

IPv4 Address Classes

This document supplements information in Chapter 2, “IP Addressing and Related Topics,” in *Guide to TCP/IP: IPv6 and IPv4, 5th Edition*.

Class A Addresses

Expressed in binary form (1s and 0s only), Class A addresses take the following binary form:

0bbbbbbb . bbbbbbbb . bbbbbbbb . bbbbbbbb

As a rule with Class A addresses, the leading digit, called the high-order bit, is always 0, and all other digits (marked with a *b* in the preceding example) can be either 1s or 0s. Note that this scheme reduces the total number of networks possible by the most significant bit. Thus, even though you can represent 255 as an 8-bit number, the requirement that a 0 appears in the first position limits the number of networks that can be addressed as Class A networks to 128 (or the numbers from 00000000 to 01111111, in which 0 counts as a number and the highest legal value is 127).

Note: We include periods to separate octets in the binary forms. This is intended purely as a visual aid—the actual machine-readable address does not contain periods.

On any IP network, addresses consisting of all 0s and all 1s are reserved for special uses, so of those 128 possible network addresses, only those from 00000001 to 01111110 (or 1 to 126, in decimal terms) are considered usable. Furthermore, the address for network 10 (00001010) is reserved for private network use (as stipulated in RFC 1918). Also, by convention, the address 127.*n.n.n* is reserved for loopback testing (or checking the integrity and usability of aTCP/IP protocol stack installed on any computer). Thus, there are a maximum of 124 Class A networks that are addressable on the public Internet.

Because the remaining three octets in a Class A address are available to hosts, this means that there are $3 * 8$, or 24, bits worth of address space available within each Class A network. You calculate the number of addresses by raising 2 to the number of bits in the address (or 2^{24} in exponential notation), then subtracting 2 from that number. That’s because all 0s and all 1s are often reserved for special network addresses and not normally used for host addresses. This number calculates to 16,777,214.

Class A address information is summarized in Table 1.

Table 1 Class A address facts and figures

| | | |
|-------------------------|----------|------------|
| Maximum networks | 27 – 2 | 126 |
| Maximum usable networks | 27 – 4 | 124 |
| Hosts per network | 224 – 2 | 16,777,214 |
| Private IP address | 10.0.0.0 | 1 |
| Address range | 1.0.0.0 | 126.0.0.0 |

Class B Addresses

Class B addresses take the following binary form:

10bbbbbb . bbbbbbbb . bbbbbbbb . bbbbbbbb

The leading two digits, or high-order bits, are 10, and the remaining digits (marked with a *b*) can be either 1s or 0s. Note that this scheme reduces the total number of networks possible by the two most significant bits. Because of the way that Class B addresses are laid out (the first two octets define the network number, and the second two octets define the host number), this leaves 14 bits worth of usable address space in the network portion of such addresses. Thus, the maximum number of usable network addresses is $2^{14} - 2$ (you always have to subtract 2 for the all-zero and all-one addresses), which calculates to 16,382. Furthermore, RFC 1918 stipulates that 16 Class B addresses, from 172.16.0.0 to 172.31.255.255, are reserved for private use. This means that the maximum number of public IP addresses for Class B is $16,382 - 16$, or 16,366.

Because the remaining two octets in a Class B address are available to hosts, this means that there are $2 * 8$, or 16, bits worth of address space available within each Class B network. You calculate the number of addresses by raising 2 to the number of bits in the address (or 2^{16} in exponential notation), then subtracting 2 from that number. That's because all 0s and all 1s normally may not be used as host addresses as they are reserved in network addresses as well. This number calculates to 65,534.

Table 2 summarizes Class B address information.

Table 2 Class B address facts and figures

| | | |
|-------------------------|------------------------------|-------------|
| Maximum networks | $2^{14} - 2$ | 16,382 |
| Maximum usable networks | $2^{14} - 18$ | 16,366 |
| Hosts per network | $2^{16} - 2$ | 65,534 |
| Private IP address | 172.16.0.0 to 172.31.255.255 | 16 |
| Address range | 128.0.0.0 | 191.255.0.0 |

Class C Addresses

Class C addresses take the following binary form:

110bbbbbb . bbbbbbbbbb . bbbbbbbbbb . bbbbbbbbbb

The leading three digits, or high-order bits, are 110, and the remaining digits (marked with a *b*) can be either 1s or 0s. Note that this scheme reduces the total number of networks possible by the most significant 3 bits. Because of the way that Class C addresses are laid out (the first three octets define the network number, and the last octet defines the host number), this leaves 21 bits worth of usable address space in the network portion of such addresses. Thus, the maximum number of usable network addresses is $2^{21} - 2$ (you always have to subtract 2 for the all-zero and all-one addresses), which calculates to 2,097,150. RFC 1918 stipulates that 256 Class C addresses, from 192.168.0.0 to 192.168.255.255, are reserved for private use. This means that the maximum number of public IP addresses for Class C is $2,097,150 - 256$, or 2,096,894.

Because only the remaining octet in a Class C address is available to hosts, this means that there are 8 bits worth of address space available for hosts to use within each Class C network address. You calculate the number of addresses by raising 2 to the number of bits in the address (or 2^8 in exponential notation), then subtracting 2 from that number. That's because all 0s and all 1s are reserved, and normally not usable as host addresses, just as they are with network addresses. This number calculates to 254.

Class C address information is summarized in Table 3.

Table 3 Class C address facts and figures

| | | |
|-------------------------|--------------------------------|-----------------|
| Maximum network | 221 – 2 | 2,097,150 |
| Maximum usable networks | 221 – 258 | 2,096,894 |
| Hosts per network | 28 – 2 | 254 |
| Private IP address | 192.168.0.0 to 192.168.255.255 | 256 |
| Address range | 192.0.1.0 | 223.255.255.255 |

Note: Not to unduly confuse matters, but RFC 1878 (finalized in December 1995) allows the all-zero and all-one addresses to be used for subnets. You might say it returns those reserved addresses to the address pool, and this works as long as all routers on the network use a modern routing protocol, such as RIPv2, OSPF, and so forth. Your authors decided to leave those addresses out of address space calculations because this approach represents the safest way to allocate address space, without risking the use of what might sometimes be an illegal address. When it comes to configuring your own networks and calculating usable address space, check your router documentation and contact your Internet service provider (ISP) to find out if these addresses are usable.

Class D and E Addresses

We hope that it is intuitively obvious that Classes D and E pick up where C leaves off. That is, Class D addresses take the following binary form:

1110bbbb . bbbbbbbb . bbbbbbbb . bbbbbbbb

Class E addresses take the following binary form:

11110bbb . bbbbbbbb . bbbbbbbb . bbbbbbbb

Remember, Class D is used for multicast addresses so multiple users can “share” a single IP address (in direct violation of the rules for Classes A through C) and receive the same broadcast “group” transmission across a network from a single point of transmission or single interface. Conservation of bandwidth explains why multicast addresses are important for streaming data, like video- or teleconferencing, or for information that is of interest to multiple consumers, such as routing table updates. The address range for Class D addresses runs from 224.0.0.0 to 239.255.255.255.

Class E addresses are used only for experimental purposes. The address range for Class E addresses runs from 240.0.0.0 to 255.255.255.255. Unless you’re working in a research and development environment, it’s unlikely that you’ll ever encounter such an address on any networks you use.