Another hurdle to overcome is that the cables and connectors used for 10 base T Ethernet do not lend themselves to being extended. They are male-to-male and, although joiners are available, they are not particularly reliable or recommended. This means that, to extend a cable, you need a hub or switch. One way that early adopters of this technology in entertainment lighting have gotten around this problem is to have a supply of cable on hand with tools and knowledge to make cables onsite if required.

TCP/IP BASICS

The IP Address

For any two devices (such as a lighting console or a computer) to talk via Ethernet they require a unique address. An IP (Internet Protocol) address is made up of four sets of numbers. Each set is a number from 0 to 255. For most applications the first three sets of numbers need to be the same, with the last set being unique; for example: 192.168.0.1 or 192.168.0.130 or 192.168.0.221

The three sets of numbers above would all work together on the same network. Remember: All devices on a network require a unique IP address.

The easiest way to think about IP addresses is that anywhere an Ethernet cable plugs into (or a replacement for a cable, i.e. in a wireless system) a device you need to assign an IP. address. So a computer with a wireless Ethernet Card and a wired LAN connection will have an IP address for each. A good analogy for IP addressing is a normal street address. The first set of numbers is the town, the second the street, the third the building number, and the fourth the apartment number.

Most business networks use a system called DHCP to automatically assign IP addresses to the computers on the network. This has many advantages, as it makes the network connection essentially plug-and-play. This is also how the Internet works; your service provider automatically assigns you an IP address each time you connect to the Internet. DHCP, however, is not used in most lighting networks and static IP addressing, where you manually give each device an IP, seems to be the order of the day; this makes the system significantly more robust, as it does not rely on a central file server and a network administrator.

The Subnet Mask

For the longest time I ignored the setting for a subnet mask, as it never seemed to make a difference when setting up small closed networks. Indeed, if you do not put a subnet mask in when setting up the IP for a computer it will automatically assign one. (Cool!) For most applications, a subnet mask of 255.255.255.0 will work just fine. You'll see that it looks very much like an IP address and, in fact, the two are closely interrelated. It is the subnet mask that defines the range of numbers compatible with your IP address. So with a Subnet Mask of 255.255.255.0 the first three sets of numbers in your IP address must be the same. With a subnet of 255.0.0.0, only the first set of numbers needs to be the same. The rule of thumb is to use a subnet of 255.0.0.0 and you should never run into problems.

HARDWARE

Ethernet and, in particular, 10 base T, hardware is very low-cost when compared to DMX hardware, which is one of the things that make it so attractive. Please remember, however, that off-the-shelf computer peripherals for Ethernet are really designed for office or domestic use so, again, as a rule of thumb, you get what you pay for — just don't go over the top!

Cables

There are basically two wiring schemes for cables and two types of cable. Just to make things more interesting, it is almost impossible to tell them apart just by looking at them. A straight cable is a pin-to-pin Category 5 cable with a male RJ-45 connector at either end. This cable goes between an Ethernet hub, or a switch, to a device such as a computer. A crossover cable is a patch cable that twists the connection between the pins (1 to 3, 2 to 6, 3 to 1 and 6 to 2). This allows two devices, such as two computers, to be linked together without the need for a hub. I strongly recommend that you mark up any crossover cables that you may have, as they wreak havoc when you are trying to cable a system and wondering why part of it does not work. In my office, all of our crossover cables are orange to distinguish them from our straight cables, which are green. The two cable types are patch and installation. For entertainment applications, patch cables are strongly recommended unless you are in a permanent installation scenario. Patch cables use stranded cores and are flexible. They both have a maximum length of 300'; however, the installation cable uses solid cores and should only be used where the cable can remain rigid.

Splitters

An Ethernet hub is the core of any Ethernet system and, as its name suggests, it's the hub that allows multiple devices to talk to each other. An Ethernet switch is similar to a hub; however, it can be significantly faster in certain applications and for larger networks. When a device sends a message to another device on the network via a hub, the hub broadcasts that message to all the devices that are connected to it. When a switch is used, it routes the message only to the device concerned — in that way minimizing the amount of superfluous information floating around your network. It's getting harder to find hubs, as opposed to switches, as the prices of switches come down. The limited cable (or segment, to give its proper Ethernet talk title) length of 10 Base T Ethernet can easily be extended by using a hub as a joiner; however, a total of only four hubs can be used in a system and only three segments can be active at any one time. An active segment has a node on it as opposed to one that just joins two hubs together. This is more commonly known as the five-four-three rule: Between any two devices on the network (or nodes if you prefer) there can be no more than five segments, four repeaters and three active segments. For longer runs, fiber optics and other solutions must be looked at.

Wireless gateways/access points/Routers

All of these devices essentially do the same thing: they provide a connection point for wireless devices to a wired Ethernet network. Most of them come with bells and whistles to allow home users an easy way to access their DSL service, among other things. However, for most lighting applications, you need worry only about if the unit is going to work for you and its range. Wireless gateways tend to have an IP address, so you can configure them from a web browser; however, this IP does not need to be in your domain /subnet (first three sets of numbers the same) in order for your other wireless devices to access the wired part of your network. Technically, these wireless devices are not Ethernet; still, many

people, including me, use the term wireless Ethernet. More on wireless Ethernet later.

ETHERNET SYSTEMS

There are (warning: controversial statement ahead) two basic functions that Ethernet offers the lighting world.

1. The transport of DMX, or another lighting control protocol, from Point A to Point B over a network. Benefits come in the form of flexibility, as blocks of channels of whole universes of DMX can be routed, merged, and split without any additional hardware. Several systems are available which translate DMX into Ethernet and then back again. In such systems a node is used to convert the DMX data into 10 Base T Ethernet where it can be manipulated and monitored using a software program. Common manipulations include LTP and HTP merging of DMX universes and the outputting of a single universe to multiple locations, much like a normal DMX splitter would do. The configuration of such networks tends to be via software, running on a computer or PDA connected to the network. Small adjustments or significant changes can be made to your system at the click of a mouse. Other benefits include electronic labeling and access to low- cost solutions to common problems, such as wireless access and long distances. An inherent problem with Ethernet is that a single Cat 5 cable has a maximum length of only 300' as opposed to 1,000' with DMX. But connections to fiber optic technologies for 10 base T Ethernet are available and can expand this distance dramatically for relatively little cost.
2. An improvement in communication between consoles. This is perhaps the most exciting aspect of Ethernet in the entertainment lighting environment. Networked lighting consoles can allow two or more operators to work on the same show at the same time, handling the same lights. Their work can then be played back on a single console without having to merge show data. Another use is remotes; low-cost PDA devices can be used as riggers' and designers' remotes. Need to give a LD his or her own monitor? Just plug a laptop into the network running offline software. Offline editor software suddenly becomes on-line editor software in a multi-user environment. This also brings up the idea of a user being able to “surf” from one lighting session to another.

There are also systems that combine both of these ideas into a single distributed processing system; here, the nodes, as well as outputting DMX data, also process the data locally, rather than having the console do it. The advantage is its theoretically unlimited channel count, as the total number of DMX channels depends only on the number of processing nodes available.

CONNECTORS & CABLE

10 Base-T Ethernet uses Category 5 cable. This eight-core cable has been designed to be cheap and lightweight. Cat 5 cables are not meant to be coiled, run over by fork lifts, and to generally take the abuse that they will get in an entertainment lighting environment. There are a number of heavier duty cables coming onto the market that have stranded cores and are double-jacketed; they are a wise investment if your Ethernet cables are going to have to deal with a harsh environment.

As far as connectors go, you have a number of choices. The standard RJ-45 unit is not an option on its own and even the hood that comes on most pre-made cables will only supply a minimal amount of protection. Of course, if you choose a completely new connector you lose one of the main benefits of Ethernet in terms of low-cost, off-the-shelf hardware from the consumer and business markets. Neutrik has come up with an ingenious solution in the form of the Ether-Con. This is a robust XLR type jacket that fits over an existing RJ-45 connector and can be assembled and disassembled without the need for tools and thus is ideal for swapping back and forth. Woodhead Connectivity has an IP67 rated version of the RJ45, which has a screw-down locking ring and is available in sealed and field attachable versions. Socapex also has a protective shell to encase a standard RJ-45 and is available in plastic, metallic bayonet, or metallic full military spec versions.

WIRELESS ETHERNET

Robert Bell wrote in these pages about programming a casino in Canada while he was across a river, 400 yards away, in the US (*Lighting Dimensions* December 2002) with his laptop using a wireless Ethernet system. This is a great example of what is possible with off-the-shelf technology using Ethernet. A gateway and a wireless card can cost as little as $150. Be aware, however, of the nature of the beast. I would not use wireless technology unless it was impossible or highly impractical to use a normal Ethernet cable. Cable is always going to be more reliable than wireless — just ask a sound technician! 802.11b (or Wi-Fi) is the standard that most of the low-cost wireless Ethernet products use. Keep in mind that 802.11b is not as much of a standard as some of the manufacturers would have you believe and certain programs may have problems talking to devices or getting devices to talk to each other. Check with the manufacturer of any specialized software what has been tested and what they recommend. 802.11b separates down into two systems, AdHoc and Infrastructure. As the names suggest, one is used for a more informal network arrangement and the other is for a more structured environment. AdHoc is really meant for laptop users to talk to each other and is, therefore, of limited use in the lighting world. Infrastructure is where a gateway/access point/router is used as the connection to the network and all wireless devices connect through this to LAN. Now it is possible, as more and more wireless devices get out there, for things to get very confusing, so the wireless part of your network has it's own ID, called an SSID. This means that if you are in a building with multiple wireless access point and potentially compatible IP addresses you can pick and choose which one you would like to connect to. An SSID is typically a word; try to be original and use something other than “Wireless”!

All wireless devices that want to communicate need to have the same SSID in order to work. As I said earlier, all wireless gateways that I have seen have their own IP address, which allows you to use a web browser such as Internet Explorer to configure them. The SSID of the unit has to be the same as that of all the other wireless devices; however, this configuration IP address does not have to be compatible with the IP addresses of other wireless devices.

PRACTICALITIES

So you want to work with Ethernet, do you? Let's set an IP address. For this example, I'm using Microsoft Windows 2000®; however, if you have a different operating system, the process is pretty much the same.

Please note: If you are already part of a network, check with your network administrator before changing your IP settings (you may not need to) and before connecting any device, such as a lighting console, to an existing network.

1. Double-click on LOCAL AREA CONNECTION
2. Click on PROPERTIES
3. Select INTERNET PROTOCOL (TCP/IP) from the list of protocols.
4. Click on PROPERTIES (image, right)
5. In the properties window you will see either your existing IP address or a selection that says OBTAIN AN IP ADDRESS AUTOMATICALLY. This is where you choose whether to have a static IP address or use DCHP address.
6. Click on the radio button USE FOLLOWING IP ADDRESS.
7. Click OK once you have entered your required IP address.
8. If you leave the SUB NET MASK field blank Windows® will prompt you that you need a SUBNET MASK and will then proceed to give you the default mask of 255.255.255.0. Just click OK to leave this menu and you're all set. Your computer now has an IP address. A word of warning: If you are using a Windows operating system pre-Windows 2000® you will need to re-boot.

There are a number of useful commands to be found in DOS for networking and are worth keeping in mind when things don't work first time:

PING: To confirm that a device is on the network and that your PC can communicate with it.

START-PROGRAMS-ACCESSORIES-COMMAND PROMPT (image, bottom left): From this DOS environment type if you typed PING 192.168.1.1, you would get a response from the device with that IP if the message got through. If not, you will get a time -out message.

IPCONFIG: If you are using DCHP addressing and you want to know what your IP address is, or if you have any doubts about your IP settings you can use the same Command Prompt environment to run IPCONFIG and this will tell you the IP address that you are using on your computer (image, bottom right)

IPCONFIG /ALL: This command, again run from the Command Prompt environment, will give you all the IP addresses in use on your computer when you are using multiple Ethernet cards.

FINAL WORDS FROM THE BUNKER

Ethernet is a new and exciting tool that has been creeping into our industry for years. It is highly powerful and flexible, which, of course, means that a certain level of complexity is only to be expected. As long as common sense prevails, it can only be of benefit. I can't envision Ethernet cables going directly into lights anytime soon, although I'm sure we'll see it at some point. Just like DMX before it, the people who embrace this new technology will find themselves able to achieve things undreamt of by their counterparts who do not adopt it. Ethernet is just another tool in the toolbox and, as such, it makes a great complement to the other tools we currently have such as effects generators for moving lights, visualization software and DMX.

RDM (Remote Device Management) and ACN (Advanced Control Network) are both up- and-coming protocols that could have a huge impact on our industry and the way that we work. RDM runs over existing DMX cable and allows for the remote identification and configuration of devices such as moving lights, color scrollers, and dimmers. When it comes out, RDM will most likely be compatible with the DMX-over-Ethernet systems that are on the market, as a number of them have had a hand in it's development. ACN is a completely new way of controlling and handling devices and it looks like it will take advantage of Ethernet.

I, for one, am a great supporter of these new and exciting tools but the bottom line is that DMX will be here for years to come as, I imagine, will Ethernet!

POINTS TO REMEMBER

Ethernet networks can be highly flexible and offer low-cost hardware; however, remember that, in general, you get what you pay for.

Everything needs an IP address and, with a few exceptions, an IP address is four sets of numbers between 0 and 255 with the first three sets of numbers identical and the last set unique.

Ethernet networks are not very forgiving, so they will either will or will not work. This is both a good point and a bad point depending on your point of view. Remember the DOS tools that are available to you help troubleshooting.

Keep track of your cables, in particular crossover cables, as these can cause huge amounts of confusion if they get mixed in with normal patch cables.

When extending cables remember the five-four-three rule. Between any two nodes there can only be five segments, four repeaters and three active segments.

Be sure of why you are using Ethernet technology and what you hope to gain from using it.

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Back to Top

BROWSE ISSUES

October 2006 September 2006 August 2006 July 2006 June 2006 May 2

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