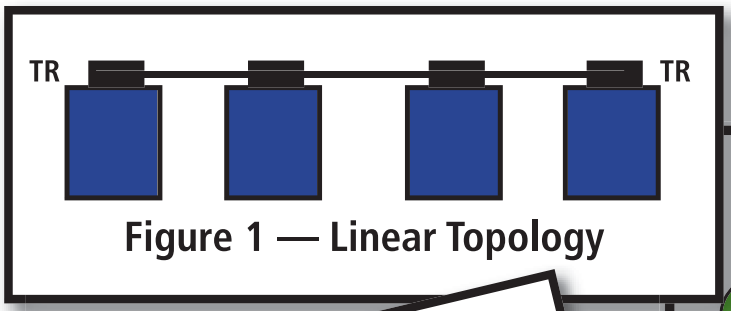

Figure 1 — Linear Topology

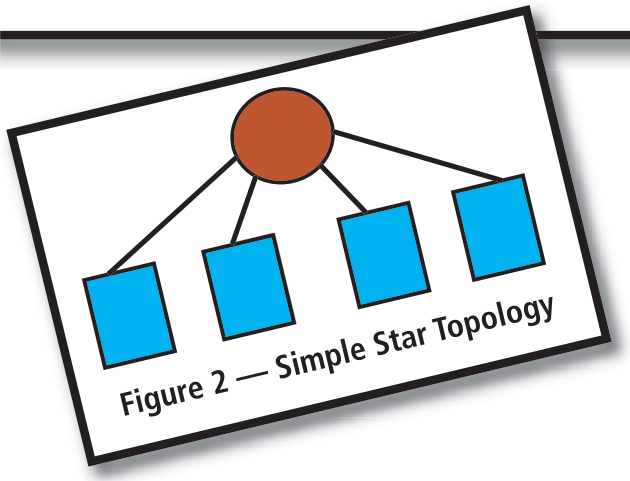
Figure 2 — Simple Star Topology

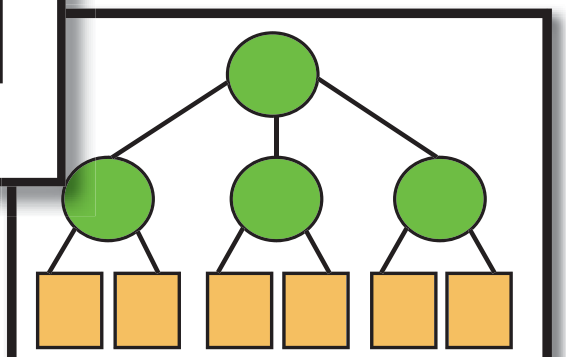
Figure 4 — Hierarchical Star Topology

DMX versus Ethernet infrastructures for lighting control networks

BY JAVID BUTLER

Planning a hybrid system lets you to capitalize on the advantages of DMX512 *and* Ethernet

PARADIGM SHIFTS ARE NEVER EASY. Even when people buy into the new paradigm quickly, there are a lot of technical details that need to be sorted out. This is where we as an industry currently stand when it comes to DMX512 and Ethernet for lighting control networks. We like the idea of Ethernet for all the good reasons, but we cannot leave DMX512 just yet. So we try to find a balance between them, and it is a balance that can be difficult to find.

The difficulty in finding a good balance between DMX512 and Ethernet is the fundamental differences in the technologies. USITT DMX512 and the new version, ANSI E1.11-2004 (commonly called DMX512-A), is based on a physical layer specification, EIA-485-A, that is found most commonly in industrial applications. While the form of Ethernet we use is found most commonly in office environments. These differences make it very difficult to merge the two systems effectively without good forethought and planning, since the industrial control environment and the office environment have different data distribution requirements.

EIA-485-A is a specification for a long-distance, multi-drop data bus, meaning that a number of devices can be distributed along a single pair of wires. In a full EIA-485-A implementation, any device along the bus can become a transmitter, but this feature has not been used in most DMX512 systems; neither USITT DMX512 nor ANSI E1.11 specify how bi-directional communications are to be done. However, this past January the final version of E1.20-Remote Device Management (RDM) passed through the ESTA Technical Standards Program and is now an American National Standard. RDM uses the full bi-directional capability of EIA-485-A to interleave bi-directional data on a DMX512-A link. This interleaved data allows controllers to set DMX512 addresses remotely, for example, or to receive device status, such as whether a lamp is on, or a device's internal temperature. All of this can be done with a single data cable that runs from device to device, like a daisy-chain, connecting all together on a link. So one cable dropped to a stage electric can provide complete RDM control over all the devices on that electric. This can be an advantage in that only one cable has to drop to the pipe, but a disadvantage in that a single bad cable or the lack of termination at the far end of a cable can take down the whole link.

Ethernet in the office environment is based on a star network, with data cables radiating out to end points from a central point, which usually is a hub or switch, and occasionally a router. In an office system a vertical riser carries bulk data from floor to floor, to hubs or switches on each floor, while horizontal cabling radiates out from the hubs to the points of use. The cabling does not run from

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device to device, in a daisy-chain fashion, as it does with a DMX512 system. The maximum distance between Ethernet devices, which is the effective diameter of the network, is limited to 200 meters (656 feet) or 100 meters per cable run with regular twisted-pair copper-wire cable, but that limitation is usually not a problem in an office because devices connected by copper-wire cable tend to be closer.

In a stage environment the main disadvantage of wired Ethernet is that every device requires a separate horizontal cable back to a hub or switch. If you have ten devices on a batten you need ten cable drops, or you have to put a hub on the batten. Even with a hub on the batten you have to run a separate cable from the hub to each device. That can be a lot of cables, but the advantage is that a single bad cable on the batten won't take down communications on the entire electric. The other disadvantage of Ethernet is the distance limitation. In some very large performance venues, the Ethernet network diameter may need to be larger than 200 meters, but these instances are rare and can be dealt with by using fiber-optic Ethernet cable.

The most common solution to using DMX512 and Ethernet together while capitalizing on the advantages of each is to use Ethernet as the primary distribution medium in the venue, and then convert to DMX512 at an Ethernet-to-DMX node to run along a batten. It helps to think about both systems together. Imagine an Ethernet star overlaid on the physical layout of the space with straight runs of DMX512 straight out from the ends of the arms of the Ethernet star. So it is Ethernet to the node, then DMX512 out from there. Don't get confused by multiple DMX512 universes. Use the node to assign DMX address ranges to a DMX cable, rather than trying to do it with your cabling. Looping DMX512 cables back and forth all over the theatre to get the addresses you want to the DMX512 devices you want will make a less reliable, less flexible system, especially when trying to use devices that support RDM. If you follow a radial-branching plan it will reduce problems and allow more flexibility to deal with last-minute changes. Remember that a DMX512 universe can appear in multiple places when transmitted over Ethernet, and use that to your advantage.

For a proscenium stage it is relatively easy to fit a star network into the space. Simply consider each electric and pipe as an arm of the star. So the arms of the star for a medium sized theatre might be: control booth, front of house, house boom left, house boom right, apron, first electric, second electric, and third electric. Simply drawing this might even point out where the Ethernet switch or hub should be located. The process of drawing this star will also help determine how many ports are needed on the switch. Then the access to the rigging will determine exactly where the transition from Ethernet to DMX512 should take place. The nodes will need to be accessible; placing a portable node on running rigging can work, but it is better to place it on a catwalk or loading bridge.

This is not a bad way to hybridize the systems, and it capitalizes on the advantages of using Ethernet for the longer data runs. A single Ethernet cable has a lot more bandwidth than a DMX512 cable, so one Ethernet cable can do the job of many DMX512 cables for moving data from one end of the venue to the other. Ethernet systems also have a lot of error checking that DMX512 does not have. DMX512 is considered unreliable from a networking perspective, in that the data is not acknowledged by the receiver—it is simply fire and forget. The only error correction inherent to DMX512 is the constant refresh of data.

Finding the right balance between the use of Ethernet and DMX512 on a lighting network depends on the system. Too many Ethernet points is a waste of money, but too few makes the system difficult to use. If the user has to run many DMX512 cables because there are two few Ethernet nodes, the user can have reliability problems because of bad DMX512 cables or long unterminated runs. A very poorly designed Ethernet-plus-DMX512 system could even make loading in more work than a DMX512-only system.

. . . a DMX512 universe can appear in multiple places when transmitted over Ethernet . . . use that to your advantage.

Many people will want to future-proof a venue by putting in cable that can be used for DMX512 or Ethernet. The Cabling Task Group, part of the Control Protocols Working Group in ESTA's Technical Standards Program, has researched the question of whether unshielded twisted pair (UTP) Category cable would be suitable for DMX512 from now into the future. We knew from testing that Category 5 would work, but Category 5e is almost all the Category 5 that can be found anymore, and there have been

reports of problems with static charge accumulation. Our research found that static accumulation is not a concern for DMX512 with Category 5, 5e, 6, and so on cables. The other characteristics of UTP cable for DMX512 are quite good for Category 5 cable and on up. In fact, the high twist ratios provide such good noise immunity that shielding is unnecessary, and there are enough wires in the cable that a pair can be designated to provide the zero-volt common reference. At present a standard including use of Category cable for DMX512 is close to being ready for public review.

This means that it is possible to cable a theatre today for DMX512 using Category cable, and convert it to Ethernet at some point in the future. There are some important cautions when doing this:

1. DMX512 can travel much further than Ethernet. So if you plan to pull Category 5 cable today for DMX512 and upgrade the system to Ethernet in the future, follow the rules for maximum Ethernet cable length. Otherwise you may find yourself having to open up walls to complete the upgrade! Install DMX512 repeaters in the places where you will eventually need Ethernet hubs or switches.
2. DMX512 is not as dependent on properly installed cable as Ethernet is, so follow the Ethernet pulling rules. If the cable gets stretched in pulling, it may work for DMX512 but may not carry Ethernet.
3. Remember that DMX512-A and RDM can be split through repeaters the same way Ethernet can, so use the overlaid-star plan to develop the system. Ethernet cannot be daisy-chained, so even one violation of the star pattern can make the future upgrade more difficult. If there are several dimmer packs or racks that will be daisy-chained on DMX512, be sure to provide for space and power for a node to convert Ethernet to DMX512 where needed.
4. Consult ESTA's *Recommended Practice for Ethernet Cabling Systems in Entertainment Lighting Applications* and the *Supplement to the Recommended Practice for Ethernet Cabling Systems in Entertainment Lighting Applications* for guidance on designing an Ethernet system.

What about wireless systems? To borrow from my favorite Food Network program, that's another show.

During this time of transition a little caution when planning control networks can keep a paradigm shift from becoming a dramatic disaster. ■

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