



help desk

Networking Knowhow | By Wayne Howell



Most days our help desk includes a network question: Should we use Cat6? What IP addresses should I use? Does it matter what I enter in the subnet field?

IP addresses seem to cause a lot of confusion, but there are just a few rules to remember. A piece of equipment that connects to a network is called a host. Every host requires an IP address - a unique number that allows hosts to communicate with each other.

There are two types of IP addressing in use - IPv4 and IPv6. I will focus on IPv4, which is most commonly used for lighting installations. An IP address is a 32-bit number comprising four 8-bit bytes (sometimes called octets). It is usually written as four decimal numbers separated by dots, for example: 192.168.1.1

The IP address actually encodes two numbers - the network address and the host address. The network address will be the same for all IP addresses on a given network, but the host addresses will be unique for each host. This simple construct allows many networks to operate on the same cable.

The subnet mask is used to decipher the network and host parts of the IP address. It is the same size and format as the IP, for example: 255.255.255.0. The significance of the subnet mask is revealed when we switch from decimal to binary. The drawing below shows our IP address and subnet mask example expressed in binary:

```
11000000.10101000.00000001.00000001
is binary IP address 192.168.1.1
11111111.11111111.11111111.00000000
is binary subnet mask 255.255.255.0
```

The binary 1s in the subnet mask define the network address and the 0s define the host address. So, we can see that the network address is 192.168.1.xxx and the host address is xxx.xxx.xxx.1.

This means the network address 192.168.1.xxx can have 256 IP addresses in the range: 192.168.1.0 to 192.168.1.255. However, there are only 254 that can be used because the first and last are reserved, so the actual range is 192.168.1.1 to 192.168.1.254. The first IP address 192.168.1.0 cannot be used as it's used to describe the network address. The last IP address 192.168.1.255 is called the broadcast address and is accepted by all hosts on a given network.

CONNECTING A LIGHTING CONSOLE

Suppose your lighting console is connected to two Ethernet-to-DMX512 gateways. The console has an IP address of 192.168.1.1 and the two gateways have IP addresses of 192.168.1.2 and 192.168.3. Everything has a subnet mask of 255.255.255.0.

The console can communicate with the gateways in two ways: by sending a message directly to each IP address - a type of transmission called unicast - or by broadcasting, i.e. sending its message to the broadcast address 192.168.1.255. In either case, the two gateways will receive the message because all hosts 'listen' on their own IP address and also to the broadcast address.

Misconfigured subnet masks are the biggest cause of network problems. Consider the example above where the gateways have been incorrectly configured with a subnet of 255.255.0.0. The console - with the correct subnet - would believe the broadcast address to be 192.168.1.255. However, the gateways - with an incorrect subnet - would believe the broadcast address to be 192.168.255.255 and communication will fail.

Besides unicast and broadcast IP addressing, there is a third type called multicast. Unicast is used for one-to-one communication; broadcast is used for

one-to-all communication; and multicast is used for one-to-group communication.

CLASSES AND CIDR

It can be rather tedious to write out all IP addresses and subnet masks. An alternative way of describing the subnet mask is called CIDR (Classless Inter Domain Routing) notation. This involves counting the leading 1s in the binary subnet mask and writing the total after a slash at the end of the IP address, for example:

```
IP: 192.168.1.1
Subnet mask: 255.255.255.0
In binary: 11111111.11111111.11111111.00000000
Number of leading 1s is 24
CIDR notation 192.168.1.1/24
```

A subtly different example:

```
IP: 192.168.1.1
Subnet mask: 255.255.0.0
In binary: 11111111.11111111.00000000.00000000
Number of leading 1s is 16
CIDR notation: 192.168.1.1/16
```

My second example may cause a raised eyebrow: is that subnet mask allowed with a 192 IP address? The answer is yes, but I would avoid it. At the inception of the Internet, IP addresses were broken down into five classes: Class A to Class E. Each could be identified by the value in the first byte of the IP address and each had a default subnet mask. These were very rigid, and it was soon realised that the model (now called classful addressing) would cause the Internet to run out of addresses.

The table below shows the way these original classful addresses were allocated:

Class	Value of first byte of IP	Default subnet mask	Quantity of IP addresses
A	0 to 127	255.0.0.0	16,777,214
B	128 to 191	255.255.0.0	65,534
C	192 to 223	255.255.255.0	254
D	224	Not applicable	Not applicable

Classful addressing did not allow a Class C address such as 192.168.1.1 to have a subnet mask of 255.255.0.0

However, CIDR replaced the classful system many years ago, and under it you can use the above example - it is called super-netting. I say that super-netting is best avoided because there are still products on the market with the outdated classful addressing in their DNA; they will misbehave when faced with subnet masks that do not match their expectations. Class descriptions are still widely used - or perhaps I should say misused. The Class is defined by the first byte of the IP address. So, an IP address starting 192 is Class C. The default subnet for Class C is 255.255.255.000 and so many people describe any host on a network with a 255.255.255.000 subnet as Class C. It is technically incorrect to do so, but it is a widely accepted error.

DHCP

So how are IP addresses allocated? There are two methods - static and dynamic. With static addressing, the user literally types in the IP address and subnet mask, which are then retained in the product's internal memory. With the dynamic, a computer allocates IP addresses to all the hosts on a network, using a protocol called DHCP (Dynamic Host Configuration Protocol).

Wayne Howell is the CEO of Artistic Licence, the lighting controls company that he founded in 1988. Wayne invented Art-Net and is actively involved in the ESTA technical standards programme.