Fault-Managed Power Ethernet Powering Techniques Call For Interest (CFI)

Managed Delivery of Kilowatts of Power Over Kilometers of Cable

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Chad Jones, Cisco Systems
Jason Potterf, Cisco Systems
George Zimmerman, CME Consulting

Today’s Panel

- Speakers
  - Bob Voss, Panduit
  - Chad Jones, Cisco Systems
  - Jason Potterf, Cisco Systems
  - George Zimmerman, CME Consulting
- Additional Panelists
  - Stan Mlyniec, VoltServer

Supporters

- Joel Goergen, Cisco Systems
- Stan Mlyniec, VoltServer
- John D'Ambrosia, Futurewei, U.S. Subsidiary of Huawei
- Mark Nowell, Cisco Systems
- Kent Lusted, Synopsys
- Steve Eaves, VoltServer
- Valerie Maguire, Copperopolis
- Peter Jones, Cisco
- Lennart Yseboodt, Signify
- Clark Carty, HPE
- Yan Zhuang, Huawei
- Jon Lewis, Dell
- James Withey, Fluke
- Yi Sun, Lightera
- Hideki Isono, Furukawa FITEL Optical Components
- Shoji Ogawa, Furukawa FITEL Optical Components
- Rick Frosch, Phihong USA
- John Calvin, Keysight Technologies
- Geoff Thompson, Independent
- John George, Lightera
- Wayne Hopkinson, Commscope
- Tim Baggett, Microchip
- Paul Nikolich, Nikolich Advisors LLC
- Scott Sommers, Molex
- Mike Wingrove, Sympatico
- Paul Vanderlaan, Panduit
- Heath Stewart, Analog Devices
- Marcel Kiessling, Beckhoff Automation
- David Brandt, Rockwell
- Andy Moorwood, Keysight Technologies
- Yong Kim, General Motors

CFI Announcement

Providing power along with Ethernet data via Power Over Ethernet (PoE) has fueled an expansion of networked devices and an ever-increasing demand for more power. PoE was specified such that it could comply with IEC 60950-1 (now IEC 62368-1) Limited Power Source (LPS) requirements, which align with Class 2 requirements in NFPA 70 (National Electrical Code). Recent developments in fault detection methods enable power delivery at higher voltages with techniques that limit energy into a fault, known as Fault Managed Power (FMP), which aligns with Class 4 power in NFPA 70. **The addition of FMP to Ethernet powering techniques, including potential modifications to Ethernet PHYs, enables greater power delivery, longer range, and increased efficiency for networked devices.** This call for interest is to request the formation of a "Fault-Managed Power Ethernet powering techniques" study group.

CFI Agenda

- Defining the Need for this CFI
- Introducing Fault Managed Power (FMP) Technology
- Motivation for This Project
- Market Considerations
- Possible Paths Forward
- Discussion & Straw Polls

Power versus data progress

- Ethernet data rates have scaled dramatically, while remote power delivery for networked devices has not kept up.
- PoE is fundamentally capped at 90W—yet devices increasingly need 300W to 3000W, often over >100m.
- The industry needs a safe, standardized way to deliver more power with data.

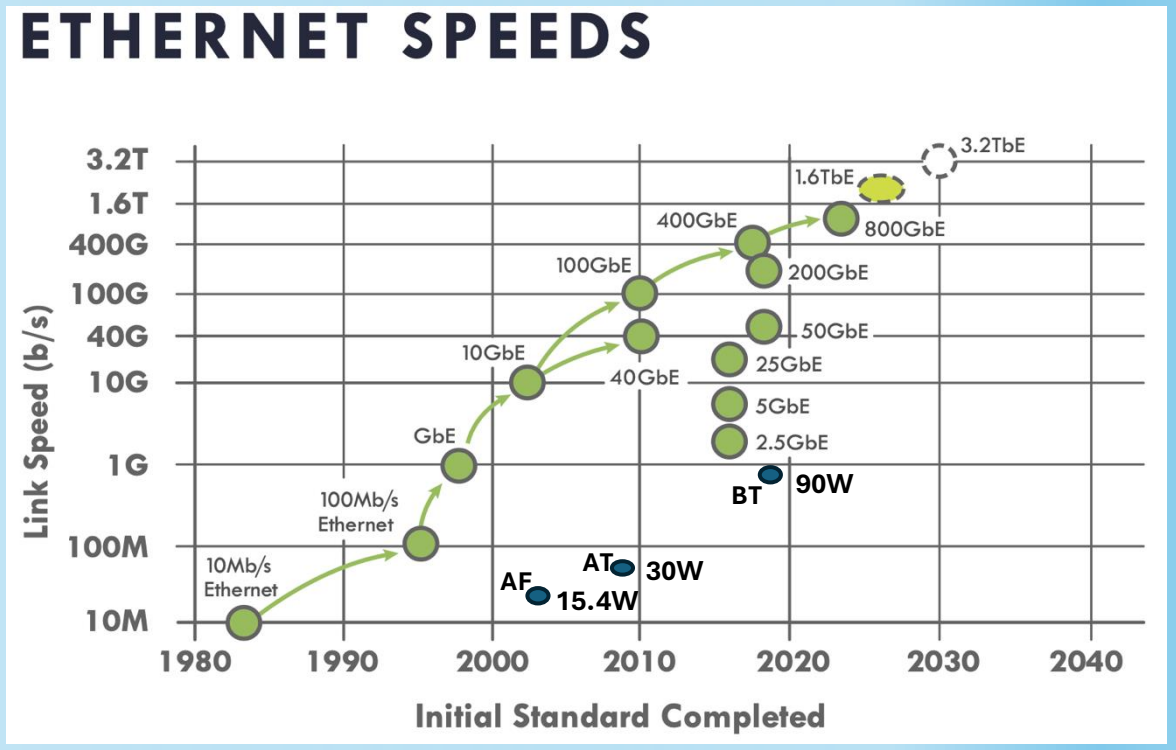


Chart courtesy of Ethernet Alliance Ethernet Roadmap: https://ethernetalliance.org/wp-content/uploads/2025/12/EthernetRoadmap-2026-Side1-2-Final-2-RGB.pdf

Introducing Fault Managed Power

An Emerging Power Delivery Technology

Fault Managed Power (FMP) Overview

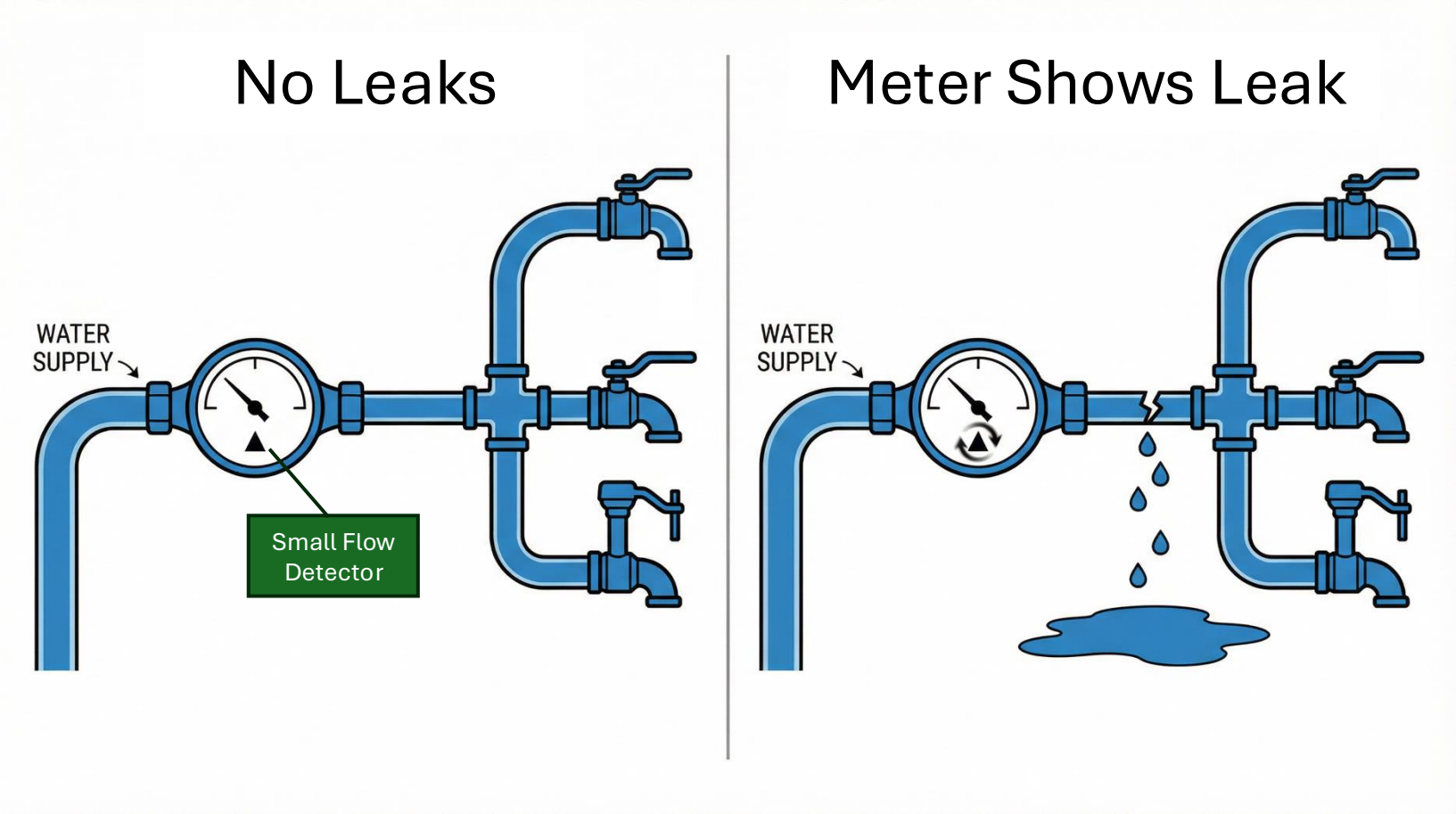
- Transmitter, cabling, and Receiver work as a coordinated system
- Fault detection occurs in milliseconds – active fault detection
- Energy delivered into fault is limited to avoid hazardous conditions
- Recognized in NFPA 70 as Class 4 limited energy systems

FMP – Electrical Leak Detection

Left side shows a plumbing system with everything off. The meter shows no flow.

Right side shows system with a leak, and the meter indicates some flow.

Water meters detect unintentional water flow; FMP detects unintentional current flow.

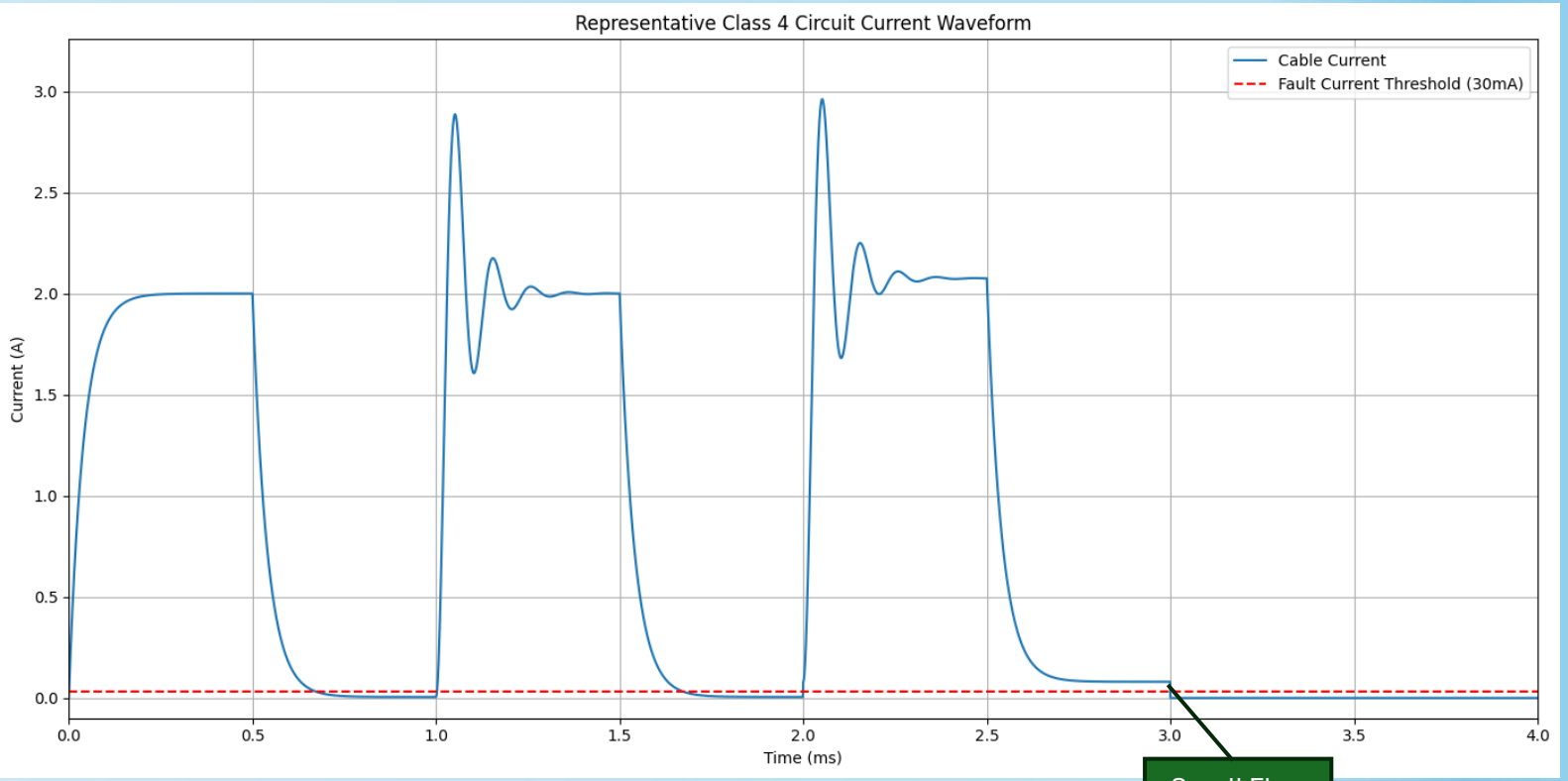


FMP – Electrical Leak Detection

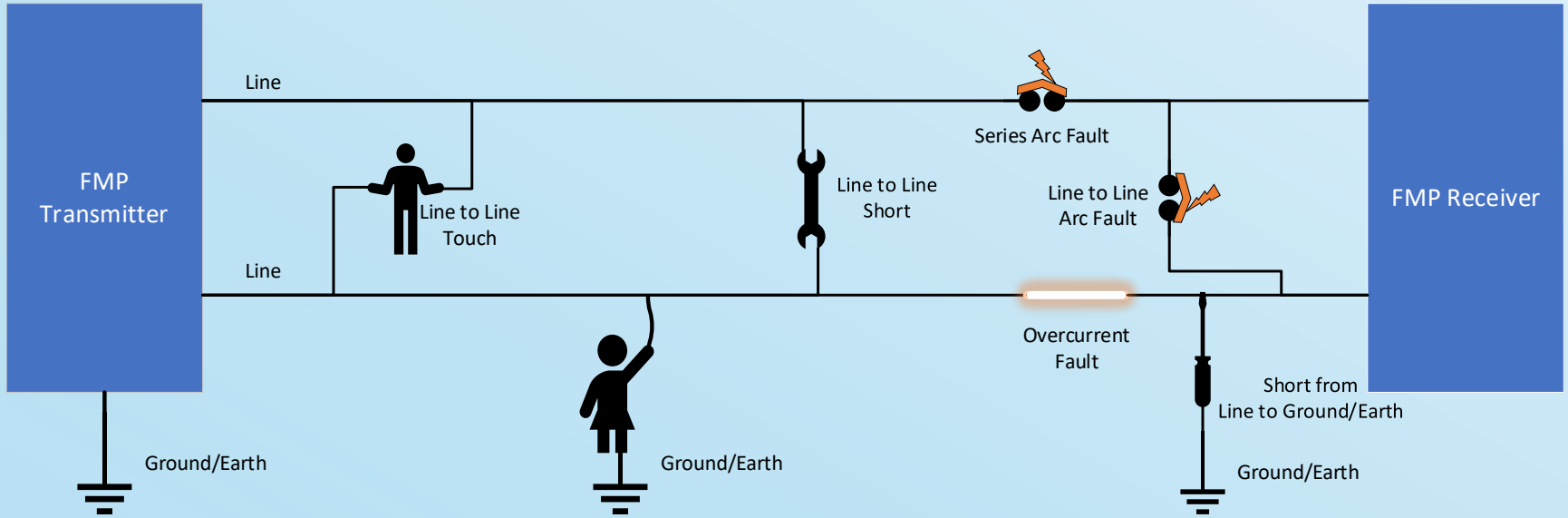
First two pulses show an FMP system with no load. The current shows no flow.

The third pulse shows a system with a leak, and the current indicates current flow above the fault threshold.

FMP detects unintentional current flow.



UL1400 FMP Systems



- FMP must protect against line-to-line and line-to-earth human touch and short circuits, series and parallel arc faults, and overcurrent faults.
- FMP devices disconnect the line from the power source before the fault can present a hazard

FMP contrasted to other protection technologies

	Capacity	Fire Prevention		Shock Injury Prevention		Telemetry	Standards
	Typical Receptacle	Overcurrent / Short-Circuit	Arc Fault	Line to Ground Shock	Line to Line Shock	Capable?	Governing Safety Standards
Circuit Breaker	2-3 kW	✓	✗	✗	✗	✗	UL 489 IEC 60947 IEC 60898
GFCI/RCD	2-3 kW	✗	✗	✓	✗	✗	UL 943 IEC 62873
AFCI/AFDD	2-3 kW	✗	✓	✗	✗	✗	UL 1699 IEC 62606
PoE	90 W	✓	✗	✓	✓+	✓	IEC 62368
FMP	3-6 kW	✓	✓	✓	✓	✓	UL 1400

[+] PoE ports address shock risk passively by limiting voltage, which limits efficiency and capacity

Motivating Factors

Delivering Power and Data in a Single Cable

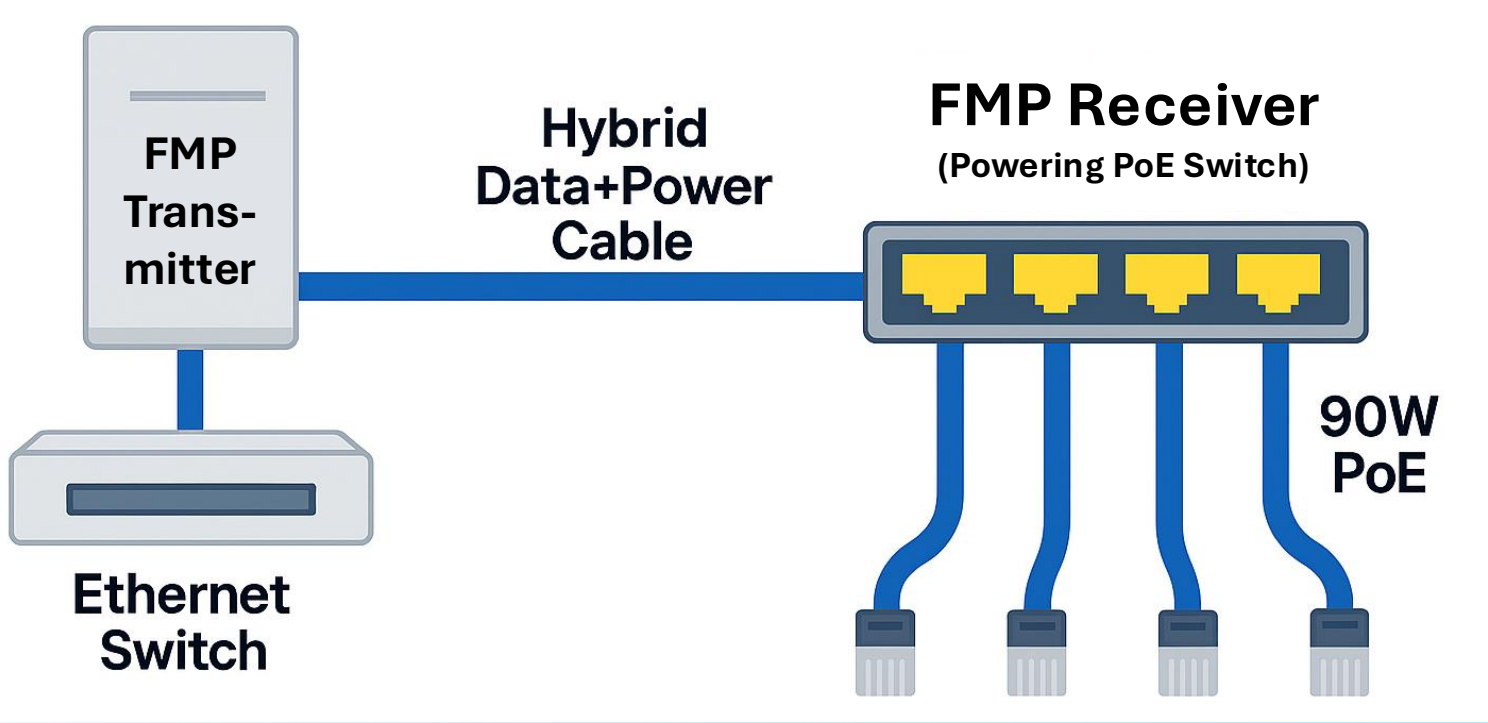
FMP and PoE in the market

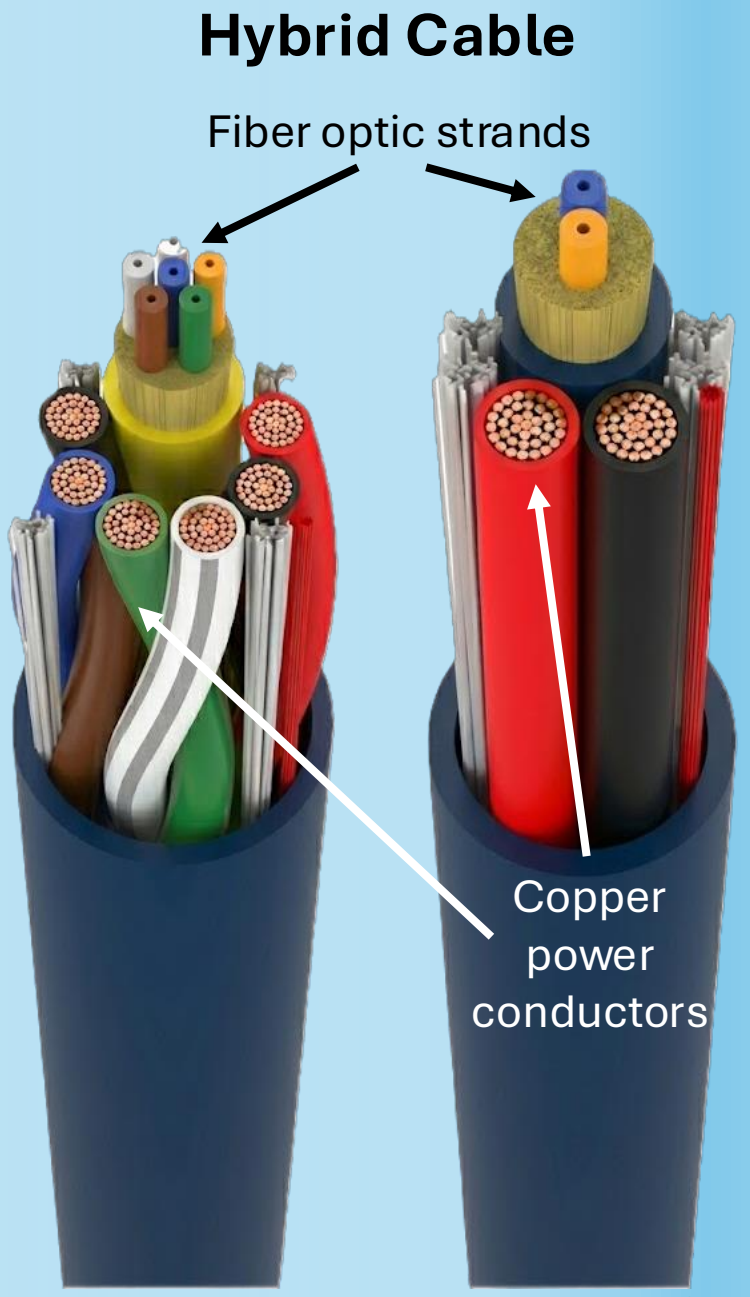
- FMP and PoE are complementary technologies
  - FMP is the “feeder”, PoE is the “branch”
  - FMP provides kW (~400 V), PoE distributes in 90 W chunks (~60 V)
- PoE cannot scale safely above 100 W, FMP fills this gap
- PoE hardware is not FMP capable due to the higher voltage
- FMP hardware could be specified to be compatible with:
  - Power over Ethernet (PoE)
  - Power over Data Lines (PoDL)
  - Multidrop Power over Ethernet (MPoE)

Opportunities FMP Enables That PoE Cannot

- Running HVAC equipment without AC installation
- Powering edge compute pods without expensive electrical work
- Providing kW safely in exposed pathways
- Reducing the number of AC-DC conversions (efficiency)

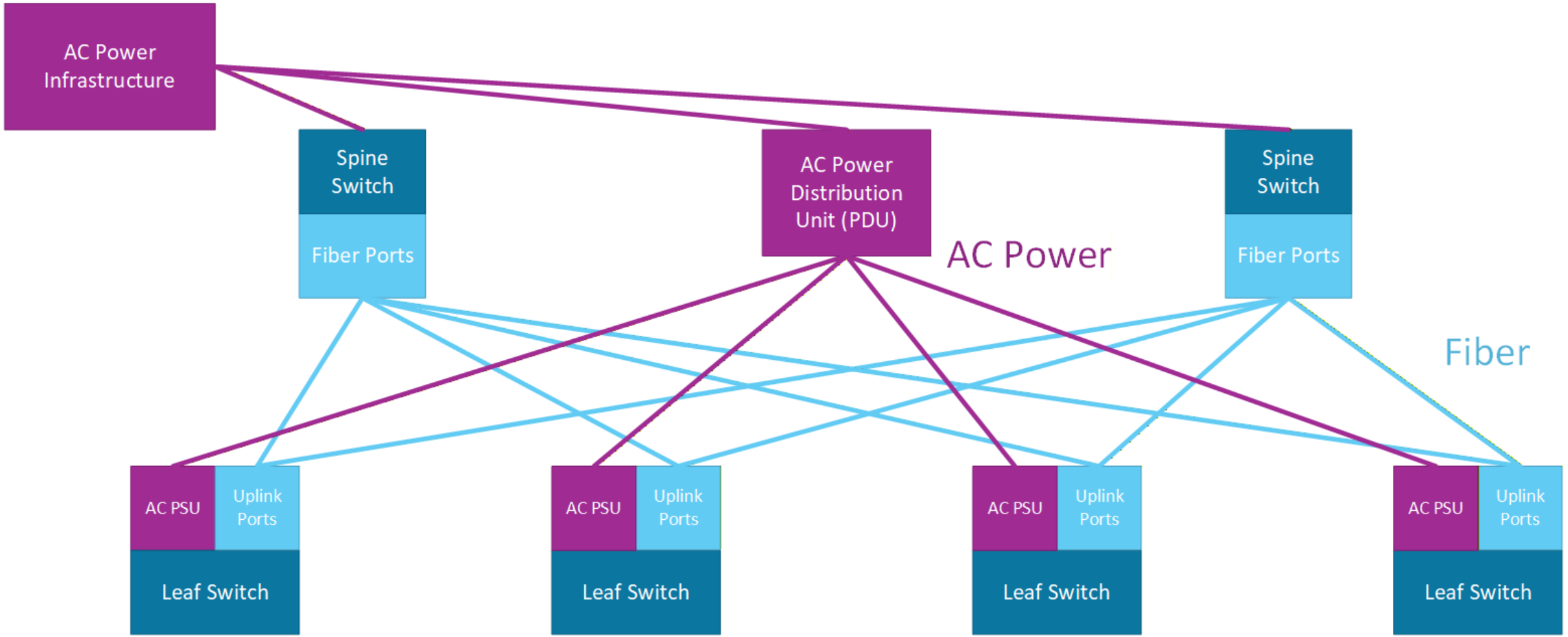
FMP and PoE





- FMP enables aggregation, distribution, and reach
- Extends Ethernet powering ecosystem

FMP + Data Architecture



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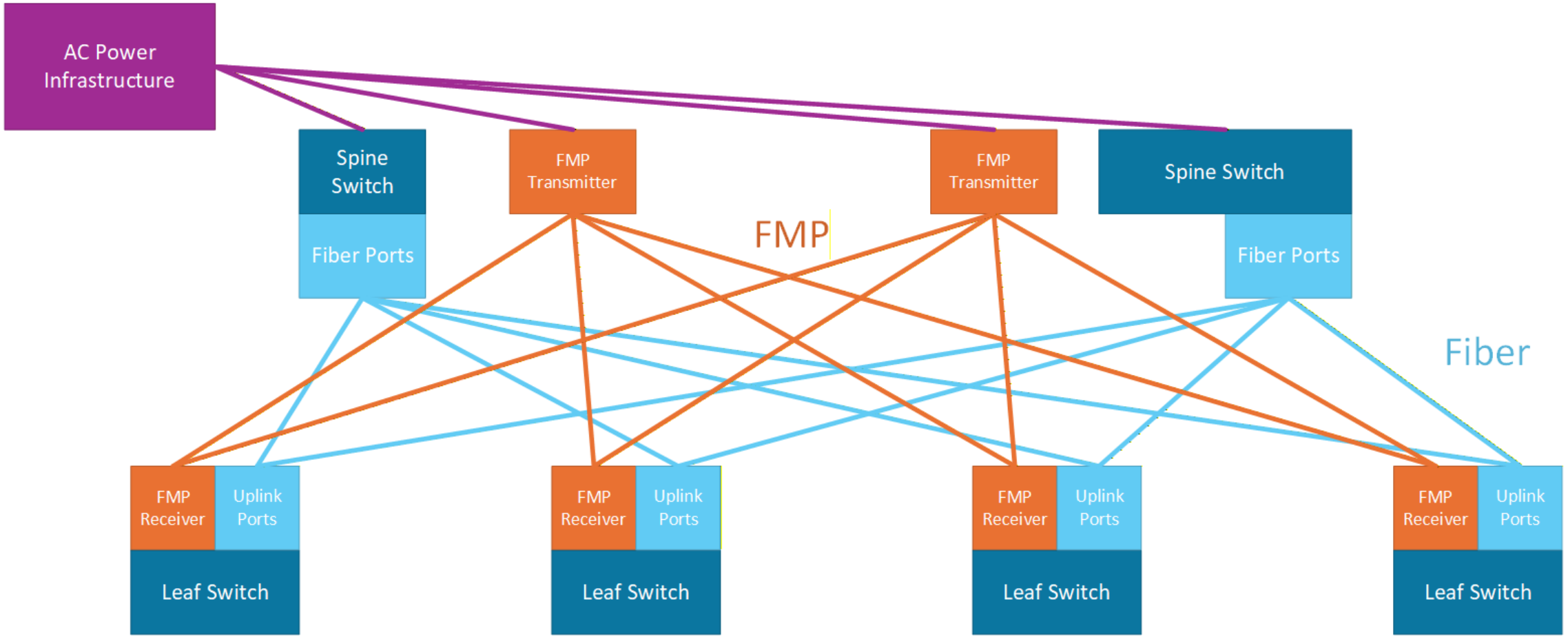

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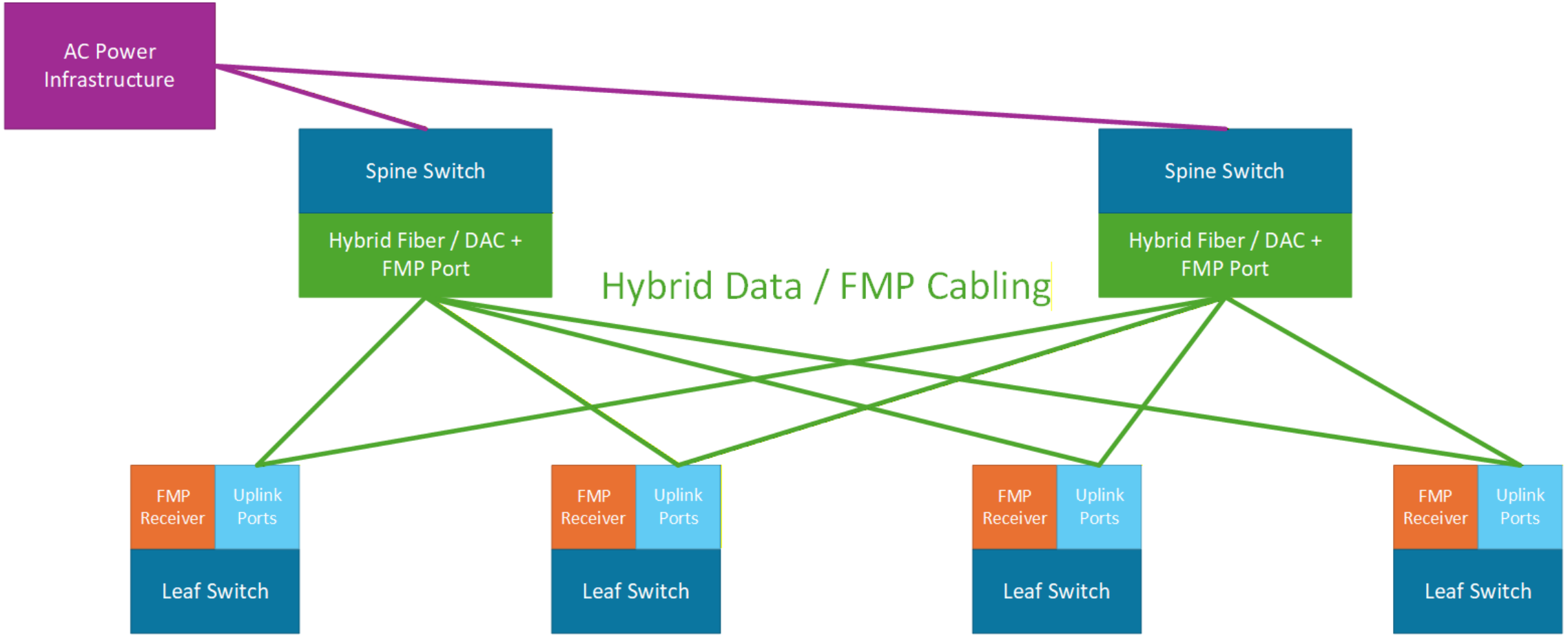
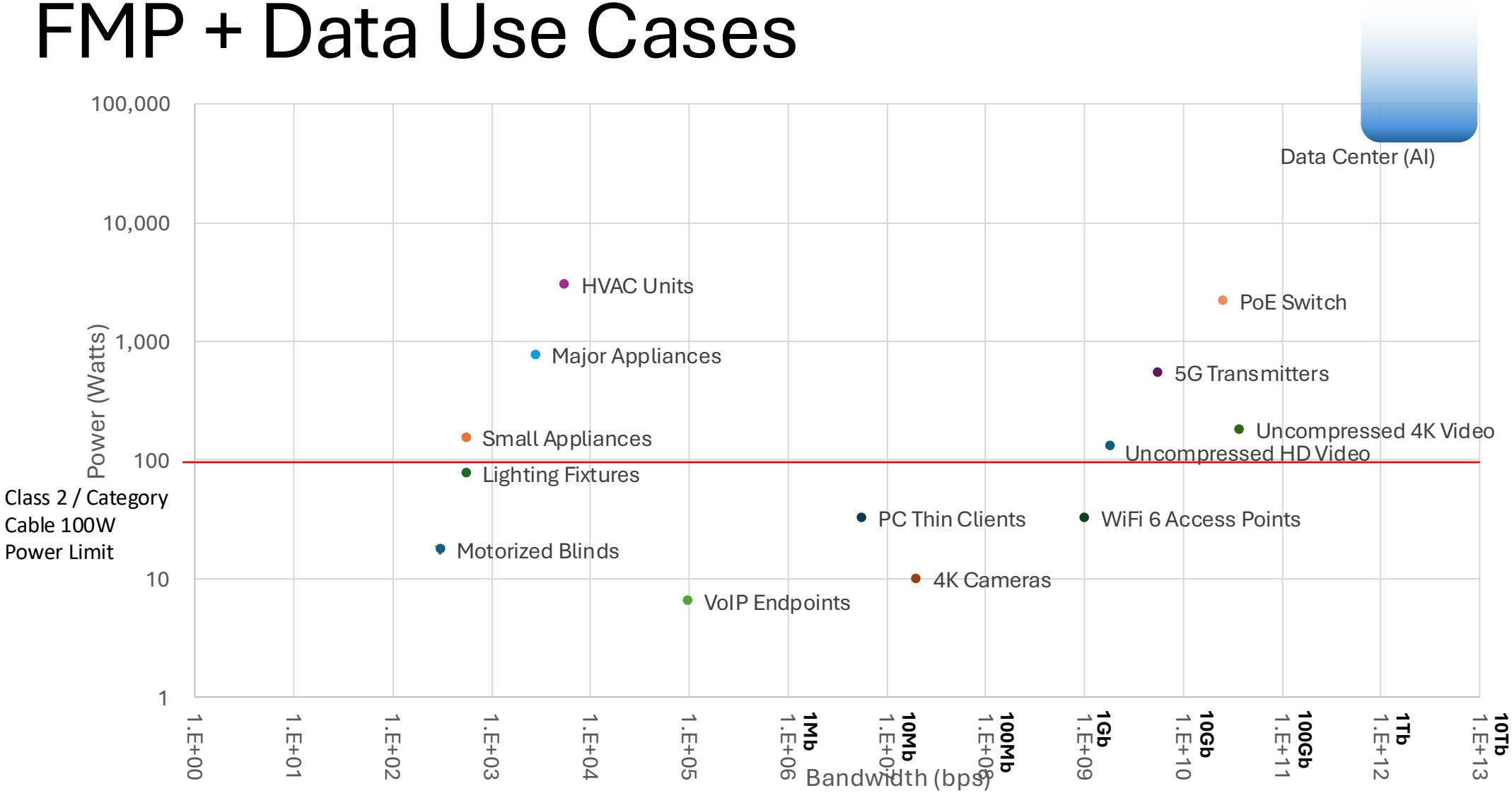


Market Considerations

A New Market at an Inflection Point

FMP + Data Use Cases



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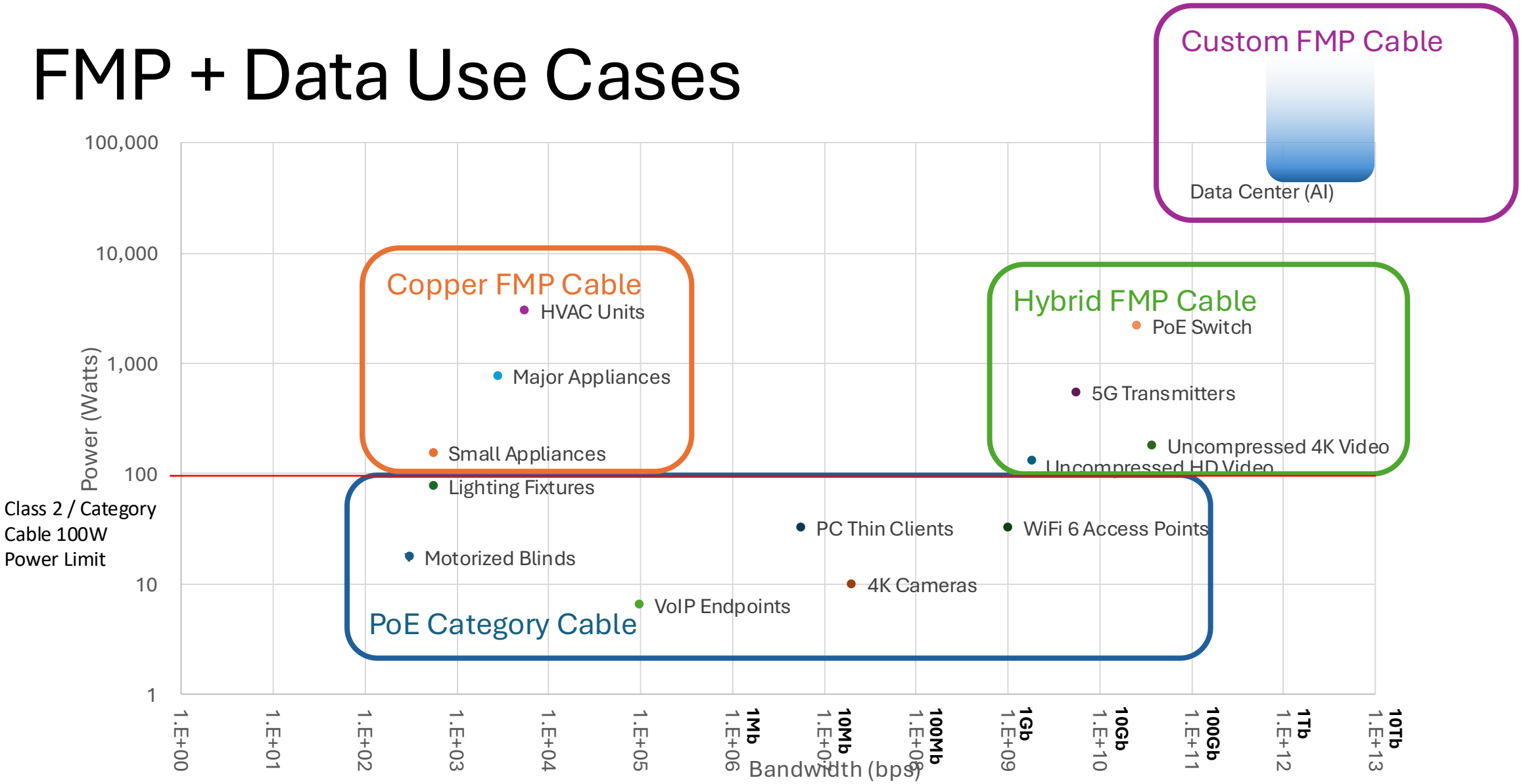


FMP Extends the PoE User Experience:
Power and Data on the Same Cable

	Copper FMP Cable[1]	Hybrid FMP Cable[2]	FMP Power Cable[3]
Reach	100m w/multigig 100-1000m w/SPE	3 km	10m – 3km
Power	6 kW	4 kW	12 kW
Supports Ethernet data	YES	YES	NO

[1] Various Ethernet PHYs, including both four-pair and single pair copper PHYs
[2] Via hybrid fiber-optic / copper cables
[3] Far end device must be powered before data is available

FMP High-Growth Application Areas

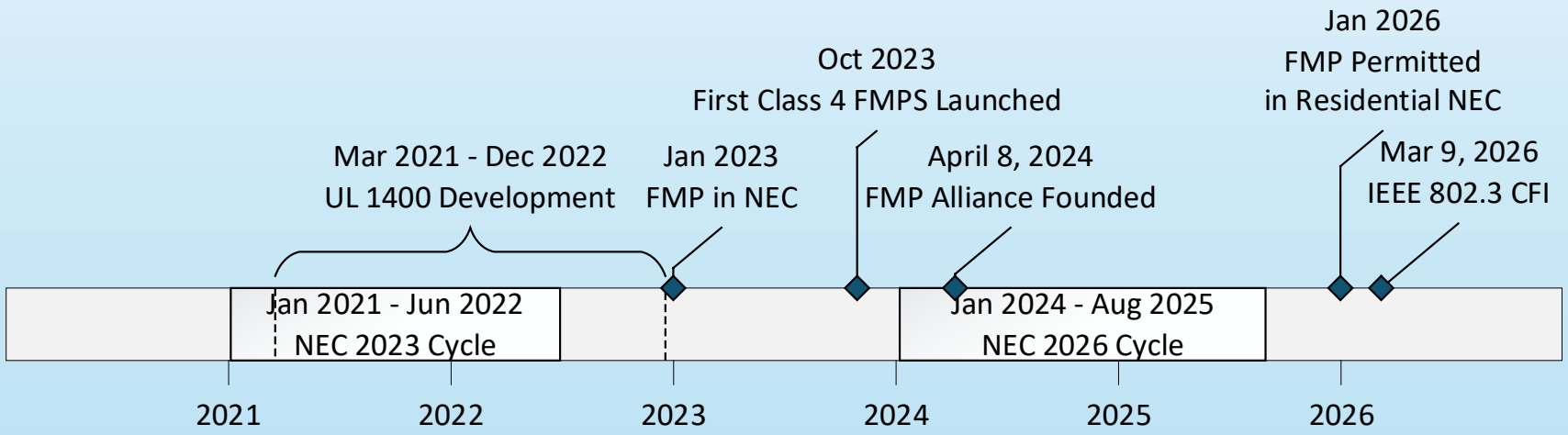
- Data Centers & Edge Computing (100 GW)
  - Potential: Goldman Sachs predicts a 165% increase in data center power demand by 2030 due to AI.
  - Opportunity: FMP provides a safe way to distribute DC power within the facility or to remote "edge" pods without the heat loss of multiple AC-DC conversions.
- Smart Buildings & Digital Ceiling (33 GW)
  - Potential: Powering LED lighting, security cameras, and Wi-Fi 7 access points via PoE switching equipment at the edge.
  - Opportunity : Centralizing the "brains" of the power system into one rack, similar to an IT switch, simplifies maintenance.
- 5G and Telecommunications
  - Potential: 5G "small cells" require significant power but are often placed in locations where running traditional AC is cost-prohibitive.
  - Opportunity : With millions of small cells projected globally, FMP is becoming the standard for "remote powering" from a centralized hub.
- Controlled Environment Agriculture (CEA)
  - Potential: Large-scale indoor farms use massive amounts of LED lighting.
  - Opportunity : FMP reduces the fire risk in humid environments while allowing centralized control of light cycles.

AI Datacenter Pivot to HVDC

- AI hyperscalers seek DC power at higher voltage levels to meet massive power demands. While effective, HVDC has challenges.
- 450V FMP from facility to rack, and redistribute as 400V DC or 56V DC from rack to circuit is much safer, reduces cost, and creates the least disruption to server / switch manufacturers

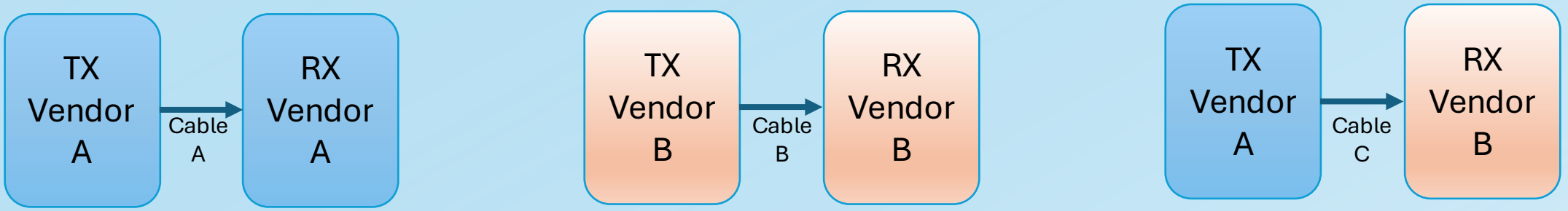
	Facility Level From Utility / Medium Voltage to Top of Rack	**Rack Level** From top of Rack to Servers / Switches	**Appliance/Circuit Level** Within Servers / Switches
One OCP Proposal	13.8 kV AC	800V DC	800V DC
FMP	450V FMP	400/56V DC	400/56V DC

Regulatory and Standards



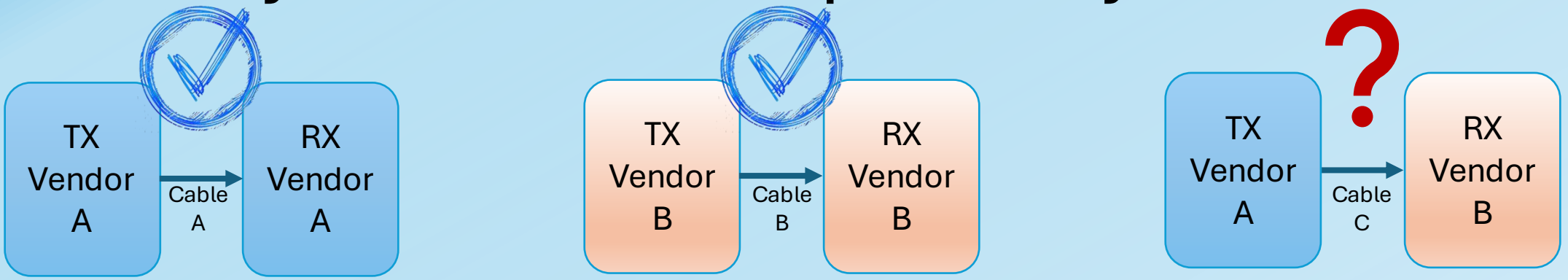
- Class 4 FMP Circuits were added to the 2023 National Electrical Code (NEC) in the US
  - Permitted uses were expanded in the 2026 NEC
- Underwriters Laboratory (UL) has published safety standards
  - UL 1400-1 covers systems
  - UL 1400-2 covers cabling
- CSA is the next national standard effort, work ongoing in other geographies
- Three proprietary systems have obtained UL 1400-1 listings, but they do not interoperate

Industry Calls for Interoperability Standards



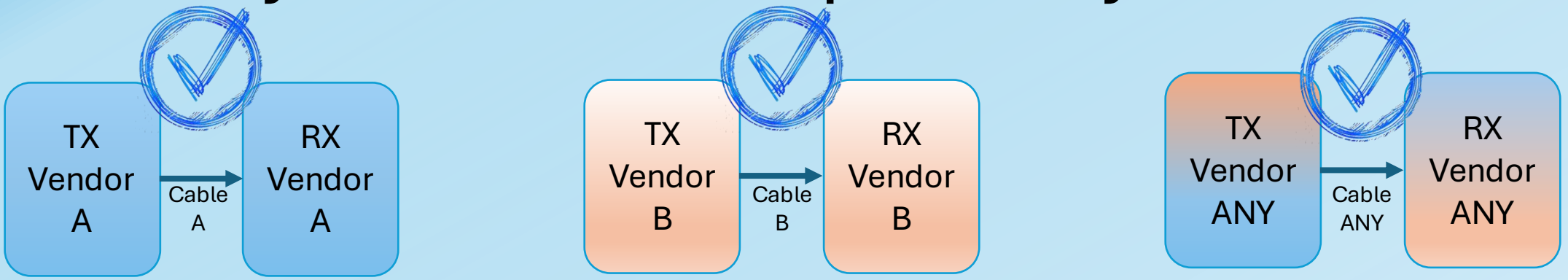
- UL 1400-1 mandates testing and listing as a system: FMP Transmitter, Cabling, and Receivers together
  - This UL mandate is due to the lack of an FMP interoperability standard

Industry Calls for Interoperability Standards



- UL 1400-1 mandates testing and listing as a system: FMP Transmitter, Cabling, and Receivers together
  - This UL mandate is due to the lack of an FMP interoperability standard
- Customers cannot mix transmitters, receivers, or cables across vendors today.

Industry Calls for Interoperability Standards



- This UL mandate can be modified when an FMP Interoperability standard is available
- The market also will be hesitant to accept single-source solutions

Interoperability is Key

Possible Paths Forward

Why This Belongs in IEEE 802.3

- IEEE 802.3 uniquely provides:
  - Ethernet powering expertise (PoE, SPE Power)
  - Multi-vendor interoperability framework
  - PHY coexistence knowledge
  - Long-term architectural stability

- UL and IEC define safety
- National Electrical Codes/IEC define Installation
- IEEE 802 defines interoperability
- IEEE 802.3 **is** Ethernet, and Ethernet needs FMP

Why Now?

- Market demand has crossed the PoE limit
  - Wi-Fi 7 APs, LED arrays, motorized shades, and edge compute nodes increasingly require >100W—PoE cannot grow further.
- Multiple proprietary systems are already shipping, accelerating fragmentation.
- Industry resources have freed up from recent SPE efforts, and multiple contributors are ready to contribute.
- Make FMP part of the Ethernet ecosystem

Ethernet Compatibility

- Existing regulations require new cabling for FMP
- Nothing in FMP is fundamentally incompatible with Ethernet. The question is which PHY modes require modification vs. can operate unchanged.
  - Transients associated with most FMP systems might disrupt data
  - Potential solution paths include:
    - Existing PHYs without modification
    - Existing PHYs with interference avoidance (RS)
    - Existing PHYs with modification
    - New PHY derived from existing PHY

Summary

- Ethernet data rates have outpaced Ethernet power delivery—creating a major unmet market need.
- Fault-Managed Power can safely deliver kWs of power over data cabling at long distances.
- Proprietary systems are emerging but cannot interoperate due to lack of an interoperability standard.
- To enable open, vendor-neutral ecosystems, **IEEE 802.3 must define interoperability.**
- FMP + Ethernet can expand Datacenter, 5G, and smart buildings markets… but not without interoperability standards

Discussion and Straw Polls

Proposed
FMP Study Group Motion

Move that the IEEE 802.3 Working Group request the formation of a Study Group to develop a Project Authorization Request (PAR) and Criteria for Standards Development (CSD) responses for Fault-Managed Power Ethernet powering techniques.

Straw Poll Question # 1

Should a study group be formed to develop a PAR, CSD responses, and objectives for “Fault-Managed Power Ethernet powering techniques”?

- ❑Yes -
- ❑No -
- ❑Abstain -

Straw Poll Question # 2

Would you participate in the “Fault-Managed Power Ethernet powering techniques" Study Group in IEEE 802.3?

- ❑Yes -
- ❑No -
- ❑Abstain -