Introduction to

Building Management System

Pamela David
AGENDA

Designing a BMS
Equipment in a Building
Control, Monitor, Manage
DataPoint Schedule

Components of a Building Management System
Peripheral Devices
Controllers
Protocols
Networks
Supervisors

BMS in EMS
**Definition**

- A Building Management System (BMS) is a computer-based control system, consisting of software and hardware, installed in buildings.

- BMS controls, monitors and manages the building’s equipment.

- Equipment in a building could include mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems.

- BMSs can integrate using Internet protocols and open standards such as XML, BACnet, LonWorks and Modbus.

- **What is a BEMS?** Building & Energy Management System (BMS, EMS, BAS, IBMS, IBS, BACS, EMCS or Intelligent Building Controls, Smart Buildings)
Equipment to BMS

- HVAC – Heating Ventilation & Air Conditioning
  - Mechanical Equipment
  - Electrical Equipment
  - Plumbing Equipment
• Fresh Air Handling Equipment
• Various Types of AHU
• Heat Recovery Cycle
• Exhaust Fans
  - Twin Fans,
  - 2 Speed,
  - VFD
• Staircase / Lobby Press. Fans
• FCUs
• VAVs

• Chillers
• Primary & Secondary Pumps
• Cooling Towers
• Condensers
Plumbing Equipment

- Pumps
  - Booster
  - Transfer
  - Irrigation
  - Sump
  - Sewage Pumps
  - Fire

Water Tank
Electrical Equipment

- MCC Panels
  - Incoming / Outgoing Feeders
- Lighting /DB Panel
- UPS
- Generators
- Elevators / Travelators
3rd Party Systems

- Chiller Plant Manager
- Fire Alarm System
- Lighting Control System
- Security System
- CCTV System
- Access Control System
<table>
<thead>
<tr>
<th>S.NO</th>
<th>EQUIPMENT</th>
<th>QUANTITY</th>
<th>LOCATION</th>
<th>CONTROL</th>
<th>MONITOR</th>
<th>INTEGRATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HVAC AIR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HVAC WATER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PLUMBING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ELECTRICAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SYSTEMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Control, Monitor, Manage

Control: If the equipment functions under the commands of the BMS

Monitor: If the equipment functions on other dictates and BMS only monitors it.

Manage: Trending, run-hour etc.
Control, Monitor, Manage

CONTROL LOOPS
1. OPEN LOOP
2. CLOSED LOOP

Open-loop control system.

Closed-loop control system.
Control, Monitor, Manage

CONTROL LOOPS
- Input Variable
- Control Logic
- Output Variable

CONTROLLED VARIABLES
- Temperature
- Pressure
- Humidity
- Water Flow
CONTROL Methods
Analog : 0-10vDC, 4-20mA
Digital : Volt-free Contacts
Control, Monitor, Manage

CONTROL LOOPS
Input Variable
Control Logic
Output Variable

Analog Input
Digital Input

Analog Output
Digital Output

INPUT

desired output response

comparision
controller
process
output

measurement

OUTPUT

Closed-loop control system.
The control program - strategy

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>STRATEGY</th>
<th>OUTPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analogue:</td>
<td>STRATEGY</td>
<td>Analogue</td>
</tr>
<tr>
<td>Temperature</td>
<td>PID</td>
<td>e.g. valve position</td>
</tr>
<tr>
<td>Pressure</td>
<td>Optimiser</td>
<td>Digital</td>
</tr>
<tr>
<td>Humidity</td>
<td>Mathematical</td>
<td>i.e ON/OFF</td>
</tr>
<tr>
<td>Digital:</td>
<td>functions</td>
<td></td>
</tr>
<tr>
<td>Run</td>
<td>Logic</td>
<td></td>
</tr>
<tr>
<td>Fault</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse (meter)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Control - Air Handling Unit

CONTROL LOOPS

- Input Variable
- Control Logic
- Output Variable

Temperature CONTROL LOOP

- Supply Air Temperature
- Maintain supply temperature at a set value.
  - Measure SA temp.
  - Compare with set-point
  - change cooling accordingly
- Water flow in CHW Pipe via Control Valve + Actuator
CONTROL - Air Handling Unit

CONTROL LOOPS

- Input Variable
- Control Logic
- Output Variable

Supply Fan CONTROL LOOP

- Real Time Clock in the DDC
- AHU to run based on time
- Fan motor Start/Stop
Monitor- Air Handling Unit

Monitoring Points
- Status / Feedback
- Alarm
- Fault

Supply Fan
- Fan Run Status – DPS / VFC
- Fan Motor Trip Alarm

Other Parameters
- H/O/A switch
- OA temperature
- Filter – Dirty alarm
**Air Handling Unit – Al, Di, Ao, Do**

**Temperature CONTROL LOOP**
- Supply Air Temperature
- Maintain supply temperature at a set value.
- Water flow in CHW Pipe via Control Valve + Actuator

**Supply Fan**
- Fan Run Status – DPS / VFC
- Fan Motor Trip Alarm

**Other Parameters**
- H/O/A switch
- OA temperature
- Filter – Dirty alarm
### Equipment schedule

<table>
<thead>
<tr>
<th>S.NO</th>
<th>EQUIPMENT</th>
<th>QUANTITY</th>
<th>LOCATION</th>
<th>CONTROL</th>
<th>MONITOR</th>
<th>INTEGRATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HVAC AIR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HVAC WATER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PLUMBING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ELECTRICAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SYSTEMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Specifications

♦ GENERAL

♦ PARTICULAR

♦ Control Schematics

♦ I/O schedule – (Datapoint List /

♦ Sequence Of Operation

♦ Network Schematic

♦ (Equipment Schedule - Quantities)
Air Handling Unit – AI, DI, AO, DO

Temperature CONTROL LOOP
- Supply Air Temperature
- Maintain supply temperature at a set value.
- Water flow in CHW Pipe via Control Valve + Actuator

Supply Fan
- Fan Run Status – DPS / VFC
- Fan Motor Trip Alarm

Other Parameters
- H/O/A switch
- OA temperature
- Filter – Dirty alarm
## Data Point or I/O schedule

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Point Description</th>
<th>Point Type</th>
<th>DI</th>
<th>DO</th>
<th>AI</th>
<th>AO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Location -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>AHU 2nos</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Condenser Water System</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total for the Outstation | 0 | 0 | 0 | 0 |
Data Point Schedule – THE FINAL DOCUMENT

• Converting a Schematic to an Data Point Schedule
• Point Description
• Field Devices / Remarks
• Supplied By – Contractor / TREND
• Third Party Field Devices
# Designing A BMS

<table>
<thead>
<tr>
<th>S.NO</th>
<th>EQUIPMENT</th>
<th>QUANTITY</th>
<th>LOCATION</th>
<th>CONTROL</th>
<th>MONITOR</th>
<th>INTEGRATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HVAC AIR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HVAC WATER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PLUMBING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ELECTRICAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SYSTEMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Designing A BMS

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Point Description</th>
<th>Point Type</th>
<th>Peripheral Details</th>
<th>Provided By</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DI  DO  AI  AO</td>
<td></td>
<td>MEP  BMS</td>
</tr>
<tr>
<td></td>
<td><strong>Location -</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>AHU 2nos</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SA Temperature Sensor</td>
<td>2</td>
<td>Duct Temperature Sensor</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Modulating CHW Valve Command</td>
<td>2</td>
<td>Valve + Actuator</td>
<td>x</td>
</tr>
</tbody>
</table>

**Condenser Water System**

| Total for the Outstation | 0  | 0  | 2  | 2  |
BUILDING MANAGEMENT SYSTEMS
ISO 16484 – Building Automation Systems Structure

Supervisor Level

Network Level

Controller Level

Input/Output Level

Controller

963 Supervisor

Network Display

Local Display

Sensors and Actuators
Topics

Supervisor
  MMI / HMI / GUI

Networks
  protocols

Controllers
  protocols

Field Devices
Field Devices

Inputs

Outputs
**Field Devices**

**Inputs**

- **Analogue**
  - Temperature
  - Pressure
  - Humidity

- **Digital**
  - Pressure Switches
  - Voltfree Contacts

- **Pulsed Meters**

- **Temperature**
  - Space, Immersion, Duct, Outside

- **Humidity**
  - Space, Duct, Outside

- **Pressure**
  - Air, Water, Static, Differential, CO2
  - Space, Duct

- **Air Quality**
  - Space, Duct

- **Light Level**
  - Space, Outside

- **Occupancy**
  - Fixed, Adjustable

- **Electricity Meters**
  - Single/Three Phase, Networked
Field Devices

Outputs

- Valves
- Valve Actuator
- Damper Actuators
- Variable Speed Drives
Field Devices
Outputs

TYPES of SIGNALS:

AO MODULATING,
DO ON/OFF,
Topics

Supervisor
MMI / HMI / GUI

Networks
protocols

Controllers

Field Devices
**DDC - Controller**

**Inputs**

- **Analogue**
  - Temperature
  - Pressure
  - Humidity

- **Digital**
  - Run / fault

- **Pulsed Meters**

**Outputs**

- **Modulating or on/off valves**
- **Time control for boilers, chillers etc.**

**Connections**

- **Analogue**
  - Temperature
  - Pressure
  - Humidity

- **Digital**
  - Run / fault

- **Pulsed Meters**

**Other Features**

- **Logs**
- **Alarms**
- **PID maths logic**
- **Times**
Applications

• boilers

• AHU’s

• chillers
DDC - Features

- Freely Programmable
- Stand-alone function (RTC, graph plots, alarm generation)
- RTC
- 32 bit Microprocessor
- Peer to peer
- 1s cycle time
- Networkable over TCP/IP
- Web server with security protected monitor/control
- Modular & Expandable
- RS232 local supervisor port
- Precise and Accurate control
Web enabled DDC
Terminal unit Controllers

- FCU
  - With 3 speed fan
  - With VFD fan
- VAV
  - Pressure Dependent
  - Pressure Independent
- Chilled beam
Unitary DDC - Features

- Freely Programmable
- Control FCUs with VFD, heater
- Power efficient
- Stand-alone function
- Peer to peer
- IO cycle time < 250 Milliseconds
- Networkable over MS/TP or TCP/IP
- Web server with security protected monitor/control
- Water balancing
- Virtual Metering function modules
- Heat Meter & Integrator
Unitary DDC - Features

APPLICATION WITH:
1 Variable speed fan coil
2 Lighting
3 Occupancy
4 Natural ventilation
5 Window blind
Room Control

Inputs

- Light Level Sensor
- CO2 Sensor
- Blind Control
- PIR Detector
- Window Contact
- Lighting dimmer
- Light switch

<250ms Input to Output for lighting cycle

Outputs

- Heating
- Cooling
- FAN
- Blinds
- Dimming control
- Dimming control
- Occupancy Signal Relay
- Room Temperature
- Room Setpoint

RD Display Option
Room Control – with 3rd Party integration

### Inputs
- Light Level Sensor
- CO2 Sensor
- Window Contact

### 3rd party display on MSTP BUS
- Room Temperature
- Room Setpoint
- Blind
- Position
- Level

### Outputs
- Heating: Raise/Lower
- Cooling: Raise/Lower
- FAN: Dimming control

Blind control module on MSTP BUS

- OR -

- OR -

- Or can be connected directly into the 3rd – party display.

Lighting control module on MSTP BUS
Room Control: VAV Controllers - Features

- Network (MS/TP)
- Integral Pressure Sensor
- Extra AI, DI, AO, DO
Topics

Supervisor

MMI / HMI / GUI

Networks

protocols

Controllers

protocols

Field Devices
Networks

- Standard networks for the protocols.
- TCP/IP
- MS/TP
- LON
- ModBus
- Mbus
Network - Features

• No. of devices on the network
• Length of the network
• Speed
• Signal strength
Networks: TCP/IP and Ethernet

- TCP/IP over Ethernet
  - Non-Proprietary network developed by IEEE
  - TCP/IP provides end-to-end connectivity specifying how data should be formatted, addressed, transmitted, routed and received at the destination.
  - the Transmission Control Protocol (TCP) and the Internet Protocol (IP)
Networks: LON

- LON – Local Operating Network
  - Proprietary network developed by Echelon.

- The Echelon network defines:
  - LonWorks, a network standard.
  - LonTalk, a communications protocol.
  - All devices must be LonMark compatible!

- All devices should have a neuron ID.
- Approximately 50 devices on a bus
• Master-Slave/Token-Passing
• It is cost-effective, relatively slow, serial communications.
• Approximately 50 devices on a bus
• Repeaters are used to lengthen the distance / quantity of devices.
Topics

Supervisor
MMI / HMI / GUI

Networks
protocols

Controllers
protocols

Field Devices
Displays

- System level
  - BMS Software
  - Intelligent Display
- Controller level
- Room level
Displays - features

ROOM DISPLAY
- Built-in Temperature Sensor – Room Temperature
- SetPoint by Occupant
- C/F
- Fan Speed / Off
- Occupancy Override
Displays - features

**CONTROLLER DISPLAY**
- Single controller display panel
- Colour Touch screen interface
- Control panel mounted
- USB Port
- Graphs
- Calendar set up
- Flash memory to retain settings on loss of power
Displays - features

SYSTEM DISPLAY

• Full colour touch screen display
• Full network access, see all controllers
• Ethernet connectivity
• Schematic/Graphic capability
• Minimal set up and commissioning
• Flexible and customisable for all users
Displays - features

Standard features

Live value and in-place adjustment of points

Updating Chart

Specified Timezone. Live Status. Click to edit

Link to Schematics. Thumbnails shown
SUPERVISOR DISPLAY - SOFTWARE

- Secure – multi level passwords
- Work Groups
- Dynamic Display of Information
- Graphical Displays
- Customisable – Autocad, jpg,
- Adjustments
- Data collection
- Archive
- Graphs, Trending
- Alarms
- Alarm Retransmission - Email, SMS, Voice, Print
- Alarm Management
- Web Server
- Client / Server Based
Understanding BMS Architecture
Topics

Supervisor
  MMI / HMI / GUI

Networks
  protocols

Controllers
  protocols

Field Devices
## From DataPoint Schedule to BMS Architecture

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Point Description</th>
<th>Point Type</th>
<th>Peripheral Details</th>
<th>Provided By</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DI  DO</td>
<td>AI  AO</td>
<td>MEP  BMS</td>
</tr>
<tr>
<td></td>
<td>Location -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AHU 2nos</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SA Temperature Sensor</td>
<td>2</td>
<td>Duct Temperature Sensor</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Modulating CHW Valve Command</td>
<td>2</td>
<td>Valve + Actuator</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Condenser Water System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total for the Outstation</td>
<td>0</td>
<td>0  2  2</td>
<td></td>
</tr>
</tbody>
</table>
From DataPoint Schedule to BMS Architecture
From DataPoint Schedule to BMS Architecture
Putting the “E” in the BEMS

- Supervisor
- Networks
  - Protocols
- Controllers
- Field Devices
TIME FOR A BREAK