ACN and RDM: Working together to add real value BY DAN ANTONUK

The story of how automatic feedback functionality became reality

OUR INDUSTRY HAS LONG DREAMT of multi-manufacturer lighting systems that incorporate intelligent feedback from controlled devices to the lighting console. The value of remote configuration and feedback has long been known, but without multi-manufacturer interoperability it has had limited utility. As a result, ESTA's standards efforts over the past 15 years have focused on providing the industry with the interoperability tools to make such feedback possible. Those tools are the ACN and RDM

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communication standards. Uptake of these standards by equipment manufacturers will greatly alleviate feedback frustration for many end users.

This article describes how two manufacturers, ETC and Wybron, worked together to apply the ACN and RDM standards to deliver products providing seamless configuration and feedback to the lighting system end user. With RDM and ACN they had the tools to build a scalable solution that everyone could embrace.

The communications methods covered by these two standards occupy unique spaces in the lighting system of today. RDM is ideally suited for bi-directional communication over what is called the DMX512 "last mile" containing devices such as color changers and automated luminaires. ACN provides a high-bandwidth network environment that is critical for larger multi-console systems. The challenge for both ETC and Wybron was that no standardized method existed to use the best attributes of ACN and RDM to create a hybrid network model.

The development project

ETC control systems already used the ACN protocol to control and monitor their dimmer racks, DMX512 gateways, and show control gateways. However, ETC had not yet fully implemented

RDM, so there was no way for ETC consoles or gateways to access information from the RDM devices that were rapidly appearing on the market, including Wybron color scrollers and automated luminaires. At the same time, Wybron's Net IT and Infogate products provided a configuration and feedback solution using the RDM protocol, but that solution had no way to manage or to monitor ACN dimmers and other ACN equipment. Nor did Wybron have a standard way to make their RDM information available on the Ethernet network or on ETC consoles. A mutual interest in providing system-wide feedback led these two companies to work together on this project.

ETC and Wybron considered a proprietary solution that could solve the immediate problem. However, neither company wanted to solve this problem more than once, so they agreed to design a solution that used ACN *and* RDM in a new model for multi-manufacturer, standardized, open-equipment communication in the lighting industry.

Why ACN and RDM occupy unique spaces in the lighting system

It is thought by some that ACN and RDM are competing standards, battling for supremacy in the lighting system in a Beta-vs.-VHS struggle. No! Each of these standards has its place in modern systems.

RDM runs on the same cable as DMX512, on the critical last mile of the lighting system. This is the area of the rig where hundreds to thousands of devices must be installed in a physically hostile environment. Serial DMX/RDM cables lend themselves to the preferred method of hookup: daisy-chaining devices together rather than using a home run of control cable for each device in a star configuration. RDM is ideally suited for set up and monitoring of DMX512 luminaires and other devices.

ACN lives on the Ethernet backbone that provides the distribution structure for control, configuration, and feedback. ACN is used for control, setup, and monitoring of Ethernet-connected devices as well as being able to carry DMX512, MIDI, SMPTE, or RDM message data over Ethernet.

What is the ACN-RDM model?

The predominant physical communications infrastructure in large theatres today is a structured-wiring Ethernet network running to various locations in the facility. Those locations may contain Ethernet dimmer racks or gateways to translate Ethernet to other types of control. In theatres, gateways commonly bridge together Ethernet with DMX512, Ethernet with RS232 serial, or Ethernet with MIDI cabling. In addition to handling the physical translation between wires, gateways also translate between communication protocols that run on the different media.
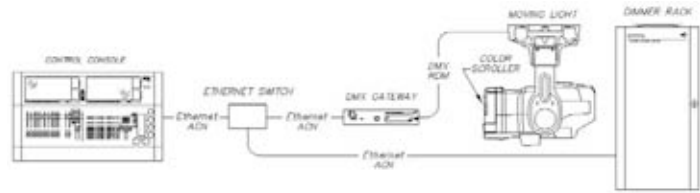

Figure 1: Physical infrastructure in large theatres today

To understand the ACN-RDM model, one has to understand more about ACN and RDM. Because RDM runs on serial DMX512 cables that can only have one talker at a time, the RDM standard was designed to support a model with a single RDM master. This master sends RDM messages that specify which RDM device (responder) is allowed to answer. RDM specifies tight timing requirements for when the RDM device must begin responding and for when the master takes control of the line again. DMX512 data is usually sent by the master as well. The RDM protocol has a single master, half-duplex, ask-listen-ask-listen model that interleaves with DMX512 to share bandwidth. RDM coexists with DMX512, both in the structure of the protocol and in the physical arrangement of the daisy-chained cables.

ACN runs on high speed Ethernet, which allows many simultaneous talkers on the network. The ACN standard was designed to support multiple controllers, and to be scalable to large systems with thousands of devices. As controllers send messages to ACN devices, those devices respond as soon as they are ready. There is no need for them to wait to be told when to respond because there is no timing limitation on when they can speak. Thus, the ACN protocol has a multiple controller, full-duplex, speak-at-will model.

ACN does not run on DMX serial lines. RDM does not run on Ethernet. *The ACN-RDM model is a design for using ACN to talk to multiple gateways, each speaking RDM to fixtures on DMX512 lines.* The model demands that gateways act as RDM masters on their DMX ports and as ACN devices on their Ethernet ports. The gateways must handle the fact that multiple ACN controllers may talk to them simultaneously and still handle the RDM side as a one master, one at a time message-response system. The ACN side of a gateway exposes a list of RDM devices each with a place to write an RDM message and a place to receive an RDM response. When an ACN controller (a console or monitoring tool) discovers a gateway using ACN discovery, it reads out the list of RDM devices the gateway has discovered using RDM discovery. Following this, it can use ACN to send any RDM message and receive whatever response is returned.

Divide and conquer

This ACN-RDM model is simple and elegant. RDM specifies a

full-featured toolkit of specific messages that are aimed at the configuration and monitoring of most DMX512 controlled equipment in existence today. ACN provides a clean way to move that toolkit up onto the Ethernet network. RDM works best with smaller numbers of RDM devices on each DMX link; discovery is faster, configuration is faster, and status polling is faster with fewer devices. To build a larger system while still keeping the optimal RDM device count per DMX link, simply add more ACN gateways. Since this solution uses only open industry-standard protocols, every manufacturer can participate and every customer can get the most flexible best-of-breed system.

The development path

Once ETC and Wybron decided to pursue the open protocol solution, a small team of engineers began meeting in August 2008. Their goal was to create the pieces of the solution for demonstration at LDI in October. There were several tasks to accomplish and not much time.

The team had to design the precise interface on the ACN side of the model. Should a gateway expose the RDM devices as ACN would, with each RDM device proxied on the network? Or should ACN tunnel the RDM protocol and require the consoles to understand everything about the RDM protocol, rather than the device-related content? The team chose not to advertise each RDM device as an ACN device. Instead, the model would expose individual devices using the ACN properties of an ACN gateway. Also, it would expose work areas for each device that allow any ACN controller to exchange RDM messages with that device. This ACN interface to RDM uses the strength of each protocol.

Wybron needed to implement ACN in their Net IT gateway—an embedded product with finite memory and processing power. Would ACN fit? Could the work be done in time? After the ANSI ratification of *ANSI E1.17 – 2006, Entertainment Technology - Architecture for Control Networks*, an effort was launched by several companies in the lighting and audio industries to develop free source code for ACN, termed OpenACN. Pathway Connectivity donated source code, some companies donated money, and others donated time. OpenACN had progressed substantially, but the code was not yet mature. Could it be the solution for getting ACN into the Wybron gateway?

Paul Geisler from Wybron's engineering team went to work. First, he pulled down the OpenACN source code from http://sourceforge.net/projects/openacn/. With help from ETC's Bill Florac, affectionately known as *Flash* for his high speed talking (and thinking), Paul ported the source code to his platform and began hooking it up to his Net IT gateway code. Paul had to change some function calls to adapt OpenACN to his network stack. Next, he had to write code to advertise his gateway

on the ACN network. Finally, Paul had to expose ACN properties that enabled a remote ACN console or ACN capable monitoring software like Infogate to obtain RDM content over the network. According to Paul, the existence of OpenACN and the collaboration between Wybron and ETC really helped him with getting all the pieces in place. ETC also wanted to finish support for RDM in their Net3 Gateways. How much variation in real world products would the gateways have to handle? What were the pitfalls in discovering RDM devices? Paul had the answers and ETC's Dan Hillstead went about implementing the RDM Master functionality in ETC's Net3 Gateways.

Meanwhile, Wybron's John Sondericker, the developer of their Infogate management tool for Mac and Windows, got to work. Infogate needed to talk ACN to be able to get feedback from ACN equipment such as ETC dimmers, and it needed to talk to the ACN side of the Net IT and ETC gateways for RDM information over the network. A problem emerged: OpenACN code was written in the C language and Infogate was written in Java! It is possible to link these two together, but creating a tight connection is not trivial and there was little time. John could rewrite the OpenACN code in Java, but time was not on our side. Then Nick Wagner of ETC suggested that the OpenACN code be used to create a standalone Windows application that would talk ACN. John could then use Java's built-in support for TCP to pass data to and from that Windows application. All agreed and work began.

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John now had to decide how he should structure his application to handle general ACN devices in addition to the RDM information he already managed. John read the ACN specification. He was especially excited about ACN's DDL (Device Description Language) and how it defined all the available properties in any particular device (see article on page 20). Along with each property, DDL provided information about what the property meant by attaching tags to it called behaviors. One tag might say "the property holds text data." Another tag might say "the text identifies the color of a gel on a color scroll." John observed that ACN was all about getting and setting the values of properties, just like RDM. The difference was that RDM had a limited set of properties that he had written specific code to support. Now he had to write code that would support devices with just about any set of properties.

ACN feedback to the Wybron Infogate GUI is shown in **Figure 2**. It shows a tree view of properties representing a dimming system and its status.
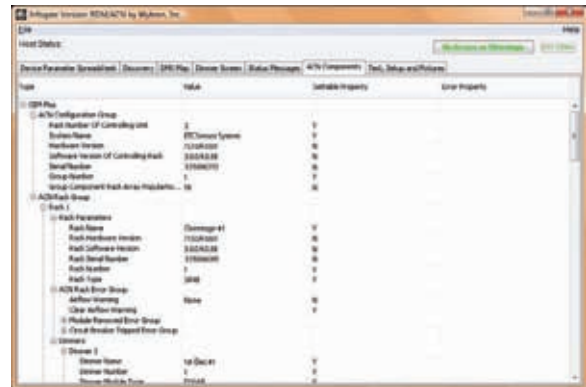

Figure 2: Infogate ACN feedback

While John was working on getting ACN into Infogate, ETC had the reverse job: implementing an understanding of RDM message content in its consoles and their user interfaces. Important feedback from an RDM device includes things like its DMX address, DMX footprint, label, manufacturer, version number, or model number. These RDM parameters fit in nicely with the ACN feedback properties already supported by the console. ETC console developer Ann Foster had no problem with integrating RDM feedback alongside our ACN feedback. All she had to do was obtain a different package of data, RDM data, from the ACN engine and update the appropriate displays.

ACN feedback to an EOS console is shown in **Figure 3**. To cause the *Circuit Breaker Tripped* error, a circuit breaker was turned off at the dimmer rack. Compare this image to the RDM feedback image in **Figure 4** to see how the feedback is treated the same way regardless of whether it came from an ACN or RDM device.

Figure 3: EOS ACN feedback for dimmer circuit breaker trip error

RDM feedback to an EOS console is shown in **Figure 4**. To cause the *Fan Failure* error message, a pencil eraser was used to jam the fan of a scroller.
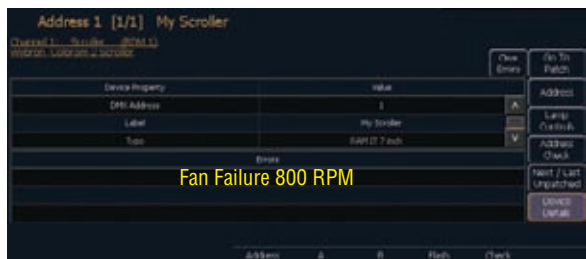

Figure 4: EOS RDM feedback for scroller fan failure error

One exciting aspect of RDM feedback is *manufacturer-specific messages.* This is an area of RDM where it reaches beyond its fixture toolkit persona and fosters future innovation. An example of this innovation is Wybron's implementation of several manufacturer-specific messages that give a user the ability to predict when maintenance will be required, for example, when a gel string will need replacement. On a Wybron scroller, you can use RDM to find out how far a gel has traveled or how much time it has spent in front of the lamp. And, even more exciting than this predictive capability is the Wybron support for reading the gel colors right out of the scroller. No longer will someone have to manually program their console with the set of available gel colors for a Wybron scroller. The console will already have asked the scroller.

Figure 5 is an image of gel colors automatically loaded via the ACN-RDM model into an EOS console. To position the scroller to a color, the console operator need only touch that color.

Figure 5: EOS Console showing gel colors read via ACN-RDM

ACN does not require any change to the protocol to support new message content. This is illustrated nicely by its ability to carry RDM content simply by exposing a set of ACN properties and defining them in DDL. RDM manufacturer-specific messages provide a similar flexibility to carry different content, but instead

of DDL, they use a parameter description. This description includes things like a text description of the message, its type, its minimum and maximum values, and its default.

Even though parameter descriptions are available directly from an RDM fixture, Ray Hill, the ETC engineer that integrated the Wybron manufacturer specific information, commented: "The most effective way for a product manufacturer to put this RDM data to good use is to know that the data is available ahead

They turned on the power and waited—and the most amazing thing happened—all the products actually talked to each other!

of time, and to write software to utilize it. The parameter description tells EOS enough information to read the message, but not enough for EOS to know what to do with it." Ray continued: "The main idea here is that consoles know how to do various things. If a console isn't written to consider that someday it might read gel colors from a scroller, then it won't be able to do that just because parameter descriptions are available. What DDL and RDM parameter descriptions do provide is a standard way to talk about new content, so that when entirely new capabilities arise, manufacturers can adopt them quickly."

So, how hard was it?

No one in his right mind would develop this kind of communications capability for any trade show, much less LDI, without first actually plugging things together to make sure they work! Their sanity already in doubt in the eyes of some, the team set their target integration test date for October 1. They had been working for a little over a month on pulling all the pieces together. When the big day came, the Wybron engineers went to ETC to plug in their gear and see if all this industry standard protocol mumbo jumbo was real or just so much paper.

This is the kind of intelligent behavior that customers will come to expect as these standards are implemented across our industry.

Scrollers were plugged into gateways. Gateways and dimmer racks were attached to network switches. An Infogate PC and an EOS console were added to the network. They turned on the power and waited—and the most amazing thing happened—all the products actually talked to each other! The RDM scrollers showed up in the EOS patch screen. The ACN dimmers showed up on the Infogate Manager PC screen. This small team of developers had designed and implemented the ACN-RDM model in a matter of weeks. Several days had been scheduled for this plug fest and those days were instead spent cleaning up code, testing, and making the user interfaces better looking.

A few weeks later at LDI 2008, both ETC and Wybron demonstrated ACN and RDM feedback to their customers using their own and one another's gateways and products. At the ESTA Interoperability Pavilion, even more RDM devices and ACN products were demonstrated providing feedback to the ETC EOS console and Infogate Management application. Without having seen each other before, these products talked to each other without difficulty. Why? Because many people worked long hours for many years defining the ACN and RDM standards.

Building this feedback functionality into these products was not a trivial effort, but it wasn't that hard. Most of the work was already done when we started: we had the open standards, and we had the free source code. This development path was not steep and not long, and the view from where we ended up is beautiful indeed.

Both ETC and Wybron believe that we have only scratched the surface of what we can do with this ACN-RDM model. For example, because EOS can see the individual fixtures on DMX lines, it automatically adjusts if a fixture is moved to a different port or gateway. Simply unplug the fixture, plug it in somewhere new, and continue to use it without worrying about changing any patch information. This is the kind of intelligent behavior that customers will come to expect as these standards are implemented across our industry. ∎

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