Fault Managed Power

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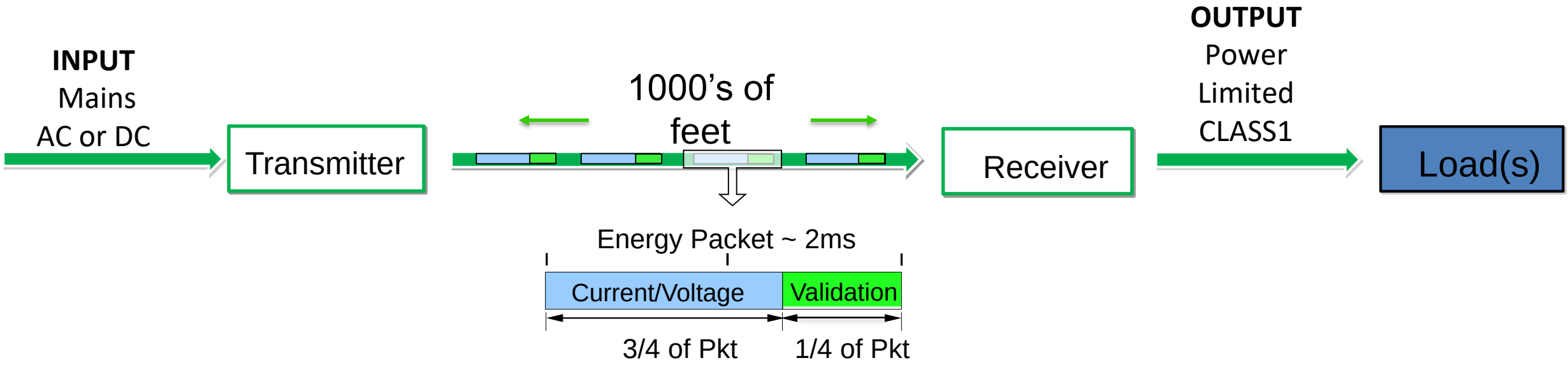
Fault Managed Power (FMP)
Digital Electricity™ (DE)



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Digital Electricity™ (DE) Safety Classification

Safety is achieved through isolation at the transmitter and with fault detection on the Digital Electricity transmission.

Fault managed power systems are designed to meet strict safety standards like IEC 62368-1, ensuring they protect both people and property even when delivering high power levels.

IEC 62368-1, introduces a hazard-based safety engineering (HBSE) approach and classifies energy sources into three classes (ES1, ES2, and ES3) based on their potential to cause pain, injury, or ignite materials. ES2 is an electrical energy source where the prospective touch voltage and the touch current exceed ES1 limits but are not capable of causing injury.

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Digital Electricity™ (DE) Safety Classification

The system safely delivers higher levels of power to remote loads than traditional power methods, without imposing a power limit on the sources. Instead, it focuses on limiting the amount of energy that can be transferred during a fault condition in the transmission line between the transmitter and receiver.

The power flow between the transmitter and receiver is constantly monitored for any signs of trouble, such as a short circuit or someone accidentally touching fault managed DC power lines. If a fault is detected the system reacts in milliseconds to shut off the power. This fast action helps prevent electric shocks or fires.

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Quick Review of Circuit Classes

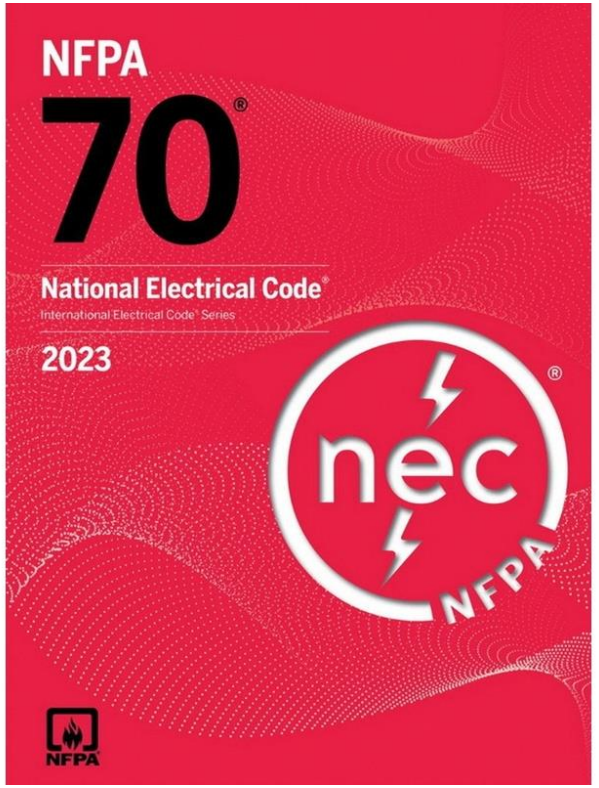
- Class 1, Class 2, and Class 3 circuits are differentiated from each other by power limitations
  - Class 2 considers safety from a fire initiation standpoint and provides acceptable protection from electric shock
  - Class 3 considers safety only from a fire initiation standpoint

Limited Energy Circuits

- Limits possibilities of ignition or ventricular fibrillation
- Devices and systems must be LISTED as a Limited Power Source (LPS)
- Power over Ethernet (PoE) is a well-known example of LPS

Class 4 – Fault Managed Power (FMP)

- 2023 Edition of NFPA 70 has a *new* Article 726
- Limits the fault power in the circuit by monitoring for faults and controlling the power transmitted into the fault
- Based upon risks associated with electric shock and fire hazards
- Defines current limits in terms of duration based on the human body model, **limit energy and power available during a fault event**
- Also requires Functional Safety – analysis of potential hazards
  - Restart, over-voltage, over current, etc.



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Summary

Fault Managed Power (FMP) provide the power capability of a ***power circuit*** with the hazard levels of a ***power-limited circuit*** enabling new ways of distributing power

Class 2 and Class 4 circuits CAN share the same cable, enclosure, or raceway.

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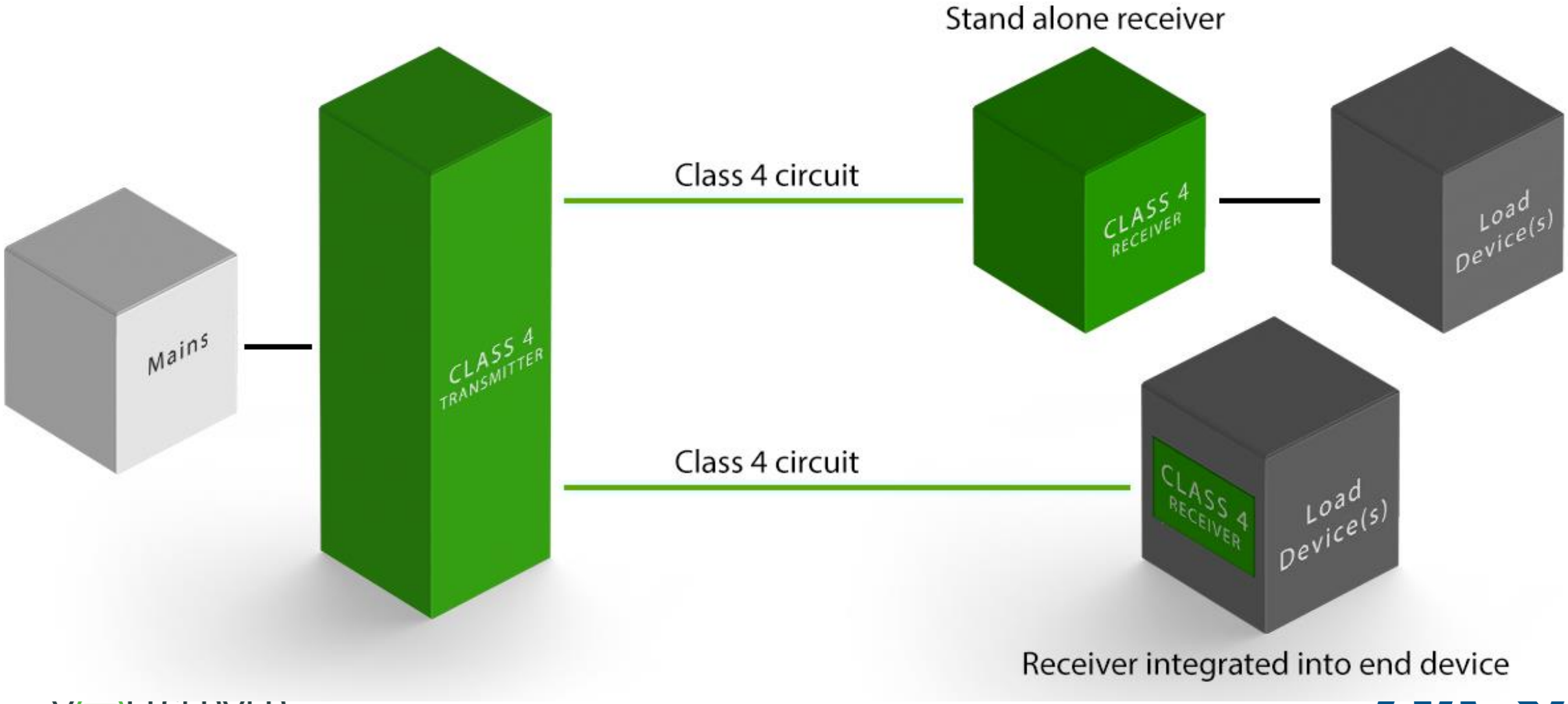
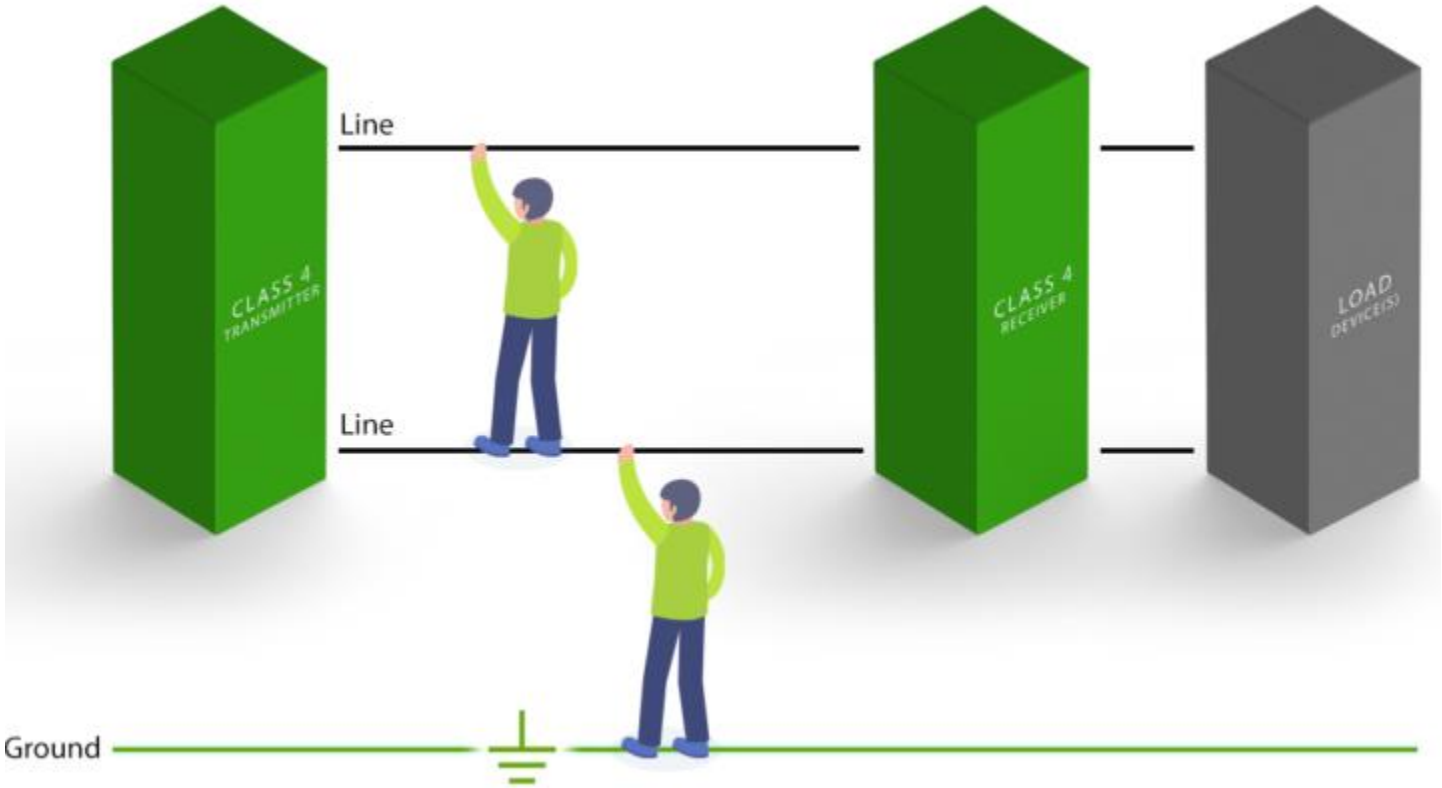
FMP System Diagram



Shock Faults



- FMP not only limit fault energy for shocks that occur between the line conductor and earth, but they also limit the fault energy for line-to-line faults.
- This means if someone accidentally touches both lines, the system will react to the fault and limit the energy into the person.
- Traditional power systems employing GFIs cannot react to line-to-line faults because GFIs cannot tell the difference between a person in contact with the wires and the load.
- FMP can tell the difference between the load and a person in contact with the lines.

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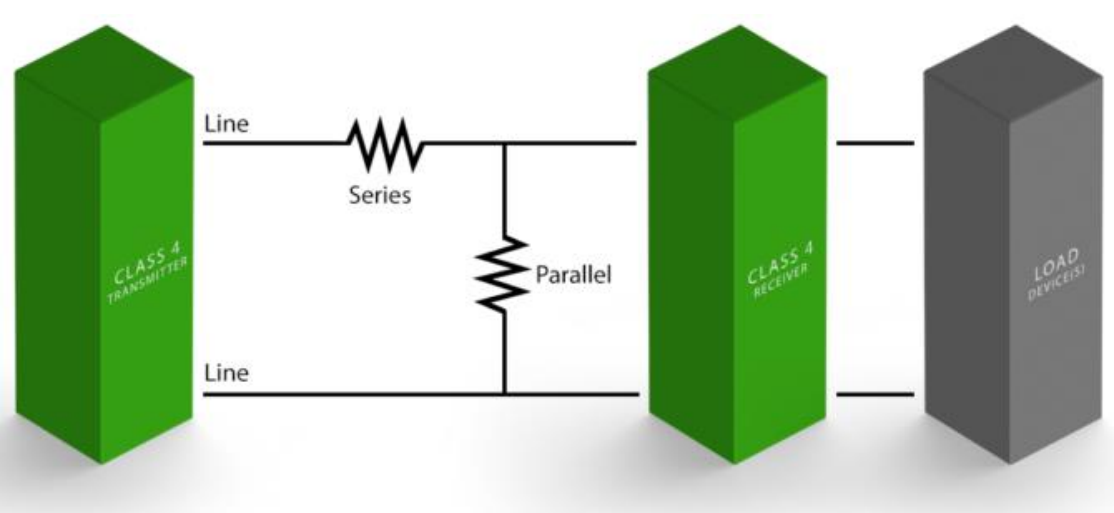
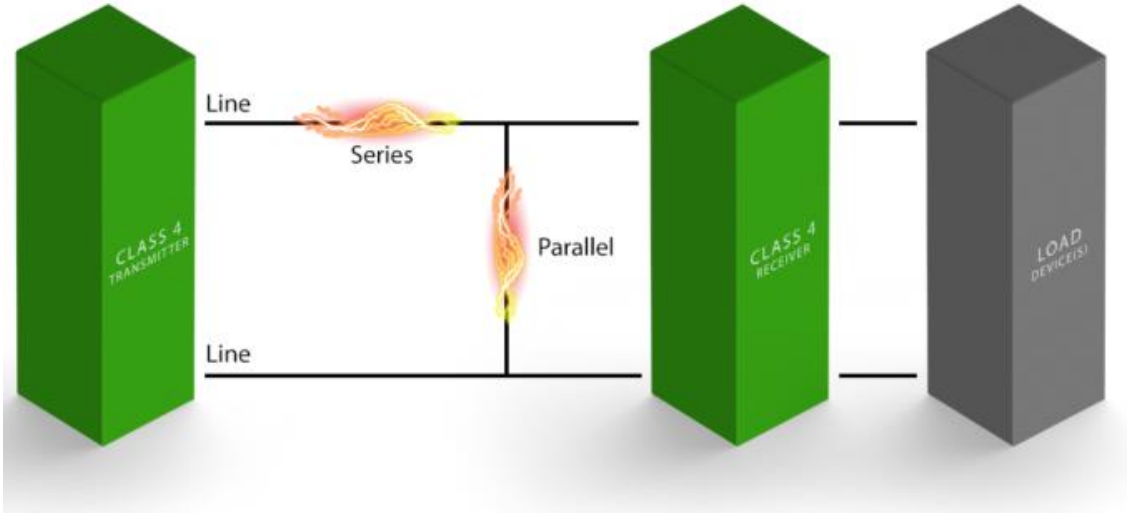
Resistive and Arc Faults





- Class 4 circuits also limit the risk of fire.
- This is accomplished by limiting the amount of energy into an arc fault as well as managing resistive faults *(resistive faults not required for Annex A of UL 1400-1, Class 4 Power)*
- FMP detects or prevents dangerous arcs that can lead to fire, both line-to-line as well as in-line.
- Resistive faults are limited to 100W for line-to-line faults which limits the amount of heat that can be generated to the same amount of heat allowed in a traditional Class 2 circuit.

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Summary of FMP Fault Protections

Hazard	Fault Type	GFCI	AFCI	FMP
Shock	Line-to-Earth	✓	✓	✓
	Line-to-Line	✗	✗	✓
Fire	Series Arc	✗	✓	✓
	Parallel Arc	✗	✓	✓
	Line-to-Line Resistive	✗	✗	✓
	Series Resistive	✗	✗	✓

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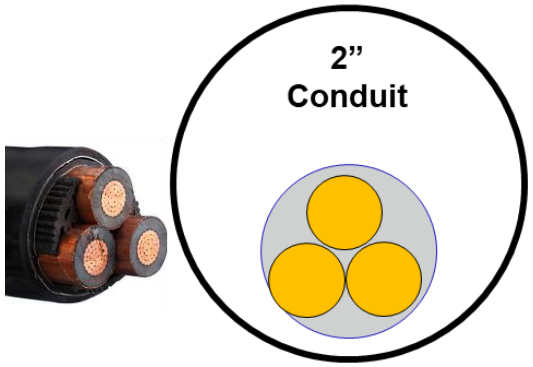
Comparison of Material Requirements

Example: Need 1,000W at 1000ft (305m)

120VAC:
3x 3AWG wires in 2” conduit



Digital Electricity:
4 pairs 18AWG, no conduit

0.322in diameter

Up to 90% reduction in embodied carbon!

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FMP Support for Common Applications

Building Edge Infrastructure / Distributed Edge

Passive Optical Networks

Smart/ Intelligent Buildings

Cellular / DAS

Cellular / Small Cell

Extended Distance Applications

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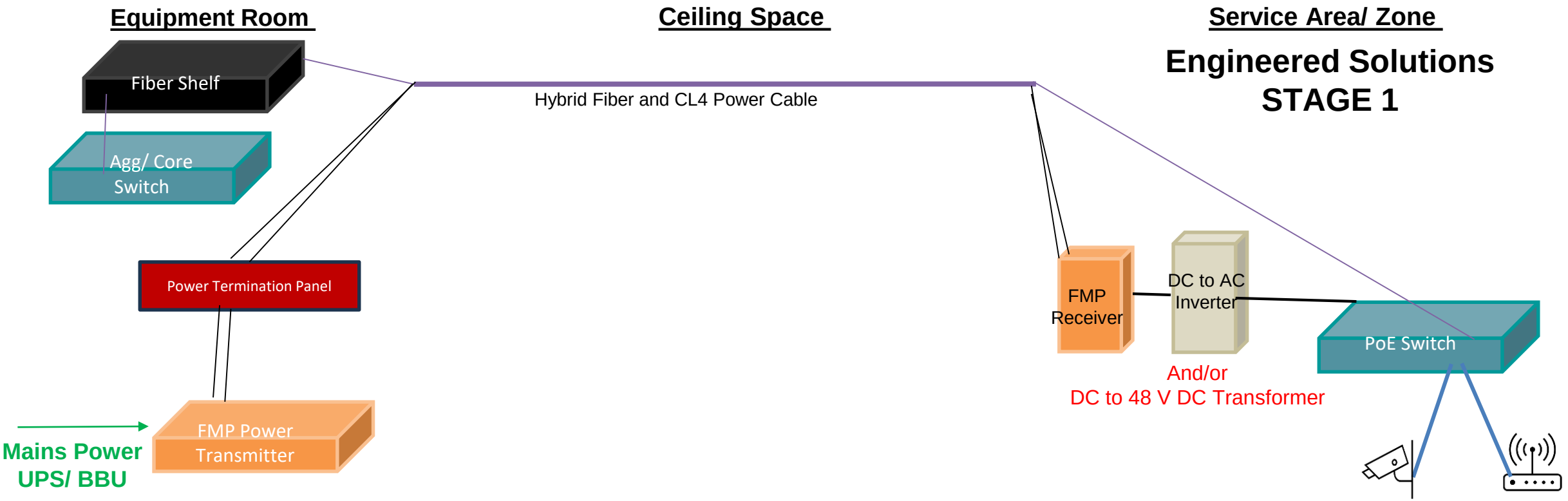
FMP System Architectures for Common Applications

Building Edge Infrastructure / Distributed Edge
Extended Distance for IT appliances



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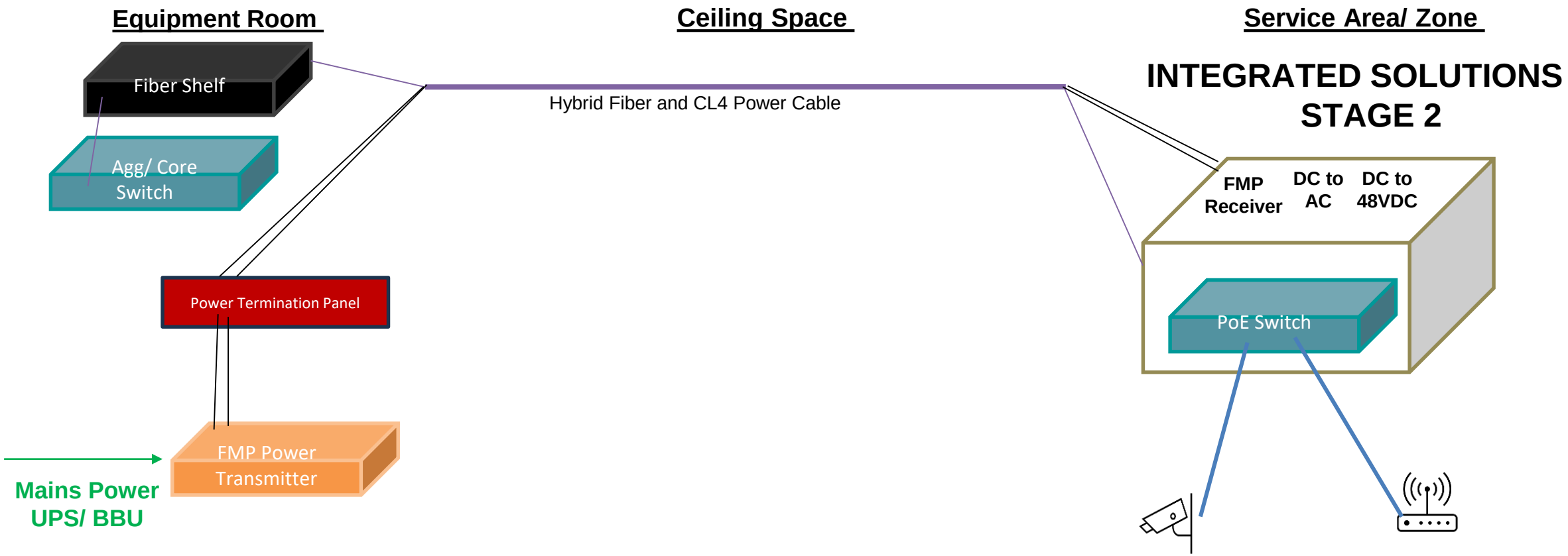
FMP System Architectures for Common Applications

Building Edge Infrastructure / Distributed Edge
Extended Distance for IT appliances



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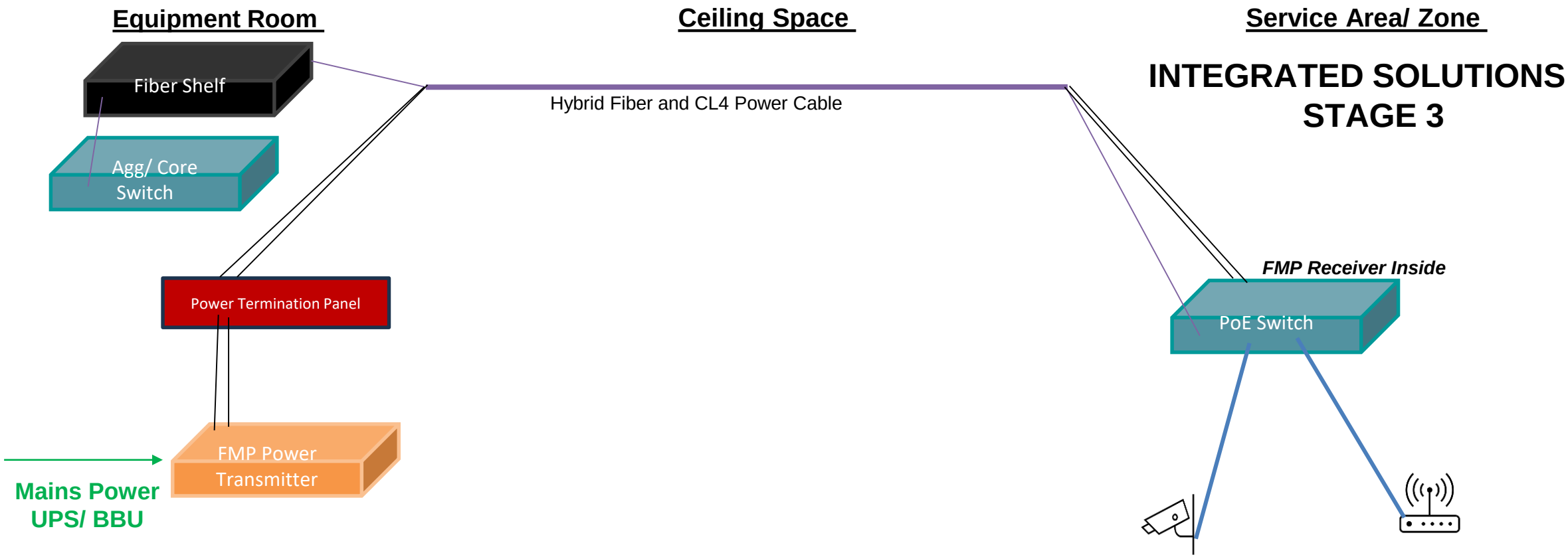

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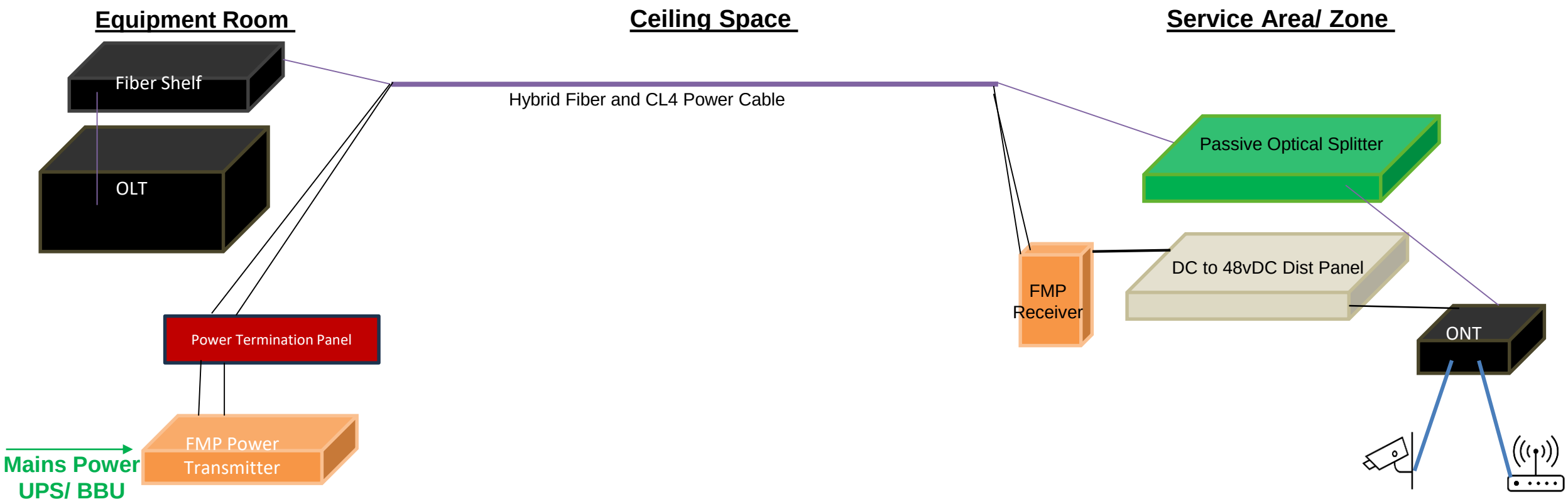
FMP System Architectures for Common Applications

PON



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Benefits of FMP

- **Safe** – NRTL certified for same wiring practices as Ethernet/PoE
- **Significant Power** – hundreds of Watts per pair of conductors
- **Significant Distance** – thousands of feet
- **Skinny Conductors** – 16-18AWG
- **System Monitoring and Control** – remotely manage your power distribution, and take action upon external events
- **Speed to Deployment** – can be run in the same pathway or cable as fiber, many jurisdictions do not require permits
- **Sustainable** – smaller cable gauges, no conduit, intelligent control over power use, can eliminate wasteful conversions of AC to DC

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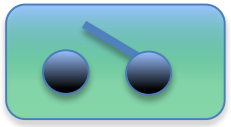
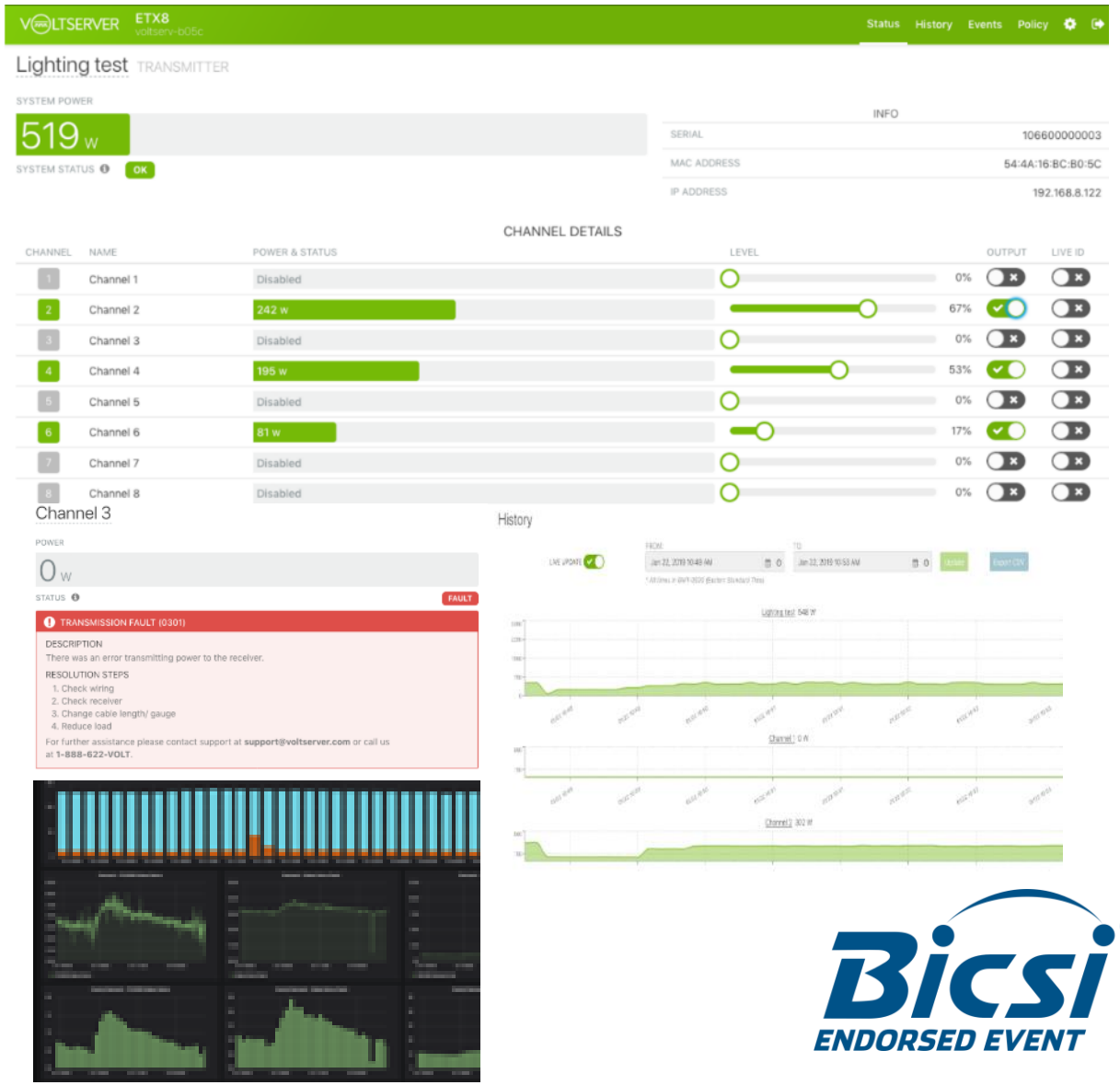
Manage Power like Data

- **Industry standard management interfaces**
  - SNMP, HTTP, REST API, hard contact…
- **“Hosted Application”** for multi-site management
- **Open API for fast 3rd party integration - BMS**
- **MTBF/MTTR Acceleration Tools**
  - LED “Find-Me”, Load profiling, warning conditions, pop-up guidance
- **Policy Software: Enables revenue generating services**
  - Power ON/OFF/DIM
  - Critical Power Prioritization
  - Metering
  - TOD/DOW

Direct HTTP Interface



Telco Dry Alarm Contacts



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FMP Case Study – Hotel Marcel

- The first Net Zero hotel in the world
- First Passive House–certified hotel
- LEED Platinum
- Pirelli Tire Building, a Nationally registered historic landmark
- Digital Electricity powers lighting and IoT in 165 guest rooms and public areas

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FMP Case Study – London Underground

- DAS provides neutral host mobile coverage along 400km of tunnels and at 270 stations
- Single hybrid cable for power (Digital Electricity) and data (fiber).
- Eliminates the need for 2 cable pulls and 2 contractor teams.
- Single head-end location enables a centralized battery backup and power monitoring system

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Case Study – Circa Resort & Casino

- 1.25 million square feet
- 777 rooms and suites
- Powered, controlled, and backed up from a central, environmentally controlled location
- Bulk power delivered to guest rooms with Digital Electricity™
- LVDC distribution within rooms
- Digital Electricity™ also powers the DAS and Wi-Fi

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