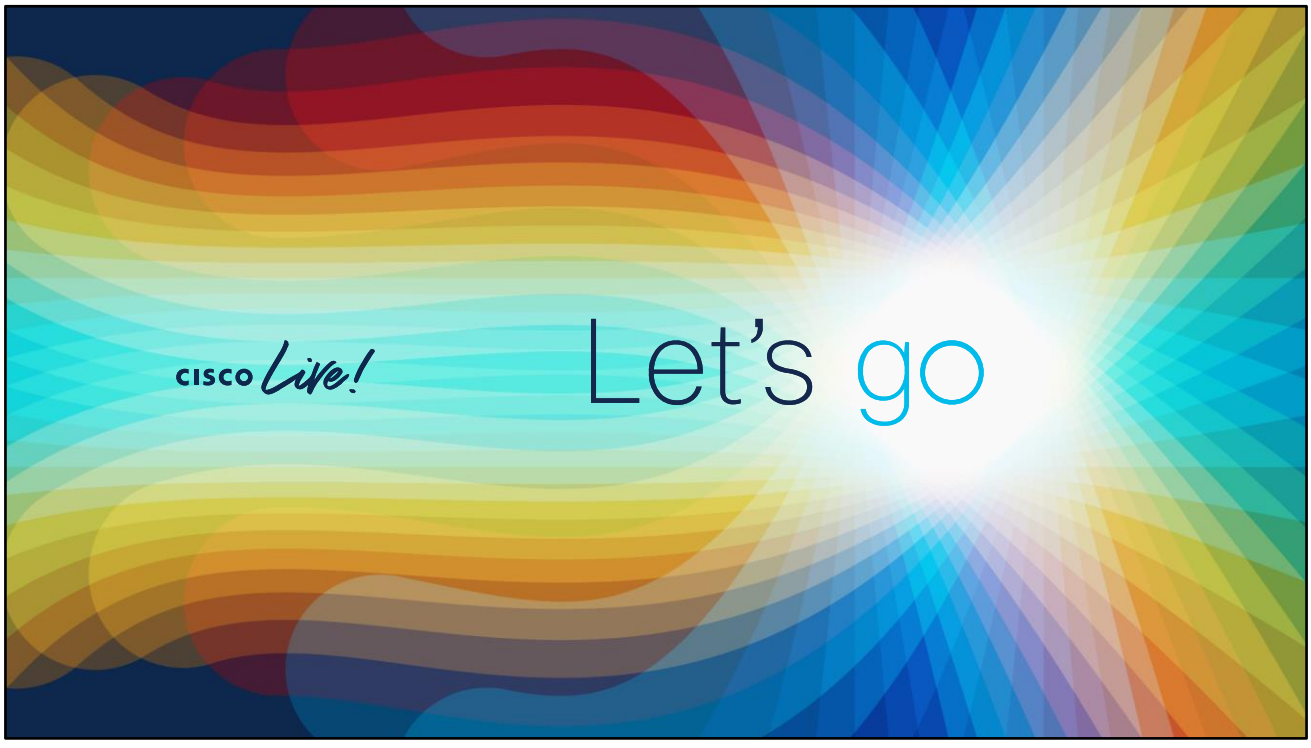
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Let's go

The bridge to possible

# Industrial Power over Ethernet (PoE)

## The Ultimate Guide for Beginners

Albert Mitchell (mitchell)
IIOT Technical Marketing Engineer

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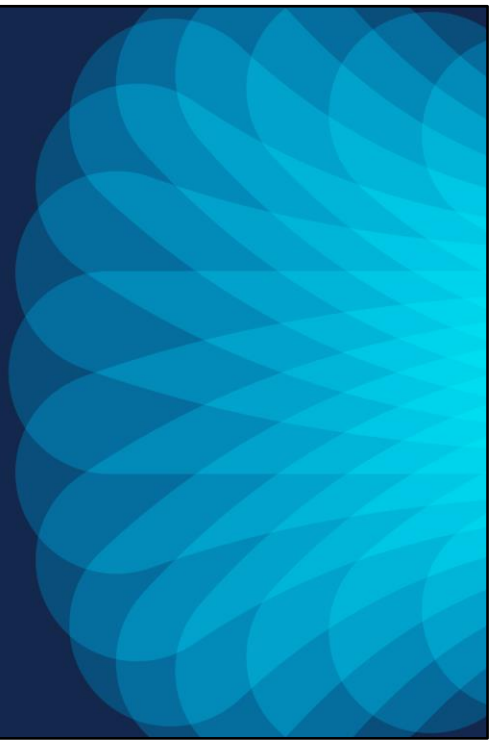
BRKIOT-1128

# Agenda

- Introduction
- Basics of Power over Ethernet
- PoE Standards and Variations
- Industrial Ethernet and POE
- Use-Cases and Benefits
- Conclusion

# What is Power over Ethernet (PoE)?



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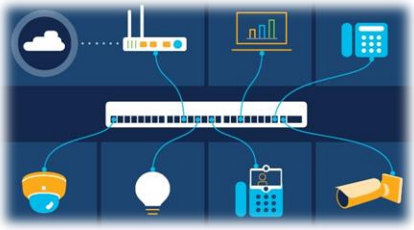
# Quick! What is Power over Ethernet?

## Basics of Power over Ethernet



**1** Power over Ethernet (PoE)

Technology that delivers DC power to devices over copper Ethernet cabling.

**2** Powering what? PoE Devices

Used for devices like IP cameras and wireless access points but extends to a wide range of options.

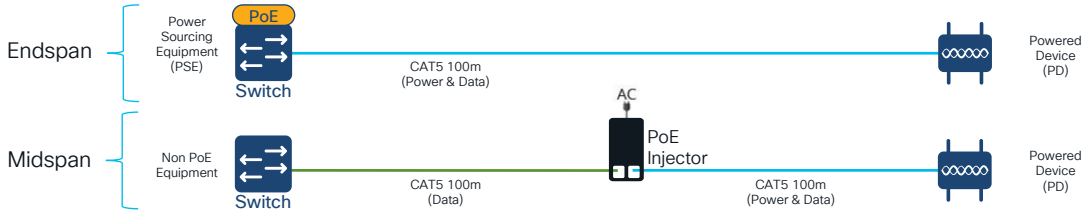
**3** To what point?

Reduce the need for separate power sources and connections, lowering cost, etc.

Fun Fact: power units in Watts

# Components of a PoE system

## Basics of Power over Ethernet




| | |
|---|---|
| Power Sourcing Equipment (PSE) | Device that supplies or injects power into the Ethernet cable for transmission along with data.<br>• **Endspan**: network switch with PoE capabilities. Supplies power directly to the end device<br>• **Midspan or Injector**: standalone device that adds PoE power to a non-PoE network<br>• PSE is governed by various IEEE 802.3 standards* that dictate maximum power, etc. |
| Powered Devices (PDs) | Devices that receives power through the same Ethernet cable that carries its data connection.<br>• Examples: IP Cameras, VoIP Phones, Wireless Access Points, Networked / IOT devices<br>• PDs are governed by various IEEE 802.3 standards* that dictate maximum power, etc. |

*Ensure compatibility between PDs and PSEs

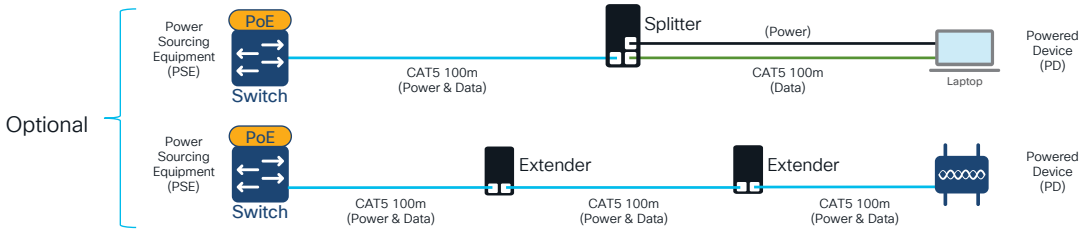




For industrial deployments we see PoE Injectors where the customer purchases a ‘solution’ or ‘machine’.  The Ethernet switch is non-poe and the an Injector is used instead.

# Components of a PoE system

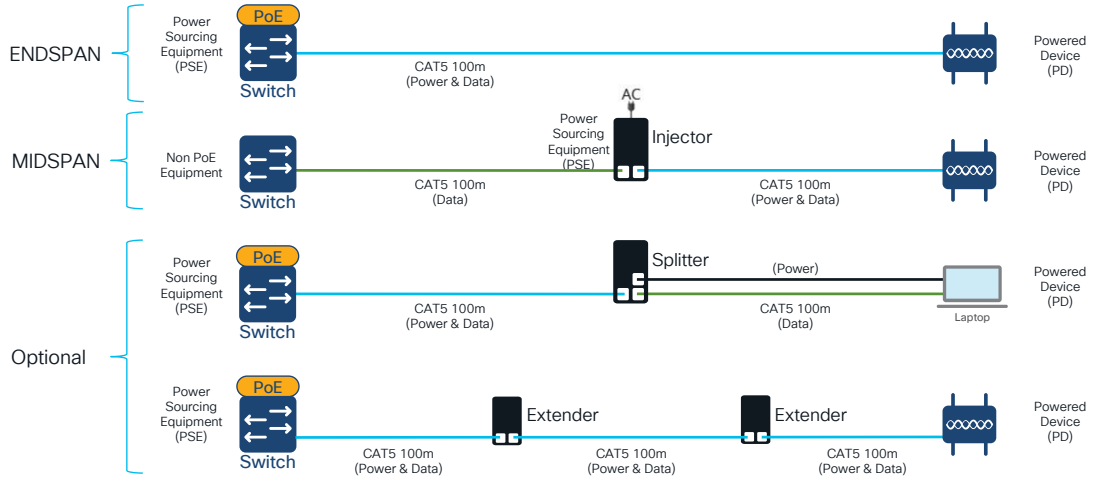
## Basics of Power over Ethernet




| | |
|---|---|
| PoE Splitter | Device separates power and data transmitted together over an Ethernet cable into 2 outputs<br>• Connects to the Ethernet cable, receives power and data from a PoE source<br>• Allows non-PoE devices to benefit from PoE by providing separate connections for data and power. |
| PoE Extender | Devices that increases Ethernet's standard maximum distance beyond 100 meters<br>• Carries power and data over the same cable<br>• May be daisy-chained to extend the range (may increase latency, decrease available power) |

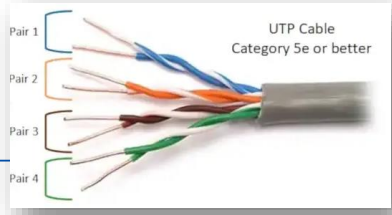
# PoE Components & Arrangement

## Basics of Power over Ethernet



# Standards defining PoE

## Basics of Power over Ethernet




| IEEE PoE Standard | Description |
|---|---|
| IEEE 802.3af (PoE) | • Supplies up to 15.4 watts of DC power<br>• Uses two of the four pairs in the Ethernet cable |
| IEEE 802.3at (PoE+) | • Supplies up to 30 watts of DC power<br>• Uses two of the four pairs in the Ethernet cable<br>• Backwards compatible with IEEE 802.3af |
| IEEE 802.3bt (PoE++ / 4PPOE) | • Supplies up to 60W (type 3) or 90W (type 4)<br>• Uses four pairs in the Ethernet cable (4 Pair Power over Ethernet) |

4PPoE = 4 Pair PoE

Heard of UPOE?

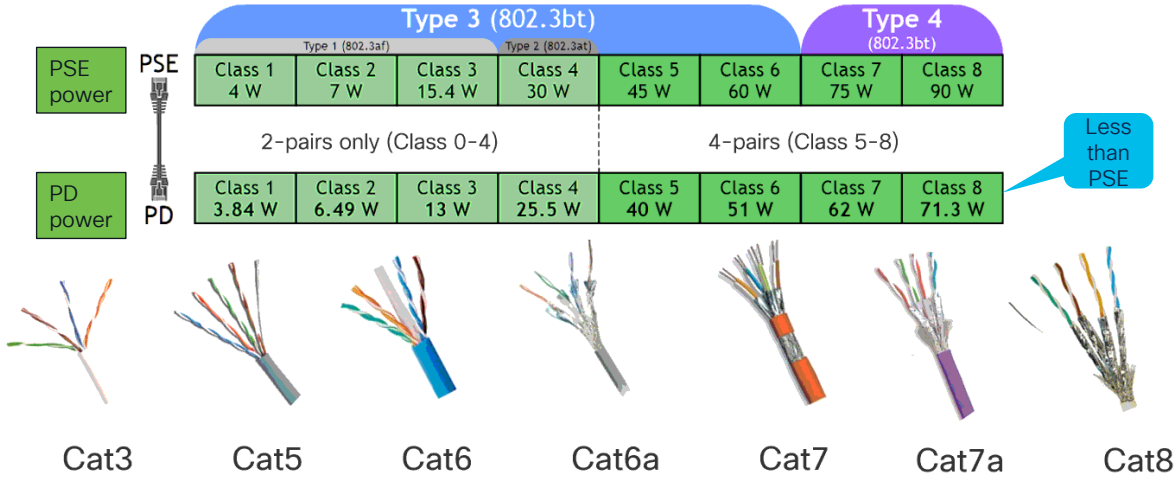




Cisco UPOE: UPOE, short for Universal Power Over Ethernet, is created by Cisco. It extends the IEEE 802.3at standard to use all four cabling pairs to supply up to 60 watts power, further expanding the types of devices that can be supported.

# Lets talk quickly about the P in PoE

## Basics of Power over Ethernet







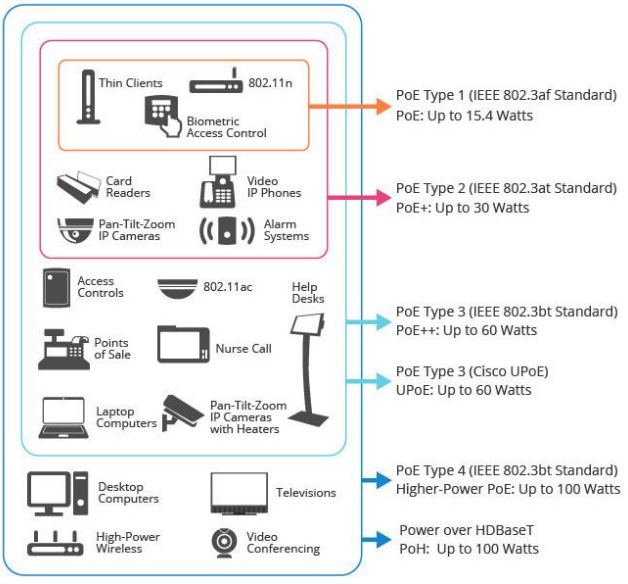

Carrying over from last slide. There are 4 “types” of PSE. And 3 IEEE standards for POE

Each type of POE has a ‘Class’ they support. This class is how the PD is defined.

The IP phone could be class 3 PD requiring up to15.4W, or it could be a Class 4 PD requiring between 15.4 and 30W.

# Powering with PoE

## types of Powered Devices (PD)








Examples of PD and the POE ‘types’ they are commonly found
There are small medium and large for any given PD. Older Wifi Access point required Type 2 (30W), newer wifi Access Points require type 3 60W or even higher depending upon how many radios are active.

# Overview of how PoE Works

## Basics of Power over Ethernet


| Action by PSE |
| --- |
| Detection of the PoE Device |
| Classifies devices as Class 0-8 |
| Starts low voltage then 48VDC |
| Provides stable DC power |
| If: PD is removed<br>If: PD Power consumption issue<br>If: PD power is out of PSE's power budget |





Detection of PD:

- Detection voltage sent → PD
- Detection of Valid resistance = valid PoE PD

Classification of PD power need

- Classifies the device as Class 0-8 type
- Supplies proper power when it detects a resistor

Start to supply power:

- Provides low voltage in less than 15usec which is then raised to 48VDC eventually

Normal Power supply:

- Provides stable power

Disconnection

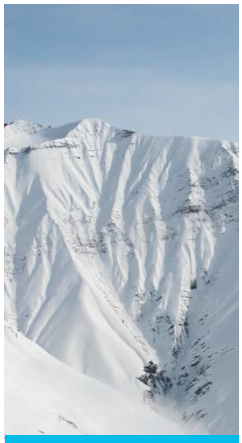
- SW cuts off power and re-enters detection if
    - PD is removed
    - Power consumption of the PD is overloaded or short-circuited

- Total power consumed by the PDs is out of the power budget of the PoE sw.

# Industrial IOT

# Industrial Networking on the extreme!!!

# Network connectivity wherever you need it



- 50C

+75C

Shock / Vibration

Water

Dust

- Industrial certifications (e.g. EN50155)
- Industrial protocols

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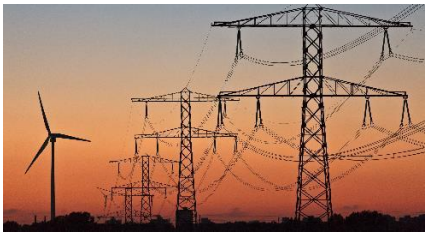
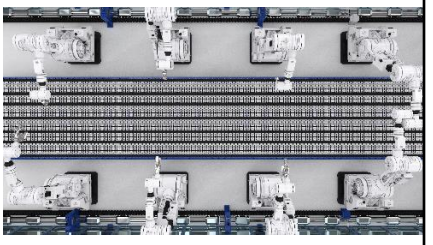
## Industrial organizations are accelerating their digital agility for a sustainable future





Digitization is accelerating, as more things are being connected at the edge. Sustainability is a growing business priority across industries and digitization is helping companies in reaching their sustainability goals.

Energy generation – there is a move from fossil to renewable at scale. Companies are using technology to drive better performance and reduce the cost of renewable generation.

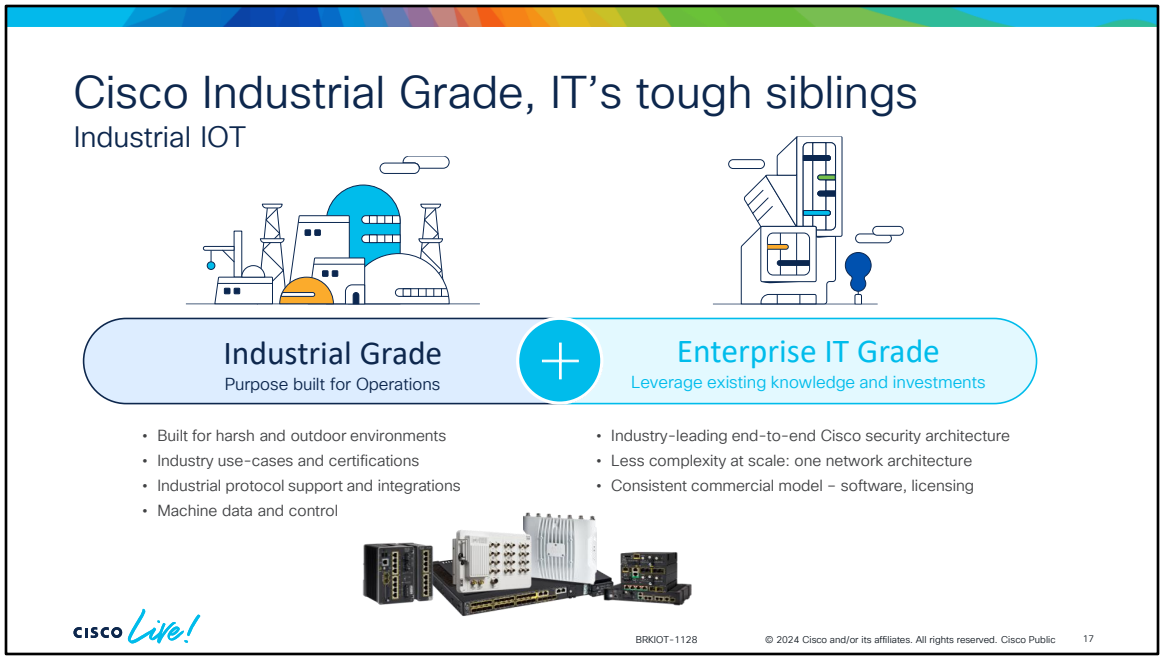
Energy distribution –They are connecting substations to improve resiliency.

Energy consumption – Manufacturing is a big consumer of energy. As we transition to green mobility electric car manufacturing, EV battery manufacturers are all

connecting to increase production efficiency and reduce energy consumption and be more sustainable.

Counties and cities are digitizing roadway infrastructure to reduce congestion and improve safety.

There are  examples in other industries roadways, mass transit etc.




## Script :

Cisco is uniquely positioned to meet the needs of both IT and operations teams. We have a ruggedized portfolio, made for industrial environments and use cases. The IoT portfolio supports industrial protocols and integrations.

The IoT portfolio is built with enterprise grade architecture that IT knows and loves. Our customers get all the benefits of the enterprise network at the industrial edge.

We are committed to the industrial space, We have been in this space for the past decade and are making investments in the portfolio to be here for the next 10. We have a flexible architecture that we can grow with our customers.

Enterprise Grade

- Industry-leading end-to-end Cisco security architecture
- Less complexity at scale: one network architecture (IOS-XE)

- Consistent commercial model - software and licensing

# Industrial Ethernet Switching vs. Enterprise Switching

| Features | Enterprise or Campus Switching | Industrial Ethernet Switching |
|---|---|---|
| Operating Tem Range | -5°C to +45°C (Built for Air conditioning) | -40°C to +75°C (Built for extreme temps) |
| Fan | Fan Cooled / Moving Parts | Fanless / convection-cooled / No Moving Parts |
| Shock & Vibration | Enterprise Level (less stringent than industrial) | Compliant to ruggedized industrial levels |
| Corrosion Resistance | No Corrosion Resistance | Deployment in Humid/corrosive environments |
| Electromagnetic Immunity | Light Industrial Immunity | Wide Electromagnetic Immunity conformance |
| Platform resiliency | FRU Fans/power supply/uplink | FRU power supply / No Fans |

# Comprehensive Industrial IoT Networking Portfolio


Cisco Industrial Networking BU is a mini Cisco Enterprise with switching, wireless, routing and security products. All for different industrial or non-carpeted deployments.

## Part of a broad market-leading industrial switching portfolio

**DIN rail**
Catalyst® IE3100, IE3200, IE3300, and IE3400

**IP67**
Catalyst IE3400 Heavy Duty Series

**Embedded**
ESS3300, Catalyst ESS9300

Rack-mount Gigabit Ethernet copper/fiber
IE 4010, IE 5000


Stackable rack-mount all fiber or all copper
Catalyst IE9300

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- Cisco introduces A full industrial router portfolio to meet all these challenges, a **new and complete portfolio** to connect any type of use case with the **flexibility, security and scalability** needed to **unite and simplify your organization's edge.**
- Only Cisco offers an architecture that links visibility, automation, and policy in the branch, data center, and campus to the edge.

# A complete portfolio

## Secured and optimized for *every* use case






Together, these products make up the broadest router portfolio on the market,. It supports the newest technologies including 5G and Wi-Fi 6 and offers a choice of cloud or prem-based management tools, including Cisco DNA-Center and Cisco IoT Operations Dashboard, to help IT and operations run connected operations at scale.

# Cisco's Outdoor and Industrial APs Today

Cisco Catalyst
IW6300 Series
802.11ac W2

Cisco Catalyst
9124 Series
802.11ax

Cisco Catalyst
IW9167 Series
802.11ax+6 GHz

Cisco Catalyst
IW9165 Series
802.11ax+6 GHz

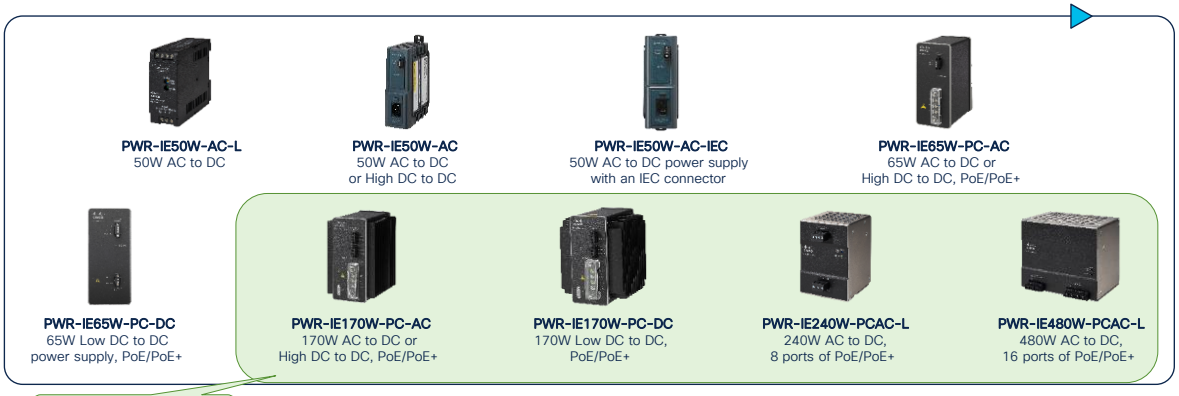




WiFi access points can be PD & PSE

# Cisco industrial DIN-rail power supplies

A full line of compact, rugged, and reliable AC and DC power supply options








Has animation

called Power supplies.  But really power converters.  AC to DC.  Or low DC to 24V DC.

# Cisco IE POE Support

| | DIN-Rail | | | | | | | | Rackmount | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | IE1000 | IE2000/U | IE3100 | IE3200 | IE3300 | IE3400 | IE3400H | IE4000 | IE4010 | IE5000 | IE9300 |
| PoE IEEE 802.3af | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ |
| PoE+ IEEE 802.3at | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ |
| PoE++ 4PPoE IEEE 802.3bt | ✗ | ✗ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| Total Ports | Up to 8 ports | Up to 4 ports | --- | 8 ports | Up to 24 ports | Up to 24 ports | --- | Up to 8 ports | Up to 24 ports | Up to 12 ports | Up to 24 ports |
| Max PoE budget in W | Up to 180W | Up to 120W | --- | Up to 240W | Up to 360W/480W | Up to 480W | --- | Up to 200W | Up to 385W | Up to 360W | Up to 720W |

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Note: portfolio subject to change. Check datasheet





The PoE budget and POE ports vary.
19” rack have more PoE budget and poe capable ports

# IE Switch Power redundancy and PoE

Q:  does the IE din rail have dual Active DC power input?

A: No.  Active and  standby.  All Power from Active power source

Q: does IE9300 POE have dual Active Power supplies

A: Yes.  Both power supplies are active and provide power for PoE





Has animation

this  was not covered earlier.

# PoE & Industrial IOT

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# The Role of PoE in Industrial IOT

## Applying PoE in Industrial IOT

- Simplified Infrastructure: data and power over single Ethernet cable. Simplifies the installation process.
- Cost-Effective: reduces the need for electrical wiring and power outlets near each device.
- Scalable: PoE supports the addition of new devices to the network with ease.





Example: providing power to wifi access points. Imagine running power and Ethernet cables to every wifi AP? Or to every IP Phone? Or every IP Camera

# How PoE Differs in Industrial IOT

## Applying PoE in Industrial IOT

- Environment: Industrial environments may require more robust PoE equipment (PSE) due to harsh conditions.
- Power Requirements: Industrial IoT devices (PDs) may have higher power requirements, possibly requiring higher-standard PoE.
- Safety Standards: Industrial settings have stricter safety standards, which can influence PoE implementation.

# Benefits of Using PoE in Industrial IOT

## Applying PoE in Industrial IOT

- Reduces Downtime: PoE can provide uninterrupted power to critical IoT devices, reducing downtime.
- Enables Remote Power Management: With PoE, you can manage power supply to devices remotely.
- Promotes Safety: By reducing the need for high-voltage electrical wiring, PoE increases safety in industrial environments.
  - Reduce install costs as well.  No Electricians.





The industrial Ethernet switches have dual power input.  This makes PDs less likely to lose power because the switches are less likely to lose power

# Key Considerations PoE in Industrial IOT

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•Different industrial environments will have unique requirements and challenges when implementing PoE. It's crucial to understand these to successfully plan and deploy a PoE network.

•This section will cover the top considerations when planning for PoE in Industrial IoT, focusing on the role of Industrial Ethernet PoE switches.

# What to keep in mind when thinking about PoE

## Key Considerations – PoE in Industrial IOT

- Power Budgeting
- Environmental Conditions
- Network Architecture
- Standards and Compliance
- Selecting the right Industrial Ethernet PoE switch





1. Power budget

•Always calculate the total power requirement for all devices, including the Industrial Ethernet PoE switch.

•Ensure the switch can deliver the required power to all devices under all operating conditions

2. Environmental

•Industrial settings can be harsh, with extreme temperatures, dust, vibration, or moisture.

•Ensure the Industrial Ethernet PoE switch and other equipment can withstand these conditions.

3. Net Architecture

•Plan your network architecture to support data and power needs of current and future devices.

•Choose an Industrial Ethernet PoE switch that allows for growth, with additional ports for future expansion.

4. Standards

•Verify that all devices and the PoE switch are compatible and meet the required PoE standards (e.g., IEEE 802.3af/at/bt).

•Ensure compliance with safety and electromagnetic compatibility standards in industrial settings.

# The Right Industrial Ethernet PoE Switch

## Key Considerations – PoE in Industrial IOT

Power Capability

Environmental Resilience

PoE Standard Compatibility

Port Density

Network Features





## Power Capability

- The PSE should provide adequate power for all connected devices, as per your power reqt.

## Environmental Resilience

- The switch should be designed for industrial conditions, such as extremes of temperature, vibration, dust, and moisture.

## PoE Standard Compatibility

- Ensure the switch supports the PoE standards required by your devices (e.g., IEEE 802.3af/at/bt).

## Port Density

- Consider the number of ports you need now, and any potential future expansion.

## Network Features

•Look for necessary network features such as VLAN support, QoS, redundancy, and security

# Cabling Considerations for Industrial PoE

- **Cable Type and Length:** PoE can be delivered over any Ethernet cabling. However, for best performance and power delivery, use Cat5e or higher-grade cable. Cable length should not exceed the Ethernet limit of 100 meters (328 feet) to avoid signal degradation.
- **Power Dissipation:** Power dissipation in the cable can result in a reduction of the power received by the Powered Device (PD). This is more pronounced over longer distances and is a key factor in calculating power budgets.
- **Cable Quality:** In industrial settings, cable quality is crucial due to harsh environmental conditions. Consider industrial-grade, shielded cables to protect against electromagnetic interference (EMI) and physical damage.
- **Cable Routing:** Be mindful of cable routing. Avoid running Ethernet cables near high-voltage lines or sources of high EMI, as they can degrade data transmission.
- **Temperature Considerations:** High temperatures can impact power capacity. If your setting has high ambient temperatures, consider this in your power budgeting calculations.

# PoE Power Budgeting

# What is PoE Power Budgeting?

Basics of Power over Ethernet

Ensure your PoE switch(PSE) has budget to meet power needs of all devices(PDs).

Prevents system overload and ensures reliable operation.

1. Identify the power draw of each device (e.g., sensors, cameras...) including the PoE switch.
2. Add up the power requirements of all devices, including the switch, to find the total power requirement.
3. Determine power output of the Industrial Ethernet PoE switch
4. Do not exceed capacity of power Source (aka Power supply)

# Utility Substation: Monitoring and Control

## PoE Power Budgeting

- Need: Monitoring and controlling utility substation equipment for optimal operation and safety.
- Solution: An Industrial Ethernet PoE switch for power and connectivity to all devices, enabling remote monitoring and control, and reducing the need for separate power supply units.
- Power Budget Planning Example:
  - PDs
    - Surveillance Camera x 2, IEEE 802.3at, 20W each
    - Environment Sensor x 4, IEEE 802.3af, 5W each
    - Control Unit x 1, IEEE 802.3at, 25W each
  - PSE
    - Industrial Ethernet PoE Switch, 25W

110W total power draw

Recommend 170W PSU

# Industrial Workspace: Powering Laptops & Devices

## PoE Power Budgeting

- Need: Powering multiple high-power devices like laptops and specialized equipment in an industrial environment.
- Using Industrial Ethernet PoE switches supporting the IEEE 802.3bt (PoE++) standard, which can deliver up to 90W per port.
- Power Budget Planning Example:
  - PDs:
    - Laptop x 2, IEEE 802.3bt, 60W each
    - Industrial Device x 6, IEEE 802.3bt, 30W each
  - PSE
    - Industrial Ethernet PoE Switch, 30W

330W total power draw

Recommend 480W PSU

# Troubleshooting POE usage

PoE Budget

Only POE capable ports

```
IE3300-8P2S_Right3#  show power inline
Available:125.0(w)  Used:0.0(w)  Remaining:125.0(w)

Interface Admin  Oper       Power   Device              Class Max
                            (Watts)
--------- ------ ---------- ------- ------------------- ----- ----
Gi1/3     auto   off        0.0     n/a                 n/a   30.0
Gi1/4     auto   off        0.0     n/a                 n/a   30.0
Gi1/5     auto   off        0.0     n/a                 n/a   30.0
Gi1/6     auto   off        0.0     n/a                 n/a   30.0
Gi1/7     auto   off        0.0     n/a                 n/a   30.0
Gi1/8     auto   off        0.0     n/a                 n/a   30.0
Gi1/9     auto   off        0.0     n/a                 n/a   30.0
Gi1/10    auto   off        0.0     n/a                 n/a   30.0
--------- ------ ---------- ---------- ---------- ------ -----
Totals:          0    on    0.0
```

```
IE3300-8P2s_Right3# config term
IE3300-8P2S_Right3(config)#power inline wattage max ?
  <4-480>  watts
```

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Shows CLI output for PoE on an IE switch.
note: default budget is 125W.
IE switch can NOT detect capabilities of Power Source

# IE Switch Power redundancy and PoE

Q: When IE-3300-8U2X has 240W PSU attached, what is default PoE budget?

A: Default is 125W PoE power budget. IE3x00 cannot detect Power capacity of attached Power source





Has animation

this was not covered earlier.

# But Wait, there's more

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## Additional PoE Features

- PoE Power Management
- Fast PoE
- Perpetual PoE
- Load Shedding





Cisco's Industrial Ethernet switches offer advanced PoE capabilities that enhance efficiency and reliability in industrial environments.

# POE Power Management and Fast POE

## Other PoE features

- **PoE Power Management:** Provide dynamic power allocation to efficiently manage power budget.
- **Fast PoE:** Ensures rapid power delivery to connected devices (PDs), enabling faster startup for PD and device replacement.
  - Power to PD even before Switch has completed boot process
  - Supported on IE9300

# Perpetual POE and Load Shedding

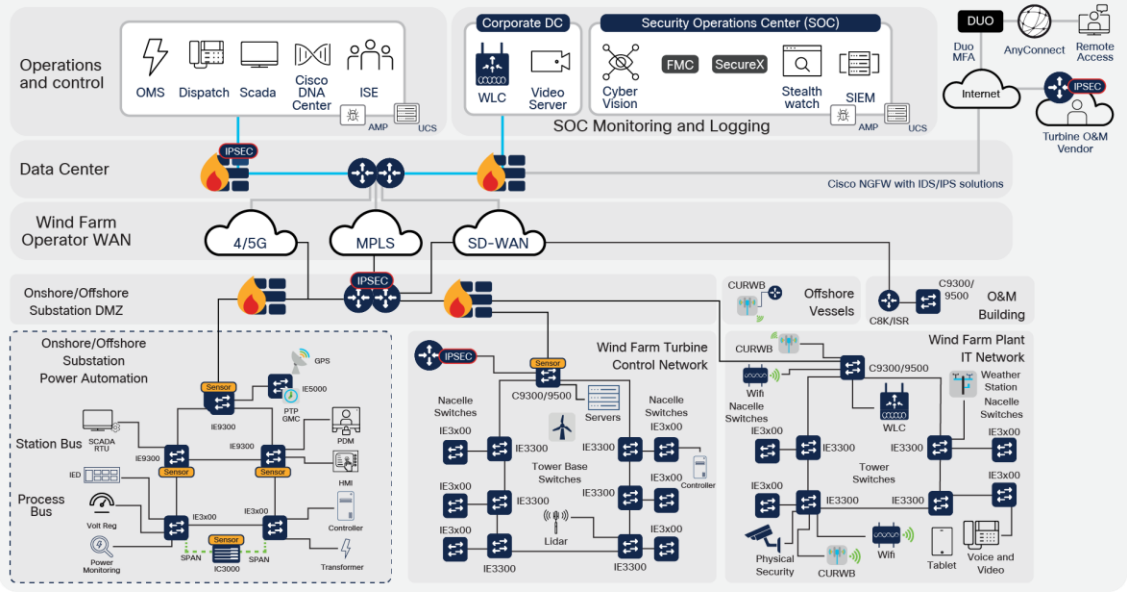
## Other PoE features

- **Perpetual PoE:** Maintain power to connected devices (PDs) even during a switch reboot, minimizing downtime.
  - Supported on IE9300
- **Load Shedding:** In case of power shortage (1 power supply/source lost), switches prioritize power delivery based on the importance of connected devices, enhancing system resilience.

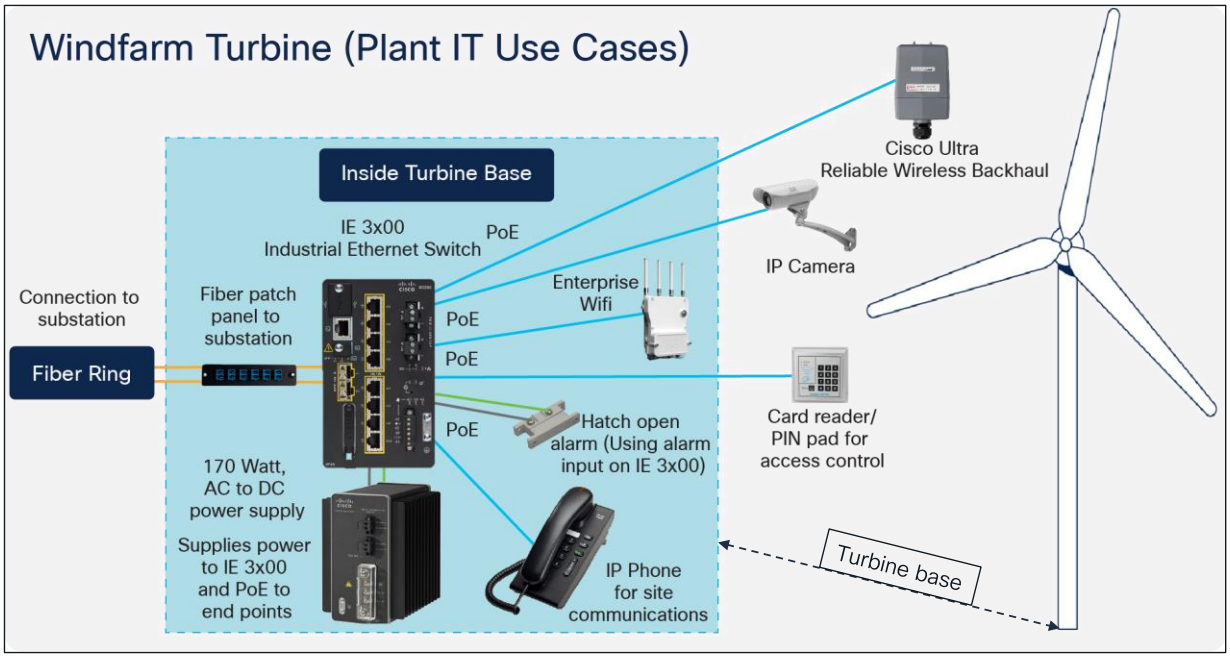
# Use Case

# Wind Farm Network Architecture

A holistic secure connectivity solution



# Windfarm Turbine (Plant IT Use Cases)



# Key Take Aways

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# Keep in mind

## Key Take Aways

- **Understanding PoE:** PoE combines data transmission and power source over a single Ethernet cable.
- **PoE in Industrial IoT:** PoE simplifies the network, cuts costs, and scales efficiently in Industrial IoT applications.
- **Power Budgeting and Case Studies:** Successful PoE implementation requires power budgeting.
- **Planning for PoE in Industrial IoT:** PoE planning involves power budgeting, environmental considerations, scalability, standards compliance, and the right PoE PSE selection.
- **Cisco Industrial Ethernet PoE Switches:** Cisco's Industrial switches provide POE/POE+/POE++ support and advanced PoE features (power management, Fast PoE, Perpetual PoE, and load shedding).

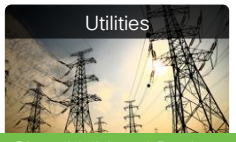
# Only Cisco provides the blueprint for success

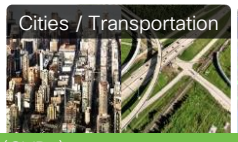
**Simplicity**
Best Practice Design and Deployment Guide

**Security**
Incorporates security best practices

**Scalability**
Scale from small to large deployments on global scale







Industry Cisco Validated Designs (CVDs)

- Industrial Automation
- Plant Wide Connectivity (CPWE)

- Connected Pipeline
- Digital Oilfield (CRD)
- O&G / Process

- Substation Automation
- Smart Metering (AMI)
- Distribution Automation
- Grid Security

- Connected Communities Infrastructure
- Connected Rail
- Connected Mass Transit
- Connected Roadways

- Extended Enterprise
- Remote and Mobile Assets (RAMA)

Proven Integrations

Rockwell Automation, Schneider Electric, EMERSON, Landis+Gyr, Itron, Cohda Wireless, Actility, ECONOLITE, SIEMENS, Honeywell, MITSUBISHI ELECTRIC, EATON, SEL, iteris, BECKWITH ELECTRIC CO. INC., CIMCON Lighting, KLAS TELECOM, Omniscient

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https://www.cisco.com/c/en/us/solutions/enterprise/design-zone-industry-solutions/index.html

## IOT Learning Map

# Internet of Things

### Transform your IoT Infrastructure

In this new IoT world, the network is the nervous system that allows everything to work together. And while it's creating limitless possibilities, it also introduced more complexity. Today everything is a connected device, from a robot to a power transformer, from a vehicle to crane.

**START**

Monday, February 5 | 8:30 a.m.
**TECIOT-1000**
IoT Fundamentals Bootcamp

Monday, February 5 | 8:45 a.m.
**TECIOT-2584**
Designing IoT Wireless Networks

Monday, February 5 | 2:00 p.m.
**TECIOT-2201**
Dive into the depths of Industrial Resiliency Protocols

Tuesday, February 6 | 11:30 a.m.
**BRKIOT-2601**
8 Tips for Deploying Indoor Wireless Mobility with Cisco Industrial Wireless

Tuesday, February 6 | 3:30 p.m.
**IBOIOT-1083**
Sensors, sensors everywhere! Using LoRaWAN and Cisco Industrial Asset Vision

Tuesday, February 6 | 4:45 p.m.
**BRKIOT-2104**
-40C Industrial Networking: Where Enterprise Products Fear to Go

Wednesday, February 7 | 3:45 p.m.
**BRKIOT-1126**
Connecting moving assets with Cisco IoT Solutions

Thursday, February 8 | 11:45 a.m.
**IBOIOT-2471**
5 ways to improve outcomes with digital transformation for roadways

Thursday, February 8 | 12:00 p.m.
**BRKIOT-2265**
Let's get Physical with IoT Wireless

Thursday, February 8 | 5:00 p.m.
**BRKIOT-2808**
Creative and unusual use case ideas for industrial networking devices.

Thursday, February 8 | 5:00 p.m.
**IBOIOT-2501**
Cisco Catalyst WAN Manager for OT/Industrial Networks: Fabric or non-fabric, which is right for me?

**FINISH**

Friday, February 9 | 9:15 a.m.
**BRKIOT-2299**
Assessing Software-Defined Access (SDA) for Industrial Automation: Best Practices for a Successful Deployment

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If you are unable to attend a live session, you can watch it in the On-Demand Library after the event.





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The bridge to possible
Thank you
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Let's go

# Windfarm Turbine (Scada/Telemetry Use Case)