Building Management Systems(BMS)

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- *The Basics Explained*

1) What is a BMS?
2) What Does it Do?
3) Benefits
4) Operational Considerations

**Advanced Management and Improvement Opportunities*

5) BMS System Architecture
6) BMS Programming
7) Extended BMS Functionality
8) Upgrades and Retrofits

1. What is a BMS?

A **Building Management System** (BMS) is a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems

- Industry jargon, Terminology and acronyms
  - What is a Building Management and Controls System
  - BMS suppliers and integrators
  - Typical System Components
  - Typical User Interface Options

Industry Jargon, Terminology and Acronyms

- Building Management Systems (BMS) also known as Building Automation Systems (BAS), Building Management and Control System (BMCS), Direct Digital Controls (DDC) and Building Controls

- *Other terms associated with Control Systems include:*
  - Supervisory, Control and Data Acquisition (SCADA)
  - Programmable Logic Controllers (PLC)
  - Energy Management System (EMS)
  - Data gathering panels (DGP)
  - Modbus, Lonworks, and Bacnet – All refer to communications protocols
  - 'Front End' – legacy term used to refer to the BMS Operator Workstation

- *Most Common Current industry term*
  - *Building Management System (BMS) or*
  - *Building Management and Control Systems (BMCS)*

What is a Building Management System?

- BMS systems are “Intelligent” microprocessor based controller networks installed to monitor and control a buildings technical systems and services such as air conditioning, ventilation, lighting and hydraulics.

- More specifically they link the functionality of individual pieces of building equipment so that they operate as one complete integrated system.

- Now installed in every major building or facility with the availability of direct integration into all other building services such as security, access control, CCTV, fire, Lifts and other life and safety systems.

- Current generation BMS systems are now based on open communications protocols and are WEB enabled allowing integration of systems from multiple system vendors and access from anywhere in the world.

NETWORK

INPUTS

OUTPUTS

What Does Intelligent Microprocessor Control Mean?

NETWORK

OUTPUTS

INPUTS

- Procured as a complete system that includes, engineering, supply, installation, programming and commissioning.
- Specialist Integrators that are either directly associated with the manufacturer or are approved re-sellers.
- All Integrators should have full factory technical support
- Need to work closely with Mechanical Services, Mechanical Electrical and other contractors.
- For new construction BMS is usually included within the mechanical services package.
- 'Tier 1 Company' only refers to a direct factory association and not to the quality of products or services…

Typical System Components – BMS Hardware

Range to Suit Applications

Operator Workstations

High Point Counts

Built In Displays

Small Point Counts

Limited Features

Typical System Components – Field Devices

Damper Actuators

Variable Speed Drives (VSD)

Air Flows Pressures

Voltages Currents

Valve Actuators

Pumps Fans Motors

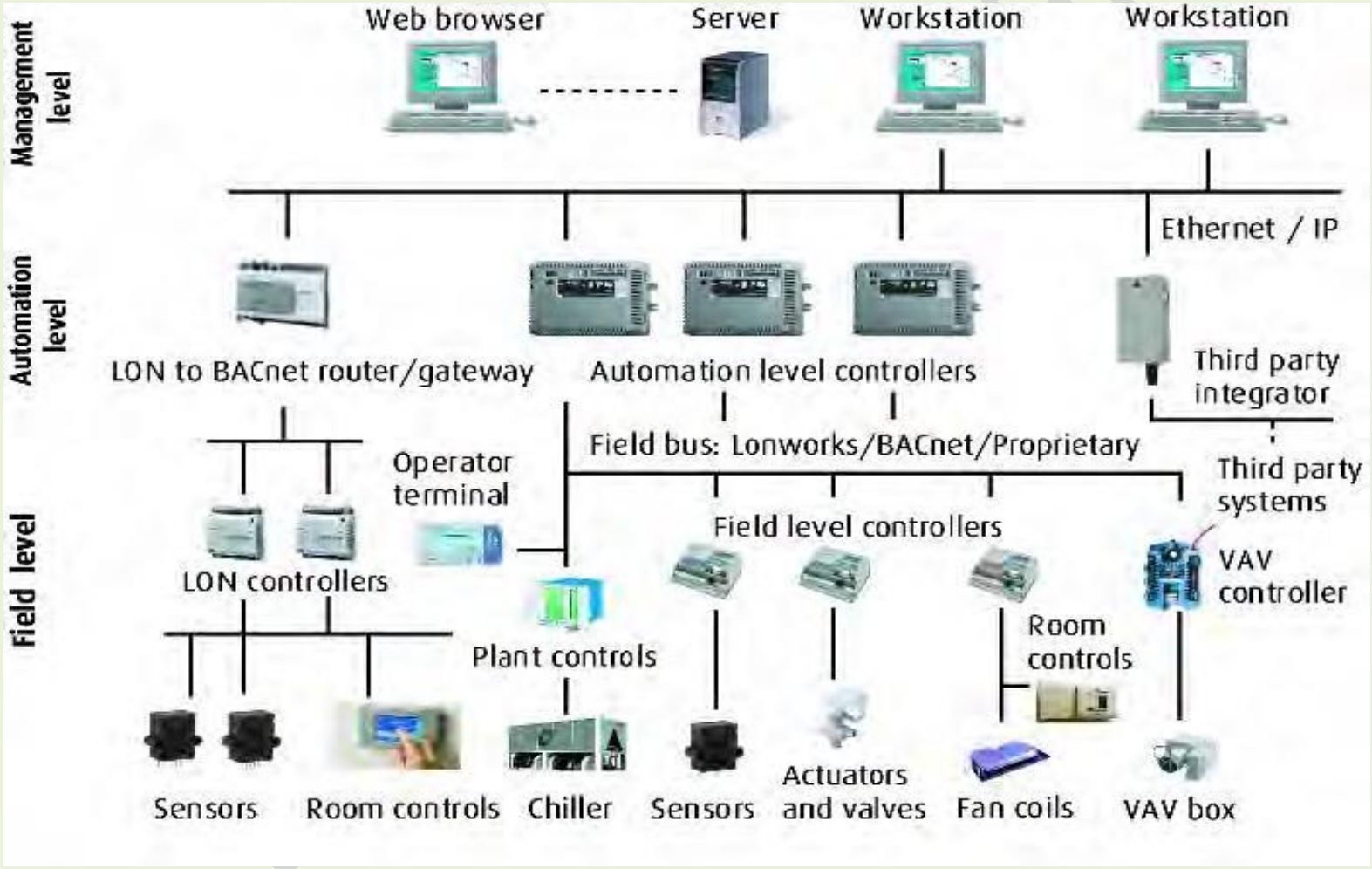
Water Flows Pressures

Chillers / Boilers Cooling Towers

Temperature Relative Humidity CO2

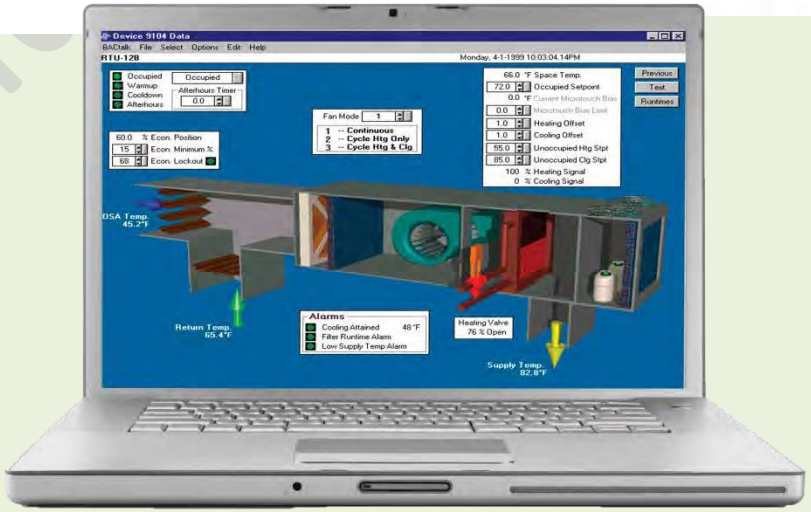
Low Level and High Level (HLI) Connections

Typical System Components - Networks



Typical User Interface Options

- Can be a basic LCD display through to full Graphic Operator Workstations.
- The Graphic Interface must be intuitive to use and not require an Engineering degree to interpret
- They must provide sufficient level of detail to enable the operator to determine what is happening and what is going to happen next
- Graphics need to provide access to parameters for tuning and seasonal information needs to be built into the system

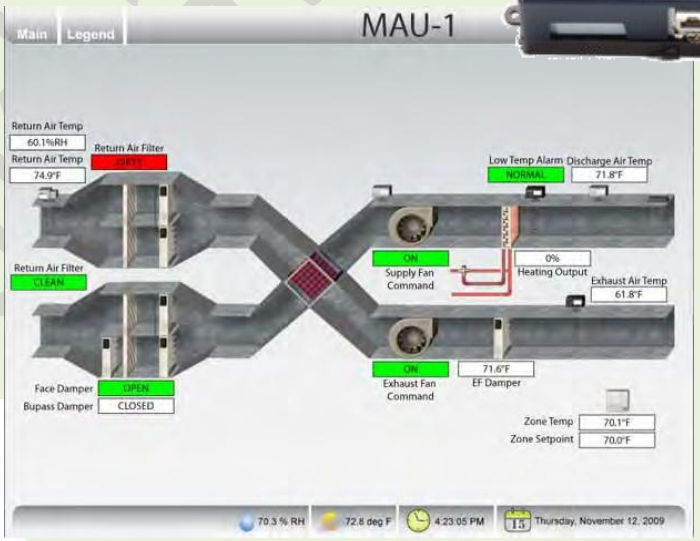


BMS Simple User Interfaces – Built in Display

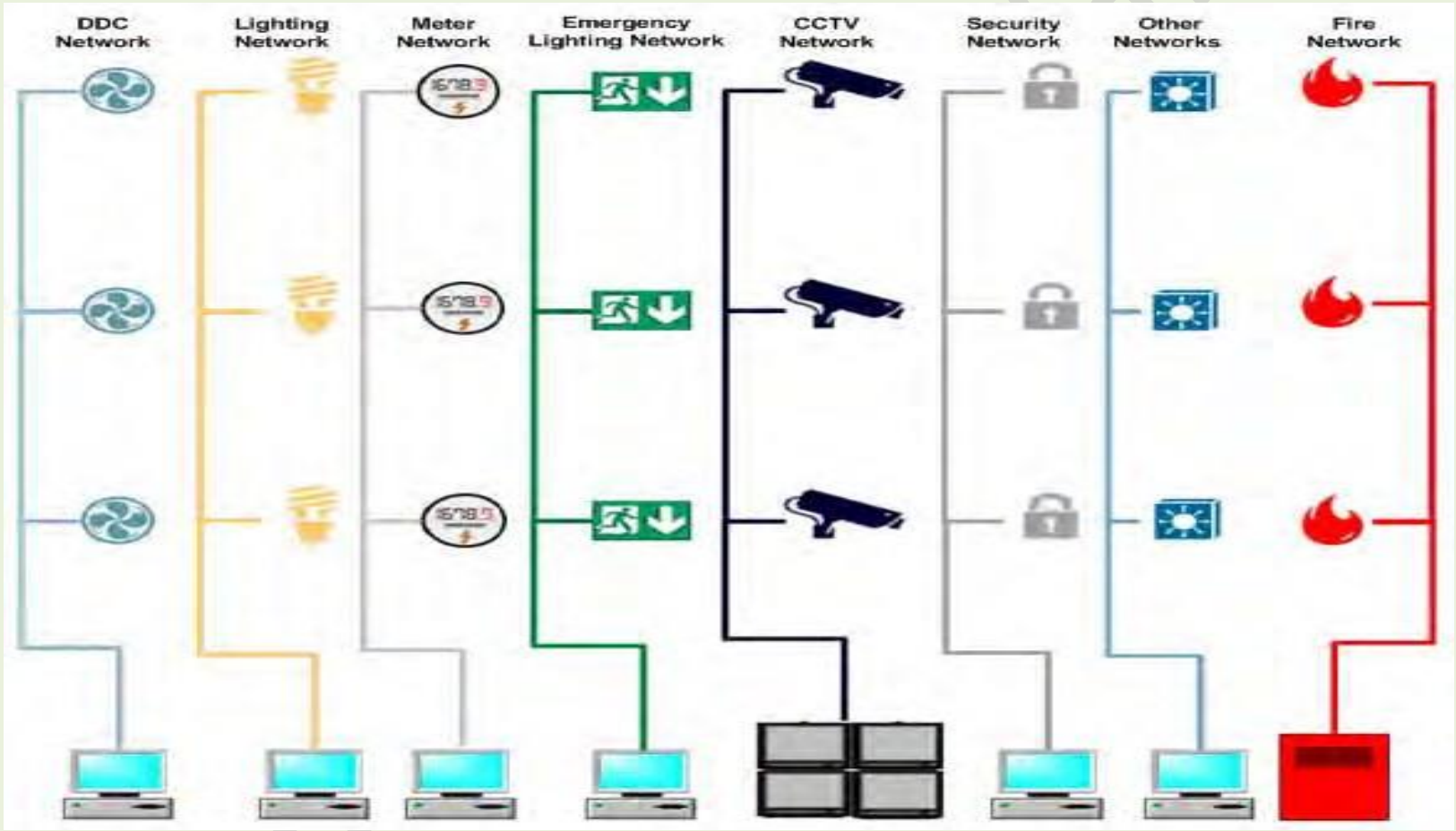
- User defined menus.
- Built into the BMS controller or a remote device
- Password protected
- Monitor and control field points, operating setpoints, time schedules, alarm management, even trend data

BMS Simple User Interfaces – WEB Server

- WEB Server built into a BMS network controller
- User defined menus and graphic pages
- Password protected, multiple access levels
- Monitor and control field points, operating setpoints, time schedules, alarm manage



Interaction With Other Building Systems



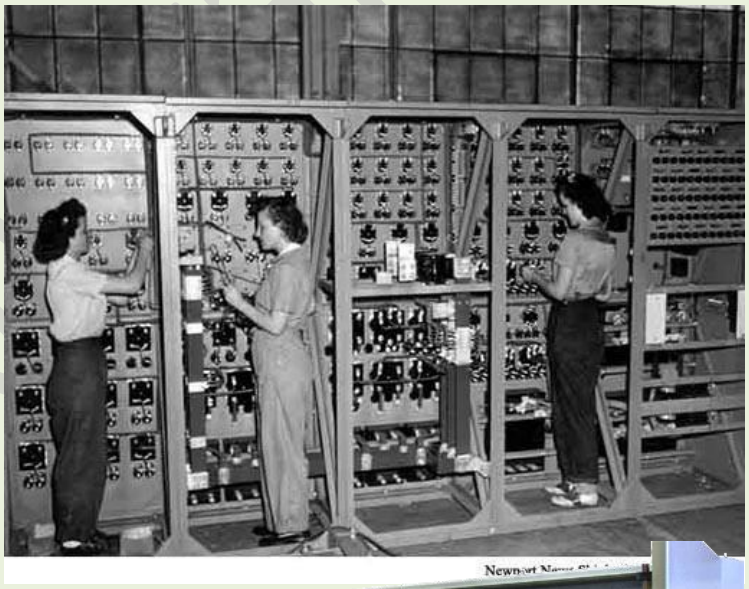
1. Benefits of Having a BMS

The advantages of a BMS versus stand alone control

- Improved Tenant comfort conditions
- Energy Management and reduced operational costs
- Management of building ratings such as NABERS

Advantages of BMS vs Stand Alone Control

- Reduced installation costs
- Flexibility and ease of change
- Customised control strategies
- Scalability
- Operator interaction, feedback and control
- Integration with other building services



Improved Tenant Comfort Conditions

- Real time monitoring of tenant conditions
- Greater load based control strategies
- Trend data of performance, improved fault finding
- Air quality management (CO2)
- After hours operational requests, tenant billing
- Alarm notifications of faults reduce downtime
- Automated change over of failed equipment

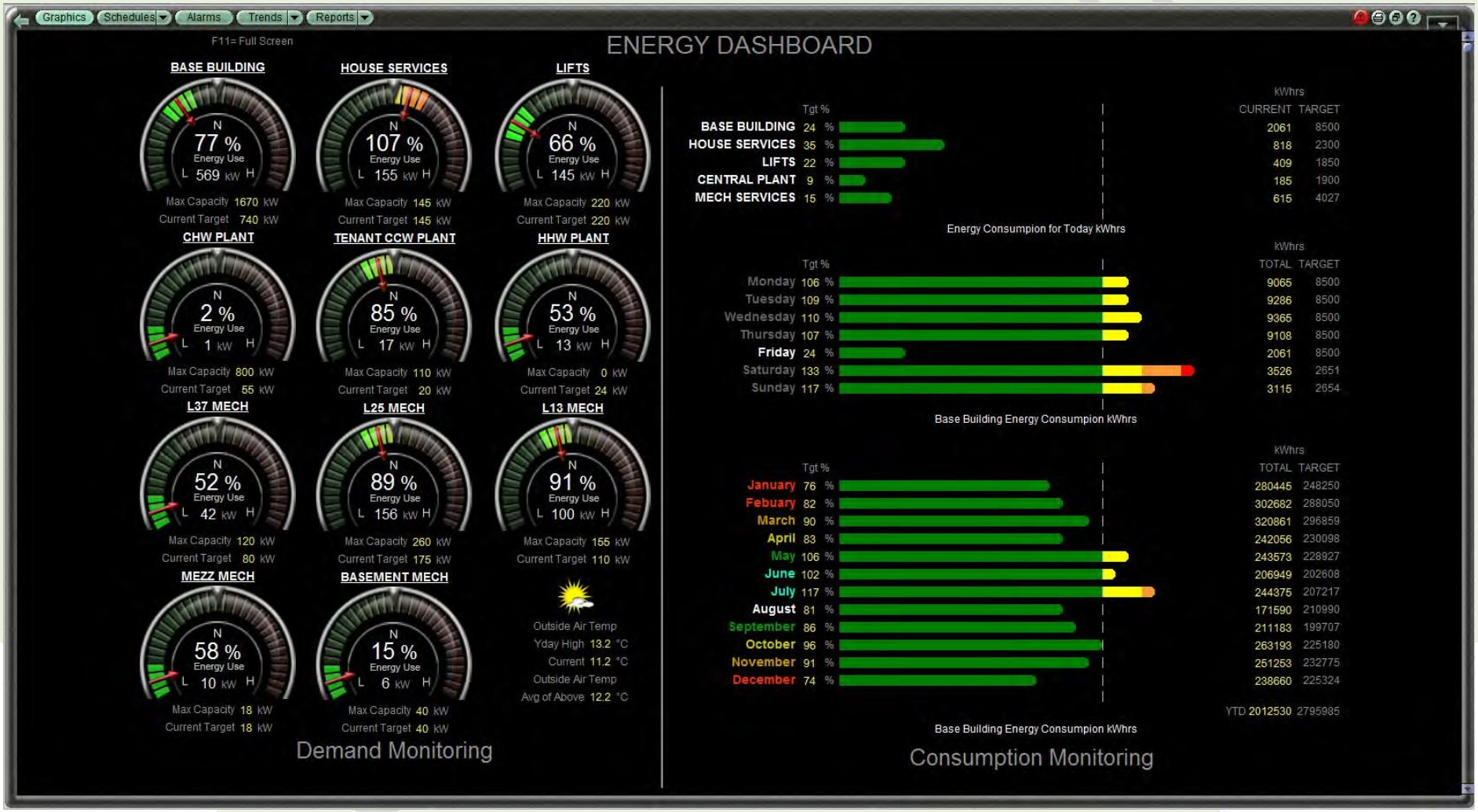
Energy Management and Reduce Operational Costs

- Optimal start and stop of plant
- Building warm up and cool down cycles
- Night purge
- Automatic Seasonal plant sequence selection
- Seasonal temperature setting adjustments
- Load based control strategies
- Economy cycle control including CO2
- Equipment runtime monitoring and duty cycling
- Occupancy control and control setback

Management of Building Ratings - NABERS

- Can be integrated with Energy Management System (EMS)
- Real time monitoring of energy performance
- Proactive adjustment not retrospective catch up
- Measurement against load profile targets
- Separation of tenant and base building loads
- Historical trend data for NABERS management
- Energy demand and consumption dashboards

  - EMS is a dedicated software packed for the monitoring and management of electrical, water, gas and thermal energy metering systems.


Graphics
Schedules
Alarms
Trends
Reports
F11= Full Screen
ENERGY DASHBOARD
BASE BUILDING
77 %
Energy Use
L 569 kW H
Max Capacity 1670 kW
Current Target 740 kW
HOUSE SERVICES
107 %
Energy Use
L 155 kW H
Max Capacity 145 kW
Current Target 145 kW
LIFTS
66 %
Energy Use
L 145 kW H
Max Capacity 220 kW
Current Target 220 kW
CHW PLANT
2 %
Energy Use
L 1 kW H
Max Capacity 800 kW
Current Target 55 kW
TENANT CCW PLANT
85 %
Energy Use
L 17 kW H
Max Capacity 110 kW
Current Target 20 kW
HHW PLANT
53 %
Energy Use
L 13 kW H
Max Capacity 0 kW
Current Target 24 kW
L37 MECH
52 %
Energy Use
L 42 kW H
Max Capacity 120 kW
Current Target 80 kW
L25 MECH
89 %
Energy Use
L 156 kW H
Max Capacity 260 kW
Current Target 175 kW
L13 MECH
91 %
Energy Use
L 100 kW H
Max Capacity 155 kW
Current Target 110 kW
MEZZ MECH
58 %
Energy Use
L 10 kW H
Max Capacity 18 kW
Current Target 18 kW
BASEMENT MECH
15 %
Energy Use
L 6 kW H
Max Capacity 40 kW
Current Target 40 kW
Outside Air Temp
Yday High 13.2 °C
Current 11.2 °C
Outside Air Temp
Avg of Above 12.2 °C
Demand Monitoring
Tgt %
kWhrs
CURRENT TARGET
BASE BUILDING 24 % 2061 8500
HOUSE SERVICES 35 % 818 2300
LIFTS 22 % 409 1850
CENTRAL PLANT 9 % 185 1900
MECH SERVICES 15 % 615 4027
Energy Consumpion for Today kWhrs
Tgt %
kWhrs
TOTAL TARGET
Monday 106 % 9065 8500
Tuesday 109 % 9286 8500
Wednesday 110 % 9365 8500
Thursday 107 % 9108 8500
Friday 24 % 2061 8500
Saturday 133 % 3526 2651
Sunday 117 % 3115 2654
Base Building Energy Consumpion kWhrs
Tgt %
kWhrs
TOTAL TARGET
January 76 % 280445 248250
Febuary 82 % 302682 288050
March 90 % 320861 296859
April 83 % 242056 230098
May 106 % 243573 228927
June 102 % 206949 202608
July 117 % 244375 207217
August 81 % 171590 210990
September 86 % 211183 199707
October 96 % 263193 225180
November 91 % 251253 232775
December 74 % 238660 225324
YTD 2012530 2795985
Base Building Energy Consumpion kWhrs
Consumption Monitoring

2. Operational Considerations

- Tuning and optimisation
- Importance of System Documentation
- System Maintenance, what, how often and by whom
- Life cycle expectations and consideration

Control Loop Optimisation

Outside Air Temp 17C

Chiller Running

Supply Air Temp 14C
Static Pressure 350pa
VSD Running at 95%

VAV Damper 15% Open

Zone Temp 22C

Chiller Stopped

Supply Air Temp 18C
Static Pressure 200pa
VSD

Zone Temp 22C

- Functional Description (FD)
  - Details the configuration of the BMS
  - Overview of the building services
  - Describes in detail each of the BMS control strategies and sequences of operation
  - Documents interaction between each part of the system

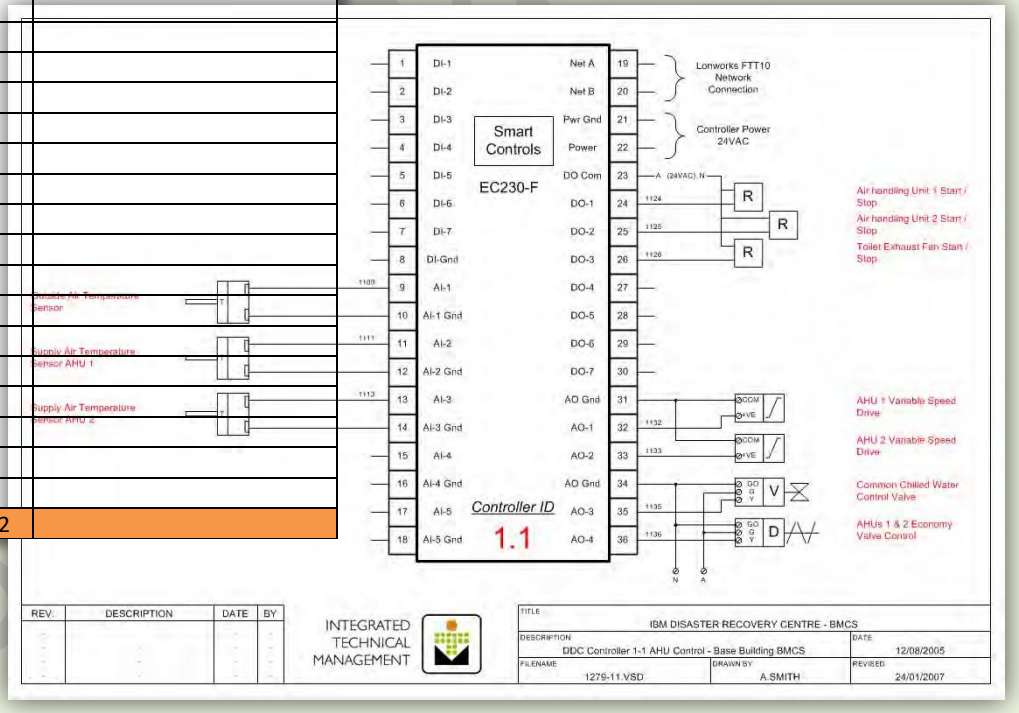
- Point Schedules
  - Detail all connected devices and their point type
  - Critical for planning and system engineering

- Control System Drawings
  - Should include a network architecture drawing
  - Detail the physical wiring connections to controllers
  - Useful for fault finding and establishing spare capacity

Importance of System Documentation

Point Description	DI	DO	AI	AO	HLI	Comments
Chiller HLI					2	Modbus Connection to Chiller
Chiller enable		2				
Chiller run status	2					
Chiller fault status	2					
CHW Pump start / stop		2				At MSSB
CHW Pump run status	2					
CHW Pump speed control				2		Direct to VSDs
CHW Flow temperature			2			
CHW return temperature			1			
CHW system pressure			1			
CHW bypass valve				1		
Tenant Cooling Tower Fans Start / Stop		2				
Tenant Cooling Tower Fans Status	2					
Tenant Cooling Tower Fans Speed				2		
Tenant Cooling Tower Spray Start / Stop		2				
Tenant Cooling Tower Spray Status	2					
Tenant CCW System Pressure			1			
Tenant CCW Pump start / stop		2				
Tenant CCW Pump run status	2					
Tenant CCW Pump speed control				2		
Tenant CCW Flow temperature			1			
Tenant CCW return temperature			1			
Totals	12	10	7	7	2	

- DI – Digital Inputs
- DO – Digital Outputs
- AI – Analogue Input
- AO – Analogue Output
- HLI – High Level Interface



- BMS Drawings show device details and wiring connections

System Maintenance

- The BMS belongs to the building owner who should act as its administrator managing BMS access rights
- The BMS should be maintained with an appropriate level of servicing
- As with any software driven system, data and files should be backed up on a regular basis
- Critical components should be identified and checked at regular intervals
- BMS functions such as trend data, reports and alarms can be used to perform maintenance by exception
- Maintenance should be approached as the performance of the controlled system not individual components, i.e. AHU or Chiller Plant
- While the BMS equipment vendor should be utilised to maintain the critical components, other suitably qualified technicians can be utilised for field equipment

BMS Lifecycle Considerations

- Considerations:
  - Check equipment production cycle status
  - Select hardware with proven record (avoid beta)
  - Check for level of software and hardware support
  - Check for forward compatibility policy

- Equipment Lifecycle:
  - BMS field controllers – 15 to 20 years
  - Field devices – 15 to 20 years
  - BMS computer hardware – 3 to 5 years
  - BMS software – Major releases 3 to 5 years

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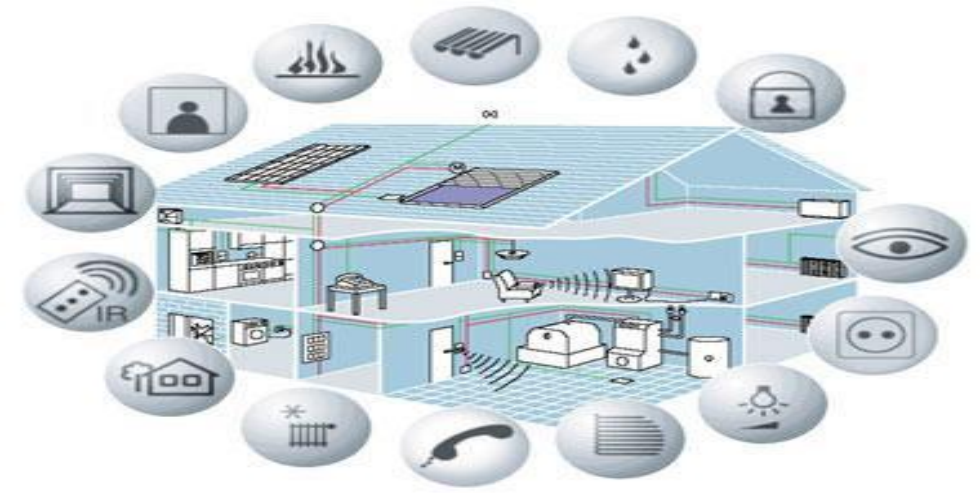


Building Management Communication Protocols

A Building Management System (BMS) is a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems. A BMS consists of software and hardware; the software program, usually configured in a hierarchical manner, can be proprietary, using such protocols as C-bus, Profibus, and so on, recently, however, new vendors are producing BMSs that integrate using Internet protocols and open standards such as DeviceNet, SOAP, XML, BACnet, LonWorks and Modbus.

BMS Characteristics

- A BMS is most common in a large building.
- Its core function is to manage the environment within the building and may control temperature, carbon dioxide levels and humidity within a building.
- BMS systems are linked to access control (turnstiles and access doors controlling who is allowed access and egress to the building) or other security systems such as closed-circuit television (CCTV) and motion detectors.
- Fire alarm systems and elevators are also sometimes linked to a BMS

Functions of Building Management Systems

To create a central computer controlled method which has three basic functions:

- Controlling
- Monitoring
- Optimizing
- Event List Display and Scheduler System the building's facilities, mechanical and electrical equipments for comfort, safety and efficiency.

A BMS system normally comprises

- Power systems
- Smart Illumination system
- Electric power control system
- Heating,Ventilation and Air-conditioning HVAC System
- Security and observation system
- Magnetic card and access system
- Fire alarm system
- Lifts, elevators etc.
- Plumbing system
- Burglar alarms
- Other engineering systems
- Trace Heating

Security Systems
Building Automation Systems

- It is a multi level security system (physical security).
- They have access control.
- All the employees are provided with access cards.
- The CCtv's are placed at all the gates and these are monitored at the receipt

Integrated Fire Alarm Systems

- . Each room has a fire alarm which detect the smoke. It is also provided with the sprinkler system.

- These sprinklers will not be in server room
- The fire extinguishers will be different in server room. A mock fire drill is conducted every month.
- Fire extinguishers are placed every corners and 10m at suitable accessible place as per fire norms

- The air chillers which are placed at the top of the building d cool air to the A.H.U(Air Handling Units) which are provided at all the levels.
- There are “N”, N>4 A.H.U’s in each level.
- The cool air is distributed to the entire level from the A.H.U’s.
- CHP Integrated system

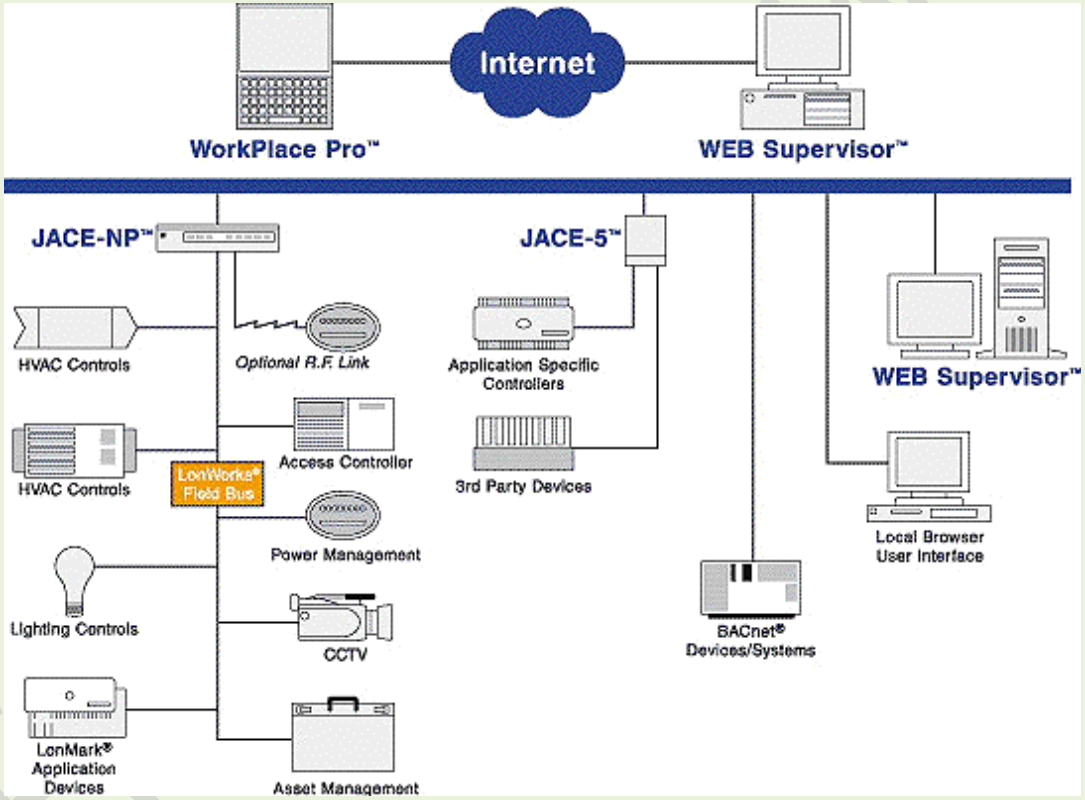
Server Room

- This is the main part in an IT room in which all the data is stored.
- This room cannot be accessed by everyone.
  It has a passcode and access card to enter.
- 18 degrees is maintained in the rooms through Precession Air Conditions with redundant System to ensure 24x7 and 5 start data center guidelines.

- ***Integarted PowerSystems***

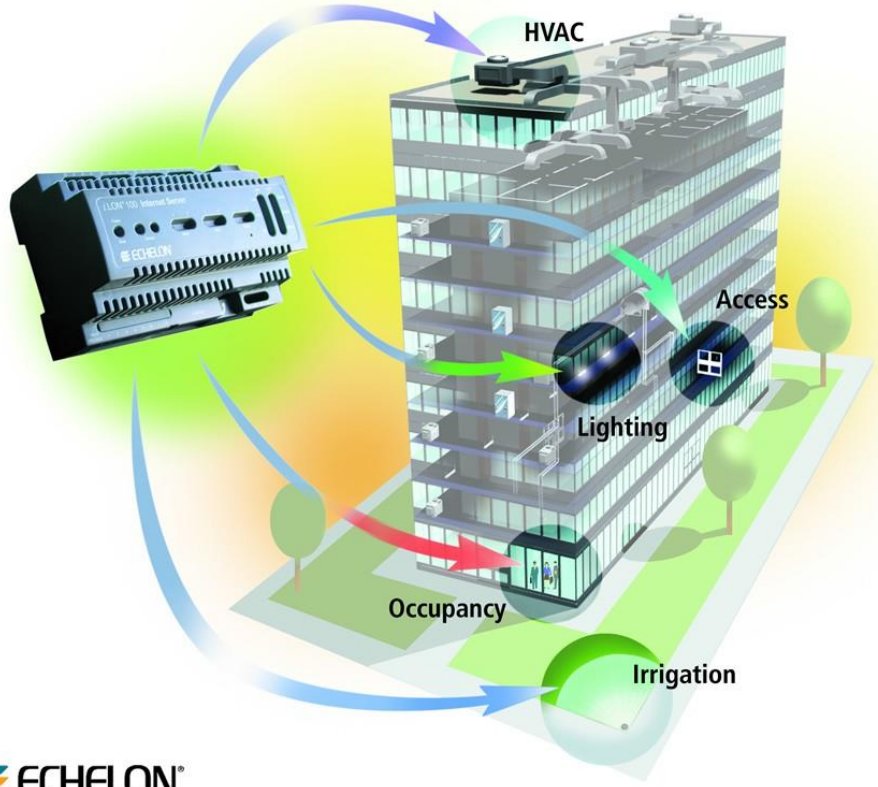
- ○ The main power comes from the electricity board.
- ○ Automatic switch on and off generators systems – if one failed the other works.
- ○ The main power will be sent to UPS (which has 120 min backup).
- ○ Each cabin has 5 power sockets
- ○ Microgrid Controller System

Integrated Systems



Network Integration with Demand Response

Significant imbalances between electricity supply and demand can destabilize the grid or cause severe voltage fluctuations and failures. Demand response, the reduction of electric demand from the grid, can relieve system stress and help prevent blackouts and brownouts. Demand response played an active role in managing energy events in various parts of the United States during the summer of 2006. Aggregating demand response efforts across a region has historically been a time-consuming and labor-intensive process. EnerNOC uses its Network Operations Center (NOC), in Boston, MA to remotely manage electricity consumption across a network of end-use customer sites and make energy available to grid operators and utilities on demand. Echelon's i.LON® Internet Server, when installed at commercial, institutional, and industrial customer sites, can enhance EnerNOC's technology by enabling a direct wireless connection from the NOC to building and energy management systems.



Internet Protocols

- DeviceNet – Interconnect Control Devices
- SOAP – Simple Object Access Protocol
- XML – eXtensible Markup Language
- BACnet – Building Automation Controls
- LonWorks – Local Operational Networks
- Modbus – Serial Communication Protocol

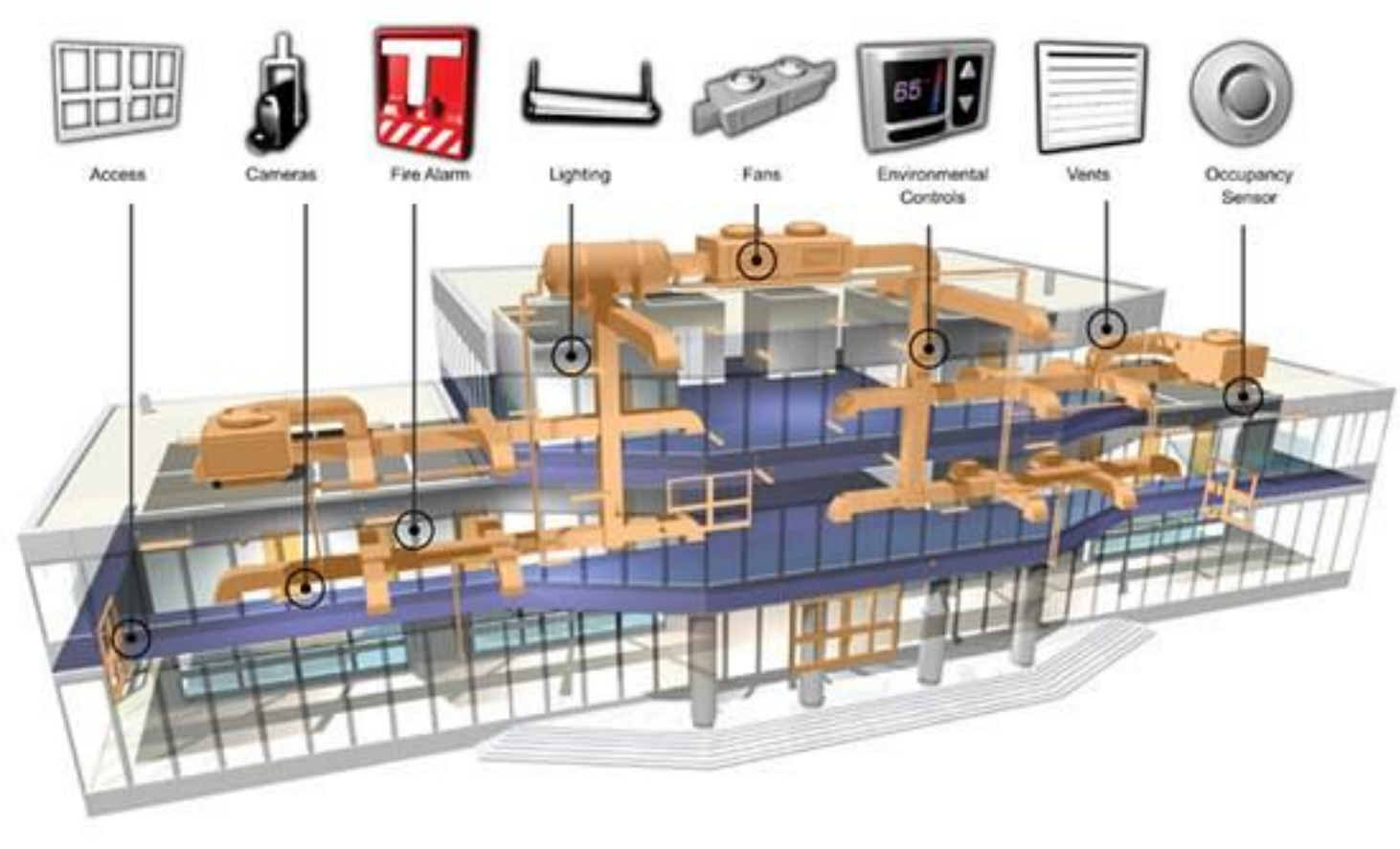
LonWorks

LonWorks (local operation network) is a networking platform specifically created to address the needs of control applications. The platform is built on a protocol created by Echelon Corporation for networking devices over media such as twisted pair, powerlines, fiber optics, and RF. It is used for the automation of various functions within buildings such as lighting and HVAC; see Intelligent building.

The Lon Works and other open Protocol

- The LonWorks® protocol provides services at each layer of the OSI seven layer reference model. The protocol is open for anyone to implement, and a reference implementation in the C programming language can be obtained from CEA. Since its invention, the protocol has become an ANSI standard, an IEC standard, a Chinese national standard, and recently has achieved ISO standardization

LONtalk Network



LONtalk Network

LonTalk is a protocol optimized for control created by Echelon Corporation for networking devices over media such as twisted pair, powerlines, fiber optics, and RF. It is popular for the automation of various functions in industrial control, home automation, transportation, and buildings systems such as lighting and HVAC; see Intelligent building. LonTalk is defined by ANSI Standard ANSI/CEA 709.1. The LonTalk protocol has been ratified by standards setting bodies in the following industries & regions:

ANSI 709.1 - Control networking (US)

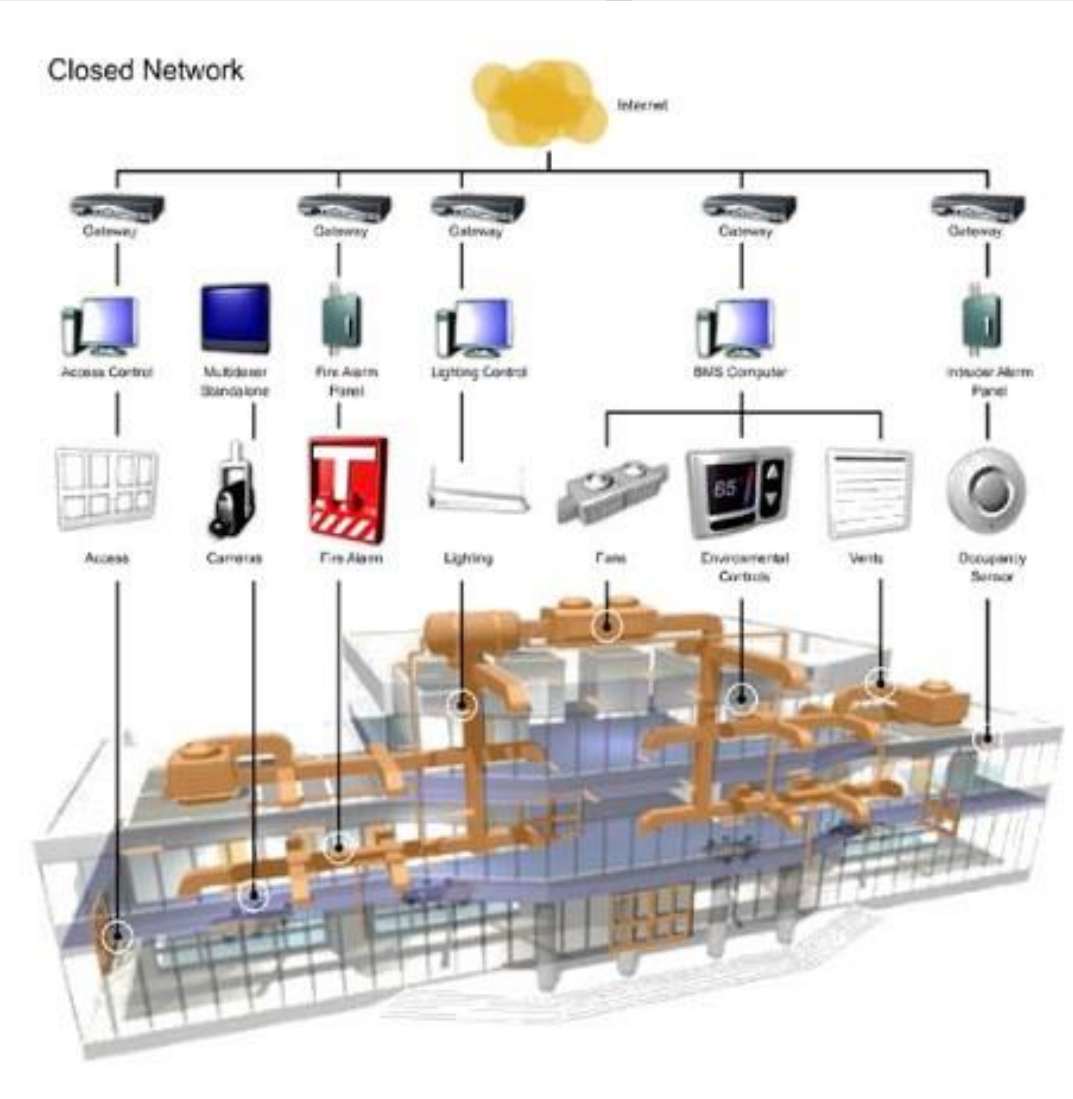
EN 14908 - Building controls (EU)

GB/Z 20177.1-2006 - Control networking and building controls (China)

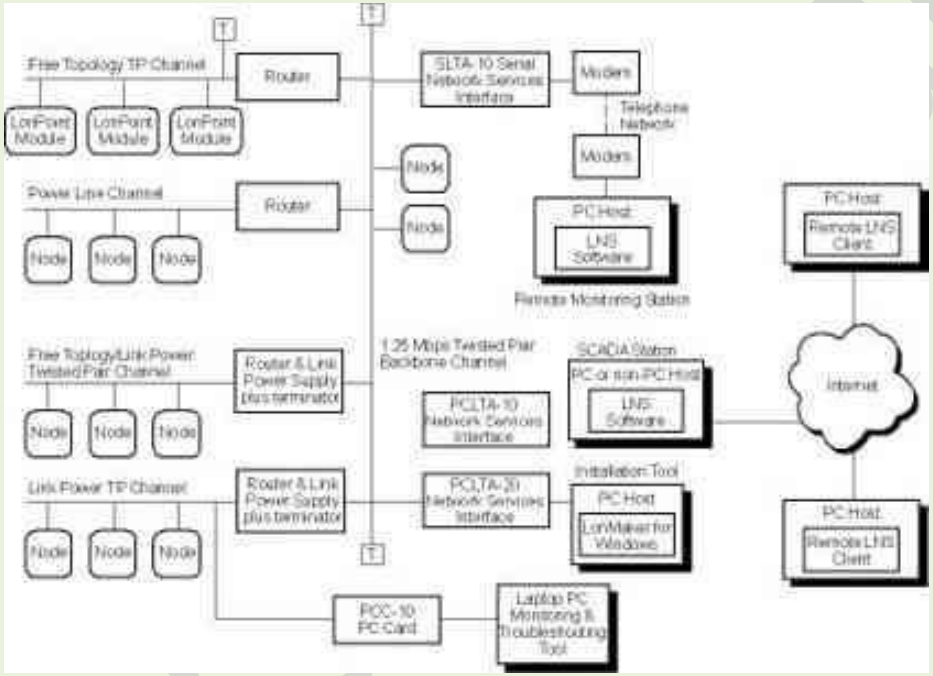
IEEE 1473-L - Train controls (US)

SEMI E54 - Semiconductor manufacturing equipment sensors & actuators (US)

IFSF - International forecourt standard for EU petrol stations



What's a LON Works?

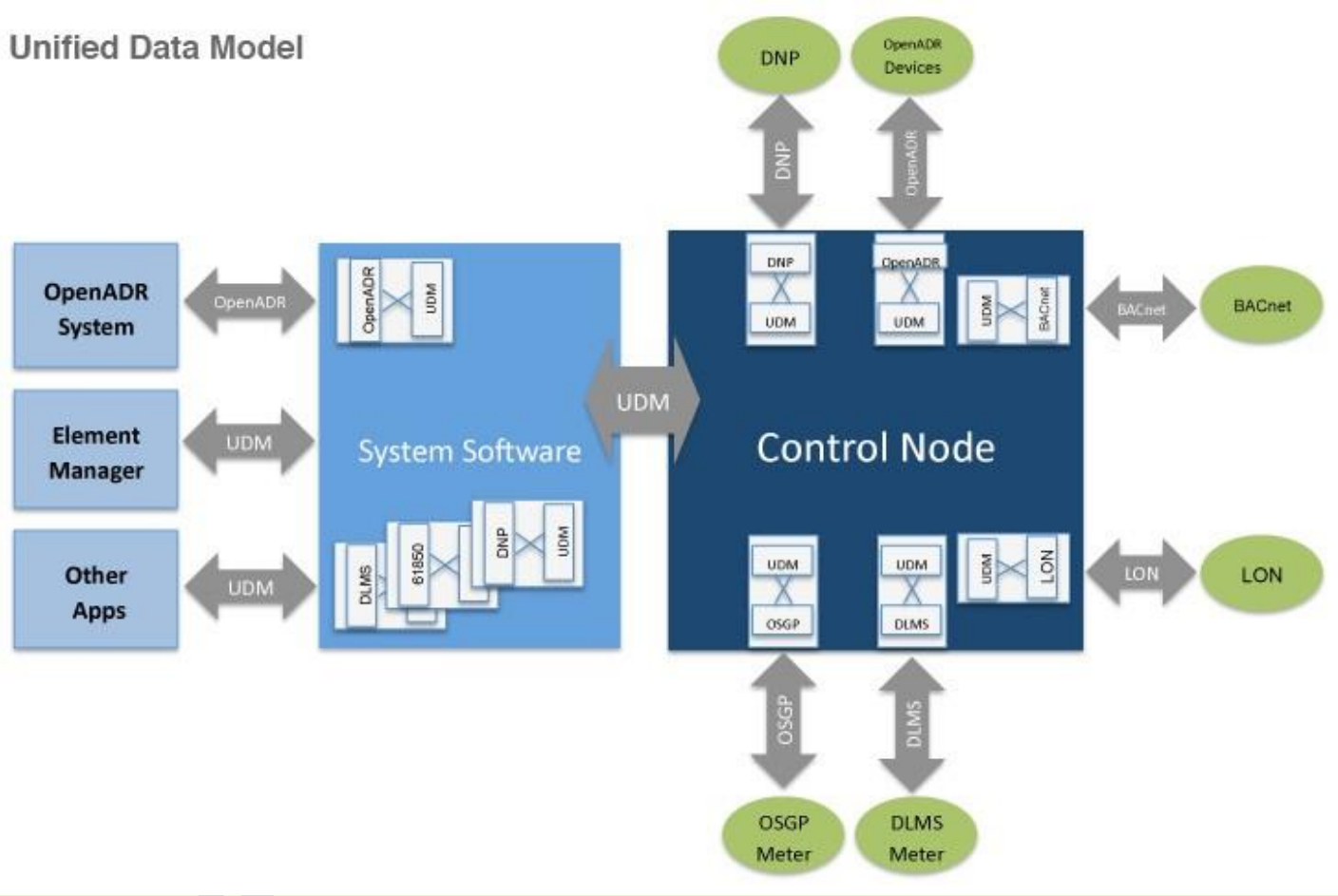


What's a LonWorks?

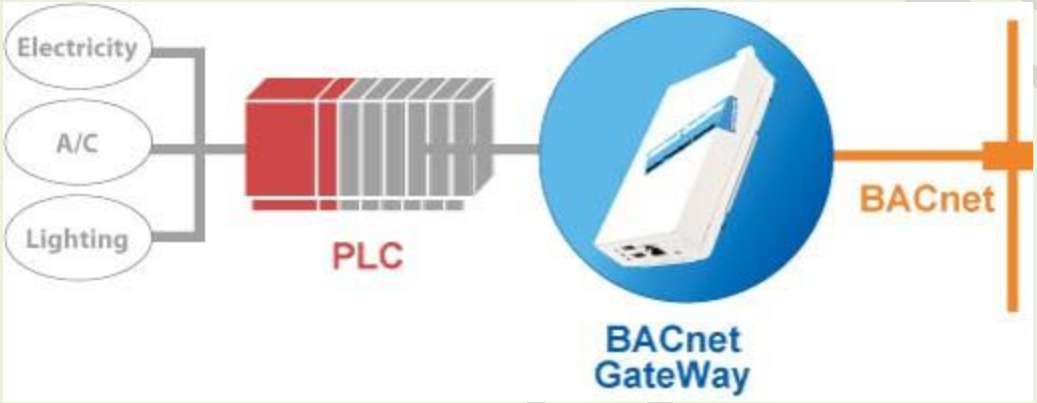
Let's take a quick look at control networks and LonWorks. A simple definition for a control network is: any group of devices working in a peer-to-peer fashion to monitor sensors, control actuators, communicate reliably, manage network operation, and provide complete access to network data. Control networks provide deterministic timing of commands, responses, events, and data transfers. LonWorks is based upon the LonWorks protocol, also known as the EIA 709.1 Control Networking Standard. Neuron chipsets are used in transceivers for communicating across LonWorks. LonWorks consist of devices such as:

•Network Interfaces => Control Modules => LonPoint Modules => Routers

Control Operating System (COS)

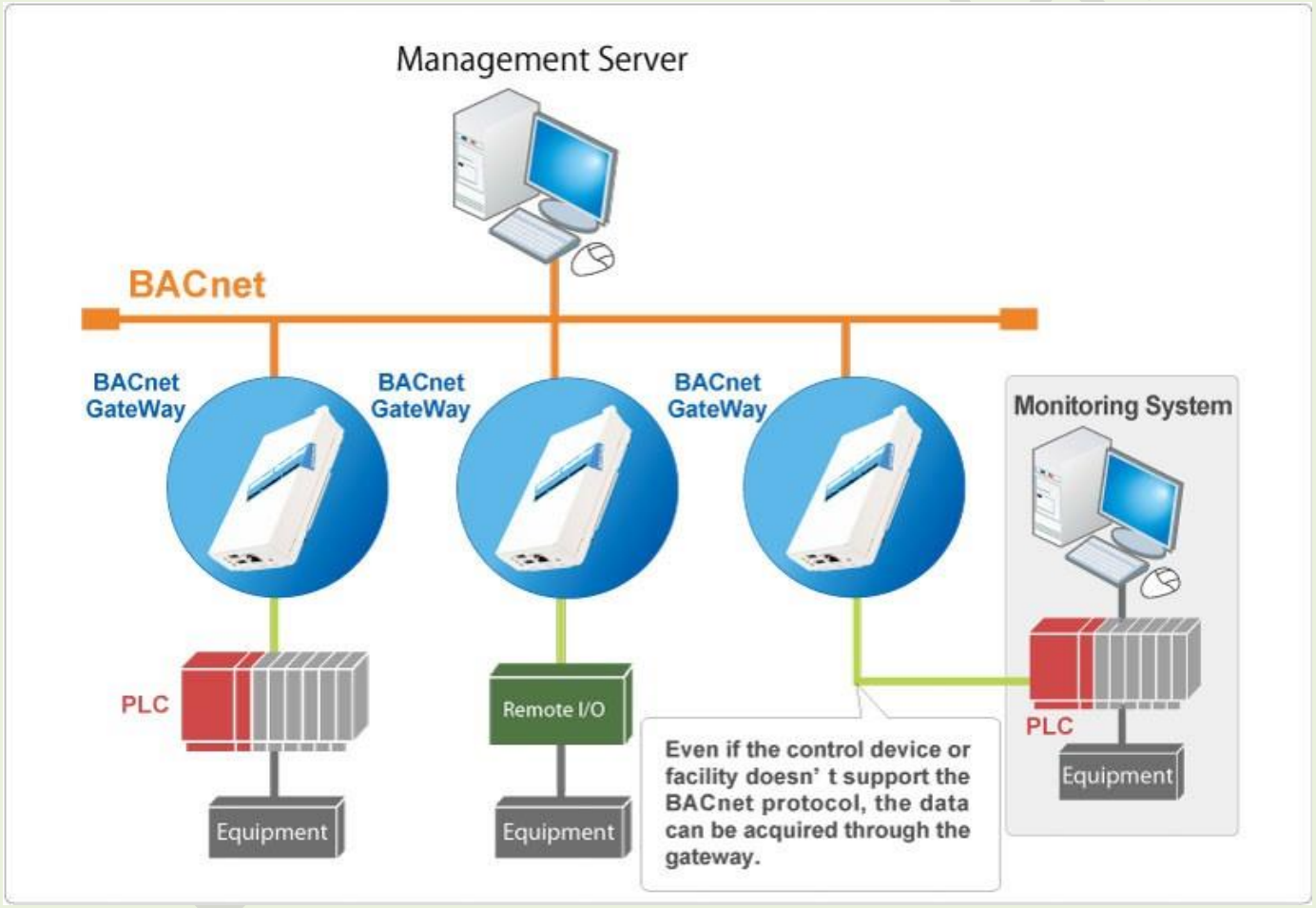


BACnet Components



BACnet is a communications protocol for building automation and control networks. It is an ASHRAE, ANSI, and ISO standard protocol. Facilities like electricity, air conditioning and lighting can be centrally supervised by using BACnet protocol. PLC Stands for Programmable Logic Controller. A sequence control device, used to control equipments by sequentially executing the programmed instructions planted beforehand with a computer or input device.

BACnet Network Diagram



Modbus

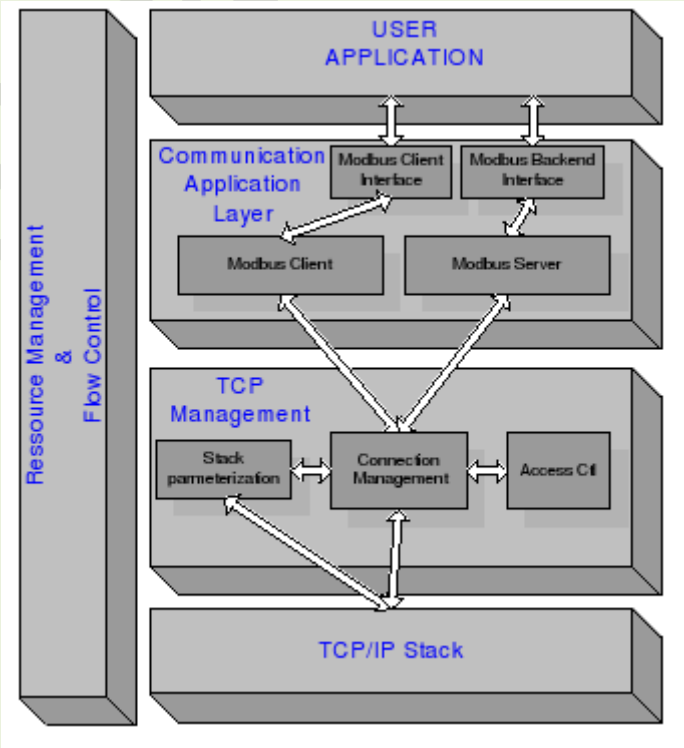
Modbus is a serial communications protocol published by Modicon in 1979 for use with its programmable logic controllers (PLCs). Simple and robust, it has since become a *de facto* standard communication protocol, and it is now amongst the most commonly available means of connecting industrial electronic devices. The main reasons for the extensive use of Modbus in the industrial environment are:

- It has been developed with industrial applications in mind
- It is openly published and royalty-free
- It is easy to deploy and maintain
- It moves raw bits or words without placing many restrictions on vendors

Modbus allows for communication between many (approximately 240) devices connected to the same network, for example a system that measures temperature and humidity and communicates the results to a computer. Modbus is often used to connect a supervisory computer with a remote terminal unit (RTU) in supervisory control and data acquisition (SCADA) systems.

Modbus Architecture

Modbus RTU is an open, serial (RS-232 or RS-485) protocol derived from the Master/Slave architecture. It is a widely accepted protocol due to its ease of use and reliability. Modbus RTU is widely used within Building Management Systems (BMS) and Industrial Automation Systems (IAS). This wide acceptance is due in large part to MODBUS RTU's ease of use.



Summary

- Building Automation Systems help keep buildings operating at higher efficiency
- Also provide for security and comfort
- EMS/BMS ensure that energy is not being used at the wrong time / or when not needed
- EMS/BMS can be integrated with DEMS to provide Automated Demand Response (ADR)
- MicroGrid Controller System