VLSM

Variable-Length Subnet Mask

Workbook

Version 2.0

192.168

192.168.10.96

192.168.10.126

172.31.15.0

10.250.1.0

Student Name:

IP Address Classes

Class A   1 – 127   (Network 127 is reserved for loopback and internal testing)

Leading bit pattern   0   00000000.00000000.00000000.00000000
                                       Network .   Host   .   Host   .   Host

Class B   128 – 191   Leading bit pattern   10   10000000.00000000.00000000.00000000
                                         Network .   Network .   Host   .   Host

Class C   192 – 223   Leading bit pattern   110   11000000.00000000.00000000.00000000
                                         Network .   Network .   Network .   Host

Class D   224 – 239   (Reserved for multicast)

Class E   240 – 255   (Reserved for experimental, used for research)

Private Address Space

Class A   10.0.0.0 to 10.255.255.255

Class B   172.16.0.0 to 172.31.255.255

Class C   192.168.0.0 to 192.168.255.255

Default Subnet Masks

Class A   255.0.0.0

Class B   255.255.0.0

Class C   255.255.255.0

This workbook assumes you already have a background in subnetting. If you don't you may want to consider completing the IP Addressing and Subnetting Workbook.

Workbooks included in the series:

IP Addressing and Subnetting Workbooks
ACLs - Access Lists Workbooks
VLSM Variable-Length Subnet Mask IWorkbooks

Classful vs. Classless
Subnetting

When you're subnetting an IP address for a network you have two options: classful and classless. Classful subnetting is the simplest method. It tends to be the most wasteful because it uses more addresses than are necessary. In classful subnetting you use the same subnet mask for each subnet, and all the subnets have the same number of addresses in them.

Classless addressing allows you to use different subnet masks and create subnets tailored to the number of users in each group. This technique is referred to as VLSM, Variable Length Subnet Masks.

What is VLSM

Variable Length Subnet Masks allow you a much tighter control over your addressing scheme. If you use a class C address with a default subnet mask you end up with one subnet containing 256 addresses. By using VLSM you can adjust the number of subnets and number of addresses depending on the specific needs of your network. The same rules apply to a class A or B addresses.

VLSM is supported by the following protocols: RIP version 2, OSPF, EIGRP, Dual IS-IS, and BGP. You need to configure your router for Variable Length Subnet Masks by setting up one of these protocols. Then configure the subnet masks of the various interfaces in the IP address interface sub-command.

Benefits of VLSM

Allows efficient use of address space
Allows the use of multiple subnet mask lengths
Breaks up an address block into smaller custom blocks
Allows for route summarization
Provides more flexibility in network design
Supports hierarchical enterprise networks

This workbook explores three different methods to figure out sub-subnets: the box method, the circle method, and a VLSM chart.

Classful Subnetting
Example

When you're subnetting an IP address for a network you have two options: classful and classless. Classful subnetting is the simplest method. It also tends to be the most wasteful because it uses more addresses than are necessary. In classful subnetting you use the same subnet mask for each subnet, and all the subnets have the same number of addresses in them.

In this example you need five subnets, each one containing 30 hosts. The serial connections only require two address each so you are wasting 28 usable addresses in each of the serial subnet ranges.

IP Address: 192.168.1.0
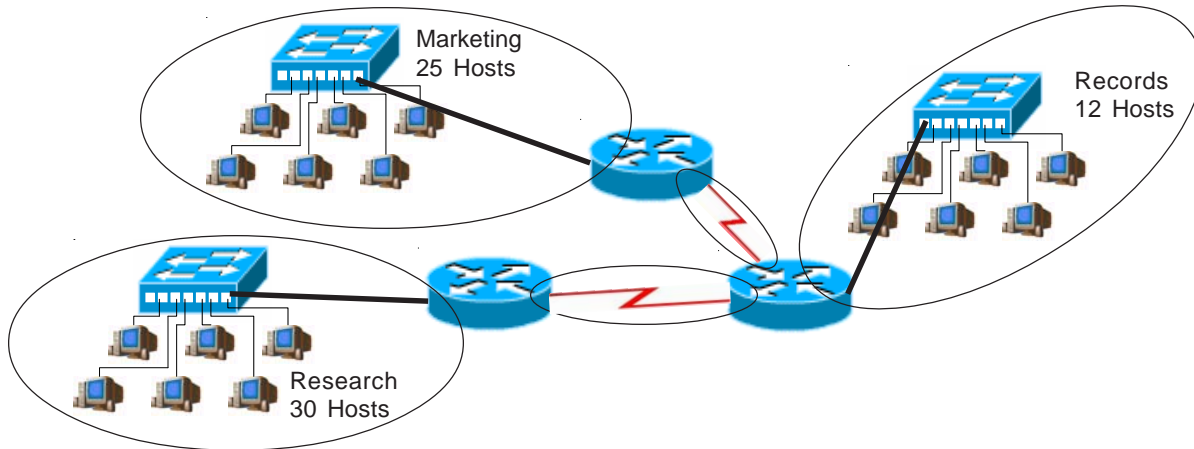
The Box Method
for visualizing subnets

Classful Subnet Ranges

192.168.1.0	to	192.168.1.31	**/27**
192.168.1.32	to	192.168.1.63	**/27**
192.168.1.64	to	192.168.1.95	**/27**
192.168.1.96	to	192.168.1.127	**/27**
192.168.1.128	to	192.168.1.159	**/27**
192.168.1.160	to	192.168.1.191	/27
192.168.1.192	to	192.168.1.223	/27
192.168.1.224	to	192.168.1.255	/27

/27
255.255.255.224
32 Hosts
8 Subnets

Classless Subnetting
Example

Classless addressing allows you to use different subnet masks and create subnets tailored to the number of users in each subnetwork. There are fewer wasted IP addresses using smaller subnets.

In this example you need at total of five subnets, two containing 30 hosts, one containing 12 hosts, and two serial connections that only require two usable addresses each.

IP Address: 192.168.1.0
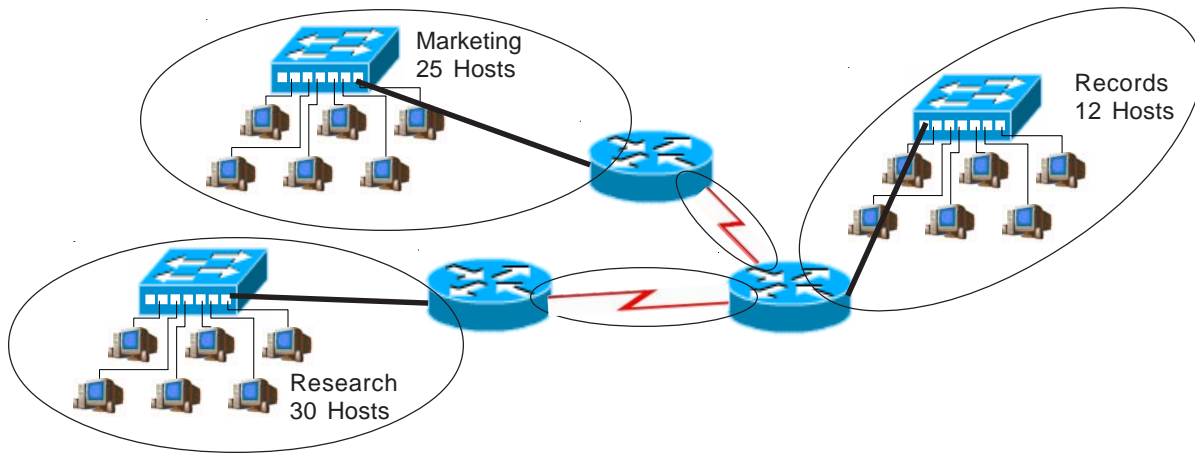
By adjusting the subnet masks you can cut your address usage by almost half in this example. This type of subnetting requires a network protocol which will support it such as: RIP version 2, EIGRP, OSPF, or BGP.

The Box Method for visualizing subnets

Classless Subnet Ranges

|			
192.168.1.0	to	192.168.1.31	**/27**
192.168.1.32	to	192.168.1.63	**/27**
192.168.1.64	to	192.168.1.79	**/28**
192.168.1.80	to	192.168.1.82	**/30**
192.168.1.84	to	192.168.1.87	**/30**
192.168.1.88	to	192.168.1.95	/29
192.168.1.96	to	192.168.1.127	/27
192.168.1.128	to	192.168.1.255	/25
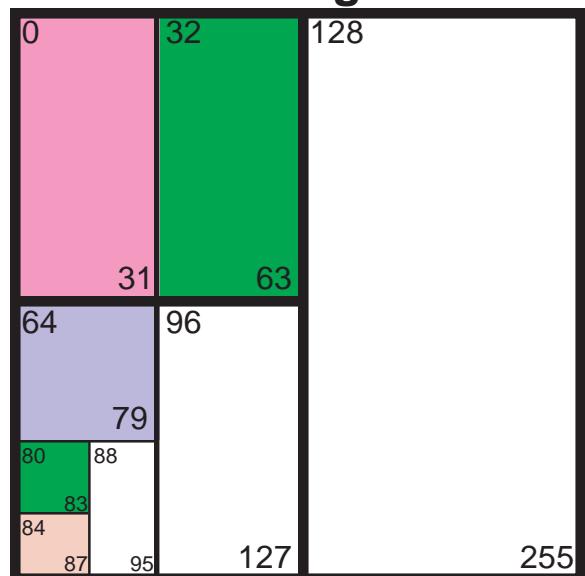
Visualizing Subnets Using
The Box Method

The box method is a simple way to visualize the breakdown of subnets and addresses into smaller sizes.   By shading or coloring in the boxes you can easily break up your subnets without overlapping your addresses. You adjust each subnet to the correct size needed.

Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet

```
0



                                    255
```
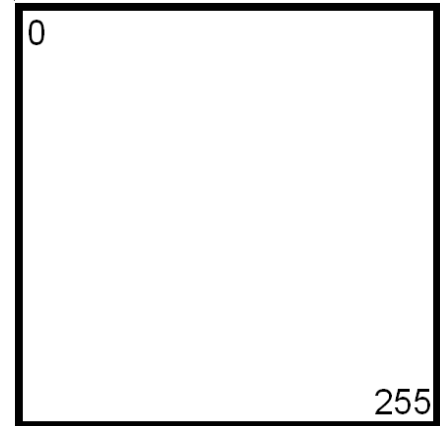
Split the box in half and you get two subnets with 128 addresses.

/25
255.255.255.128
128 Hosts
2 Subnets

```
0            128



        127            255
```
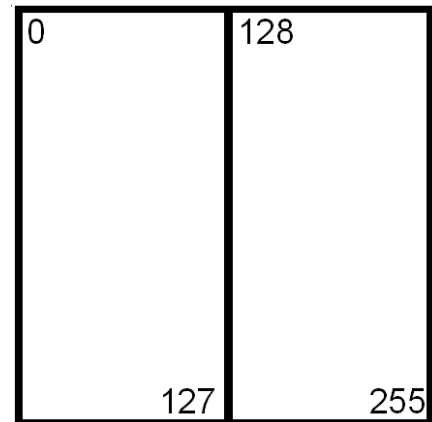
Divide the box into quarters and you get four subnets with 64 addresses.

/26
255.255.255.192
64 Hosts
4 Subnets

```
0            128


        63            191
64           192


        127            255
```

4

Split each individual square and you get eight subnets with 32 addresses.

/27
255.255.255.224
32 Hosts
8 Subnets

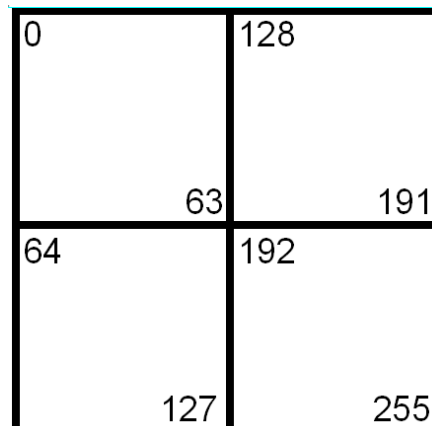| 0	32	128	160
31	63	159	191
64	96	192	224
95	127	223	255

Split the boxes in half again and you get sixteen subnets with sixteen addresses.

/28
255.255.255.240
16 Hosts
16 Subnets

0	32	128	160
15	47	143	175
16	48	144	176
31	63	159	191
64	96	192	224
79	111	207	239
80	112	208	240
95	127	223	255

The next split gives you thirty two subnets with eight addresses.

/29
255.255.255.248
8 Hosts
32 Subnets

0	8	32	40	128	136	160	168
7	15	39	47	135	143	167	175
16	24	48	56	144	152	176	184
23	31	55	63	151	159	183	191
64	72	96	104	192	200	224	232
71	79	103	111	199	207	321	239
80	88	112	120	208	216	240	248
87	95	119	127	215	223	247	255

The last split gives sixty four subnets with four addresses each.

/30
255.255.255.252
4 Hosts
64 Subnets

0	8	32	40	128	136	160	168
3	11	35	43	131	139	163	171
4	12	36	44	132	140	164	172
7	15	39	47	135	143	167	175
16	24	48	56	144	152	176	184
19	27	51	59	147	155	179	187
20	28	52	60	148	156	180	188
23	31	55	63	151	159	183	191
64	72	96	104	192	200	224	232
67	75	99	107	195	203	227	235
68	76	100	108	196	204	228	236
71	79	103	111	199	207	231	239
80	88	112	120	208	216	240	248
83	91	115	123	211	219	243	251
84	92	116	124	212	220	244	252
87	95	119	127	215	223	247	255

VLSM Addressing

Box Method

(Sample)

Problem 1

Using the network diagram and information given create an addressing scheme which utilizes variable-length subnet masks. Show the subnet address and CIDR in the boxes below, color or shade the sub-subnets used in the box. This business will be using the class C address 220.10.10.0. Remember to start with your largest groups first.

Marketing
Department
60 Hosts

Research
Department
28 Hosts

LAN Address:

220.10.10.0/26

LAN Address:

220.10.10.64/27

Color in the squares used with different
shades to highlight each subnet.

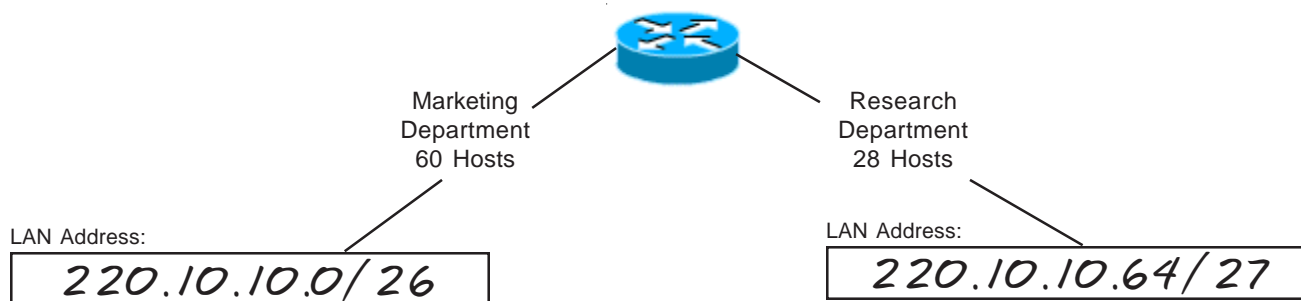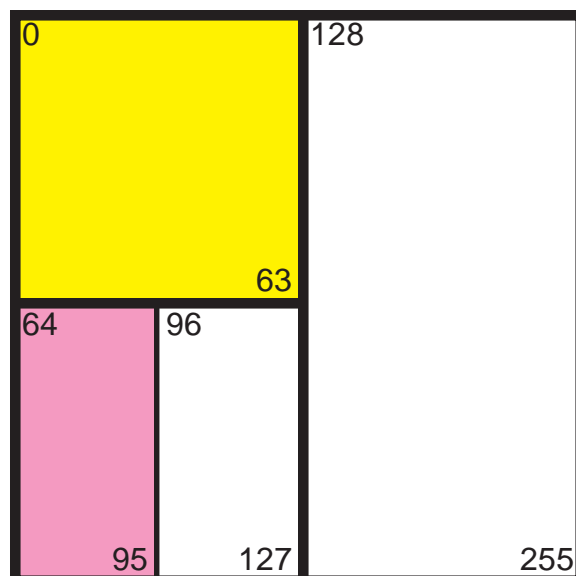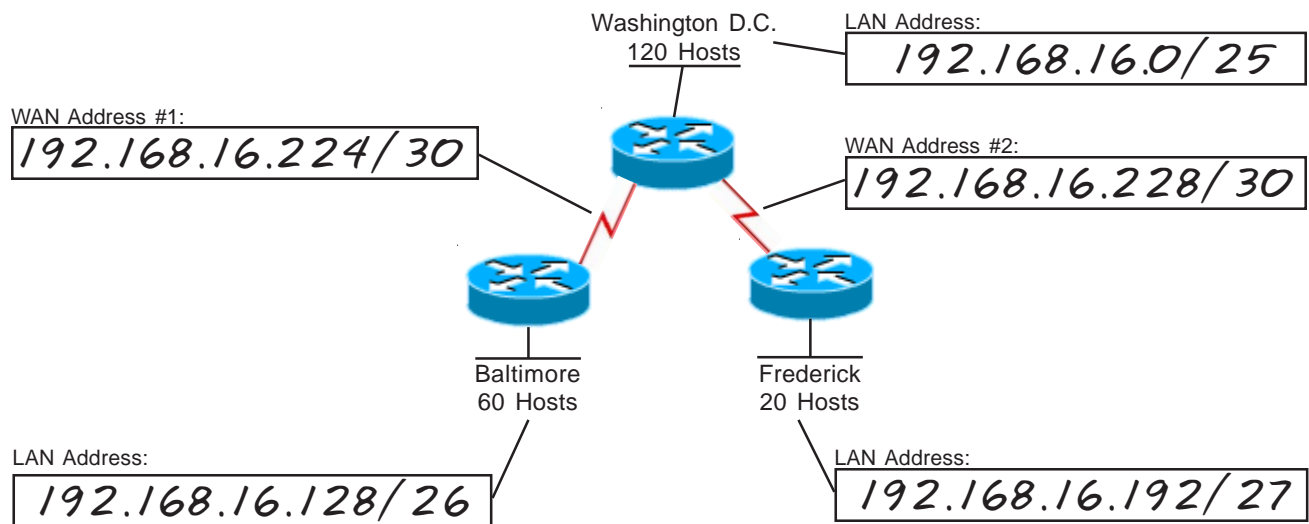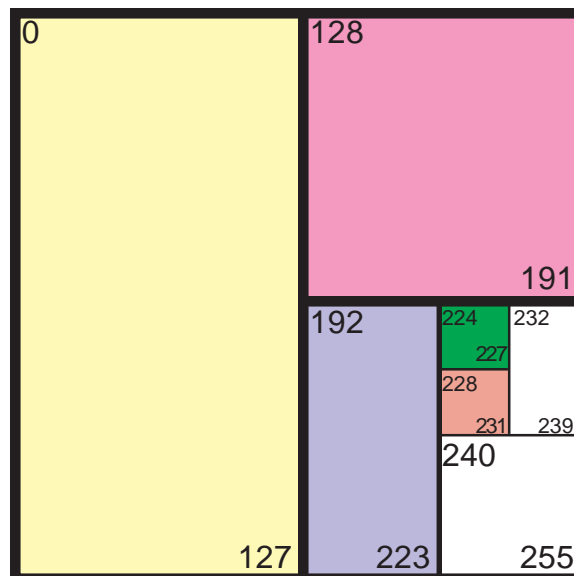|	
0	128
63	
64 96	
95 127	255

VLSM Addressing

Box Method

(Sample)

Problem 2

Using the network diagram and information given create an addressing scheme which utilizes variable-length subnet masks. Show the subnet address and CIDR in the boxes below, color or shade the sub-subnets used in the box. This company will be using the class C address 192.168.16.0. Remember to start with your largest groups first.

Washington D.C.
120 Hosts

LAN Address:
192.168.16.0/25

WAN Address #1:
192.168.16.224/30

WAN Address #2:
192.168.16.228/30

Baltimore
60 Hosts

Frederick
20 Hosts

LAN Address:
192.168.16.128/26

LAN Address:
192.168.16.192/27

Color in the squares used with different shades to highlight each subnet.

0	128
	191

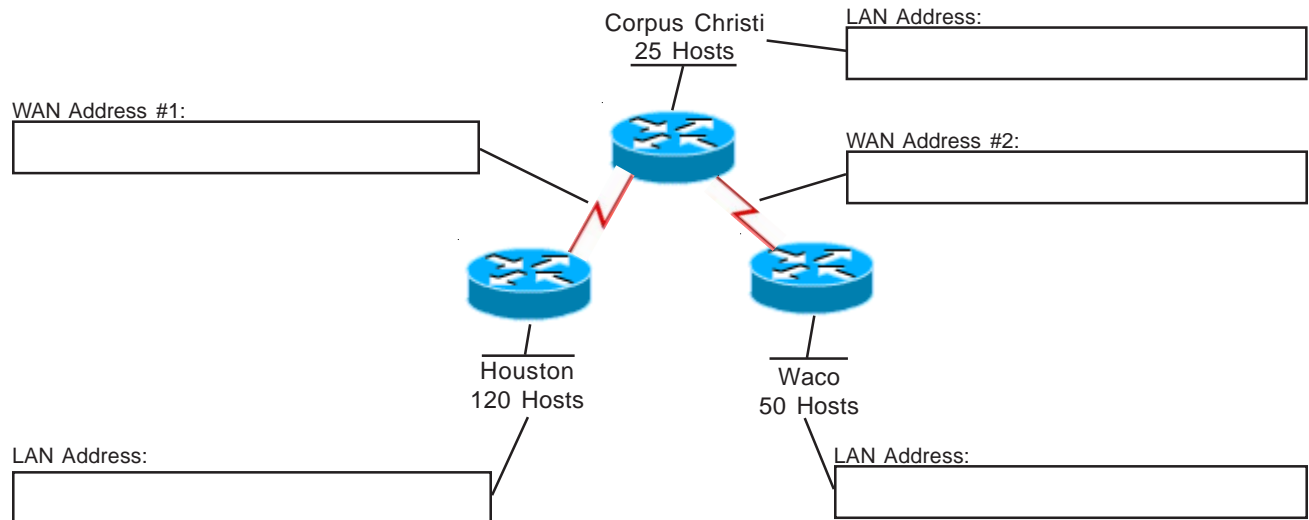| | 192 | 224 | 232 |
		227	
		228	
		231	239
		240	
127	223		255

VLSM Addressing
Box Method

Problem 4

Using the network diagram and information given create an addressing scheme which utilizes variable-length subnet masks. Show the subnet address and CIDR in the boxes below, color or shade the sub-subnets used in the box. This company will be using the class C address 220.108.38.0. Remember to start with your largest groups first.

Corpus Christi
25 Hosts

LAN Address:

WAN Address #1:

WAN Address #2:

Houston
120 Hosts

Waco
50 Hosts

LAN Address:

LAN Address:

Color in the squares used with different
shades to highlight each subnet.

0	8	32	40	128	136	160	168
3	11	35	43	131	139	163	171
4	12	36	44	132	140	164	172
7	15	39	47	135	143	167	175
16	24	48	56	144	152	176	184
19	27	51	59	147	155	179	187
20	28	52	60	148	156	180	188
23	31	55	63	151	159	183	191
64	72	96	104	192	200	224	232
67	75	99	107	195	203	227	235
68	76	100	108	196	204	228	236
71	79	103	111	199	207	231	239
80	88	112	120	208	216	240	248
83	91	115	123	211	219	243	251
84	92	116	124	212	220	244	252
87	95	119	127	215	223	247	255

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VLSM Addressing
Box Method

Problem 5

Using the network diagram and information given create an addressing scheme which utilizes variable-length subnet masks. Show the subnet address and CIDR in the boxes below, color or shade the sub-subnets used in the box. This company will be using the class C address 192.168.10.0. Remember to start with your largest groups first.

WAN Address #1:

New York
115 Hosts

LAN Address:

LAN Address:

San Jose

WAN Address #2:

LAN Address:

12 Hosts

Fargo
23 Hosts

48 Hosts

LAN Address:

Color in the squares used with different
shades to highlight each subnet.

0	8	32	40	128	136	160	168
3	11	35	43	131	139	163	171
4	12	36	44	132	140	164	172
7	15	39	47	135	143	167	175
16	24	48	56	144	152	176	184
19	27	51	59	147	155	179	187
20	28	52	60	148	156	180	188
23	31	55	63	151	159	183	191
64	72	96	104	192	200	224	232
67	75	99	107	195	203	227	235
68	76	100	108	196	204	228	236
71	79	103	111	199	207	231	239
80	88	112	120	208	216	240	248
83	91	115	123	211	219	243	251
84	92	116	124	212	220	244	252
87	95	119	127	215	223	247	255

VLSM Addressing
Box Method

Problem 6

Using the network diagram and information given create an addressing scheme which utilizes variable-length subnet masks. Show the subnet address and CIDR in the boxes below, color or shade the sub-subnets used in the box. This company will be using the class C address 222.10.150.0. Remember to start with your largest groups first.
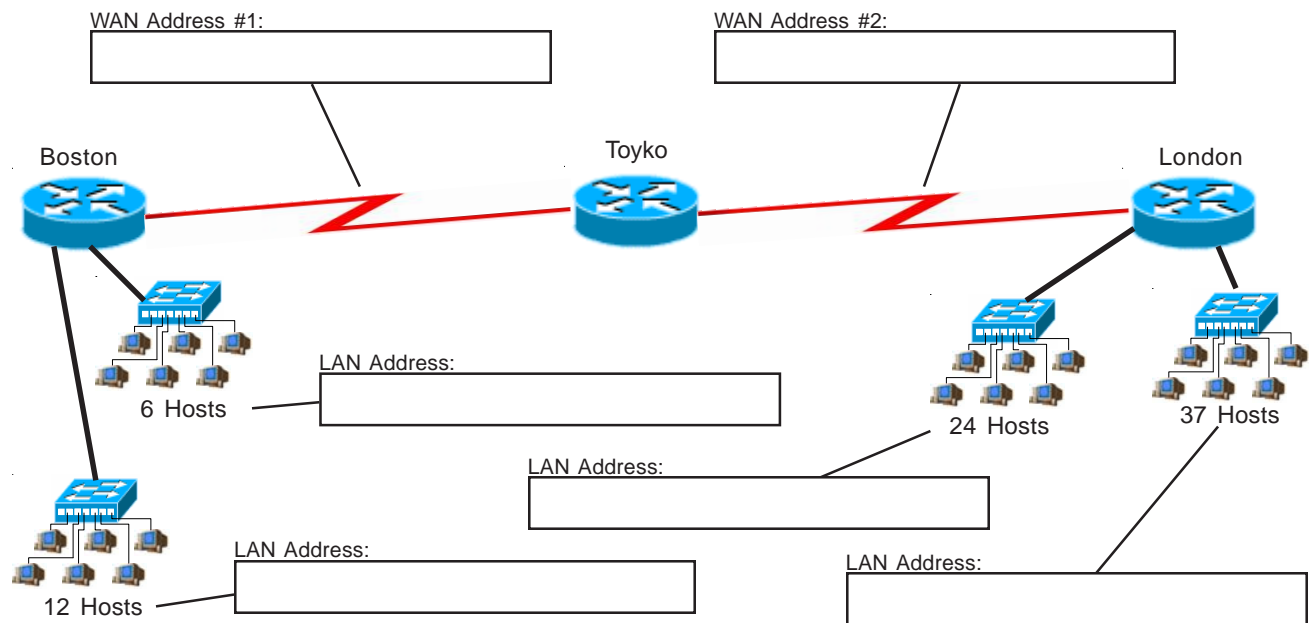
WAN Address #1:

WAN Address #2:

Boston

Toyko

London

LAN Address:

6 Hosts

24 Hosts

37 Hosts

LAN Address:

LAN Address:

12 Hosts

LAN Address:

LAN Address:

Draw the necessary lines and color in the used squares
with different shades to highlight each subnet.

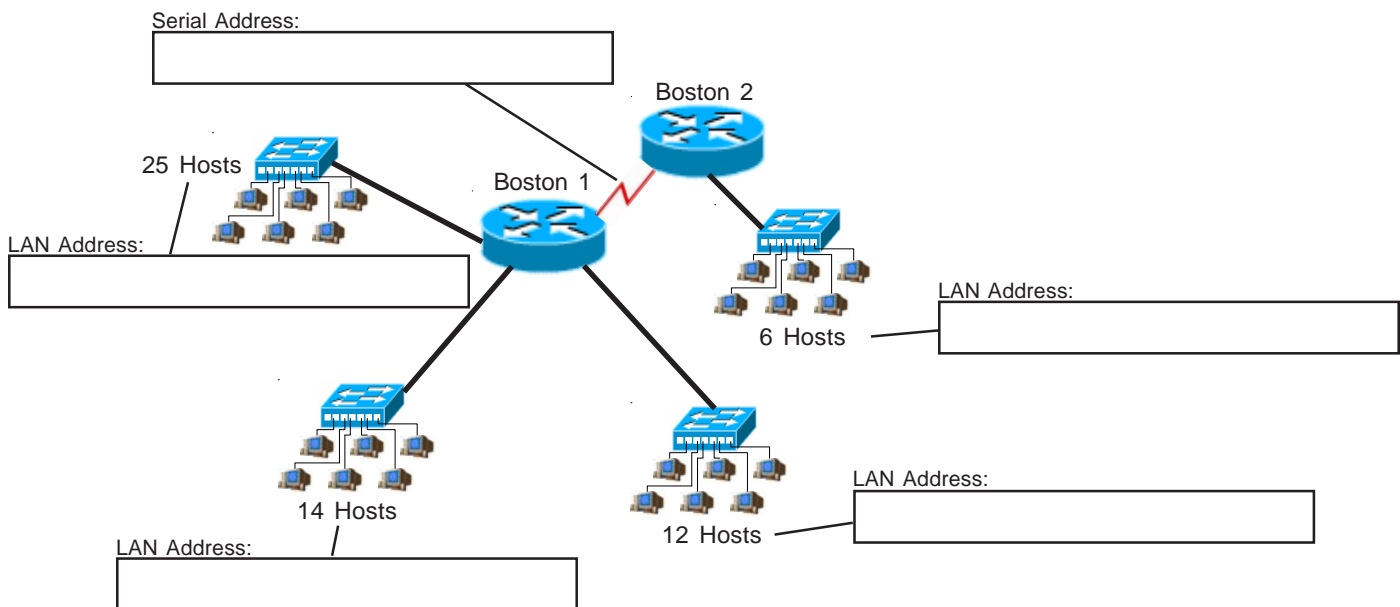| 0	32	128	160
31	63	159	191
64	96	192	224
95	127	223	255

VLSM Addressing
Box Method

Problem 7

Using the network diagram and information given create an addressing scheme which utilizes variable-length subnet masks. Show the subnet address and subnet mask in the boxes below, color or shade the sub-subnets used in the box. This company will be using the class C address 200.150.70.0. Remember to start with your largest groups first.

Serial Address:

Boston 2

25 Hosts

Boston 1

LAN Address:

LAN Address:

6 Hosts

14 Hosts

12 Hosts

LAN Address:

LAN Address:

Draw the necessary lines and color in the used squares
with different shades to highlight each subnet.
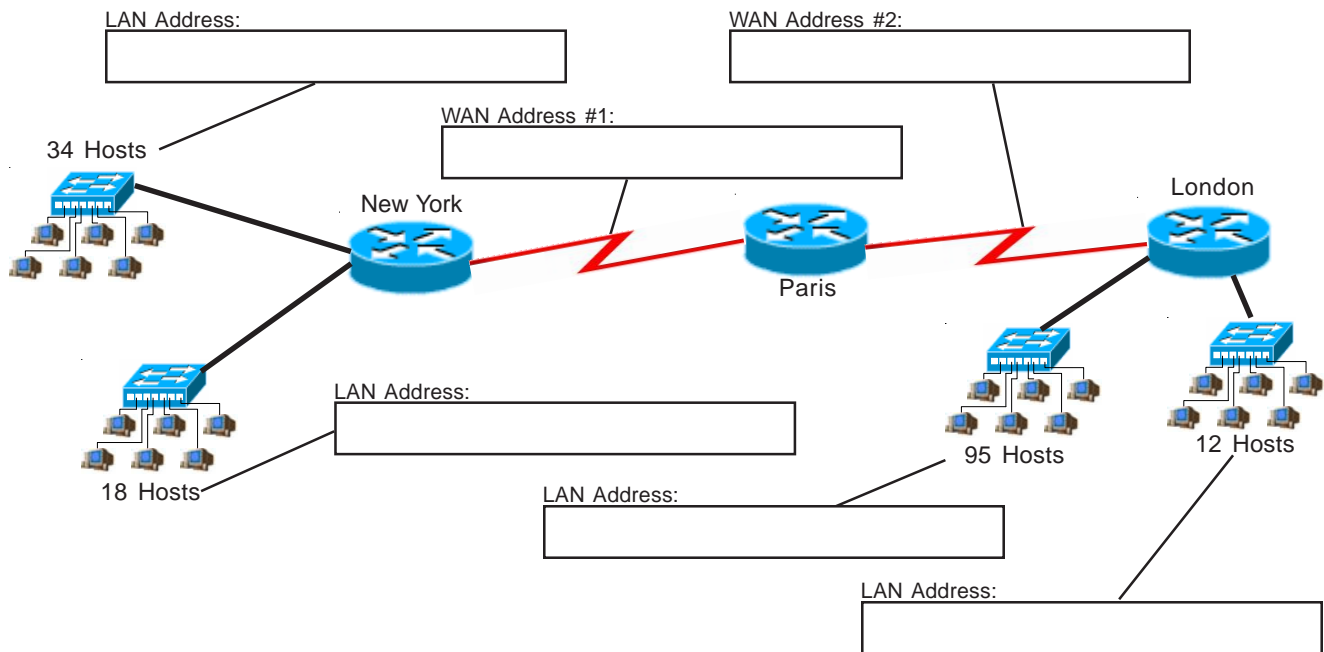
0	128
63	191
64	192
127	255

VLSM Addressing
Box Method

Problem 8

Using the network diagram and information given create an addressing scheme which utilizes variable-length subnet masks. Show the subnet address and subnet mask in the boxes below, color or shade the sub-subnets used in the box. This company will be using the class C address 192.168.24.0. Remember to start with your largest groups first.

LAN Address:

WAN Address #2:

WAN Address #1:

34 Hosts

London

New York

Paris

LAN Address:

95 Hosts

12 Hosts

18 Hosts

LAN Address:

LAN Address:

Draw the necessary lines and color in the used squares
with different shades to highlight each subnet.

0

255

13