Network Considerations and Best Practices

Luis Suau

Lessons learned with deployments over the last 9 years

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About Me

Luis Suau

Background Summary: 40 Years of IT Expertise, 26 Year Cisco veteran who played a key role in the research, development, and commercialization of the Cisco Digital Building Solution (2011-2020). Resides in Fort Lauderdale, FL

01 Political Influences in the Project

02 Project Scope and the Network

03 Network Topology and Design

04 Planning Details

05 Observations and Lessons Learned

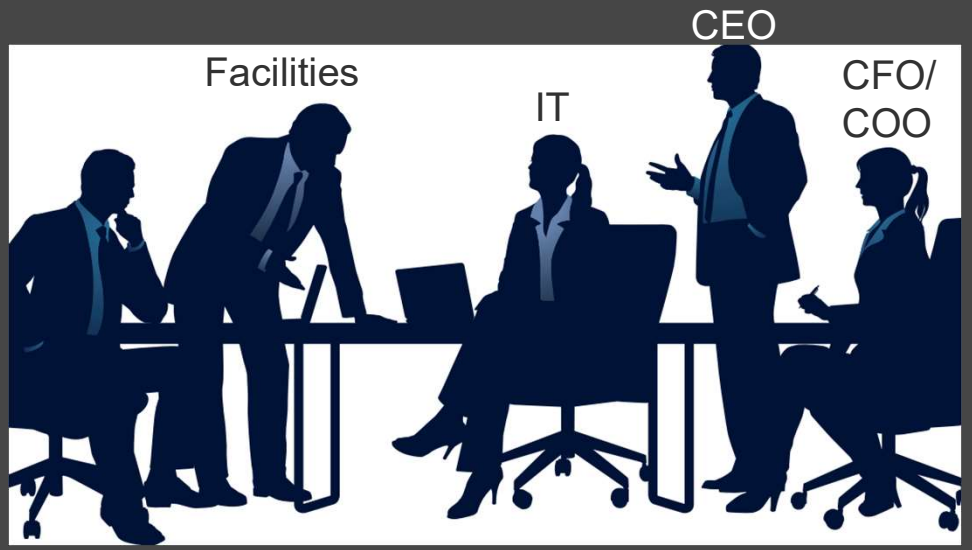
Politics and Influences

Who is your customer really?

Politics make strange bedfellows

Questions to consider

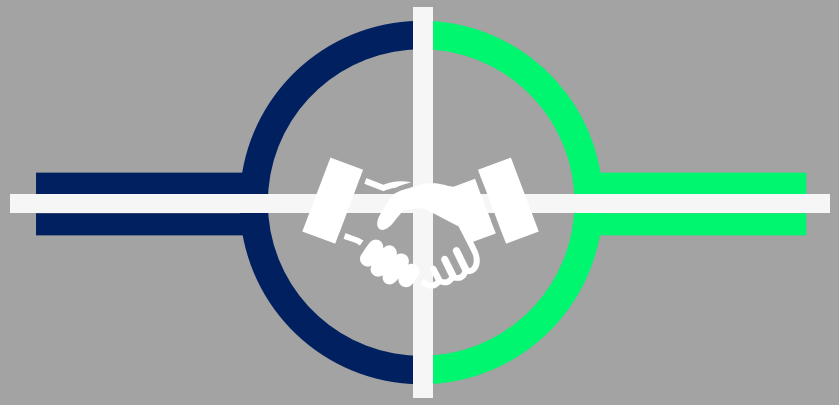
- Who is the project champion?
- Whose Budget is affected?
- Who may be losing control?
- Who is risk averse?
- Who is leading innovation?



Working Together

IT Functions

- IP Addressing/Subnet
- Network Connectivity
- Security Standards

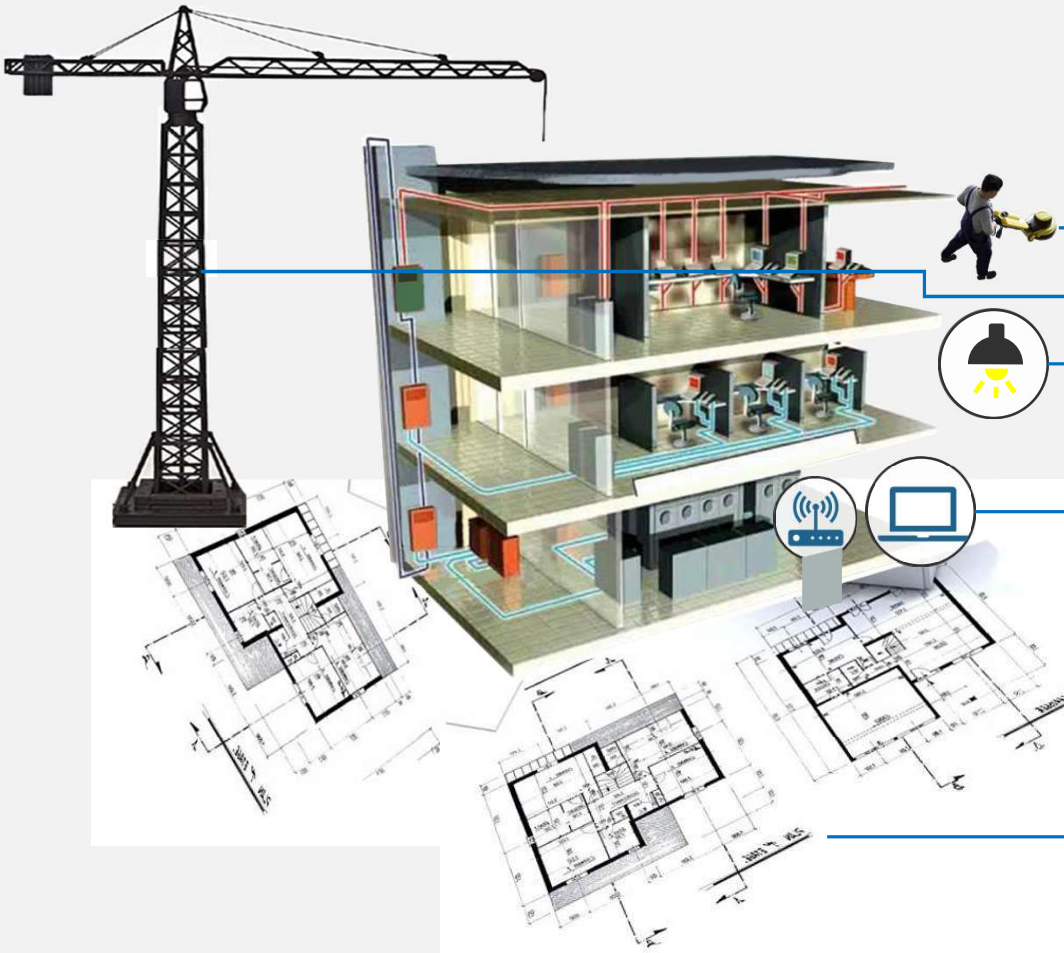


OT Functions

- Ceiling Access (OSHA)
- Contractor Management
- Code/Building Compliance

- The Digital Building is a “Networked Solution”
- Greatest success occurs when IT & OT (Facilities) work closely together
- Lack of cooperation means one side must make decisions for the other leading to conflict and political problems

Critical Roles of the Building Process



Facilities Management

General Contractor & Project Manager

MEP's

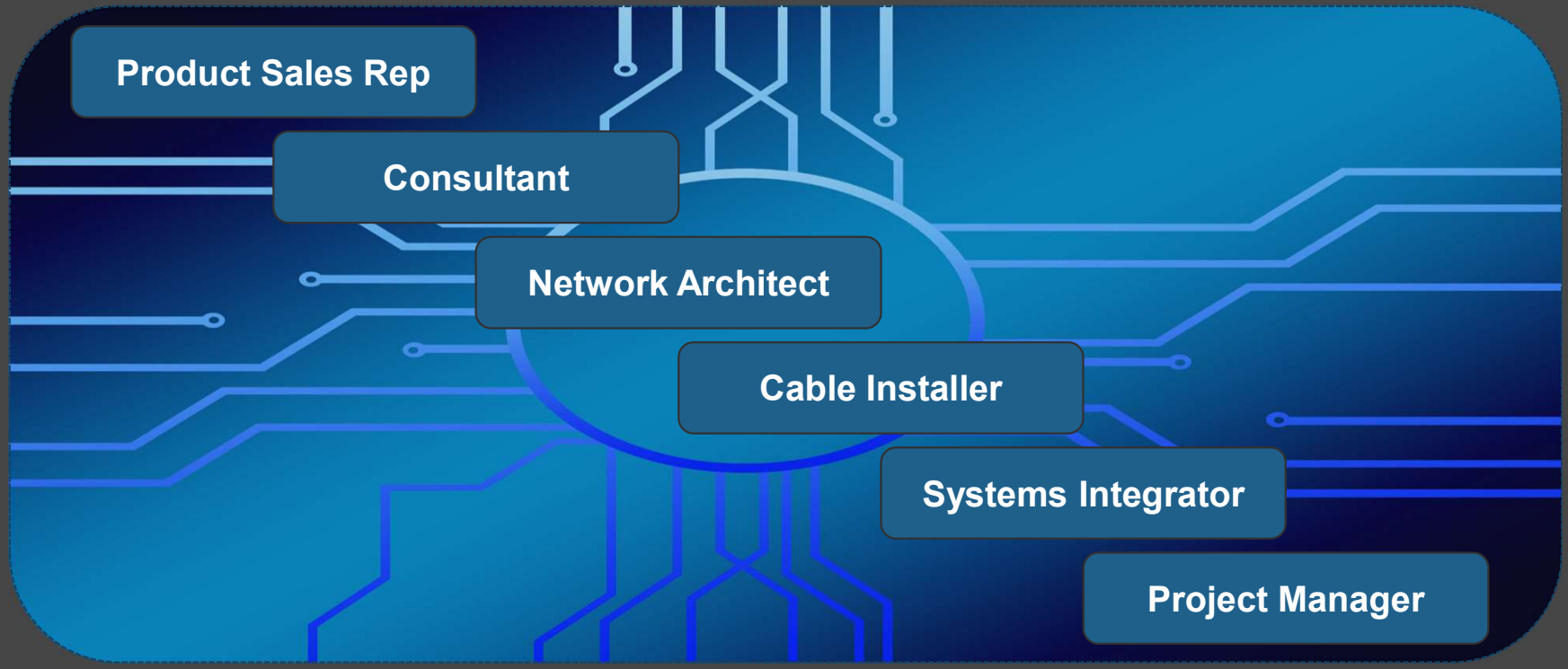
Low Voltage & Structured Cable Contractor

Electricians

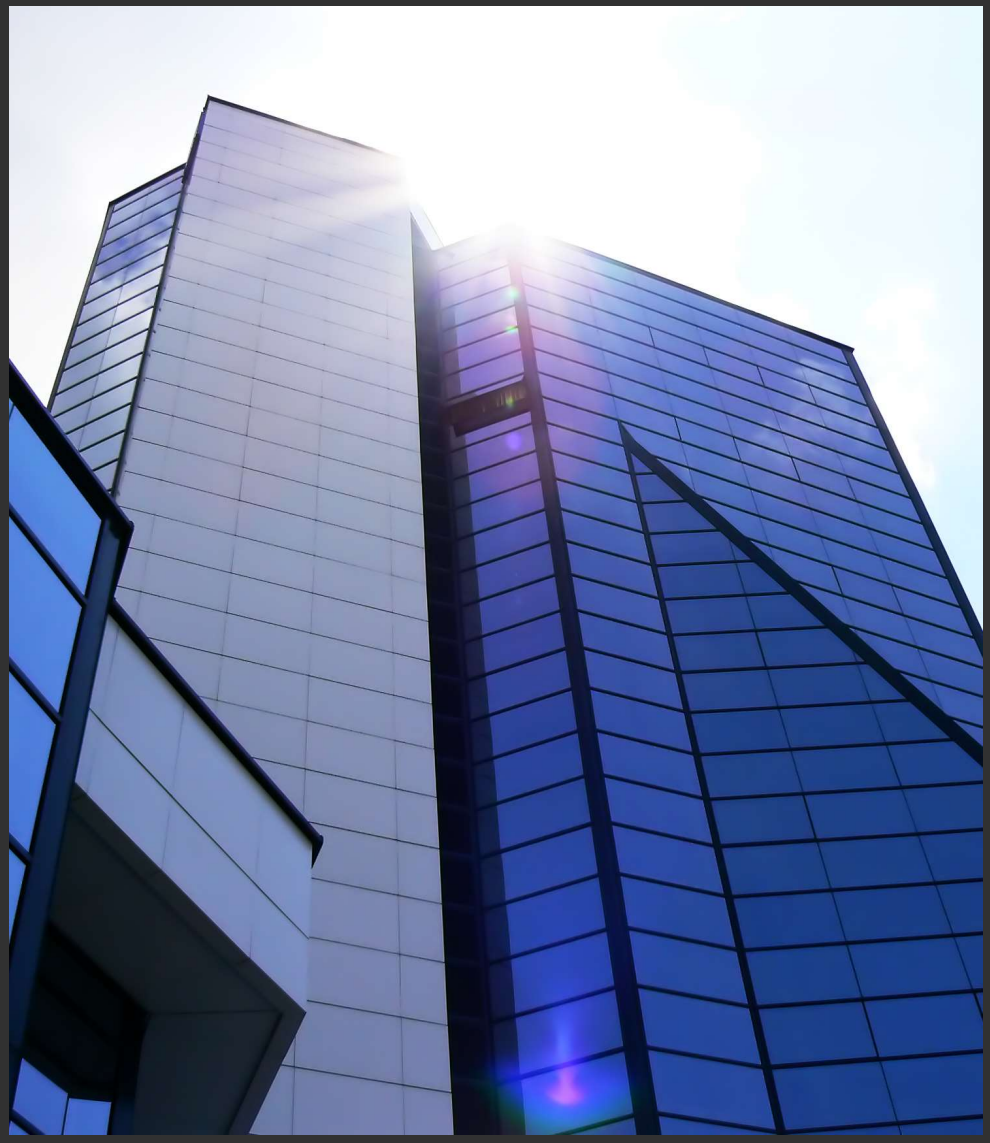
IT Consultant & Systems Integrator

Architect

What is your role?



Project Scope and the Network



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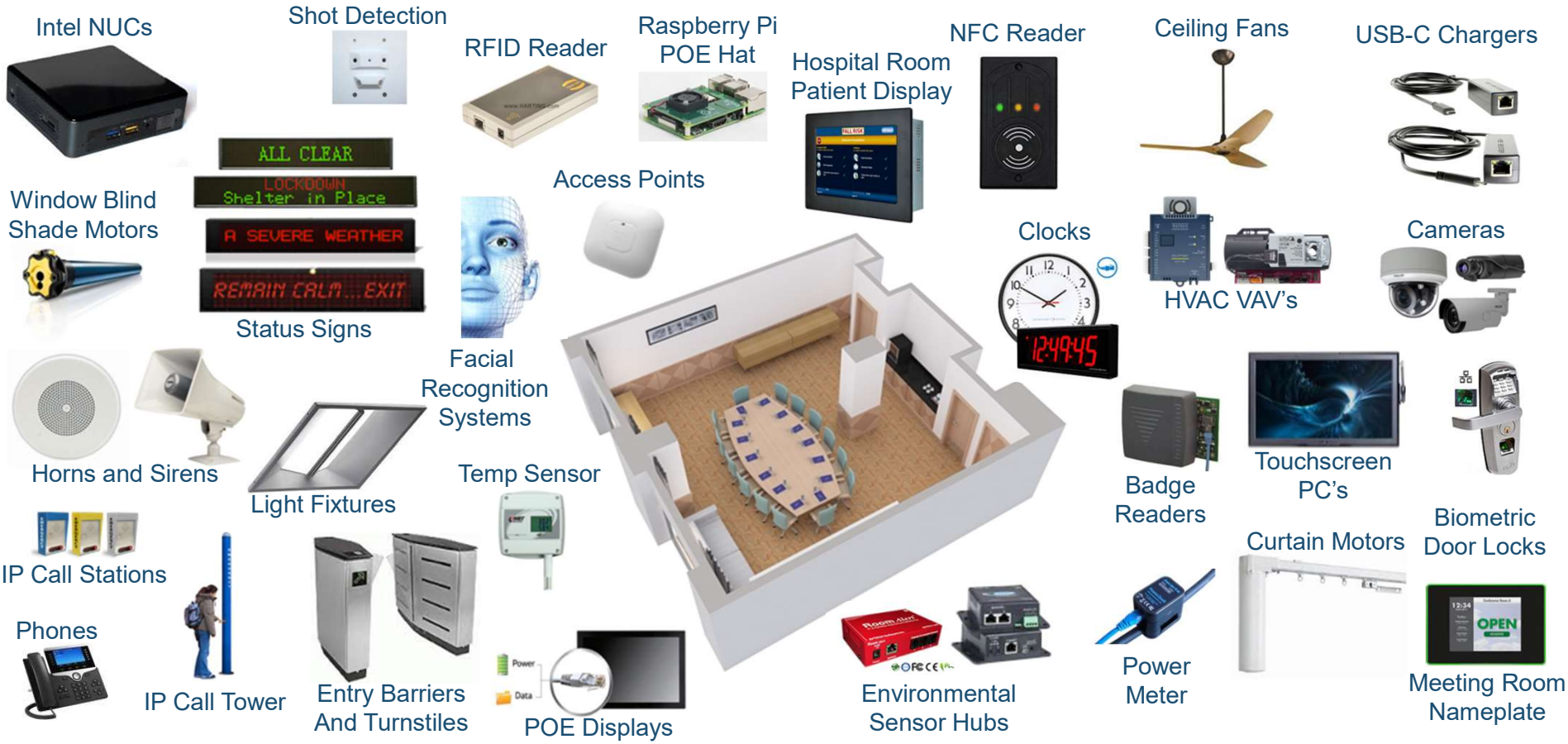
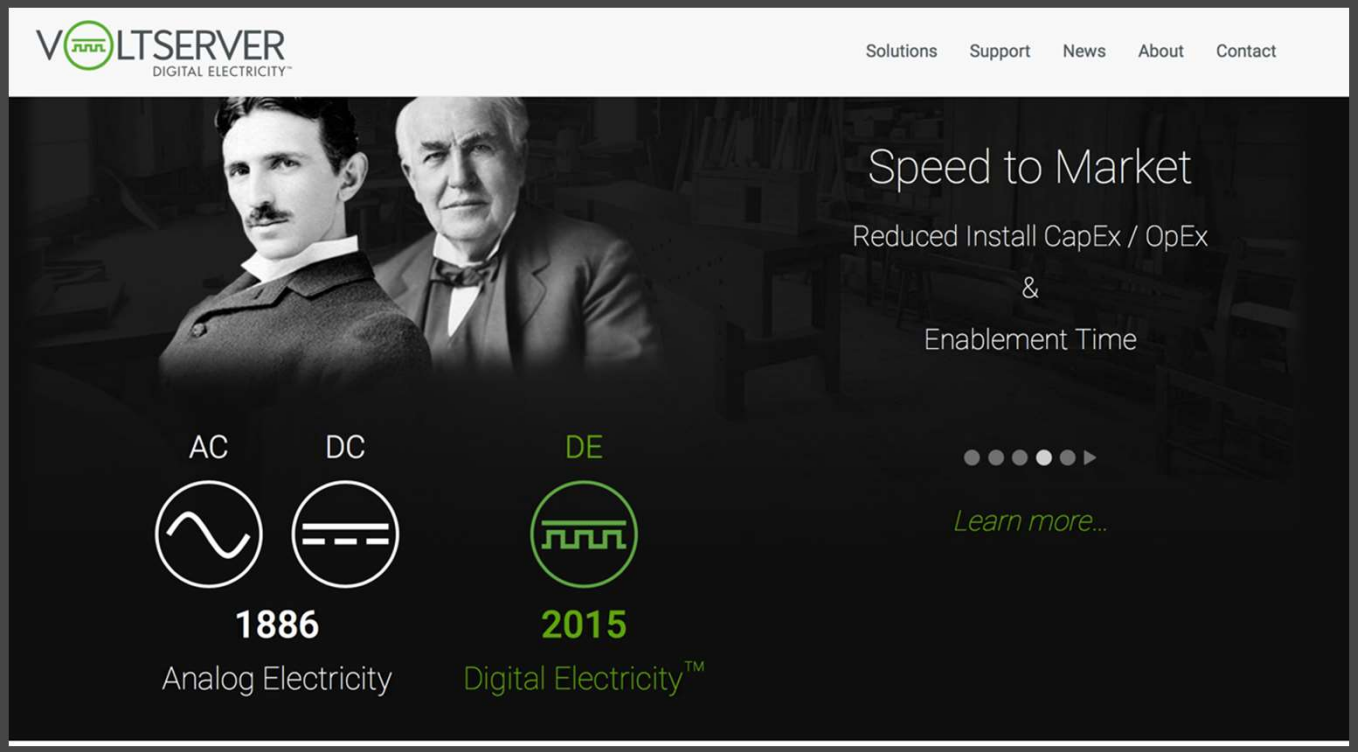
Complexity tends to be proportional to project size

Existing IP/POE Digital Building Endpoints:

A Growing List of POE Products and Manufacturers

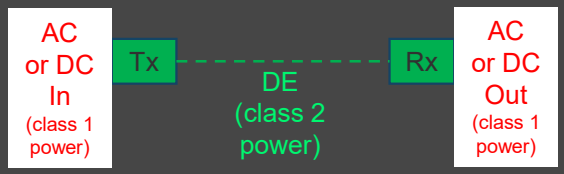


Digital Electricity or similar emerging DC Power Distribution Technologies



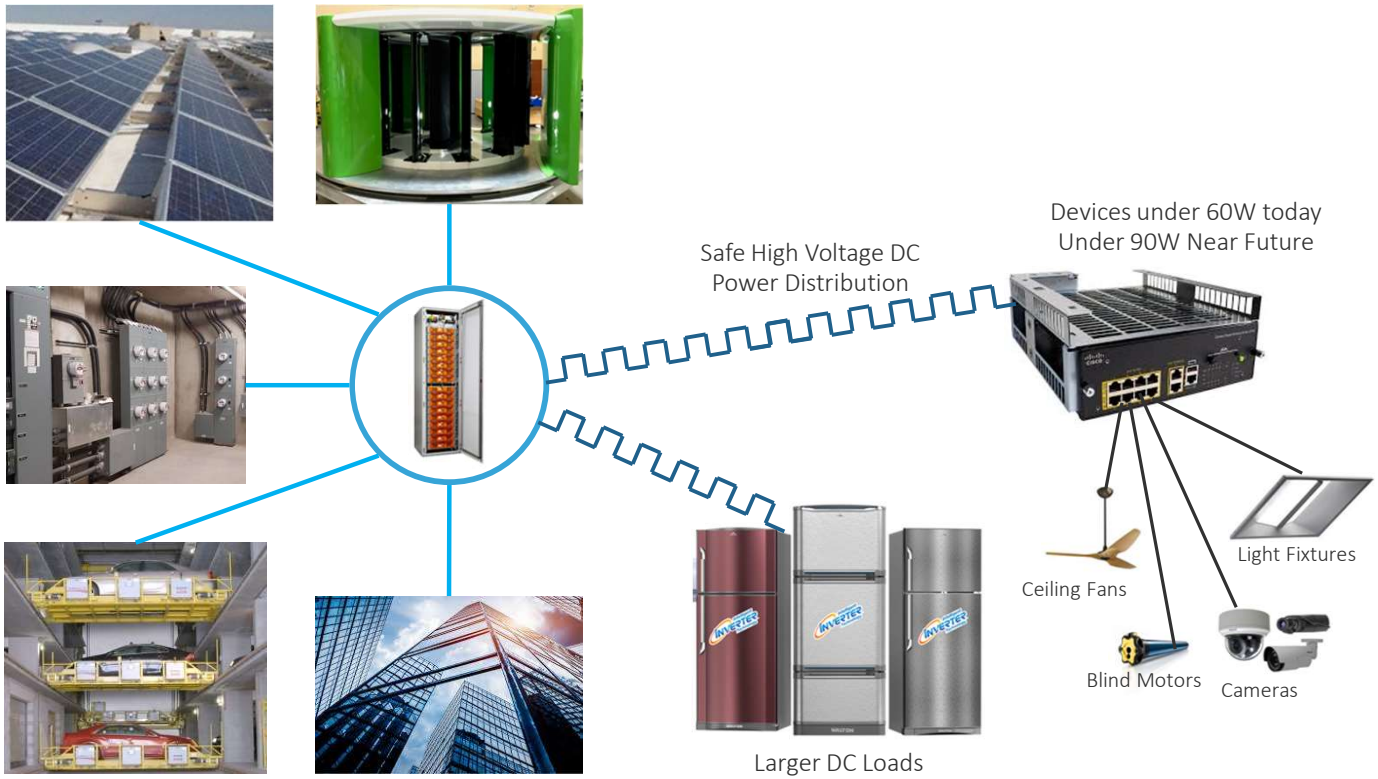
VoltServer Digital Electricity:

- Pulsed (packetized) DC Power
  - Safe to Touch
  - NRTL Listed, IEC 62368-1 limited power source
    - Listed as a Limited Power Source and qualifies to be installed under Article 725 of NEC
  - Each Pulse packet checks for:
    - High Current
    - Ground Fault
    - Arc Fault
    - High Resistance (loose connection)
    - Touch (Resistive Load)
  - Range up to 2KM
  - 500W at 1K ft, 1 pair 18 AWG cable



A Path to a Building DC Microgrid

- ***Building Materials Science continues to improve:***
  - DC Powered
  - Connected
  - Sensor Rich
- ***Commercial Inverter Based Appliances Continue to Emerge***
- ***Many Variable Speed/Frequency Drives can be DC Powered today*** (check with Manufacturers)
- ***The DC Microgrid Emerges in the Building***



Network Topology and Design

Is the Network Centralized or Distributed?

- More Cabling Required
- Controlled Access in IDF
- Greater IDF Cooling Requirements
- Power needed in IDF

- Less Cabling, patch cables to endpoints
- Allows for ring and daisy chain topologies
- Ceiling is less secure, service requires ladder
- Less Cooling in IDF, lower cost switches
- Distributed Power required in ceiling

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POE Lighting & UL-924

IOTA

Igor

Platformatics

The Emergency Lighting part of the network is generally designed by POE lighting partners such that **the network switch is passive and plays no control role; therefore the switch has no requirement to be UL-924 listed**. POE Lighting partners are aware of these design considerations. Local AHJ Acceptance will dictate option utilized. Options:

1) Uncontrolled Emergency Lighting (lights always on, no control)
Requires switch power from UL-924 Listed UPS

2) Controlled Emergency Lighting (UL-924 LED Driver)
https://www.igor-tech.com/news-and-insights/news/igor-awarded-industrys-first-central-ul-924-certification-for-a-poe-solution
Note: Control Provided by Igor Software Platform

3) Unit based battery pack on UL-924 light
Dependent on POE Lighting partner. The network switch is passive just like an electrical junction box.
https://www.iotaengineering.com/poecp12v1a.html
https://www.platformatics.com/wp-content/uploads/2019/03/ELN-CS-3-26-19v1.3-edd.pdf

4) Hybrid POE-Line Voltage approach

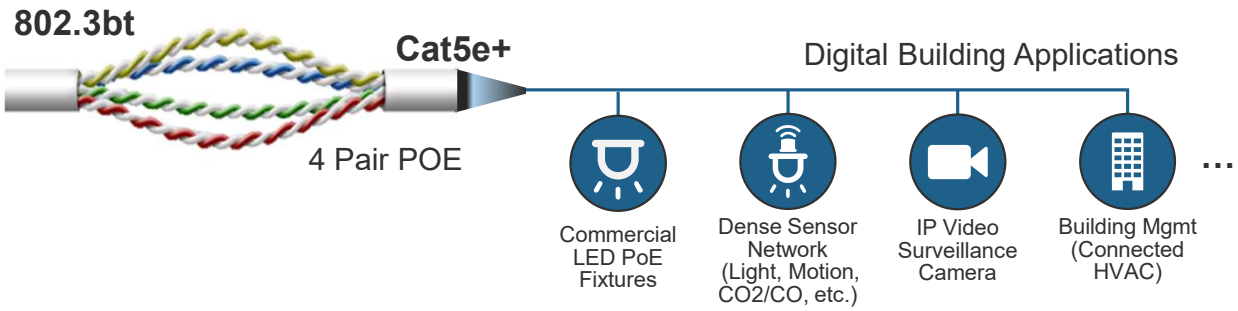
Enhanced PoE Capabilities on the Digital Building Switches Enable Scale

Cisco Catalyst 9400

Cisco Catalyst 9200/9300

Transition Networks
SM24TBT2DPA

Cisco Catalyst CDB



Cisco: Perpetual POE or Transition: Soft Reboot

- Provides non-stop 802.3bt power
- Switch can continue to provide power during configuration and reboot

Cisco Fast POE/UPOE

- Restores power to powered device within 5 secs of power resumption

2+ Event Classification

- Simplified power negotiation without LLDP
- Physical layer negotiation < 1s based on class/type

Will the Network be Isolated or Integrated?

- Safer
- Harder to Manage and Upgrade
- Problematic to Integrate with IT systems

- Requires cooperation with IT
- Subject to IT policies and guidelines
- Allows for Integration with IT Systems (AV/telephony, calendaring, access control, etc)

Network Architecture: Reference Topics

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Network Segmentation and VLANs

- Use of VLANs, Firewalls, Policy/ACL's, and other networking features is fundamental to protect the network
- Understand partner system implementation and endpoint behavior.
  - Is control broadcast, unicast, multicast?
  - Is control autonomous, zoned, or cloud based?
  - Are control apps server, appliance, VM or cloud based
  - Understand system and component failure behavior. What are the redundancy plans?
  - What IP Ports are used? What data flows must be allowed?

DHCP vs Static Addressing

Advanced Topics

- Network Access Control (device profiling)
- IETF Manufacturer's Usage Description
- Software Defined Architecture

Rat Hole Alert!

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The larger the project, the greater the complexity. Seek Network Architects and Consultants for help.

Systems Integration and other complexities

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- Is integration led by the lighting partner or a 3rd party?
- Are API's well documented?
- Do API's meet security criteria?
- Is integration system to system or coordinated through middleware?
- What protocols may be involved?
  - https
  - COAP
  - MQTT
  - BACnet
  - ModBus
  - JSON

Rat Hole Alert!

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Planning and Details

Network Power Resilience

Cisco Catalyst 9400

- Resilient Architecture
- Dynamic Power Management
- High Cost

- Cisco StackPower provides a shared power architecture
- Dynamic Power Management
- Lower Cost

Ensure ordered power cords match outlets receptacle types

VoltServer: Digital Electricity

- VoltServer has been deployed several Digital Building projects
- Work with VoltServer on specific applications for design and testing for specific projects

Benefits

- Facilitates network installation by placing greater control on low voltage (minimized electrical labor).
- Improves Safety, less risk of shock
- Extends energy management upstream from the POE System
- Enables a digital fault management platform
- May reduce Total Cost of Installation

Complications (using DC Output)

- Switch Manufacturers:
  - Switch must be NRTL listed for high voltage DC input

Transmitter shelf

Receivers

AC Output

DC Output

Ampacity and Heat Load Calculations

- MEP will need switch product datasheets and help to calculate load ampacity in order to determine electrical circuits to power the network and Heat Load (BTU's) for IDF/MDF cooling
- Higher Voltage is more efficient to drive the power supplies
- Tables in datasheet may not reflect all possible options (ie, 208VAC)
- May need to have switch manufacturer contacts to obtain the right level of details

Table 20. Power specifications – platinum rated power supplies

Description	Specification		
	*PWR-C1-1100WAC-P	*PWR-C1-715WAC-P	PWR-C1-350WAC-P
Power supply rated maximum	1100W	715W	350W
Total output BTU (note: 1000 BTU/hr = 293W)	3754 BTU/hr, 1100W	2440 BTU/hr, 715W	1194 BTU/hr, 350W
Input-voltage range and frequency	115V to 240 VAC, 50 to 60 Hz	100 to 240 VAC, 50 to 60 Hz	100 to 240 VAC, 50 to 60 Hz
Input current	12-6A	10-5A	4-2A

Table 22. Power consumption of standalone 9300 Series Switches with platinum rated power supply (tested on Cisco IOS XE 16.8.1)

				Measured P(W)							
				Half port traffic					Full port traffic		
SKU	FEP	Uplink	Input	0.01%/EEE	10%	30%	50%	100%	0.01%/EEE	10%	30%
C9300-24P	715W-P	C9300-NM-8X	115Vac	89.2	94.3	99	100.1	100.7	92	98.9	103.5
			230Vac	86.7	91.8	96.4	97.5	98	89.4	97.1	101.4
C9300-24T	350W-P	C9300-NM-8X	115Vac	83.1	88.2	92.9	94	94.5	85.8	92.9	97.2
			230Vac	81.9	86.8	91.3	92.4	92.9	84.4	91.6	95.9
C9300-24U	1100W-P	C9300-NM-8X	115Vac	90.5	95.9	100.5	101.6	102.1	93.3	100.6	104.9
			230Vac	88.1	93.1	97.7	98.8	99.4	92.8	98	102.4

Observations and Lessons Learned

The importance of Lab Testing and Staging

- Prototype the deployment
  - Reduces Risks, work out control details
- Validate network and endpoint connectivity and functionality

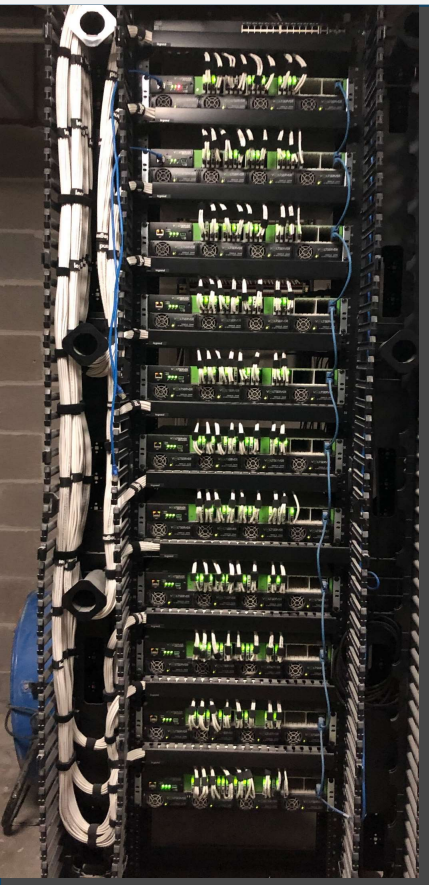
Plan!

Plan!

Plan!

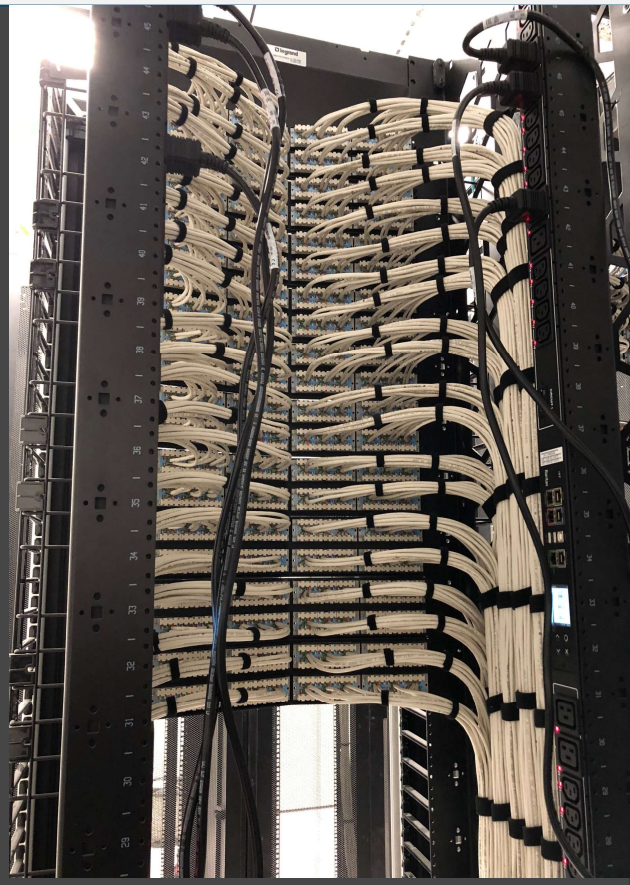
- Preplan as much as possible:
  - Addressing, Labelling
- Preconfigure as much as possible
  - Reduces the number of times that devices must be touched along the installation process
- Maintain documentation along the way

Cabling



18AWG Digital Electricity cabling

- **Wire Gauge is important**
- **Digital Electricity**
  - Vet cabling Digital Electricity cabling requirements with VoltServer. Cable Gauge will vary with distance and power load.
  - Prefer Outside rated cable in vertical riser applications to survive water leaks during construction.
- **POE**
  - Application is **high-power**, **low-data**. **22AWG** Cat5e or Cat6 tends best for dealing with power loss over distance
  - Prefer UTP over STP. At longer distances STP have observed issues (possibly due to EMI)
  - Test and verify all field connections. Follow BICSI standards. If bundling pay attention bundle size, ampacity, and heat rise applicable to 2017 NEC®
  - Use factory made cables where possible to minimize field terminations. Improve reliability, speed installation.



Digital Building – Centralized Deployment

Commissioning

- **Network Commissioning**
  - Network Configuration
  - Connectivity Validation
  - Validate POE High Availability features
  - Validate Network failure behaviors

- **Lighting System Commissioning**
  - The process of configuring lighting system behavior
  - Described in written lighting controls narrative
    - Behavior of sensors, controls, and endpoints
    - What happens when you press a wall switch button
    - Grouping of Lights
    - Compliance: UL-924, ASHRAE 90.1
    - API integration of other systems:
      - HVAC
      - Shading
      - A/V room control

Documentation

- **System High-Level Description**
  - Description of Systems Installed and Behavior (particularly UL-924)
- **Records Drawings:**
  - Network Topology, Addressing, and Configuration Specifics
  - Cabling Layout, Pathway, and Space Designs
  - Electrical line diagrams and PDU configuration
- **Other System Documentation and Manuals**
- **Lighting Specific:**
  - Reflective Ceiling Plan (RCP)
  - Fixture Schedule
  - Sensor Documentation
  - Controls Narrative
  - API's
- **Endpoint Documentation as available**
  - IP Addresses (if static)
  - MAC Addresses
  - Configuration Details
- **Integration Documentation**
- **Service Contacts and Support Details**

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Labeling


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- **Labeling is fundamental to Verification, Testing, and Maintenance**
- **Key to project documentation**
- **Follow TIA-606-C**
  https://global.ihs.com/doc_detail.cfm?&item_s_key=00142041&item_key_date=820611&input_doc_number=TIA%20606%2DC&input_doc_title=

THANK YOU