The CIDRD mail list archive: <ftp://aarnet.edu.au/pub/mailing-lists/cidrd>

Internet Drafts published by the CIDRD working group are available from: <http://www.ietf.cnri.reston.va.us/ids.by.wg/cidrd.html>

Procedures for Internet/Enterprise Renumbering (PIER)

General information about the PIER working group of the IETF and its charter is available from: <http://www.ietf.cnri.reston.va.us/html.charters/pier-charter.html>

To subscribe to the PIER mailing list: <pier-request@isi.edu>

The PIER mail list archive: < ftp://ftp.isi.edu/pier-archive>

Papers developed by PIER are available from: <http://www.isi.edu:80/div7/pier/>.

Dynamic Host Configuration (DHCP)

For information about the DHCP working group, current Internet-Drafts, and Requests for Comments: <http://www.ietf.cnri.reston.va.us/html.charters/dhc-charter.html>

To access the DHCP Home Page: <http://charlotte.acns.nwu.edu/internet/tech/dhcp/>

To subscribe to the DHCP mailing list: <host-conf-request@sol.eg.bucknell.edu>

The DHCP mail list archive: <ftp://ftp.bucknell.edu/pub/dhcp>

IPng (IPNGWG)

For information about the IPng working group, current Internet-Drafts, and Requests for Comments: <http://www.ietf.cnri.reston.va.us/html.charters/ipngwg-charter.html>

To access the IPng Home Page: <http://playground.sun.com/pub/ipng/html/ipng-main.html>

To subscribe to the IPng mailing list: < majordomo@sunroof.eng.sun.com>

The IPng mail list archive: <ftp://parcftp.xerox.com/pub/ipng>

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Appendix B - Classful IP Addressing

Practice Exercises

1. Complete the following table which provides practice in converting a number from binary notation to decimal format.

Binary	128	64	32	16	8	4	2	1	Decimal
11001100	1	1	0	0	1	1	0	0	128+64+8+4 = 204
10101010									
11100011									
10110011									
00110101									

2. Complete the following table which provides practice in converting a number from decimal notation to binary format.

Decimal	128	64	32	16	8	4	2	1	Binary
48	0	0	1	1	0	0	0	0	$48=32+16=00110000_2$
222									
119									
135									
60									

3. Express 145.32.59.24 in binary format and identify the address class:

____

4. Express 200.42.129.16 in binary format and identify the address class:

____

5. Express 14.82.19.54 in binary format and identify the address class:

____

Solutions to Classful IP Addressing Practice Exercises

1. Complete the following table which provides practice in converting a number from binary notation to decimal format.

Binary	128	64	32	16	8	4	2	1	Decimal
11001100	1	1	0	0	1	1	0	0	**204**
10101010	1	0	1	0	1	0	1	0	**170**
11100011	1	1	1	0	0	0	1	1	**227**
10110011	1	0	1	1	0	0	1	1	**179**
00110101	0	0	1	1	0	1	0	1	**53**

2. Complete the following table which provides practice in converting a number from decimal notation to binary format.

Decimal	128	64	32	16	8	4	2	1	Binary
48	0	0	1	1	0	0	0	0	**0011 0000**
222	1	1	0	1	1	1	1	0	**1101 1110**
119	0	1	1	1	0	1	1	1	**0111 0111**
135	1	0	0	0	0	1	1	1	**1000 0111**
60	0	0	1	1	1	1	0	0	**0011 1100**

3. Express 145.32.59.24 in binary format and identify the classful prefix length.

   10010001.00100000.00111011.00011000 /16 or Class B

4. Express 200.42.129.16 in binary format and identify the classful prefix length.

   11001000.00101010.10000001.00010000 /24 or Class C

5. Express 14.82.19.54 in binary format and identify the classful prefix length.

   00001110.01010010. 00010011.00110110 /8 or Class A

Appendix C - Subnetting Examples

Subnetting Exercise #1

Assume that you have been assigned the 132.45.0.0/16 network block. You need to establish eight subnets

1. ___________ binary digits are required to define eight subnets.

2. Specify the extended-network-prefix that allows the creation of 8 subnets.

   ____

3. Express the subnets in binary format and dotted decimal notation:

   #0 ____

   #1 ____

   #2 ____

   #3 ____

   #4 ____

   #5 ____

   #6 ____

   #7 ____

4. List the range of host addresses that can be assigned to Subnet #3 (132.45.96.0/19).

   ____

   ____

   ____

   ____

   ____

6. What is the broadcast address for Subnet #3 (132.45.96.0/19).

   ____

Subnetting Exercise #2

1. Assume that you have been assigned the 200.35.1.0/24 network block. Define an extended-network-prefix that allows the creation of 20 hosts on each subnet.

   ____

2. What is the maximum number of hosts that can be assigned to each subnet?

   ____

3. What is the maximum number of subnets that can be defined?

   ____

4. Specify the subnets of 200.35.1.0/24 in binary format and dotted decimal notation.

   ____

   ____

   ____

   ____

   ____

   ____

   ____

   ____

5. List range of host addresses that can be assigned to Subnet #6 (200.35.1.192/27)

   ____

   ____

   ____

   ____

6. What is the broadcast address for subnet 200.35.1.192/27?

Solution for Subnetting Exercise #1

Assume that you have been assigned the 132.45.0.0/16 network block. You need to establish 8 subnets.

1. Three binary digits are required to define the eight subnets.

2. Specify the extended-network-prefix that allows the creation of 8 subnets.

   /19 or 255.255.224.0

3. Express the subnets in binary format and dotted decimal notation:

```
Subnet #0:  10000100.00101101.00000000.00000000 = 132.45.0.0/19
Subnet #1:  10000100.00101101.00100000.00000000 = 132.45.32.0/19
Subnet #2:  10000100.00101101.01000000.00000000 = 132.45.64.0/19
Subnet #3:  10000100.00101101.01100000.00000000 = 132.45.96.0/19
Subnet #4:  10000100.00101101.10000000.00000000 = 132.45.128.0/19
Subnet #5:  10000100.00101101.10100000.00000000 = 132.45.160.0/19
Subnet #6:  10000100.00101101.11000000.00000000 = 132.45.192.0/19
Subnet #7:  10000100.00101101.11100000.00000000 = 132.45.224.0/19
```

4. List the range of host addresses that can be assigned to Subnet #3 (132.45.96.0/19).

```
Subnet #3:  10000100.00101101.01100000.00000000 = 132.45.96.0/19

Host #1:    10000100.00101101.01100000.00000001 = 132.45.96.1/19
Host #2:    10000100.00101101.01100000.00000010 = 132.45.96.2/19
Host #3:    10000100.00101101.01100000.00000011 = 132.45.96.3/19
    :
Host #8190: 10000100.00101101.01111111.11111110 = 132.45.127.254/19
```

4. What is the broadcast address for Subnet #3 (132.45.96.0/19)?

```
10000100.00101101.01111111.11111111 = 132.45.127.255/19
```

Solution for Subnetting Exercise #2

1. Assume that you have been assigned the 200.35.1.0/24 network block. Define an extended-network-prefix that allows the creation of 20 hosts on each subnet.

   A minimum of five bits are required to define 20 hosts so the extended-network-prefix is a /27 (27 = 32-5).

2. What is the maximum number of hosts that can be assigned to each subnet?

   The maximum number of hosts on each subnet is 2^5-2, or 30.

3. What is the maximum number of subnets that can be defined?

   The maximum number of subnets is 2^3, or 8.

4. Specify the subnets of 200.35.1.0/24 in binary format and dotted decimal notation.

```
Subnet #0:  11001000.00100011.00000001.00000000 = 200.35.1.0/27
Subnet #1:  11001000.00100011.00000001.00100000 = 200.35.1.32/27
Subnet #2:  11001000.00100011.00000001.01000000 = 200.35.1.64/27
Subnet #3:  11001000.00100011.00000001.01100000 = 200.35.1.96/27
Subnet #4:  11001000.00100011.00000001.10000000 = 200.35.1.128/27
Subnet #5:  11001000.00100011.00000001.10100000 = 200.35.1.160/27
Subnet #6:  11001000.00100011.00000001.11000000 = 200.35.1.192/27
Subnet #7:  11001000.00100011.00000001.11100000 = 200.35.1.224/27
```

5. List range of host addresses that can be assigned to Subnet #6 (200.35.1.192/27)

```
Subnet #6:  11001000.00100011.00000001.11000000 = 200.35.1.192/27

Host #1:  11001000.00100011.00000001.11000001 = 200.35.1.193/27
Host #2:  11001000.00100011.00000001.11000010 = 200.35.1.194/27
Host #3:  11001000.00100011.00000001.11000011 = 200.35.1.195/27
    :
Host #29: 11001000.00100011.00000001.11011101 = 200.35.1.221/27
Host #30: 11001000.00100011.00000001.11011110 = 200.35.1.222/27
```

6. What is the broadcast address for subnet 200.35.1.192/27?

```
11001000.00100011.00000001.11011111 = 200.35.1.223
```

Appendix D - VLSM Example

VLSM Exercise

Given

An organization has been assigned the network number 140.25.0.0/16 and it plans to deploy VLSM. Figure C-1 provides a graphic display of the VLSM design for the organization.

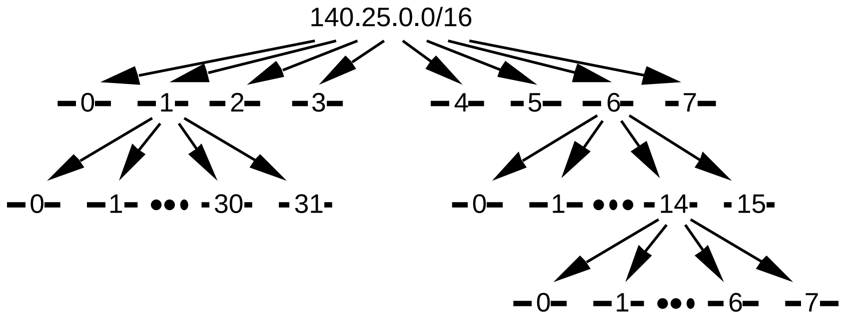

Figure C-1: Address Strategy for VLSM Example

To arrive at this design, the first step of the subnetting process divides the base network address into 8 equal-sized address blocks. Then Subnet #1 is divided it into 32 equal-sized address blocks and Subnet #6 is divided into 16 equal-sized address blocks. Finally, Subnet #6-14 is divided into 8 equal-sized address blocks.

1. Specify the eight subnets of 140.25.0.0/16:

#0 ______________________________

#1 ______________________________

#2 ______________________________

#3 ______________________________

#4 ______________________________

#5 ______________________________

#6 ______________________________

#7 ______________________________

2. List the host addresses that can be assigned to Subnet #3 (140.25.96.0):

____

____

____

____

____

____

3. Identify the broadcast address for Subnet #3 (140.25.96.0):

____

4. Specify the 16 subnets of Subnet #6 (140.25.192.0/19):

#6-0____

#6-1____

#6-2____

#6-3____

#6-4____

#6-5____

#6-6____

#6-7____

#6-8____

#6-9____

#6-10____

#6-11____

#6-12 ____

#6-13 ____

#6-14 ____

#6-15 ____

5. List the host addresses that can be assigned to Subnet #6-3 (140.25.198.0/23):

____

____

____

____

____

____

6. Identify the broadcast address for Subnet #6-3 (140.25.198.0/23):

____

7. Specify the eight subnets of Subnet #6-14 (140.25.220.0/23):

#6-14-0 ____

#6-14-1 ____

#6-14-2 ____

#6-14-3 ____

#6-14-4 ____

#6-14-5 ____

#6-14-6 ____

#6-14-7 ____

8. List the host addresses that can be assigned to Subnet #6-14-2 (140.25.220.128/26):

9. Identify the broadcast address for Subnet #6-14-2 (140.25.220.128/26):

Solution for VLSM Exercise

1. Specify the eight subnets of 140.25.0.0/16:

```
Base Network: 10001100.00011001.00000000.00000000 = 140.25.0.0/16

Subnet #0:    10001100.00011001.00000000.00000000 = 140.25.0.0/19
Subnet #1:    10001100.00011001.00100000.00000000 = 140.25.32.0/19
Subnet #2:    10001100.00011001.01000000.00000000 = 140.25.64.0/19
Subnet #3:    10001100.00011001.01100000.00000000 = 140.25.96.0/19
Subnet #4:    10001100.00011001.10000000.00000000 = 140.25.128.0/19
Subnet #5:    10001100.00011001.10100000.00000000 = 140.25.160.0/19
Subnet #6:    10001100.00011001.11000000.00000000 = 140.25.192.0/19
Subnet #7:    10001100.00011001.11100000.00000000 = 140.25.224.0/19
```

2. List the host addresses that can be assigned to Subnet #3 (140.25.96.0)

```
Subnet #3:  10001100.00011001.01100000.00000000 = 140.25.96.0/19

Host #1:    10001100.00011001.01100000.00000001 = 140.25.96.1/19
Host #2:    10001100.00011001.01100000.00000010 = 140.25.96.2/19
Host #3:    10001100.00011001.01100000.00000011 = 140.25.96.3/19
   .
   .
Host #8189: 10001100.00011001.01111111.11111101 = 140.25.127.253/19
Host #8190: 10001100.00011001.01111111.11111110 = 140.25.127.254/19
```

3. Identify the broadcast address for Subnet #3 (140.25.96.0)

```
10001100.00011001.01111111.11111111 = 140.25.127.255
```

4. Specify the 16 subnets of Subnet #6 (140.25.192.0/19):

```
Subnet #6:    10001100.00011001.11000000.00000000 = 140.25.192.0/19

Subnet #6-0:  10001100.00011001.11000000.00000000 = 140.25.192.0/23
Subnet #6-1:  10001100.00011001.11000010.00000000 = 140.25.194.0/23
Subnet #6-2:  10001100.00011001.11000100.00000000 = 140.25.196.0/23
Subnet #6-3:  10001100.00011001.11000110.00000000 = 140.25.198.0/23
Subnet #6-4:  10001100.00011001.11001000.00000000 = 140.25.200.0/23
    .
    .
Subnet #6-14: 10001100.00011001.11011100.00000000 = 140.25.220.0/23
Subnet #6-15: 10001100.00011001.11011110.00000000 = 140.25.222.0/23
```

5. List the host addresses that can be assigned to Subnet #6-3 (140.25.198.0/23):

```
Subnet #6-3: 10001100.00011001.11000110.00000000 = 140.25.198.0/23

Host #1      10001100.00011001.11000110.00000001 = 140.25.198.1/23
Host #2      10001100.00011001.11000110.00000010 = 140.25.198.2/23
Host #3      10001100.00011001.11000110.00000011 = 140.25.198.3/23
Host #4      10001100.00011001.11000110.00000100 = 140.25.198.4/23
Host #5      10001100.00011001.11000110.00000110 = 140.25.198.5/23
    .
    .
Host #509    10001100.00011001.11000111.11111101 = 140.25.199.253/23
Host #510    10001100.00011001.11000111.11111110 = 140.25.199.254/23
```

6. Identify the broadcast address for Subnet #6-3 (140.25.198.0/23)

```
10001100.00011001.11000111.11111111 = 140.25.199.255
```

7. Specify the eight subnets of Subnet #6-14 (140.25.220.0/23):

Subnet #6-14: 10001100.00011001.11011110.00000000 = 140.25.220.0/23

Subnet#6-14-0:10001100.00011001.1101110**0.00**000000 = 140.25.220.0/26
Subnet#6-14-1:10001100.00011001.1101110**0.01**000000 = 140.25.220.64/26
Subnet#6-14-2:10001100.00011001.1101110**0.10**000000 = 140.25.220.128/26
Subnet#6-14-3:10001100.00011001.1101110**0.11**000000 = 140.25.220.192/26
Subnet#6-14-4:10001100.00011001.1101110**1.00**000000 = 140.25.221.0/26
Subnet#6-14-5:10001100.00011001.1101110**1.01**000000 = 140.25.221.64/26
Subnet#6-14-6:10001100.00011001.1101110**1.10**000000 = 140.25.221.128/26
Subnet#6-14-7:10001100.00011001.1101110**1.11**000000 = 140.25.221.192/26

8. List the host addresses that can be assigned to Subnet #6-14-2 (140.25.220.128/26):

Subnet#6-14-2:10001100.00011001.11011100.10000000 = 140.25.220.128/26

Host #1 10001100.00011001.11011100.10**000001** = 140.25.220.129/26
Host #2 10001100.00011001.11011100.10**000010** = 140.25.220.130/26
Host #3 10001100.00011001.11011100.10**000011** = 140.25.220.131/26
Host #4 10001100.00011001.11011100.10**000100** = 140.25.220.132/26
Host #5 10001100.00011001.11011100.10**000101** = 140.25.220.133/26
.
.
Host #61 10001100.00011001.11011100.10**111101** = 140.25.220.189/26
Host #62 10001100.00011001.11011100.10**111110** = 140.25.220.190/26

9. Identify the broadcast address for Subnet #6-14-2 (140.25.220.128/26):

10001100.00011001.11011100.10**111111** = 140.25.220.191

Appendix E - CIDR Examples

CIDR Practice Exercises

1. List the individual networks numbers defined by the CIDR block 200.56.168.0/21.

2. List the individual networks numbers defined by the CIDR block 195.24/13.

3. Aggregate the following set of (4) IP /24 network addresses to the highest degree possible.

```
212.56.132.0/24
212.56.133.0/24
212.56.134.0/24
212.56.135.0/24
```

____

4. Aggregate the following set of (4) IP /24 network addresses to the highest degree possible.

```
212.56.146.0/24
212.56.147.0/24
212.56.148.0/24
212.56.149.0/24
```

____

5. Aggregate the following set of (64) IP /24 network addresses to the highest degree possible.

```
202.1.96.0/24
202.1.97.0/24
202.1.98.0/24
      :
202.1.126.0/24
202.1.127.0/24
202.1.128.0/24
202.1.129.0/24
      :
202.1.158.0/24
202.1.159.0/24
```

____

6. How would you express the entire Class A address space as a single CIDR advertisement?

____

7. How would you express the entire Class B address space as a single CIDR advertisement?

8. How would you express the entire Class C address space as a single CIDR advertisement?

Solutions for CIDR Pracitice Exercises

1. List the individual networks numbers defined by the CIDR block 200.56.168.0/21.

   a. Express the CIDR block in binary format:

   ```
   200.56.168.0/21     11001000.00111000.10101000.00000000
   ```

   b. The /21 mask is 3 bits shorter than the natural mask for a traditional /24. This means that the CIDR block identifies a block of 8 (or 2^3) consecutive /24 network numbers.

   c. The range of /24 network numbers defined by the CIDR block 200.56.168.0/21 includes:

   ```
   Net #0:  11001000.00111000.10101000.xxxxxxxx 200.56.168.0
   Net #1:  11001000.00111000.10101001.xxxxxxxx 200.56.169.0
   Net #2:  11001000.00111000.10101010.xxxxxxxx 200.56.170.0
   Net #3:  11001000.00111000.10101011.xxxxxxxx 200.56.171.0
   Net #4:  11001000.00111000.10101100.xxxxxxxx 200.56.172.0
   Net #5:  11001000.00111000.10101101.xxxxxxxx 200.56.173.0
   Net #6:  11001000.00111000.10101110.xxxxxxxx 200.56.174.0
   Net #7:  11001000.00111000.10101111.xxxxxxxx 200.56.175.0
   ```

2. List the individual networks numbers defined by the CIDR block 195.24/13.

   a. Express the CIDR block in binary format:

   ```
   195.24.0.0/13       11000011.00011000.00000000.00000000
   ```

   b. The /13 mask is 11 bits shorter than the natural mask for a traditional /24. This means that the CIDR block identifies a block of 2,048 (or 2^{11}) consecutive /24 network numbers.

c. The range of /24 network numbers defined by the CIDR block 195.24/13 include:

```
Net #0:    11000011.00011000.00000000.xxxxxxxx 195.24.0.0
Net #1:    11000011.00011000.00000001.xxxxxxxx 195.24.1.0
Net #2:    11000011.00011000.00000010.xxxxxxxx 195.24.2.0
     .
                       .
                       .
Net #2045: 11000011.00011111.11111101.xxxxxxxx 195.31.253.0
Net #2046: 11000011.00011111.11111110.xxxxxxxx 195.31.254.0
Net #2047: 11000011.00011111.11111111.xxxxxxxx 195.31.255.0
```

3. Aggregate the following set of (4) IP /24 network addresses to the highest degree possible.

```
212.56.132.0/24
212.56.133.0/24
212.56.134.0/24
212.56.135.0/24
```

a. List each address in binary format and determine the common prefix for all of the addresses:

```
212.56.132.0/24    11010100.00111000.10000100.00000000
212.56.133.0/24    11010100.00111000.10000101.00000000
212.56.134.0/24    11010100.00111000.10000110.00000000
212.56.135.0/24    11010100.00111000.10000111.00000000

Common Prefix:     11010100.00111000.10000100.00000000
```

b. The CIDR aggregation is:

```
212.56.132.0/22
```

4. Aggregate the following set of (4) IP /24 network addresses to the highest degree possible.

```
212.56.146.0/24
212.56.147.0/24
212.56.148.0/24
212.56.149.0/24
```

a. List each address in binary format and determine the common prefix for all of the addresses:

```
212.56.146.0/24    11010100.00111000.10010010.00000000
212.56.147.0/24    11010100.00111000.10010011.00000000
212.56.148.0/24    11010100.00111000.10010100.00000000
212.56.148.0/24    11010100.00111000.10010101.00000000
```

b. Note that this set of four /24s cannot be summarized as a single /23!

212.56.146.0/23   11010100.00111000.**1001001**0.00000000
212.56.148.0/23   11010100.00111000.**1001010**0.00000000

c. The CIDR aggregation is:

212.56.146.0/23
212.56.148.0/23

Note that if two /23s are to be aggregated into a /22, then both /23s must fall within a single /22 block! Since each of the two /23s is a member of a different /22 block, they cannot be aggregated into a single /22 (even though they are consecutive!). They could be aggregated into 222.56.144/21, but this aggregation would include four network numbers that were not part of the original allocation. Hence, the smallest possible aggregate is two /23s.

5. Aggregate the following set of (64) IP /24 network addresses to the highest degree possible.

202.1.96.0/24
202.1.97.0/24
202.1.98.0/24
:
202.1.126.0/24
202.1.127.0/24
202.1.128.0/24
202.1.129.0/24
:
202.1.158.0/24
202.1.159.0/24

a. List each address in binary format and determine the common prefix for all of the addresses:

202.1.96.0/24   11001010.00000001.011**00000**.00000000
202.1.97.0/24   11001010.00000001.011**00001**.00000000
202.1.98.0/24   11001010.00000001.011**00010**.00000000
:
202.1.126.0/24   11001010.00000001.011**11110**.00000000
202.1.127.0/24   11001010.00000001.011**11111**.00000000
202.1.128.0/24   11001010.00000001.100**00000**.00000000
202.1.129.0/24   11001010.00000001.100**00001**.00000000
:
202.1.158.0/24   11001010.00000001.100**11110**.00000000
202.1.159.0/24   11001010.00000001.100**11111**.00000000

b. Note that this set of 64 /24s cannot be summarized as a single /19!

202.1.96.0/19   11001010.00000001.**011**00000.00000000
202.1.128.0/19   11001010.00000001.**100**00000.00000000

c. The CIDR aggregation is:

```
202.1.96.0/19
202.1.128.0/19
```

Similar to the previous example, if two /19s are to be aggregated into a /18, the /19s must fall within a single /18 block! Since each of these two /19s is a member of a different /18 block, they cannot be aggregated into a single /18. They could be aggregated into 202.1/16, but this aggregation would include 192 network numbers that were not part of the original allocation. Thus, the smallest possible aggregate is two /19s.

6. How would you express the entire Class A address space as a single CIDR advertisement?

   Since the leading bit of all Class A addresses is a "0", the entire Class A address space can be expressed as 0/1.

7. How would you express the entire Class B address space as a single CIDR advertisement?

   Since the leading two bits of all Class B addresses are "10", the entire Class B address space can be expressed as 128/2.

8. How would you express the entire Class C address space as a single CIDR advertisement?

   Since the leading three bits of all Class C addresses are "110", the entire Class C address space can be expressed as 192/3.