Digital Ceiling Lighting and Cabling Design Challenges

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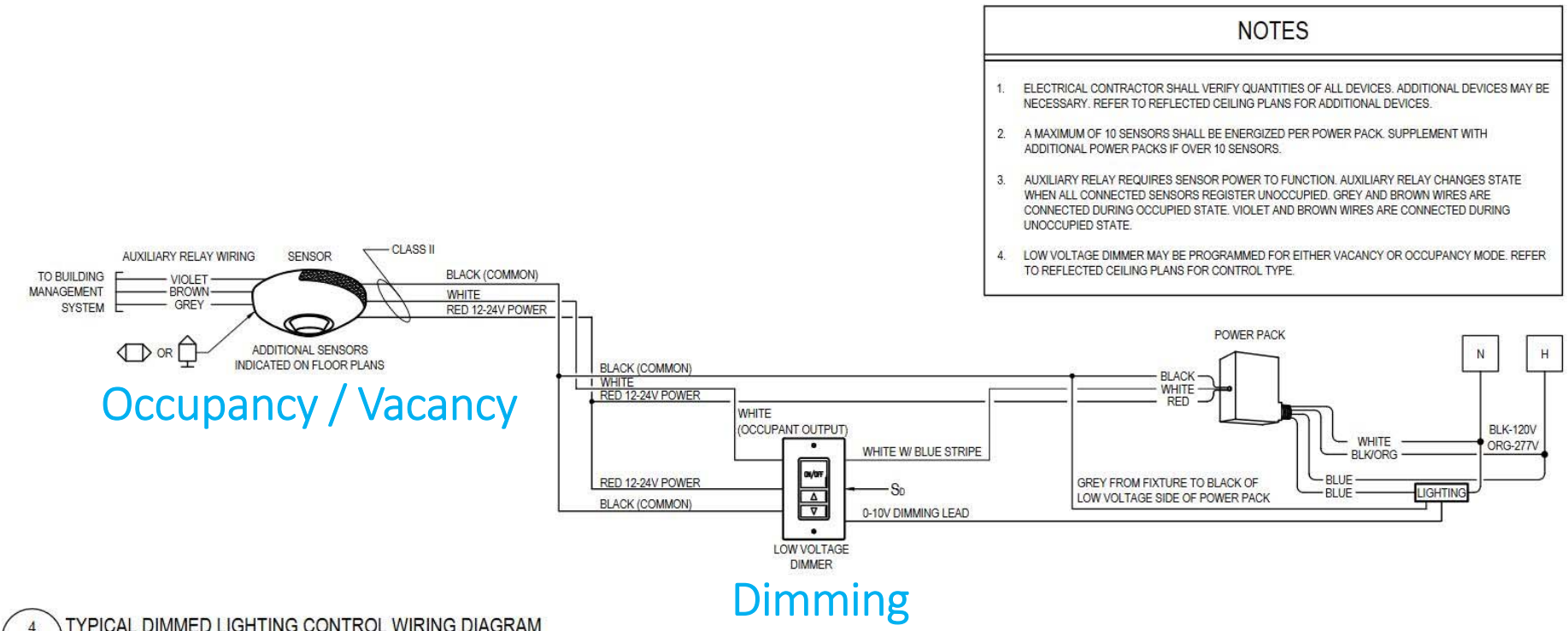
Agenda

- Digital Lighting Topologies
- Cabling Standards
- Cabling Design for Digital Lighting Topologies
- Recommendations

Digital Lighting Topologies

Digital Lighting Topologies

Why do we need digital lighting? Features!

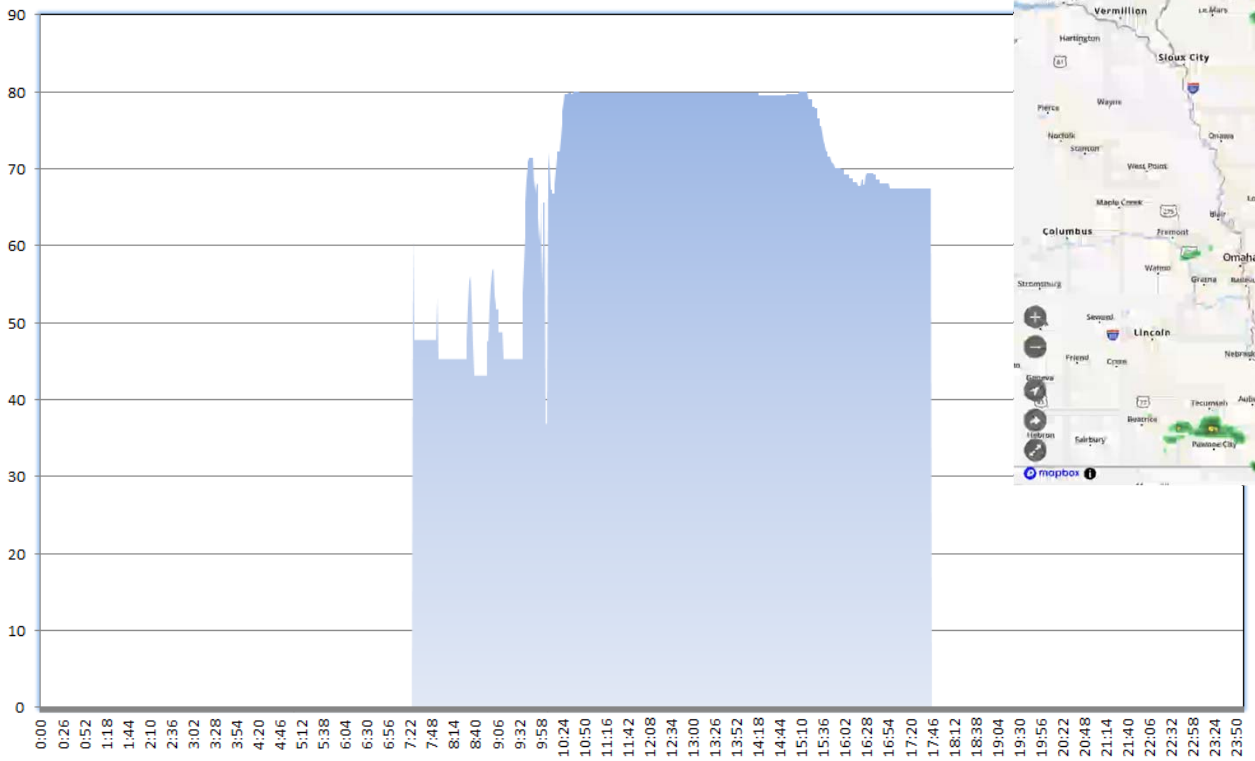


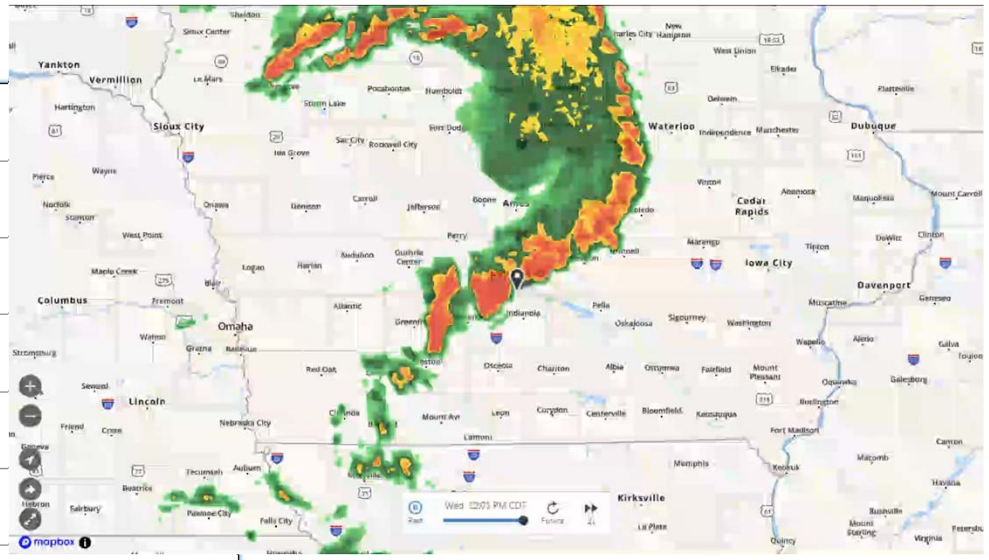
Digital Lighting Topologies

Why do we need digital lighting? Features!

Digital Lighting Topologies

Why do we need digital lighting? Features! Daylight Harvesting.





July 17, 2019

High End Trim, Occupancy, Vacancy,
Daylight Harvesting & Rhythm

Digital Lighting Topologies

Topologies? Fixture vs Node

Fixture Centric

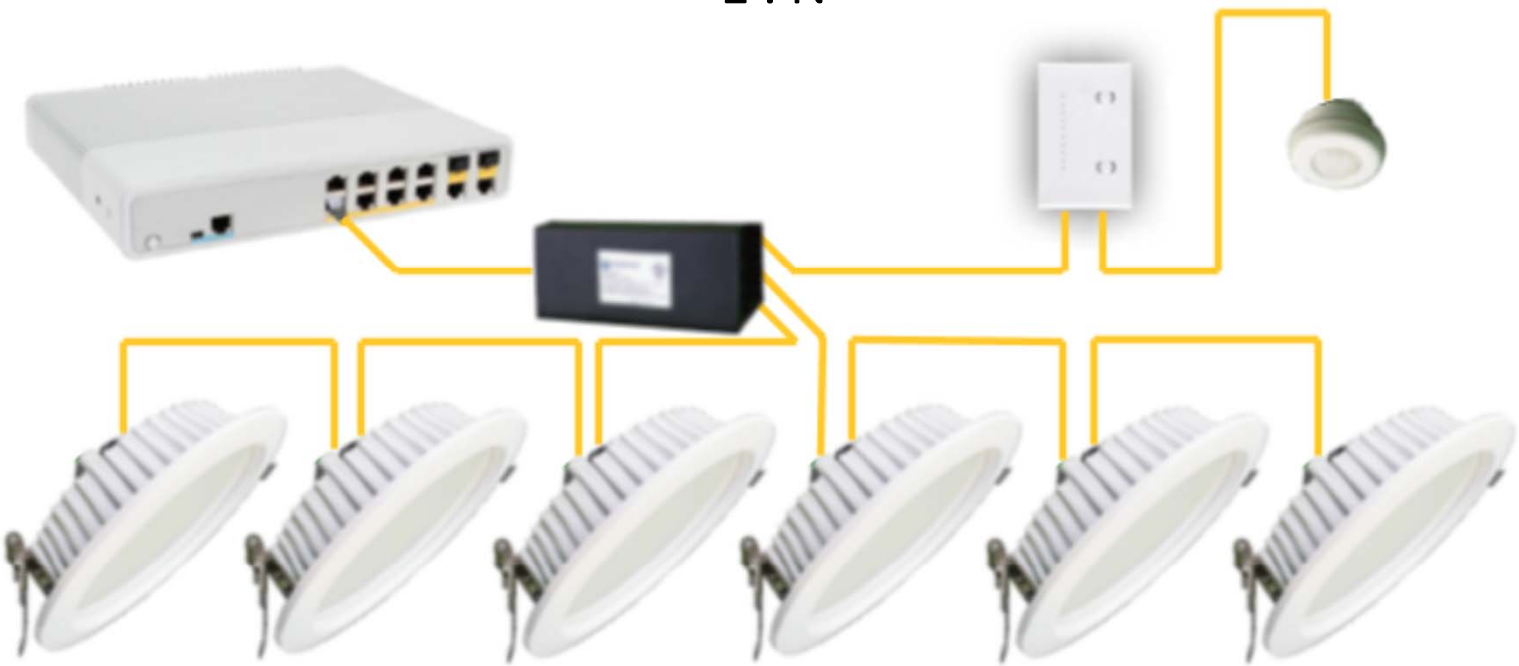
1 : 1

Digital Lighting Topologies

Topologies? Fixture vs Node

Node Centric

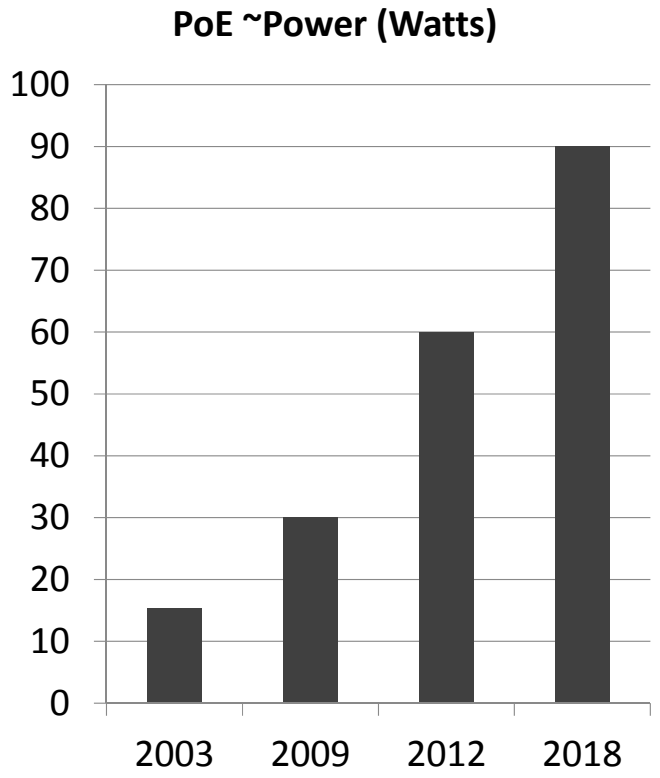
1 : N



Digital Lighting Topologies

Node Centric. PoE Power.

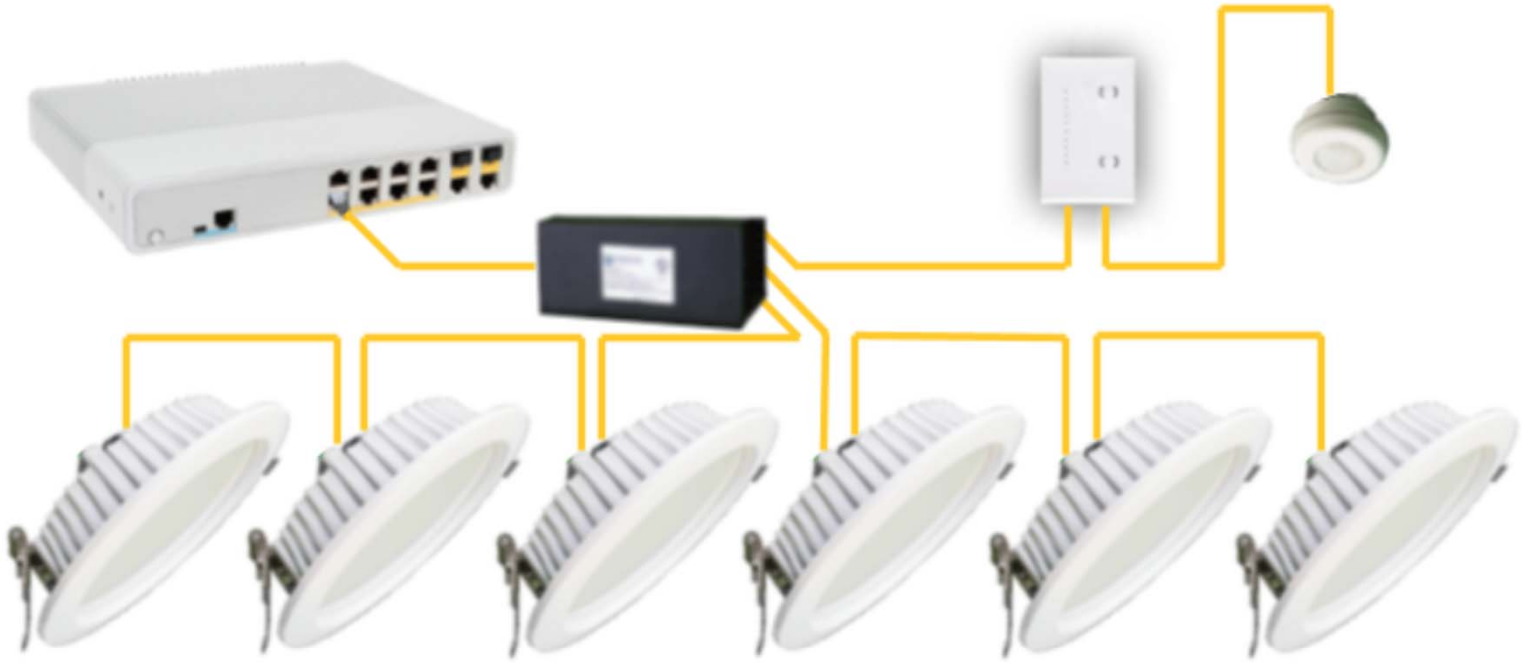
- IEEE 802.3af (PoE)
  - 2003
  - 15.4W, 13W
- IEEE 802.3at (PoE+)
  - 2009
  - 30W, 25.5W
- Cisco (UPOE Prestandard)
  - 2012
  - **Four-Pair : 60W, 51W**
- IEEE 802.3bt (PoE++, 4PPoE)
  - 2018
  - **Four-Pair : 60W, 51W**
  - Four-Pair : 90W, 71.3W



Digital Lighting Topologies

Node Centric. Fixture capabilities.

1W + 1W + 1W = 3W

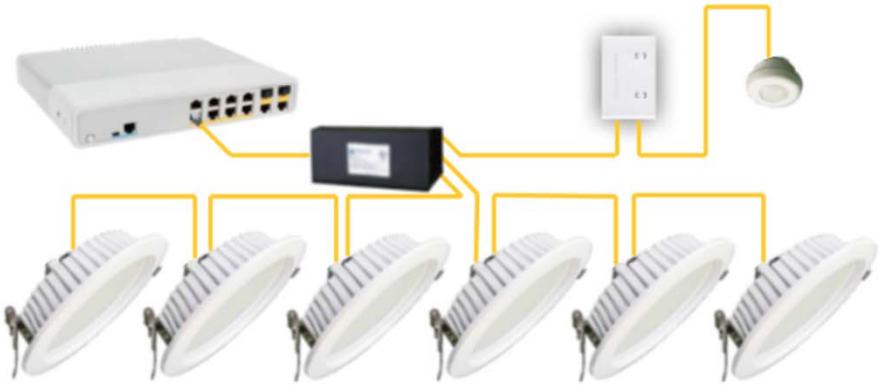


51W

8W + 8W + 8W + 8W + 8W + 8W = 48W

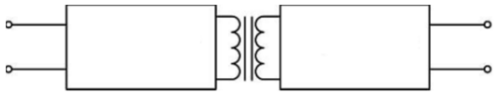
Digital Lighting Topologies

Node Centric. Hardware Design Challenges.



- Isolation (DC / DC)

  802.3af, IEC



- Plenum Rating

  NEC, UL 2043

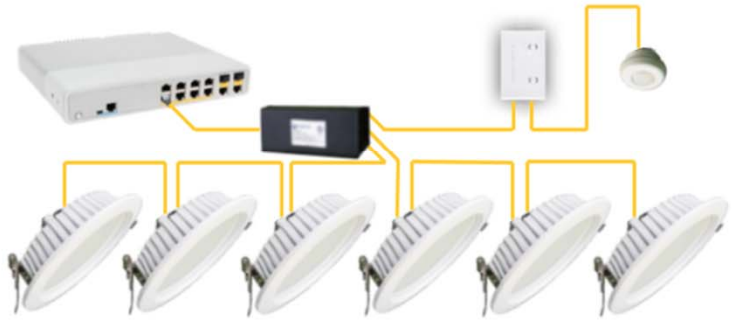
- Multiple Channels
- High Power Input
- Multiple Fixture Options

IEC (International Electrotechnical Commission) NEC (National Electrical Code) UL (Underwriters Laboratories)

Digital Lighting Topologies

Fixture vs Node Centric. Approximate costs.

Fixture Centric			
PSE Port (30W)	7	$ 100.00	$ 700.00
Downlight	6	$ 150.00	$ 900.00
Switch	1	$ 100.00	$ 100.00
			$ 1,700.00



Node Centric			
PSE Port (60W)	1	$ 150.00	$ 150.00
Node	1	$ 250.00	$ 250.00
Downlight	6	$ 75.00	$ 450.00
Switch	1	$ 75.00	$ 75.00
			$ 925.00
Sensor	1	$ 75.00	$ 75.00
			$ 1,000.00

Cabling Design for Digital Lighting Topologies

Best Practice.

Manufacturer Recommended
(RS485)

Standard Practice
(60W UPOE)

Manufacturer Recommended
(21V @ 1100mA)

23AWG CAT6

Manufacturer Recommended
(21V @ 350mA)

Digital Lighting Topologies

Power to the light is everything!

$$k_{LossPercentage} = ((P_{Load} / V_{Load}) \times R_{Wire}) / V_{Source}$$

Where $V_{Source} = 50V$

$P_{Load} = 25.5W$

$R_{Wire} = 12.5\Omega$

$V_{Load} = 42.5V$

60W UPOE at PSE = 51W at PD

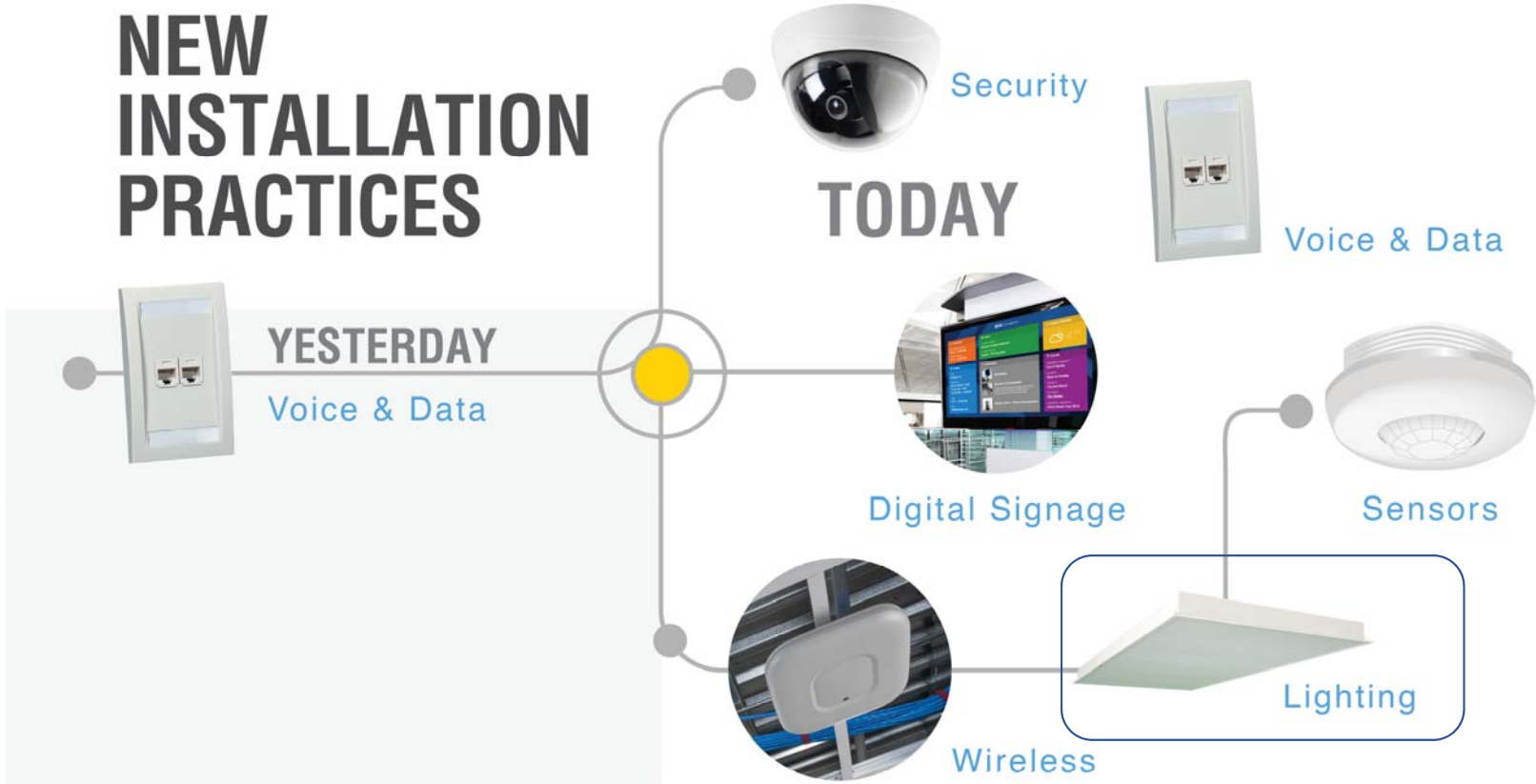
Loss of 1 Watt every 36ish feet between PSE and PD

Keep the runs short!

Centralized vs Decentralized?

Cabling Standards

NEW INSTALLATION PRACTICES



Major Cabling Standards

- Power over Ethernet
- TIA TSB-184-A
  - Working on TSB-184-A-1 for 28 AWG
- 2017 National Electric Code
- New ANSI/TIA-568.2-D
- ANSI C137.0-2017
  - American National Standard for Lighting Systems
- Coming Soon! Single Pair Ethernet

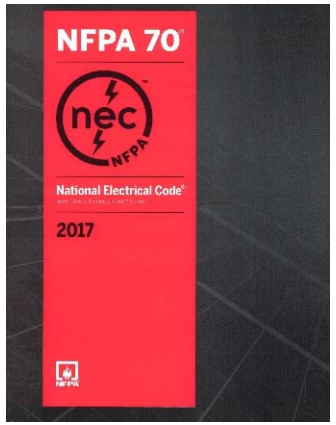
PoE Performance Summary

Type	Standards	Maximum Current	Number of Energized Pairs	Power at Source	Power at Device	Maximum Data Rate	Standard Ratified
PoE	IEEE 802.3af (802.3at Type 1)	350 mA	2	15.4 W	13 W	1000BASE-T	2003
PoE+	IEEE 802.3at Type 2	600 mA	2	30 W	25.5 W	1000BASE-T	2009
PoE++ (4PPoE)	**Proposed IEEE 802.3bt Type 3** **Proposed IEEE 802.3bt Type 4**	**600 mA** **960 mA**	**4**	**60 W** **99 W**	**51 W** **71 W**	**10GBASE-T**	**APPROVED**
No IEEE standard	Cisco UPOE HDBaseT (www.hdbaset.org)	600 mA 1000 mA	4	60 W 100 W	51 W 100 W	Varies	Exists today – no official ratification

- Current increase by 1.5X
- Power going from 2 pairs to 4 pairs
- Approximately 3X increase in power

Impact of 2017 National Electric Code

- Recognizes new UL listing for Limited Power (LP) cables
  - LP not required
  - Need at least a 0.5A rating
  - Example: `TYPE CMP-LP(0.5A) (UL) 23 AWG 90°C`
- LP simplifies installation and inspection
  - With no LP, refer to ampacity table



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PoE++ (4PPoE)	Proposed IEEE 802.3bt Type 3	600 mA	4	60 W	51 W
PoE++ (4PPoE)	Proposed IEEE 802.3bt Type 4	960 mA	4	90 W	71.3 W

NEC® 2017 not a concern

NEC® 2017 imposes new requirements

Ampacity Table

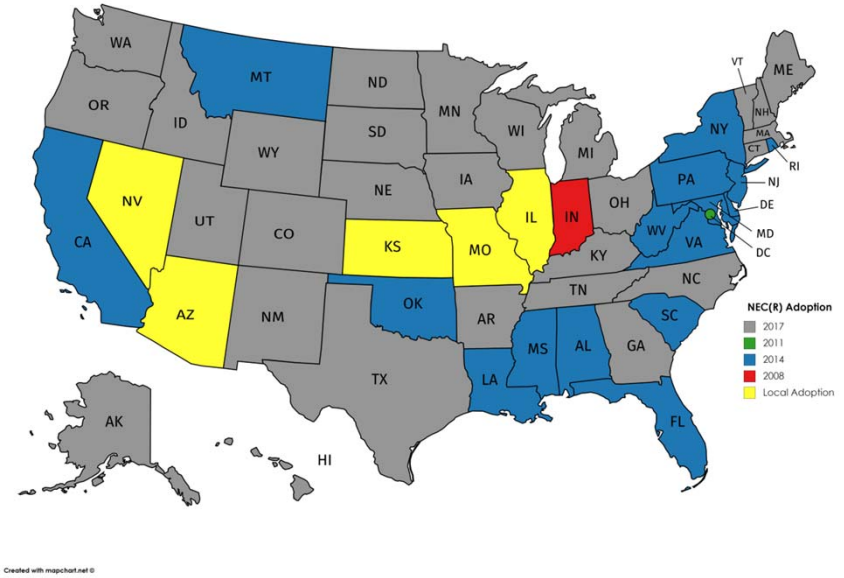
AWG	Number of 4-Pair Cables in a Bundle																			
	1			2-7			8-19			20-37			38-61			62-91			92-192		
	Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating		
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.8	1.0	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2.0	2.0	2.0	1.0	1.4	1.6	0.8	1.0	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3.0	3.0	3.0	1.4	1.8	2.1	1.0	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.7	0.8	0.5	0.6	0.7

Note 1: For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.
Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

- Cat 5e (24 AWG, 60C): Maximum bundle size of 61
- Cat 6A (23 AWG, 75C): Maximum bundle size of 192

When will the 2017 NEC® Apply to Me?

- Depends on state
- 2017 adoption is up
- Often a lag between code adoption and local awareness
- Code can be interpreted differently at a local level



Cable Type Discussion

- 23 vs 24 AWG
  - 23 AWG less heat loss / power loss
  - 23 AWG needed for LP rating
- Copper Clad Aluminum?
  - NO!
  - Not allowed by standards
  - Not safe
  - Aluminum is ~50% higher resistance

Cable	23 AWG	24 AWG
Copper	8.1 W	10.3 W
Copper Clad Aluminum 10%	12.6 W	15.9 W
Copper Clad Aluminum 15%	12.2 W	15.4 W

Power Loss over 200 feet of cable @ 20C

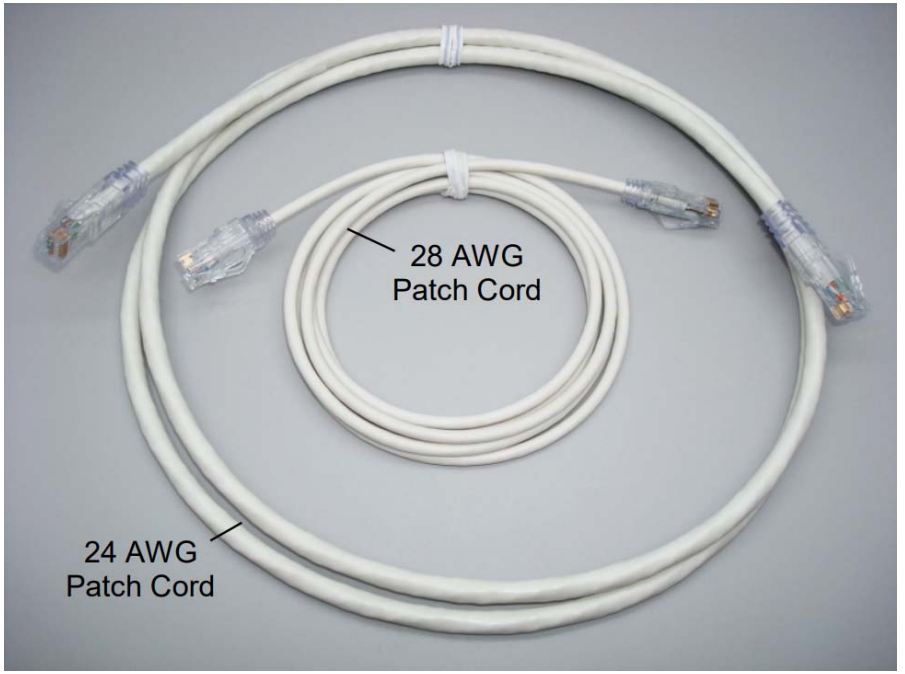
Use 23 AWG standard copper cable for horizontal backbone

ANSI/TIA-568.2-D

- Governing copper standard
- Replaces ANSI/TIA-568-C.2
- 28 AWG patch cords now standards compliant
- Recognizes & test method for field terminated plugs

28 AWG Patch Cords

- New change in ANSI/TIA-568.2-D
- Recognizes for patch cords only
  - No horizontal cables
  - 1.95 de-rating
- Working on TSB-184-A-1 addendum
  - 28 AWG supporting PoE++
  - Smaller bundle sizes & bundle spacing

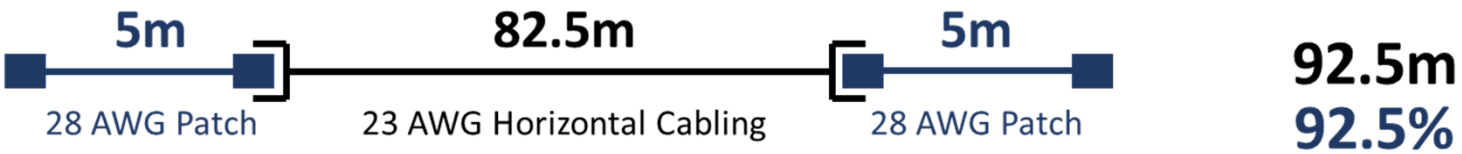


Impact of 28 AWG on Channel Length

100 meter Channel (24 AWG Patch)

96 meter Channel (28 AWG Patch)

93 meter Channel (28 AWG Patch)



Modular Plug Terminated Links

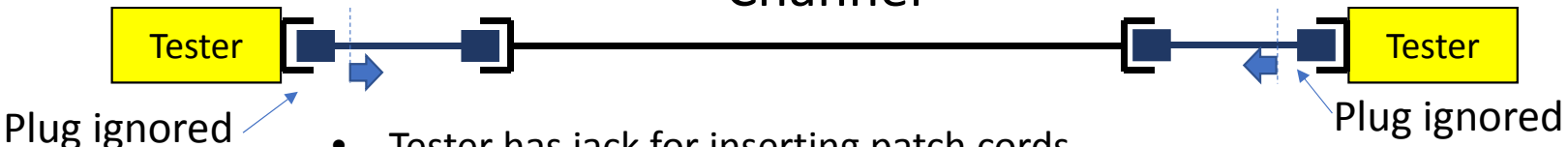
- Modular Plug Terminated Links = Permanent Link
  - Same test limits
  - Referred to as MPTL
- Why MPTL?
  - Cleaner look
  - Replace components & labor
  - Ensure compliance (plenum)
  - Ensures performance of that plug
- Is terminating a plug in the field standards compliant? YES!

Traditional Methods to Test Links and Channels

Permanent Link

- Tester has plug for inserting into jack
- Tester tests both jacks & cable

Channel

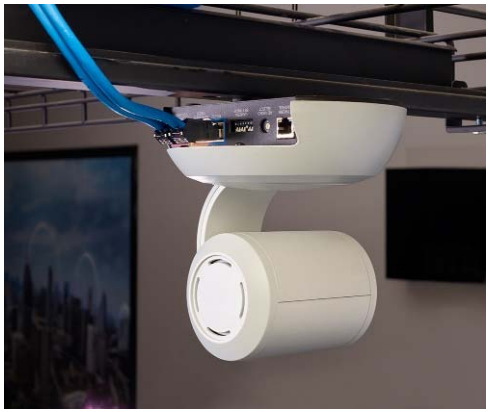


- Tester has jack for inserting patch cords
- Tester ignores plug inserted into tester (only continuity)

Modular Plug Terminated Links

- Tester uses normal permanent link adapter (cord) to plug into one end
- Tester uses patch cord adapter on other end (could be both)
- Tests performance of ALL components plug, cable, and jack

- Modular Plug Terminated Links = Permanent Link
  - Available on some field testers (called MPTL)
- Ensures plug meets performance requirements
  - Important for wireless access points & cameras



Coming Soon… Single Pair Ethernet

- Panduit World Headquarters
- 600,000 feet of 4-pair
- 500,000 feet of 2-wire
  - HVAC
  - Lighting control
  - Access control
  - Etc.

Single Pair is Unique

Parameter	4-pair	Single Pair
Data Rate	Up to 10 Gb/s (10GBASE-T)	10 Mb/s at 1000 m (1 Gb/s at shorter dist.)
Power Levels	Up to 71 W (PoE++)	Up to 15 W (TBD)
Reach	Up to 100 m	Up to 1000 m
Connector Type	RJ45	Modified LC
RU Density	48 ports in 1 RU	96 ports in 1 RU




Cabling Design for Digital Lighting Topologies

Cabling for Fixture Centric (2 fixtures)

Jacks in patch panel

Switch

Light Fixture

Switch

Light Fixture

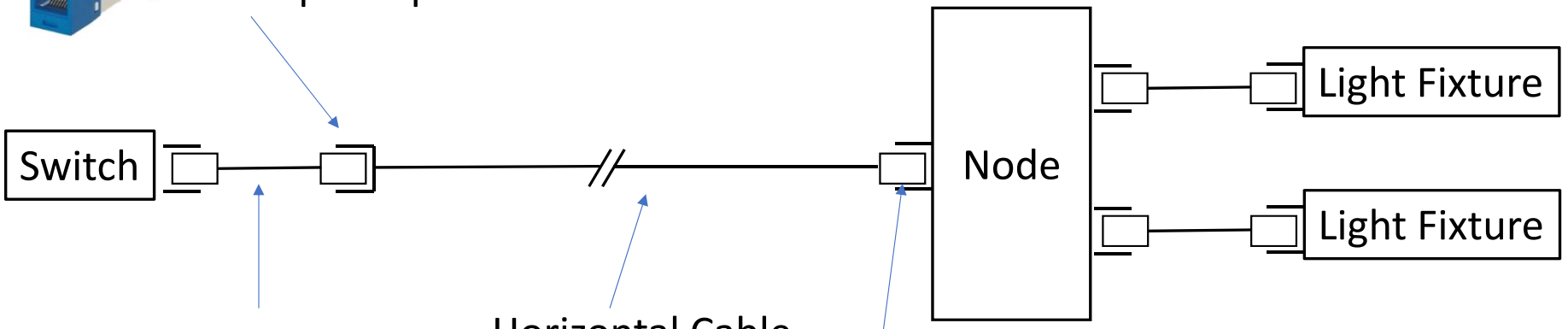
28 AWG patch cords

Horizontal Cable

Field Terminable Plug

Cabling for Node Centric (2 fixtures)

Jacks in patch panel



28 AWG patch cords

Horizontal Cable

Field Terminable Plug

Cabling Comparison

Parameter	Fixture Centric	Node Centric
Switch Ports	2	1
Jacks	2	1
Patch Cords	2	3
Field Term Plugs	2	1
Horizontal Cable	2x150 feet = 300 feet	150 feet

100% savings on horizontal cable with Node Centric

Cabling Design for Digital Lighting Topologies

Centralized vs Decentralized.

Centralized

Decentralized

New smaller, PoE switches allow for installation in plenum spaces; closer to lighting loads.

Summary & Recommendations

- Node Centric provides optical cost structure
  - Hardware savings vs fixture centric
  - Cabling savings vs fixture centric
- New standards important to consider
  - LP ratings for PoE
  - 28 AWG patch cords for space savings
  - Modular plug terminated links
- Test your cables
- Design with flexibility in mind
- Follow manufacturer recommendations