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Building Management Systems (BMS)

Seminar 2 - Advanced Management and Improvement Opportunities

Presented By: Andrew Smith

Leader Building Technologies –

A.G. Coombs Advisory

A.G.Coombs

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Seminar 2 – Advanced Management and Improvement Opportunities

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

Seminar 1 – The Basics Explained

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

5. BMS System Architecture

- BMS Types and scalability
- Open system protocols, what does this really mean
- High Level Interfaces (HLI)
- Integration with other building systems
- Distributed Building control networks
- Licensing and other limitations

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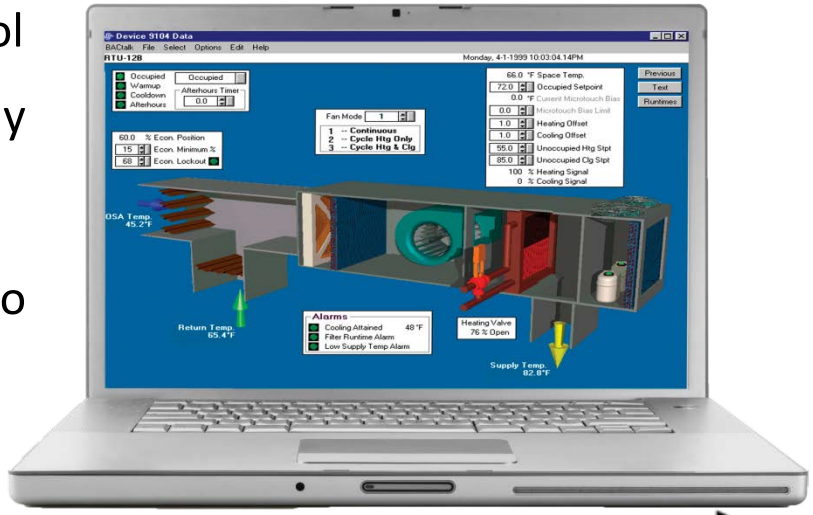
BMS Types and Scalability

- Can be a single BMS controller to hundreds of networked controllers
- Have a basic LCD display, a simple WEB interface through to fully animated Graphic Operator Workstations.
- Basic pre-programmed (canned) control functions to fully customised and freely programmable
- Stand alone BMS or fully integrated into other building systems



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Open System Protocols – What does this Mean??

- The term "Open System" is often confused with "Open Protocols" but these terms are not interchangeable.

- An "Open Protocol" refers to an industry standard communications dialog that allows BMS controllers to communicate together much like PC's talk on a network in a common language. Two of the major protocols in use are;

BACnet™

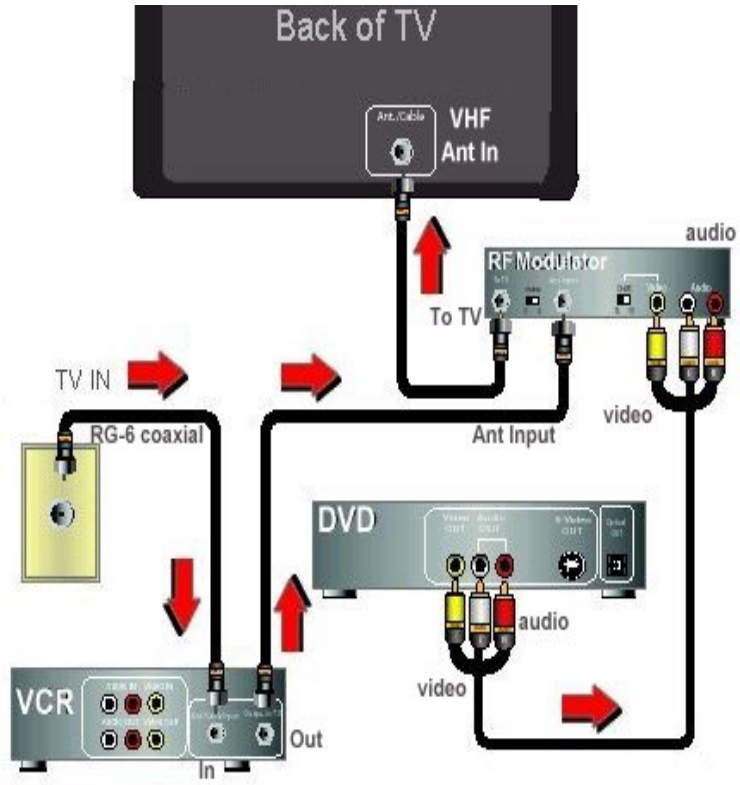
LONMARK®

- Do not be confused by which one is the better alternative or which one provides vender independence. ***Vendor specific configuration tools are still required…***

- What you need is an "Open System" and this has less to do with technology and more to do with venders attitude, its staff and their engineering expertise.

Open System Protocols – Comparison

- Each device can be from a different manufacturer
- Use each individual manufacturers user interface to configure and program their equipment only
- Connections made between the devices with standard connections
- Data is shared between the devices via standard industry protocols
- Standard protocol ensures interoperability between devices
- Each device can be replaced with one from a different manufacturer



High Level Interfaces (HLIs)

- Communication between devices or complete systems over a data network
- Enable integration between building systems
- Replaces traditional ‘hard wired’ connections between devices
- Can provide data for hundreds of points over a single connection
- Provides additional information and extended functionality
- Communications can be custom interfaces or standard open protocols
- Open system protocols include Lonworks, Bacnet or Modbus.
- Standard Open protocols reduce configuration, engineering, etc

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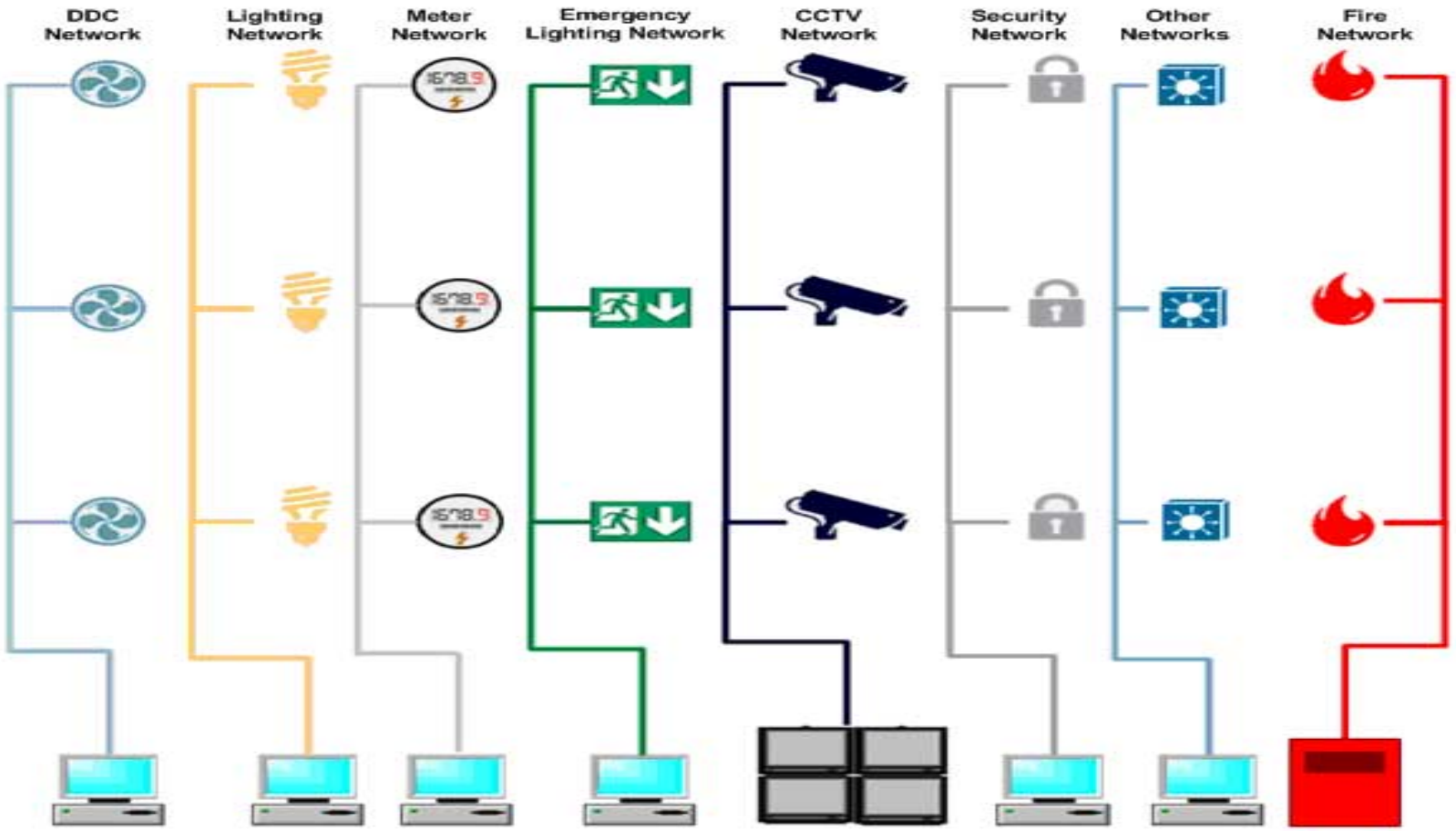
Integration With Other Building Systems



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Integration With Other Building Systems

- There are many reason to integrate the BMS with other building systems…
  - Single user interface to monitor and control all building services
  - Consolidated Alarm and Fault management
  - Extended Functionality such as:
    - Single point for all time scheduling functions
    - Electrical load management based on energy system
    - Consolidated after hours control of lighting and HVAC
    - Occupancy control of HVAC using Security and Access Control
    - Lighting control in the event of a security breach
    - Extended secondary fire mode control of lighting, security, etc***

****All primary fire mode controls must meet Australian standards*

Distributed Building Control Networks?

- Building control functions don't have to be limited to being performed within the BMS controllers alone
- Networks, High Level Interfaces (HLI) and integration allow control functionality to be distributed
- Devices include Variable Speed Drives (VSDs), chillers and packaged and split air conditioning units
- Each device directly performs its own specialised control
- Via the HLI, the BMS monitors operational status and allows for adjustment of control parameters such time schedules and setpoints

Licensing and Other Limitations

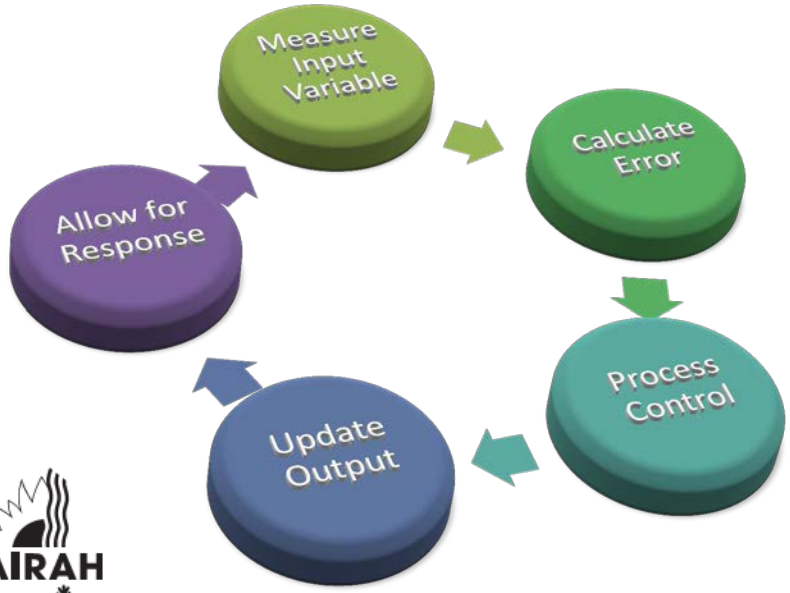
- When selecting a BMS consideration should be made with regard to all relevant software and point licensing, network limitations and spare capacity…
  - Licenses associated to the number of points connected to the BMS
  - Licenses of configuration tools used to configure the BMS
  - Data network limitations to the number of connected BMS controllers
  - System design should allow for spare capacity for future expansion
  - WEB user interfaces may have license restrictions for connected PCs
  - Maintenance issues if your BMS is not current software revisions?

6. BMCS Programming

- Application programming
  - Canned, graphical, event and script
- Standard programming loops such as PID, PI and P
- Advanced programming strategies for energy efficiency
- Control loop tuning and energy optimisation

Application Programming – Control Loops

- There are 2 basic types of control Loops, event driven and closed loop.
- Event driven control which triggers from a change of state event such as time schedules or the change of state of an input (analog or digital)
- Closed loop control continually uses the controlled variable as feed back and adjusts the output device in direct response.



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Application Programming – Text Based

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File Edit Block Convert Options View Help

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```
1  //AC1 CONTROL.
2  If 'AC_B3-1_FAN_STS' OnFor 30S Then
3    If 'AC_B3-1_ZT' > 'AC_B3-1_SP' + 1 Then
4      'AC_B3-1_COOL_ENABLE' = On
5    Else
6      'AC_B3-1_COOL_ENABLE' = Off
7    End If
8  End If
9
10    // AC 2 CONTROL
11  If 'AC_B3-2_ZT' > 24 Then
12     'AC_B3-2_FAN_ENABLE' = On
13   ElseIf  'AC_B3-2_ZT' < 22 Then
14    'AC_B3-2_FAN_ENABLE' = Off
15      End If
16
17
18  If 'AC_B3-2_FAN_STS' OnFor 30S Then
19     If 'AC_B3-2_ZT' > 'AC_B3-2_SP' + 1 Then //(if sp=24!) cool 25deg on
20     'AC_B3-2_COOL_ENABLE' = On
21     ElseIf  'AC_B3-2_ZT' < 'AC_B3-2_SP' - 1 Then //cool 23deg off
22   'AC_B3-2_COOL_ENABLE' = Off
23       End If
24         End If
25
26  Avg_Temp = Average ('AC_B3-1_ZT', 'AC_B3-2_ZT')
```

27: 1 | Modified | Insert

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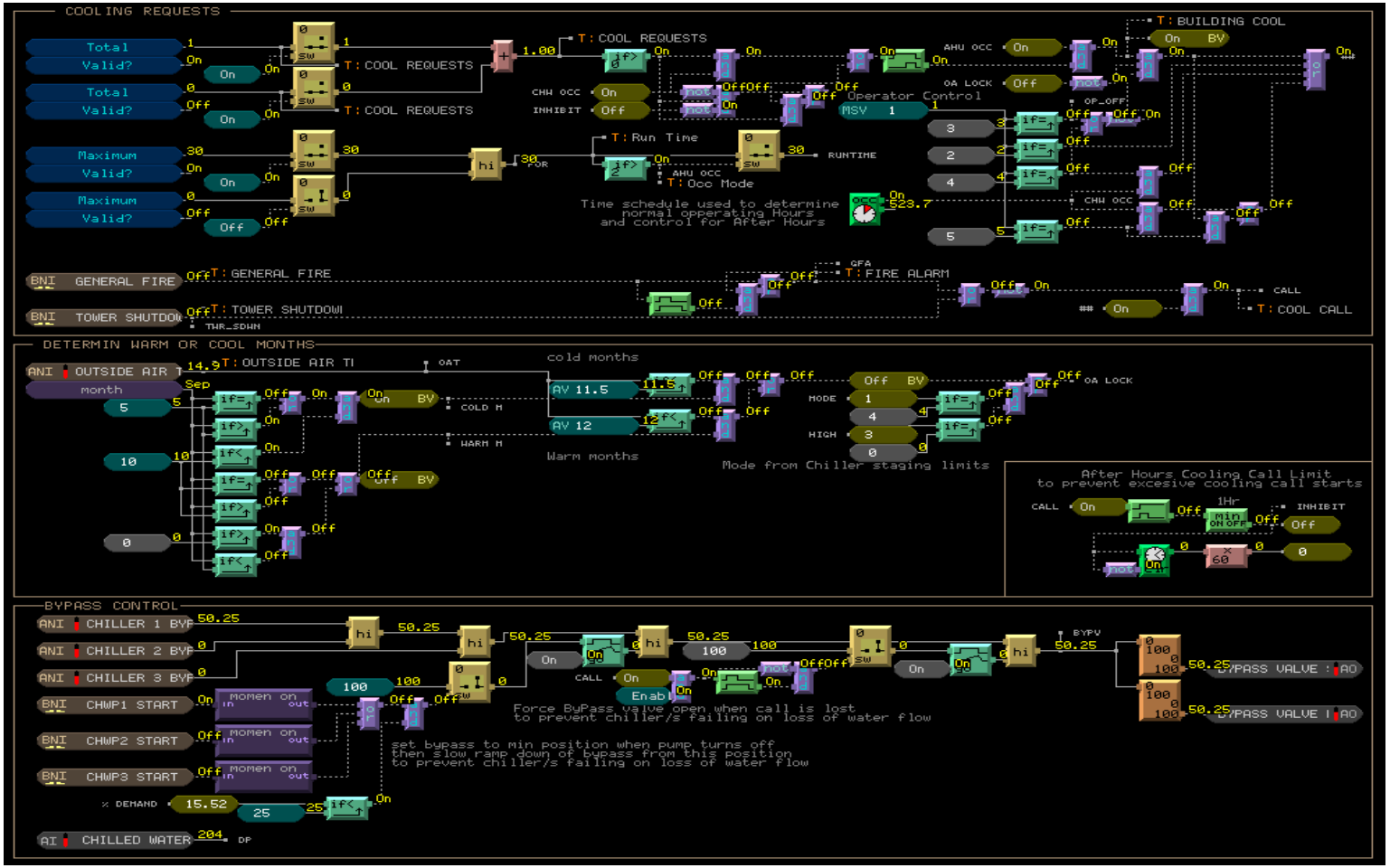
Application Programming – Graphical



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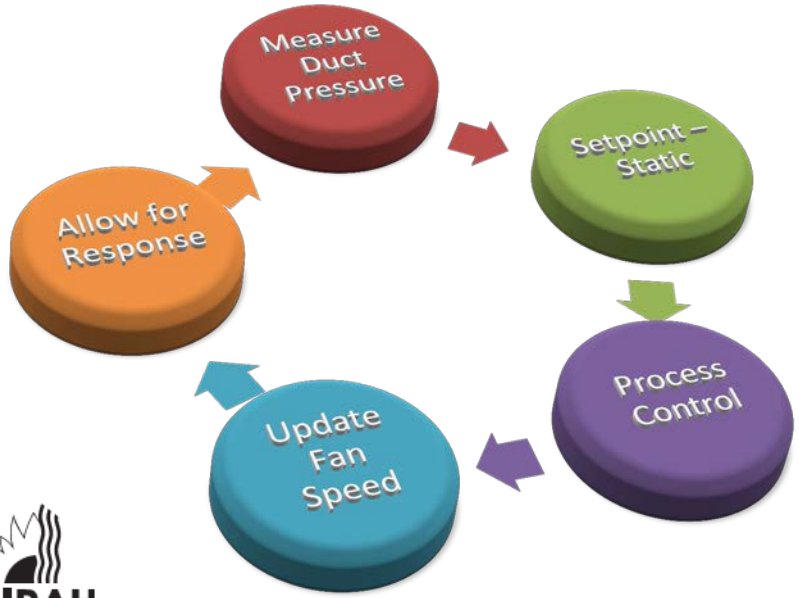
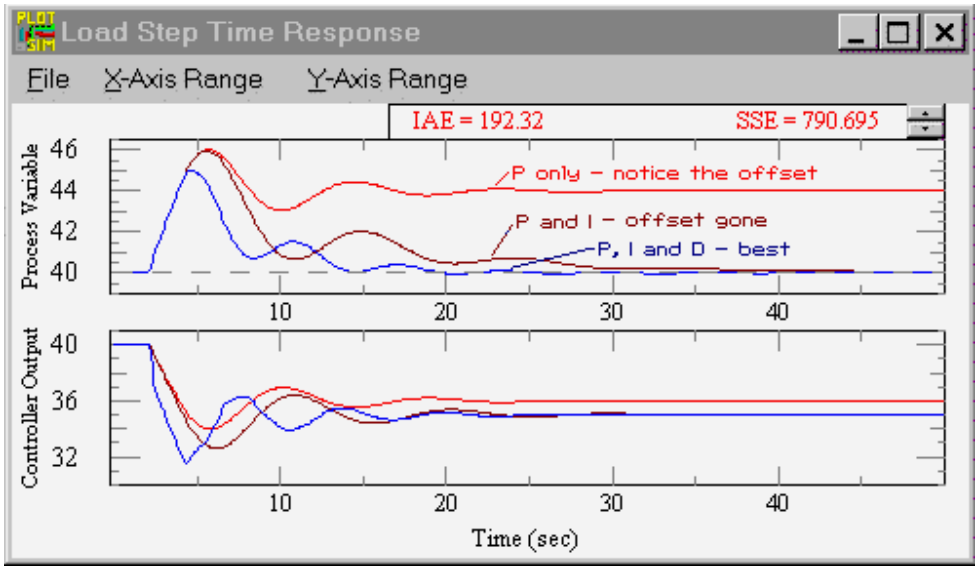
Standard Programming Loops – P, P+I, PID

- The most commonly referenced control loop – the PID loop
  - ‘P’ = Proportion control band
  - ‘I’ = Integral gain control
  - ‘D’ = Derivative term
- Can be either P only, P+I or PID (rare)
- Each loop needs an input variable, a setpoint, an output control variable and a loop timer
- Proportional Band – a value based on the error from setpoint
- Integral Gain – added value based on how long the error has existed
- Derivative Term – added value based on the speed the input variable is changing
- Dead Band – a range close to the setpoint when no change occurs
- Loop Timer – How often to check the input variable against setpoint

Standard Programming Loops – P, P+I, PID

- P Only – Loop settles with an error from setpoint
- P+I – Control variable close to setpoint, output maintained
- PID – Same as P+I but faster to respond, output maintained





Advanced Programming for Energy Efficiency

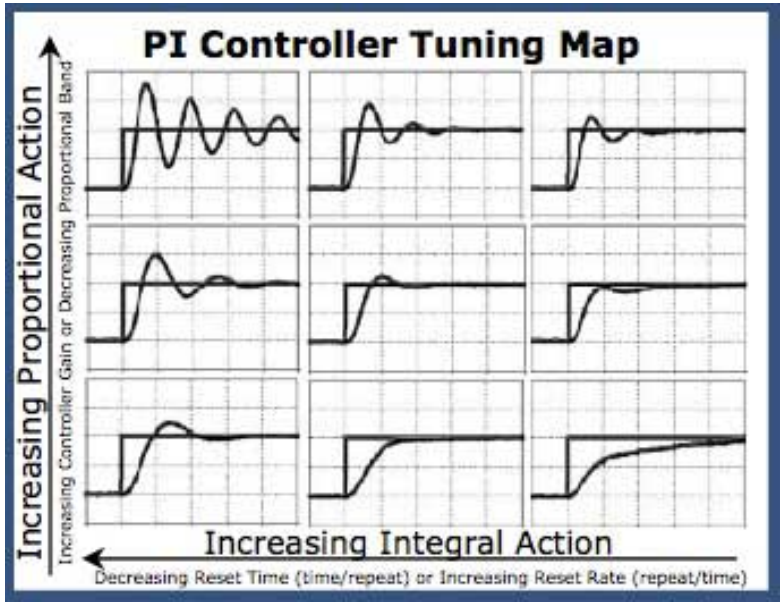
- Control algorithms focused on energy efficiency
- Allow for a wider range of acceptable conditions
- Aim to use just enough heating or cooling
- Start up just in time and run just for long enough
- Remove all overlap between systems
- Sequences that match plant capacity to building load
- Use most energy efficient plant when possible
- Automatically adjust for seasonal conditions
- Part load, building turn down or part occupancy

Energy Efficiency Control Strategies

- Examples of energy efficient control strategies include:
  - Optimal start up – Start the air conditioning at the latest possible time to reach comfort conditions as the building becomes occupied
  - Optimal plant stop – Stop the heating and cooling plant at the earliest possible time to allow the system inertia to maintain conditions
  - Proportional only zone control – Allow a wider range of acceptable temperature but within limits
  - Variable air pressure control – Automatically adjust the fan speed control to provide just enough air
  - Variable water pressure control – Automatically adjust the pump speed control to provide just enough water
  - Variable cooling water temperature – only chill the cooling water enough to cater for the building load

Control Loop Tuning - Recap

- BMS control loop Tuning and Optimisation are not the same thing….
- BMS control loop tuning ensures that the equipment operates in a stable, predictable and repeatable manner.
- Optimisation focuses on operating the equipment in the most energy efficient manner without impacting on the tenant comfort
- The first stage of optimisation includes BMS loop tuning.



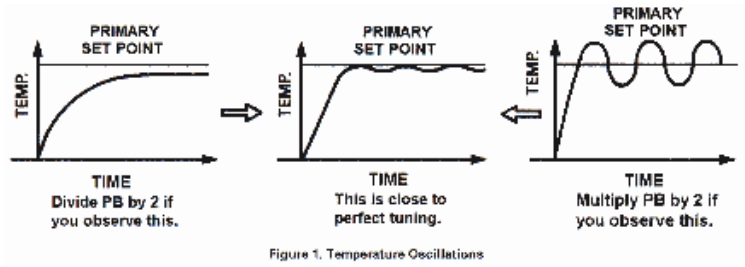


Figure 1. Temperature Oscillations

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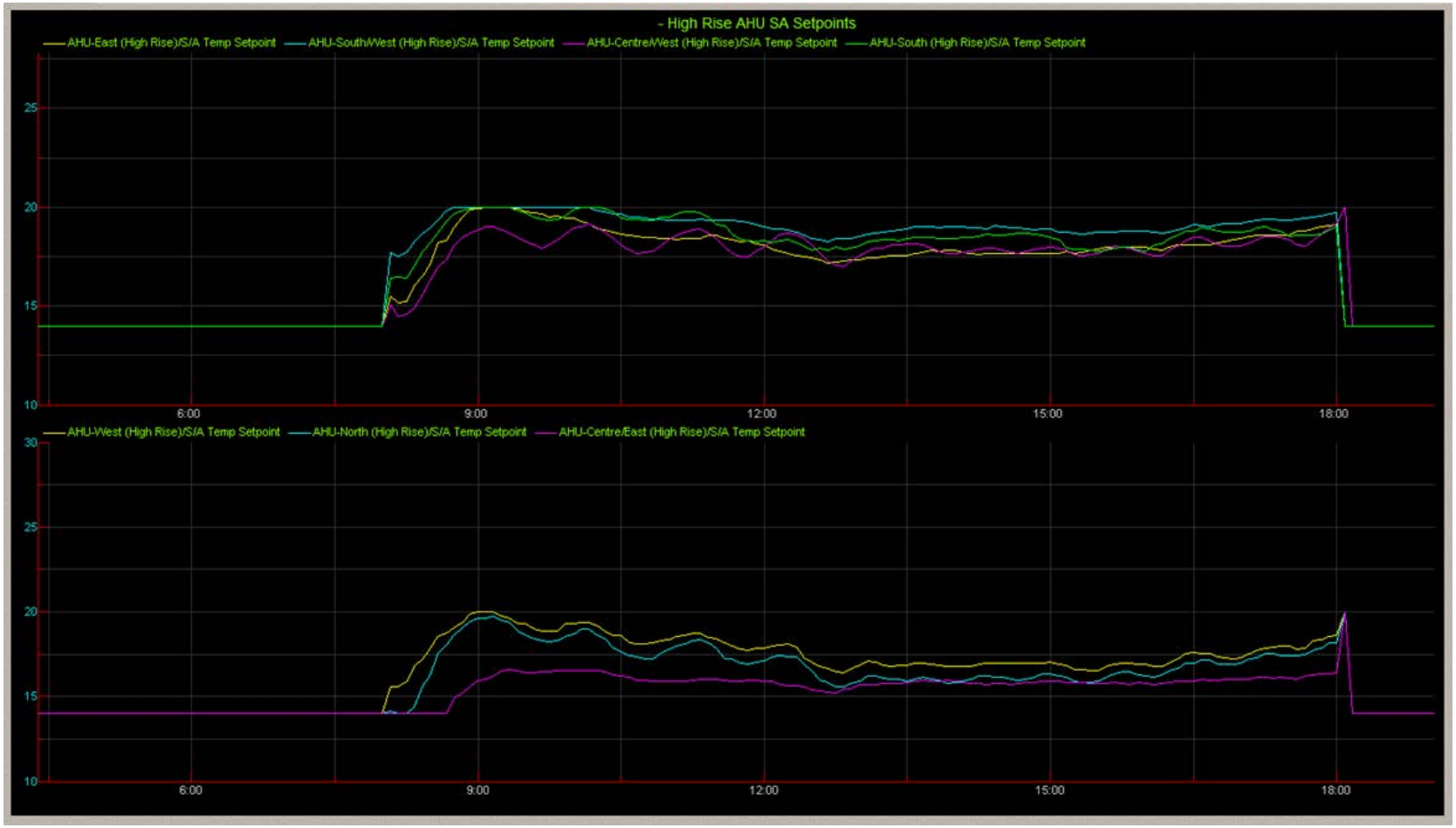
Control Loop Tuning Examples – SA Temperature



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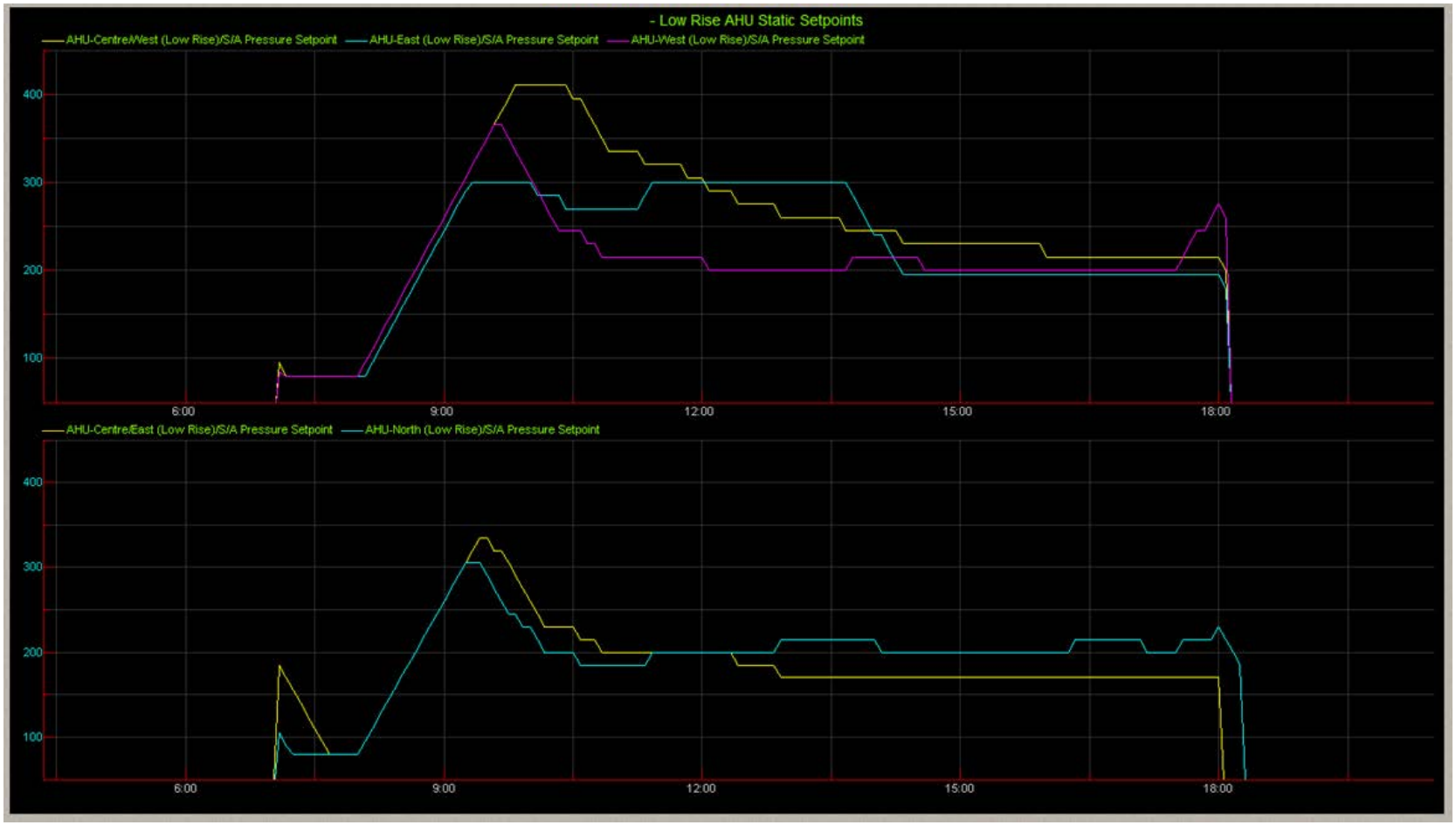
Optimisation Example – Static Pressure Setpoints



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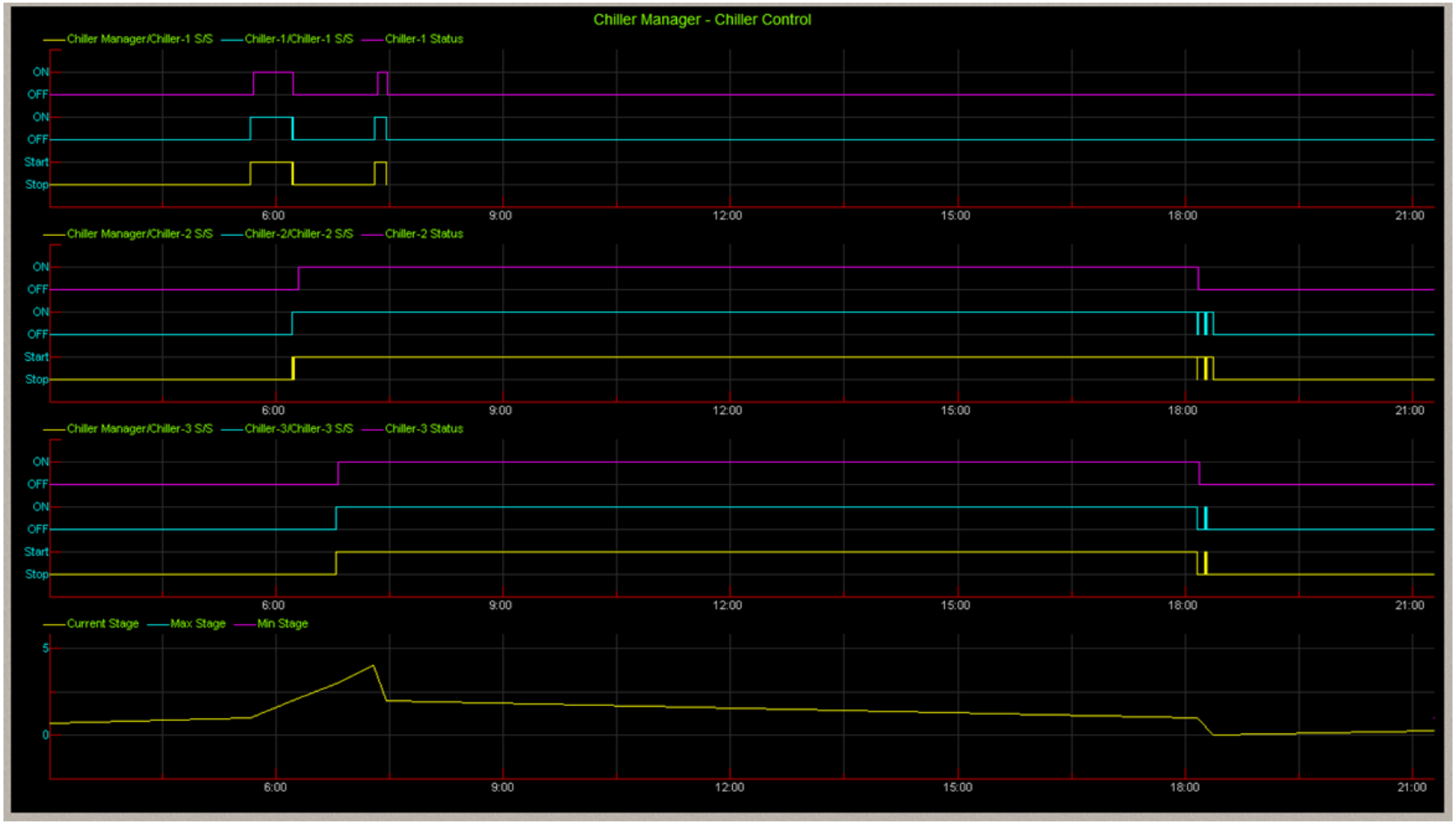
Optimisation Example – Chiller Staging



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7. Extended BMCS Functionality

- Advanced User interface functions
- Trend data, sampling rates and numbers of samples
- Automated reporting
- Alarm and event management

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Advanced User Interface Functions

- Operator override control and adjustment of BMS points
- Condition based alarming and alarm management options
- Point trend sampling trend logging, graphing and data export
- Automated and customised reporting
- Multiple user access levels, view only to administrator
- Operator activity logging and audit trails
- Real time monitoring of control logic

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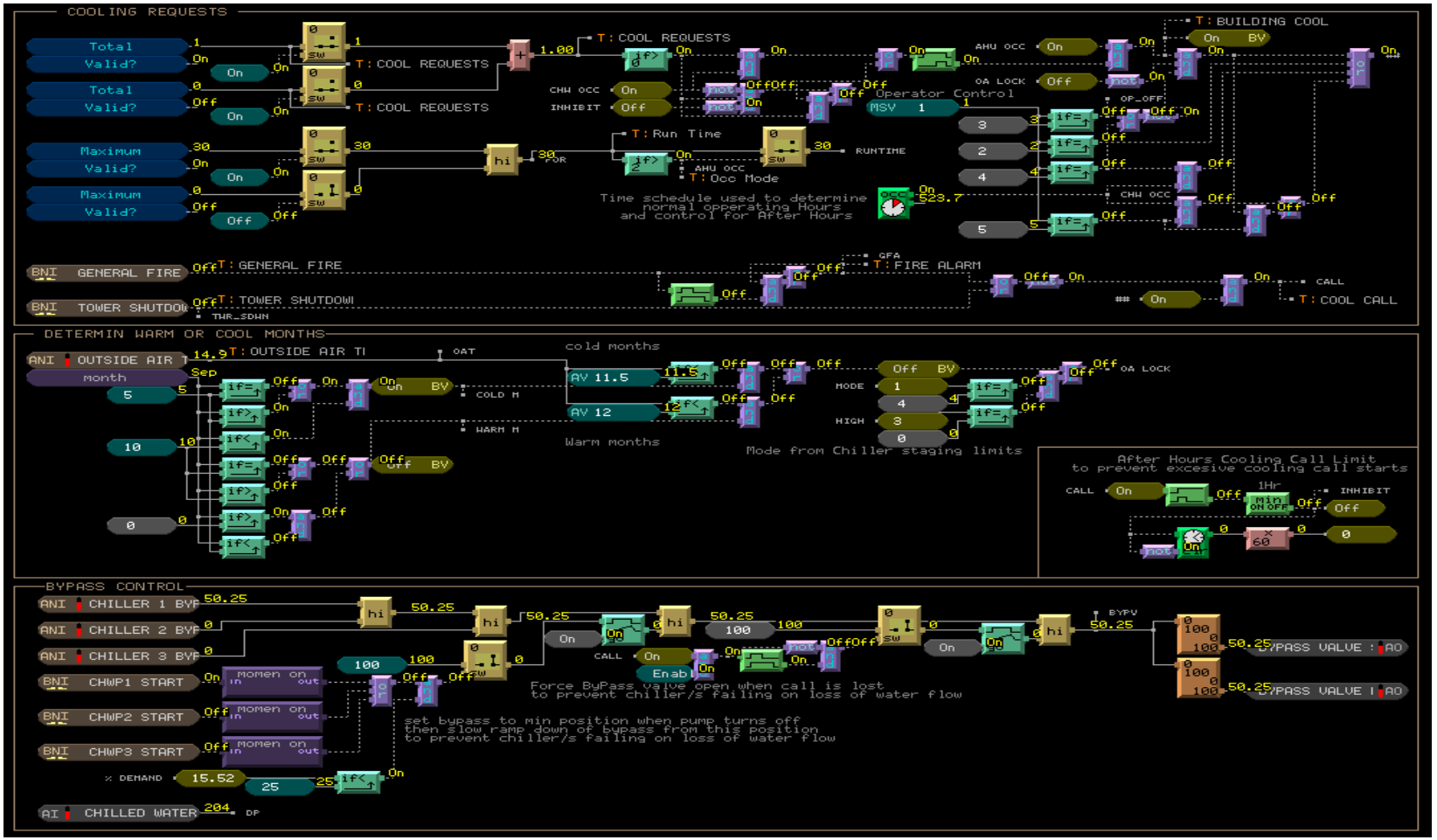
Real Time Monitoring of Control Logic



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Trend Data and Trend Logging

- BMS trending provides a historical look at plant performance
- Allows a retrospective look at control for fault finding and fine tuning
- Trend sampling is set up for individual BMS points
- Analogue BMS points are usually sampled at intervals
- Binary BMS points are usually sampled on a change of state (COV)
- The interval between samples should reflect the rate the point changes
- Incorrect sampling rates will distort results or mask problems
- Individual point trends can be grouped and displayed logically
- Group point trends to put performance into context
- Keep enough trend data history to allow for full analysis

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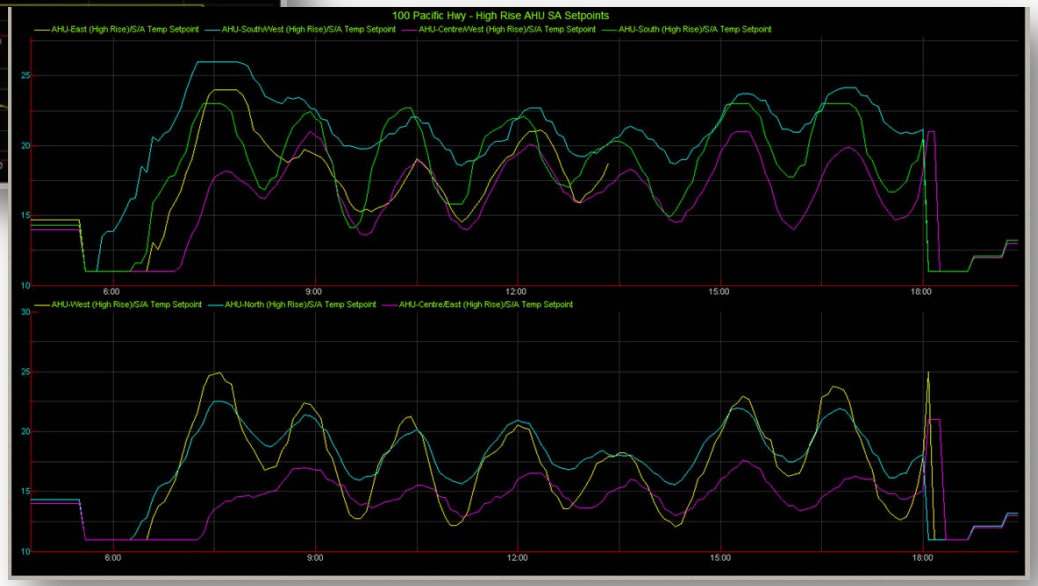
Trend Data and Trend Logging

Binary or On/Off points captured on change of state (COV)



Analogue points captured on appropriate time intervals

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Automated Reporting

- Reports set up to run automatically based on time or event
- Can also apply to automatically grouping predefined points
- Can be system related such as operator override or alarms
- Can also be customised for the installation
- Operational summaries of critical plant or groups of items
- Related to maintenance events such as fire mode testing
- Multiple output options including printer, exports and email

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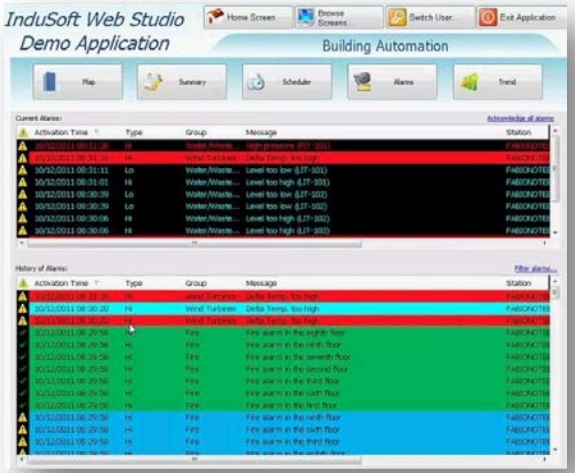
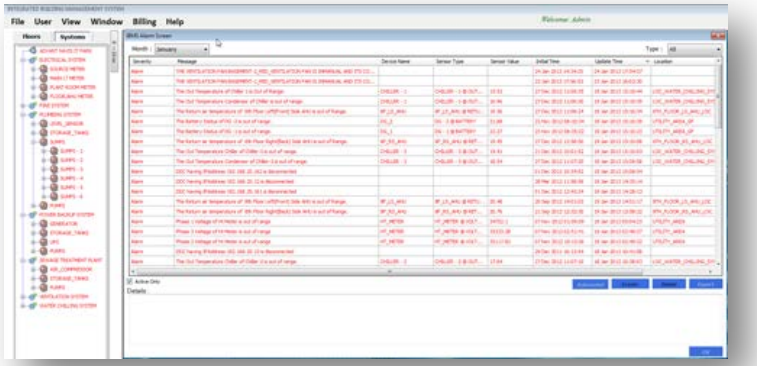
Alarms and Alarm Management

- BMS Points can have multiple alarm states
- Alarms can be conditional, suppressed or delayed
- Multiple alarm levels, notification, warning, critical, fire life safety
- Selectable alarm actions, acknowledged, repeated
- Alarm output options include Screen, Printer, SMS and email
- Alarm summaries include active alarms and historical alarm logs





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8. Upgrades and Retrofits

- When to retrofit or upgrade
- Partial or staged upgrade options
- Total system replacement
- The opportunity to set new standards
- Importance of decommissioning and commissioning

When to Upgrade or Retrofit

- When should you consider to upgrade or retrofit?
  - Availability of BMS hardware spare parts or technical support
  - Reliability issues with the current BMS
  - Access to functionality to improve energy efficiency
  - Major building fit out project or plant upgrade

- Identify the key objectives and drivers
- What are the options, upgrade, migration, full replacement
- What will the impacts be on my building and tenants??
- Plan well in advance, don't wait until the last minute
- Consider getting some independent advice…

Partial or Staged Upgrade Options

- Update to a newer version of the current BMS
- Allows for refresh of existing system at reduced cost
- Access to new functions and features
- Can target BMS hardware devices at end of life or obsolete
- Opportunity to review control strategies and user interfaces
- Works can be sequenced with tenant churn or retrofits
- Logistically a simpler option than full replacement

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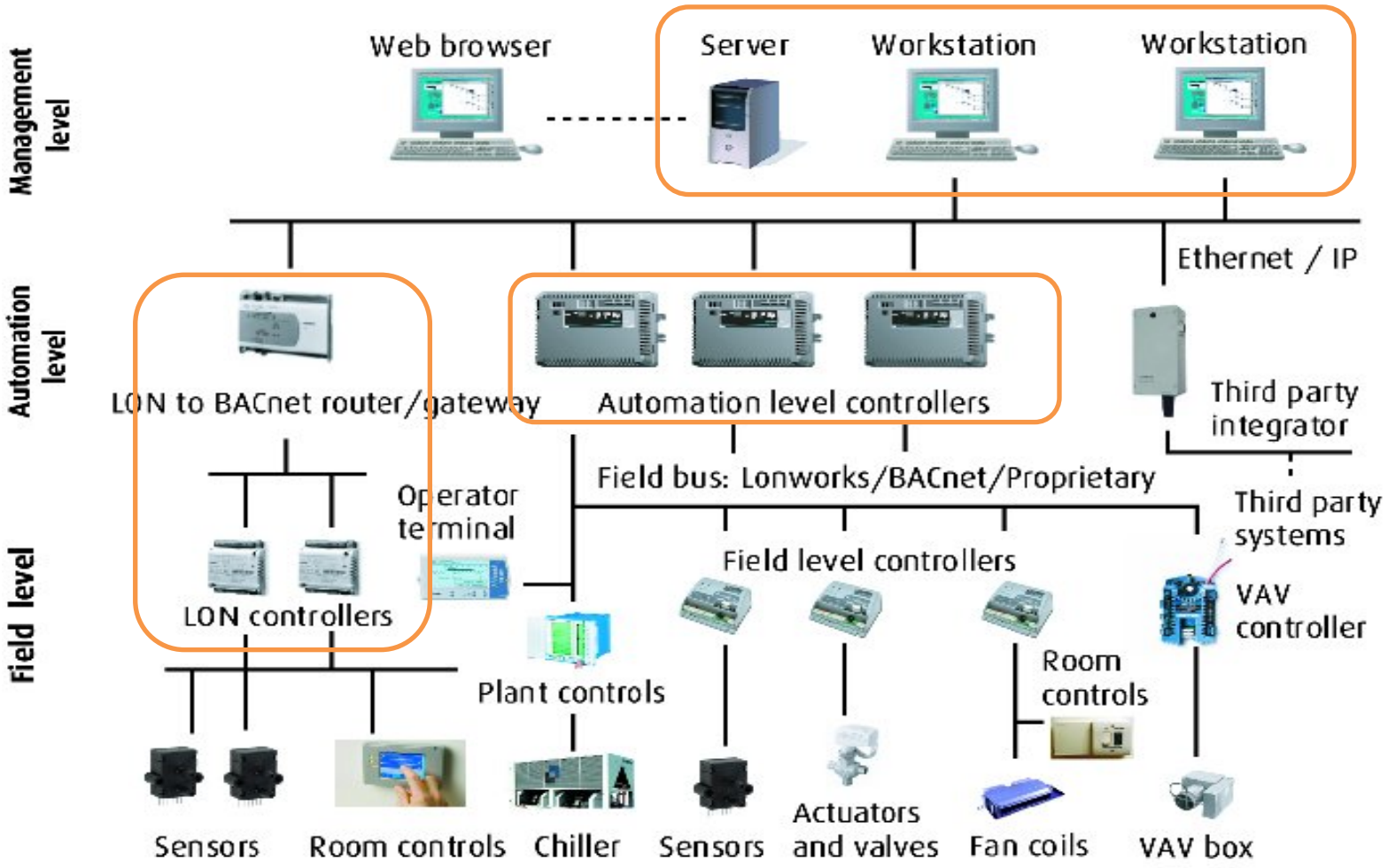
Partial Upgrade Option



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Total System Replacement

- Total replacement of the current BMS hardware and software
- Opportunity to select best available BMS solution for site
- Some field input and output devices can be retained
- New high speed communications network should be included
- Logistical challenges for a tenanted buildings
- A well developed change over works program is required
- Requires full commissioning of the entire system

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Opportunity to Set New Standards

- Don't just copy what you already have…
- Opportunity to review all control strategies
- Upgrade to energy efficient control
- Set standards for new user interfaces, especially graphic displays
- Take time to workshop and document requirements
- Agree on user interfaces, trending, alarming and reporting
- Its your system so take an active role

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Decommissioning and Commissioning

- Decommissioning is just as important as commissioning
- Capture years of improvements and ‘enhancements’
- A chance to right the wrongs…
- Chance to address the underlying issues
- ‘Point to Point’ testing of all connected field equipment
- Software and hardware commissioning
- Seasonal commissioning and tuning
- Generic calibration factors do not work
- Don’t just commission by faults

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Advanced Management and Improvement Opportunities– Recap…

- Building Management Systems are scalable from one to many devices.
- Can use standard open protocols to communicate to other systems
- Allow for distributed control functionality with specialised equipment
- Include complex control options to achieve energy efficient operation
- Include functionality to manage and fine tune building performance
- Require good sound planning when implementing or upgrading
- Are not ‘Black Boxes’ and should be utilised to their full potential….

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