The Healthcare Edge: Reimagining Healthcare in an Internet of Everything (IoT) Enabled and AI Driven World

"Integrated Healthcare Facilities of the Future: Improved Maintenance and Operations in the Connected World"

Schneider Electric Solutions Support HealthCare Infrastructure and Operations Leading to Patient Comfort, Safety & Satisfaction

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Learning Objectives –

Identify Challenges Driving the Digital Healthcare Evolution

Understanding the Importance of Data and Cyber Security in Managing Patients and Facility Operations

Basic Knowledge of IT/OT Network Architecture and The Need for Resilient Power

Understating UPS Systems Application for Resilience and Important Codes and Standards Changes for BESS

	Key Priorities, Trends and Drivers of Digital Health Care
	Medical and Operational IoT and OT
	Integrated Healthcare Data, Cyber Security Network and Architecture
	UPS Basic Functions
	UPS Design Considerations
	Key Codes & Standard UPS & Battery Systems
	Summary Results of A Digital Healthcare System
	Questions?

The Big Picture

Can Be Intimidating!

With Determination, Planning and a Step-by-Step Approach…

Achieving Goals is Possible!

"Nothing is particularly hard if you break it down into small jobs“ Henry Ford

FHEA 2022 Keynote Reminder Time to Climb Allen Mallory

The Healthcare Organization Perspective…

Patient Satisfaction…
Community Recognition…
Cost Reduction, Efficiency…
Capex Justification, More…

Health System Priorities

Pressure on Healthcare Facilities Teams is Building… All These Responsibilities and More….

- **Labor Shortage and Aging Work Force**…Less Qualified Candidates… **Retirement/ The Silver Tsunami** are Leading to Knowledge Drain
- **Wide Range of Systems and Platforms**…Diverse Data Sources Make Collection, Reporting and Analysis Extremely Difficult
- **Limited Budgets and Inflation**…Forcing Deferment of Capital Projects or Upgrades and Increased Risk of Unplanned System Failures

Healthcare Energy Challenges

Hospitals are the third-most energy-intensive type of commercial building after food service and food sales buildings.

They use an average of 193,300 BTUs of energy per square foot per year, which is the same as 1.5 gallons of gas for every square foot of space.

34.6%

year-over-year rise in energy costs in the U.S. from 2021 to 2022

Source: McKinsey, 2022

18

billion-dollar weather and climate disasters in 2022

Source: NOAA, 2023

88%

of customers expect companies to accelerate digitization

Source: Salesforce, State of the Connected Customer, 2022

Recent Trends in Data Growth in Hospitals

Hospitals produce an average of 50 petabytes of data each year.

97% of that data is unused.

30% of the world's data volume is being generated by the healthcare industry.*

*Data from World Economic Forum Report 2019

By 2025, the compound annual growth rate of data for healthcare will reach 36%.

Examples…Healthcare is Getting Smarter, More Connected and Medical Operational Technology (OT) is Evolving

Robotic Surgery

AI Imaging Analysis

Imaging Systems

Digital Patient Care

Medical Wearables

Research & Development

Patient Level Healthcare Operational Technology (OT) Internet of Things(IOT) Examples

The Things…Wearables, Scanners, Vital Statistic Monitors, Room Controls…

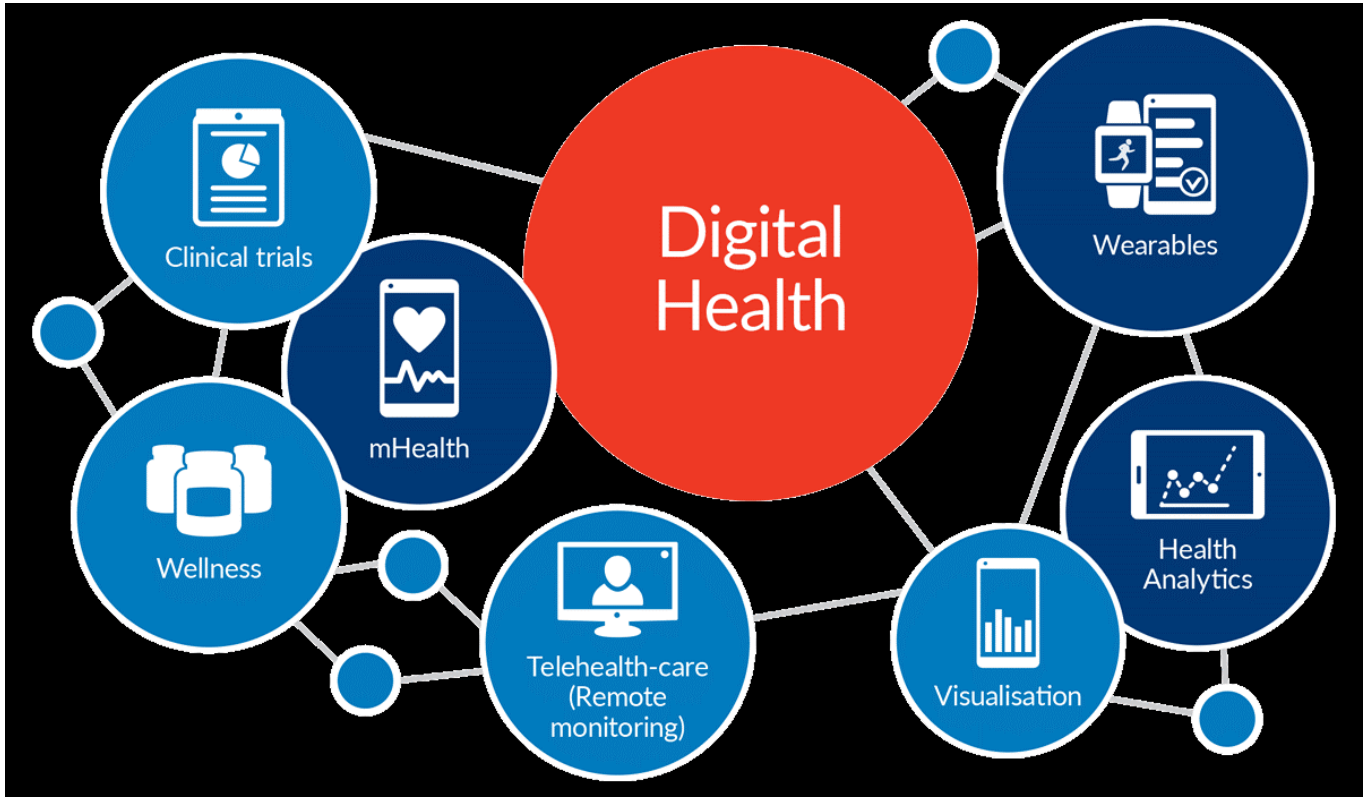
The Network….The Connection to Private IP Subnetwork for Internet or Private Cellular LTE Network Public WiFi

The Systems….Systems or users with web enabled devices that analyze, monitor, control or report on the “things”

Patient satisfaction and outcome are a direct result of how well systems work to keep them in a safe and comfortable environment!

…and this Hybrid Architecture is Enabling Digital Healthcare

Digital technologies enhance the **efficiency** of healthcare delivery and make medical care more personalized and precise



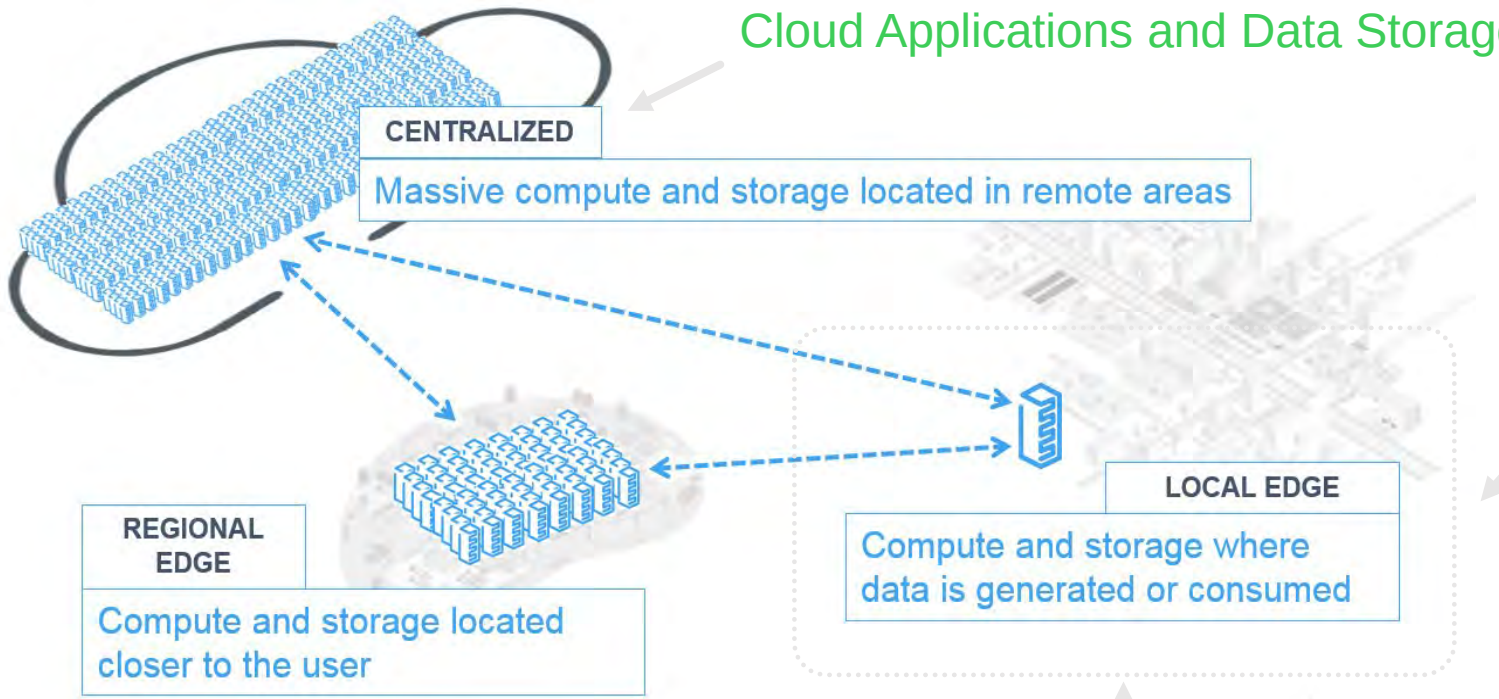
Examples of Facilities Operational Technologies (OT) or The Industrial Internet of Things (IIOT)

Sensor and Devices
Intelligent Connected
Central Energy Plant

…Where the Network Connection, Visibility and Control are Become Mission Critical!

IT System Terminology-Edge, Regional Edge & Cloud Compute Environments

Cloud - for Compute Such as AI Analysis, Cloud Applications and Data Storage



1. Location
   - Often not dedicate IT environment
   - Semi-controlled temperature or dust
2. Staffing
   - No local IT staff
   - No one to locally troubleshoot
3. Visibility
   - Limited Status
   - Expensive to Send Someone if not staffed
4. Security
   - Unrestricted access
   - Network vulnerabilities in physical layer

Edge- Typical IDF/MDF/LAN often shared with other infrastructure
Positive is less Network Latency

Regional Edge- Data Center For Streaming, 5G and other Data Heavy Functions Like Autonomous Vehicles or AI

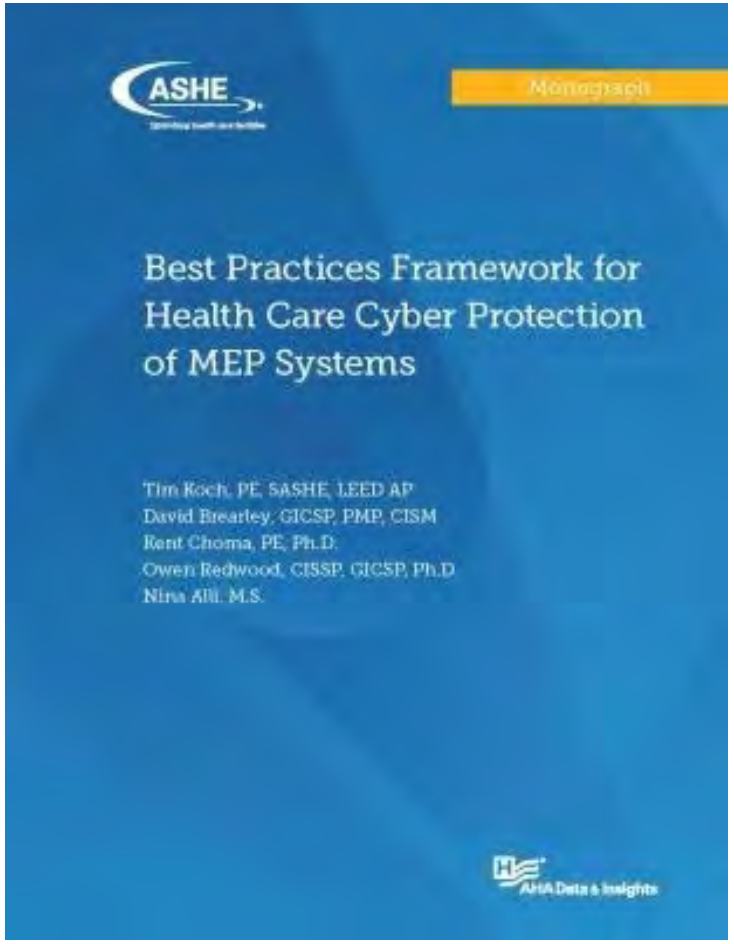
Healthcare IT /OT and Cyber Security Considerations

Healthcare IT is Focused on Data…Patient Records, Billing, Protected Health Data, Medical System Data.

Healthcare (Facilities) OT/IIOT Focused on Technology that Controls the Physical Environment…Electrical Systems, Mechanical Systems, Security, Med Gas, Water, Elevators and More.

Working With Your IT Department

"To protect plants, systems, machines and networks against cyberthreats, it is necessary to implement — and continuously maintain — a holistic, state-of-the-art security concept."



https://www.ashe.org/hdrcyber

Healthcare Cyber Security Standards & Practices

“I want to help ensure that my facility’s systems are aligned with our organization’s cyber security policies and align with international standards to help reduce risk of cyber attacks.”

Comply with standards & best practices

1. **Cyber Security is a Constantly, Evolving Risk**

2. **Organizational Strategy that Covers People, Technology and Processes**

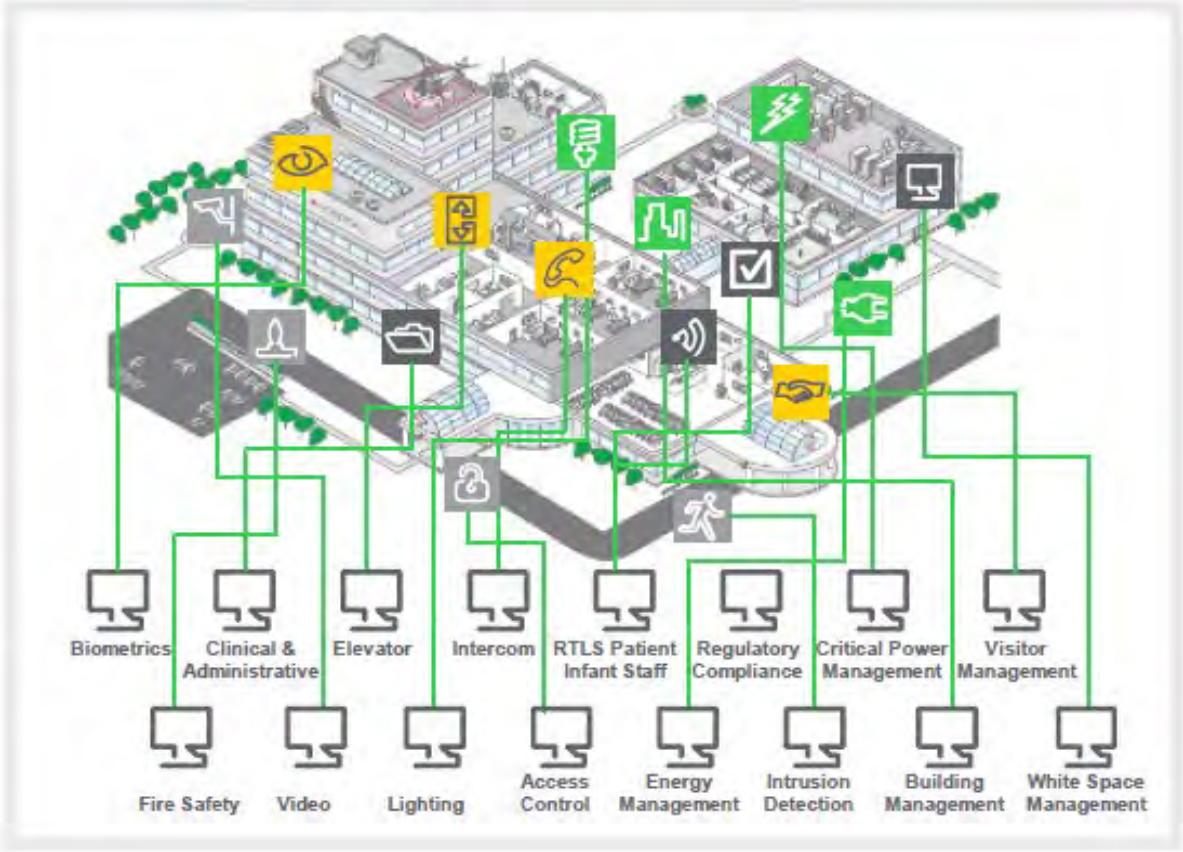
3. **Use Devices With Security Standard- Example:** → **IEC 62443** is a set of security standards for the secure development of Industrial Automation and Control Systems (IACS).

4. **Best practices and technical features reduce risk**
   a. **Secure Networking Architecture**
   b. **Active Directory Integration**
   c. **Two Factor Authentication**
   d. **User Privilege / Authorization Policy**

Integrated Healthcare Facilities Infrastructure

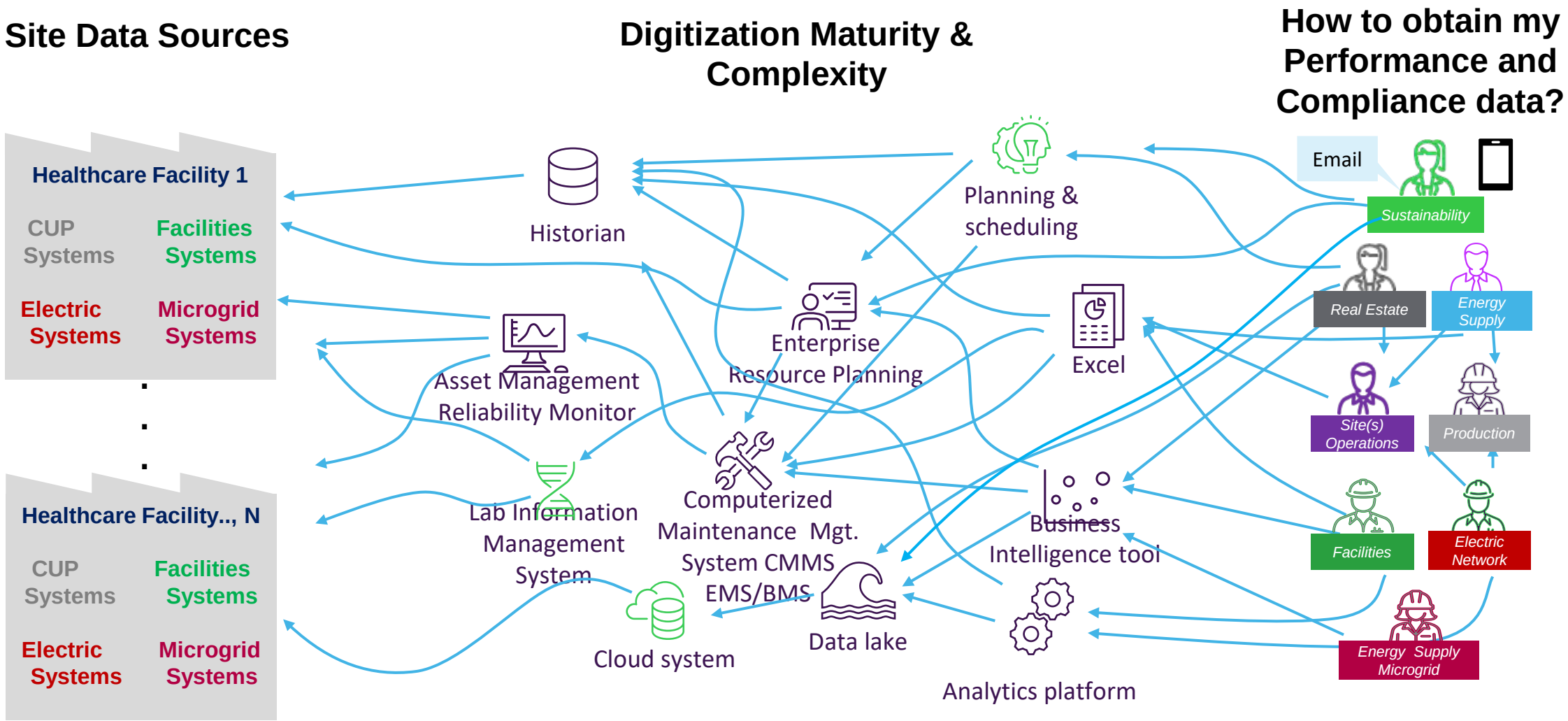
Traditional Healthcare OT Systems Are Often In Silos

Traditional Facilities Design



- Multiple networks from different vendors
- Too many systems to learn
- Complex troubleshooting
- Higher capital and operational expenditures
- Obstacles to achieving energy efficiency
- Data not shared between systems
- Limits analytic possibilities

Collection of Site Performance for Compliance and Energy Data Can Be Challenging



Goal - Provide Users with Site Data Via Common Database

Site Operations Data

Healthcare Site 1

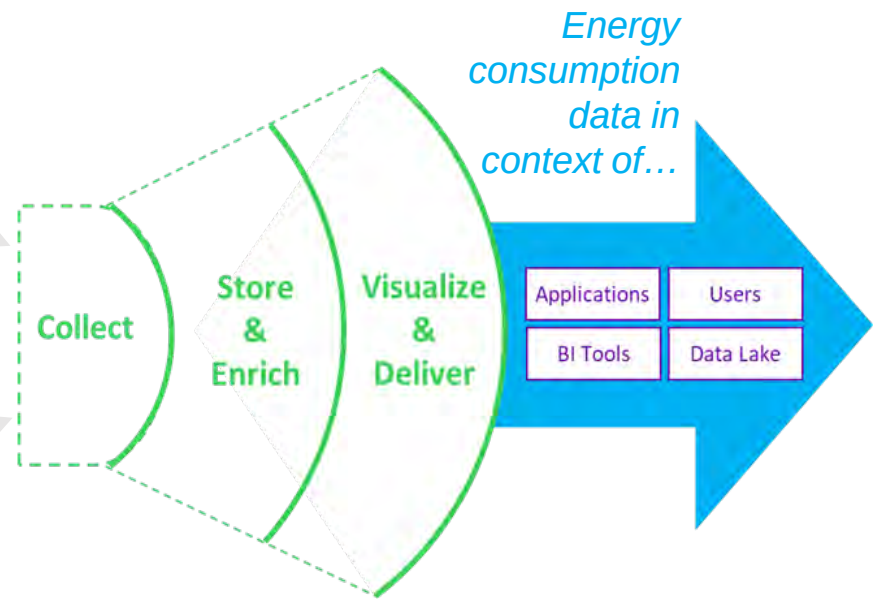
CUP Systems | Facilities Systems | Electric Systems | Microgrid Systems

Connect

Healthcare Site N

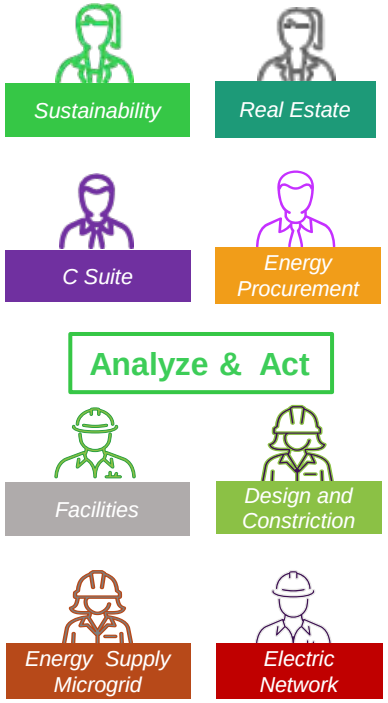
CUP Systems | Facilities Systems | Electric Systems | Microgrid Systems

Facility/Energy Data Hub



Energy consumption data in context of…

Users & Applications



OT ——— IT

Outcomes

- Single version of the truth
- No impact on OT systems
- Less OT network traffic
- Lower Cybersecurity risk
- Automated energy data flow
- More timely information
- Less labor
- Better decision making

Digital Healthcare OT Monitoring System Architecture

Digital Healthcare Network Architecture for Energy Monitoring Control and Decision Making

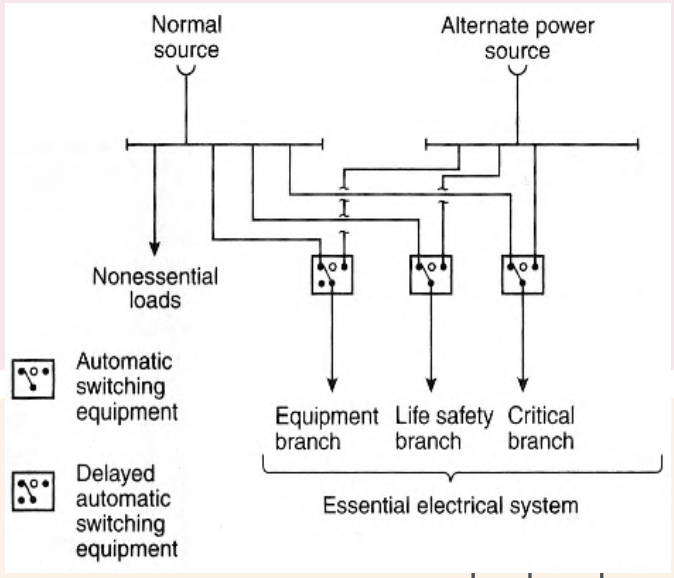
Intelligent Power Monitor Network Architecture for Hospitals

Medium Voltage

Low Voltage

Final Distribution

Architecture Overview



LV Gear

UPS

BMS Meters Controls

Building Systems

UPS

IT PDU

Data Center MDF IDF

UPS

UPS

Critical

Operating Room Intensive Care Imaging

Equipment

MV IEEE C37.30.2 SWGR

Substation MV XFMR

QED SWBD / PZ4 LVDO

ATS 7000

Galaxy UPS / Smart UPS

Line Isolation / I-Line D

Connected Product

ION9000 (Meter)

Sepam Micom (Protection Relay)

Vamp (Arc Flash)

PS100 (Aux Supply)

Easergy T300 (Switch Control & ATS)

NT / NW / MTZ

NSX

PLC or 3rd Party (ATS)

PM5000 PM8000

AccuSine

Link 150

ATV VFD

NSX

ieM3000

IM20-H

HRP Display

UPS Modbus TCP

Line Isolation Monitor

IsoGuard

Edge Control

Power Monitoring Expert with Power Advisor Digital Services

UPS

Local HMI

UPS to Power Meters Controls During Interruptions

Services Applications

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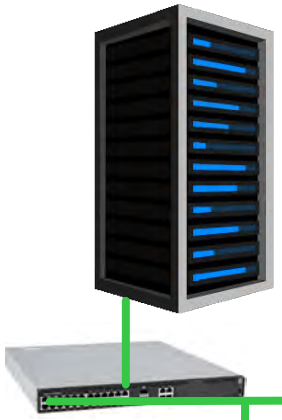
Simplified Power Monitoring Network Architecture On Prem

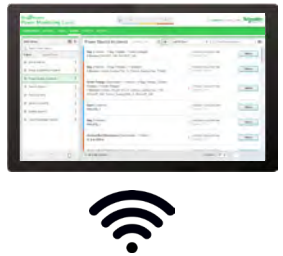
Simple and Centralized

Server: IT Department
Application + Database

Thick Clients: Analysis
Engineering Tools

Thin Clients:
Main User Interface (Web Client)





IP Backbone

Modbus and ION Protocols

Power Meters

Protection Relays

Breakers, Trip Units, Gateways

UPSs

PQ Correction Equipment

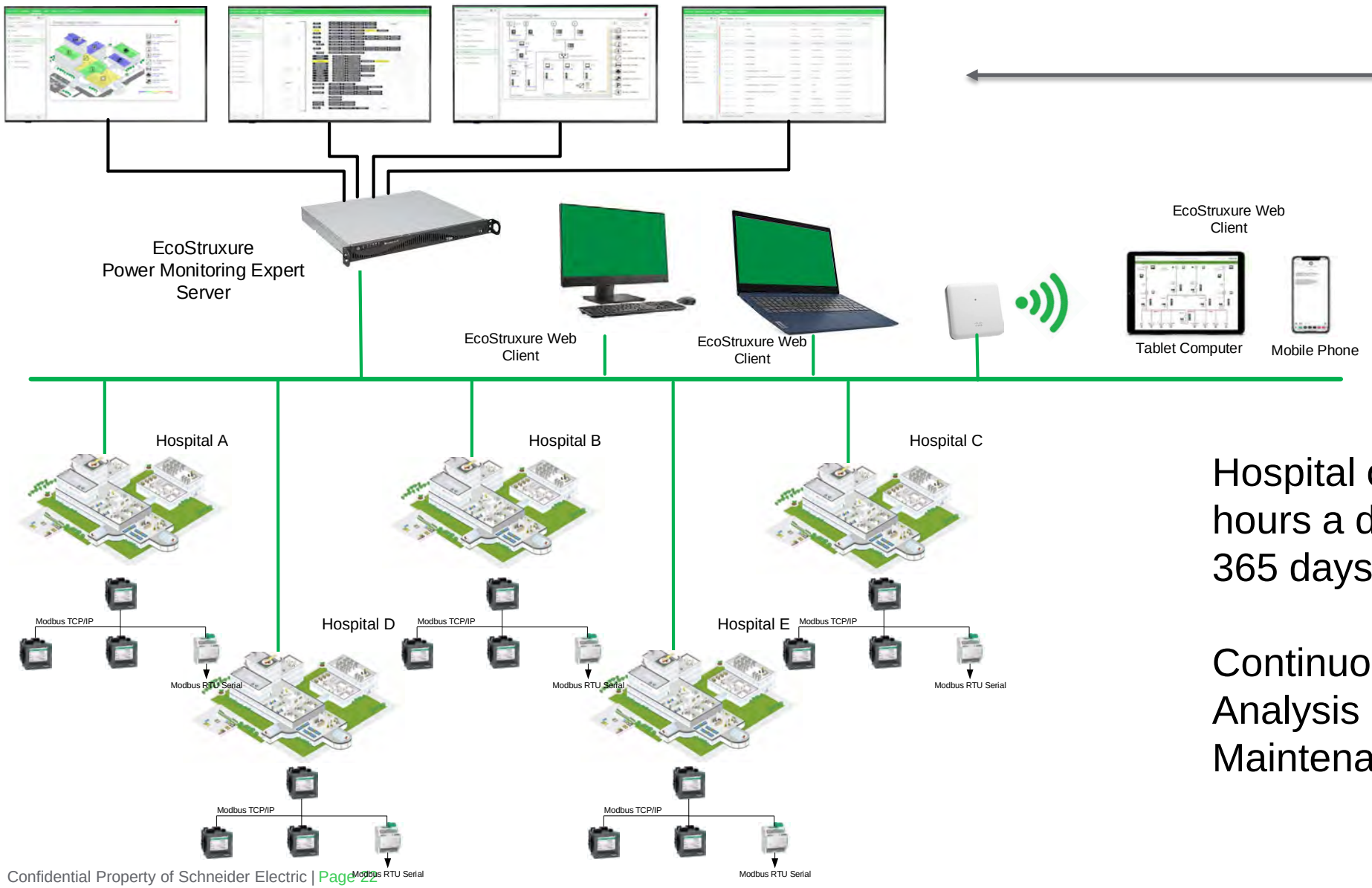
Variable Speed Drives

Final Distribution Breakers, Sensors, Gateways

RTUs, PLCs

Water, Air, Gas, Steam

Multi Site Network Architecture -Remote Operations Center



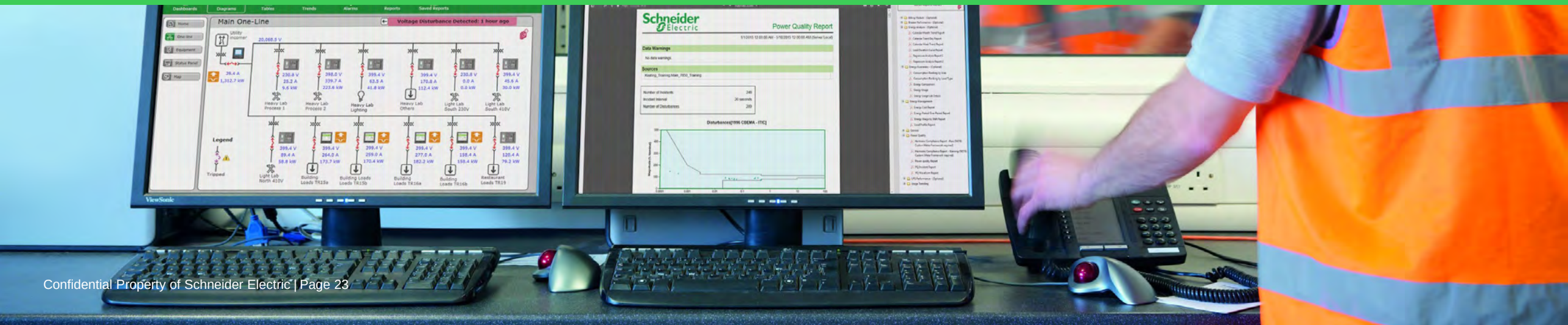
The ability to remotely track, assess, and resolve issues

Hospital operations run 24 hours a day, 7 days a week, 365 days a year…

Continuous Monitoring and Analysis is Key to Proactive Maintenance and Response

UPS Fundamentals and Application for Healthcare Systems

How to Select and Apply the Right UPS Solution

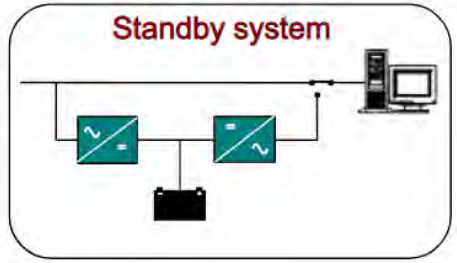


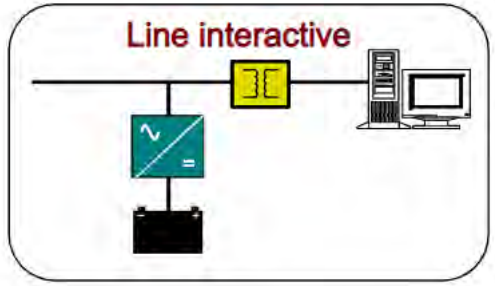
UPS Types (UPS Basics)

What Unit DO We Choose …“It Depends”!!

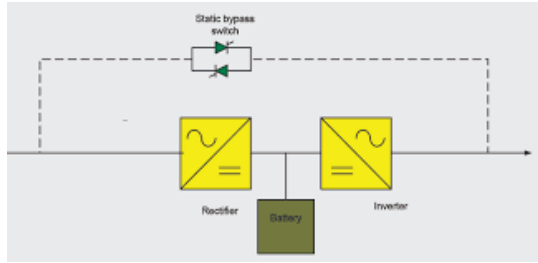
The answer to this question is that it varies based on the topology of the UPS:

- **Offline/Standby (Good)**
- **Line Interactive (Better)**
- **Double Conversion (Best)**





Double Conversion



Schneider IT has several white papers on these topics https://www.apc.com

- White Paper 1 – “The Different Types of UPS Systems”
- White Paper 75 – “Comparing UPS System Design Configurations”
- White Paper 79 – “Technical Comparison, On-line v. Line Interactive UPS Designs”

Basic Brick UPS…

Standby/Offline UPS (Good)

When and How They Work:

- Most common UPS for personal computers
- Standby
  - **Inverter only starts when power fails**
  - **Transfer switch delay (CLICK)**
- High efficiency (due to not operating inverter and rectifier in normal operation)
  - But lower efficiency when operating online
- Compact footprint
- May provide noise filtration and surge suppression
- Smaller Loads (Typically 200 to 800 VA)

Standby/Offline UPS – Typical Form Factor

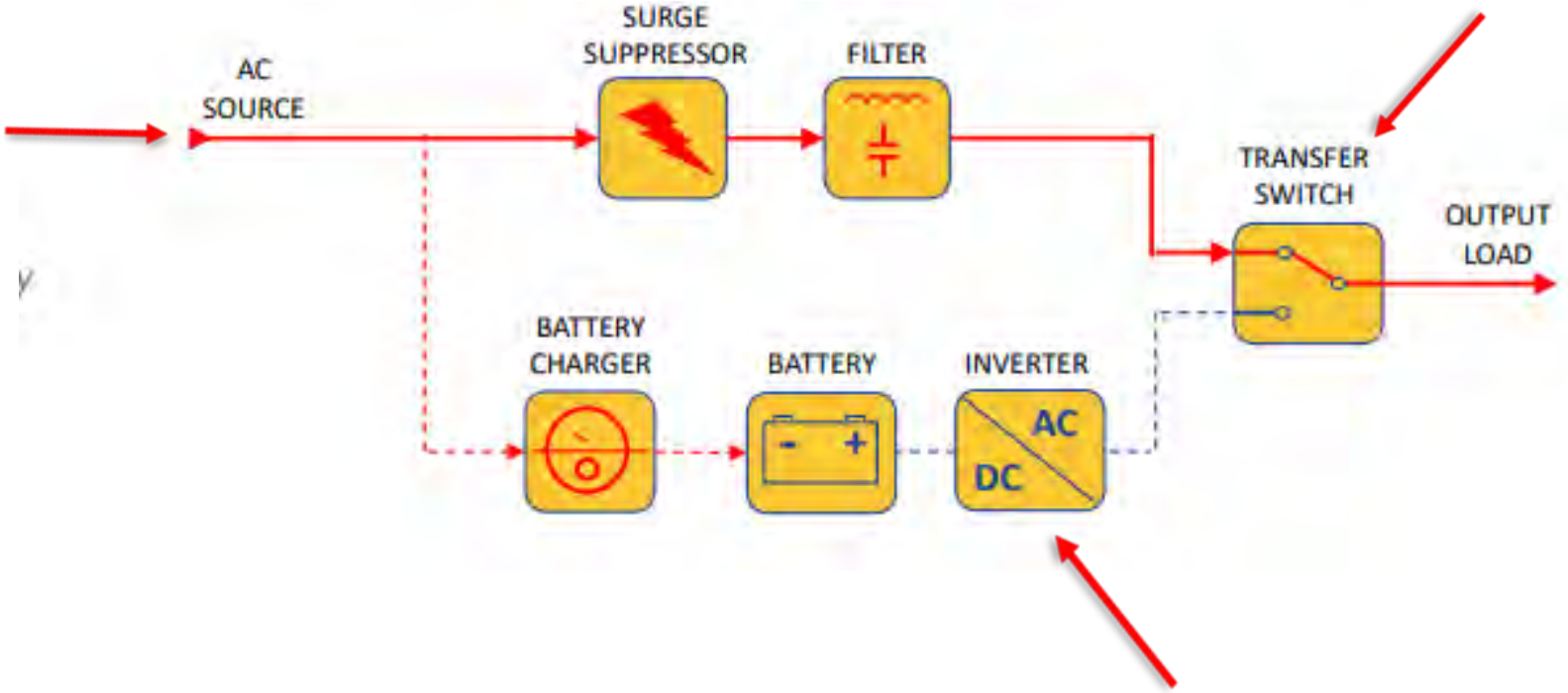
Types of UPS Systems

Standby or Offline UPS (Good)

Normal Power Path
Filtered Street Power

Clicking Sound When Utility Power is Removed is Transfer Switch Swapping Over to the AC Inverter Circuit

Normal Power Path



Inverter is “Offline” Until Input Power is Removed

Types of UPS Systems

Line Interactive UPS (Better)

How it works…

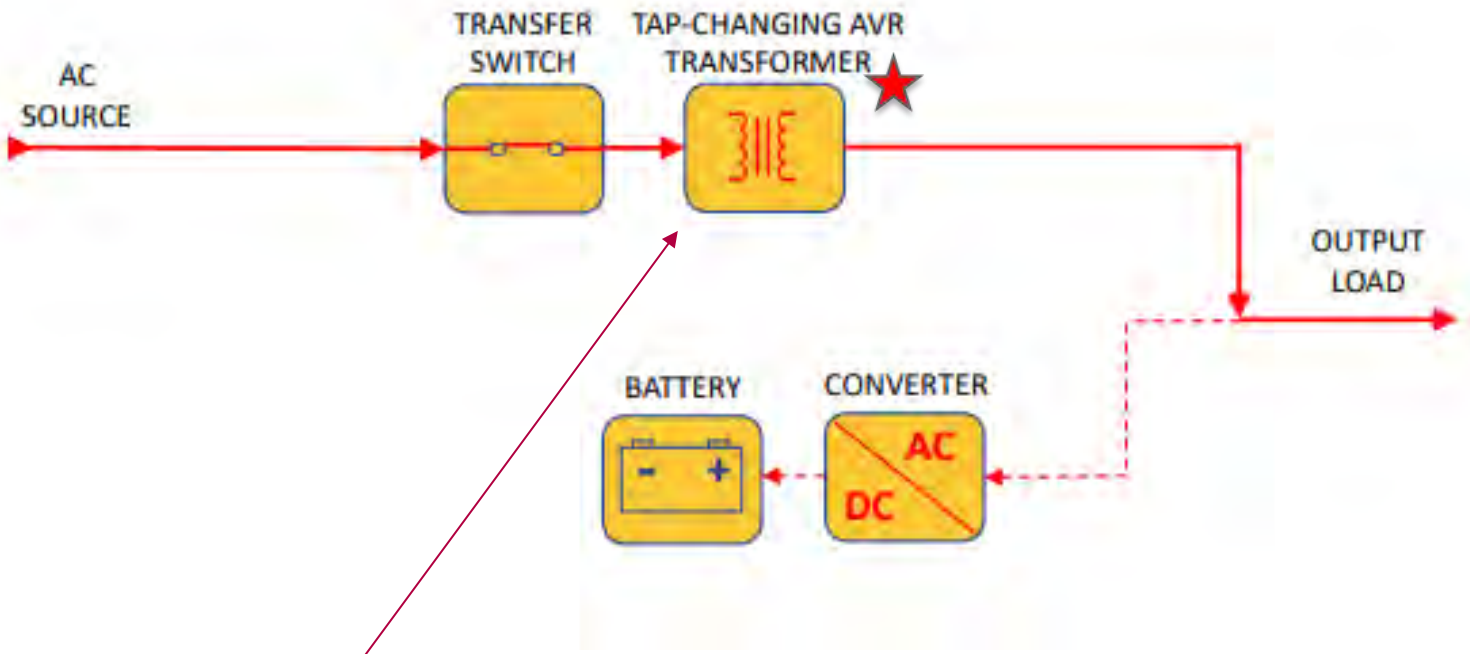
- Most common for small business, IT servers, switch closets
- Inverter is always “on” supplying load
- Battery charging when ac power available
- Reduced switching transients when compared to standby type
- May include a tap-changing transformer for voltage regulation reducing battery stress
- Most designs have a static bypass allowing ac power flow to load after inverter failure

Line Interactive UPS – Typical Form Factor Examples

A & B Line Interactive Redundant Power for Critical Rack Load

Types of UPS Systems

Line Interactive UPS



- The power interface provides:
  - conditioning of the output voltage;
  - a relay that disconnects the AC input during operation on battery power.

Typically used in the 0.5-5kVA power range

Types of UPS Systems

Double Conversion UPS

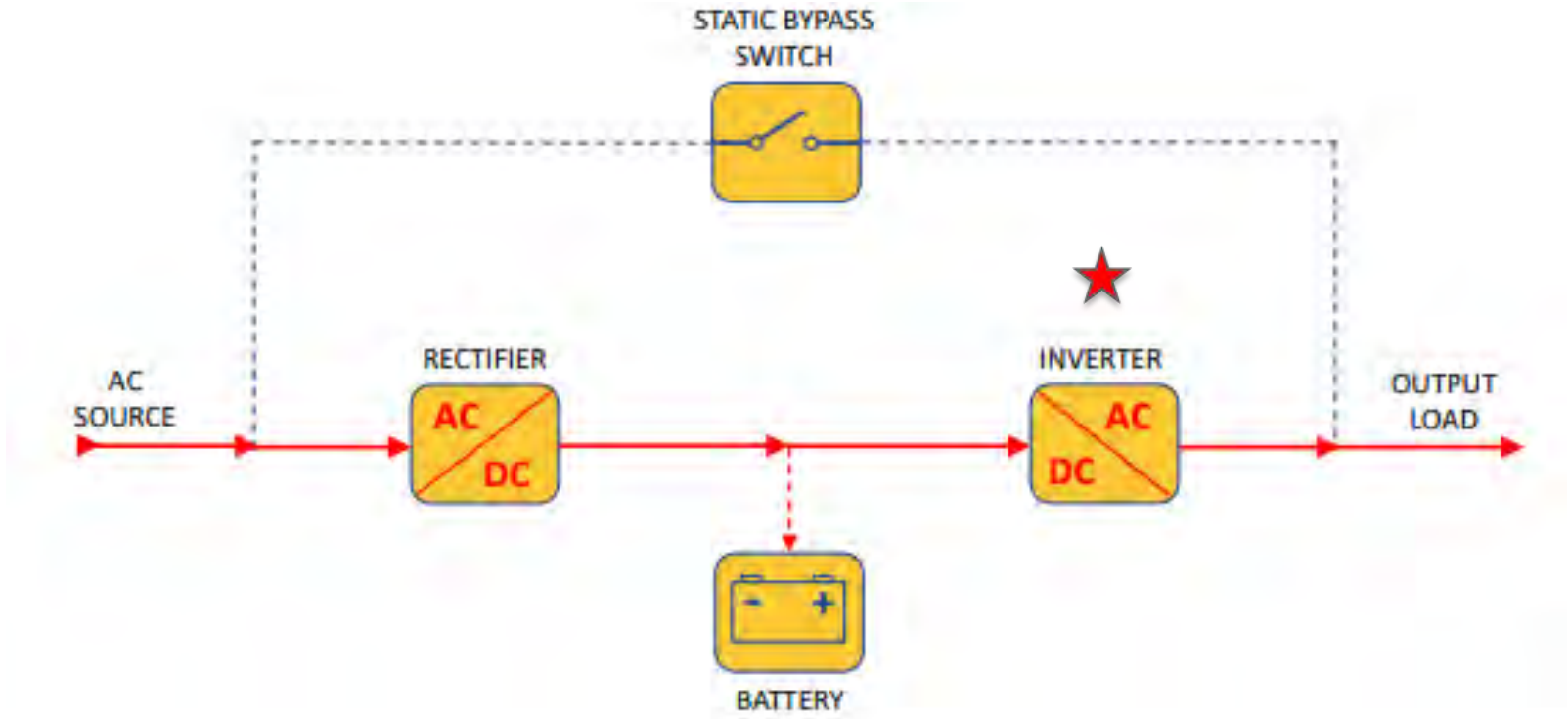
How it works…

- Online operation…no transfer time delay
- Nearly ideal output characteristics and performance…..BUT
  - Both the battery charger and the inverter convert the entire load power flow
  - Reduces efficiency and increases heat generation
  - Constant wear on the power switching components impacts reliability and life
  - Battery charger is a large non-linear load and may impact other aspects of the power system

Types of UPS Systems

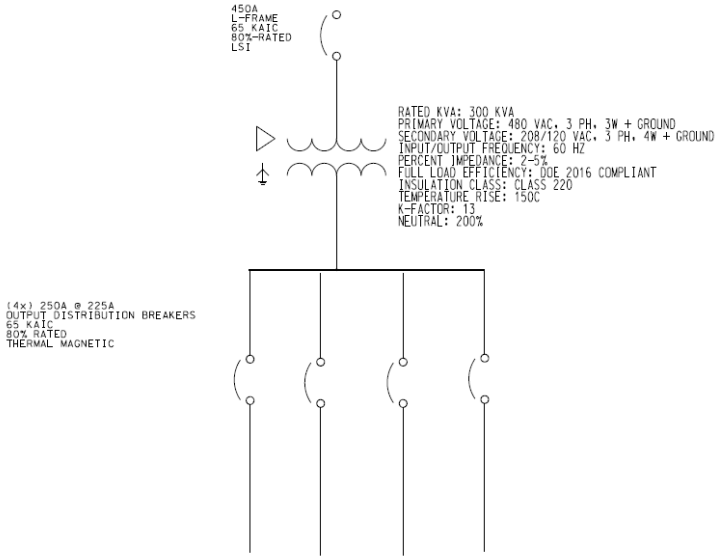
Double Conversion UPS

- Typically For Critical Systems
- Most common 3-phase UPS
- Full power conditioning
- Best in class protection of the load
- Preserves VRLA battery life



Typical UPS Design & Application Questions?

1. Size (kW/kVA) of Load?... Run Time Required?... Single Phase vs. Three Phase?
2. What Voltage is Available for UPS & What is Load Voltage?(480,208,120/240 VAC)
3. For 3 Phase System - 3 Wire or 4 Wire Input and output? Neutral Needed?
4. UPS Output or Floor PDUs, Busway, PDUs or Panelboards?



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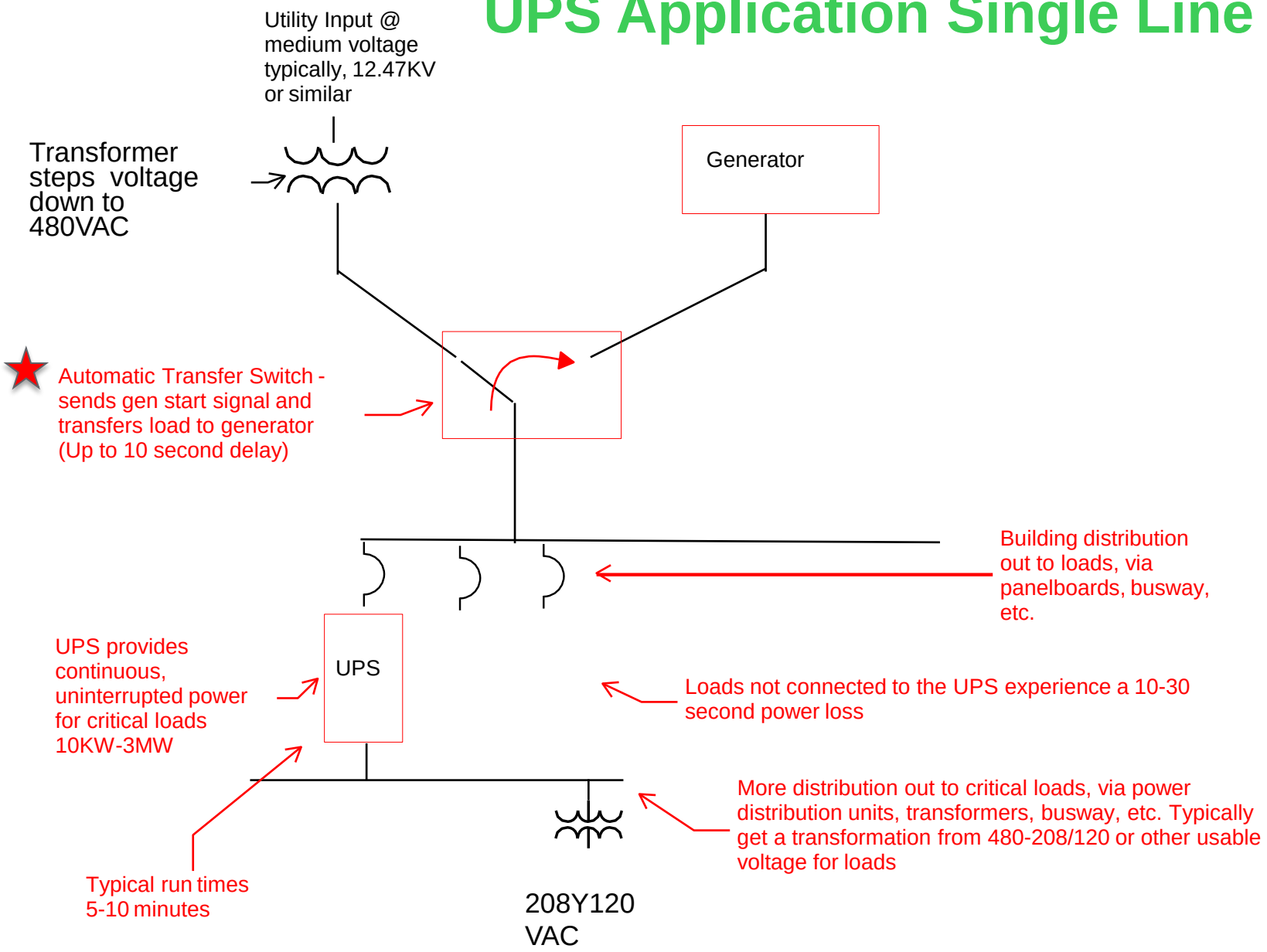
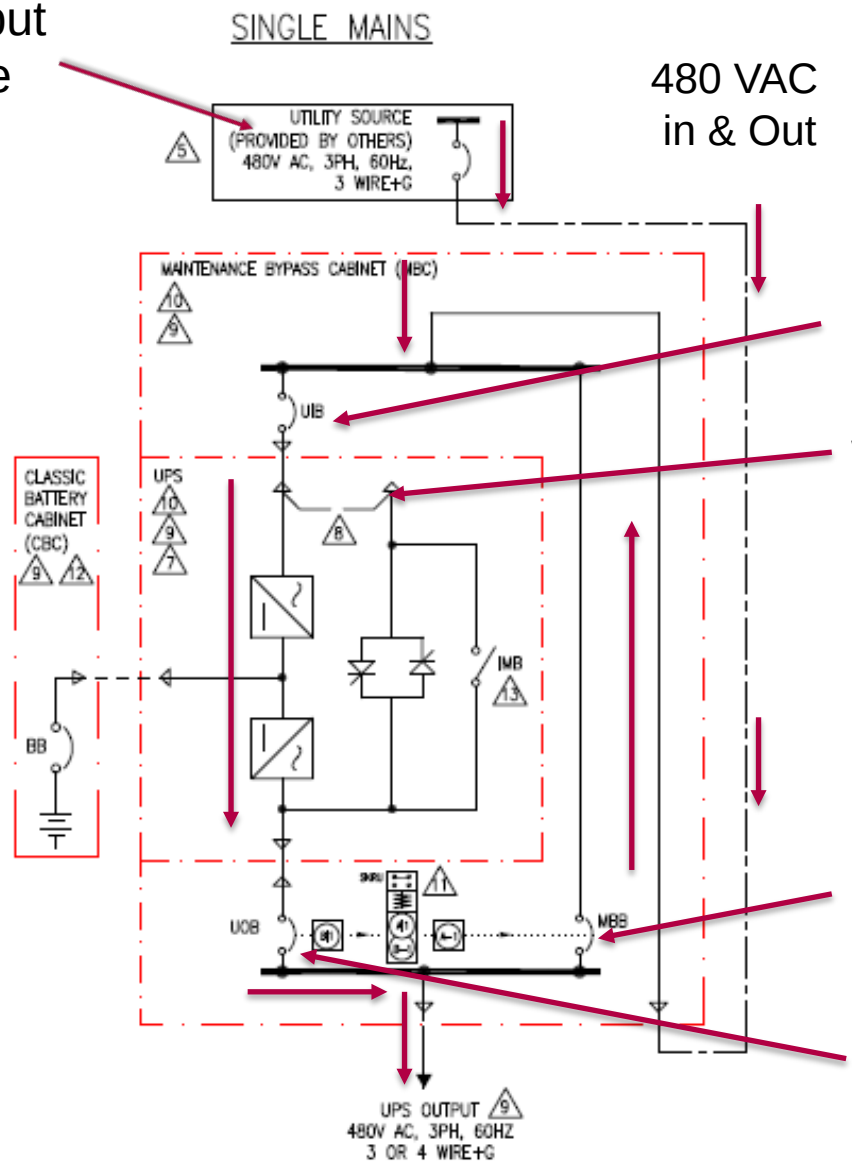
UPS Application Single Line Diagram



Typic UPS Local Power Path Including 3 Breaker Maintenance Bypass

AC Input Source

480 VAC in & Out



Breaker Status

UIB Closed

Jumper In for Single Input

MBB Normally Open

UOB Closed

100 kW Galaxy VS with 3 Breaker Close Couple MBC

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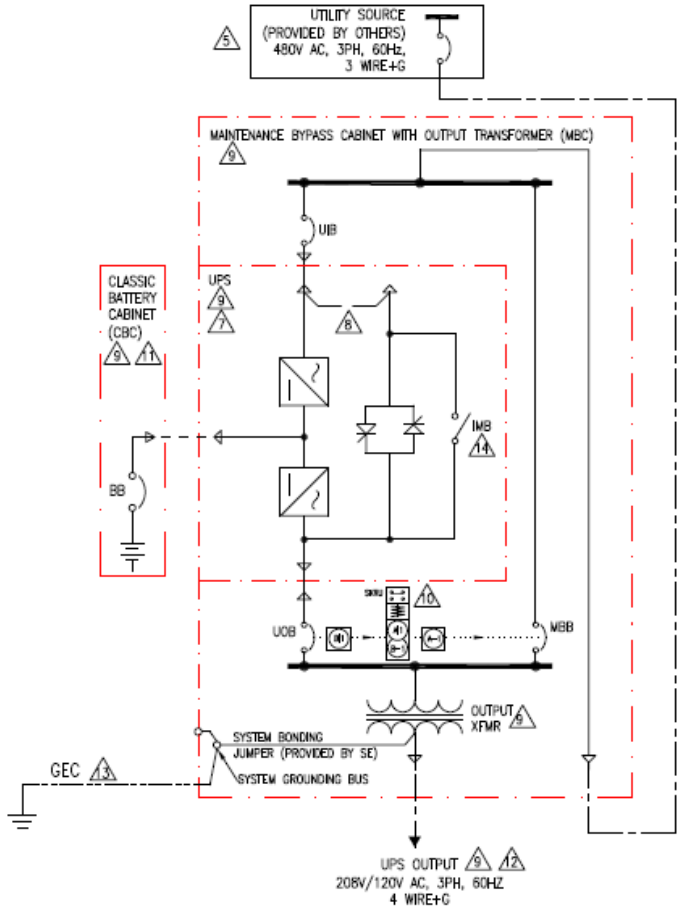
Sizing the Breaker for a UPS System

UPS Maintenance Bypass Output Transformer 480 VAC input 208Y120 VAC Out



GALAXY VS 10–50KW 480V OR 600V AC IN/208V AC OUT UPS SYSTEM SITE PLANNING DATA (MBC WITH INPUT XFMR)

MAINS INPUT : 480/600V AC, 60HZ 3PH 3 WIRE+G OUTPUT: 208V AC, 60HZ, 4WIRE+G
NOMINAL DC VOLTAGE: FOR 32 BLOCKS: 384V DC, 40 BLOCKS: 480V DC, 48 BLOCKS: +/–288V DC (WHEN USING 48 BLOCKS SPLIT STRING IS MANDATORY)

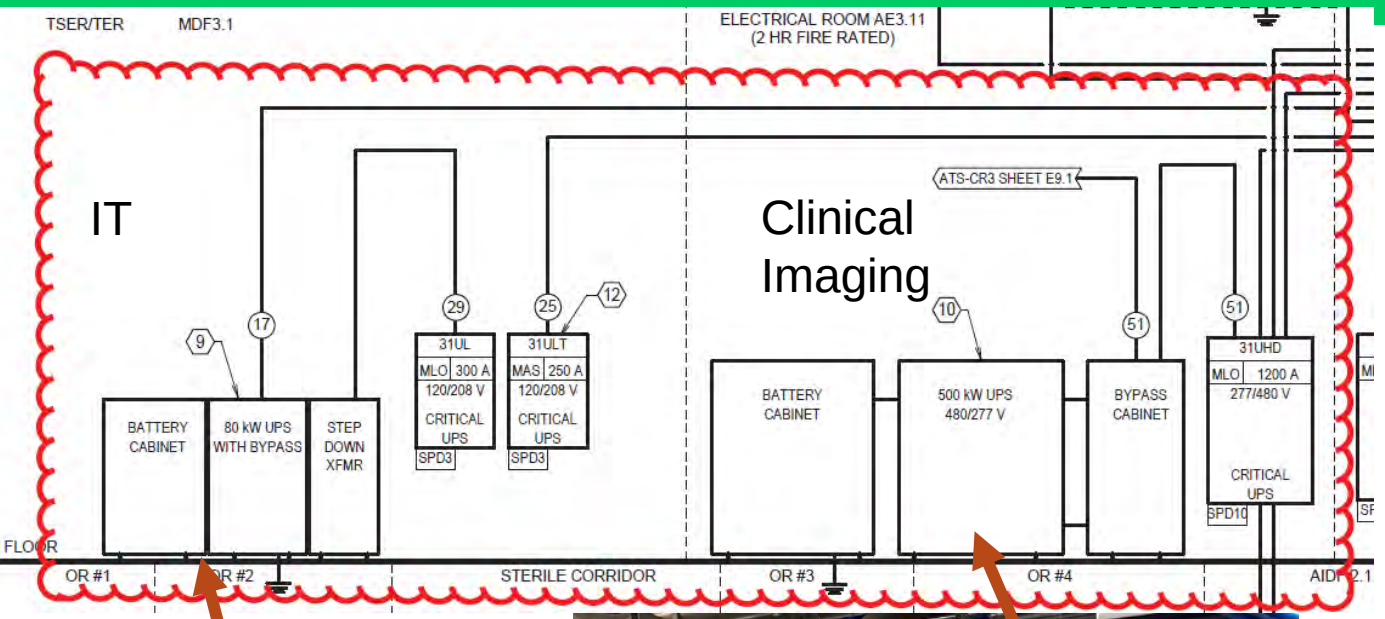
UPS RATING (kW)	UPS SKU NUMBER	APPLICABLE MBC SKU NUMBER	TRANSFORMER SPECIFICATION	APPLICABLE BATTERY CABINET SKU NUMBERS/ (BATTERY BREAKER RATING)		NOMINAL MAINS INPUT CURRENT (NO CHARGING) (A) 480V/600V AC	NOMINAL MAINS INPUT CURRENT (FULL CHARGING) (A) 480V/600V AC	OUTPUT NEUTRAL CURRENT (A)	UPS/ SYSTEM OUTPUT NEUTRAL CURRENT (A)	BATTERY CURRENT (ADC)				RECOMMENDED UPSTREAM PROTECTION (MAKE: SCHNEIDER ELECTRIC)	
										32 BATTERIES		40 BATTERIES			
										FULL LOAD CURRENT @NOMINAL VOLTAGE (384V DC)	FULL LOAD CURRENT @EOD VOLTAGE (307V DC)	FULL LOAD CURRENT @NOMINAL VOLTAGE (480V DC)	FULL LOAD CURRENT @EOD VOLTAGE (384V DC)	@480V INPUT	@600V INPUT
10	GVSUPS10KFS	GVSBPIT25	30KVA 600/480V AC IN, 208V AC OUT DY1	GVSCBT1/ GVSCBT1ST (150AF/AT)	GVSCBT2/ GVSCBT3/ GVSCBT4/ GVSCBT5/ GVSCBT2ST/	13/10	15/12	48	28	27	34	22	27	HJL36060U31X	HJL36060U31X
15	GVSUPS15KFS					19/15	23/16	72	42	41	51	33	41		
20	GVSUPS20KFS					26/20	31/25	96	56	54	68	43	54		
25	GVSUPS25KFS					32/26	38/31	120	69	68	85	54	68		

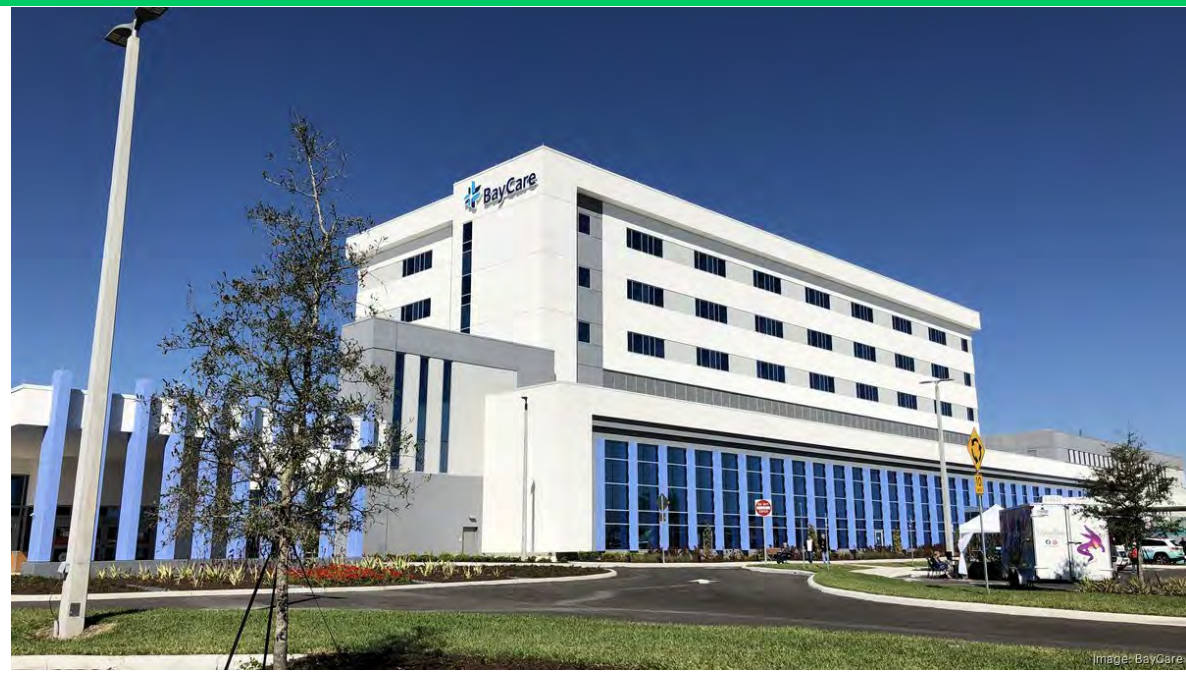
Example:
Phase Current by kW - 25 kW/(1.732 x.480kV) = 30 A per Phase

However, the actual listed current value is 38 A Per Phase so the required breaker would be 38 A x 1.2 = 45.6A or **50 A Breaker**

This is due to Charging at Full Load!

Some Larger Hospitals are Choosing Central UPS Systems for Imaging & Critical OR Panels with Separate Units for IT Networks





Central Imaging and IT Units Help With Floor Space Challenges.

This

At the Same Time Distributed Networks are Expanding with Free Standing ER's, Urgent Care, Outpatient Surgery & More…

Secure Network

Edge Computing & Communications

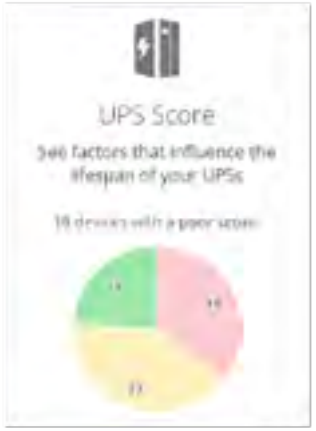
Monitoring and Maintaining UPS Systems and Batteries Requires a Connected, Proactive Approach

Security Vulnerabilities

Firmware Updates

UPS Load

UPS Health Score



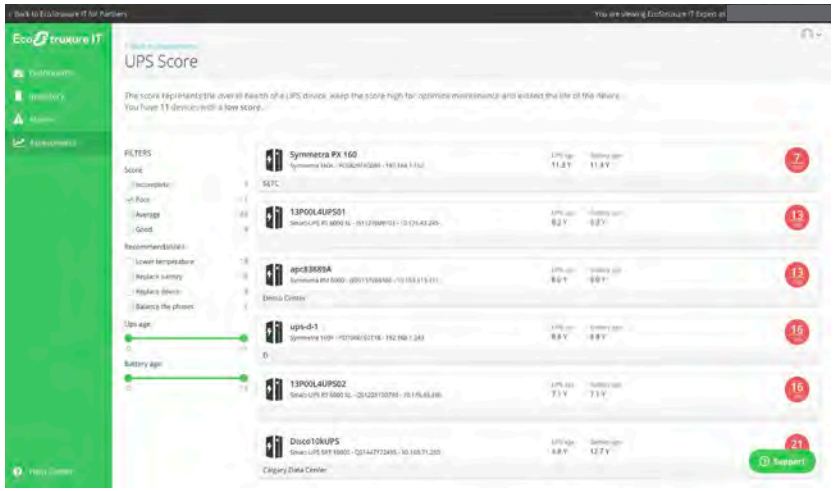
Critical Alarms

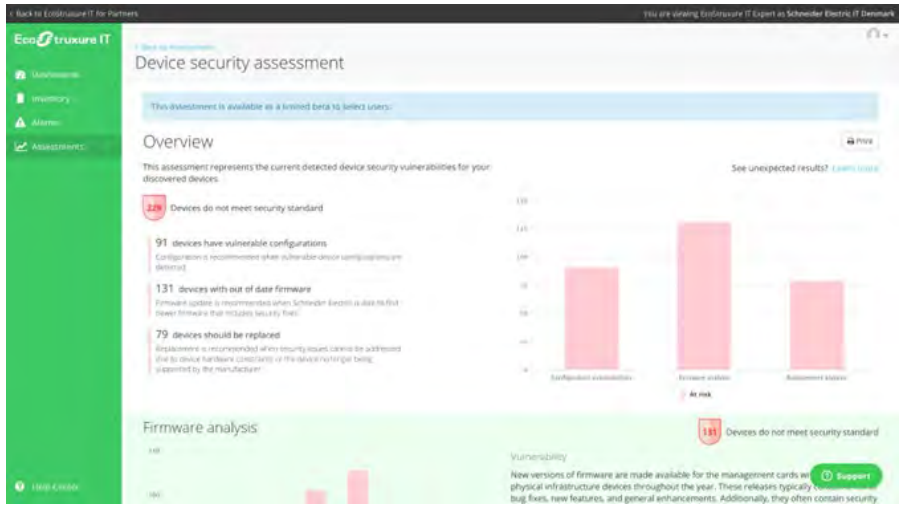
Lifespan Alarms

Device Configurations

91 UPS devices have 9 different configurations

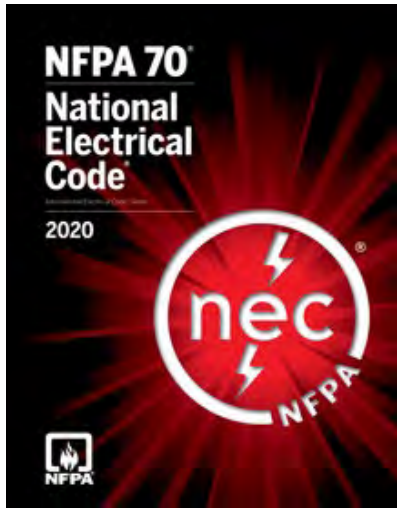
88 Rack PDUs have 12 different configurations

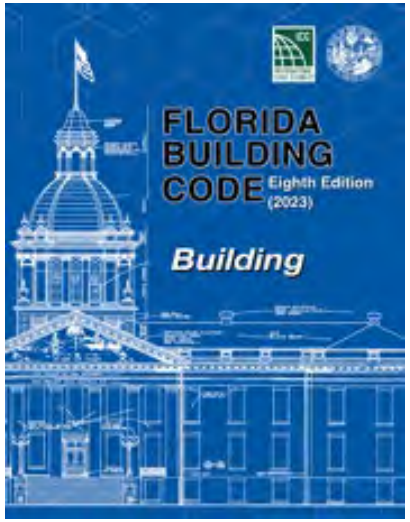


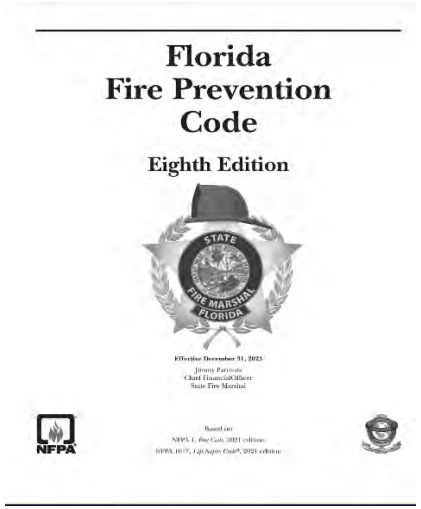


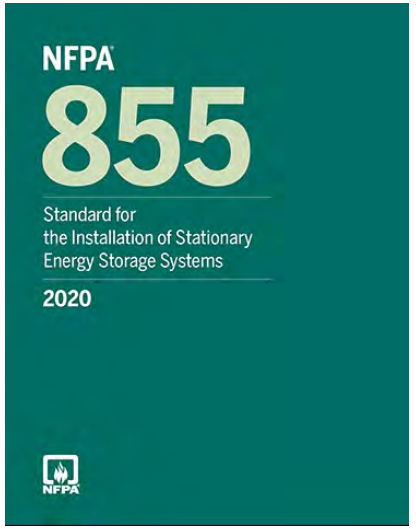
Codes & Standards

What are some Key Codes & Standards For UPS and Battery Energy Storage Systems (BESS) for Commercial and Healthcare Applications in The Current Code Cycle for Florida?









The Current Florida Code Cycle Includes The Following Standards-

NFPA 70 (2020)

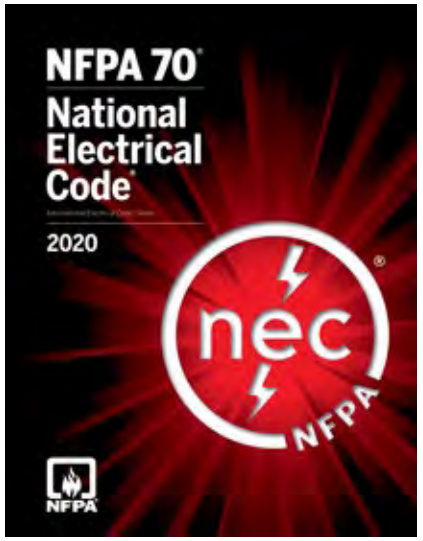
8th Edition FBC Buildings (2023)

Florida Fire Prevention Code (2023)

NFPA 1 (2021)

NFPA 855 (2020)

NFPA 70 (NEC) & Additional Codes Considerations



National Electrical Code (2020) – Currently In Effect Florida

Uninterruptible power supplies (UPS), Definition, **Article 100 Uninterruptible Power Supply.** A power supply used to provide a highly regulated alternating current power to a load for some period of time in the event of a power failure.

Informational Note: In addition, it may provide a more constant voltage and frequency supply to the load, reducing the effects of voltage and frequency variations

480 – Stationary Installation of Storage Batteries; **706 –** Energy Storage System ESS

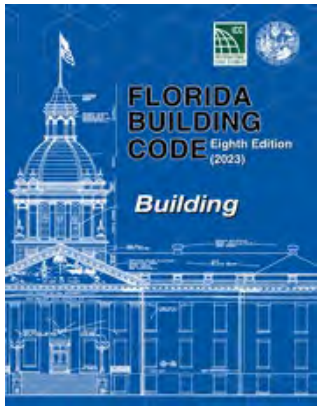
645.10 & .11 - Information Technology Equipment – Requires **Power Off Remote Disconnect Means. Includes any UPS over 750 VA located in the Same Room With ITE. - Remote Disconnect Controls (Sometimes called EPO)** ★

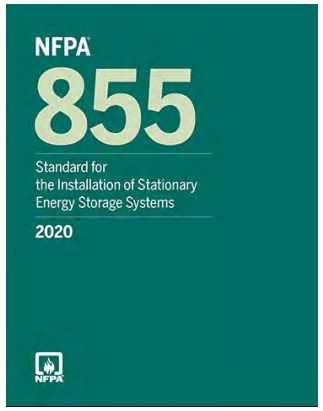
700.12(C) - Emergency Systems – **UPS Must Run 1.5 hr. Minimum (UL924 Only)**

701.12(C) – Legally Required Standby Systems – Same as Above (UPS 1.5 hr.)

708.20(G) – Critical Operation Power Systems – If Used ad COPS – Must have Automatic Charging and a 15 Min Hold Feature if Only Source of COPS

What Codes & Standards Govern Battery Energy Storage Systems (BESS) In Commercial and Healthcare in Florida?





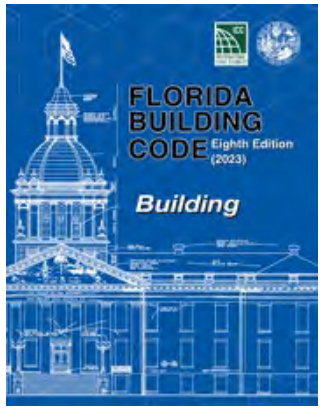
8th Edition FBC Buildings (2023) and Florida Fire Prevention Code (2023); NFPA 1 (2021); NFPA 855 (2020) Are All Part of the Current Requirements for BESS in Commercial Buildings

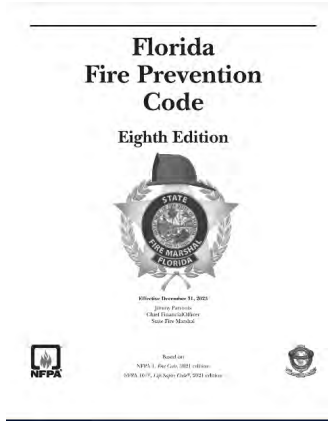
The Florida Building Code, Buildings 8th Edition (Effective Dec 31, 2023) Paragraph 101.4.5 Fire Prevention Refers Directly to the …

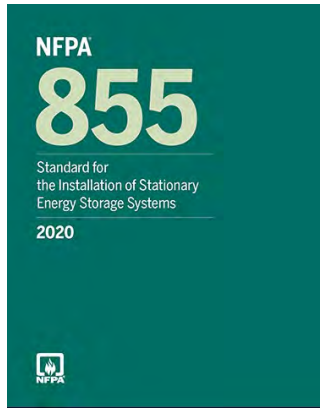
The Florida Fire Prevention Code (Effective Dec 31, 2023) and this Code References…

NFPA 1 Fire Code (2021) Florida Version (Effective Dec 31, 2023) and **Chapter 52** of This Code directs the Installation of Battery Energy Storage Systems Of Certain Capacity to Comply with …**NFPA 855 (2021) Standard for The Installation Of Stationary Energy Storage Systems**

Here is the Reference from NFPA 1 (2020) to The Capacity Threshold for Required Compliance with NFPA 855







NFPA 1 (2021) Chapter 52 Is The Code That Requires Compliance with NFPA 855 (2020) Standard When Installing Battery Energy Storage Systems Over Certain Energy Capacity

Energy Storage Systems
52.1 General.

Energy storage systems (ESS) having an aggregate capacity exceeding the threshold quantities established in
Table 1.3 of NFPA 855 shall comply with Chapter 52. (of NFPA 1)

Power Capacity Level in NFPA 855 Table 1.3 Where BESS Must Comply With NFPA 1 Chapter 52

NFPA 855- 1.3* Application. This standard applies to ESS exceeding the values shown in Table 1.3.

Table 1.3 Threshold Quantities

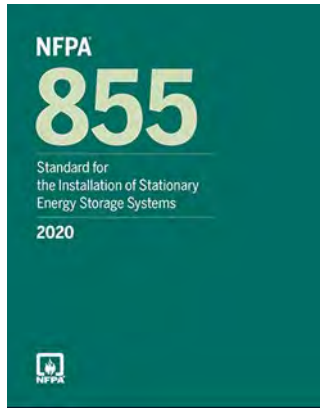
ESS Technology	Aggregate Capacity[a] kWh	MJ
Battery ESS		
Lead-acid, all types	70	252
Nickel including Ni-Cad, Ni-MH, and Ni-Zn[b]	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20	72
Flow batteries[c]	20	72
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESS		
Electrochemical double layer capacitors[d]	3	10.8
Other ESS		
All other ESS	70	252

[a]For ESS units rated in amp-hrs, kWh equals maximum rated voltage multiplied by amp-hr rating divided by 1000.
[b]Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), and nickel zinc (Ni-Zn).
[c]Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.
[d]Capacitors used for power factor correction, filtering, and reactive power flow are exempt

Lead Acid VRLA Threshold **70 kWh**

Lithium Ion Threshold **20 kWh**

Most 3 Phase Li-oN Battery Cabinets Are Above this Threshold

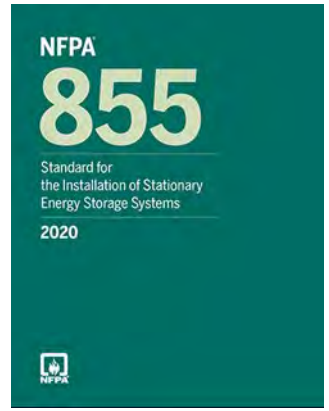


How Do we Get or Calculate the BESS kWh?

The Capacity of the BESS is Expressed in Terms of Total Amp-hours of Capacity the Battery System Contains.*

*Note Ah = the amount of current a battery can produce in a one-hour period.

You can get to total Amp-hours from the battery data sheets.



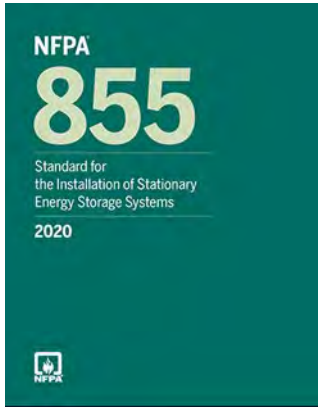
Sometime manufactures supply the kWh capacity of battery systems

Formula for Calculating kWh when Amp-hours (Ah) and Nominal DC Voltage battery Voltage are known

$$kWh = (Ah \times V) / 1{,}000$$

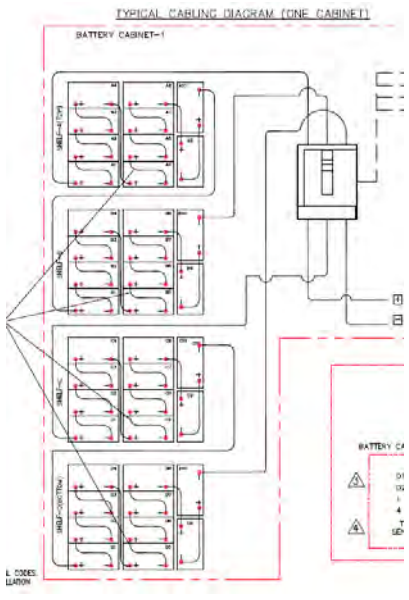
How Do we Get or Calculate the BESS kWh?

Example 100 kW UPS 480 VAC UPS, 10 Min. Run Time non-modular **VRLA batteries** in a single 40 battery string.
40 Leoch XP12-300FR Batteries (82 Ah and 12V DC)



Formula - kWh = (Ah x V) / 1,000

kWh per battery = (82 Ah x 12 v)/1000w/kW = .984 kWh per Battery
X 40 Batteries/Per String = **39.36 kWh.** Below 75 kWh NFPA Table 1.3



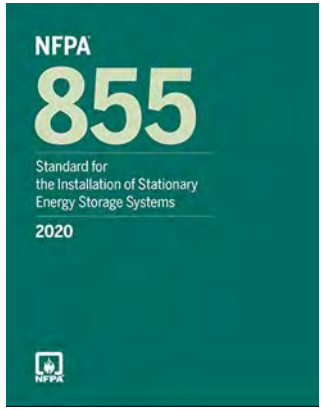
BATTERY RUNTIMES (minutes) at Full Load (calculated)				Classic Battery Cabinets								
				1x GVSCBT4			1x GVSCBT5			2x GVSCBT4		
				39" / 1000mm Wide			39" / 1000mm Wide			2x 39" / 1000mm Wide		
				40 Batteries (Leoch:XP12-300FR)			40 Batteries (Leoch:XP12-350FR)			40 Batteries (Leoch:XP12-300FR)		
			UPS SKU	PF 0.8	PF 0.9	PF 1	PF 0.8	PF 0.9	PF 1	PF 0.8	PF 0.9	PF 1
GALAXY VS (1 PM)	480V	20kW	GVSUPS20KGS	105.0	94.5	83.0	125.0	110.0	100.0	240.0	210.0	185.0
		30kW	GVSUPS30KGS	67.0	58.0	51.0	80.5	70.0	62.0	150.0	130.0	115.0
		40kW	GVSUPS40KGS	47.5	41.0	36.0	57.0	49.5	43.5	105.0	94.5	83.5
		50kW	GVSUPS50KGS	36.0	31.0	27.0	43.5	37.5	33.0	83.5	72.5	64.0
GALAXY VS (2 PM)	480V	60kW	GVSUPS60KGS	28.5	24.5	21.0	34.5	30.0	26.0	67.0	58.5	51.5
		80kW	GVSUPS80KGS	19.5	16.5	14.0	24.0	20.5	17.5	47.5	41.0	36.0
		100kW	GVSUPS100KGS	14.0	12.0	10.0	17.5	15.0	12.5	36.0	31.0	27.0
		10kW										

Installation Requirement Highlights… NFPA 855 Chapter 4 (2020 Edition)

Table 4.4.2 Indoor ESS Installations:

Compliance Required	Dedicated-Use Buildings[a]	Non-Dedicated-Use Buildings[b]	Reference
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.3
Size and separation	Yes[c]	Yes	Section 4.6
Maximum stored energy	No	Yes	Section 4.8
Elevation	Yes	Yes	4.3.9
Separation	NA	Yes	4.3.6
Smoke and fire detection	Yes[d]	Yes	Section 4.10
Fire control and suppression	Yes[c]	Yes	Section 4.11
Water supply	Yes[c]	Yes	Section 4.13
Signage	Yes	Yes	4.3.5
Occupied work centers	Not allowed	Yes	Section 4.7
Technology-specific protection	Yes	Yes	Chapters 9–13

Select Sections from NFPA 855 2020 Edition



4.3.6 Separation. Rooms or spaces containing ESS shall be separated from other areas of the building by fire barriers with a **minimum 2-hour fire resistance rating and horizontal assemblies with a minimum 2-hour fire resistance rating**, constructed in accordance with the local building code.

4.3.9 Elevation ESS shall be located only on floors that can **be accessed by external fire department laddering capabilities** unless a higher location is approved by the AHJ.

UPS with VRLA Exception:

4.11.5 Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with UL 1778, utilized for standby power applications, which is limited to not more than **10 percent of the floor area on the floor on which the ESS is located, shall not be required to have a fire suppression system installed**.

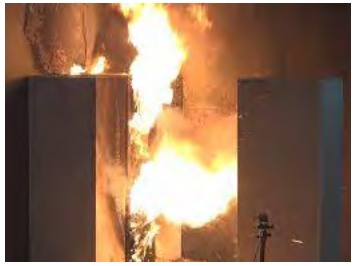
Additional UPS and BESS Standards and Tests

UL 1778 UL Standard for Safety Uninterruptible Power Systems

This Standard specifies requirements intended to ensure safety for the Operator and, where specifically stat
for Service Personnel.

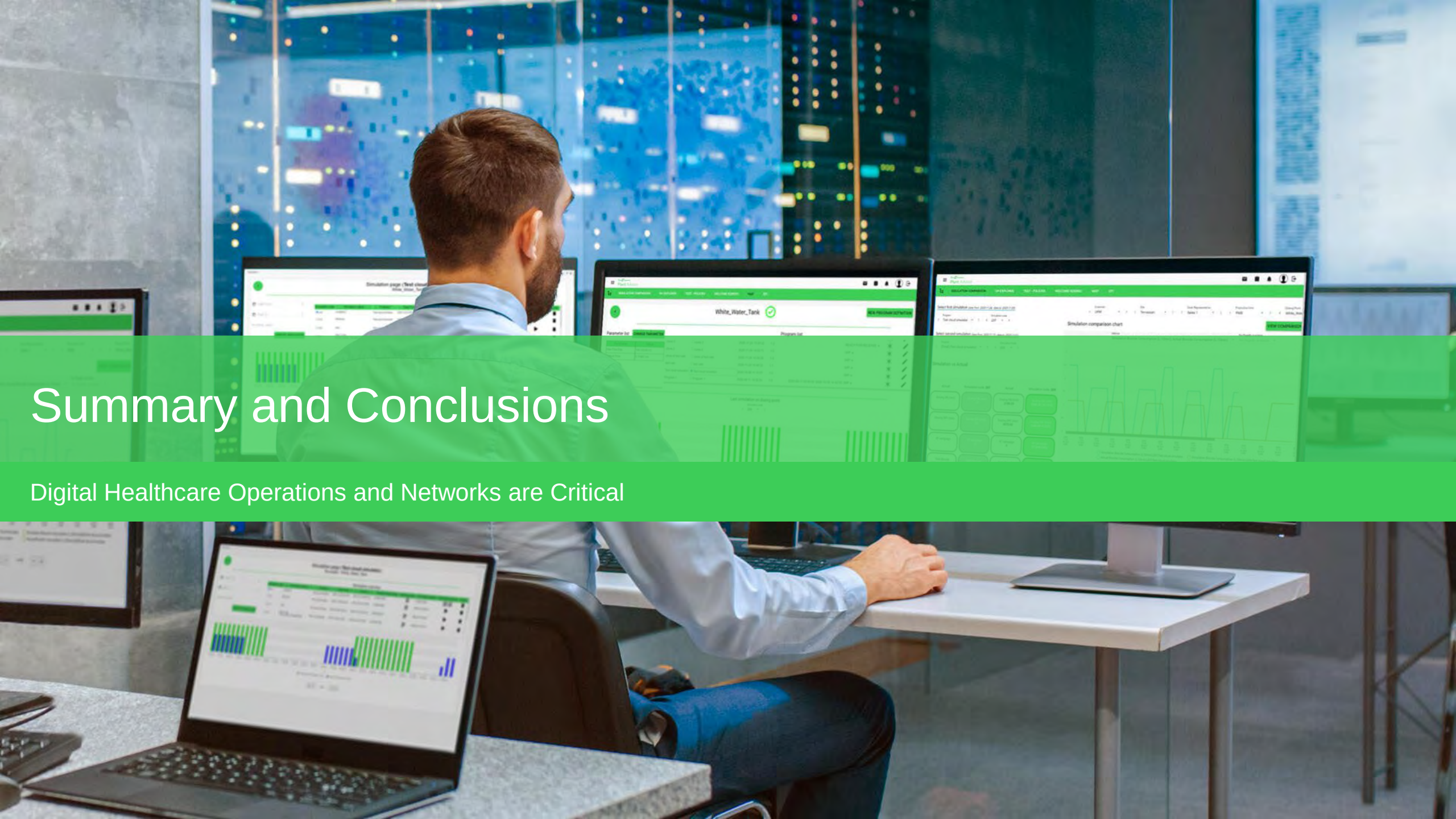
This Standard is intended to reduce the risk of fire, electric shock, or injury to persons from installed equipment, both as a single unit or as a system of interconnected units, subject to installing, operating, and maintaining the equipment in the manner prescribed by the manufacture

UL 1973–Li-Ion Battery & other system listing for UPS applications



UL9540A test –Test method for evaluating Fire Propagation in Battery Energy Storage Systems – Actually Forced Into Failure!
Passing allows up to 600 kWh of Batteries to Be Grouped Together

- **UL 924** Standard for Safety of Emergency Lighting and Power Equipment. – Must keep Emergency Lighting on for **90 Minutes**.
  Applied where Generator Is Not Present or Does Not Set for Emergency Power Requirements. UPS can be used if Listed

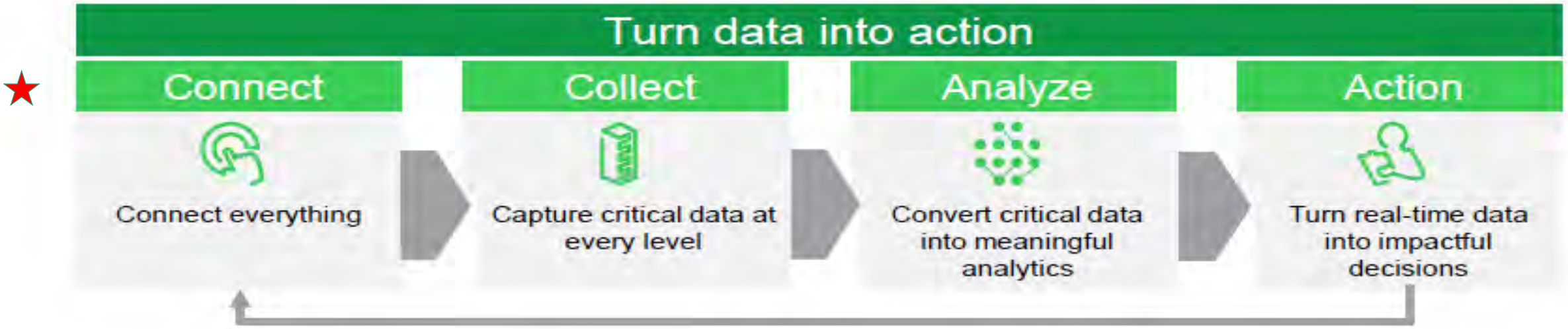


Summary and Conclusions

Digital Healthcare Operations and Networks are Critical

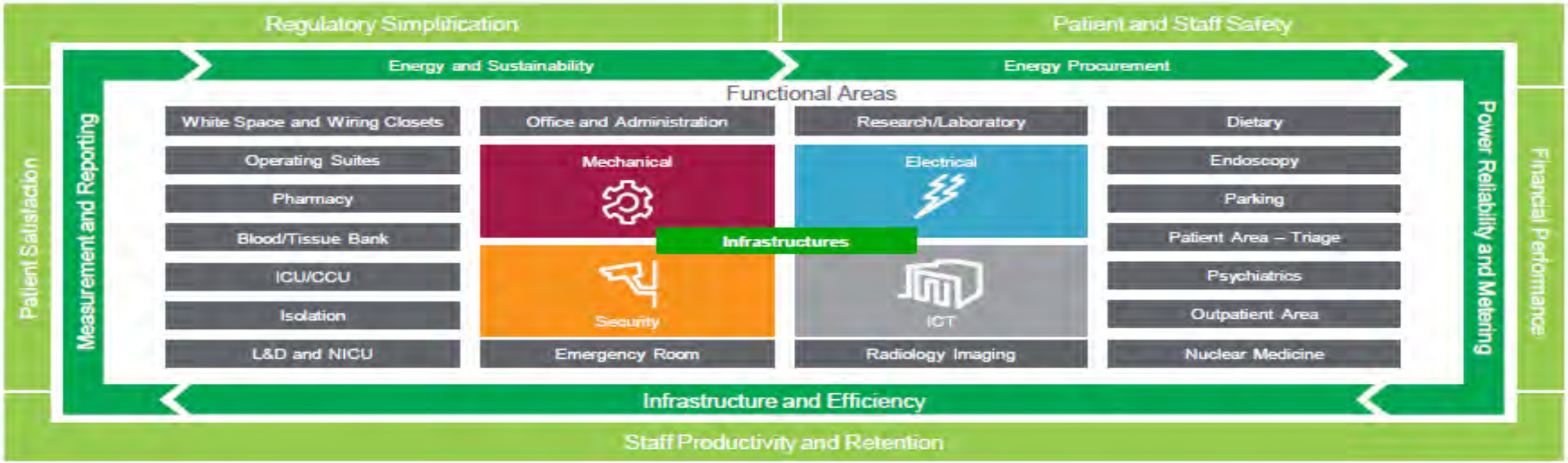
Summary – Resilient Power Systems and Networks Are A Must to Enable Data to Become Actionable

EcoStruxure™ Innovation At Every Level for Healthcare



Integrated Healthcare is a Continuous Journey Requiring Flexibility and Input from the Entire Organization

Impact on Business Priorities



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Summary

HealthCare Innovation Using IOT, IIOT, Automation, Computing, Streaming and Data Collection & Storage are Driving The Need For More Security and Reliable Power Systems to Support These Demands

Changing Technology & Safety Concerns are Driving Several Codes & Standards that Apply to UPS and Battery Energy Storage Systems(BESS), Especially Lithium Ion and Other Newer Battery Technologies

Integrated Digital Healthcare is Here to Stay si Resilient Power Systems and Networks are Critical for Safety & Continuity

Helping Customers with Electrification and Digitization of Healthcare for Tomorrow.

Questions?

Thank You!

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And Power System Specialist
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