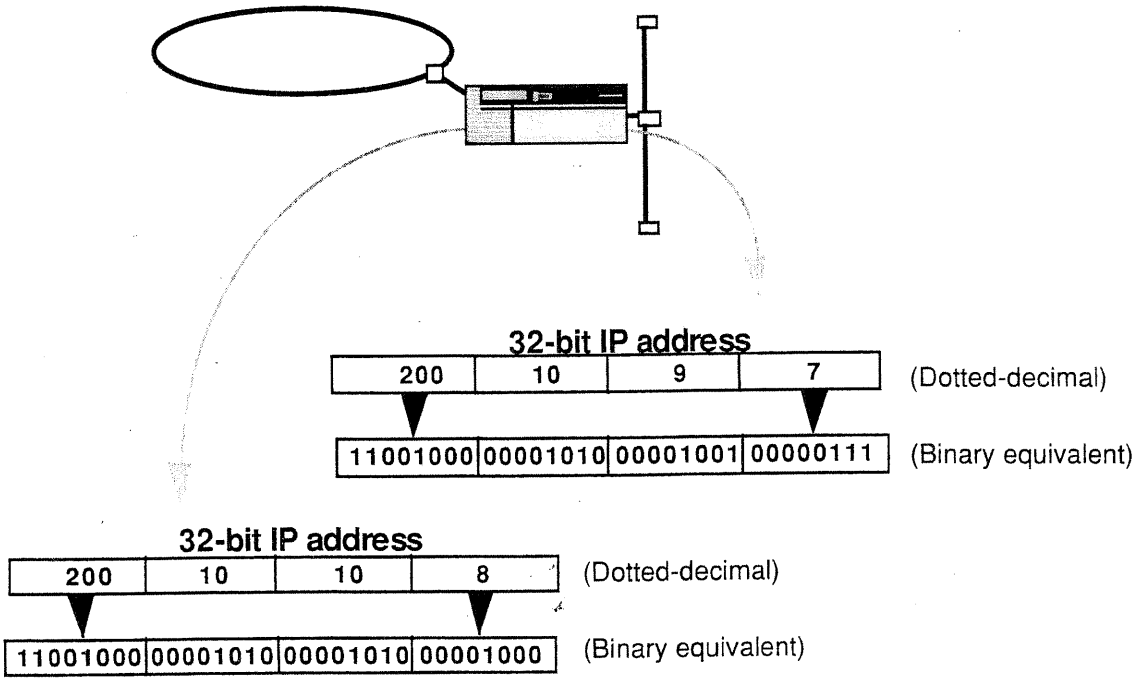
IP Addressing

The following is a partial listing of IP addressing properties:

- The physical medium to which a host connects is referred to as an IP network.
- A unique IP address is assigned to each physical connection of a host to a network.
- If a host has more than one connection to a network, it will have more than one IP address.
- An IP address is represented as four decimal integers, with each integer corresponding to one byte. All IP addresses are therefore 32 bits in length. This addressing is known as dotted-decimal notation.

IP Addressing

Dotted-decimal Notation



Each physical connection has a separate 32-bit address represented in dotted-decimal notation.

Network Addressing

The IP address (represented in dotted-decimal notation) is divided into two primary segments—the network ID and host ID.

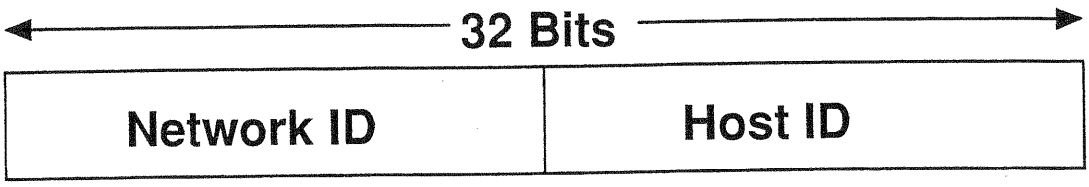
Network ID

This portion of the IP address identifies the network to which this address belongs. Information is routed to a destination based upon this portion of the IP address.

Host ID

This portion of the IP address identifies an individual host on a destination network. It is not used (read) until the destination network has been reached.

Network Addressing



IP Address Classes

Address Classification

There are three primary classes of IP addresses. As displayed on the opposite page, the high-order bits of any IP address identify the class.

Each class allocates a different number of bits to the network and to the host portion of the address.

- Class A allows up to 126 networks and up to 16,777,214 hosts.
- Class B allows up to 16,384 networks and 65,534 hosts.
- Class C allows up to 2,097,152 networks and 254 hosts.
- Class D, with a range of 224 to 239, is used for Internet multicasting.

Note

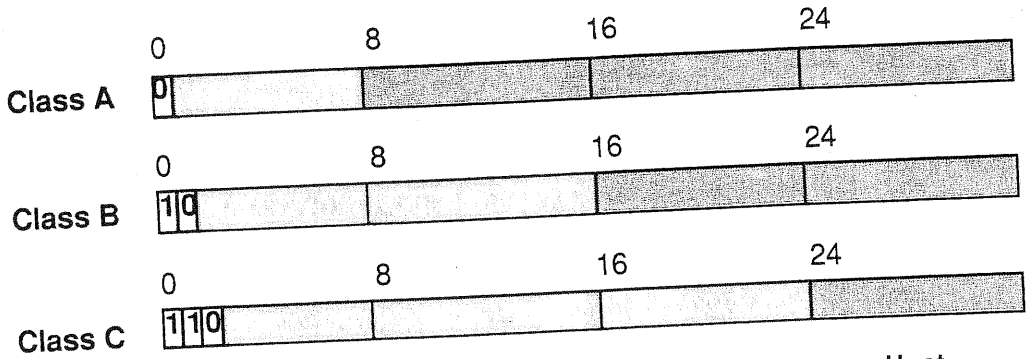
A host address of all 0s or all 1s is not permitted; these addresses are used for broadcasts.

Natural Masks

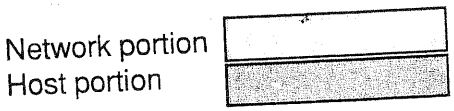
A natural network mask is implied by address class and is used to determine the network and host portion of an IP address. In a mask, any bit set to a one (1) defines the network address; any bit set to a zero (0) defines the host address. For each address class, the natural network mask is as follows:

- Class A address has an implied natural mask of 255.0.0.0.
- Class B address has an implied natural mask of 255.255.0.0.
- Class C address has an implied natural mask of 255.255.255.0.

IP Address Classes



	First Octet	Range	Example	Network	Host
Class A	0 XXXXXXX	1 – 127	25.0.0.11	25.	0.0.11
Class B	1 0 XXXXXX	128-191	140.250.1.44	140.250.	1.44
Class C	1 1 0 XXXXX	192-223	192.21.47.16	192.21.47.	16



Subnet Addressing

Subnet addressing is an extension of the Internet addressing scheme that allows a site to subdivide a single Internet address for use across multiple physical networks.

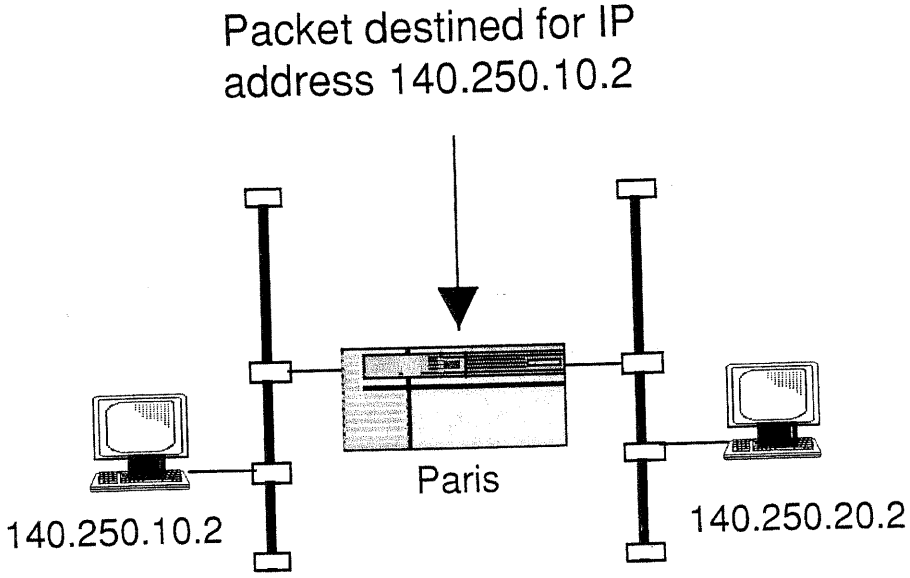
This addressing is useful when a limited number of IP network addresses have been allocated from the Network Information Center (NIC) and multiple physical networks must be accessed.

IP datagrams are routed based upon the network portion of the address. If the company is assigned one network address yet there are many physical networks to administer, a router will be unable to differentiate networks unless subnetting is used.

One Problem Subnetting Resolves

A router named Paris receives a packet from the Internet destined for host 140.250.10.2. The router makes its routing decisions exclusively on the network portion of the packet; therefore, without subnetting, it would not know which interface to use to actually reach a specific host.

Subnet Addressing



Reason for subnetting

Subnet Addressing Implementation

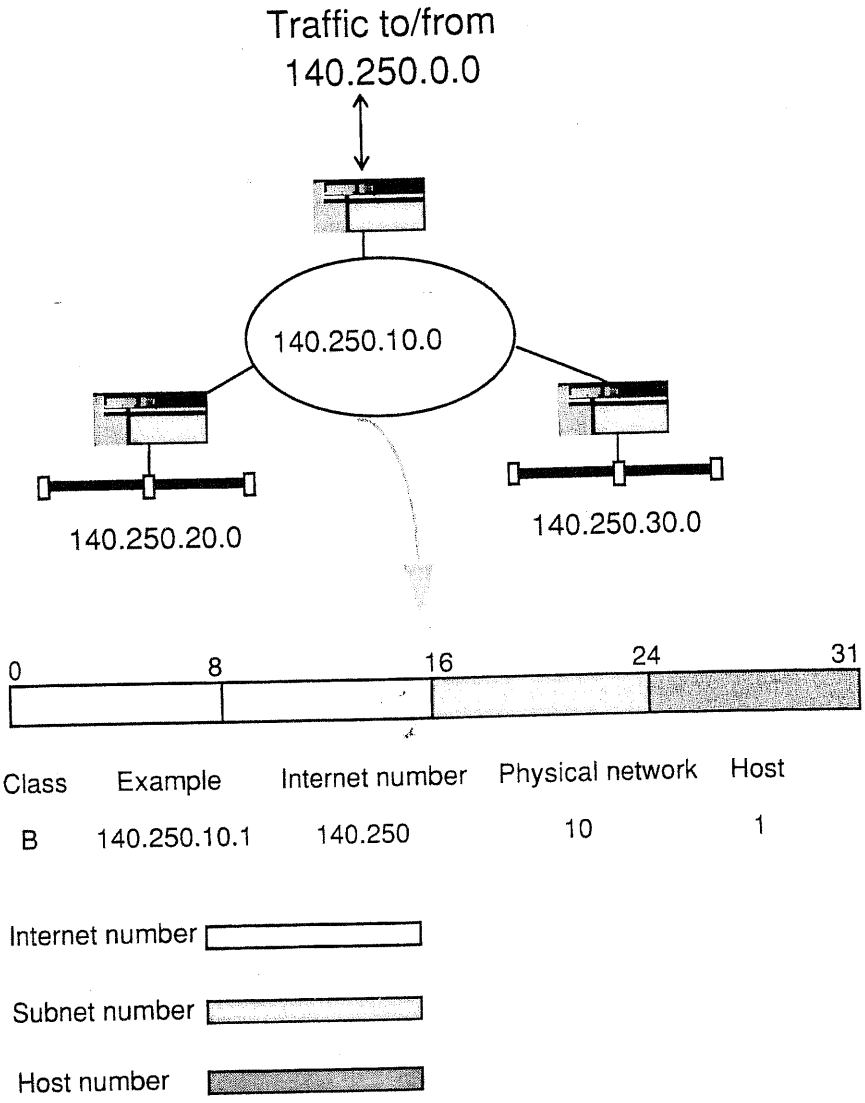
Subnet addressing takes a portion of the Internet address and uses it to define networks within networks, or subnetworks.

In the example on the opposite page, the Class B IP address has a network portion (first two octets) of 140.250.

The host portion of the Internet address has been reallocated. The third octet is dedicated to the subnetwork number, and the fourth octet is dedicated to the host ID.

Defining a subnet in this way allows a network administrator to build many physical networks while using only one Internet address. From the perspective of an Internet user looking at that address, there appears to be only one physical network.

Subnet Addressing Implementation



Subnet Masks

The subnet mask specifies the portion of the IP address that is going to be used to define IP networks and subnetworks (as opposed to hosts). Subnetworks are implemented using a subnet mask. This mask is entered when configuring an IP address.

Mask Value

The following is a list of IP mask properties:

- For every bit position in the IP address that is part of the network ID or subnetwork ID, a 1 is set.
- For every bit position in the IP address that is part of the host ID portion, a 0 is set.
- The mask is entered in dotted-decimal notation.

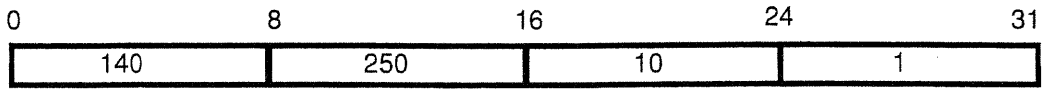
Subnetting Rules

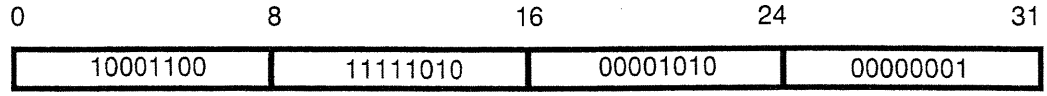
The following is a list of fundamental subnetting rules:

- When using Routing Information Protocol (RIP) version 1, the same mask must be applied throughout the physical networks that *share the same network address*. All devices connected to the networks that compose the subnet must have the same mask.
- A host address of all 0s or 1s is not permitted.

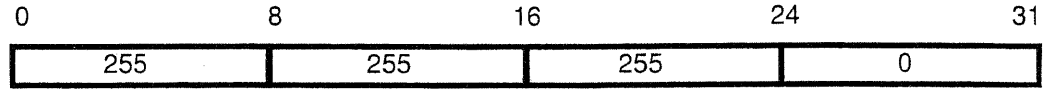
Subnet Masks

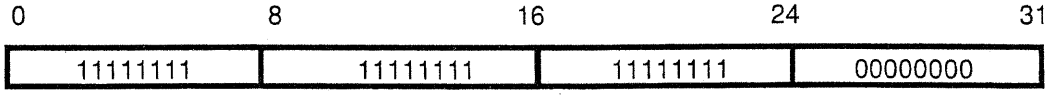
Class B





Mask





Subnet Address Restrictions

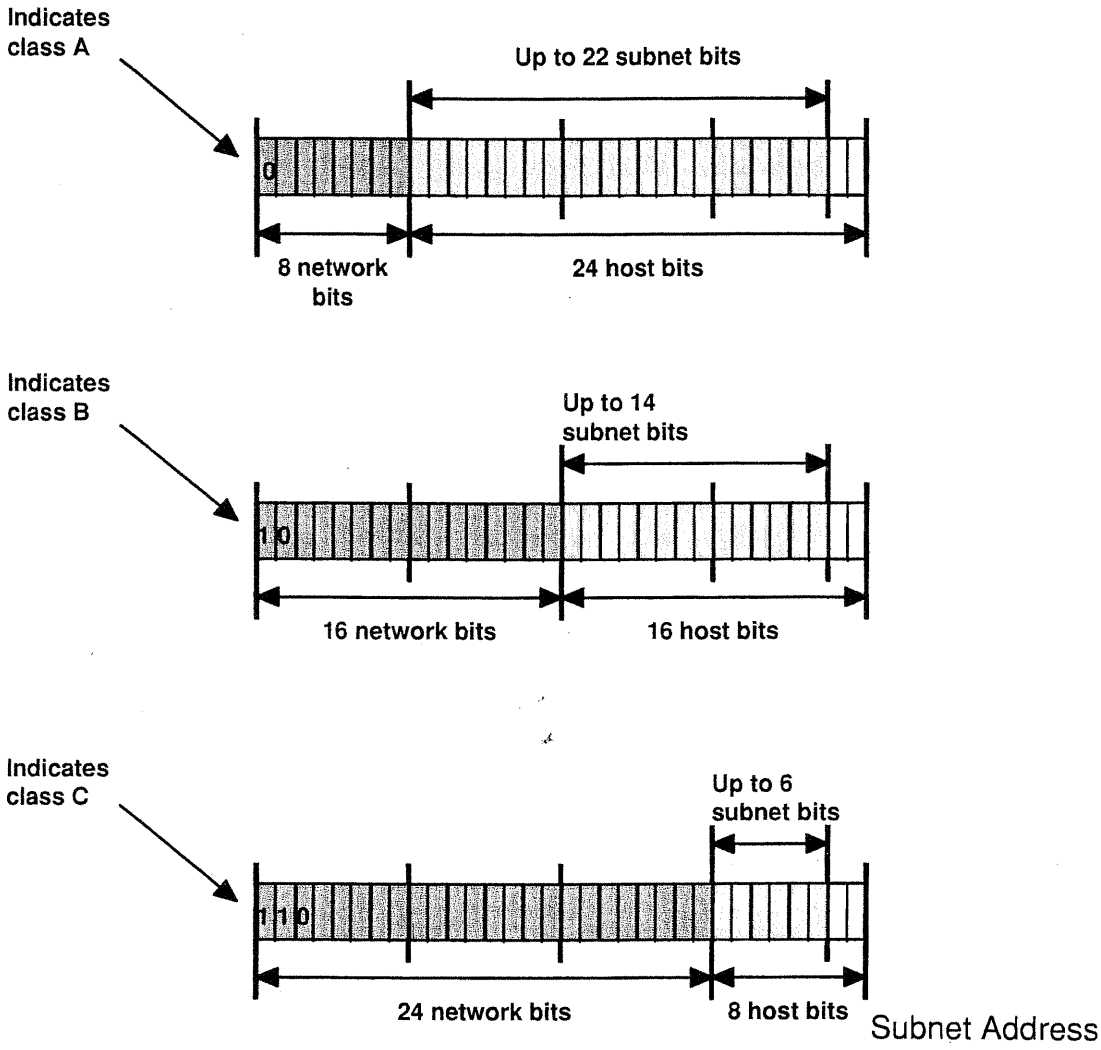
The more bits you allocate for subnetworks, the fewer bits available for host numbers—possibly leaving you unable to accommodate an expansion of hosts on one (or more) physical networks.

Conversely, the more bits allocated for host IDs, the fewer bits available for subnetworks—possibly leaving you unable to accommodate the growth of physical networks within your enterprise.

Planning is essential for proper assignment of subnet masks.

Reassignment of IP addresses (and subnet masks) to all nodes within the subnetwork is always possible, but rarely feasible.

Subnet Address Restrictions



Addressing Problem

Given the network topology displayed on the opposite page and a newly assigned IP address of 192.192.1.0, you have been informed of the following:

- The newly assigned IP address will be used immediately to connect a series of Access Nodes (AN®)—AN1, AN2, and AN3—to the corporate hub site requiring a total of 10 subnetworks (includes the Ethernet at the corporate hub site). Additionally, there is a long-range plan that may require connecting a total of 9 remote sites, thus requiring a grand total of 28 subnetworks.
- Each LAN will have no more than 6 hosts (including the router interface).

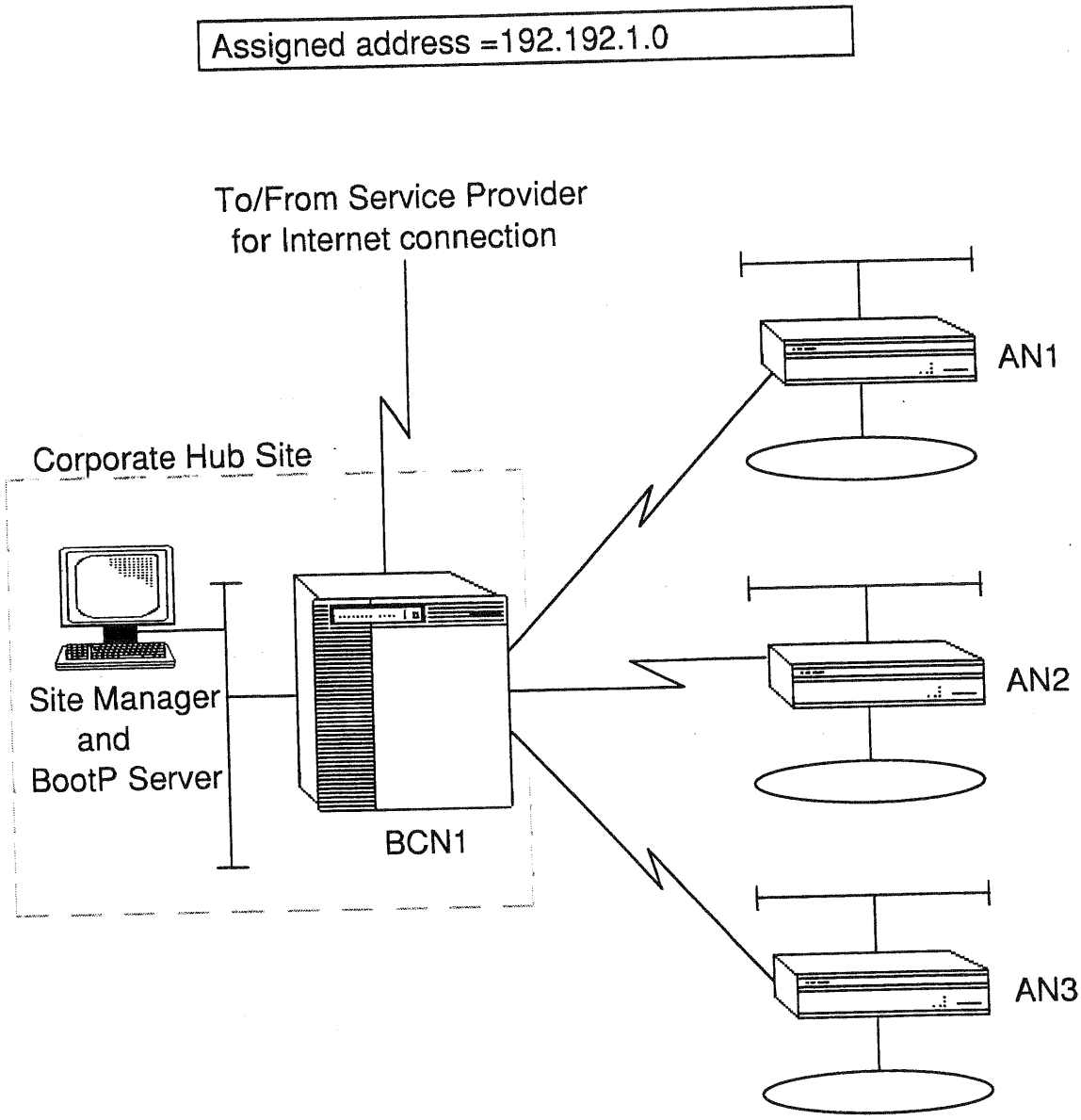
Aside from the interface used to attach to the Internet, take a few minutes to:

1. Identify a subnet mask that will accommodate 28 subnetworks.
2. Identify the first 10 subnetworks you would assign. This includes the Ethernet located at the corporate hub site.
3. Identify an IP host address to be assigned to the appropriate interfaces of each router displayed on the opposite page.

Note

There may be more than one solution to the defined problem.

Addressing Problem



Addressing Solution

Subnet Mask

To meet immediate requirements and to accommodate future growth, a subnet mask of 255.255.255.248 will be sufficient.

Extending the network portion of the IP address 5 bits will provide up to 30 subnetworks*, with up to 6 hosts for each subnetwork.

Subnetwork Assignment

The table on the opposite page lists the possible subnetworks in ascending order. It may seem appropriate to begin assigning these subnetworks starting from the top of the list. However, when assigning subnetwork addresses to physical networks, the most flexible use of the address space is to assign subnetworks in an order in which the bits used to define a subnetwork are set from left to right. This is further explained in the following pages.

*32 subnetworks would be available if both the "all zeros" and "all ones" subnets are enabled.

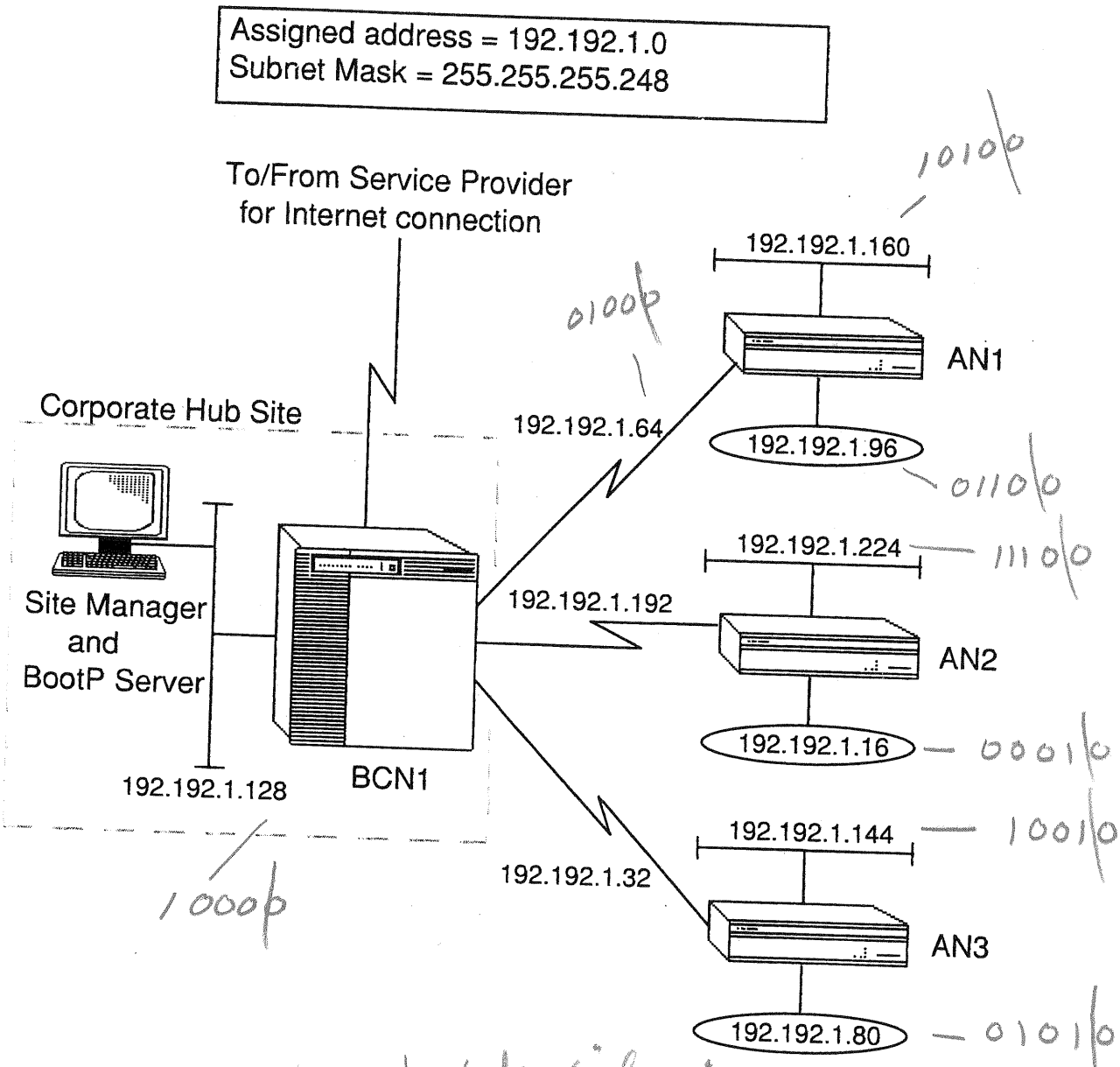
Addressing Solution

Order of Assignment	Decimal Equivalent	Subnetwork 128	64	32	16	8	Host / Subnet 4	2	1
	192.192.1.0	0	0	0	0	0			
	192.192.1.8	0	0	0	0	1			
	192.192.1.16	0	0	0	1	0			
	192.192.1.24	0	0	0	1	1			
	192.192.1.32	0	0	1	0	0			
	192.192.1.40	0	0	1	0	1			
	192.192.1.48	0	0	1	1	0			
	192.192.1.56	0	0	1	1	1			
	192.192.1.64	0	1	0	0	0			
	192.192.1.72	0	1	0	0	1			
	192.192.1.80	0	1	0	1	0			
	192.192.1.88	0	1	0	1	1			
	192.192.1.96	0	1	1	0	0	0	0	0
	192.192.1.104	0	1	1	0	1	0	0	1
	192.192.1.112	0	1	1	1	0	0	1	0
	192.192.1.120	0	1	1	1	1	0	1	1
	192.192.1.128	1	0	0	0	0	1	0	0
	192.192.1.136	1	0	0	0	1	1	0	1
	192.192.1.144	1	0	0	1	0	1	1	0
	192.192.1.152	1	0	0	1	1	1	1	1
	192.192.1.160	1	0	1	0	0			
	192.192.1.168	1	0	1	0	1			
	192.192.1.176	1	0	1	1	0			
	192.192.1.184	1	0	1	1	1			
	192.192.1.192	1	1	0	0	0			
	192.192.1.200	1	1	0	0	1			
	192.192.1.208	1	1	0	1	0			
	192.192.1.216	1	1	0	1	1			
	192.192.1.224	1	1	1	0	0			
	192.192.1.232	1	1	1	0	1			
	192.192.1.240	1	1	1	1	0			
	192.192.1.248	1	1	1	1	1			

Addressing Solution

Order of Assignment	Decimal Equivalent	Subnetwork 128	64	32	16	8	Host / Subnet 4	2	1
1-Hub Site	192.192.1.**128**	1	0	0	0	0			
2-WAN1	192.192.1.**64**	0	1	0	0	0			
3-WAN2	192.192.1.**192**	1	1	0	0	0			
4-WAN3	192.192.1.**32**	0	0	1	0	0			
5-LAN1E	192.192.1.**160**	1	0	1	0	0			
6-LAN1T	192.192.1.**96**	0	1	1	0	0			
7-LAN2E	192.192.1.**224**	1	1	1	0	0			
8-LAN2T	192.192.1.**16**	0	0	0	1	0			
9-LAN3E	192.192.1.**144**	1	0	0	1	0			
10-LAN3T	192.192.1.**80**	0	1	0	1	0			
11	192.192.1.**208**	1	1	0	1	0			
12	192.192.1.**48**	0	0	1	1	0			
13	192.192.1.**176**	1	0	1	1	0	0	0	0
14	192.192.1.**112**	0	1	1	1	0	0	0	1
15	192.192.1.**240**	1	1	1	1	0	0	1	0
16	192.192.1.**8**	0	0	0	0	1	0	1	1
17	192.192.1.**136**	1	0	0	0	1	1	0	0
18	192.192.1.**72**	0	1	0	0	1	1	0	1
19	192.192.1.**200**	1	1	0	0	1	1	1	0
20	192.192.1.**40**	0	0	1	0	1	1	1	1
21	192.192.1.**168**	1	0	1	0	1			
22	192.192.1.**104**	0	1	1	0	1			
23	192.192.1.**232**	1	1	1	0	1			
24	192.192.1.**24**	0	0	0	1	1			
25	192.192.1.**152**	1	0	0	1	1			
26	192.192.1.**88**	0	1	0	1	1			
27	192.192.1.**216**	1	1	0	1	1			
28	192.192.1.**56**	0	0	1	1	1			
29	192.192.1.**184**	1	0	1	1	1			
30	192.192.1.**120**	0	1	1	1	1			
31	192.192.1.**0**	0	0	0	0	0			
	192.192.1.**248**	1	1	1	1	1			

Addressing Solution



SN's chosen to learn last digit alone for expansion purposes