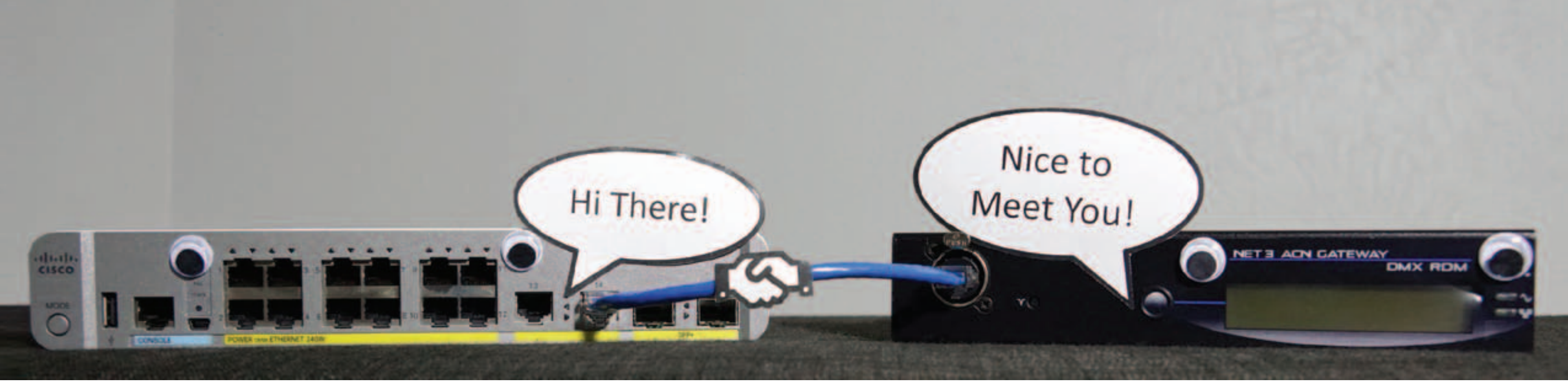

It's time ESTA devices and network switches officially met.

Network advertisement of entertainment protocols

BY **JASON POTTERF**

Provided you are using a managed Ethernet switch, all NAEP compliant devices connected to an Ethernet network will be automatically discovered, mapped, and even configured by a suitable network management tool.

LIGHTS SPEND A LOT OF THEIR TIME in the dark. Only when they get the okay from their human overlords can they light up their neighboring luminaires and everything else in the room. More and more, lighting equipment receives these orders to turn on via an Ethernet network, held together by an array of switches and routers. Ironically, while these luminaires do a great job lighting up the room, the switches and routers remain in the dark about to whom they are connected. This is especially true when it comes to neighboring ESTA devices. A new ESTA project intends to change this, and along the way, the whole entertainment technology user experience.

We all know the value of knowing your neighbors. Mrs. Johnson down the block drives slowly, but she's deaf, so don't bother honking. Tony, next door, for some inexplicable reason, owns his own cement mixer, so if you need to pour a sidewalk at 2:00 a.m., he's your man. Then of course, there's Steve. He's not allowed in the neighborhood anymore after *the incident.* Sure, you could get along without knowing any of these things, but your daily life is easier when you know what to expect from the people around you.

LLDP is the *de facto* solution to learning about your network neighbors for switched Ethernet networks.

Ethernet networks have neighbors too. In fact, data won't go anywhere without a little help from network neighbors. Here's an example from the entertainment lighting industry: You press "Go" on your lighting console at front of house. The console sends this "Go" command over an Ethernet link to the front-of-house Ethernet switch. Each Ethernet link is comprised of exactly two devices, which are called neighbors. The front-of-house switch is connected via yet another Ethernet link to its neighbor switch on the stage. That switch is then connected to its neighbor, which could be a DMX512 gateway, a distributed processing node, or even a native Ethernet lighting device. Your "Go" command makes its way through the network, one link at a time, being passed between neighbors until it reaches its destination. That's how wired Ethernet networks were designed to work.

Neighborly cooperation is critical to keep everyone safe and happy. In the previous example, the console relies on its immediate neighbor switch to communicate on the network, but that switch has responsibilities beyond just that one neighbor. Switches have many ports, and thus many neighbors, and must look out for the whole neighborhood's wellbeing as they make decisions about passing along messages. The cheapest switches on the market are aloof to the data passing through their ports, but more advanced managed Ethernet switches are more like a member of the neighborhood watch. They can be told to put Mrs. Johnson in her own slow lane, to keep Steve out, and to let anyone looking for a cement mixer know about Tony.

Knowledge of your neighbors takes effort to acquire. Anyone who has been to a block party knows that meeting your neighbor usually starts with a handshake. Next, you say "Hi, my name is Larry. What's your name?" followed by the usual small talk. "Which street do you live on? Where did you grow up? What do you do for a living? Do you have any kids?" You can get to know your neighbor based on the answers to these questions, and they let you provide the appropriate hospitality based on what you learn.

ESTA protocols don't have any LLDP TLVs defined . . . yet. The ESTA BSR E1.63 Network Advertisement of Entertainment Protocols standard's goal is to fix that.

For a long time, switches and routers have done this too. As intelligent networking equipment became commonplace, vendors realized that allowing networking devices to chat with each would make everyone's life easier. All they needed was a common language. At first, only proprietary languages for this kind of small talk proliferated. Cisco Discovery Protocol and Nortel Discovery Protocol, among others, became commonplace.

These proprietary protocols took advantage of a non-descript feature of Ethernet that allowed network equipment to send data packets that are only shared between immediate neighbors on a single connection. This connection is called the local link. These link local messages are typically sent immediately upon establishing a connection, and work regardless of if things like IP addresses are configured. Since a switch can have multiple devices attached, these messages are by design not allowed to propagate beyond this local link to avoid confusion. Thus, each one of these exchanges is a private conversation between neighbors with no gossip allowed.

At first, these conversations were only between routers and switches. However, with the rise of IP telephones, we started to see the end devices (called "stations" in IEEE parlance) having these handshake conversations with the switches as well. In fact, this is now required if you intend to receive your power over the Ethernet connection in a way that is compliant with the *IEEE802.3af/at/bt Power over Ethernet* standards.

The proliferation of proprietary languages discouraged interoperability between different manufacturers' networking equipment, causing a problem for their users. The solution was a standard called *IEEE 802.1ab*—"Station and Media Access Control Discovery" which defines the industry standard Link Layer Discovery Protocol (LLDP). The beauty of this protocol is in its simplicity of operation. It's too bad the same care wasn't put into choosing the name.

LLDP works like this: Each neighbor sends a single link local data packet, once every few seconds. Each neighbor doesn't wait for the other to ask questions one at a time. Instead, it just writes down its answers to all the questions it thinks are important and sends it to the neighbor. The neighbor reciprocates and may or may not answer the same questions. They agree to re-send this same data every few seconds, but can send it sooner if it changes its mind on any of the answers. This goes on forever, or until the neighbors are disconnected. LLDP really is that simple.

The LLDP protocol designers were clever enough to make it exceedingly easy to expand the protocol. Adding additional questions without altering the original standard was as simple as publishing the format for the answer. This resulted in widespread adoption, and now LLDP is the *de facto* solution to learning about your network neighbors for switched Ethernet networks.

Before moving on to the gritty details, it's important to discuss why this information is useful in an Ethernet network. The first (and still quite possibly the best) use for neighbor discovery is determining the network topology map on-the-fly. Pretend street maps don't exist, and imagine you have all your neighbors email addresses. If you ask everyone in your neighborhood for the name of their left, right, front, and back immediate neighbors, you can very quickly work out a surprisingly accurate map of your neighborhood by overlapping their responses.

The same applies to LLDP-enabled networks. You can ask your central switch or router for the name and address of every device connected to its ports. You can then use its responses to make similar queries on all of its neighbor devices, and then those neighbor's neighbors, and so on. In the end, a simple piece of software can draw a connection diagram of the entire network, with detailed information about each device in the diagram. This is why many IT departments don't bother with drawing complex maps of their network connections: It's easier to let the computer figure it out automatically in real time.

Topology discovery was only the tip of the iceberg. IP telephone vendors developed an extension to LLDP (TIA-1057 Link Layer Discovery Protocol for Media Devices, aka LLDP-MED) to communicate critical information. Since there was a very long cable between each IP phone and its switch, it was critical to keep track of where that phone is physically located in the building in case someone dials emergency services. LLDP-MED allowed this information to be programmed into the phone, and the phone could then announce it to the neighbor switch upon connection, regardless of to which port it was connected. Also, as previously mentioned, the *IEEE 802.3af/at/bt Power over Ethernet* standard required powered devices to notify the power sourcing equipment of how much power they needed. This was accomplished via LLDP. Additionally, every manufacturer with an IEEE Organizationally Unique Identifier (OUI) or Company ID (CID) had the ability to specify their own LLDP answers, and many did.

As one would expect from the IEEE, these LLDP answers have a complex name and an associated acronym. They are called type, length, and value fields, or TLVs for short. Here is an example of what they look like:

TLV Information String, is allowed to be formatted in any way desired, including being subdivided into information fields, or entirely used for a string of text. The length of this TLV Information String is then recorded in the TLV Length.

If IEEE standard TLVs were the only option, we would have run out of type values long ago. The authors knew this, so they reserved type 127 for extensions to the protocol. This allows the definition of Organizationally Defined TLVs, provided you have an OUI or CID at your disposal. If you do, you simply use Type 127, and then provide your OUI/CID at the beginning of the TLV information string. This allows over 16 million Organizationally Defined TLV sets to be developed. Each TLV set is allocated an 8-bit subtype, allowing up to 256 TLVs per OUI/CID. The result is that over four billion TLV definitions are possible, which is more than we'll ever need.

An LLDP frame is just an array of either

and read the type and the length of the first one encountered. Based on these two bytes of data, you then know if you are interested in the information in the value field, as well as how many bytes are in the value field. If you care, you read the value and keep it. If you don't, you skip past the value to find the next TLV. You repeat this process until you reach the end of LLDPDU TLV.

Only a few TLVs are required, namely: Chassis ID, Port ID, and the Time to Live (TTL). The TTL communicates how long all of the TLVs provided should be kept. There are many other TLVs available, but the choice of which ones to include is up to the individual manufacturer.

Thanks to LLDP, current network switches can identify if an attached device is a router, a switch, or an IP phone. It can even tell if it is a video conferencing device, a PoE powered device, or a camera. These switches can then be programmed to react to these TLVs, providing on-the-fly configuration of

IEEE STANDARD SPECIFIED TLVS

Field Name	TLV Type	TLV Information String Length	TLV Information String
Field Width	7 bits	9 bits	0-511 Bytes
Sample Contents	System Name Type Decimal: 5	Length of "Tony's Cement Mixer" Decimal: 19	"Tony's Cement Mixer" UTF-8 String
Bits on the wire	Binary: 000 0101	Binary: 0 0001 0011	Hexadecimal: 54 6F 6E 79 E2 80 99 73 20 43 65 6D 65 6E 74 20 4D 69 78 65 72

ORGANIZATIONALLY DEFINED TLVS

Field Name	TLV Type	TLV Information String Length	Organizationally Unique Identifier (OUI)	Organizationally Defined SubType	Organizationally Defined Information String
Field Width	7 bits	9 bits	24 bits	8 bits	0-507 Bytes
Sample Contents	Organizationally Specific TLV Type Decimal: 127	Length of "V15.30" + 4 Decimal: 10	TIA LLDP-MED OUI OUI: 00-12-BB	LLDP-MED Firmware Revision Subtype Decimal: 6	"V15.30" UTF-8 String
Bits on the wire	Binary: 111 1111	Binary: 0 0000 1010	Hexadecimal: 00 12 BB	Hexadecimal: 06	Hexadecimal: 56 31 35 2E 33 30

LLDP TLVs come in two flavors: IEEE standard and organizationally defined. IEEE standard TLVs are defined in the LLDP standard directly, and have the simplest structure. Each TLV has a 7-bit type value assigned, allowing up to 128 TLVs to be defined. The TLV Value, also known as the

IEEE standard or Organizationally Defined TLVs, with a special End of LLDPDU TLV at the end. This frame is sent, with a special Ethertype value, to the layer two LLDP multicast address so that the other neighbor knows to keep the frame just between them. Upon receipt, you jump to the list of TLVs

a switch based on what's plugged into each port. This way, it doesn't matter how you plug in your equipment, or if an IP phone moves from port 8 to port 12, everything will work as expected automatically.

ESTA protocols don't have any LLDP TLVs defined . . . yet. The ESTA BSR E1.63

Network Advertisement of Entertainment Protocols standard's goal is to fix that. In fact, that's all that the standard will do. It will define a set of TLVs that can be used to identify ESTA standards-compatible devices, and provide extra information about how these devices use ESTA protocols. It will also define the corresponding Simple Network Management Protocol (SNMP) Management Information Base (MIB) formats for each TLV. These MIBs will allow network management software to collect the information provided by NAEP TLVs to the routers and switches that comprise the network infrastructure.

When we sat down to define the scope and requirements for NAEP, one of the first things we discussed during the first task group meeting was what the standard will ***not*** do. We agreed that NAEP will not replicate any functionality provided by other ESTA standards. NAEP will not define any function that requires either device on the link to implement NAEP in order to function normally. NAEP will not operate with wireless devices, as LLDP is not defined for wireless systems. Finally, NAEP will not create a set of TLVs so large that the networking infrastructure manufacturers would be unwilling to implement them.

With these guidelines established, the list of what NAEP will do took shape. First, it will allow the devices that implement ESTA protocols to provide basic identifying information to the network infrastructure. Then, it will inform the network infrastructure as to which ESTA protocols are implemented in the device, along with any additional details about the implementation that might be relevant to the network. NAEP will also allow new TLVs that communicate information about the Network Infrastructure to the ESTA devices, beyond what is already available in the current standard TLVs. In particular, if supported by the network infrastructure manufacturers, this could allow discovery of the multicast capabilities of a switch, which is critical to many ESTA protocols' operation.

In order to define NAEP TLVs, LLDP requires ESTA to register an Organizationally Unique Identifier (OUI) with the IEEE. While some ESTA members have their own OUIs, quite a few do not, as there is a significant expense involved in acquiring one. As a service to ESTA members, NAEP will allow ESTA members to create manufacturer specific TLVs under NAEP TLVs using their ESTA Manufacturer ID, thus piggybacking on the ESTA OUI.

Finally, an end to the tyranny of the network patch diagram.

What does all of this mean to the end user? Provided you are using a managed Ethernet switch, all NAEP compliant devices connected to an Ethernet network will be automatically discovered, mapped, and even configured by a suitable network management tool. This will result in a dynamic view of the state of the network, and will also identify to the user any network faults in real time. The user can see what each device is, what its IP address and MAC address are, the manufacturer name, model, and serial number, configured VLAN, along with a list of all ESTA protocols supported. Through vendor specific TLVs, you may even determine if manufacturer-specific protocols such as Art-Net or Pathport Protocol are used on a device. Advanced switches may even be programmed to configure themselves based on the NAEP data they receive.

This is exciting for entertainment networks. Finally, an end to the tyranny of the network patch diagram. Network management software will generate them for you on-the-fly. Switches will be configurable to recognize ESTA devices, after that, it will all be plug and play. Media servers will be immediately recognized and given a dedicated network to themselves. Legacy Art-Net devices will be given network segments with no broadcast limitations. And, if on the next tour stop someone plugs things into the switch differently, everything will work. You will even be able to configure your switch to deny access to the entertainment network to any devices that shouldn't be connected . . . in case Steve shows up.

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Want to Help?

The NAEP Task Group will be meeting over the next few months to develop the first draft of the standard. If you don't want to wait for the official public review period, consider joining the ESTA Control Protocols Working Group. And of course, if you have any questions about NAEP not answered here, the author's email can be found in his bio at the end of this article.