DMX, Ethernet and Cat 5

It is not too long ago when a lighting control standard meant that most dimmer sliders could be operated using standard lengths of 2" x 1" (50 x 25) timber. The timber was used to move more than two of the direct operated 500mm sliders at the same time. When electronic dimming became widespread in the 1970s, there was a sort of a standard in the eventual adoption of the 14 pin Military specification Canon connector for every 12 (or sometimes 10) channels of analogue control wiring. There was also a standardisation of control voltage: zero volts was dimmer off, ten volts was dimmer at full, and five volts was around about, more or less, approximately half way.

The problem was that some systems used +10v for full and others used -10v. So, even if you had a console with Canon plugs on it, dimmers with Canon sockets on them, and multicore cables with the right number of cores (12 and 14 were both popular numbers), there was still a reasonable chance that the desk and dimmers would be incompatible. Some clever dimmer manufacturers incorporated switches or special circuitry to handle either flavour of console, but generally the situation was a sorry mess.

When consoles began to incorporate microprocessors for memory and playback functions, the engineers also began to use multiplexing techniques which allowed a whole console load of dimmer control signals to be shared over just a few wires, thus replacing the need for a multicore cable for every dozen or so dimmers. As there was no established standard method for multiplexing the signals, each team of engineers developed their own system, using different voltages, update rates, cable types, connectors, etc. At the dimmer end, the de-multiplexer (demux) box generally had a bunch of 10volt outputs, usually switchable to either polarity. However, the output connectors on these boxes were invariably not 14 pin Canons, requiring special interface cables to be made up for each brand (and sometimes even model) of demux.

The complete lack of interchangeability of system components finally got the better of our brethren in the United States, and the US Institute for Theatre Technology (USITT) set about working with the equipment manufacturers in that country to define a standard for lighting control signals. Probably because everyone had already developed their products, the Analog Multiplex (AMX) standard they set, AMX192/1986, was widely disregarded or offered as a costly add-on. In the US it saw some adoption, but here in Australasia, it was virtually only known as a selectable output option on a few Strand consoles. However, the USITT had also set about defining a standard for the forthcoming generation of all-digital control systems.

This Digital Multiplex (DMX) protocol was available to console and dimmer designers from quite early in the development process for their new digitally-controlled systems, and was at first widely, then later universally adopted. The DMX512/1986 protocol was slightly tweaked in 1990 to become the DMX512/1990 standard in use today. It specifies the transmission voltages, the data rate, the format of the data content, the type of cable and the type of connector to be used. Only devices that meet all of these criteria are permitted to be labelled DMX512/1990.

RJLnxx Connectors

This standard is in turn, in the process of becoming DMX512-A. The new incarnation of DMX512 will include a range of additional capabilities and features, whilst retaining interoperability with all existing DMX512/1990 equipment. Exactly which of many proposed extensions to the DMX512 standard will be incorporated in the new protocol, is still a matter for discussion and public comment through American National Standards Institute (ANSI) committee BSR E1.11.

Whatever the standards group eventually decide, some things won't change. The data stream from controller to equipment will still be in blocks of up to 512, eight-bit (256 step) levels, and it will still be in the form of RS-485 serial data over a transmission line network. DMX512-A is not intended to address the problems associated with using large numbers of robotic luminaires. It doesn't offer 16-bit (65,536 step) levels, it doesn't handle more than 512 pieces of data in a block, and it doesn't deal with more than two DMX512 universes down a single 5-core cable. All of these issues, and many more, are being examined by another ANSI working group: BSR E1.17, Entertainment Technology - Multipurpose Network Control Protocol Suite, otherwise known as the Advanced Control Network (ACN Suite).

In the words of the working group. "The ACN is intended to provide the next generation standard for the distribution of data in lighting control networks. ACN needs to do much more than just supersede DMX. Ideally, ACN will unify lighting control networking, allowing a single network to carry many different kinds of lighting-related data and to connect equipment from different manufacturers. ACN is not limited to lighting. It is expected that support for audio control and stage automation will also be incorporated." You can learn much more about the ACN group by visiting the Technical Standards Program pages at the ESTA website.

These truly immense goals will of course, take a long time to achieve. Not surprisingly, after several years of work, the committee is nowhere near completing the task, or even offering a good guess at the final product. Consequently, equipment manufacturers have each started to develop such parts of an ACN as they need for their present and future products. Whilst all of them would welcome an ACN standard, and many designers are making certain that their equipment is capable of incorporating an ACN standard when it appears, they are all heading down the road of designing and building proprietary products. There is some concern that, like AMX192, by the time the ACN200? Standard arrives, the industry will have irrevocably fragmented into islands of incompatible proprietary protocols.

Already there are advanced networked products from, Compulite, ETC, Strand, Enttec, Siemens/ADB, High End, Avolites, Bytecraft and many others. Some of the devices simply use a 10 or 100Mbps Ethernet port as a way of multiplexing many universes of DMX control signals over a single category 5 data cable. Most however, incorporate additional management, support, monitoring and auxiliary device control functions, on a network that has the capacity to deliver between 30 and 350 DMX512 universes of bi-directional data without even raising a sweat.

There is one clear outcome from this broad range of possibilities for the developments in lighting control: if you aren't already using one, there is a high likelihood of an Ethernet lighting network in your future. If you are considering any installation or upgrade in a venue or studio, you would be wise to consider including Ethernet capable cabling or even optical fibre as a part of your cable infrastructure. This not merely an investment for some possible future control protocol, it can actually be put into use straight away. Category 5 (cat 5) twisted-pair data cable, the familiar "blue string" that is almost universally used for data and telecommunications cabling, is perfectly adequate for DMX512 transmission.

In a series of independent laboratory tests conducted for ESTA's DMX-over- Category 5 Cable Task Group, cat 5 was found to be as suitable for DMX512 data transmission as the recommended standard DMX512 cables. It should however be noted, that cat 5 cable is Unshielded Twisted Pair (UTP) cable which needs to be run inside a grounded metal duct or conduit to give the same level of noise immunity as the recommended types of DMX512 cable. A slightly more expensive form of data cable, Shielded Twisted Pair (STP), is suitable for use where ducts and conduits are not present or

Proposed Connection Schedule for DMX512 systems using 4-twisted pair ISO/IEC 11801 Category 5 or higher Cable.

Pair	Wire No	Colour	Function	DMX512 Pin
Pair 2	1	white / orange	Data 1 +	XLR5 - Pin 3
	2	orange	Data 1 -	XLR5 - Pin 2
Pair 3	3	white / green	Data 2 +	XLR5 - Pin 5
	6	green	Data 2 -	XLR5 - Pin 4
Pair 1	4	blue	Not assigned	
	5	white / blue	Not assigned	
Pair 4	7	white / brown	Signal Common	XLR5 - Pin 1
	8	brown	Signal Common	XLR5 - Pin 1
Shield			Drain	

NB. This proposal appeared in an interim discussion paper and may not be the schedule actually recommended as part of the DMX512-A standard.

EtherCon Plugs and Socket

practicable. This practice has already been adopted for the television studios at Channel Seven's new Melbourne Broadcast Centre, where STP data cable has been used for all DMX distribution.

Existing Ethernet-based control systems use UTP/STP terminated in standard 8pin modular (RJ45) connectors, a trend which seems likely to continue for some time. As electrical engineers, telecommunications technicians and installation contractors are already familiar with specifying, installing and maintaining communications cabling based on these standards, it is probably wise to stay with them, despite the incompatibility of the connectors with the DMX512 standard. In the current draft of the proposed DMX512-A standard there is a proposal for a standard usage of the conductors in data cable. It is included in this article for informational purposes only, as the proposal has not yet been approved, and may yet undergo changes. What it does offer, is an interim scheme that avoids the use of the wires that carry the ringing voltage in telephone systems that use data cable.

The final piece necessary to assemble the jigsaw puzzle of a DMX512 over data cable system, is robust and reliable data connector to terminate the data line and provide a connection point for the DMX512 standard system. There are now several "ruggedized" versions available of the fragile RJ45 modular connector. From a lighting point of view, the most familiar of these is the Neutrik EtherCon. In this system, the plug consists of an XLR-style shell that fits over some standard RJ45 line plugs, while the panel-mounted modular socket is designed to securely mate with the line plug. There is also the extremely robust RJ Lnxx industrial connector from Woodhead Connectivity, but its design is better suited to fixed installations than the production oriented EtherCon design. There is also a rumour about that Amphenol Australia may soon be producing an XLR-style RJ45 connector that will most probably be compatible with the Neutrik version.

The futures of, lighting technology, DMX512, Ethernet and cat 5 appear to be inextricable intertwined for many years to come. It is not too early to start mapping out how they can be brought together to help keep our current costs down, whilst also simplifying our transition to future technologies.

ESTA Technical Standards Program
Neutrik connectors
Woodhead Connectivity
ACN Overview and Goals
Report on DMX512 over Cat 5 Cable