POWER AND COOLING CONSULTANTS MASTER CLASS 2016

HITTING THE GREEN MARK:

BEST PRACTICES IN DATA CENTER OPTIMIZATION

EMERSON
Network Power

Efficiency Through Thermal Management and Monitoring (iCOM-S)

Wong Chat Wai

Application Manager

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Network Power

Agenda

- Thermal Management Control
- Product Introduction
  - ICOM Family : ICOM-S, ICOM, Wireless Sensor
- Green Mark Point Allocation
- Pre Site Assessment
  - Prerequisite Site Technical Info
  - Site Assessment and Verification
  - ICOM-S Design and Sizing
- Site Implementation Work
  - Pre Site Installation Work
  - Site Installation
  - Data Collection(Before Optimization)
  - Site Adjustment and Improvement Work(Continue)
  - Data Collection(After Optimization)
- Case Study



Control

Thermal Management Control

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Why are Controls Important?

Controls are THE key component to saving energy while continuing to provide reliable operation for your data center

Mechanical Design + Sequence of Operation = **Desired Operation**

All aspects of a data center design are affected by controls

Startup & Commissioning issues typically caused by poorly tested routines

Market and Customers

- Market Trends
  - Moving from Unit to Component to System optimization
  - Focus to make complex systems simple
  - Moving from Automation to Autonomy
  - Growing benefits of comprehensive control solutions
- Customer Expectations
  - Protection and Reliability
  - Simple / Easy & Maintainable (Open Protocols)
  - Cost Effective and Quick ROI
  - Information to become smarter and make better decisions
  - Single pane of glass
  - Quickly respond to market needs
  - Great support and response to issues

Thermal Management Controls

iCOM®-S
Room Supervisory Control

Customer Benefit

1. Up to 50% energy savings
2. Reduce Installation by 30%
3. Insight for action
4. Flexible and sustainable
5. Protection and Security



Feature

1. Teamwork / Optimized Aisle
2. Integrated SW & HW
3. Metrics – efficiency & capacity
4. Wireless & Wired Sensors
5. Built in encryption and failover

The New iCOM
Unit Control

1. Highest equipment protection
2. 10-20% higher efficiency
3. 20% Faster deployment
4. Easy to use
5. Insight and Notification



1. Self Healing routines
2. Integrated economizer routines
3. Backdraft dampers
4. Wizard setup & auto help
5. 9” display and BMS protocols

iCOM Controls Architecture

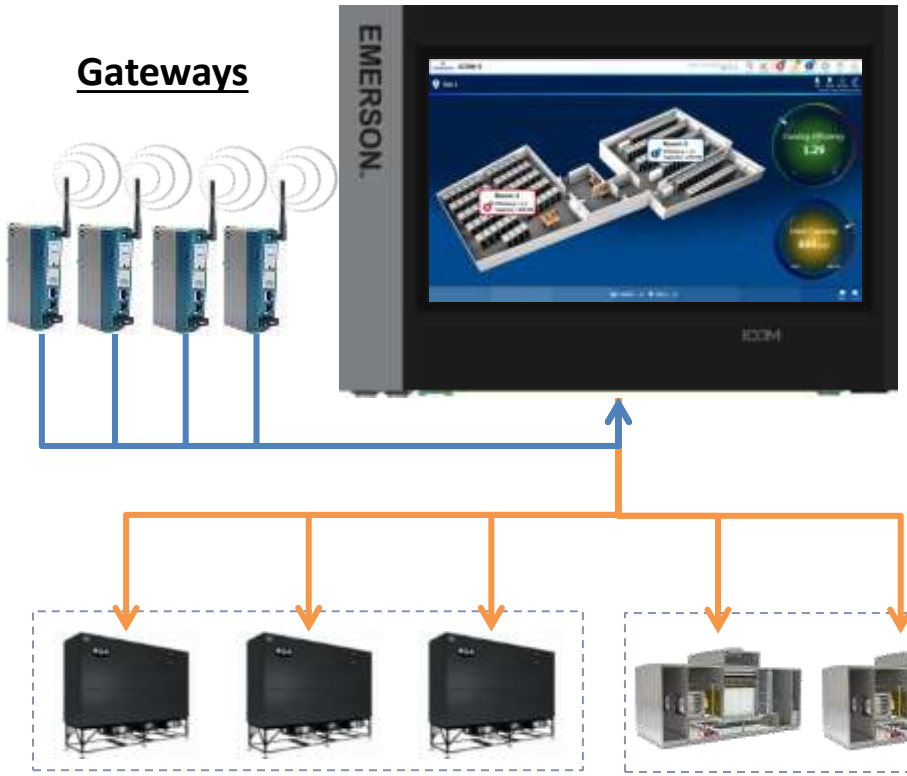


iCOM Wireless

- Auto Configuration
- Secured with 128 bit encryption
- Resilient - Self Healing
- Scalable Mesh Network

SUPERVISOR

UNIT



iCOM-S

- Monitors space temperatures
- Direct M2M Integration
- Key metric summaries
- Alarm management
- Historical analysis of data

iCOM

- Unit / Component protection
- Fallback mode if wall display disconnects



Green Mark

Point Allocation

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Green Mark Point Allocation

BCA-IDA Green Mark for New Data Centres (Version NDC 1.1)

POINT ALLOCATION

	ASSESSMENT CRITERIA	POINT ALLOCATIONS
ENERGY EFFICIENCY		
Minimum 35 points to be scored	**Part 1 – Energy Efficiency**	
	1-1 Overall Energy Efficiency - Maximum Design PUE[1] - PUE Improvements over Reference Model (Full Load and Part Load)	 10 15
	1-2 Systems Energy Efficiency - Cooling System (including Air Management System) - Electrical System - IT Equipment	 12 8 8
	1-3 Energy Efficiency and Performance Verification - Commissioning of Energy Systems - Measurement and Verification Plan - Energy Metering and Reporting of PUE	 4 3 3
	1-4 Data Centre Design and Energy Management - Data Centre Planning and Design - Data Centre Operations and Energy Management	 5 5
	1-5 Energy Efficient Features and Innovations	10
	SubTotal (Part 1)	**83**

Proposed Data Centre Facility Energy Model

The computer simulation of the data centre facility and systems shall be carried out with an approved energy modelling software. A typical building energy modelling program may be used with the following enhancements:

a) The program must be able to accept a high proportion of internal loads from electrical equipment

b) A separate calculator shall be used to estimate the losses in the power supply chain (transformers, switchgear, UPSs and PDUs.) under various load conditions. These losses shall then be included as additional internal loads, dissipated as heat, at the appropriate spaces housing such equipment.

c) The system configurations must be able to accept redundant equipment and sequencing arrangements that enable the spare equipment capacity to be on "hot" standby, i.e. running together with base capacity.

Calculate the proposed data centre performance using the energy modelling software at full load, 66% and 33% load. Determine the PUE and compare with the reference model to obtain the improvements in energy performance at the various load points.

The energy performance improvements may come primarily from facility infrastructure design, selection of equipment, their capacities and part-load characteristics and how they are operated. Savings related to the energy use by the IT equipment will not be assessed in the model. The designer may use the opportunity to determine the optimum operating configuration of equipment and systems in terms of energy performance but must commit to the selection in the submission, which will be subject to verification in accordance with section 1-3.

1-3 Energy Efficiency and Performance Verification	
1-3-1 Commissioning of Energy Systems	(4 points)
To verify that the data centre's energy related systems are installed, calibrated and perform according to the owner's project requirements, basis of design, construction documents and that they meet the minimum requirements of the Green Mark criteria. Commissioning shall be carried out at multiple load points (33%, 66% and 100%) and under normal utility operations, maintenance operations and failure conditions. The commissioning shall include verification of the Power Use Effectiveness (PUE) according to the design criteria at partial and full load conditions.	
1-3-2 Measurement and Verification Plan	(3 points)
The purpose of a measurement and verification plan is to have the ability to reconcile the actual data centre energy consumption over time with the design performance. Develop and implement a measurement and verification (M&V) plan. The M&V period must cover at least 1 year of post-construction occupancy. Using the partial (33%, 66%) and full load design projections and commissioning results, compare actual operating conditions to the plan, and provide a narrative to summarize performance, explaining where results vary from plan and including average hourly PUE.	



iCOM - S

Supervisory Control

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iCOM-S
The Next Generation of Supervisor Control

1. *Harmony and Efficiency*: Advanced M2M teamwork with up to 50% energy savings
2. *Insight for Action*: Full floor plan, real time visibility and analytics through a 22” high definition wall display
3. *Simple Deployment*: Integrated hardware and software provide seamless setup and installation
4. ***Protection and Security***: Advanced monitoring, alarming and system protection

- ***iCOM-S* is the single point to *connect, collect and optimize thermal system performance***
  - ***Simple setup and sensor (wireless or wired) integration***
  - **Gateway between Units and DCIM**



1. iCOM-S Harmony & Efficiency

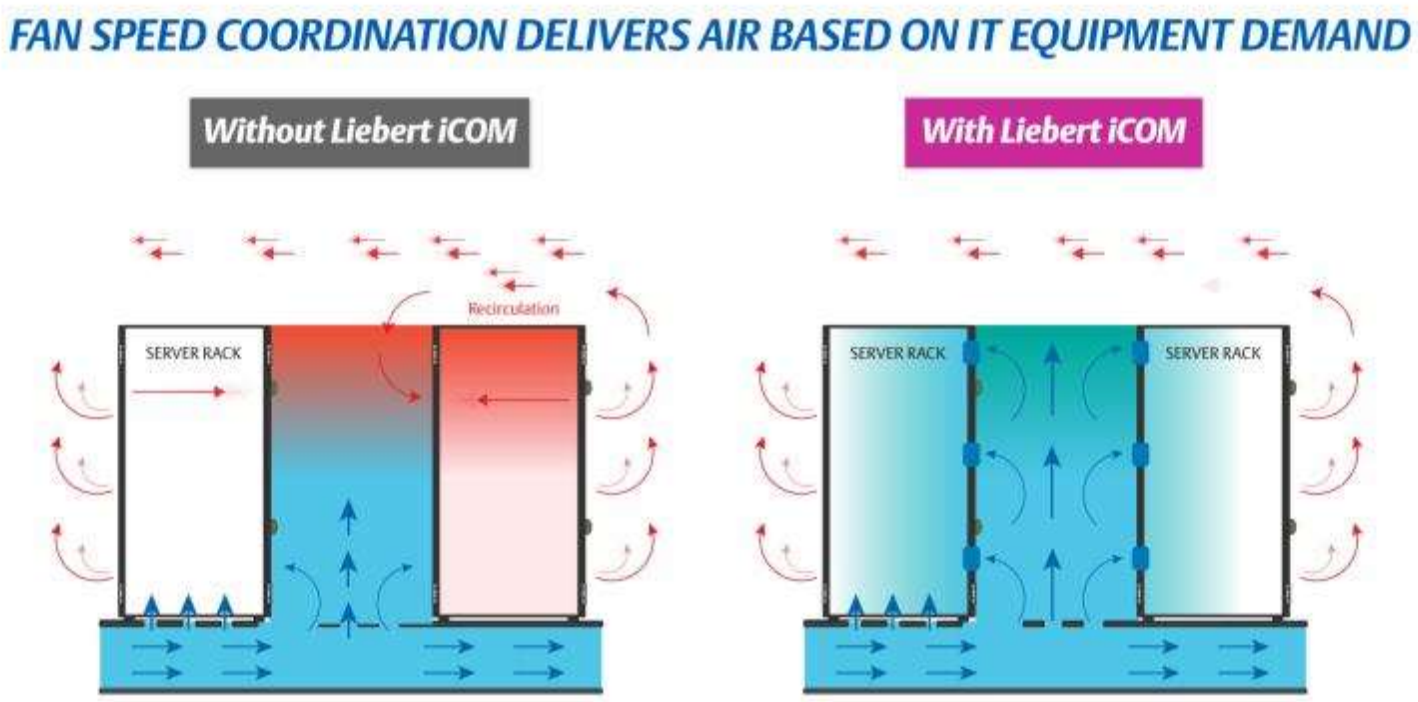
Central point to collect, process and control cooling in the data center

- Advanced M2M Teamwork with wireless sensor integration
  - Unit to Unit coordination for cooling mode and capacity output
  - Monitor, control and match IT equipment
- Airflow and Temperature coordination
- Shared sensor information across groups to reduce temperature variations
- Auto deactivation of un-needed units in low load conditions
- Supply compensation adjust leaving air temperature to delay activation of a standby unit

Save up to 50% of your energy

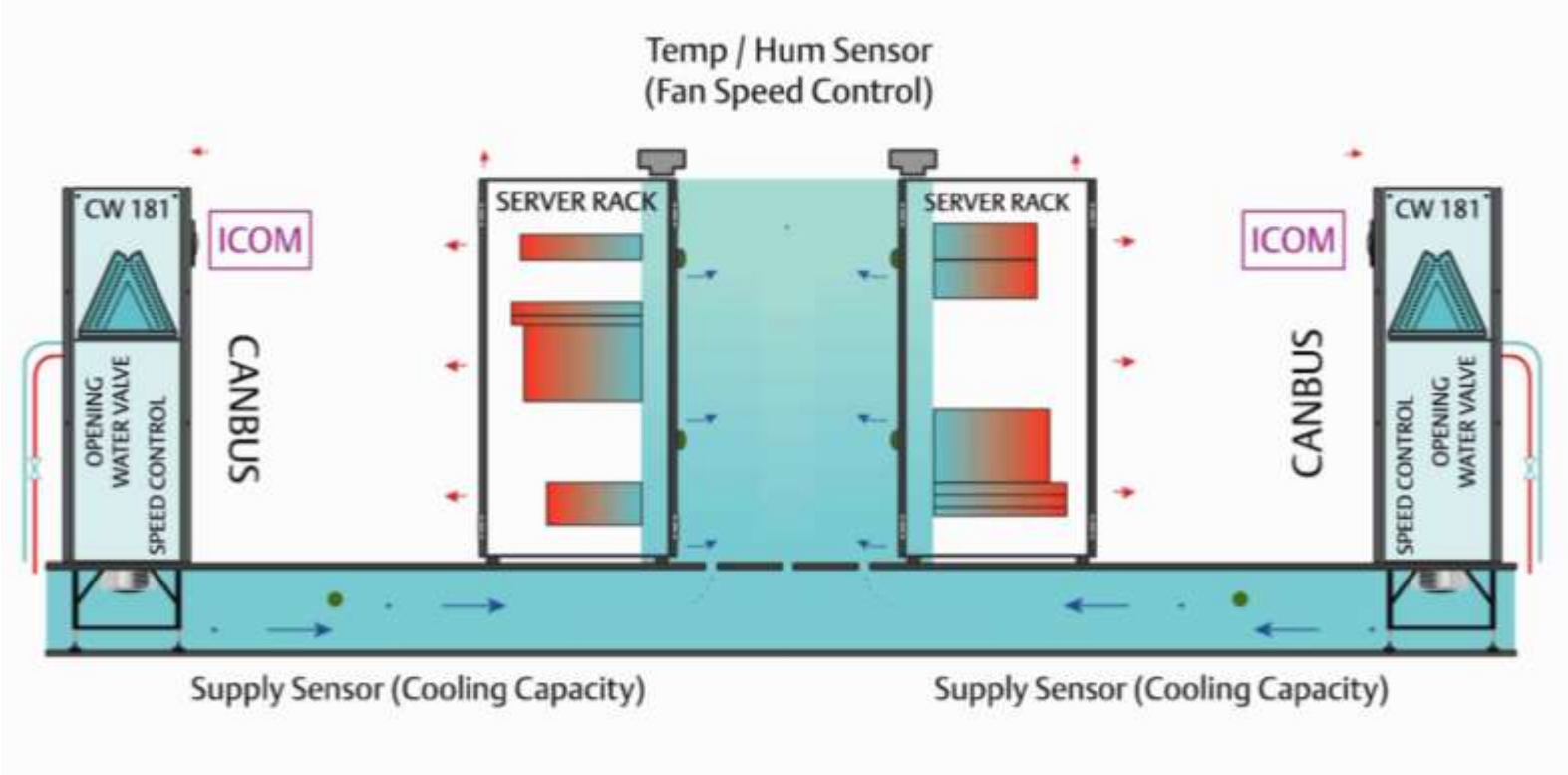


Direct Control over IT Inlet

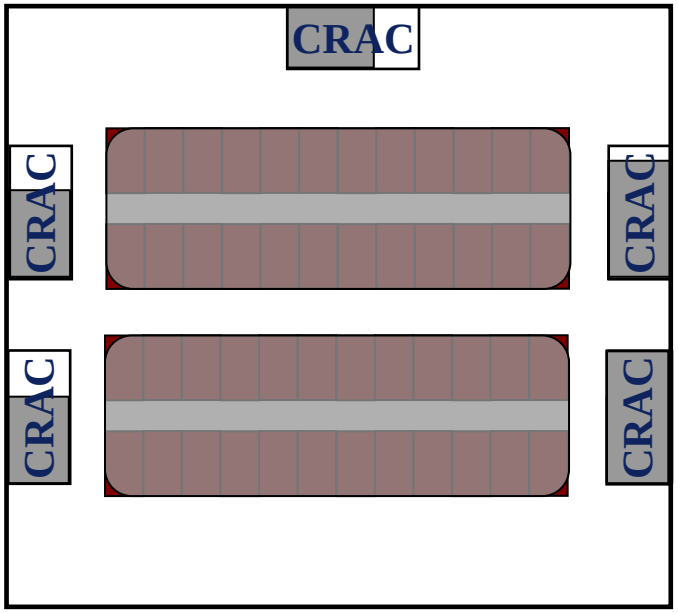


Eliminate unwanted hot aisle recirculation into cold aisle by providing the correct amount of airflow

Optimized Aisle



Teamwork – Variable Speed

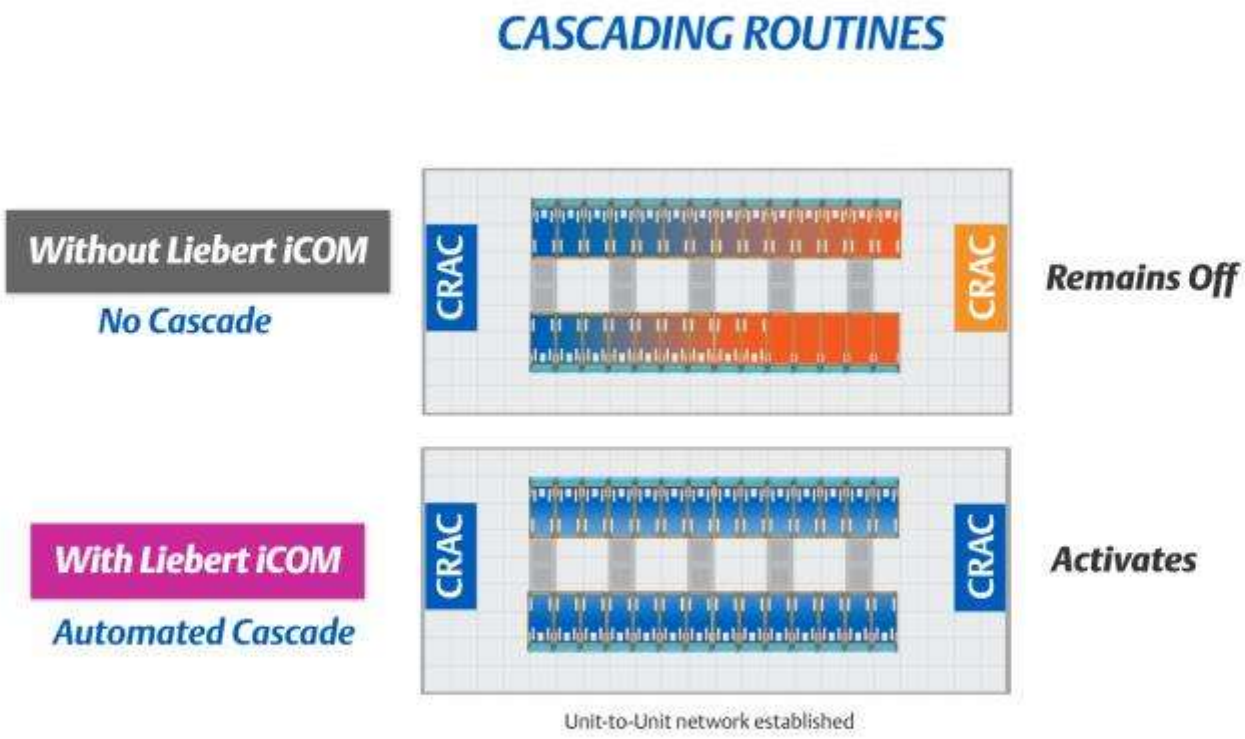


M2M CONTROL FOR ENERGY SAVINGS

	Without Liebert iCOM	With Liebert iCOM
Energy Savings		40%
Energy $ / Year	$19,216	$11,540
Unit 1 Fan Speed	30%	60%
Unit 2 Fan Speed	35%	60%
Unit 3 Fan Speed	80%	60%
Unit 4 Fan Speed	100%	60%
Unit 5 Fan Speed	60%	60%
Total CFM	122,000	122,000

Fan speed coordination balances unit loading and decreases overall energy usage

Cascade Routines



Automate cooling unit activation and deactivation based on IT load in the space

2. iCOM-S Insight for Action

Visibility into your Thermal System

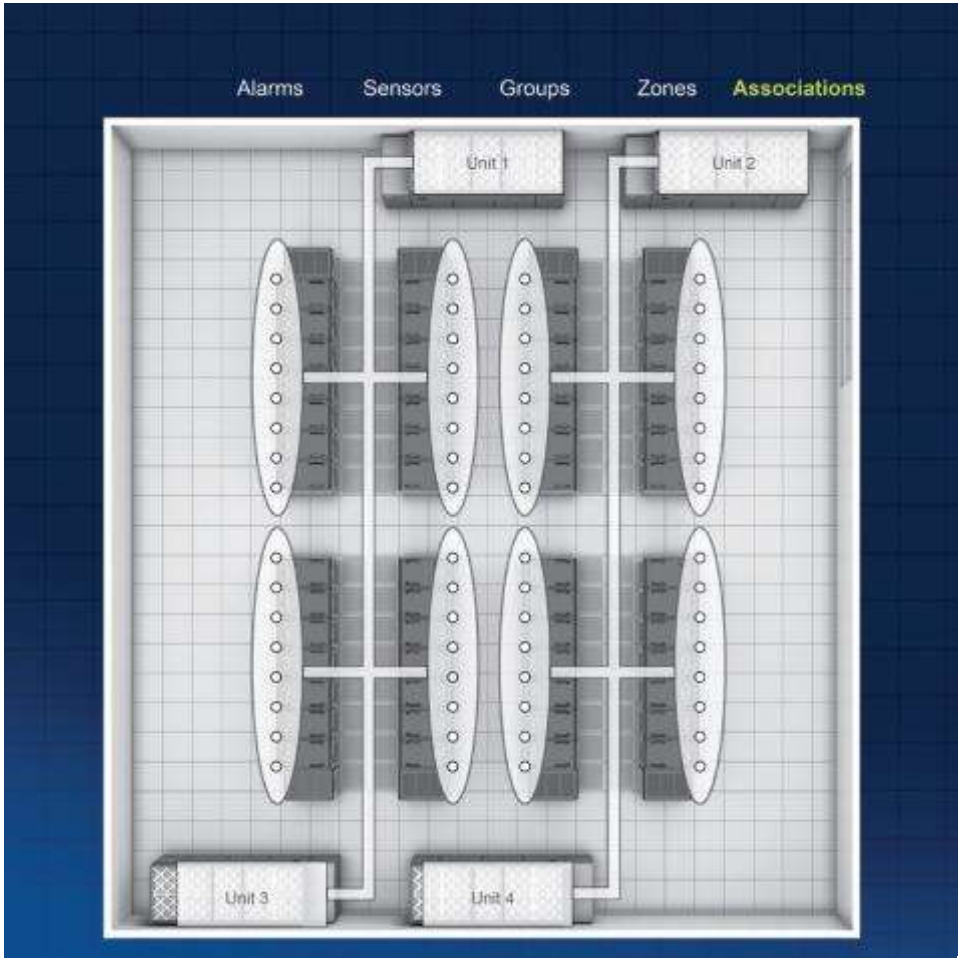
- Advanced Monitoring: Visibility into Unit, Room and Site status
- Floorplan visual thermal map and set event thresholds & alarms
- Efficiency, Capacity and System Performance Monitoring
- Alerts for unit and sensor exceeded thresholds
- Historical trends updated every 30 seconds so key data is logged
- Add up to 4800 sensor points into your data center

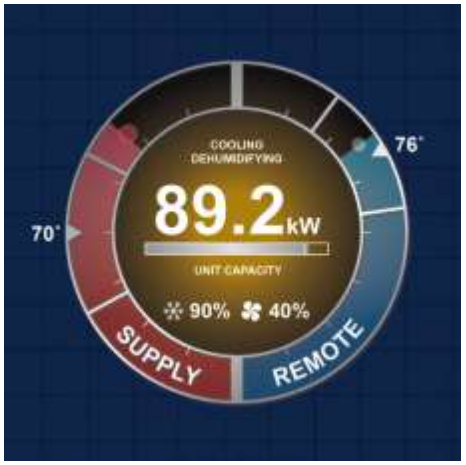


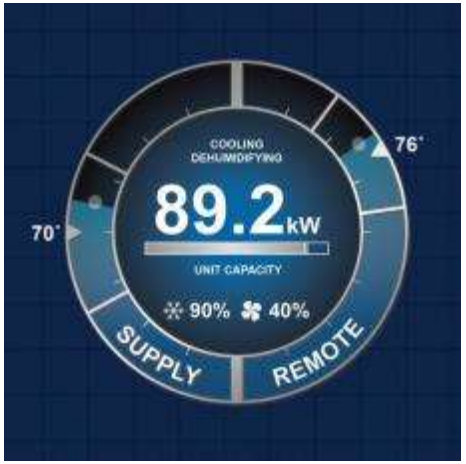
Trends and Key Metrics



Real Time Indicators





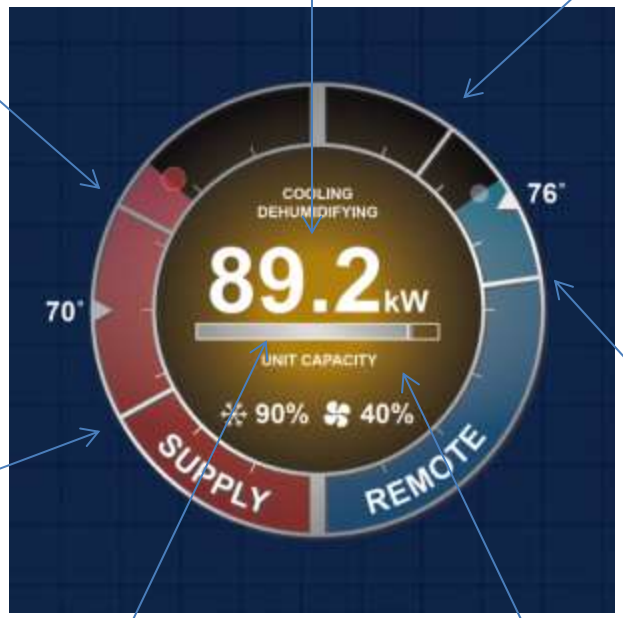


Dials Display

Max Recommended Supply Air Temperature

Current Metric Value

Max Recommended Return Air Temperature



Min Recommended Supply Air Temperature

Min Recommended Return Air Temperature

Visual Reference to where current metric is compare to recommended or available

Dial Background (Blue if good, Yellow if out of Range or Alarm

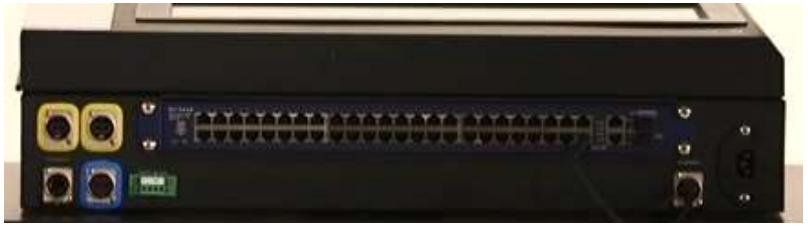
3. iCOM-S Deployment

Simple Setup and Installation

- Auto sensor detect and configuration
- Single wall plug in connection
- Integrated cable management and wall mount bracket
- DIN Rail bracket for quick gateway installation
- Stand alone floor plan tool
- More than 40 Ethernet ports to connect gateways and equipment
- Import new configurations and floor layouts in less than 5 minutes
- Simple software upgrades as new features are released

Reduce installation cost by 30%





Easy Floor Plan Setup

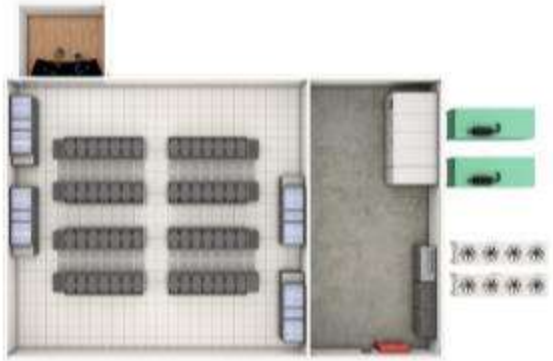
OPEN PLATFORM
Quickly import floor plans

Without Liebert iCOM

Build floor plan in vendor tool
More than 4 Hours

With Liebert iCOM

Import floor plan
Less than 30 Minutes



Keep your graphics and database updated as your data center evolves without costly 3rd party technician involvement

Deployment – Auto Configuration

Time to Deploy

(500kW Site)

200 Sensors, 36 units, 6 groups

52% Reduction
~$35,000 Savings in labor

??? Days
Stand Alone

3rd Party

Which Data Points
Point Mapping
Point Description



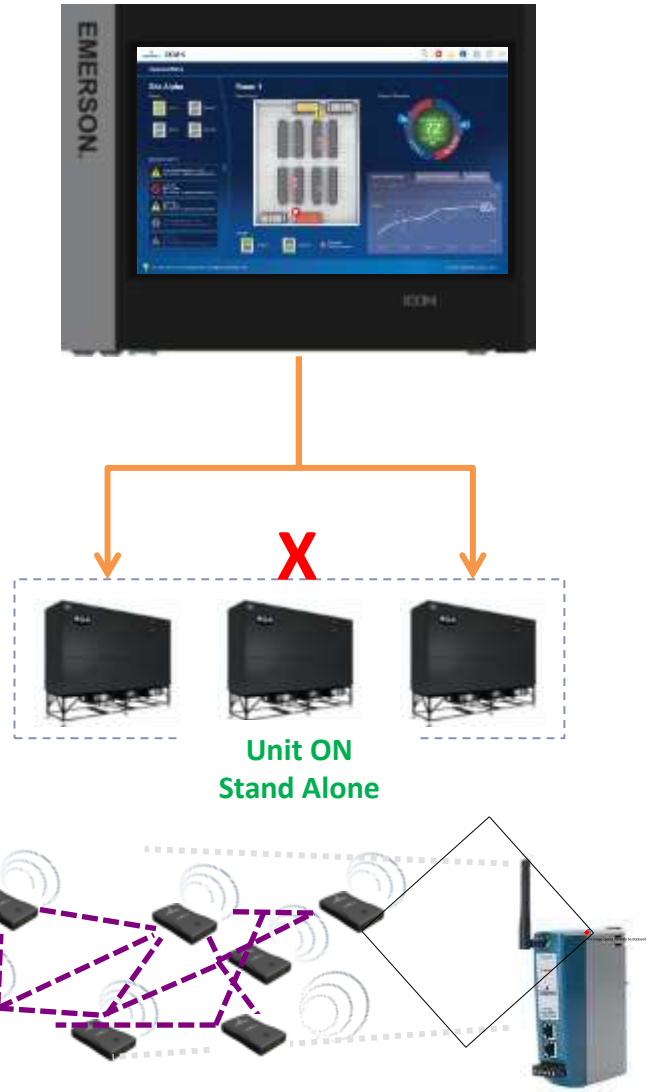
2 Days
Integrated



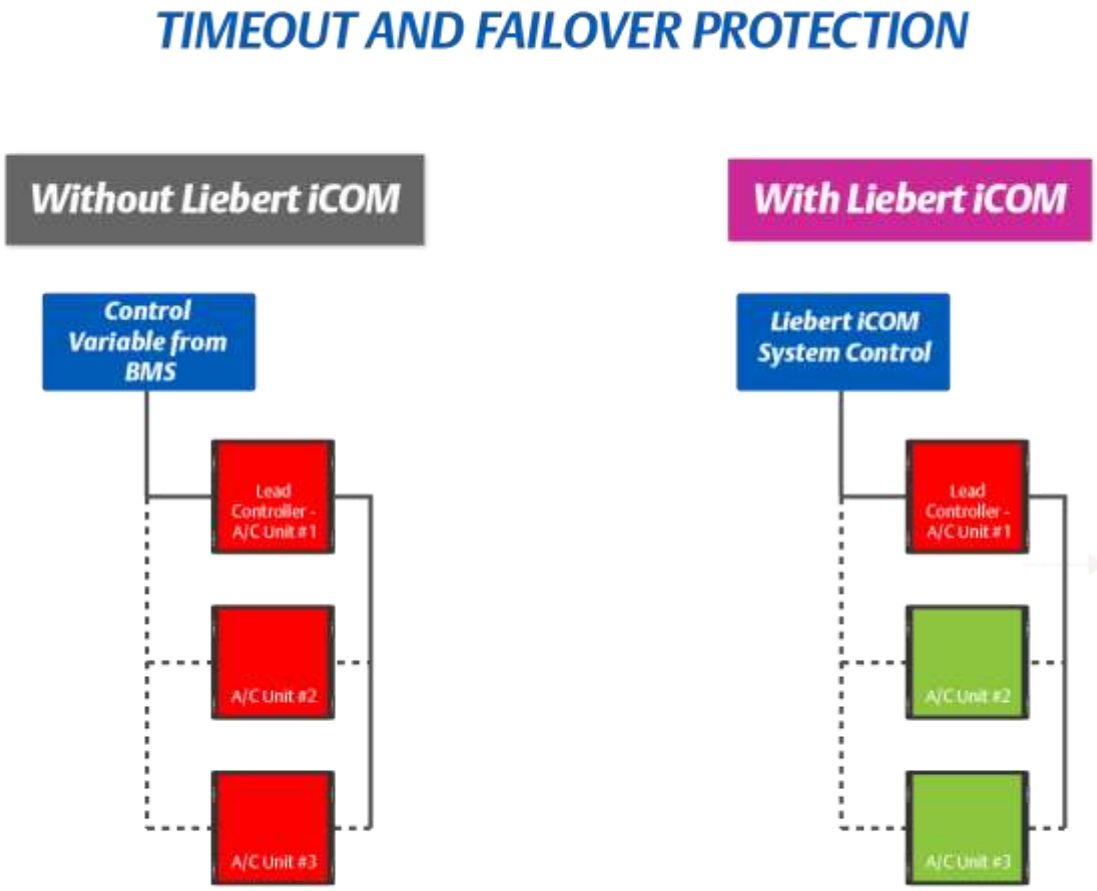
4. iCOM-S Protection & Security

***Defend against** downtime and threats*

- Built in disconnect and failure redundancies eliminate downtime
- Built in account management and user accounts prevent human error
- Disaster recovery through USB Backup
- Wireless
  - 128 bit wireless sensor encryption
  - Wireless network self heals
  - Channel hoping prevents other wireless networks from interfering
- Wired
  - Redundancy in case of wireless failure
  - Sensor accuracy / out of range checks

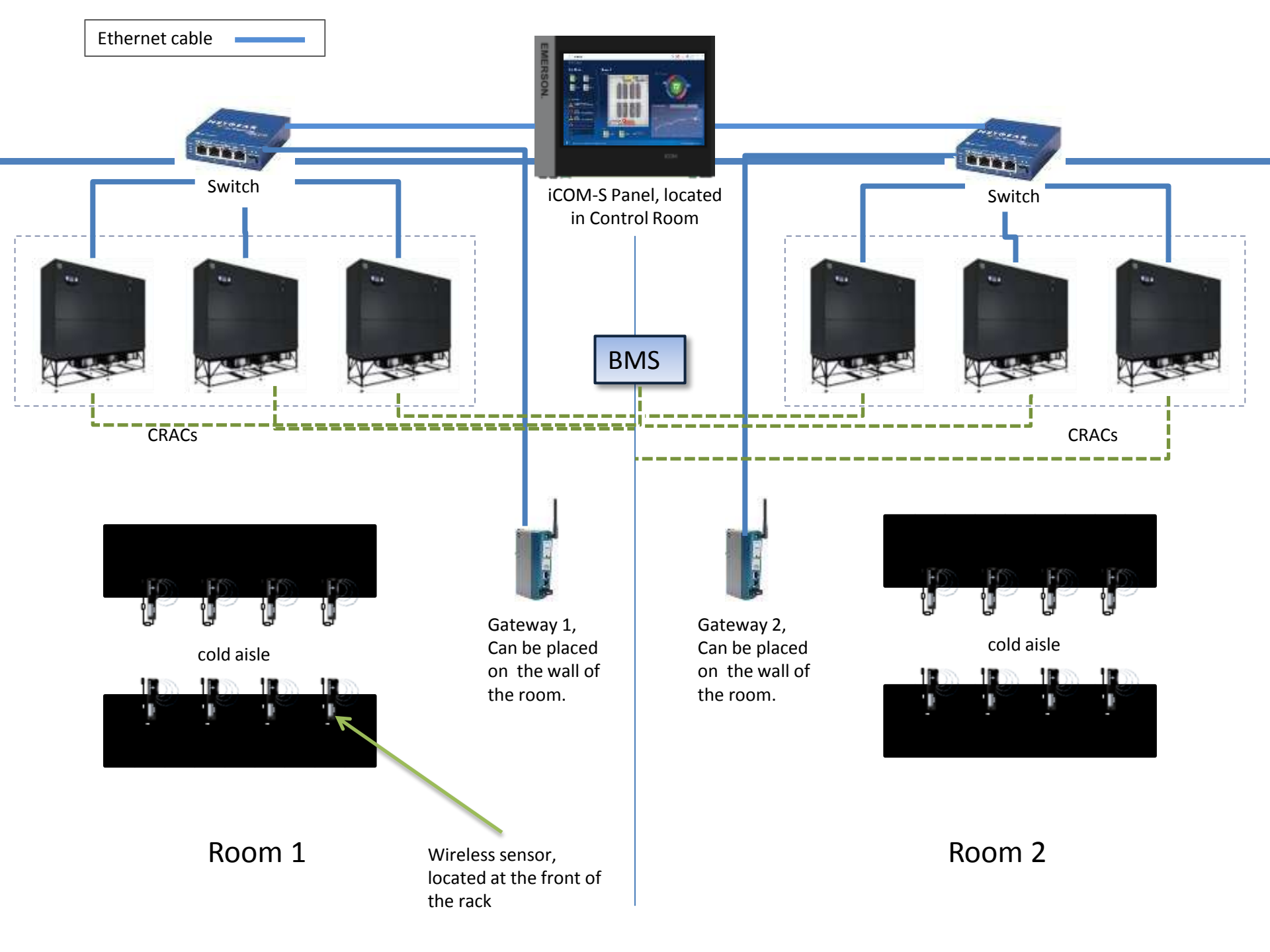


Timeout and Failure Protection



Lead controller failure results in all units down

Lead controller failure, next unit takes over

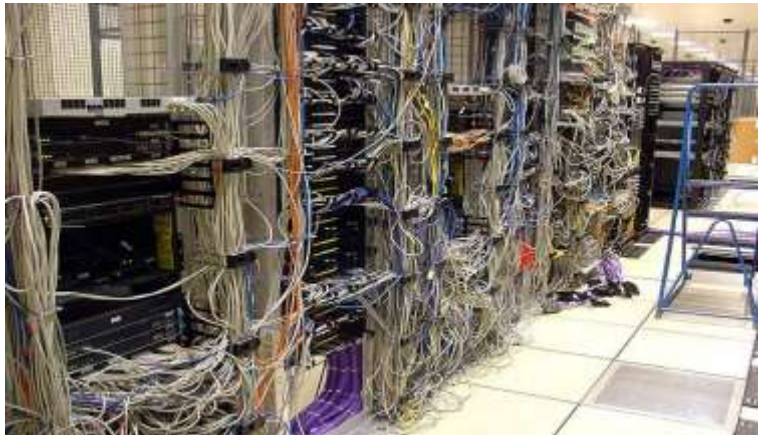

Ethernet cable
Switch
iCOM-S Panel, located in Control Room
Switch
BMS
CRACs
CRACs
cold aisle
Gateway 1, Can be placed on the wall of the room.
Gateway 2, Can be placed on the wall of the room.
cold aisle
Room 1
Wireless sensor, located at the front of the rack
Room 2

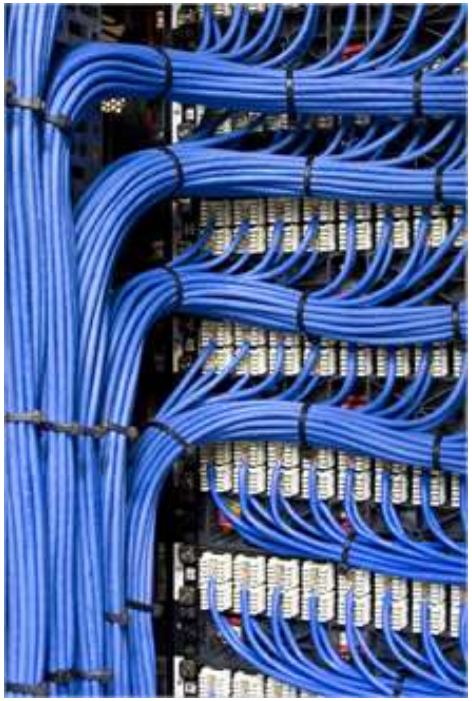
Wireless Sensor

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Data Center Cabling (It's complex enough!)

- We don't need more wires
- Installation and maintenance costs
- Scalability and Flexibility issues









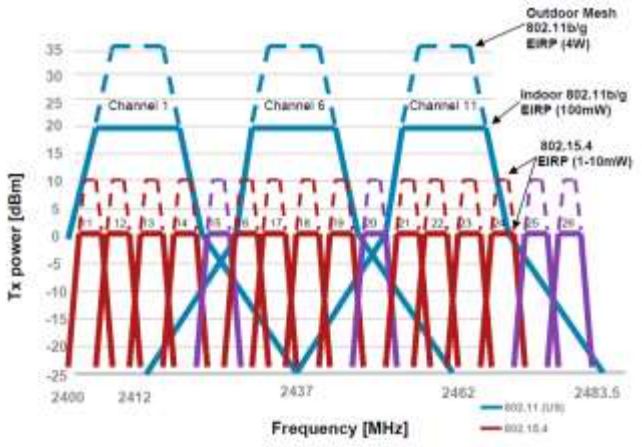
Not all Data Centers are created equal

Emerson Wireless Solutions Bring High Reliability

Reliable Data Transmission

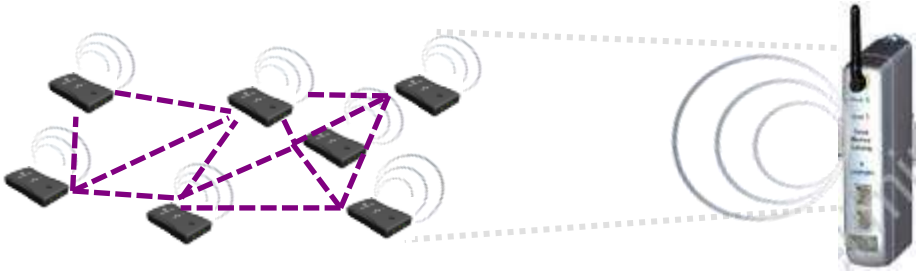
Greater than 99% Reliability

- Redundant Gateways and Communication Paths
- Coexistence and Noise immunity
- Devices talk to each other and find best communication path
- Self organizing and Self healing Mesh
- Supports multi-hop communication



Coexistence with 2.4GHz ISM devices

Wireless Sensor Devices | **Wireless Gateway** | **Control System**

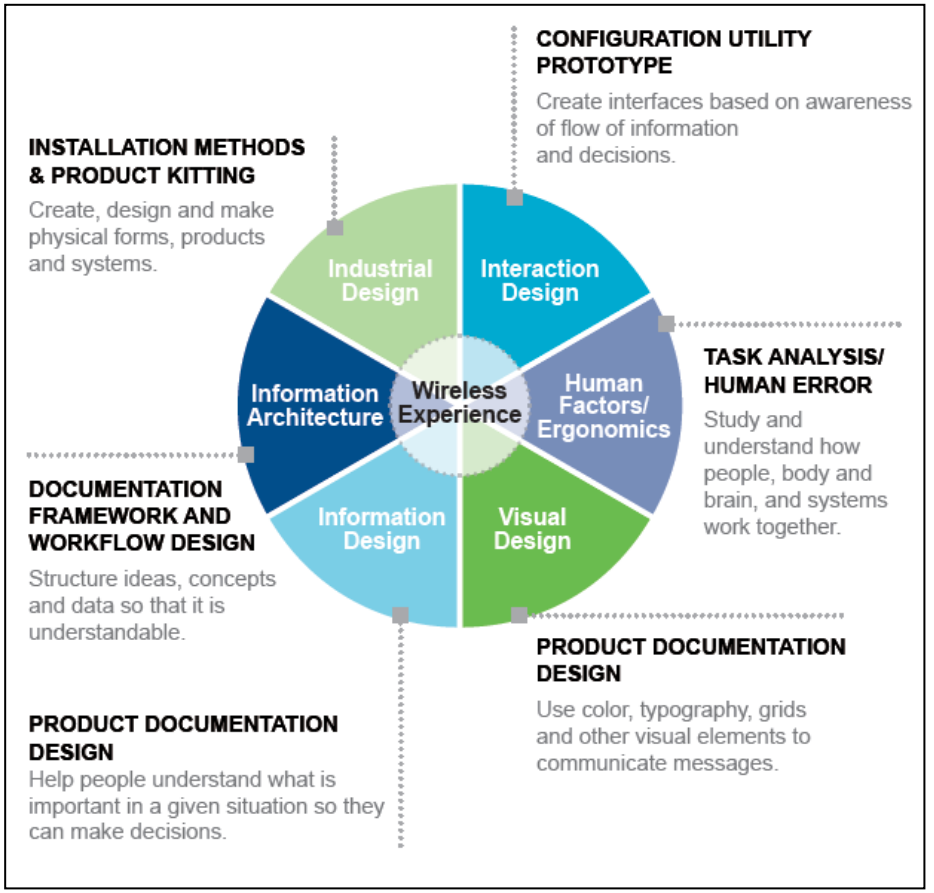


Wired To Control System (e.g.; iCom)

Wireless Sensors are Flexible and Scalable

Easy To Reconfigure & Expand

- Based on Open Protocol WirelessHART® IEC62591
- Human Center Design for ease of deployment
- Documentation and Configuration Tools available
- Deployment workflow streamlined
- Start Small With Limited Investment
- Expand Seamlessly When Ready



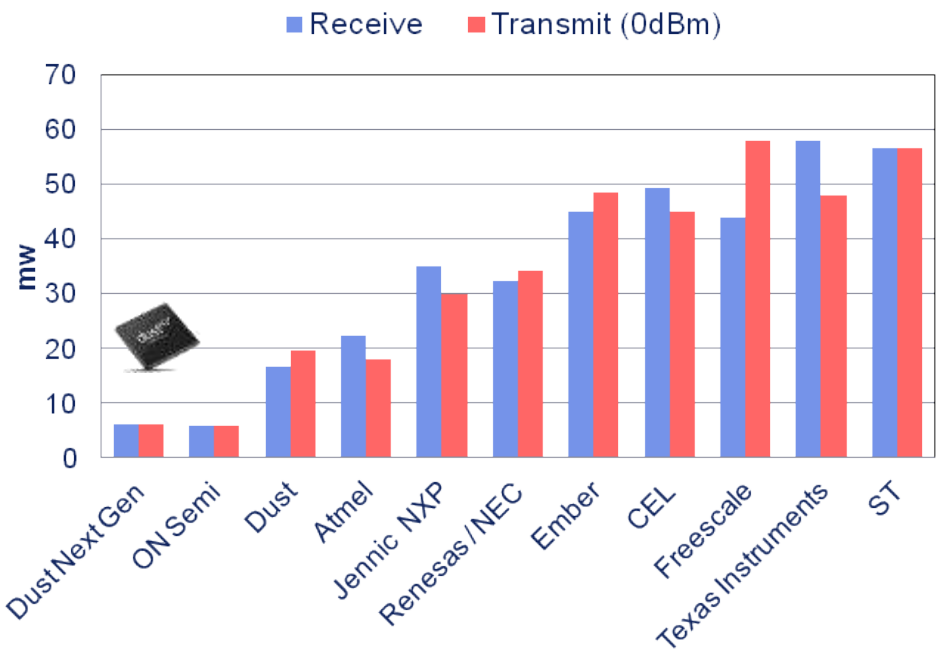
Ultra Low Power Consumption Enables Long, and Maintenance Free Operation

Optimized Run Time

- Dust/Linear WirelessHART chipset



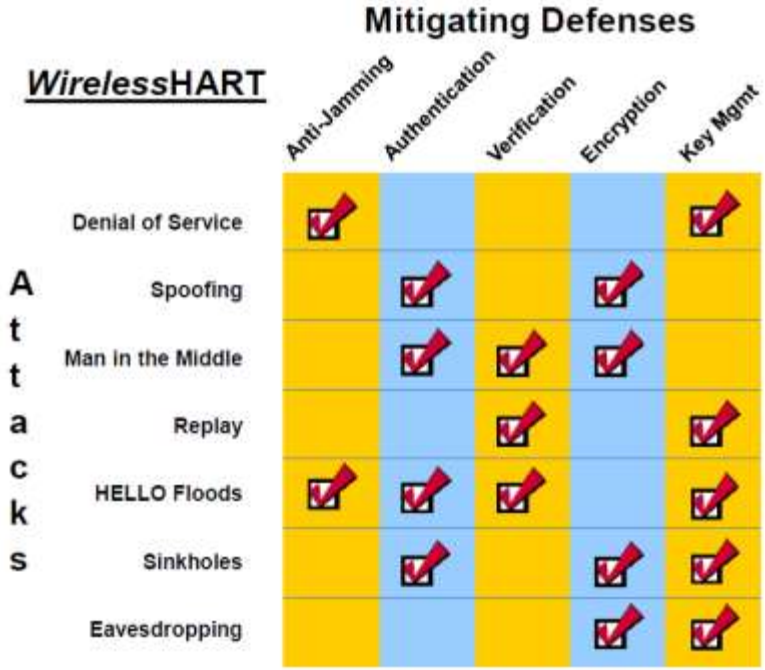
- Power Usage Is 10 Times Lower Than Other Wireless Solutions That Consider Themselves “Low Power”
- 5+ Year Battery Life Through Scheduled Wake-Up and TDMA



Emerson Wireless Solutions Provide Comprehensive Security

Secure Network Communication

- Channel Hopping, Multi Path Routing and Anti Jamming
- Built In and Always On AES 128-Bit Encryption
- Automatically Rotating Enryp. Keys
- Each Gateway Maintains List of Devices Allowed To Communicate
- Message Integrity Codes Are Used To Verify Messages



WirelessHART Is Recommended By U.S. Homeland Security, Idaho National Labs and Carnegie Mellon University

Pre Site Assessment

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Pre Site Assessment

Prerequisite Site Document

- DC Layout
- Unit Information : Brand, Model, Type
- Thermal Unit Sensor Placement
- Thermal Unit power tap-off DB/BTU Meter(Cooling Load)

Site Assessment and Verification

- Check equipment placement /location
- Verify the model/Type for the Cooling Unit Component
- Verify Sensor and Rack Position
- Verify Chiller Piping Routing and Valve Type

ICOM-S Design & Sizing

- Determine the Wireless Sensor & Gateway location and quantity
- Determine ICOM-S location
- Determine work & execution plan

Site Implementation Work



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Site Implementation Work

Pre Site Installation Work

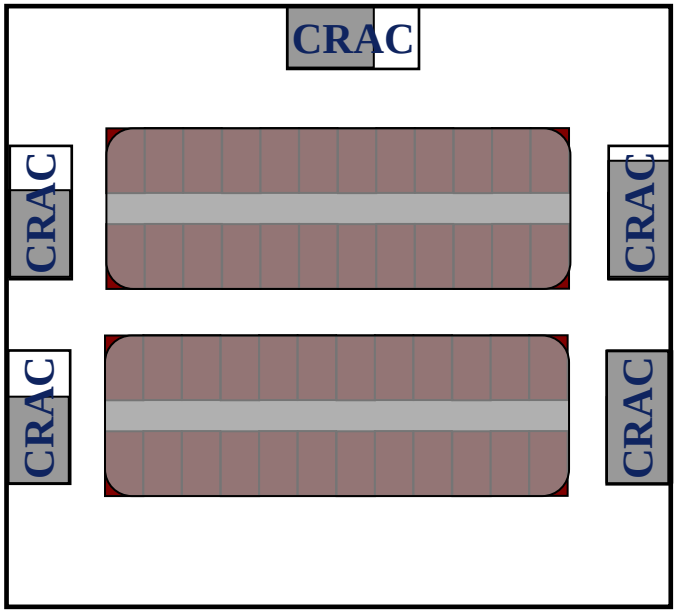
- Assign Wireless sensor name and location
- Simple Site Layout Design and Configure

Site Installation

- Network Cabling/Power Cabling work
- Mounting ICOM-S Panel
- Placement of Sensor
- Initialize/Activate Sensor into ICOM-S
- Establish ICOM to ICOM-S Communication
- Install Power Meter on Thermal unit(If require)



Teamwork – Variable Speed

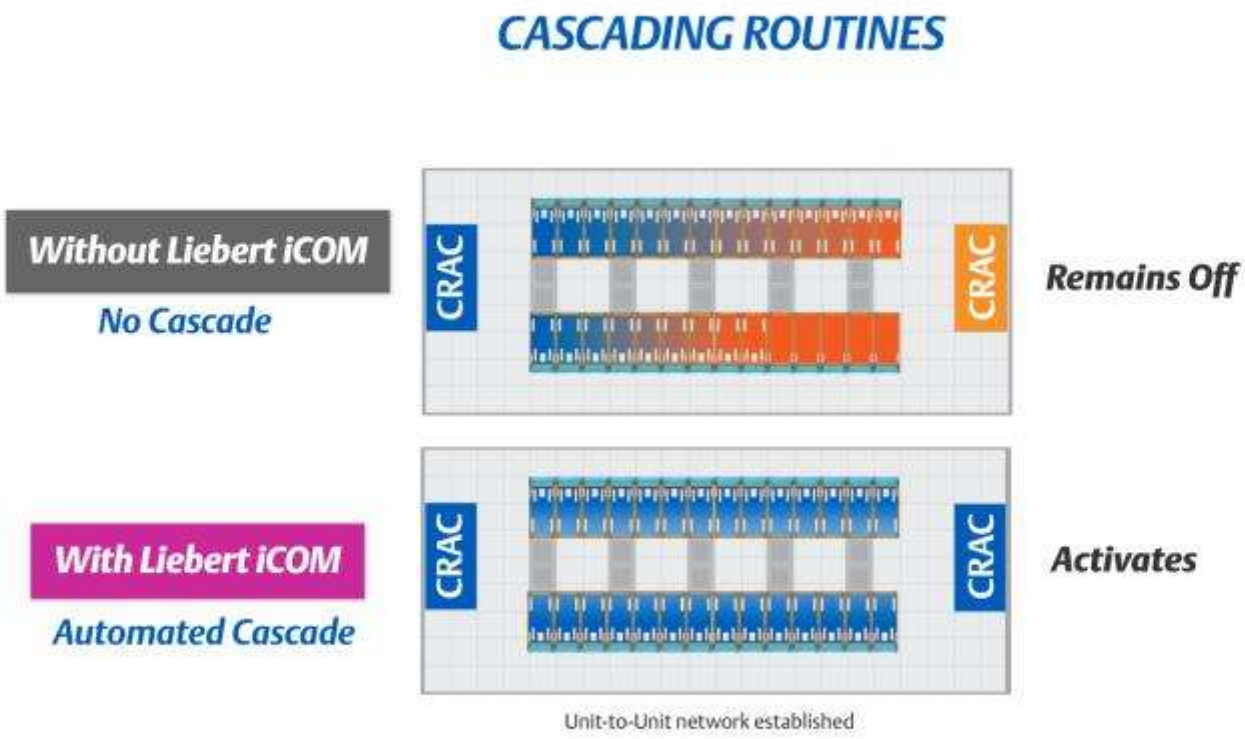


M2M CONTROL FOR ENERGY SAVINGS

	Without Liebert iCOM	With Liebert iCOM
Energy Savings		40%
Energy $ / Year	$19,216	$11,540
Unit 1 Fan Speed	30%	60%
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Unit 4 Fan Speed	100%	60%
Unit 5 Fan Speed	60%	60%
Total CFM	122,000	122,000

Fan speed coordination balances unit loading and decreases overall energy usage

Cascade Routines



Automate cooling unit activation and deactivation based on IT load in the space

Site Assessment and Adjustment

- Relocate or replace the perforated panel
- Air balancing and even out under floor Pressure
- Add Blanking panel to the Rack
- Cool lock air management



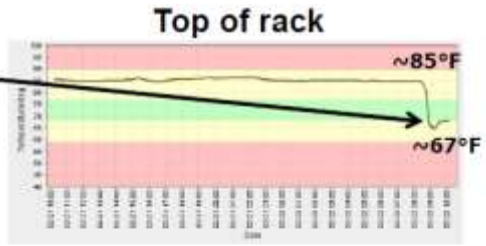


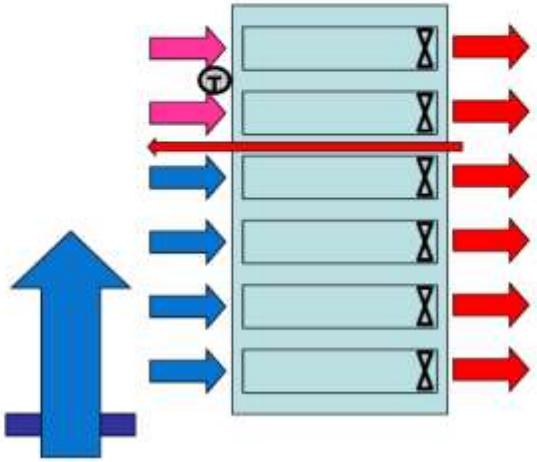
Retrofit Opportunities



Cable Management

Effect of adding one 12” blanking panel to the middle of a rack





Before

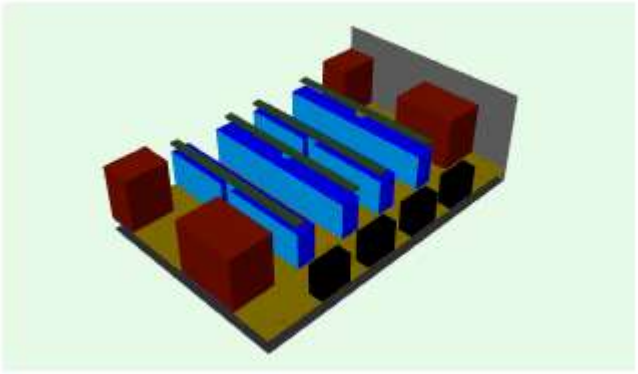


After

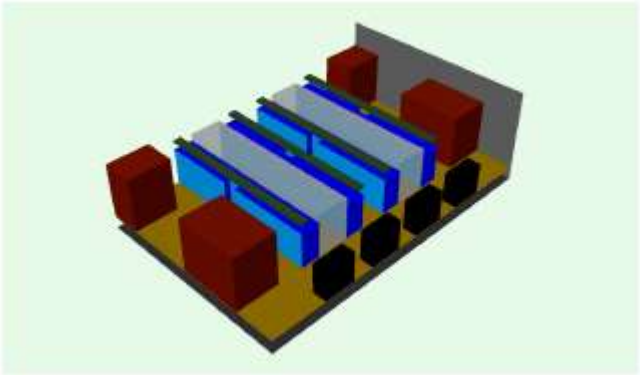


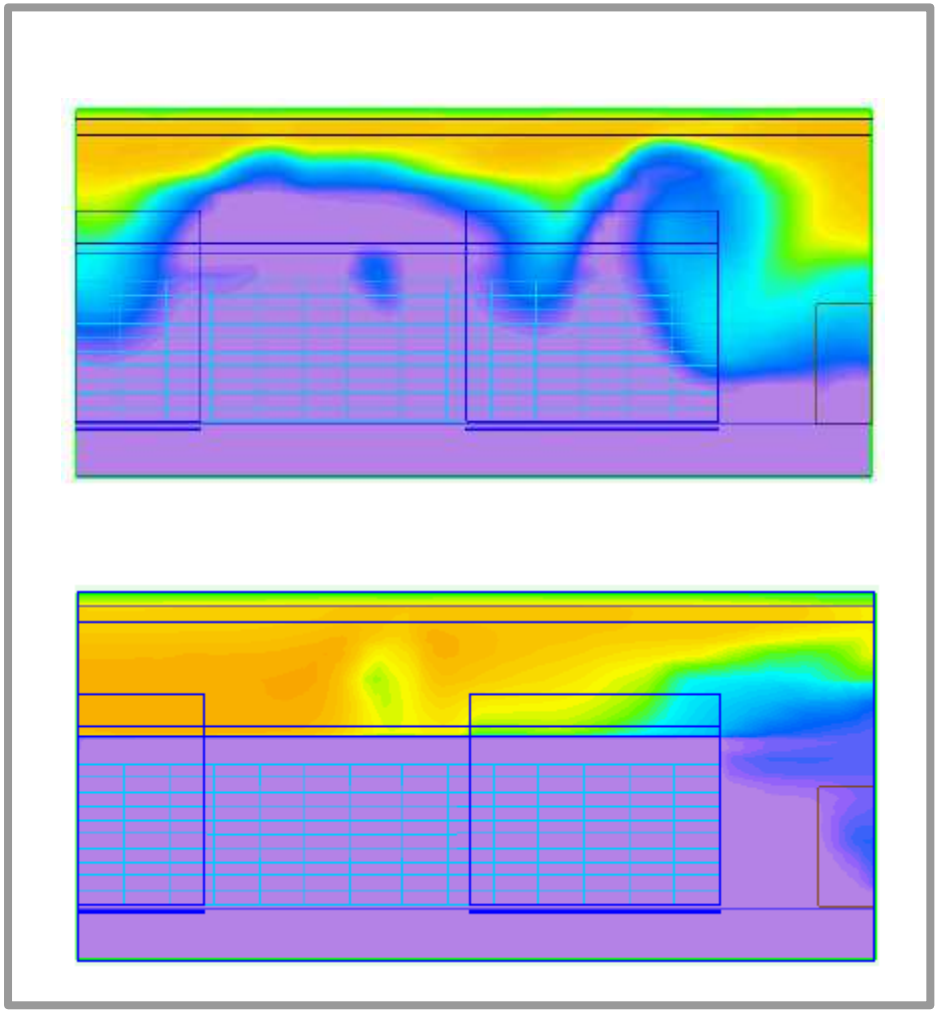
No Containment Vs Containment

No Containment



Containment





CFD Modeling

Case Study

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Case Study

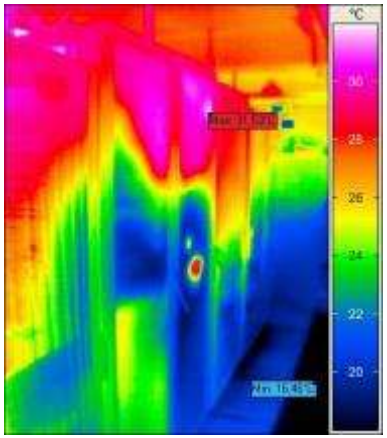
Customer	Co-Lo Facility (CA)
Size	~30,000 sq. ft.
Units	36 Chilled Water Units
Upgrade/Retrofits	EC Fans, iCOM™ Networking, Wireless Sensors
PUE Before	1.47
Payback	18 Months
PUE After Wireless	1.30 ($53/rack savings due to wireless)
Rebates	Yes ($200,000 from just PUE reduction to 1.35)
Additional Benefits	Increased visibility at IT equipment, provided additional protection through iCOM™ Teamwork routines

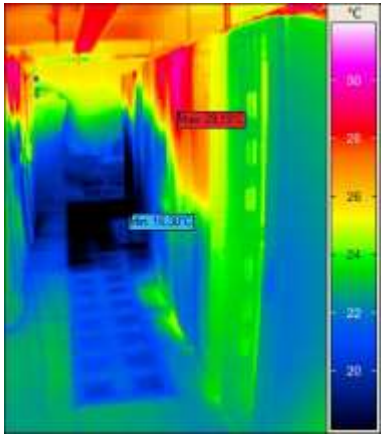




Case Study

Customer	Co-Lo Facility (HK)
Size	~20,000 sq. ft.
Units	32 Chilled Water CRAC Units
Upgrade/Retrofits	iCOM-S, Wireless Sensors, Pressure Sensors, Reorganize Server, Blanking Panel
Pow Consumption Before	152.5 kW
Pow Consumption After	41.6 kW
% Saving	72%

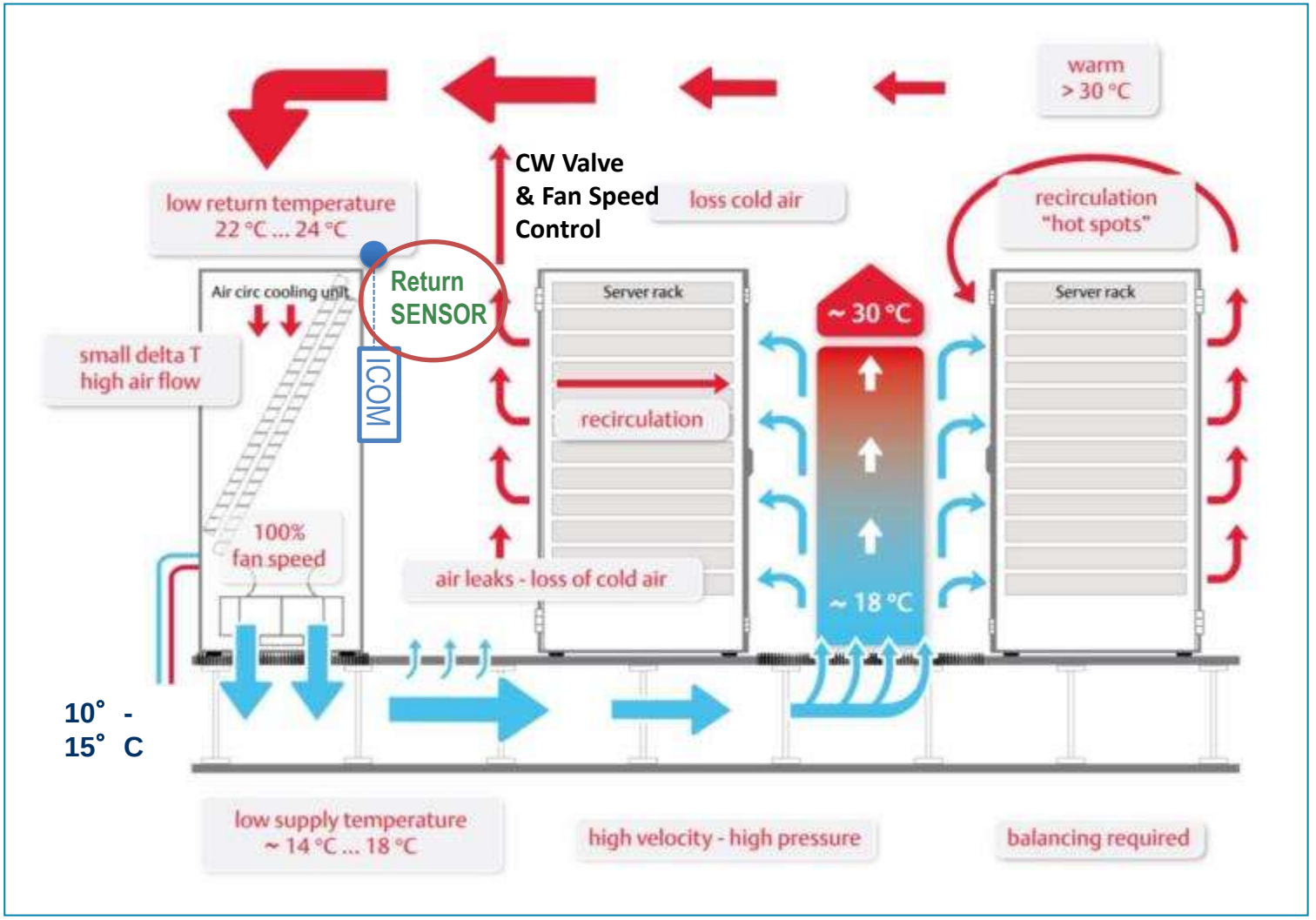




Before Optimization

- CRAC control Strategy,
  - Return air control
    - Cooling source – CW valve controlled by return air sensor
    - Fan Speed – controlled by return air sensor
  - Hotspots exist in the data hall
  - Wrong orientation server

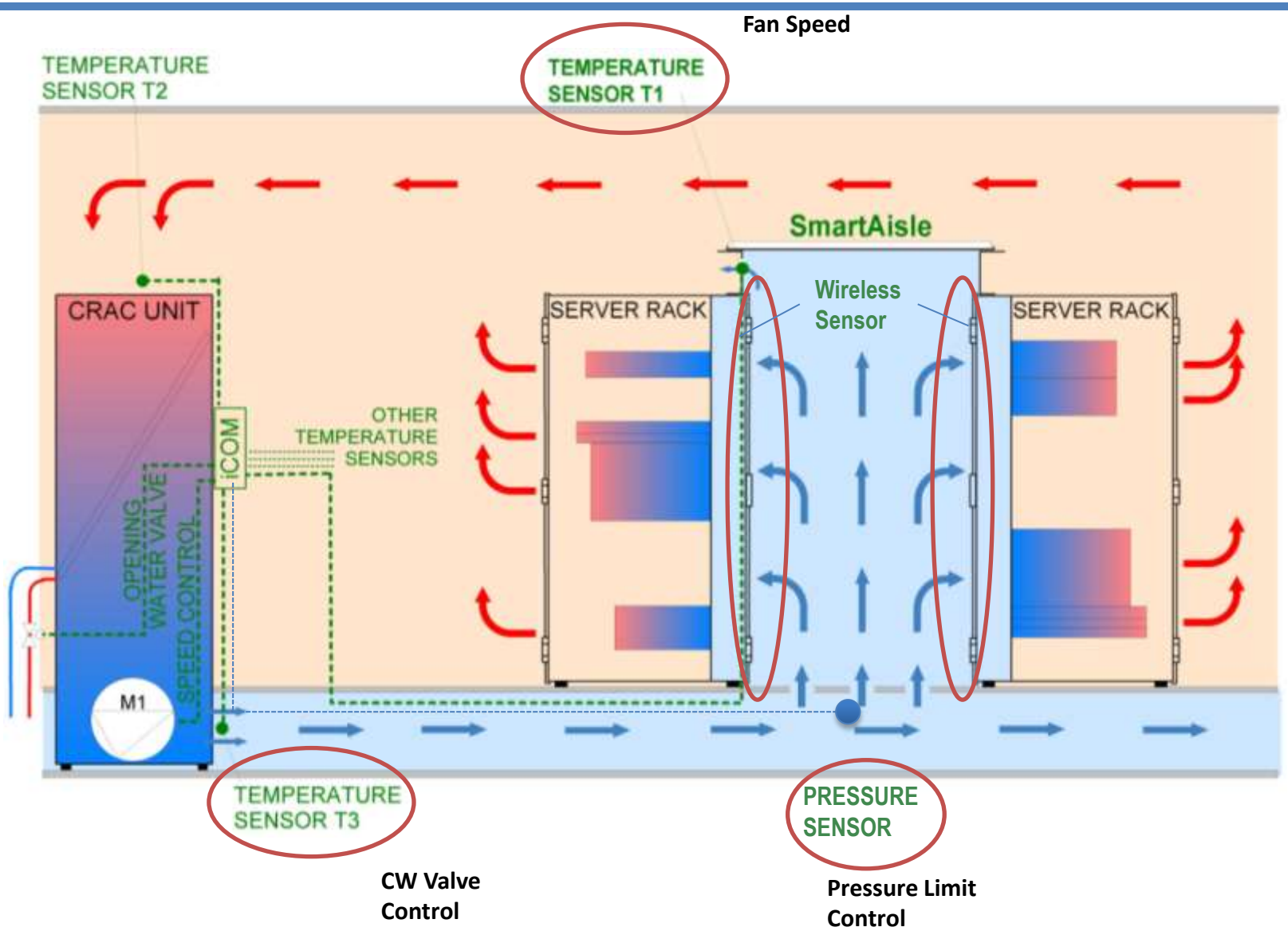
Before Optimization



After Optimization

- CRAC control strategy,
  - Cooling source – CW valve controlled by supply air sensor
  - Under raised floor pressure sensor for pressure limit control
  - Fan Speed – controlled by remote/wireless rack sensor
  - Blanking panels are added
  - Reorganize Server

After Optimization



Outcome

- Overall fan speed are reduced from 80% to 40%
- Hotspots are eliminated

Fan power consumption (kW) @ 19 November, 2015			
Data Hall	Return air control	iCom-S Control	Energy Saving
1	31.8	14.5	17.3
2	29.4	8.5	20.9
3	28.5	8.5	20
4	26.4	8.5	17.9
5	27.6	8.5	19.1
6	8.7	4.8	3.9
Total	152.4	53.3	99.1

Fan power consumption (kW) @ 4 December, 2015			
Data Hall	Return air control	iCom-S Control	Energy Saving
1	31.8	14.5	17.3
2	29.4	5.2	24.2
3	28.5	8.5	20
4	26.4	5.2	21.2
5	27.6	4.9	22.7
6	8.7	3.3	5.4
Total	152.4	41.6	110.8

From 152.4 kw to 41.6 kw

72% Saving

Green Mark ~ ICOM-S

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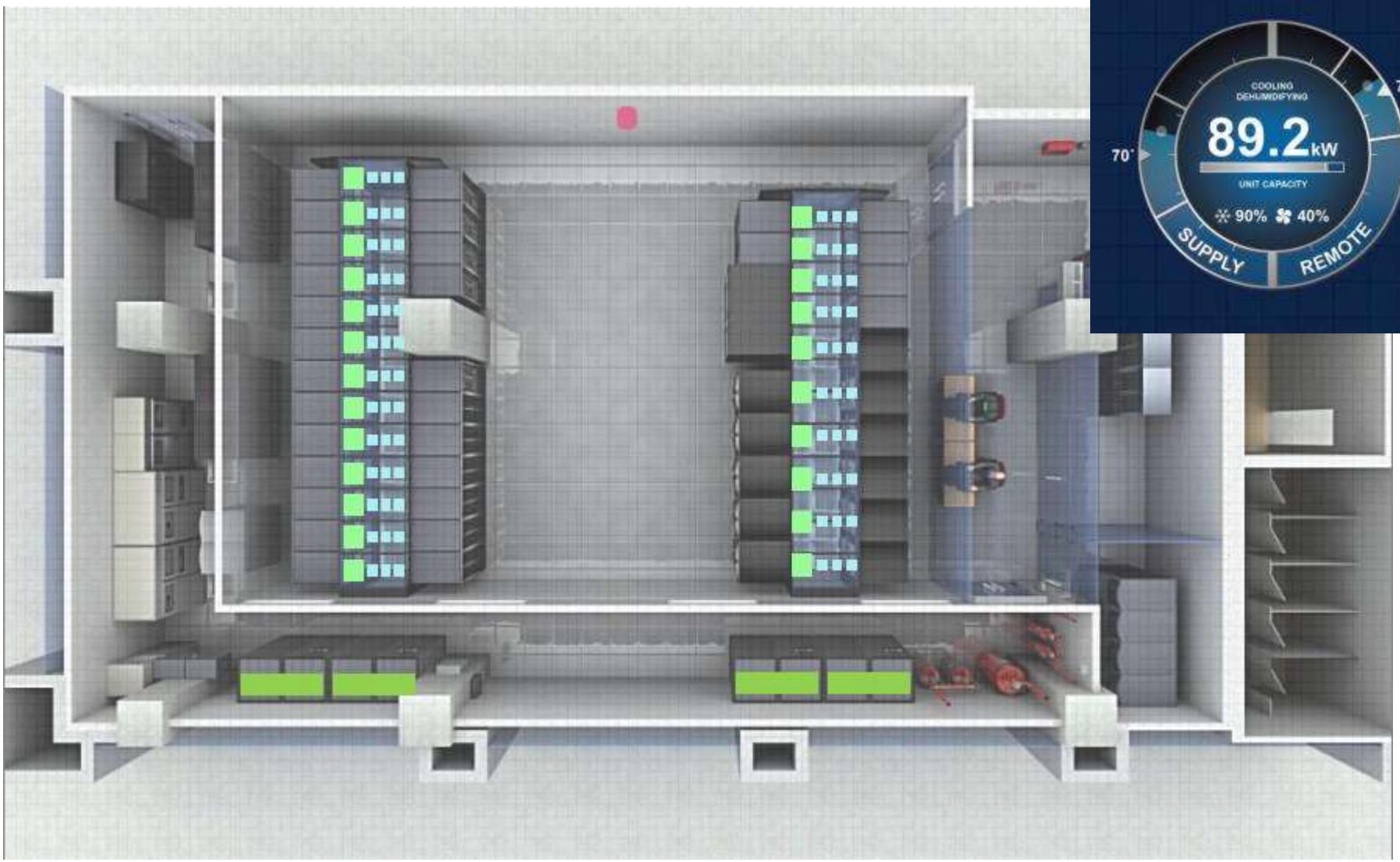
Green Mark ~ ICOM-S

BCA-IDA Green Mark for New Data Centres (Version NDC 1.1)

POINT ALLOCATION

	ASSESSMENT CRITERIA	POINT ALLOCATIONS
ENERGY EFFICIENCY		
Minimum 35 points to be scored	**Part 1 – Energy Efficiency**	
	1-1 Overall Energy Efficiency - Maximum Design PUE[1] - PUE Improvements over Reference Model (Full Load and Part Load)	 10 15
	1-2 Systems Energy Efficiency - Cooling System (including Air Management System) - Electrical System - IT Equipment	 12 8 8
	1-3 Energy Efficiency and Performance Verification - Commissioning of Energy Systems - Measurement and Verification Plan - Energy Metering and Reporting of PUE	 4 3 3
	1-4 Data Centre Design and Energy Management - Data Centre Planning and Design - Data Centre Operations and Energy Management	 5 5
	1-5 Energy Efficient Features and Innovations	10
	SubTotal (Part 1)	**83**

PUE Improvement over reference model



Measurement and Verification Plan

	Site	Room	Unit	Group
Capacity(kW)	X	X	X	X
Capacity Use (%)	X	X	X	X
CFM	X	X	X	X
CFM Used (%)	X	X	X	X
CFM Available	X	X		X
CFM/KW	X	X	X	X
Cold Aisle (F)	X	X		X
Efficiency	X	X	X	X
Hot Aisle (F)	X	X		X
HVAC Power (kW)	X	X	(Data Tab)	X
Unit dT (F)		X		X
Unit Return (F)		X (enable)	(Data Tab)	X (enable)
Unit Supply (F)		X (enable)	(Data Tab)	X (enable)


Thank You
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