

10.250.1.0

VLSM
Variable-Length Subnet Mask
Workbook
Version 1.0
Instructor's Edition

192.168

192.168.10.96

192.168.10.126

172.31.15.0

10.250.1.0

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](#).

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Special Thanks to Melvin Baker and Jim Dorsch
for taking the time to check this workbook for errors.

Instructors (and anyone else for that matter) please do not post the Instructors version on public websites. When you do this your giving everyone else worldwide the answers. Yes, students look for answers this way. It also discourages others; myself included, from posting high quality materials.

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.

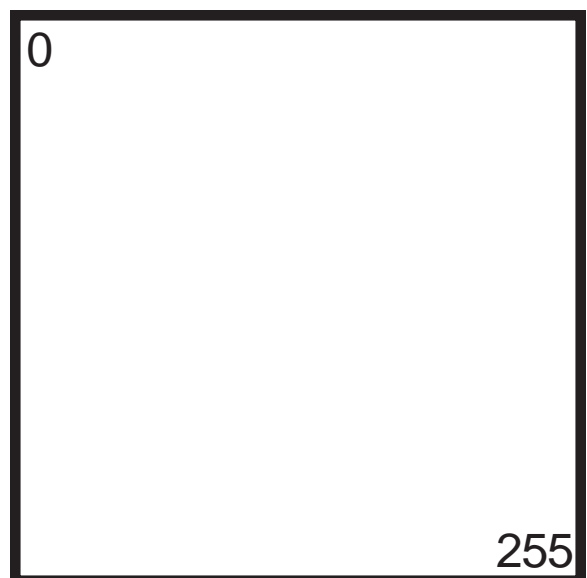
VLSM is supported by Cisco, OSPF, Dual IS-IS, BGP-4, and EIGRP. You need to configure your router for Variable Length Subnet Masking by setting up one of these protocols. Then configure the subnet masks of the various interfaces in the IP address interface sub-command. To use supernet you must also configure IP classless routes.

The Box Method

The box method is the simplest way to visualize the breakdown of a range of addresses into smaller different sized subnets.

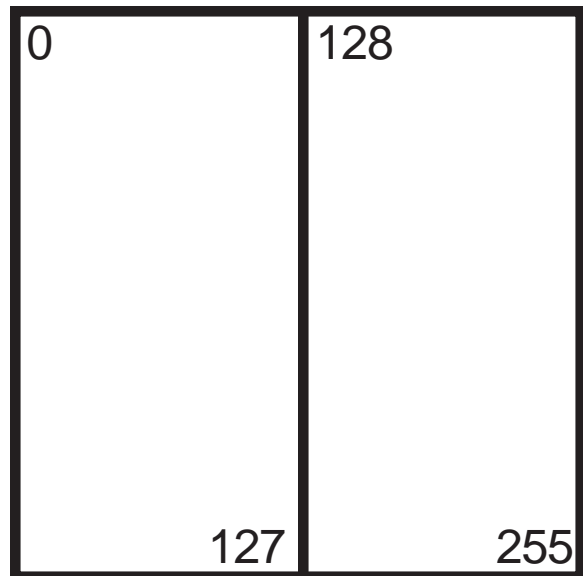
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet



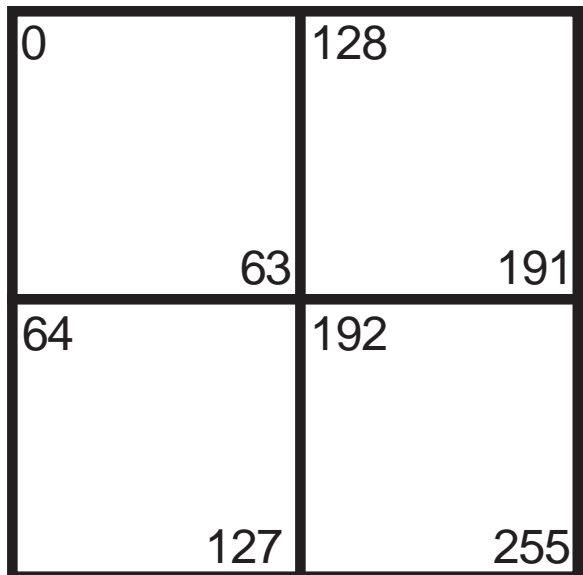
Split the box in half and you get two subnets with 128 addresses,

/25
 255.255.255.128
 128 Hosts
 2 Subnets



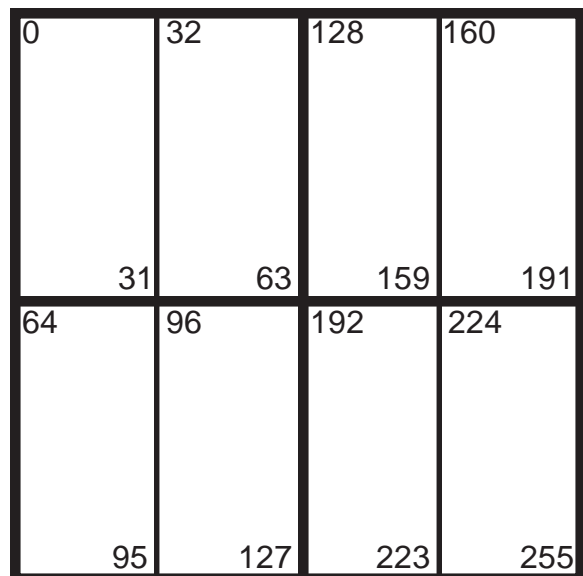
Divide the box into quarters and you get four subnets with 64 addresses,

/26
 255.255.255.192
 64 Hosts
 4 Subnets



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

/27
 255.255.255.224
 32 Hosts
 8 Subnets



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, You can use these squares in any combination to fit your addressing needs.

/30
255.255.255.252
4 Hosts
64 Subnets

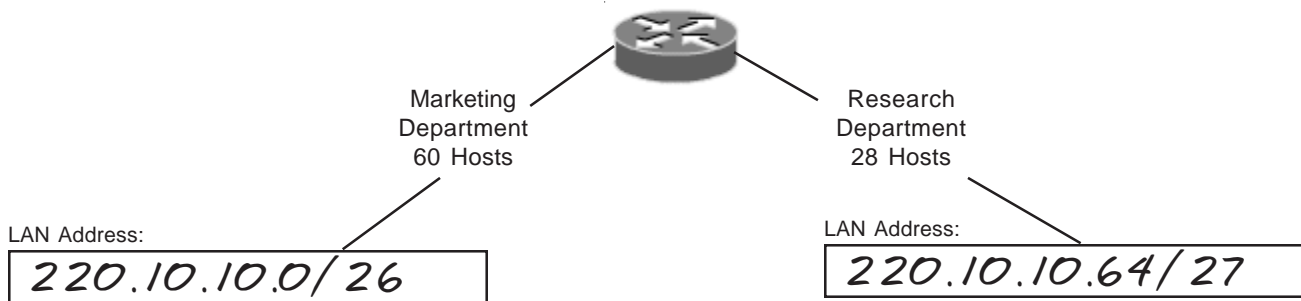
0	8	32	40	128	136	160	168
3	11	35	43	131	139	163	171
4	12	36	44	132	140	164	172
7	15	39	47	135	143	167	175
16	24	48	56	144	152	176	184
19	27	51	59	147	155	179	187
20	28	52	60	148	156	180	188
23	31	55	63	151	159	183	191
64	72	96	104	192	200	224	232
67	75	99	107	195	203	227	235
68	76	100	108	196	204	228	236
71	79	103	111	199	207	321	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

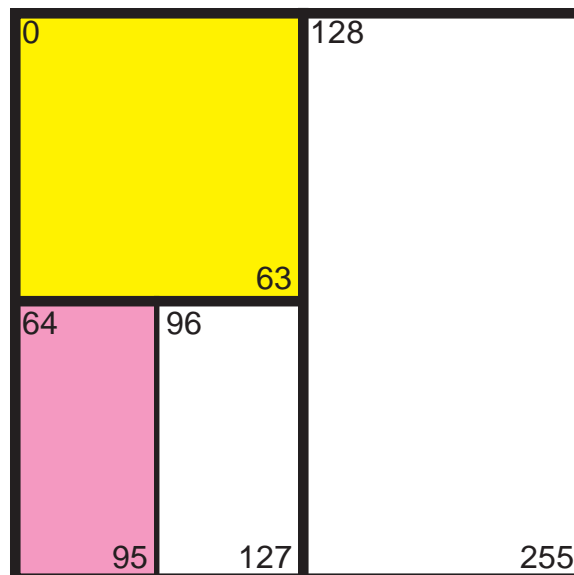
(Sample)

Problem 1

Using the network diagram and information given create an addressing scheme which utilizes variable-length subnet masks. Show the subnet address and subnet mask 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.



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

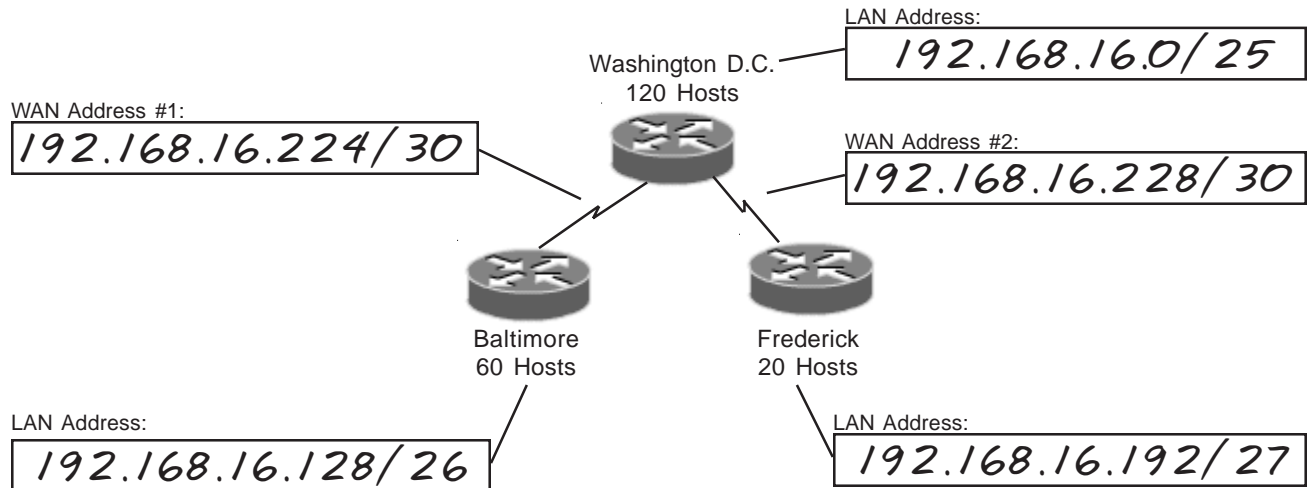


VLSM Addressing

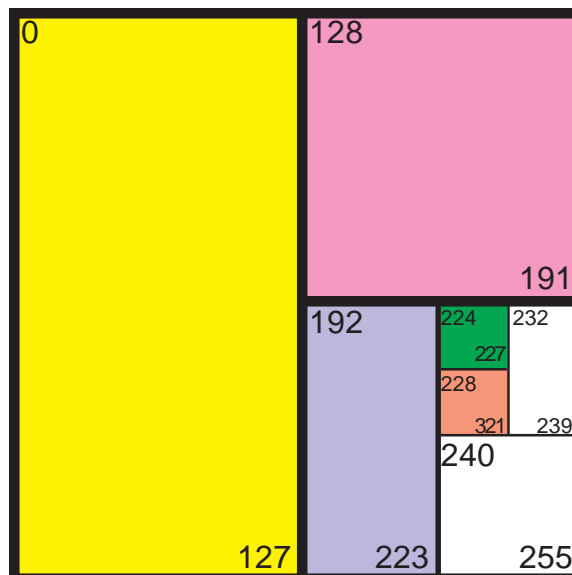
(Sample)

Problem 2

Using the network diagram and information given create an addressing scheme which utilizes variable-length subnet masks. Show the subnet address and 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 192.168.16.0. Remember to start with your largest groups first.



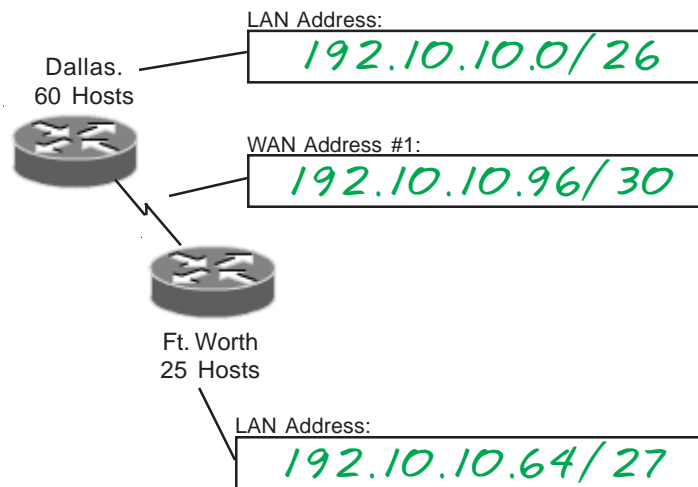
Color in the squares used with different shades to highlight each sub-subnet.



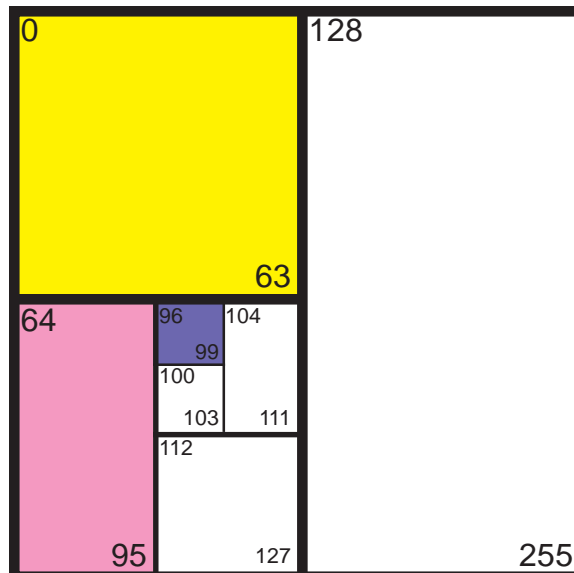
VLSM Addressing

Problem 3

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 192.10.10.0. Remember to start with your largest groups first.



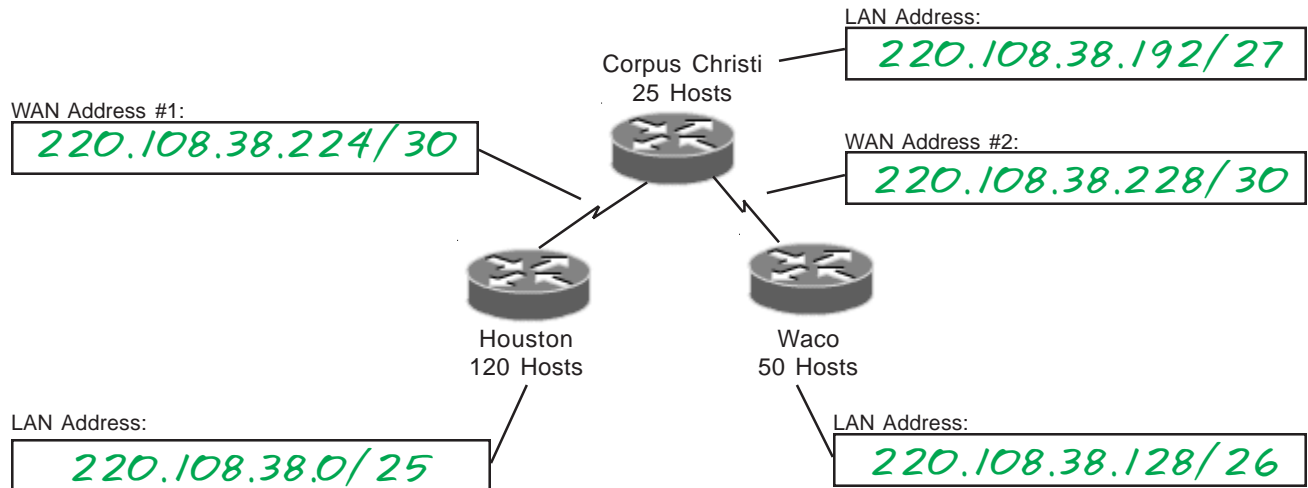
Color in the squares used with different shades to highlight each sub-subnet.



VLSM Addressing

Problem 4

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 220.108.38.0. Remember to start with your largest groups first.



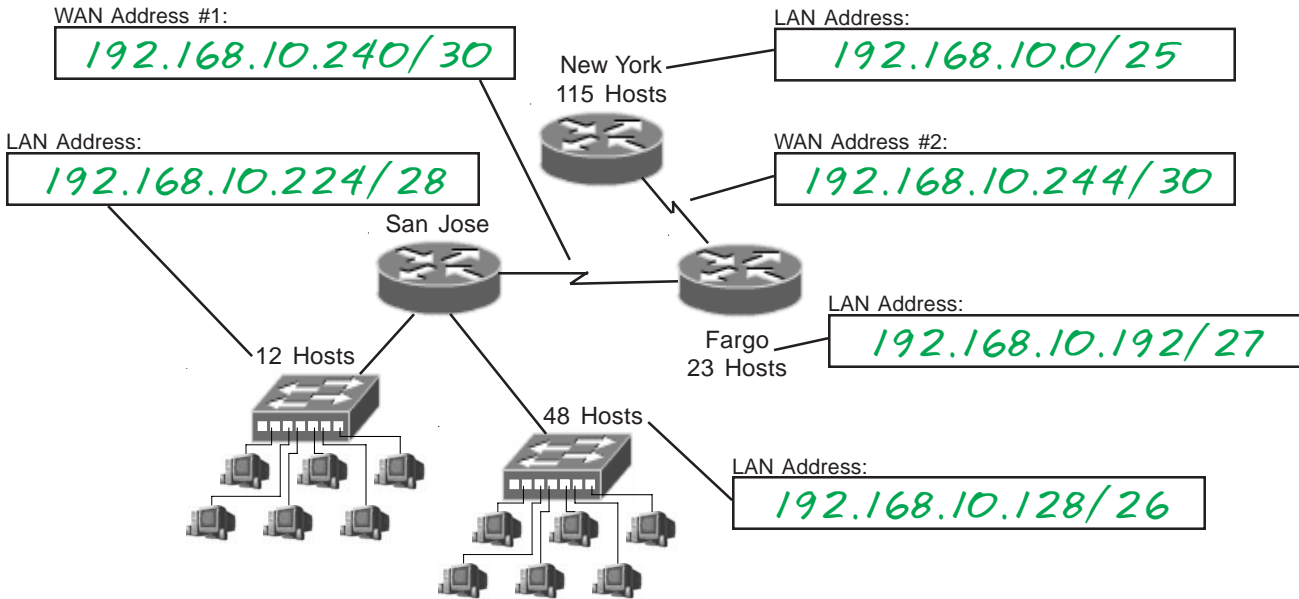
Color in the squares used with different shades to highlight each sub-subnet.

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	321	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

Problem 5

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 192.168.10.0. Remember to start with your largest groups first.



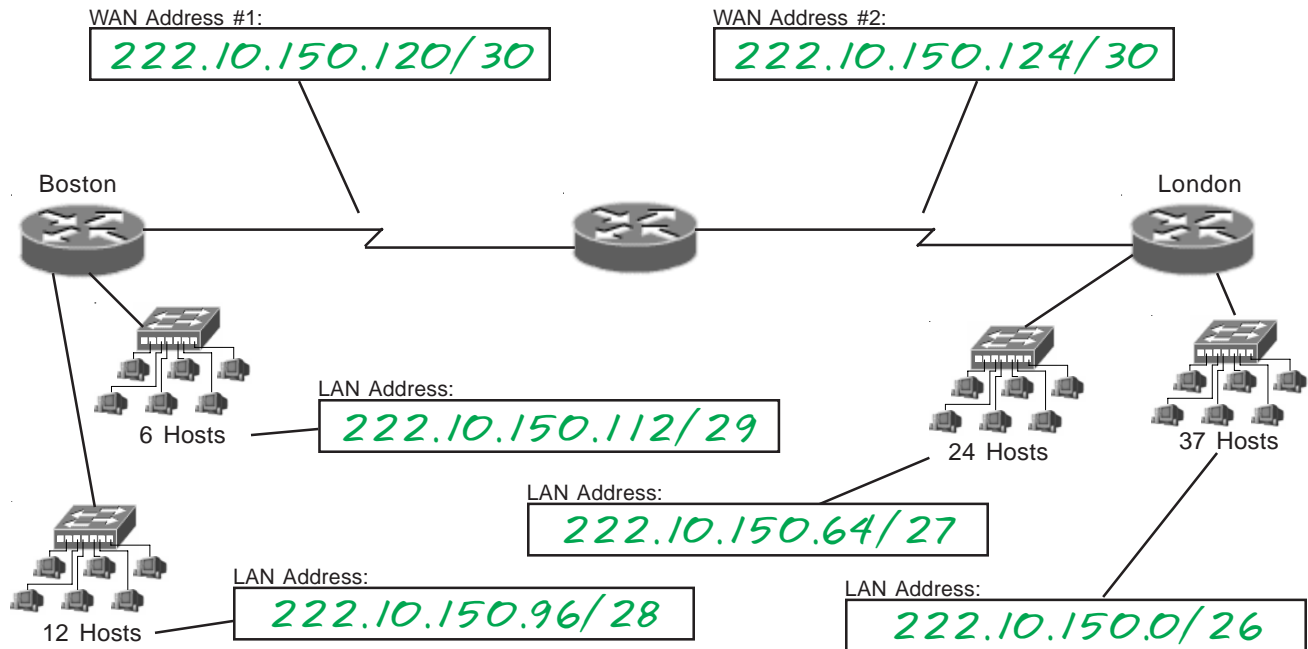
Color in the squares used with different shades to highlight each sub-subnet.

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	321	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

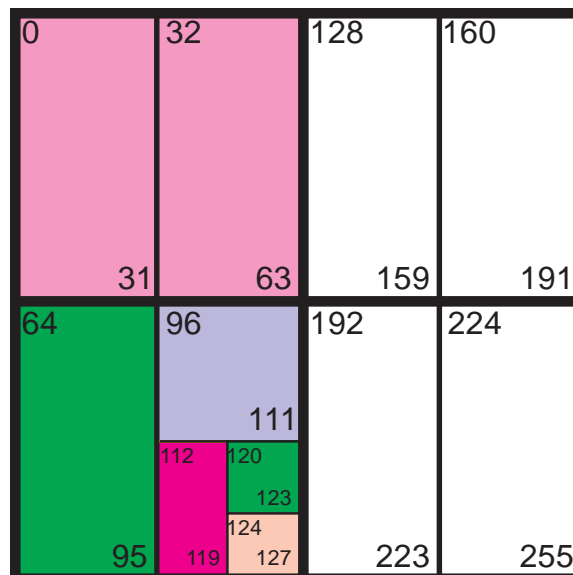
VLSM Addressing

Problem 6

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 222.10.150.0. Remember to start with your largest groups first.



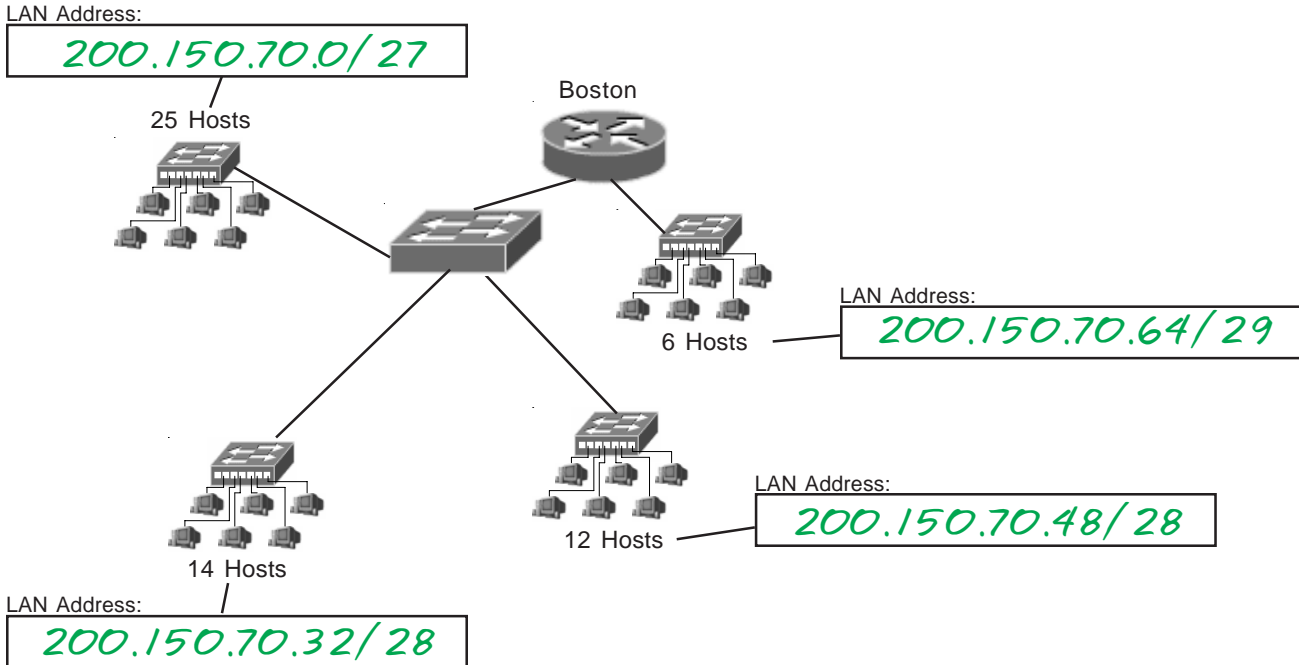
Draw the necessary lines and color in the used squares with different shades to highlight each sub-subnet.



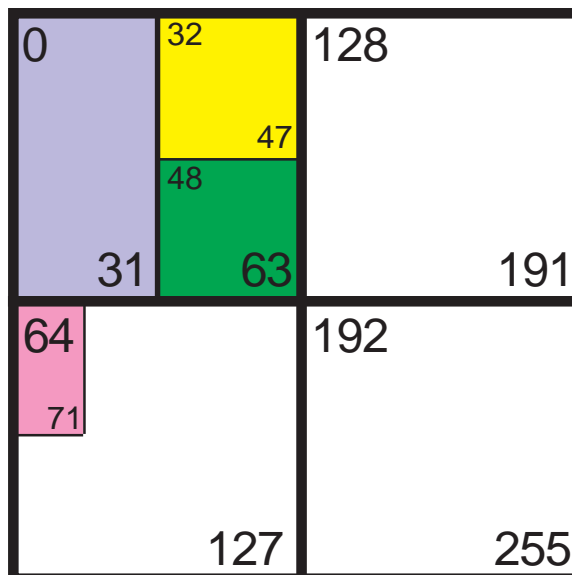
VLSM Addressing

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.



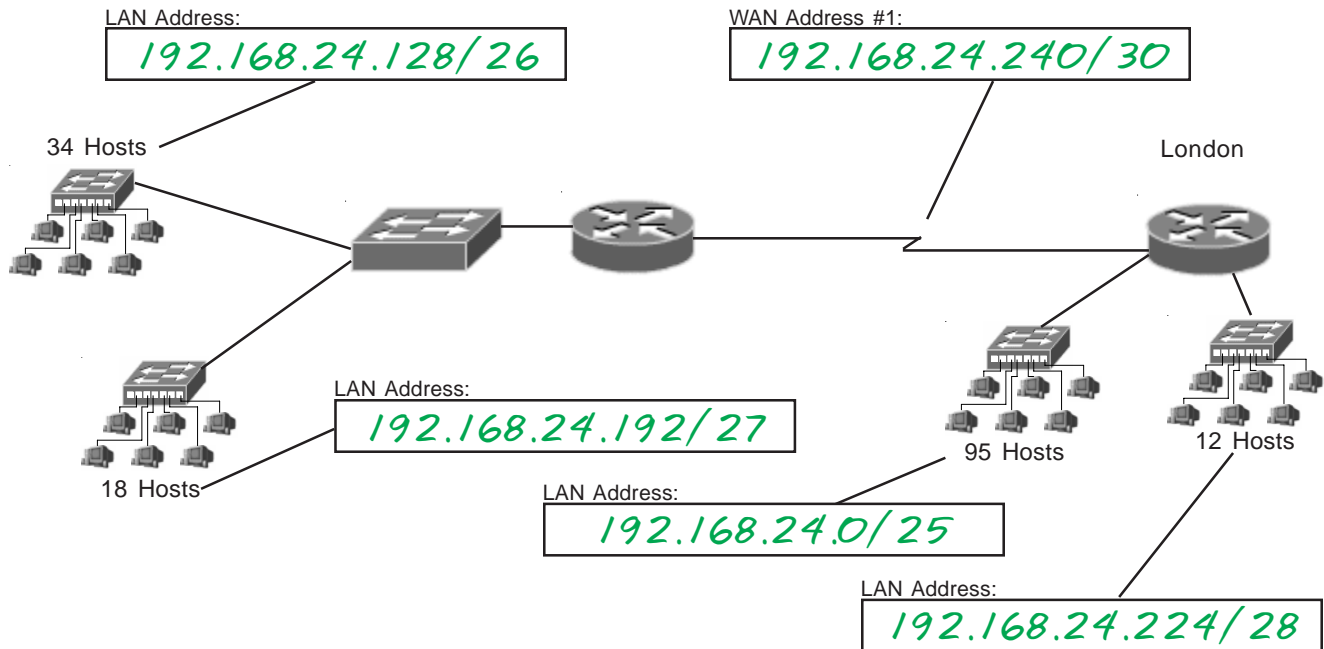
Draw the necessary lines and color in the used squares with different shades to highlight each sub-subnet.



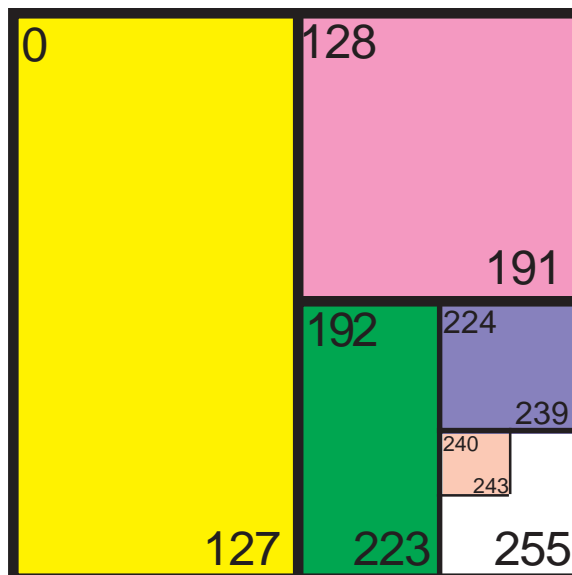
VLSM Addressing

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.



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



VLSM Addressing

(Sample)

Problem 9

You are developing a school network with the class C address 192.168.2.0/24. There will be three computer labs with 30 computers each that need to be on different sub-subnets. Forty eight classrooms with one computer each that will comprise a single sub-subnet. The administrative office and guidance office contain a total of seven computers which will need to be grouped together. Plan for four more mini labs with six computers to each sub-subnetwork. Divide the network using variable length subnet masks. Complete the information required below. Remember to work from largest to smallest.

Subnet	Subnet Address	Subnet Mask (/X)	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.2.0	/26	192.168.2.1	192.168.2.62	192.168.2.63
2	192.168.2.64	/27	192.168.2.65	192.168.2.94	192.168.2.95
3	192.168.2.96	/27	192.168.2.97	192.168.2.126	192.168.2.127
4	192.168.2.128	/27	192.168.2.129	192.168.2.158	192.168.2.159
5	192.168.2.160	/28	192.168.2.161	192.168.2.174	192.168.2.175
6	192.168.2.176	/29	192.168.2.177	192.168.2.182	192.168.2.183
7	192.168.2.184	/29	192.168.2.185	192.168.2.190	192.168.2.191
8	192.168.2.192	/29	192.168.2.193	192.168.2.198	192.168.2.199
9	192.168.2.200	/29	192.168.2.201	192.168.2.206	192.168.2.207
10					
11					
12					
13					
14					

VLSM Addressing

(Sample)

Problem 10

You are setting up a small business network with the class C address 220.55.80.0/24. The marketing division will need 12 computers. Research and development needs 27 computers. The reception area will need two computers. Management requires 19 computers. Divide the network using variable length subnet masks. Complete the information required below. Remember to work from largest to smallest.

Subnet	Subnet Address	Subnet Mask (/X)	First Usable Host	Last Usable Host	Broadcast Address
1	220.55.80.0	/27	220.55.80.1	220.55.80.30	220.55.80.31
2	220.55.80.32	/27	220.55.80.	220.55.80.62	220.55.80.63
3	220.55.80.64	/28	220.55.80.65	220.55.80.78	220.55.80.79
4	220.55.80.80	/30	220.55.80.81	220.55.80.82	220.55.80.83
5					
6					
7					
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12					
13					
14					

VLSM Addressing

Problem 11

You are setting up a medium sized network with the class C address 222.37.34.0/24. Marketing needs 29 computers. Research and development needs 110 computers. Bookkeeping will use 12 computers. The reception area will need three computers. Management requires 60 computers. Divide the network using variable length subnet masks. Complete the information required below. Remember to work from largest to smallest.

Subnet	Subnet Address	Subnet Mask (/X)	First Usable Host	Last Usable Host	Broadcast Address
1	222.37.34.0	/25	222.37.34.1	222.37.34.126	222.37.34.127
2	222.37.34.128	/26	222.37.34.129	222.37.34.190	222.37.34.191
3	222.37.34.192	/27	222.37.34.193	222.37.34.222	222.37.34.223
4	222.37.34.224	/28	222.37.34.225	222.37.34.238	222.37.34.239
5	222.37.34.240	/29	222.37.34.241	222.37.34.246	222.37.34.247
6					
7					
8					
9					
10					
11					
12					
13					
14					

VLSM Addressing

Problem 12

A shipping company needs to set up its network across several locations. The Denver office needs six computers. The Waco office needs 22 computers. The Fargo office will need five computers. The WAN links between all three locations need to be included in the solution. Using the IP address 192.168.10.0/24 divide the network using VLSM. Complete the information required below. Remember to work from largest to smallest.

Subnet	Subnet Address	Subnet Mask (/X)	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.10.0	/27	192.168.10.1	192.168.10.30	192.168.10.31
2	192.168.10.32	/29	192.168.10.33	192.168.10.38	192.168.10.39
3	192.168.10.40	/29	192.168.10.41	192.168.10.46	192.168.10.47
4	192.168.10.48	/30	192.168.10.49	192.168.10.50	192.168.10.51
5	192.168.10.52	/30	192.168.10.53	192.168.10.54	192.168.10.55
6					
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9					
10					
11					
12					
13					
14					

VLSM Addressing

Problem 13

A new school is being built in the local school district. It will have three computer labs with 28 computers each. There will be 58 classrooms with 2 computers each that need to be on one sub-subnet. The office staff and administrators will need 7 computers. The guidance and attendance office will have 5 computers. Setup the remaining addressing into one sub-subnet for future expansion. The school has been given the address 223.145.75.0/24. Complete the information required below. Remember to work from largest to smallest.

Subnet	Subnet Address	Subnet Mask (/X)	First Usable Host	Last Usable Host	Broadcast Address
1	223.145.75.0	/25	223.145.75.1	223.145.75.126	223.145.75.127
2	223.145.75.128	/27	223.145.75.129	223.145.75.158	223.145.75.159
3	223.145.75.160	/27	223.145.75.161	223.145.75.190	223.145.75.191
4	223.145.75.192	/27	223.145.75.193	223.145.75.222	223.145.75.223
5	223.145.75.224	/28	223.145.75.225	223.145.75.238	223.145.75.239
6	223.145.75.240	/29	223.145.75.241	223.145.75.246	223.145.75.247
7	223.145.75.248	/29	223.145.75.249	223.145.75.254	223.145.75.255
8					
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VLSM Addressing

Problem 14

A local college is setting up a campus wide network. The technology wing will be on its own network address of 192.168.250.0/24. The office wing will include 15 computers. There are 2 labs of 20 computers each, 2 labs of 30 computers each and one lab of 35 computers. Complete the information required below. Remember to work from largest to smallest.

Subnet	Subnet Address	Subnet Mask (/X)	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.250.0	/26	92.168.250.1	92.168.250.62	92.168.250.63
2	92.168.250.64	/27	92.168.250.65	92.168.250.94	92.168.250.95
3	92.168.250.96	/27	92.168.250.97	92.168.250.126	92.168.250.127
4	92.168.250.128	/27	92.168.250.129	92.168.250.158	92.168.250.159
5	92.168.250.160	/27	92.168.250.161	92.168.250.190	92.168.250.191
6	92.168.250.192	/27	92.168.250.193	92.168.250.222	92.168.250.223
7					
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VLSM Addressing

Problem 15

You are setting up a network for a company in four locations. Location A has 8 computers. Location B has 122 computers. Location C has 4 computers. Location D has 55 computers. There is a WAN connection between all four locations. Complete the information required below using the class C address 192.168.10.0. Remember to work from largest to smallest.

Subnet	Subnet Address	Subnet Mask (/X)	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.10.0	/25	192.168.10.1	192.168.10.126	192.168.10.127
2	192.168.10.128	/26	192.168.10.129	192.168.10.190	192.168.10.191
3	192.168.10.192	/28	192.168.10.193	192.168.10.206	192.168.10.207
4	192.168.10.208	/29	192.168.10.209	192.168.10.214	192.168.10.215
5	192.168.10.216	/30	192.168.10.217	192.168.10.218	192.168.10.219
6	192.168.10.220	/30	192.168.10.221	192.168.10.222	192.168.10.223
7	192.168.10.224	/30	192.168.10.225	192.168.10.226	192.168.10.227
8					
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10					
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VLSM Addressing

Problem 16

A college dormitory is being remodeled. A new network is being installed. There are 50 dorm rooms with two drops each that will be on one sub-subnet. The offices will have 5 drops. The reception desk will have three drops. A small study hall will include 30 drops. Using the IP address 192.168.12.0/24 complete the information required below using VLSM. Work from largest to smallest.

Subnet	Subnet Address	Subnet Mask (/X)	First Usable Host	Last Usable Host	Broadcast Address
1	192.168.12.0	/25	192.168.12.1	192.168.12.126	192.168.12.127
2	192.168.12.128	/27	192.168.12.129	192.168.12.158	192.168.12.159
3	192.168.12.160	/29	192.168.12.161	192.168.12.166	192.168.12.167
4	192.168.12.168	/29	192.168.12.169	192.168.12.174	192.168.12.175
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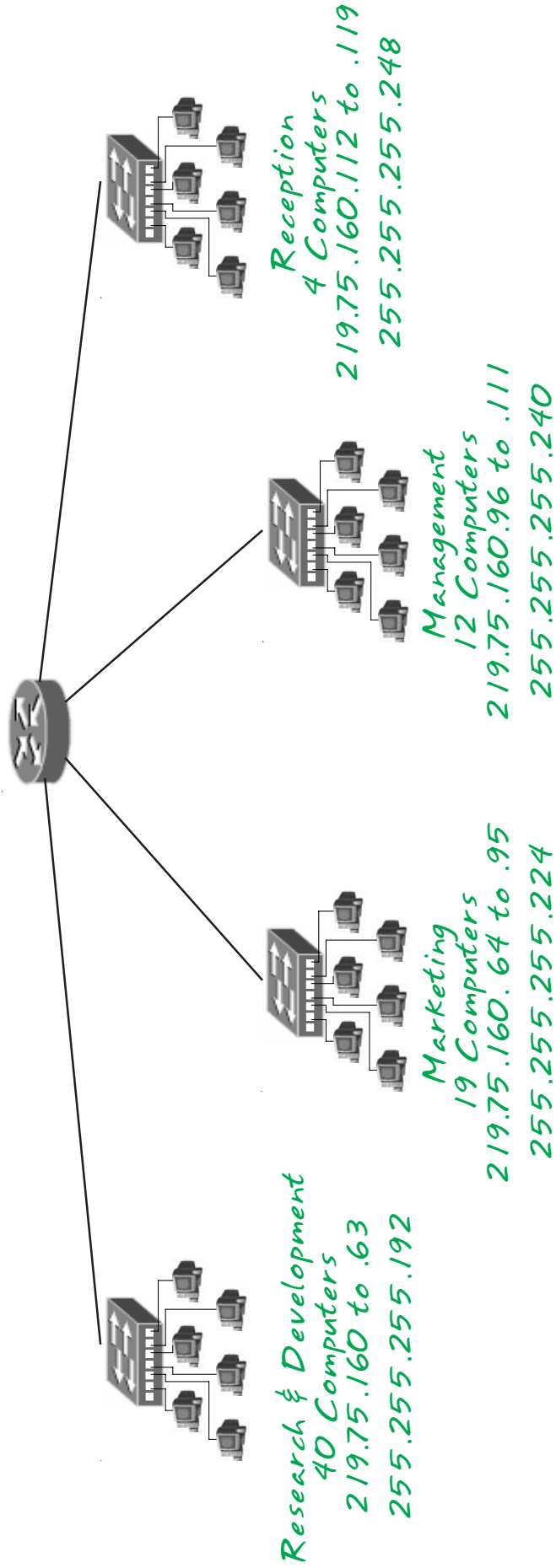
VLSM Addressing

Problem 17

You are setting up a business network with the class C address 219.75.160.0/24. The marketing division will need 19 computers. Research and development needs 40 computers. The reception area will need four computers. Management requires 12 computers. Divide the network using variable length subnet masks. On the opposite page draw a detailed map of this network. Include the sub-subnet IP addresses for each branch of the network with the subnet mask. One router with four ethernet ports will be used for this network.

Subnet	Subnet Address	Subnet Mask (/X)	First Usable Host	Last Usable Host	Broadcast Address
1	219.75.160.0	/26	219.75.160.1	219.75.160.62	219.75.160.63
2	219.75.160.64	/27	219.75.160.65	219.75.160.94	219.75.160.95
3	219.75.160.96	/28	219.75.160.97	219.75.160.110	219.75.160.111
4	219.75.160.112	/29	219.75.160.113	219.75.160.118	219.75.160.119
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Problem 17 - Detailed Map



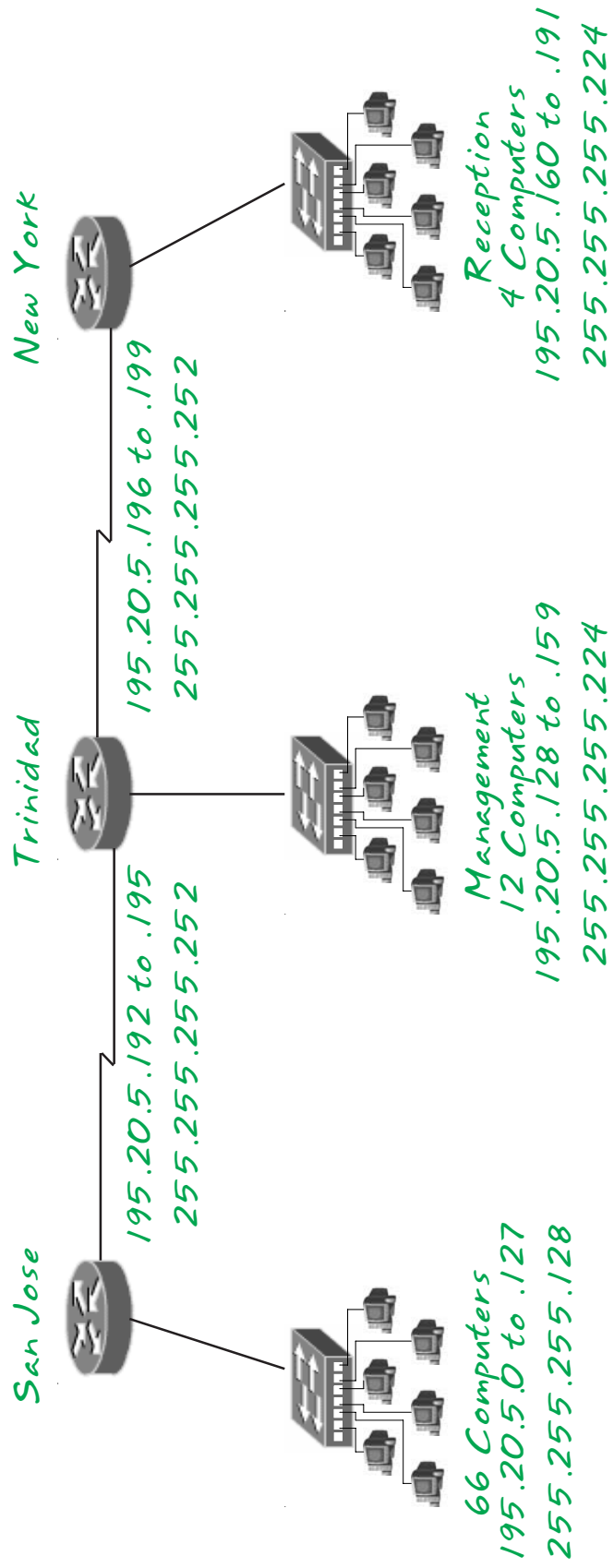
VLSM Addressing

Problem 18

A small company needs to set up its network across several locations. The New York branch office needs 15 computers. The San Jose office needs 66 computers. The Trinidad office will need 18 computers. The WAN links between all three locations need to be included. Using the IP address 195.20.5.0/24 divide the network using VLSM. On the opposite page draw a detailed map of this network. Include the sub-subnet IP addresses for each branch of the network with the subnet mask. Label the WAN links with the same information. Complete the information required below. Work from largest to smallest.

Subnet	Subnet Address	Subnet Mask (/X)	First Usable Host	Last Usable Host	Broadcast Address
1	195.20.5.0	/25	195.20.5.1	195.20.5.126	195.20.5.127
2	195.20.5.128	/27	195.20.5.129	195.20.5.158	195.20.5.159
3	195.20.5.160	/27	195.20.5.161	195.20.5.190	195.20.5.191
4	195.20.5.192	/30	195.20.5.193	195.20.5.194	195.20.5.195
5	195.20.5.196	/30	195.20.5.197	195.20.5.198	195.20.5.199
6					
7					
8					
9					
10					
11					
12					
13					
14					

Problem 18 - Detailed Map



Class A Addressing Guide

# of Bits Borrowed	Subnet Mask	Total # of Subnets	Usable # of Subnets	Total # of Hosts	Usable # of Hosts
2	255.192.0.0	4	2	4,194,304	4,194,302
3	255.224.0.0	8	6	2,097,152	2,097,150
4	255.240.0.0	16	14	1,048,576	1,048,574
5	255.248.0.0	32	30	524,288	524,286
6	255.252.0.0	64	62	262,144	262,142
7	255.254.0.0	128	126	131,072	131,070
8	255.255.0.0	256	254	65,536	65,534
9	255.255.128.0	512	510	32,768	32,766
10	255.255.192.0	1,024	1,022	16,384	16,382
11	255.255.224.0	2,048	2,046	8,192	8,190
12	255.255.240.0	4,096	4,094	4,096	4,094
13	255.255.248.0	8,192	8,190	2,048	2,046
14	255.255.252.0	16,384	16,382	1,024	1,022
15	255.255.254.0	32,768	32,766	512	510
16	255.255.255.0	65,536	65,534	256	254
17	255.255.255.128	131,072	131,070	128	126
18	255.255.255.192	262,144	262,142	64	62
19	255.255.255.224	524,288	524,286	32	30
20	255.255.255.240	1,048,576	1,048,574	16	14
21	255.255.255.248	2,097,152	2,097,150	8	6
22	255.255.255.252	4,194,304	4,194,302	4	2

Class B Addressing Guide

# of Bits Borrowed	Subnet Mask	Total # of Subnets	Usable # of Subnets	Total # of Hosts	Usable # of Hosts
2	255.255.192.0	4	2	16,384	16,382
3	255.255.224.0	8	6	8,192	8,190
4	255.255.240.0	16	14	4,096	4,094
5	255.255.248.0	32	30	2,048	2,046
6	255.255.252.0	64	62	1,024	1,022
7	255.255.254.0	128	126	512	510
8	255.255.255.0	256	254	256	254
9	255.255.255.128	512	510	128	126
10	255.255.255.192	1,024	1,022	64	62
11	255.255.255.224	2,048	2,046	32	30
12	255.255.255.240	4,096	4,094	16	14
13	255.255.255.248	8,192	8,190	8	6
14	255.255.255.252	16,384	16,382	4	2

Class C Addressing Guide

# of Bits Borrowed	Subnet Mask	Total # of Subnets	Usable # of Subnets	Total # of Hosts	Usable # of Hosts
2	255.255.255.192	4	2	64	62
3	255.255.255.224	8	6	32	30
4	255.255.255.240	16	14	16	14
5	255.255.255.248	32	30	8	6
6	255.255.255.252	64	62	4	2

VLSM Chart 24-30 Bits

/24 255.255.255.0 256 Hosts	/25 255.255.255.128 128 Hosts	/26 255.255.255.192 64 Hosts	/27 255.255.255.224 32 Hosts	/28 255.255.255.240 16 Hosts	/29 255.255.255.248 8 Hosts	/30 255.255.255.252 4 Hosts				
0 - 255	0-127	0-63	0-31	0-15	0-7	0-3				
					8-15	4-7	8-11			
				16-31	16-23	12-15	16-19			
					24-31	20-23	24-27			
			32-63	32-47	32-39	28-31	32-35			
					40-47	36-39	40-43			
					48-63	48-55	44-47	48-51		
						56-63	52-55	56-59		
		64-127		64-79	64-71	60-63	64-67			
					72-79	64-67	68-71			
					80-95	80-87	72-75	80-83		
						88-95	76-79	84-87		
			96-127	96-111	96-103	88-91	92-95			
					104-111	96-99	100-103			
				112-127	112-119	104-107	112-115			
					120-127	108-111	116-119			
	128-255	128-191	128-159	128-143	128-135	128-131	128-135			
					136-143	132-135	136-139			
				144-159	144-151	140-143	144-147			
					152-159	144-147	148-151			
			160-191	160-175	16-167	152-155	160-163			
					168-175	156-159	164-167			
				176-191	176-183	160-163	168-171			
					184-191	164-167	172-175			
		192-255	192-207	192-207	176-179	176-183	176-179	180-183		
					184-191	184-187	184-187	188-191		
				208-223	192-199	192-195	192-195	192-195		
					200-207	196-199	196-199	200-203		
			224-239	208-223	208-215	200-207	204-207	208-211	212-215	
					216-223	208-211	212-215	216-219	220-223	
				224-239	224-231	224-227	224-227	224-227	228-231	232-235
					232-239	228-231	232-235	236-239	240-243	244-247
240-255	240-255	240-247	240-243	240-243	244-247	248-251				
		248-255	244-247	248-251	252-255					

