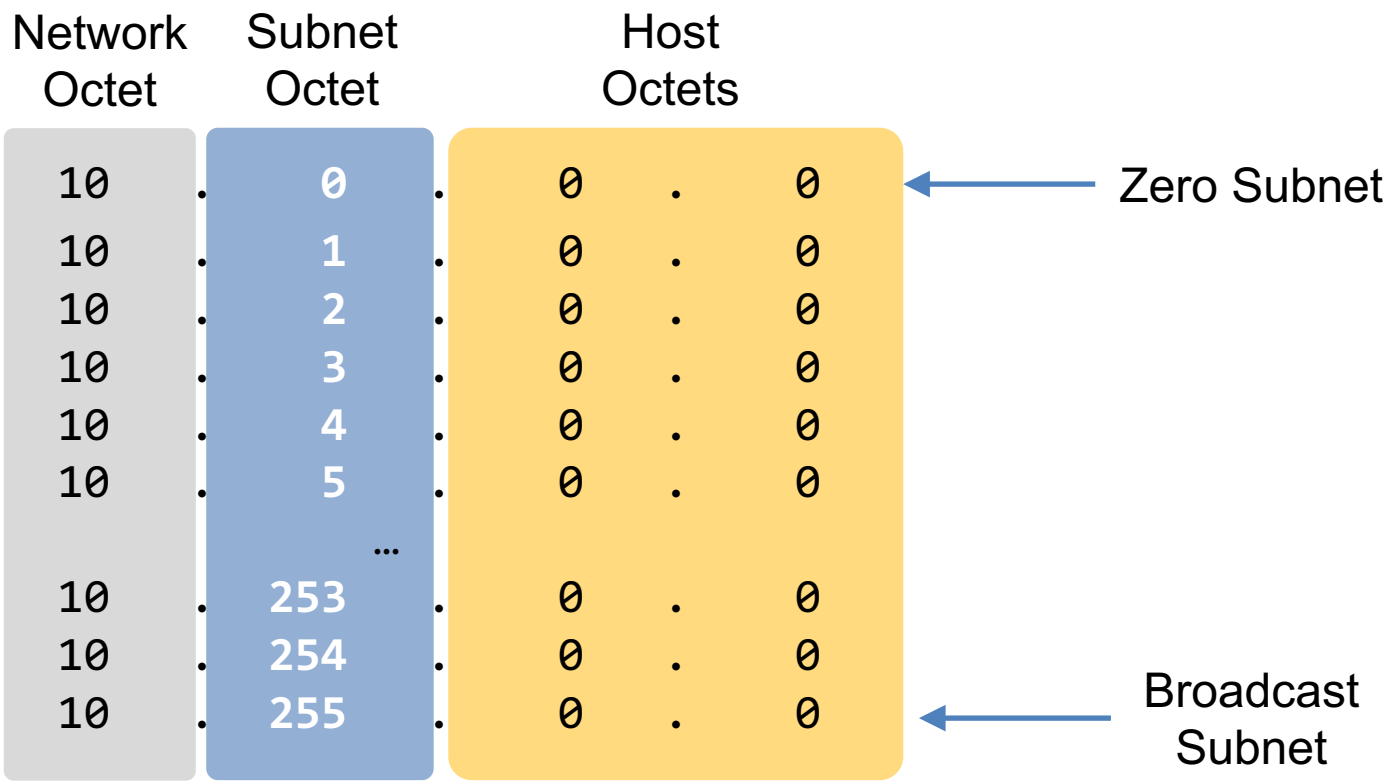
How to Subnet a Class A with /16

Example:

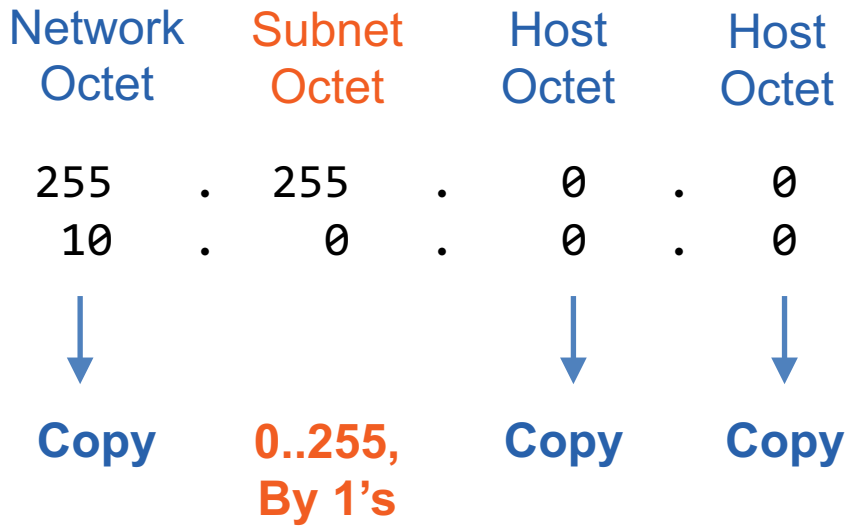
`10.0.0.0`
`255.255.0.0`

Subnet Octet:
Count by Magic #
Start at 0
All < 256

Magic:
256
-255
1



Visual Review of Subnetting Class A with /16



In This Lesson...

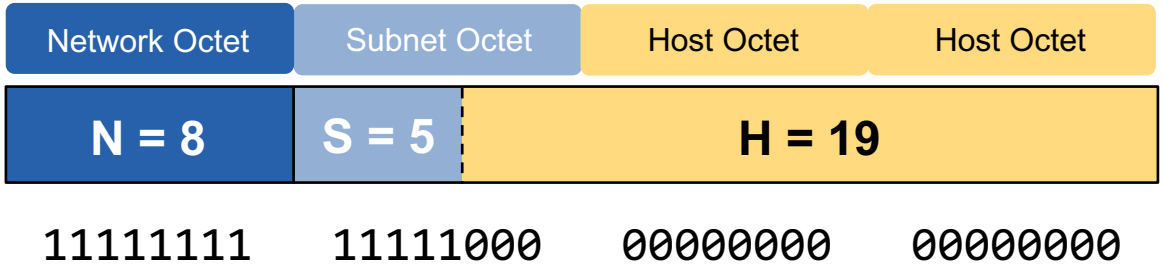
Finding All Subnets: 1 Subnet Octet

- Process: Class B with 8 Subnet Bits
- Process: Class B with <8 Subnet Bits
- Process: Class A with 8 Subnet Bits
- **Process: Class A with <8 Subnet Bits**
- Process: Class C with <8 Subnet Bits
- Learning Stages and Practice

Example 4: Class A with /13

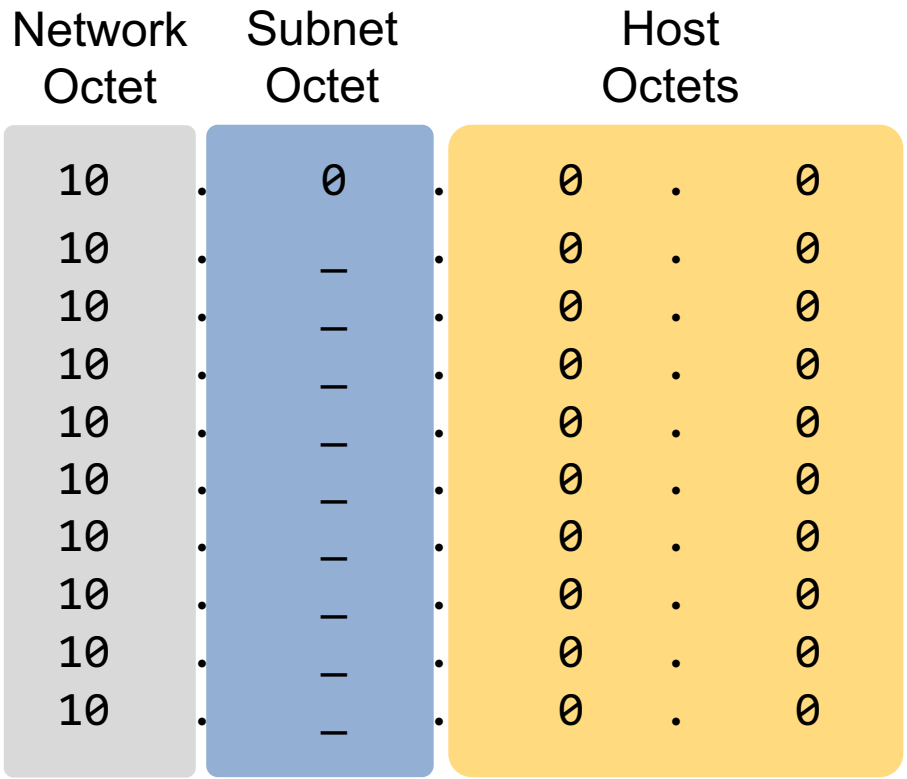
Example:

```
10.0.0.0
255.248.0.0
```



Example 4: List of Subnet IDs (Incomplete)

Network Octets: Same Values As Network ID



Host Octets: Same Value As Network ID (0)

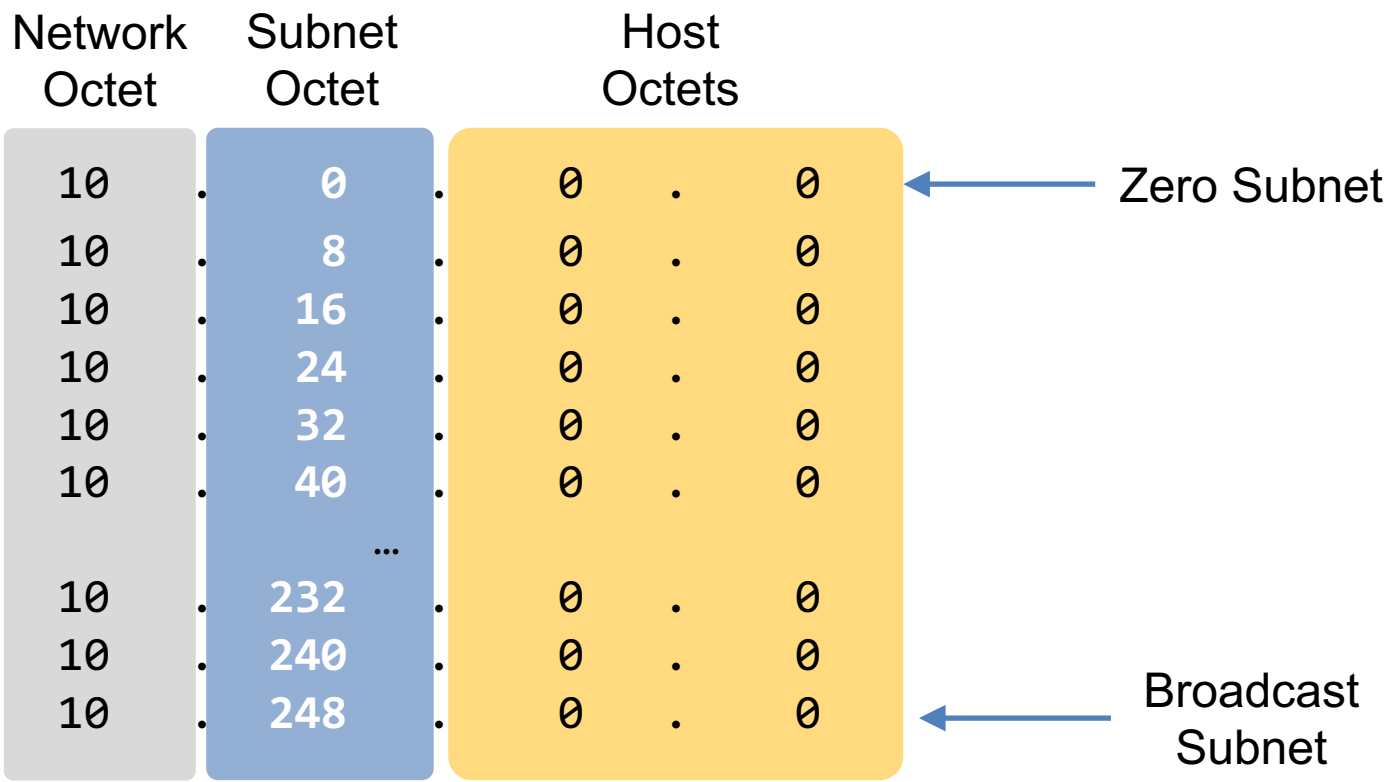
How to Subnet a Class A with /13

Example:

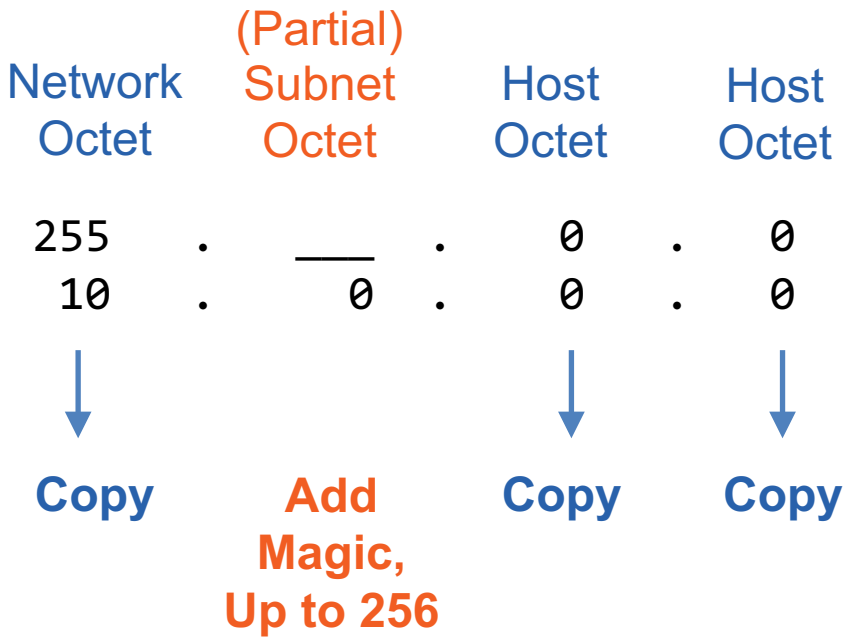
10.0.0.0
255.248.0.0

Subnet Octet:
Count by Magic #
Start at 0
All < 256

Magic:
256
-248
8



Visual Review of Subnetting Class A, /9 - /16



In This Lesson...

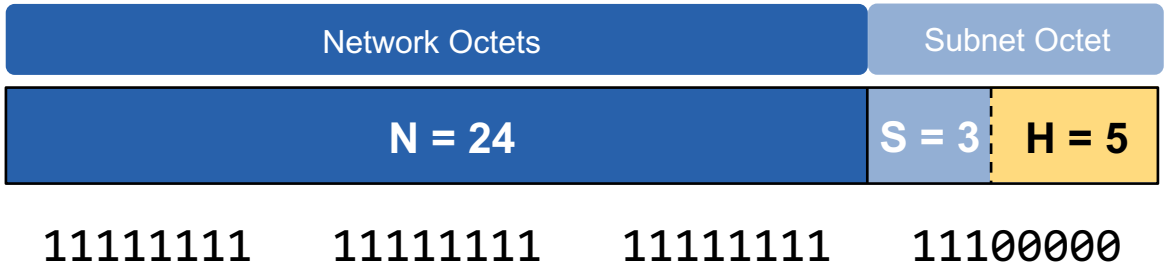
Finding All Subnets: 1 Subnet Octet

- Process: Class B with 8 Subnet Bits
- Process: Class B with <8 Subnet Bits
- Process: Class A with 8 Subnet Bits
- Process: Class A with <8 Subnet Bits
- **Process: Class C with <8 Subnet Bits**
- Learning Stages and Practice

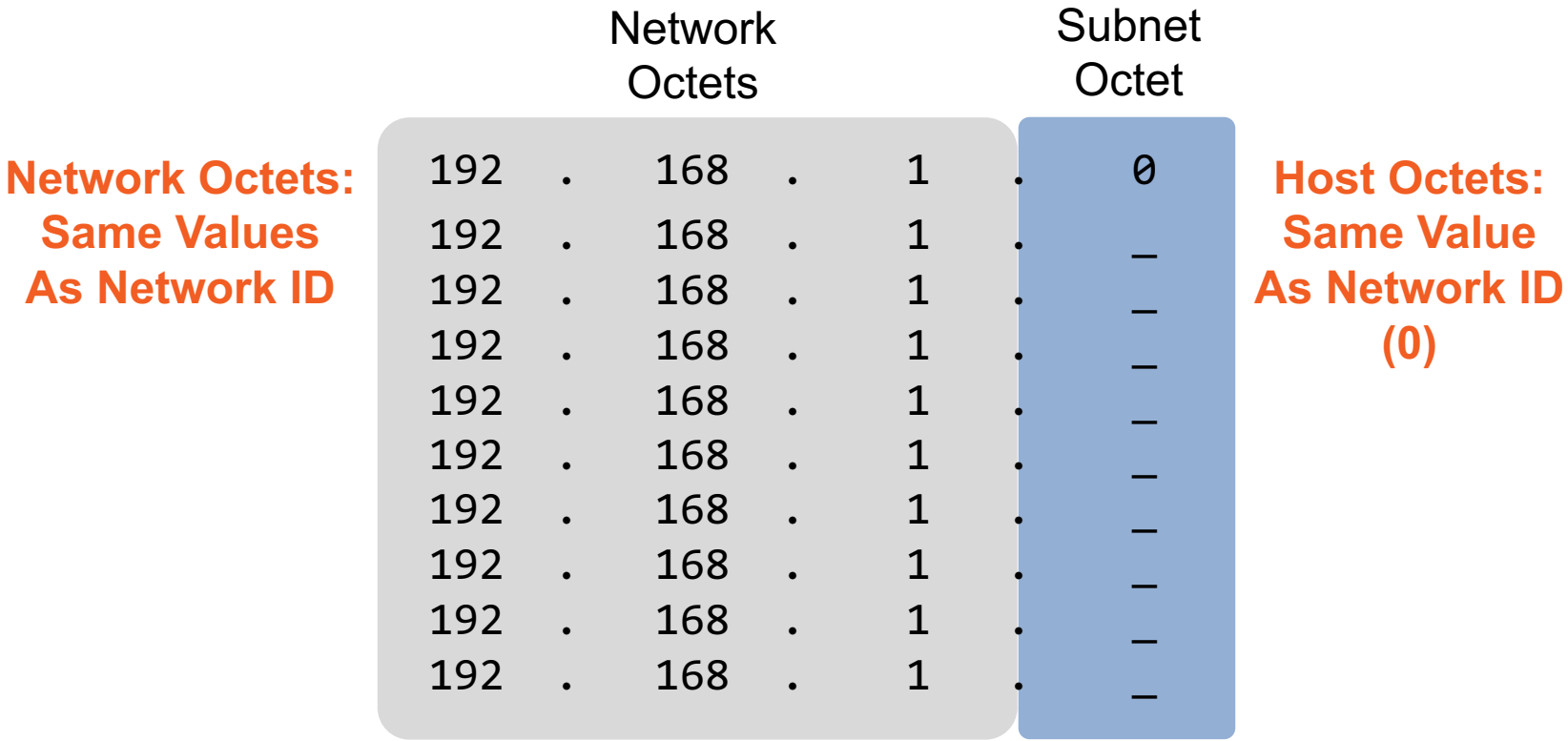
Example 5: Class C with /27

Example:

192.168.1.0
255.255.255.224



Example 5: List of Subnet IDs (Incomplete)



How to Subnet a Class C with /27

Example:

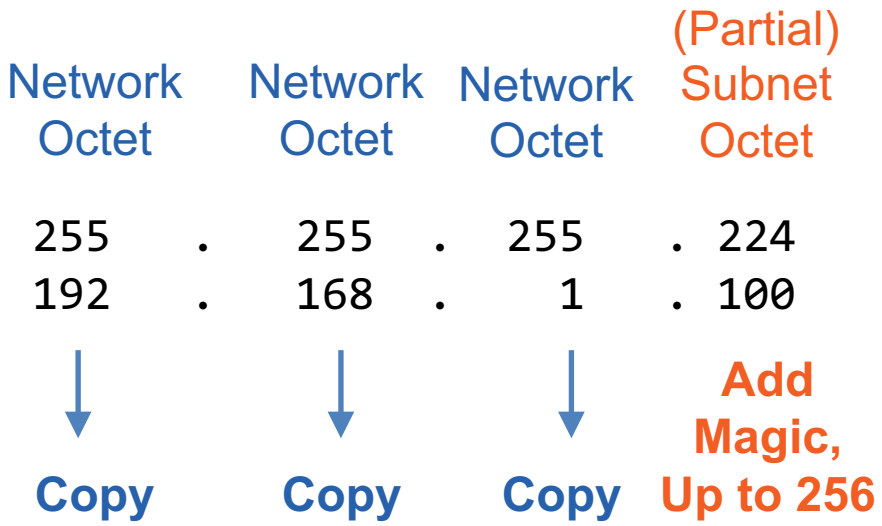
192.168.1.0
255.255.255.224

Subnet Octet:
Count by Magic #
Start at 0
All < 256

Magic:
256
-224
32

Network Octet		Subnet Octet				
192	.	168	.	1	.	0 ← Zero Subnet
192	.	168	.	1	.	32
192	.	168	.	1	.	64
192	.	168	.	1	.	96
192	.	168	.	1	.	128
192	.	168	.	1	.	160
192	.	168	.	1	.	192
192	.	168	.	1	.	224 ← Broadcast Subnet

Visual Review of Subnetting Class C, /27



In This Lesson...

Finding All Subnets: 1 Subnet Octet

- Process: Class B with 8 Subnet Bits
- Process: Class B with <8 Subnet Bits
- Process: Class A with 8 Subnet Bits
- Process: Class A with <8 Subnet Bits
- Process: Class C with <8 Subnet Bits
- **Learning Stages and Practice**

Stages

Stage	Primary Study Goal	Have You Understood and Memorized Ideas and Processes?	Do You Get 100% Correct?	Do You Go Fast?
1	Learning	**No**		
2	Perfecting	Yes	**No**	
3	Accelerating	Yes	Yes	**No**
4	Completed	**Yes**	**Yes**	**Yes**

Stage 1 (Learn) Advice for This Exercise

The Usual Approach

1. Use Notes/Examples
2. Check Answer if Unsure
3. Investigate Mistakes
4. **Ask Instructor to Work the Problem!**

Specifically…

1. Be Patient
2. Learn the Steps

Graduate to Stage 2 Now if:

1. Could Hide All Notes and Still Answer!

Stage 2 (Perfect) Advice for This Exercise

The Usual Approach:

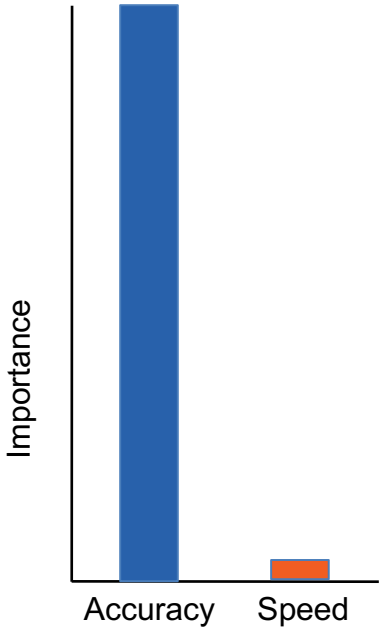
1. No Notes
2. Take Your Time
3. Complete a question set before checking answers

Specifically:

1. Keep Being Patient!
2. **#1 Subnetting Skill: Become Great at This Process!**

Graduate to Stage 3 Now if:

1. 100% Confident You can Find Answers without Notes
2. Can Set Aside for a Few Days and Still Remember How



Stage 3 (Accelerate) Advice for this Exercise

Usual Approach: Time Trial

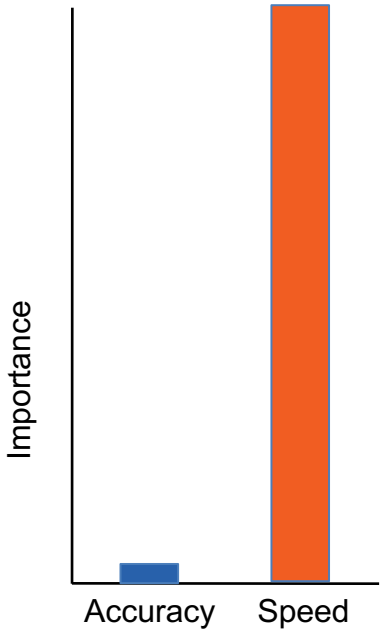
1. Set a per-item time goal
2. Write pre-exam Notes
3. Start Clock
4. Complete the entire question set
5. Compare your speed to time goal

Specific for this Process:

1. >> Reps
2. Magic Multiple Speed Practice

Graduate to Stage 4 Now if:

1. Meet Speed Goals



Getting Faster at Magic Multiples

Address Octet	Magic = 4	Magic = 8	Magic = 16	Magic = 32	Magic = 64
29	28	24	16	0	0
52					

Speed Goals for CCNA Exam

Subnetting Processes	Book Speed Goals	Your Speed Goal	Your Current Speed	Your Current Stage
Find Classful Network Facts *	10			
Convert Mask Formats *	10			
Find Subnet Facts	30			
Interpret Design w/ Mask	15			
Choose One Mask	15			
Find All Subnet IDs *	45			

* These Time Estimates Do Not Include the Time to Write/Type the Answers

Practice!

Exercises for:

“Finding All Subnets –
1 Subnet Octet”

Come Back to Class!

Exercises for:

“Finding All Subnets –
1 Subnet Octet”

Time Finished!

IPv4 Subnetting – Sections

Section 1: Analyzing Individual Subnets

Section 2: Converting Subnet Masks

Section 3: Analyzing IP Networks

Section 4: Identifying the Subnets of a Network

Section 5: Analyzing Designs Using Masks

Section 6: Subnetting and the Exam

IPv4 Subnetting – Section 4

Noticing Patterns in Subnet IDs

Finding All Subnets: Network and Host Octets

* Finding All Subnets: 1 Subnet Octet

*** Finding All Subnets: >1 Subnet Octet**

In This Lesson...

Finding All Subnets: >1 Subnet Octet

- **Process Overview, Find All Subnets, >8 Subnet Bits**
- Example: Class A with 16 Subnet Bits
- Example: Class B with 10 Subnet Bits
- Summary: Processes to Find All Subnets
- Learning Stages and Practice

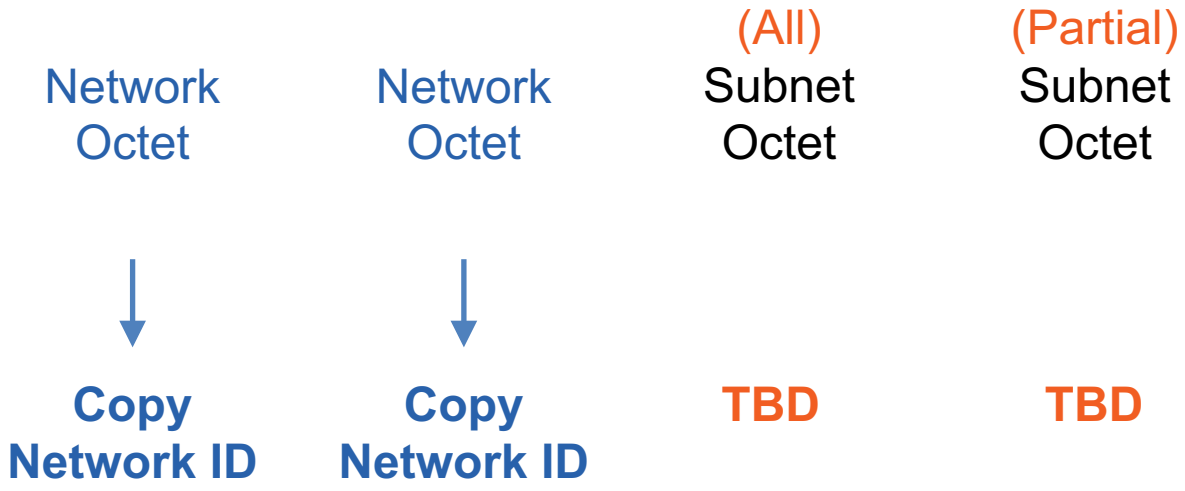
Text Rules: Finding All Subnets (Partial)

1. **Set Up the Problem:**
   - Write the Mask First, Followed by Network ID
   - Leave Space for More Subnet ID's Below
2. **Identify and Process Network (Only) Octets**
   - Apply Class A, B, or C, Rules to Determine 1, 2, or 3 Network Octets
   - Copy Network ID to ALL Subnet IDs for All Network Octets
3. **Identify and Process Host (Only) Octets**
   - Octets with DDN Mask Octet = 0 are Host Only Octets
   - Copy Network ID to Subnet IDs for All Host Octets
   - (Also... Host Octet Values of Subnet IDs Will be 0)
4. **Process Octets w/ Subnet Bits**
   - Details to be Determined

Visual Rules: 2 Subnet Octets

Network Octet	(All) Subnet Octet	(Partial) Subnet Octet	Host Octet
			
Copy Network ID	**TBD**	**TBD**	**Copy (Always 0)**

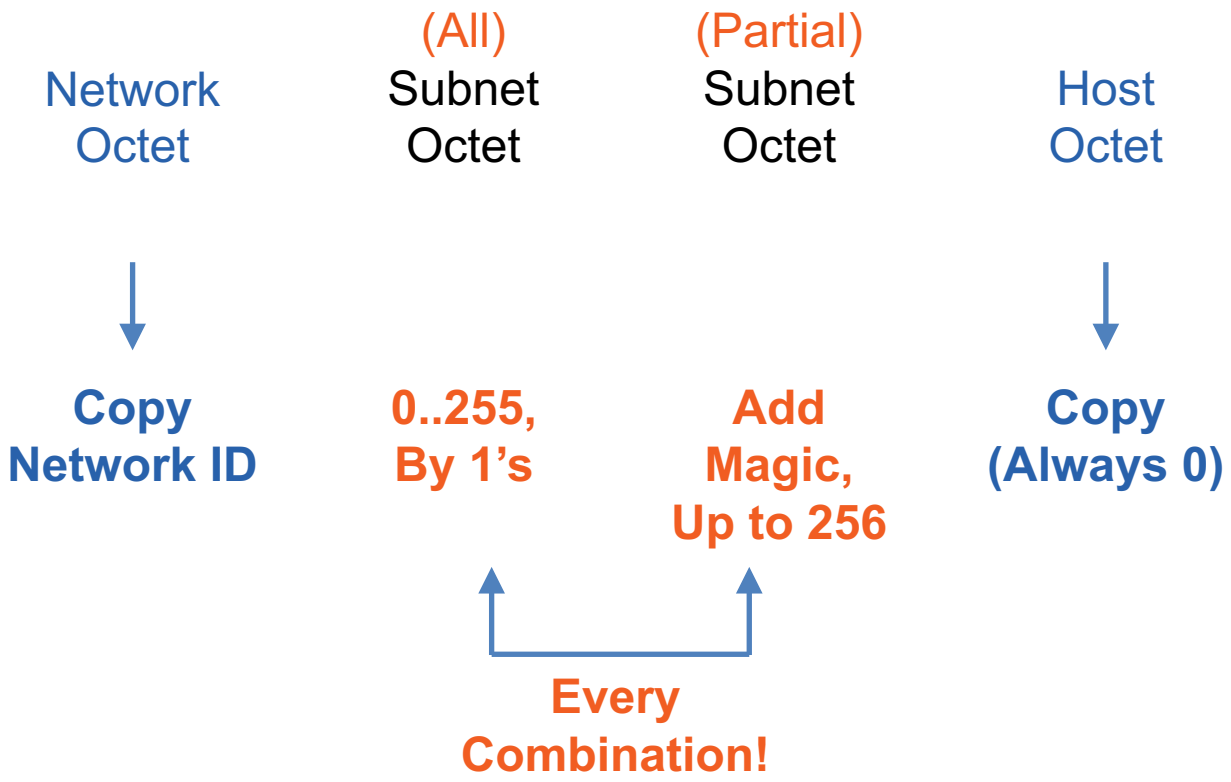
Visual Rules: 2 Subnet Octets



Visual Rules: 3 Subnet Octets

Network Octet	(All) Subnet Octet	(All) Subnet Octet	(Partial) Subnet Octet
			
Copy Network ID	**TBD**	**TBD**	**TBD**

Visual Rules: >1 Subnet Octets



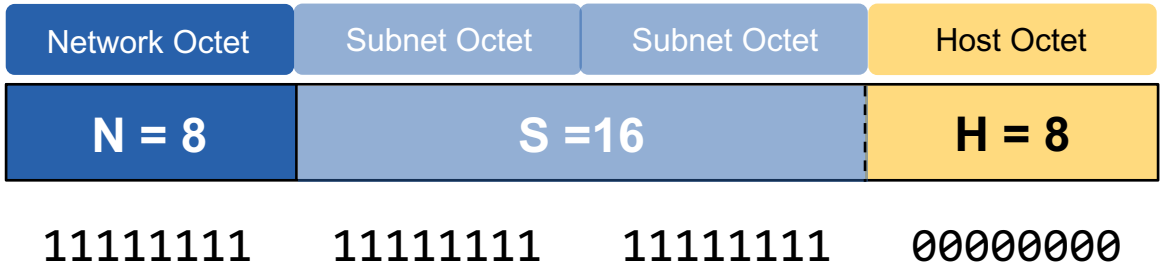
In This Lesson...

Finding All Subnets: >1 Subnet Octet

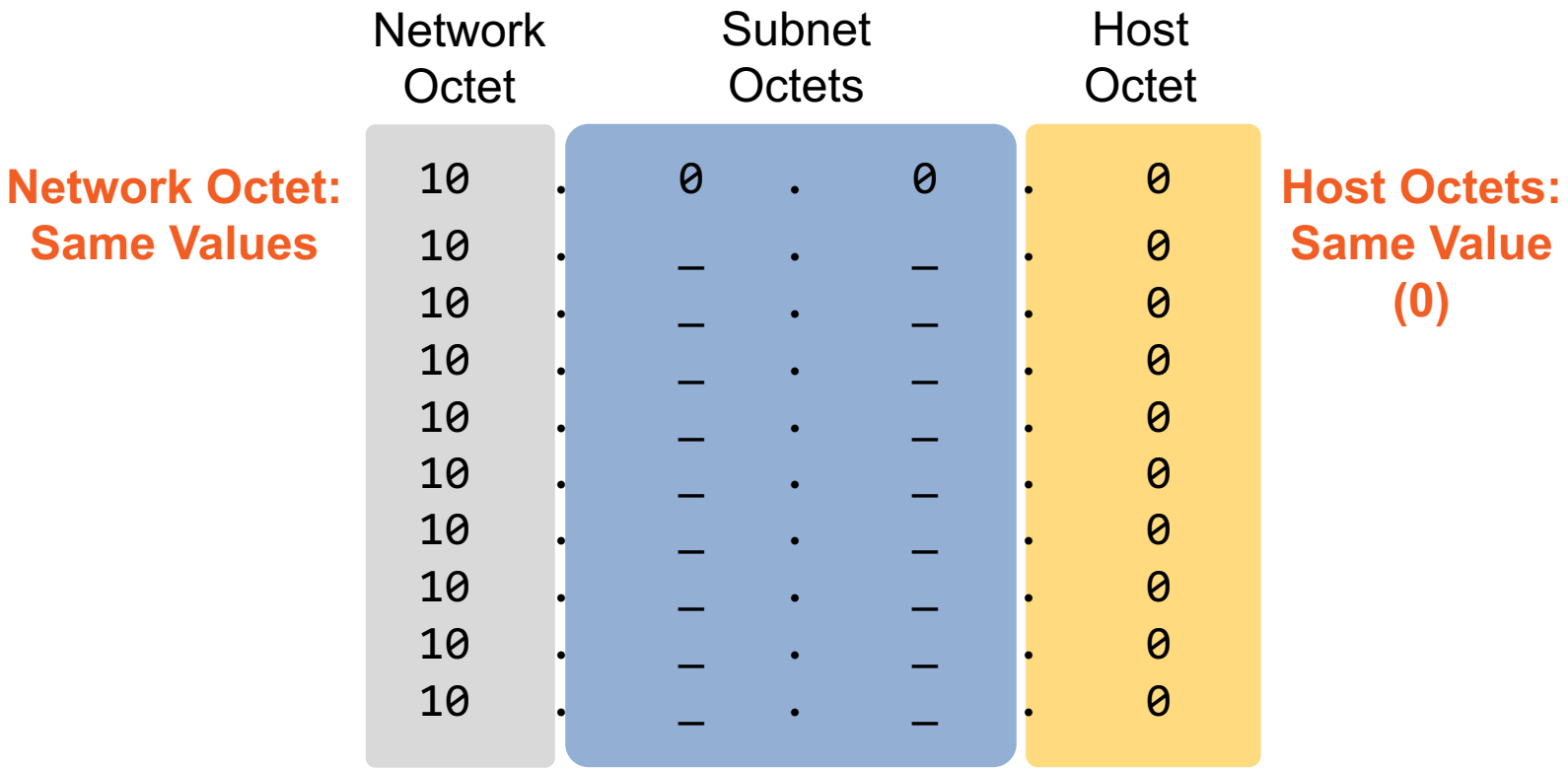
- Process Overview, Find All Subnets, >8 Subnet Bits
- **Example: Class A with 16 Subnet Bits**
- Example: Class B with 10 Subnet Bits
- Summary: Processes to Find All Subnets
- Learning Stages and Practice

How to Subnet Class A with /24

10.0.0.0
255.255.255.0



How to Subnet a Class A with /24



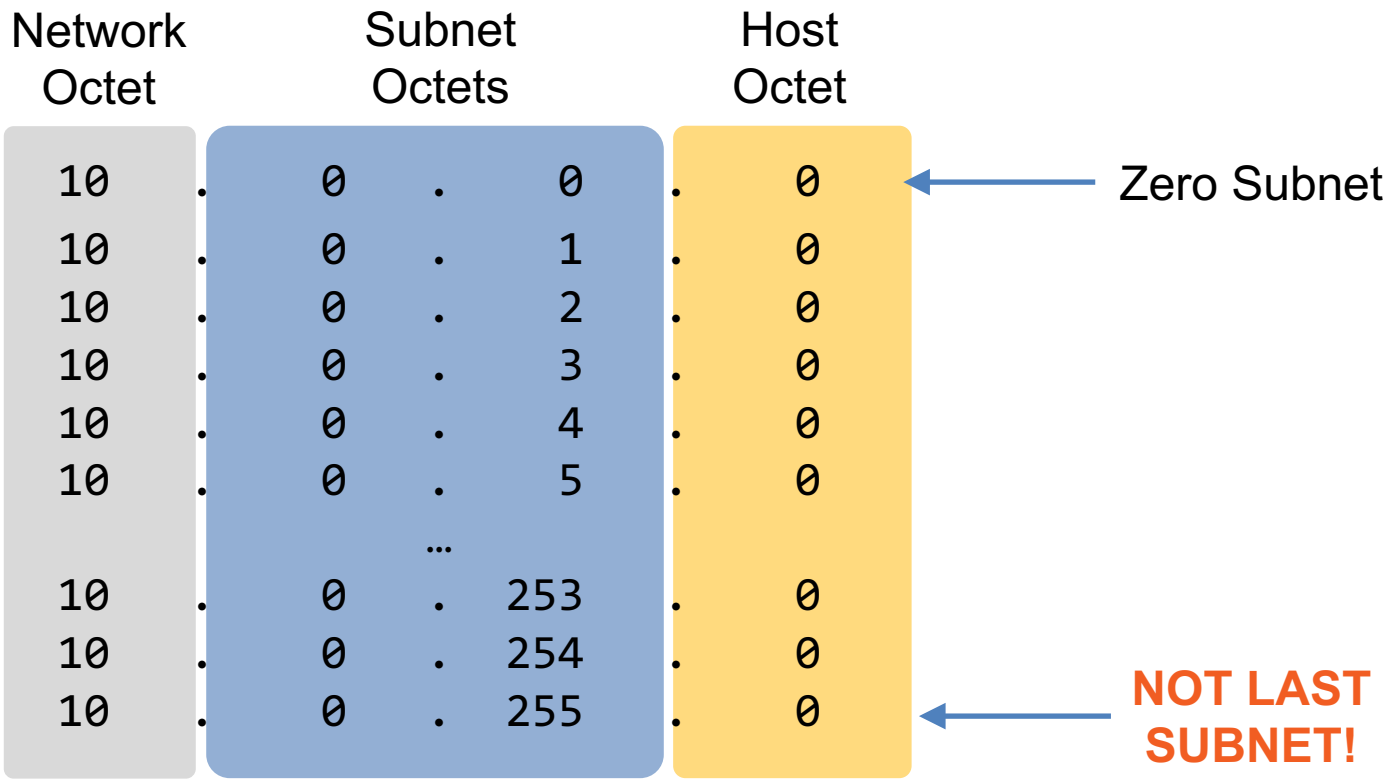
Class A with /24: First Block of 256 Subnets

10.0.0.0
255.255.255.0

Right Subnet Octet:
Count by Magic #
Start at 0
All < 256

Other Subnet Octets:
Use 0s for Now

Magic:
256
-255
1

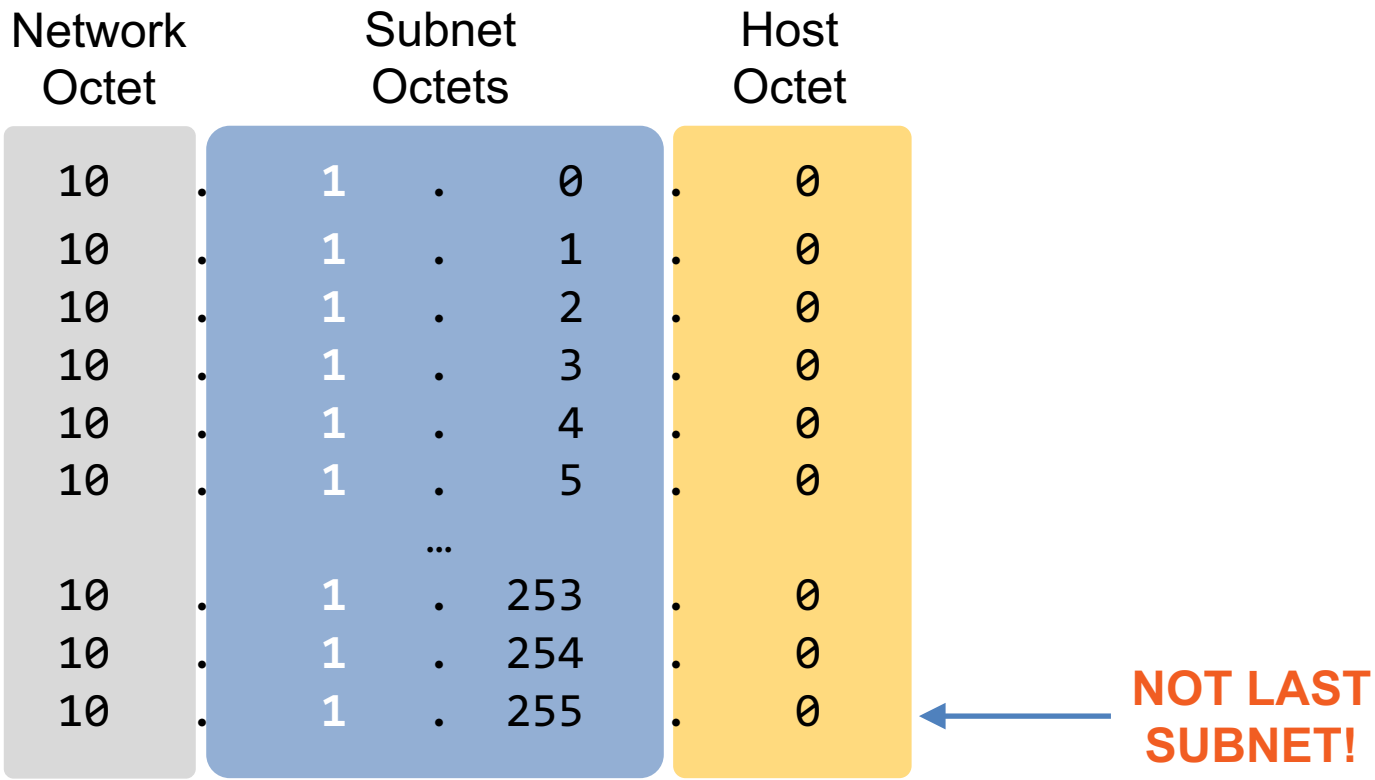


Class A with /24: Next Block of 256 Subnets

10.0.0.0
255.255.255.0

Right Subnet Octet: Repeat the Pattern

Other Subnet Octets: Use 1s Next

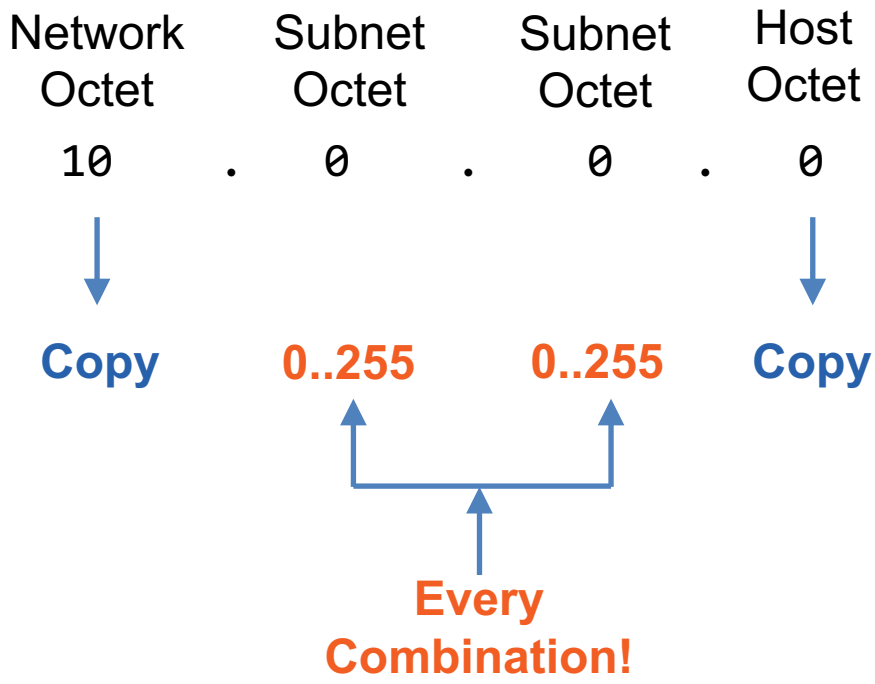


Class A with /24: Summary of Subnets

10. 0. 0. 0	10. 1. 0. 0	10. 2. 0. 0	
10. 0. 1. 0	10. 1. 1. 0	10. 2. 1. 0	
10. 0. 2. 0	10. 1. 2. 0	10. 2. 2. 0	
10. 0. 3. 0	10. 1. 3. 0	10. 2. 3. 0	
10. 0. 4. 0	10. 1. 4. 0	10. 2. 4. 0	
10. 0. 5. 0	10. 1. 5. 0	10. 2. 5. 0	
10. 0. 6. 0	10. 1. 6. 0	10. 2. 6. 0	
10. 0. 7. 0	10. 1. 7. 0	10. 2. 7. 0	
10. 0. 8. 0	10. 1. 8. 0	10. 2. 8. 0	
10. 0. 9. 0	10. 1. 9. 0	10. 2. 9. 0	
10. 0. 10. 0	10. 1. 10. 0	10. 2. 10. 0	
…	…	…	
10. 0.249. 0	10. 1.249. 0	10. 2.249. 0	
10. 0.250. 0	10. 1.250. 0	10. 2.250. 0	
10. 0.251. 0	10. 1.251. 0	10. 2.251. 0	
10. 0.252. 0	10. 1.252. 0	10. 2.252. 0	
10. 0.253. 0	10. 1.253. 0	10. 2.253. 0	
10. 0.254. 0	10. 1.254. 0	10. 2.254. 0	
10. 0.255. 0	10. 1.255. 0	10. 2.255. 0	

10.254. 0. 0	10.255. 0. 0
10.254. 1. 0	10.255. 1. 0
10.254. 2. 0	10.255. 2. 0
10.254. 3. 0	10.255. 3. 0
10.254. 4. 0	10.255. 4. 0
10.254. 5. 0	10.255. 5. 0
10.254. 6. 0	10.255. 6. 0
10.254. 7. 0	10.255. 7. 0
10.254. 8. 0	10.255. 8. 0
10.254. 9. 0	10.255. 9. 0
10.254. 10. 0	10.255. 10. 0
…	…
10.254.249. 0	10.255.249. 0
10.254.250. 0	10.255.250. 0
10.254.251. 0	10.255.251. 0
10.254.252. 0	10.255.252. 0
10.254.253. 0	10.255.253. 0
10.254.254. 0	10.255.254. 0
10.254.255. 0	10.255.255. 0

Visual Rules: Subnetting Class A with /24



Text Rules: Subnetting Class A with /24

1. **Address Structure Will Be**
   A. 1st Octet is Network
   B. 2nd and 3rd Octets are All Subnet
   C. 4th Octets is All Host
2. **Set Up the Problem:**
   A. Write the Network ID at the Top (Zero Subnet)
   B. Leave Space for More Subnet ID's Below
3. **Copy the Network ID's Values for Network and Host Octets**
   - Network Octets (Octet 1)
   - Host Octets (Octet 4)
4. **Subnet Octets (Octets 2 and 3):**
   - Values are 0..255 in Both Octets
   - Every Combination of 0..255 in both Octets (256 * 256 Combinations)

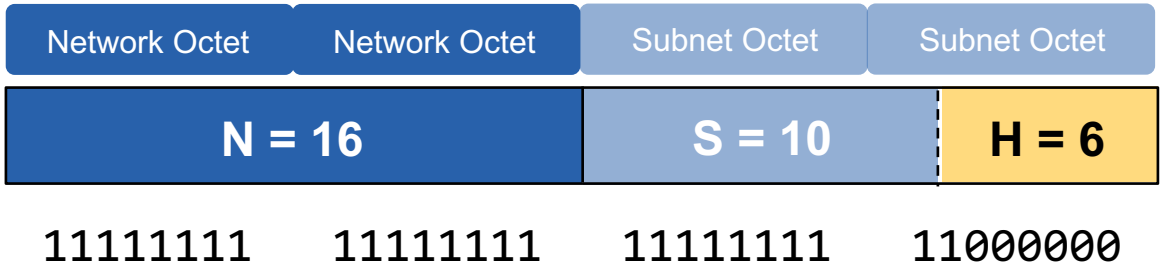
In This Lesson...

Finding All Subnets: >1 Subnet Octet

- Process Overview, Find All Subnets, >8 Subnet Bits
- Example: Class A with 16 Subnet Bits
- **Example: Class B with 10 Subnet Bits**
- Summary: Processes to Find All Subnets
- Learning Stages and Practice

How to Subnet Class B with /26

172.16.0.0
255.255.255.192



Example 2: List of Subnet IDs (Partial)

Network Octets: Same Values As Network ID

Network Octets			(All) Subnet Octet	(Partial) Subnet Octet
255	. 255	.	255	. 192
172	. 16	.	0	. 0
172	. 16	.	_	. _
172	. 16	.	_	. _
172	. 16	.	_	. _
172	. 16	.	_	. _
172	. 16	.	_	. _
172	. 16	.	_	. _
172	. 16	.	_	. _
172	. 16	.	_	. _
172	. 16	.	_	. _

Example 2: First Block of Subnet IDs

172.16.0.0

255.255.255.192

Right Subnet Octet:
Count by Magic #
Start at 0
All < 256

Other Subnet Octet:
Use 0s for Now

Magic:
256
-192
64

	Network Octets			(All) Subnet Octet	(Partial) Subnet Octet
255	. 255	.	255	.	192
172	. 16	.	0	.	0
172	. 16	.	0	.	64
172	. 16	.	0	.	128
172	. 16	.	0	.	192

Example 2: Next Block Subnet IDs

172.16.0.0
255.255.255.192

Partial Subnet Octet: Repeat the Pattern

Other Subnet Octet: Use 1s Next

Network Octets			(All) Subnet Octet	(Partial) Subnet Octet
255	255	255	255	192
172	16	0	0	0
172	16	0	0	64
172	16	0	0	128
172	16	0	0	192
172	16	0	1	0
172	16	0	1	64
172	16	0	1	128
172	16	0	1	192

Class B with /26: Summary of Subnets

172. 16. 0. 0	172. 16. 4. 0	172. 16.248. 0	172. 16.252. 0
172. 16. 0. 64	172. 16. 4. 64	172. 16.248. 64	172. 16.252. 64
172. 16. 0.128	172. 16. 4.128	172. 16.248.128	172. 16.252.128
172. 16. 0.192	172. 16. 4.192	172. 16.248.192	172. 16.252.192
172. 16. 1. 0	172. 16. 5. 0	172. 16.249. 0	172. 16.253. 0
172. 16. 1. 64	172. 16. 5. 64	172. 16.249. 64	172. 16.253. 64
172. 16. 1.128	172. 16. 5.128	172. 16.249.128	172. 16.253.128
172. 16. 1.192	172. 16. 5.192	172. 16.249.192	172. 16.253.192
172. 16. 2. 0	172. 16. 6. 0	172. 16.250. 0	172. 16.254. 0
172. 16. 2. 64	172. 16. 6. 64	172. 16.250. 64	172. 16.254. 64
172. 16. 2.128	172. 16. 6.128	172. 16.250.128	172. 16.254.128
172. 16. 2.192	172. 16. 6.192	172. 16.250.192	172. 16.254.192
172. 16. 3. 0	172. 16. 7. 0	172. 16.251. 0	172. 16.255. 0
172. 16. 3. 64	172. 16. 7. 64	172. 16.251. 64	172. 16.255. 64
172. 16. 3.128	172. 16. 7.128	172. 16.251.128	172. 16.255.128
172. 16. 3.192	172. 16. 7.192	172. 16.251.192	172. 16.255.192

In This Lesson...

Finding All Subnets: >1 Subnet Octet

- Process Overview, Find All Subnets, >8 Subnet Bits
- Example: Class A with 16 Subnet Bits
- Example: Class B with 10 Subnet Bits
- **Summary: Processes to Find All Subnets**
- Learning Stages and Practice

Text Rules: Finding Subnet ID Values >1 Subnet Octet

1. **Create the First Block of Subnet IDs:**
   A. First Subnet ID: Same Number as Network ID
   B. Create First Block by Changing Rightmost Subnet Octet:
      A. Calculate Magic Number for that Octet
      B. Find Multiples of the Magic Number, From 0 Through 255

2. **If Two Subnet Octets Exist:**
   A. Create 256 Blocks like the First Block
   B. One Block for Each Value 0..255 in the Subnet Octet on the Left

3. **If Three Subnet Octets Exist:**
   A. Create 65,536 Blocks (256 * 256) Like the First Block
   B. One Block for Each Combination of Values of 0..255 in the First Two Subnet Octets

Visual Rules: 2 Subnet Octets

Network Octet	(All) Subnet Octet	(Partial) Subnet Octet	Host Octet
↓			↓
Copy Network ID	**=0 for Block 1; =1 for Block 2; So On Through 255**	**Multiples of the Magic Number**	**Copy (Always 0)**

Visual Rules: 2 Subnet Octets

Network Octet	Network Octet	(All) Subnet Octet	(Partial) Subnet Octet
↓	↓		
Copy Network ID	**Copy Network ID**	**=0 for Block 1; =1 for Block 1; So On Through 255**	**Multiples of the Magic Number**

Visual Rules: 3 Subnet Octets

Network Octet	(All) Subnet Octet	(All) Subnet Octet	(Partial) Subnet Octet
			
Copy Network ID	**0 for First 256 Blocks; 1 for Next 256 Blocks; So on Through 255**	**=0 for Block 1; =1 for Block 2; So On Through 255**	**Multiples of the Magic Number**

In This Lesson...

Finding All Subnets: >1 Subnet Octet

- Process Overview, Find All Subnets, >8 Subnet Bits
- Example: Class A with 16 Subnet Bits
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- Summary: Processes to Find All Subnets
- **Learning Stages and Practice**

Stage 1 (Learn) Advice for This Exercise

The Usual Approach

1. Use Notes/Examples
2. Check Answer if Unsure
3. Investigate Mistakes
4. **Ask Instructor to Work the Problem!**

Specifically…

1. Be Patient
2. Learn the Steps

Graduate to Stage 2 Now if:

1. Could Hide All Notes and Still Answer!

Stage 2 (Perfect) Advice for This Exercise

The Usual Approach:

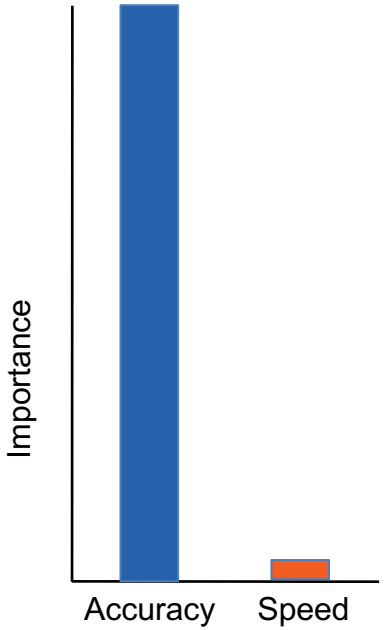
1. No Notes
2. Take Your Time
3. Complete a Question Set before Checking Answers

For These Processes:

1. Keep Being Patient!

Graduate to Stage 3 Now if:

1. 100% Confident You can Find Answers without Notes
2. Can Set Aside for a Few Days and Still Remember How



Stage 3 (Accelerate) Advice for this Exercise

Usual Approach: Time Trial

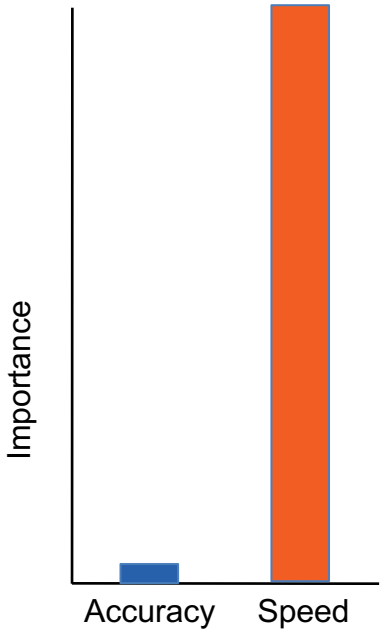
1. Write Pre-exam Notes
2. Set a Per-item Time Goal
3. Start Clock
4. Complete the Entire Question Set
5. Compare your Speed to Time Goal

Specifically:

1. >> Reps
2. Magic Multiple Speed Practice

Graduate to Stage 4 Now if:

1. Meet Speed Goals



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Practice!

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Come Back to Class!

Exercises for:

“Finding All Subnets –
>1 Subnet Octet”

Time Finished!