LEDucation

PoE Lighting - Ins and Outs

leducation.org

LEDucation

Bill Ellis
President, Candela Controls, Inc.

Bill Ellis is the President and Co-Founder of Candela Controls, Inc., a lighting systems integrator/specialty contractor located in Winter Garden, FL. Founded in 1999, Candela Controls, Inc. has completed over 500 projects to date in 28 states and 5 Countries. Projects include work in the Gaming, Large Hospitality, Theme Park, Museum, Theatre industries, and other unusual projects. Bill has presented at several LightFair International conferences, and for IESNA, PLASA, and ESTA on a range of lighting control topics, including Advance Control Solutions, the use of DMX512, RDM, sACN, DALI, and PoE integrations.

ledcation.org

I have presented at several different conferences on a range of lighting control topics, and participate as a member on several standards making bodies, including the Illuminating Engineering Society's Lighting Control Systems, Assembly and Performance Lighting, Museum and Art Gallery Committees, and ESTA, the Entertainment Services and Technology Association's Control Protocol Working Group

LEDucation

leducation.org

LEDucation

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

leducation.org

LEDucation

Course Description

- This seminar will leave participants with an understanding of what Power over Ethernet (PoE) means in its practical uses in today's and future lighting systems.
- Explore both the hardware and software needs of the system from the design of a system, and the selection of components, through the installation needs in the field, to allow for better understanding of this new and engaging technology for lighting control.

LEDucation

Learning Objectives

At the end of the this course, participants will be able to:

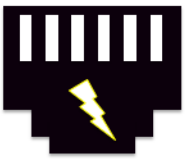
1. Understanding the PoE standards, and how they apply to lighting.
2. Explain and understand the key components of a PoE lighting system, and how they connect and work with each other.
3. Provide best practices and tips for successful application and installation.
4. Explore and understand how the issues PoE lighting control presents with building and life safety code requirements.

leducation.org

LEDucation

What is PoE?

- Power over Ethernet
- Network cables carry electrical power alongside data
  - Cat5e/Cat6 Ethernet cable
- IEEE 802.3af approved in 2003
  - VoIP phones
  - Stationary IP cameras
  - Wireless Access Points
- 802.3bt ratified in 2017



leducation.org

LEDucation

PoE Terms

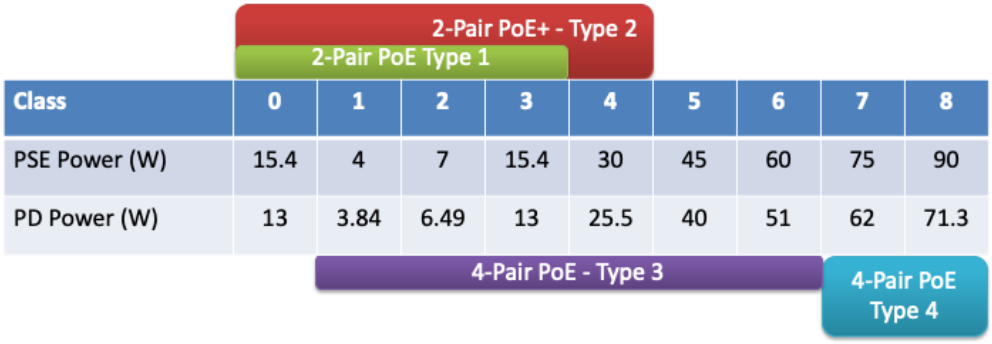
- PSE – Power Sourcing Equipment
- PD – Powered Device
- TR – Telecommunication Room

leducation.org

LEDucation

PoE Classes

- What defines a class
  - Classes are based on application



Class	0	1	2	3	4	5	6	7	8
PSE Power (W)	15.4	4	7	15.4	30	45	60	75	90
PD Power (W)	13	3.84	6.49	13	25.5	40	51	62	71.3

leducation.org

As PoE has changed to meet growing technology and application requirements, it has been divided into classes. PoE devices, on the other hand, are categorized by a type depending on their power requirements.
PSE Power – Maximum power available at the power sourcing equipment (PSE)
PD Power – Power required by PoE class at the Powered Device (PD)

Most devices needed more power than was offered in Type 1 (13w). IE camera that pan and tilt. Wireless access points becoming more advanced required more power.

LEDucation

PoE Type

Types are based on Devices

Name	Type	Standard	Approval Date	Max Power to Port
PoE, 2-Pair PoE	Type 1	IEEE 802.3af	2003	15.4W
PoE+, PoE Plus	Type 2	IEEE 802.3at	2009	30 W
PoE++, 4-Pair PoE, 4PPoE, UPoE	Type 3	IEEE 802.3bt	2018	60W
High-power PoE	Type 4	IEEE 802.3bt	2018	90W

leducation.org

https://www.belden.com/blog/digital-building/poe-types-what-they-mean-and-how-they-re-used

LEDucation

PoE Benefits in Lighting

- Lower install costs
- Simplified install
- Safer install
- Flexibility
- Network management
- Energy savings
- More finite control – Circadian rhythms
- Support for other services
  - Sensors
  - Feedback

ieducation.org

Lower install costs. Cat5e or Cat6 cable is being used to transmit the signal and power, with that cost compared against the use of THHN conductors and a separate control cable for the luminaire control. There is a lot of discussion with regards to the labor side of the installation, with an electrician on the line voltage install vs a data technician for the category cable installation, but one thing to keep in mind is you don't completely remove the electrician from the equation.

A simplified installation, raceways, be that conduit, MC Flex, or some other means for a line voltage installation, compared to the network cable being a Class 2 signal as defined by NFPA 70, the National Electrical Code, which would allow for "free wire" installation, with the use of cable hooks, cable tray, or other rated means of cable installation, not requiring conduit.

A safer installation would be expected, as the power being supplied for a PoE device is between 48 and 54VDC, with a maximum wattage of 90W, so the chance of fire or other hazard is reduced. In addition, with the way most Power Sourcing Equipment works, they will turn off the power at the port if a device disconnects, or if the cable is cut.

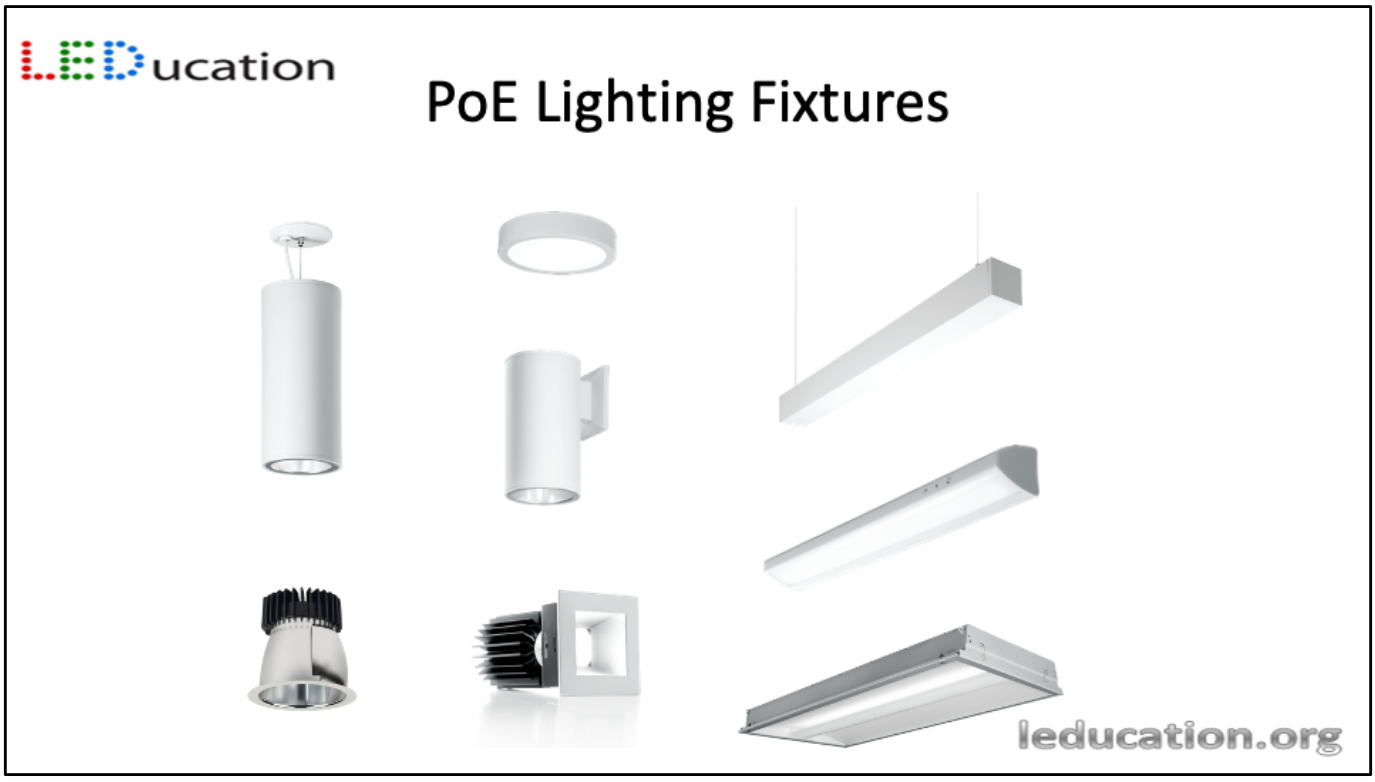
Flexibility in our install, with us not being restricted in a way by raceways, moves, changes, and adds could be more easily accomplished when the lighting needs to be rearranged in a given space.

Network management, our fixtures are end-points on our Ethernet Network, and the vast majority of them provide control and feedback on performance and other sensory data, all over our same category cable.

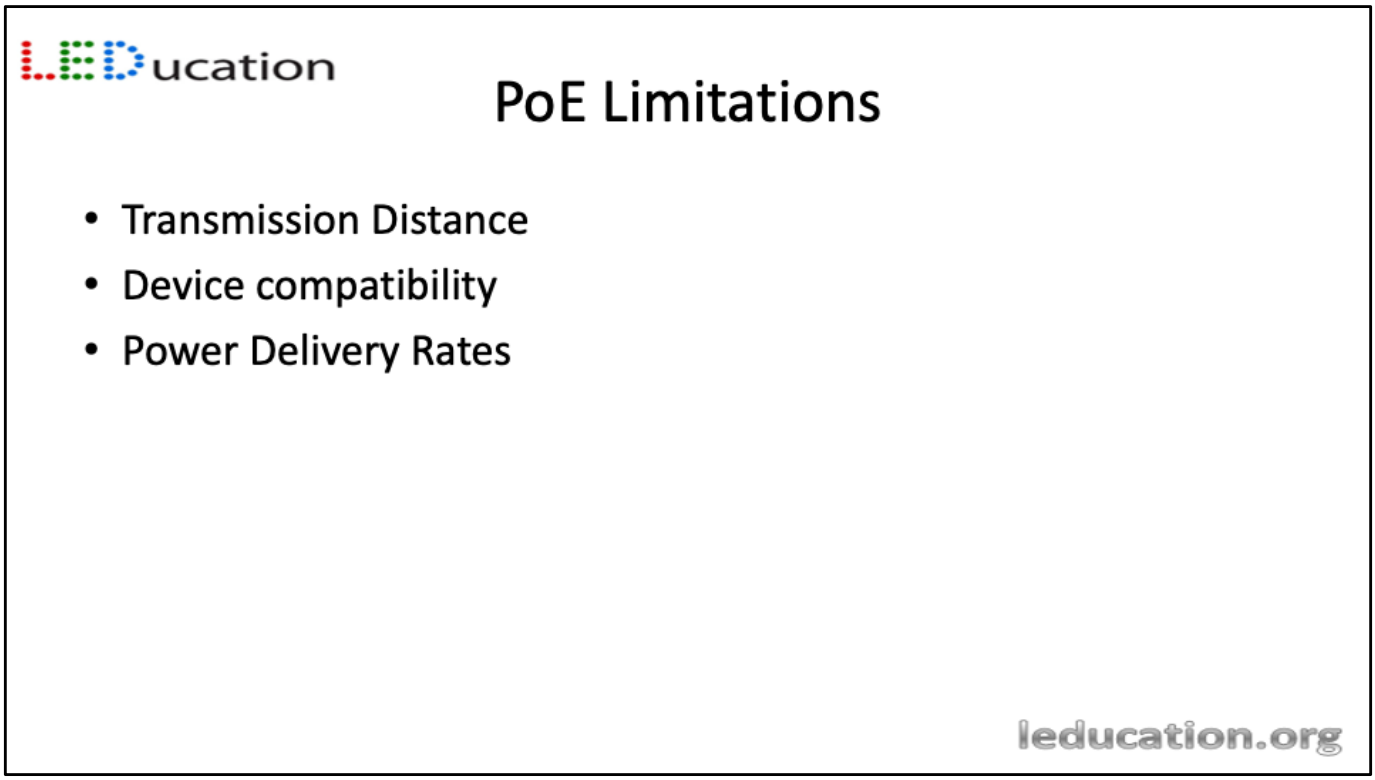
Our energy savings are driven with our use of LEDs for the lighting source, and the more direct use of DC power present in PoE systems to operate them. We don't have that need to convert power from AC to DC at the fixture, so we don't have the power loss and heat generation from that process.

We can gain more finite control, as it allows in most systems for control of individual fixtures without the need for additional signaling cable, potentially making it easier to assemble systems and take advantage of emerging technologies and concepts, such as Circadian rhythms.

And finally, support for other services, such as a variety of sensors for the collection of atmospheric and traffic data, or provide feedback to occupants of spaces via a visual means.



PoE does not mean a designer is limited in their choice of fixtures for the application, as it is in most applications, it is a different driver that is being used in the fixture body and with the LED array.



Ethernet cabling standards, as defined under ANSI/TIA-EIA 568, limit length to 100m. When planning out cabling, we usually allow for a 90m circuit length for the installed cable, and 10m to patch and connection points at either end, in our TR closet, and at the fixture. This factor also can be used to cover unintended obstructions in running our cable from point A to point B.

An extender can extend the span up to 4,000ft (1,219m)
Older devices receive power and data separately and will need an injector or splitter.

Device compatibility. PoE as a standard by IEEE, is based on amount of power being delivered to a device, how the device negotiates for that power from our Power Sourcing Equipment, how we use the four pairs in our category cable to deliver that power, and that is really it for the standard. It is an Ethernet signal, and as such, one manufacturer's PoE fixtures and controls don't operate another manufacturer's fixtures, as it comes down to the formatting of the signal that is running over the Ethernet circuit. It means that some thought in the beginning needs to be put into the selection of a PoE line of fixtures and control, as there is no standard that defines the signal side, like there is with DMX512 and DALI, for example.

And Power Delivery rates. We have 90W of power at our source, and 71W of power in our Type 4 hardware, so that could restrict what fixtures could be powered via PoE. Higher powered source might still be more efficient being powered by line voltage circuits. Of course, as LEDs progress in efficacy, we can see more and more applications being able to leverage the available power of a PoE system, based on today's standards.

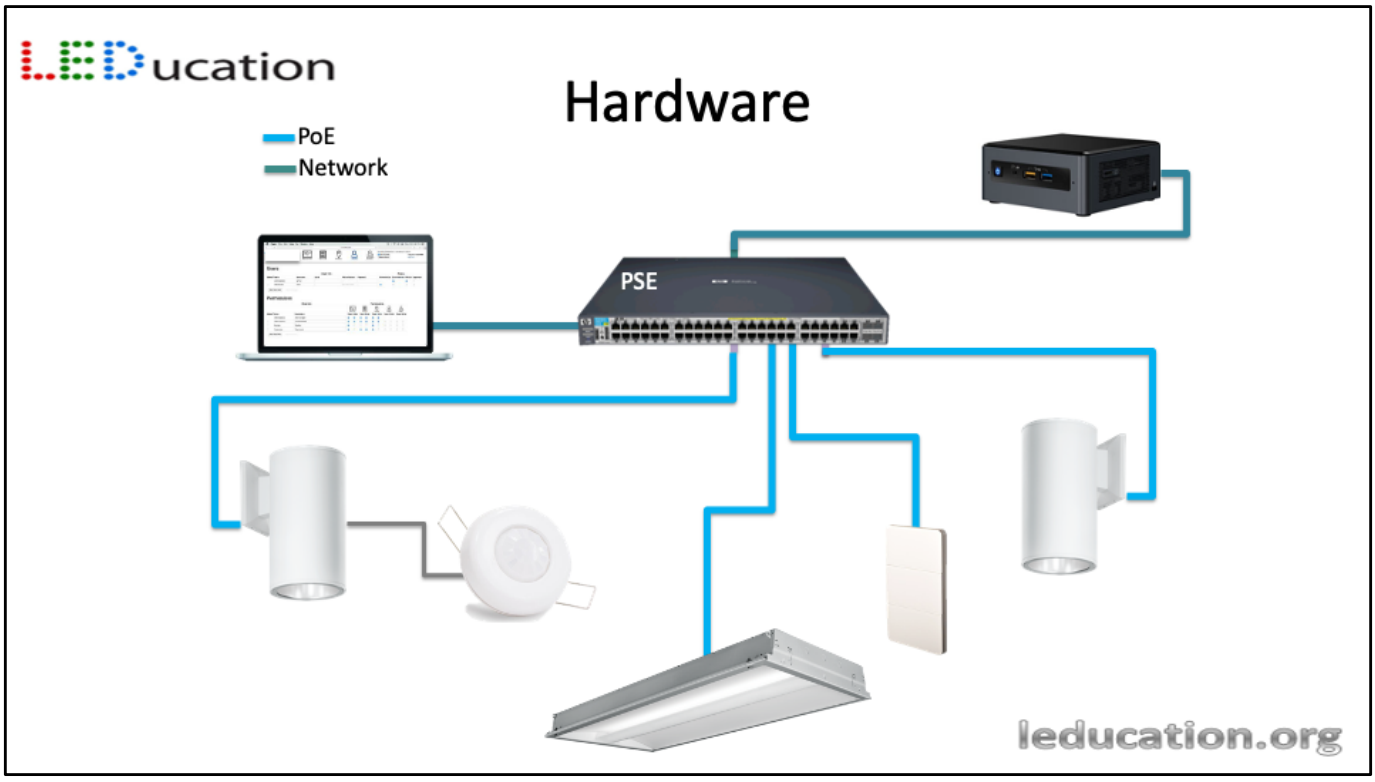
LEDucation

Hardware

- PSE - Power Sourcing Equipment
  - PoE Switch
- PoE Splitter
- PoE Injector
- PoE Extender

leducation.org

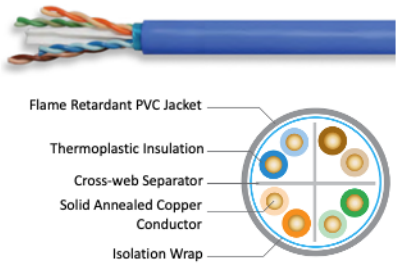
PoE switch- network switch with the ability to provide power over Ethernet from each interface while still being able to forward frames.
PoE Splitter- Supplies power by splitting the power from the data and feeding it to a separate input that a non PoE compliant devices can use.
PoE Injector- Sends power to PoE equipment that receives data through existing non-PoE switch
PoE Extender- Devices used to extend Ethernet network devices beyond the 100m distance limit for twisted pair Ethernet cable


LEDucation
Hardware
PoE
Network
PSE
leducation.org

LEDucation

Wiring

- Higher power levels can impact cable durability and performance due to cable heating
- LP Cables
- NEC implications
- Bundling @ higher power



leducation.org

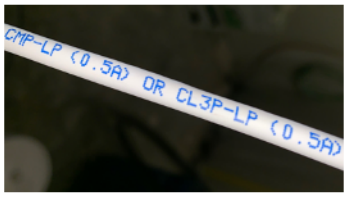
Concerns about heat generation at the higher power levels we are now talking about on our Category cable. Remember, for years, 30W was our maximum power, and has anyone ever felt an Ethernet cable that was hot, or even warm to the touch.

But we are now talking about much higher power levels on these cables, and then, we take the cables as we are entering our TR spaces, racks, cable trays, and start bundling these cables, each carrying that higher power limit, and that started to wake people up to potential issues, and rightfully so.

The National Electrical Code took interest, and has started to address these concerns, looking at our safety issues with the amount of power and related heat we are now talking about.

LP Cables

- Not a code requirement
  - Optional marking
- In accordance with standard ampacity tables based on the AWG size, temp. ratings, and bundle size. Even though current may be higher than the LP rating of the cable.
- Certified LP by UL



UL LISTED

leducation.org

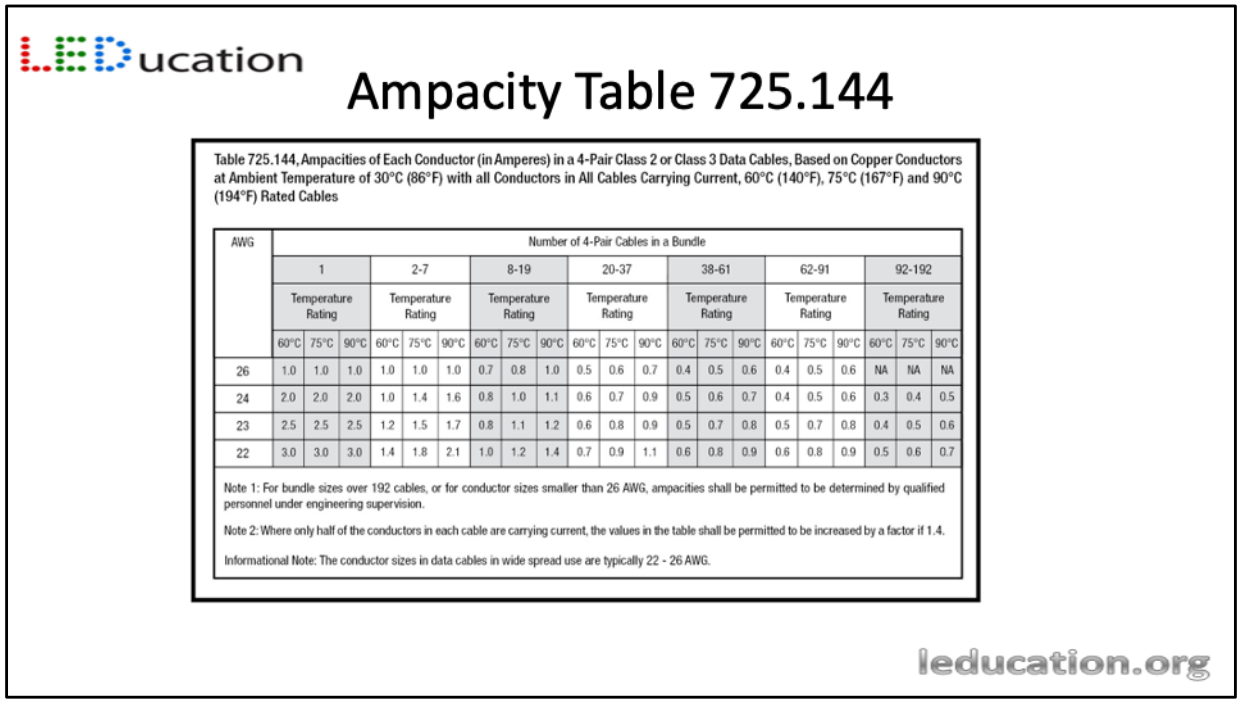
Limited Power Cable

New designation effective September 2015. Comes about from a concern in the industry in regards to 24 and 23 AWG Communication cables carrying higher power levels and the related heat rise on the cable when bundled. Per NFPA 70 Chapter 8, it is possible to have up to 100W of power per circuit, and a typical Category cable has four circuits with its pairs. With IEEE 802.3bt moving up to the 100W power range, there is a concern that we could have 400W of power on a Category 6 cable.

UL working to revise UL 444 which covers communication cable to address the power needs. The LP marking is something from UL and is not part of any ANSI standard, it is a certification. UL builds a bundle of 192 runs of cable in a 6' non-metallic tube to simulate the heating of the cable, subjecting the bundle to different current levels, and measuring the temperature rise inside the bundle. Increment the power until you reach the temperature rating of the cable, record how much current is passing, and you have your LP rating of your cable.

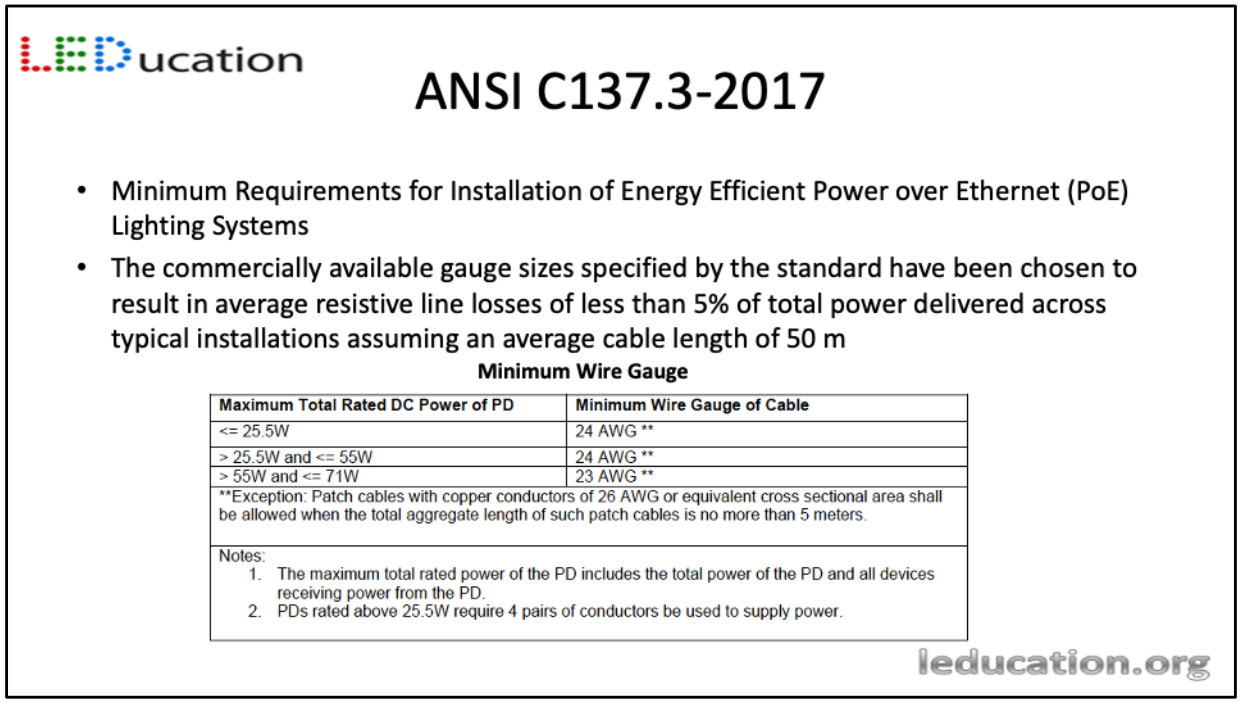
NEC 725.144(B) permits the use of Class 2-LP or Class 3-LP cables to supply power to equipment at current levels up to the marked ampere limit located immediately

following the -LP suffix. No bundle size limits are specified. The Informational Note 2 to this section also permits LP cable to be used in accordance with the ampacities in Table 725.144 that are the same as Class 2 and Class 3 cables without the LP suffix based on the AWG size, temperature ratings and bundle size, even though the current may be higher than the LP rating of the cable.



Prior to the addition of Section 725.144 and Table 725.144 in the 2017 *NEC*, designers, installers and AHJs did not know if a safety hazard could occur when 4-pair data cables carrying power as well as data were bundled together in cable trays or cable routing assemblies. To address the risks of cable heating associated with cables carrying power and data, UL conducted a fact-finding investigation to support the addition of Table 725.144 in the 2017 *NEC* that establishes an ampacity table for each 22 to 26 AWG conductor in 4-pair Class 2 or Class 3 data cables in bundles up to 192 cables.

NEC 725.144(A) requires Class 2 and Class 3 cables used to transmit power and data to comply with Table 725.144 to determine code-compliant ampacities for each conductor in an installation.



C137 National Electrical Manufacturer's Association Lighting Systems Committee

Short document, four pages.

24ga wiring is very typical of your Cat5e cable, and the vast majority of your Cat 6 cables are a 23ga conductor.

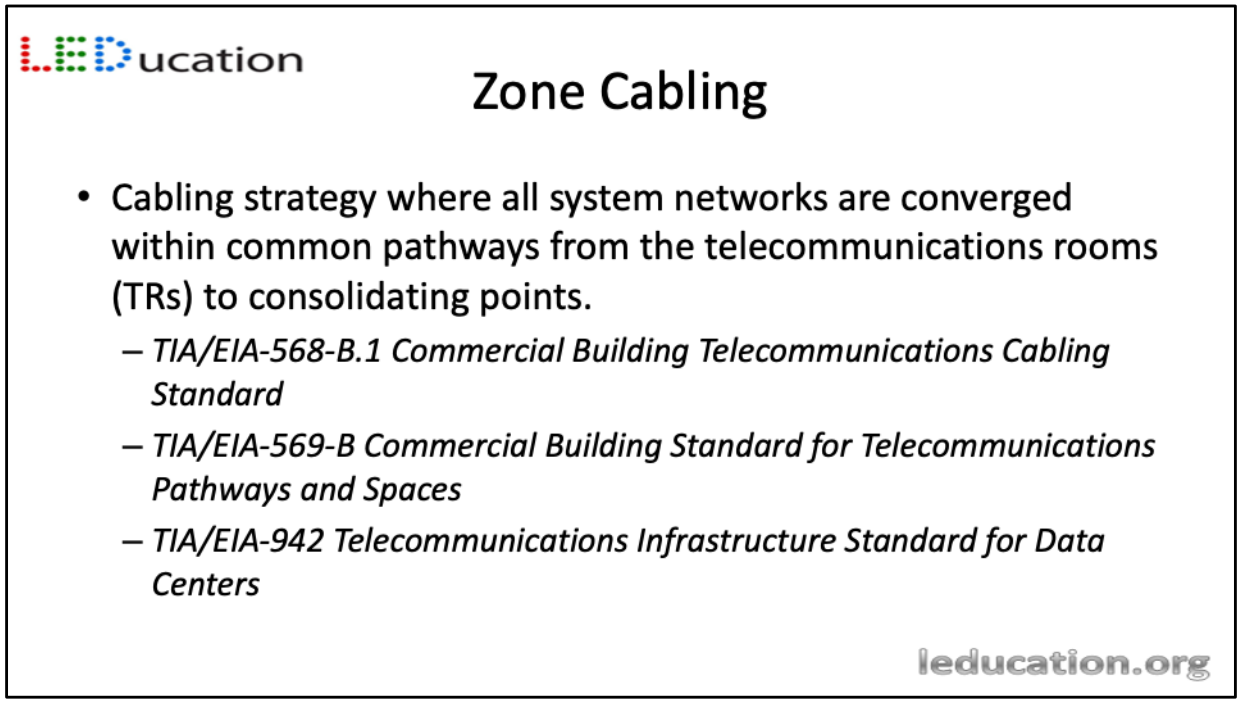
What does this mean? As a general rule of thumb, if your PD device requires 55W or less of power, you can run a Cat 5e cable that is 24ga wiring, and you won't have any ampacity issues. If you have a higher power requirement, use Cat 6 cable. Now you could say, just run Cat 6 cable for everything and be done with it, but there is a cost associated with that statement. It is a cost/benefit consideration.

Remember, Cat5e cables good for 100Mbit or 1Gb signals, and in this application, lighting, our data rate requirements are just not that great. Turn the source on, dim it, etc. Even add sensors, we still do not have a great data speed requirement to be concerned with here. We are not pushing a real time video signal where we can't afford dropped frames. So put a couple of hundred lighting fixtures in a building, with an average circuit length of 50m, and there is a cost evaluation to be looked at using

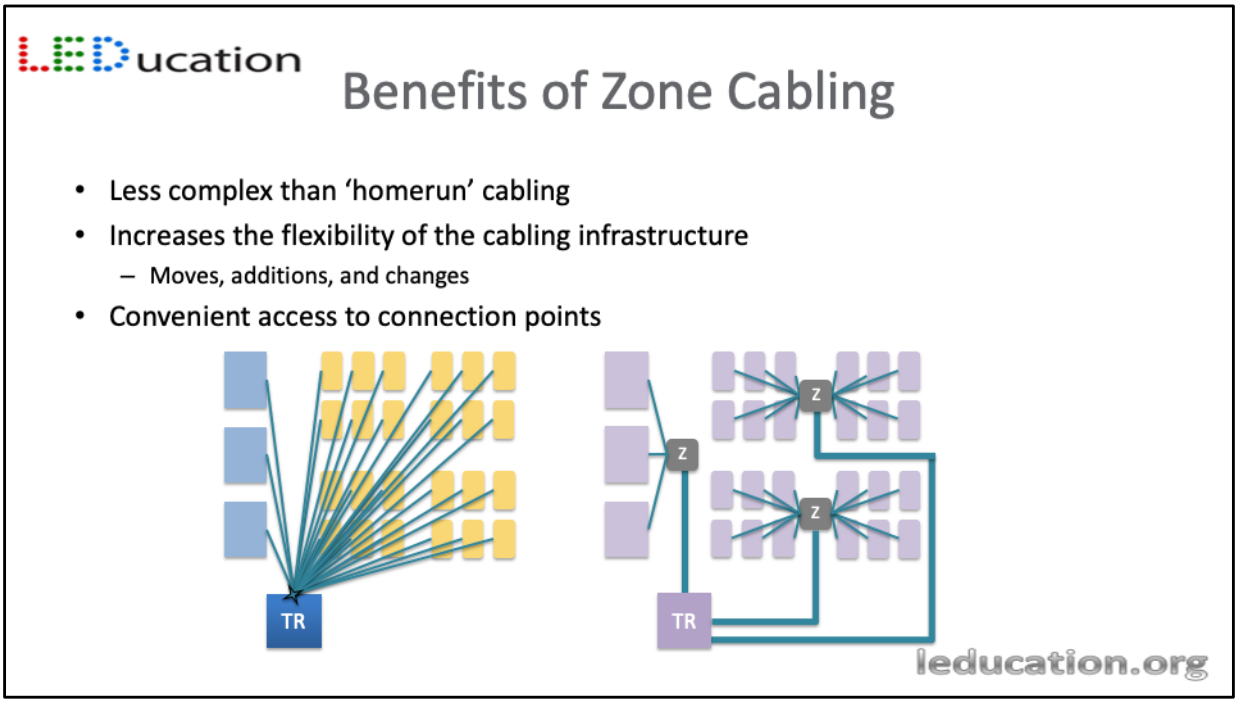
Cat5e vs Cat6 cable. How often after the installation are we going to want to go to a higher wattage fixture requiring a cable change, where we would not also be doing a major architectural change.

Another note here is the RJ45 connector we are all so used to. We are talking now of 100W of power over our small plastic friend, and mating or, more importantly, demating under power. Yet another standard, IEC 60603-7 is addressing some of those concerns, and TSB-184-A from the ANSI/TIA568 committee is addressing these higher power delivery concerns with our cabling infrastructure.

And speaking of cabling…..

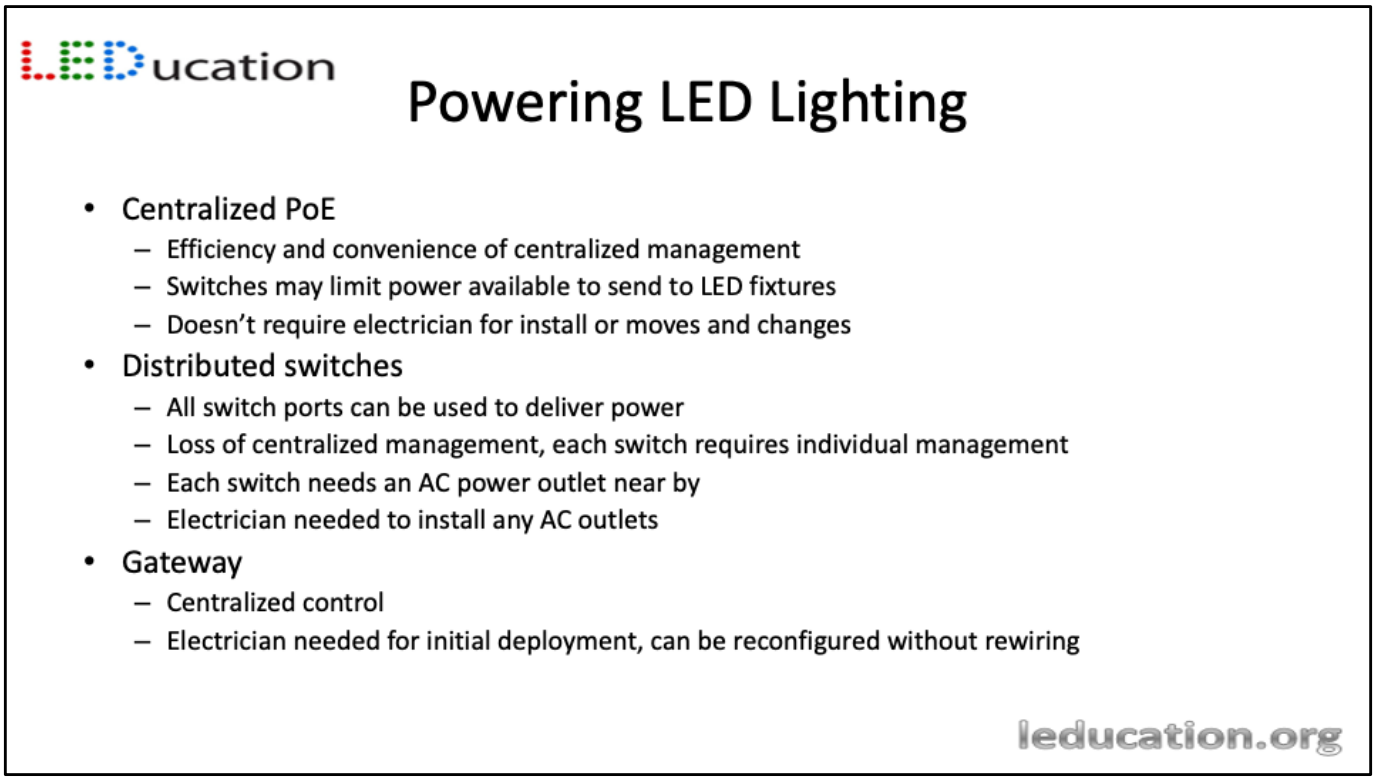


This is stuff your IT designers know, what they live and breath every day. It is most likely they will be making the decisions as to the cabling methods on a project, as it might just be determined it is their domain. But you should be able to talk intelligently here, and you have some different needs with lighting (mostly a density at the ceiling level) that they aren't looking at. Their density is at the desktop level. Yes, touchscreens, wireless access points, VoIP phones, security cameras are driving their PoE requirements, but that stuff isn't usually getting laid out in a grid pattern or some other denser requirement like we see in lighting.



Our cable runs are shorter from our power source to the PD device (our light fixture).

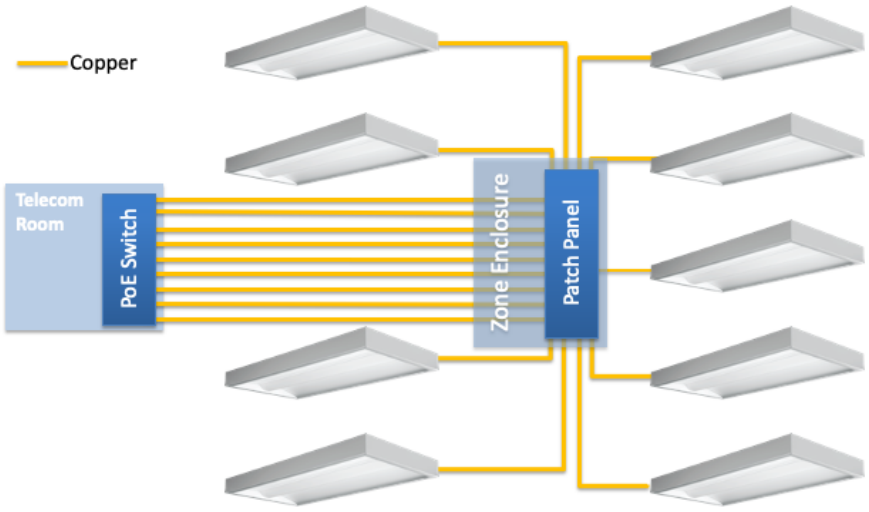
Our moves or changes or more contained in the area where the work is being done, rather than maybe crossing over other areas to get back to our telecom room.



First two are very common strategies for distribution of cabling providing signal and power. The third is a different concept from some manufacturers, where larger power and signal is fed out to a gateway device, this is the PoE core, and then it might go to an analog or low level digital signal and power to the devices themselves. They might use a category type cable for that last bit or run, or you might find it is a two conductor cable. They might take the large available power (remember our 90W of delivery) and then distribute it to several smaller fixtures. You might give up individual control of fixtures, as now we are just driving them with usually a PWM signal, but you have fewer home runs, and can leverage that larger power delivery.

LEDucation

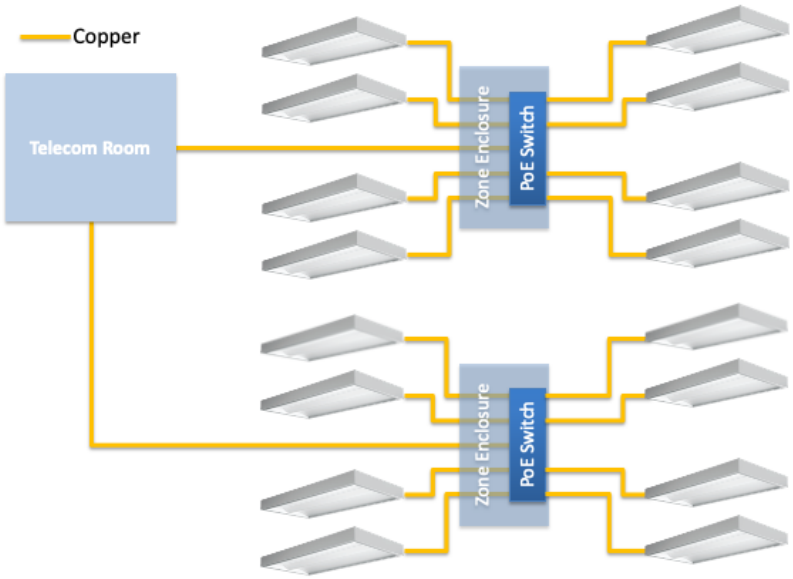
Centralized PoE



leducation.org

LEDucation

Distributed PoE



leducation.org

LEDucation

Centralized vs. Distributed PoE Switches

Distributed Advantages	Distributed Disadvantages
Requires less cabling	More difficult to perform maintenance on equipment in ceiling box/zone enclosure
Distance is less of a limitation	Decentralizes active equipment
Smaller PoE switches are generally more cost-effective	New power infrastructure needs to be run into the ceiling

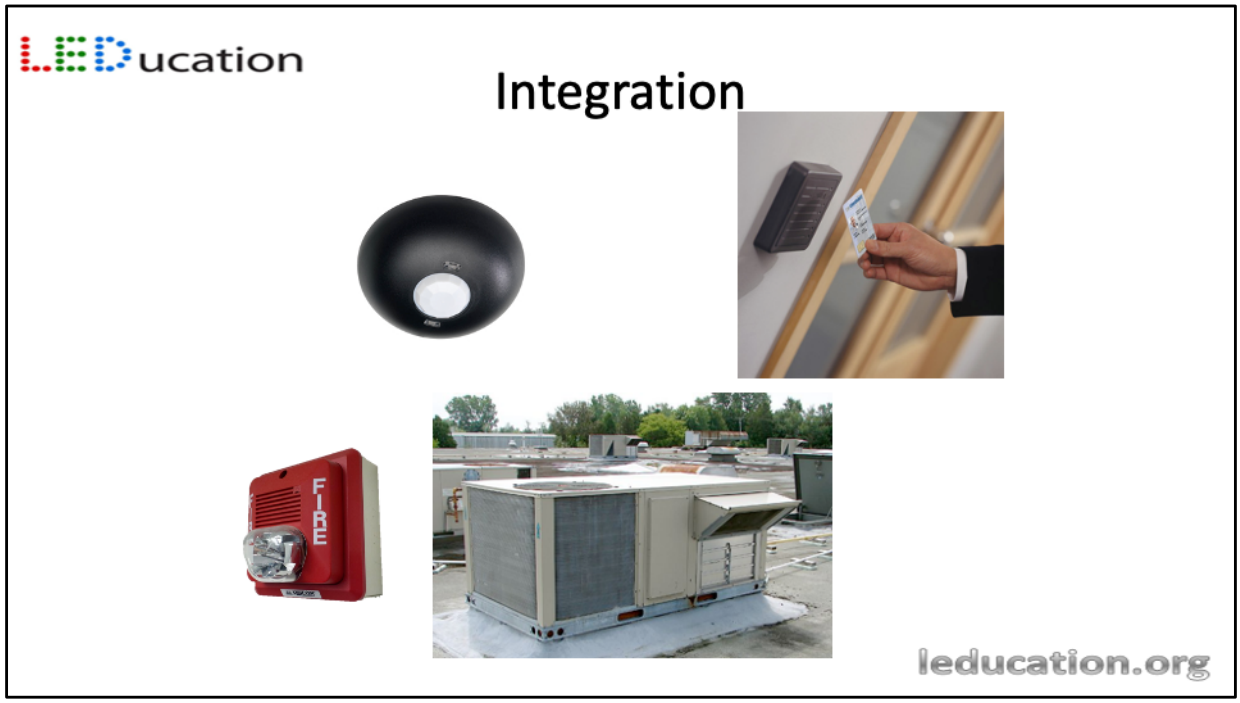
Centralized Advantages	Centralized Disadvantages
Uses existing power infrastructure	Requires more cabling
Centralizes active equipment	Distance limitations from TR limited to 100m or less
Easier to perform maintenance on equipment in TR	Larger PoE switches are generally less cost-effective

LEDucation

PoE Software

- Allows for configuration
- User interfaces
- Data collection and polling
- Unique by manufacturer

leducation.org



Variety of integrations, which most of you might be aware of. Sensors from different systems sharing data, access control allowing lighting to be turned on, HVAC changes can occur based on occupancy, etc.

The interesting part is that now, lighting becomes another service on the network, where most of these other systems are already living, particularly things like access control and BMS systems. So this integration now becomes a software coding integration, rather then getting some wire carrying some common denominator signal to allow two different systems to share basic information. Of course, this integration takes a different kind of work, as it is software now, but opens up many more possibilities as all those various pieces of data are on the network.

An interesting concept is with fire alarm systems slowing moving to some form of IP based signal on a network (we won't discuss the critical system requirements this presents), but imagine now that the lighting system responds to a fire alarm not just in turning all lighting on, but is able to provide direction for best path of egress, because the alarm system is sharing real time data on where the emergency is in a building, and the lighting is used to tell occupants where to go and not go to remove themselves from the emergency. This concept becomes a lot easier to grasp when all

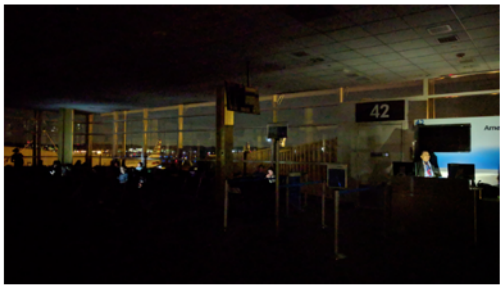
that data is on the network rather than coming across on some lower level communication path.

LEDucation

Emergency Lighting

- **NFPA 101 – Life Safety Code**

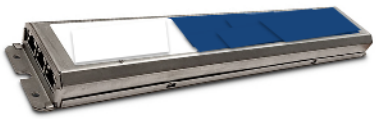
7.9.2.1 Emergency illumination shall be provided for not less than 1-1/2 hours in the event of failure of normal lighting.



LEDucation

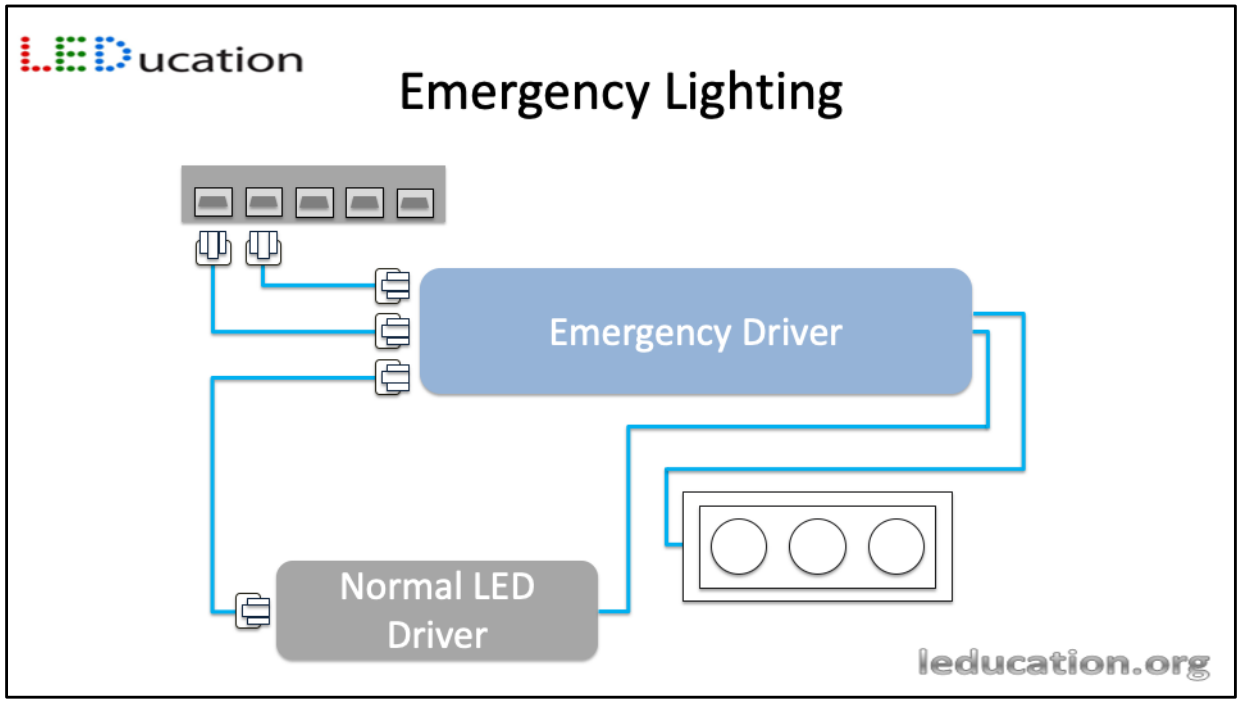
Emergency Lighting

- UPS connected to the network switch
  - **NFPA70 Section 701.12(C)** - Storage batteries shall be of suitable rating and capacity to supply and maintain the total load for a minimum period of 1½ hours without the voltage applied to the load falling below 87½% of normal.
  - Is our switch UL924 listed for bypass of signals in an emergency event?
- Integral batteries, similar to unit devices
- Centralized Emergency Backup System
- Emergency Drivers



leducation.org

Your usual UPS is not designed around this requirement, it is designed to sustain for a shorter period of time and allow for an orderly shut down of a system.



One example on the market today, where two runs of cable from the switch are used. One is to provide pass through power to a normal PoE LED driver, and provide that monitoring of power, while the second run from the PSE provides the charging circuit for an onboard battery. The device then provides the UL924 bypass like a typical unit device, moving the LED array onto the battery

LEDucation

Future of PoE Lighting

- Smart Lighting
- Smart Buildings
- Smart Cities
- Analytics
- Data Collection
- IoT

LEDucation

Q & A

Please use your chat window for your questions, and please remember to fill out your evaluation of today's presentation.

leducation.org

LEDucation

This concludes The American Institute of Architects Continuing Education Systems Course

leducation.org