

A primer for Ethernet-based protocols: The prequel

A COUPLE OF WEEKS AGO I asked a console programmer, who also happens to teach console programming classes, which version of Art-Net a particular console uses. The answer was, “I didn’t know that there were different versions of Art-Net.”

Not that it matters, as long as everything works as expected, but that’s not always been my experience. There always seems to be some gotcha. And, if your Art-Net configuration doesn’t work right out of the box, then you might have to do some detective work to figure out where the problem lies. Knowing the history of Art-Net, how the three versions in wide use differ, and how these differences affect the configuration of your system might help you if you get in a bind. (Art-Net 4 is to be released September 18 at PLASA 2016.)

Setting up an Ethernet network

In the last issue, I wrote about the proliferation of Ethernet-based protocols, namely Art-Net and Streaming ACN (sACN), and about some software tools to help diagnose problems with these protocols, including DMX-Workshop, ArtNetominator, and Wireshark. (I have since learned about another great packet sniffer and analyzer tool for sACN called sACNView. It’s a Windows application that allows you to view active sources of sACN including up to 20 sACN universes, the names and IP addresses, the CIDs or component identifiers, the priority, the number of frames per second or the refresh



Many automated lighting consoles default to broadcasting Art-Net protocol. If you configure it to unicast by deselecting the broadcast option, then it will use less bandwidth and produce less network congestion.

rate, sequence errors, status, DMX level information for each DMX slot, and more.) But the article didn’t really cover setting up an Ethernet network for the express purpose of transmitting Ethernet-based protocols like Art-Net and sACN. So, as in the grand tradition of Hollywood (think *Star Wars*, *Planet of the Apes*, and *The Godfather*), this is the prequel to the last article, which means that it should have been written first.

The basics

When you want to network two or more computers in your home or office, there’s a good chance you’re going to set up a wired Ethernet network. And that’s typically how we set up an entertainment network. The same rules apply, and the same hardware will work. We most often use Ethernet

cables and at least one network switch.

The Ethernet cables we use today are usually the familiar unshielded twisted pair (UTP) terminated with RJ-45 connectors. Most often we use Cat 5e or the higher bandwidth Cat 6a. You can get Cat 7 cable, and Cat 8 was ratified in June 2016, so you’ll soon see it on your favorite vendor’s web site. But currently, there are no consoles or entertainment switches that can take advantage of the upgrade, so they are very scarce in our industry as of right now.

If you’re lucky, you can simply connect your console to a switch using your Ethernet cables, and everything will work properly. If you’re not so lucky, or if you’re more of a hands-on person and want to use your own configuration, then you will have to dig into the settings.

In addition to configuring the console

to output an Ethernet-based protocol and setting the starting DMX address on the dimmer rack or luminaire, you may or may not have to configure the type of casting (unicast, multicast, or broadcast), the subnet, the universe, the IP address and the subnet mask in the console, and in the controlled device you may or may not have to configure the subnet, universe, IP address, and subnet mask.

“... if your Art-Net configuration doesn't work right out of the box, then you might have to do some detective work to figure out where the problem lies.”

Casting, IP addresses, and subnet masks

The type of casting might also affect some of the other settings. The original Art-Net protocol, which was simply called Art-Net but is now referred to as Art-Net 1, broadcast the data to all devices on the network. In the case of a broadcast signal, the only requirement to receive the data is that the IP addresses of the receiving devices are configured properly so that they can communicate with the console across the network.

An IP address is a soft address, meaning that it can be changed by the user. There are currently two different versions of IP addressing—version 4 (IPv4) and version 6 (IPv6)—but most of the gear we use today uses IPv4, including Art-Net and sACN.

An IPv4 address is a 32-bit binary number that is commonly written in quad dotted decimal notation, meaning it has four segments, each of which is separated by a decimal, like “10.0.0.5.” The decimal numbers in an IPv4 address can range from 0 to 255, and if you try to use a higher number you'll get an error message. There are two parts to an IPv4 address; the first part is called the network portion, and

the part that is left over is called the host portion, each of which is of variable length. The length of those two portions of the IP address is determined by something called the “subnet mask.”

The subnet mask is a 32-bit binary number that, like the IP address, is commonly written in quad dotted decimal, but, unlike the IP address, in binary form, it's always a series of 1s followed by a series of 0s, as in “11111111111111110000000000000000.” The 1s in the subnet mask correspond to the network portion of the IP address and the 0s correspond to the host portion. So, when you type in the subnet mask in decimal form, the device takes its binary equivalent and uses it to know which part of the IP address is the network portion and which part is the host portion.

The most common settings for the subnet mask are 255.0.0.0, 255.255.0.0, and 255.255.255.0, but there are many other legal subnet masks, like 255.128.0.0 or 255.192.0.0. As long as the quad dotted decimal number translates to a series of 1s followed by a series of 0s, it's a legal subnet mask.

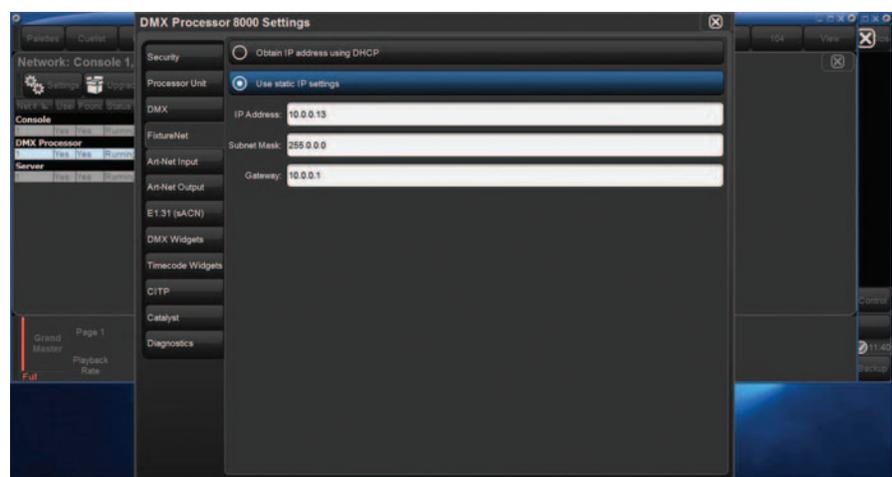
Routable and non-routable IP addresses

You might have noticed that some IPv4 addresses are very common. That's because

“The type of casting might also affect some of the other settings.”

there are groups of IP addresses that are reserved for use on private networks, and those are called “non-routable” addresses. And then there are others reserved for use on the Internet, which are called “routable” addresses. The most common non-routable IPv4 addresses in use today are either 192.168.x.y or 10.x.y.z, where x, y, and z are numbers that can range from 0 to 255. That's why you very often see those IP addresses, and those are the ones we normally use for private networks, with the sole exception of some Art-Net devices.

If you read the user manual for some Art-Net devices, it might tell you to use the IP address 2.x.y.z. This is a routable IP address, meaning that it can be used on the Internet. Somebody owns and uses that address on the Internet. If you try to use it and connect to the Internet, you'll have problems. If you know how to block it from the Internet in the settings of your router, you'll be fine, but it's probably better to avoid that scenario by using a non-routable IP address like 10.x.y.z.



In order for any two devices on the same network to communicate with each other, including consoles and automated lighting, the network portion of the IP address and the subnet mask must match.

The art of networking

The most important point to remember about configuring IPv4 addresses and subnet masks is that, in order for any two devices on the same network to communicate with each other, the network portion of their respective IP addresses has to match, and the subnet mask has to match. Otherwise, they might as well not be connected because they won't see each other on the network. The subnet mask setting has tripped me up on more than one occasion. Now it's the first thing I check after configuring the IP address.

“... in order for any two devices on the same network to communicate with each other, the network portion of their respective IP addresses has to match, and the subnet mask has to match.”

Art-Net 1 was launched in 1998, and at that time, lighting systems were generally much smaller than they are today and the devices that use it were simpler with fewer control channels. Also, computer networking hardware was slower than the hardware available today. Art-Net 1 always broadcasts the data, which generates more traffic on the network compared to multicasting or unicasting. As a result, it could only allow for somewhere around 10 to 40 universes of DMX. At the time, that was enough, but that soon changed as lighting systems got bigger and luminaires got more complex with more control channels.

So the next version, Art-Net 2, which came out in 2006, allowed unicasting to reduce traffic on the network, and it increased the possible number of DMX universes to 256. Unicasting is one-to-one, meaning that the console sends the control data to a specific device. For that to work properly, the console needs to know the IP address of every device on the network. If the manufacturer has properly

implemented the protocol, then the console will automatically discover any Art-Net 2-enabled device when it is first connected to the network. However, many consoles that use Art-Net default to broadcast, so you might have to turn off broadcast in the settings of the console if you want to unicast the data.

Why would you want to unicast instead of broadcast? If your system is big enough and has a lot of nodes, then there might be too much traffic in broadcast mode, resulting in the loss of Art-Net signal. If you have a small system, then broadcast will more than likely work just fine.

Art-Net 3 expanded the possible number of universes by changing from an 8-bit universe to a 15-bit universe. More specifically, it added a 7-bit subnet to the 8-bit net, which means that there are a possible 32,768 DMX universes, at least in theory. In practice, it would take a blazing fast network to take full advantage of it.

Art-Net 4, the latest version, will allow you to use Art-Net to discover and manage devices using RDM while using Streaming ACN (sACN) to transport up to 63,999 universes of DMX, just in case 32,768 doesn't light you up. ■



Richard Cadena is Technical Editor of *Lighting&Sound America* and *Lighting&Sound International* and a Contributing Editor to *Protocol*. He is also an ETCP Certified Entertainment Electrician and an

ETCP Recognized Trainer. Richard is the author of *Electricity for the Entertainment Electrician & Technician*, *Automated Lighting: The Art and Science of Moving Light*, and *Lighting Design for Modern Houses of Worship*.