Back to Basics – DDC/BMS/EMS & Integration

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Back to Basics – DDC/BMS/EMS & Integration

The views and opinions expressed in this presentation are from my experiences in the industry over 20 years. These are not explicit views of Innotech directly and may differ between people and manufacturers.

Agenda

- Terminology
- Direct Digital Controls (DDC)
- Building Management Systems (BMS)
- Energy Management Systems (EMS)
- Proprietary Systems
- Interoperable Systems
- Misinterpretations of “Open Technology”
- Looking after the Clients best interests (Initially and ongoing)
- Engineering Practices and Serviceability
- Integration Demonstration with multiple vendors

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System Terminology

- **DDC System** - Direct Digital Control System
- **BMS** - Building Management System
- **EMS** - Energy Management System
- **I/O -** Inputs/Outputs
- **Hardware -** Physical devices used to make decisions for controlled outputs, based on changes in input conditions
- **HMI** – Human Machine Interface (A controller or network display)
- **Software -** The computer interface for the hardware, or separate utilities to perform value-added tasks
- **HLI**- High Level Interface. The ability to send and receive a greater amount of data over a single communications Bus
- **Protocol** – A defined communications language (Such as BACnet, Modbus, Lonworks, Meter-bus, KNX, DALI, Innotech)

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System Terminology

- **Bus** – The physical communications platform used for inter-device communications and connection to the BMS computer. This does not define the protocol used. Types of Bus include:
  - **RS485** communications – Over specific cable
  - **Ethernet** – Over a computer Network
- **Proprietary** - A defined protocol that is unique to an individual or company. The raw code is not in the public domain
- **Open Technology** - A solution based on uniformity and interoperability. A philosophy used to ensure competitive pricing and client focussed benefits
- **Integration** - The process of translating from one protocol to another
- **Interoperability** - The ability to integrate with other vendors equipment
- **Interconnectivity** - Devices that are the same between manufacturers, allowing swapping of brands. (A device with the same communications protocol may be interoperable, but may have different internal variables and not a straight swap)
- **Native** - Using a common protocol between vendors on a common Bus
- **Gateway** – A hardware or software device used to translate between protocols (Hardware solutions are preferred due to failsafe operation)

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DDC, BMS, EMS – What's the difference?

DDC System – Direct Digital Control System

- Programmable controllers with their own Central Processing Unit (CPU)
- Generally basic software, with various capabilities, such as:
  - Data extraction
  - Alarming
  - Viewing an altering schedules and system variables
- Controllers have the ability to communicate with other controllers and operate stand-alone
- May be equipped with or without:
  - a HMI (Human-Machine Interface)
  - on-board data-logging
  - Ethernet connection
  - RS485 connection

Not all DDC software and hardware is the same, and it does differ between manufacturers. Some controllers are networkable, allow selection of various functions, but do not allow altering of the control logic within the device. These are often called "**canned**" controllers. (E.g. Some VAV's and Fan-Coil Unit controllers)

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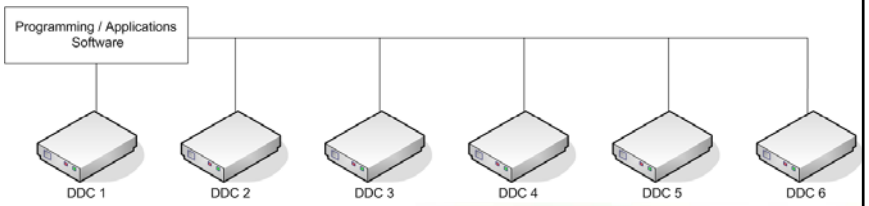
DDC / BMS / EMS

DDC – Direct Digital Control System



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DDC, BMS, EMS – What's the difference?

BMS – Building Management System

- Use **DDC** hardware
- More advanced Graphical User Interfaces (**GUI**), or **SCADA** (Supervisory Control And Data Acquisition) software:
  - Using a combination of standard templates and client customisation
  - Suited for less skilled personnel
  - 3-D animations via application software or web-server technology
  - Specific Site and Floor Plans
  - Real-time and historical trending of data
  - Complex alarm capabilities, acknowledgments and audit trails
- Integration with other services and protocols using on-board translators, gateway devices or software

A **BMS** that is engineered well, will be easier to use, require less training, and be intuitive to the user.

Where a DDC system may not require much more than addressing and programming of a device, a BMS requires time for planning, engineering programming, BMS graphics development, integration of services, documentation, commissioning, data validation, tuning and service and maintenance to ensure optimum performance and savings are maintained.

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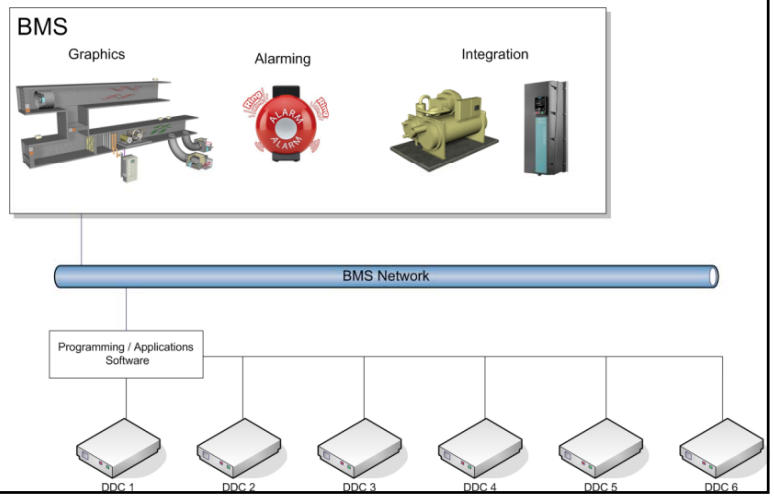
DDC / BMS / EMS

DDC/BMS – Building Management System



DDC, BMS, EMS – What's the difference?

EMS– Energy Management System

- Use **DDC** hardware for energy management strategies
- May include the integration and totalisation/billing of various services via a combination of **HLI** or Low Level switching contacts on a DDC, such as:
  - HVAC&R
  - Electrical Power
  - Water (Mains and Rain Harvesting)
  - Gas
  - Oil
  - Thermal Energy
  - Lighting
  - Security
  - Access Control
- Uses complex databases and queries ,to enable basic users simple viewing and printing of reports, bills and exporting of data to third party reporting programs

*The BMS **may** have full EMS capabilities, however some manufacturers utilise third party software to provide the EMS functionality for analysis, billing and reporting. There is a greater expectation for the BMS to provide the complete solution from the one interface for ease of use for the client, and less licensing costs, initially and ongoing.*

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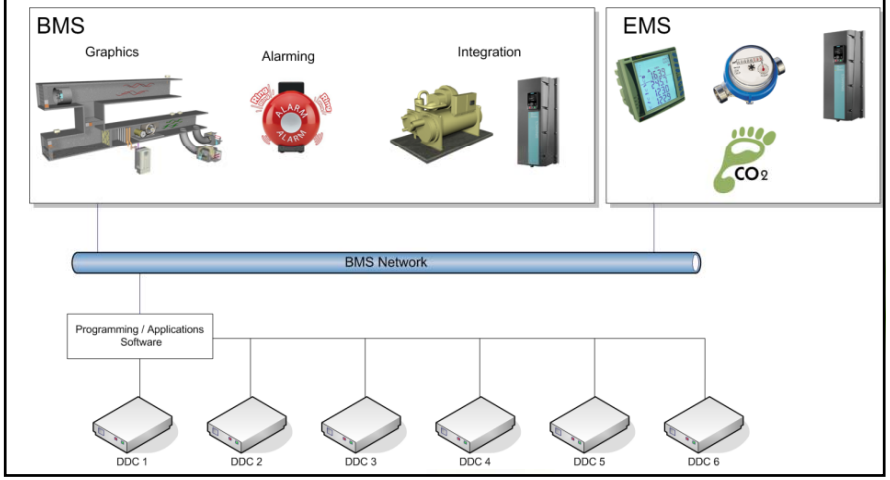
DDC / BMS / EMS

DDC/BMS/EMS– Energy Management System



Proprietary Systems

What is a Proprietary System?

- A full proprietary system does not allow interoperability with other manufacturers
- Uses a specific protocol and bus for its communications layer

With this style of system, the client is tied to that manufacturer for hardware costs, software costs and upgrades, as well as service and maintenance for the life-cycle of the equipment. ***However, although many systems use proprietary communications, not all systems that use proprietary protocols are a "closed" systems.***

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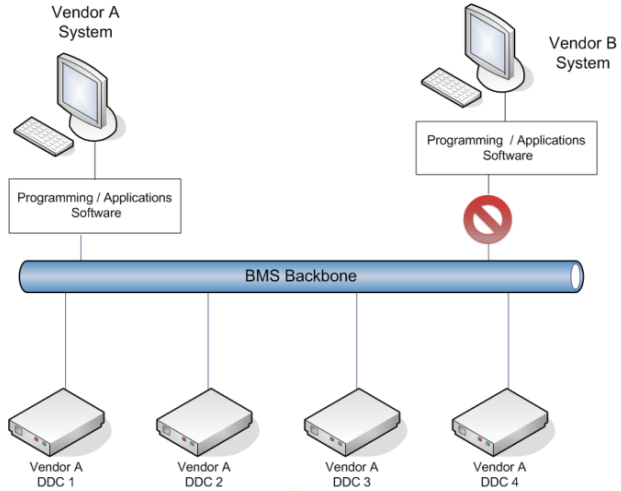
Proprietary Systems

A Full Proprietary – Closed System



Open Systems

What is an "Open Technology" System?

- "Open Technology" is a term used to ensure the proposed system is capable of interoperability between vendors/manufacturers to allow the client to select *any vendor at any time*

- In my view there are two kinds of Interoperable solutions:
  - **Native** Systems
  - **Proprietary Systems** with I**nteroperable capabilities**

The following slides explain each system, the pro's and con's, as well as **misconceptions** in the marketplace when specifying BMS/EMS.

Open Systems - Interoperability

A Native System – Using the BACnet protocol for this example

- All vendors communicate via a common protocol and on a common bus
- May utilise gateways devices or software for other protocols, or have other protocols on board, but their native language is BACnet
- Standards ensure an ease of integration between devices & manufacturers
- Points/Objects may automatically be exposed to other equipment using the same protocol. (*But not always, and sometimes they have proprietary naming conventions*)
- Most use proprietary programming software which is **not** available to other manufacturers
- Some use proprietary protocols and communications for lower level devices, utilising the native primary controller as a gateway/translator

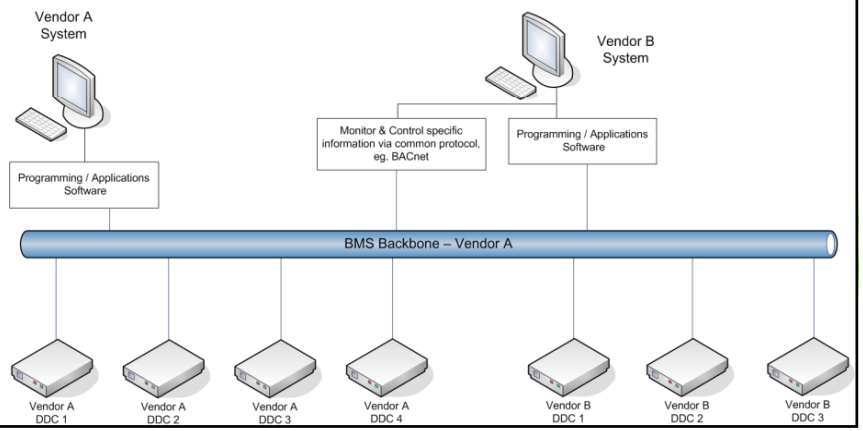
*A **positive** for the "Native" solution is the initial cost of infrastructure. If all manufacturers equipment uses the same protocol, only the one communications bus is required. Another benefit is maintenance, as there is generally less hardware or software required to integrate with the other systems of the same protocol.*

*A **negative** for these systems is when there is no leadership or master of the BMS network. As the BMS network uses a common protocol, many believe a device or computer can simply be connected. A single incorrectly addressed device, device with faulty communications, or computer with BACnet software can bring down the entire network.*

Locating the offending device or computer can take time and be difficult.

Open Systems - Interoperability

Native Protocol (E.g. BACnet) – Open System



Open Systems - Interoperability

A Proprietary System with Interoperability Capabilities

- Generally a single bus for the proprietary controller network, and another bus for the other protocols used (Like BACnet)
- May utilise gateways devices or software for other protocol integration
- Use proprietary programming software, as per the Native solution
- Requires mapping of points from one protocol to another, however most point/objects can be sent and received from these systems

*A **positive** for this solution is that there is a line of segregation between the two protocols. Therefore the proprietary controller network is less likely to be impacted by other vendors equipment or computers being added.*

*A **negative** for this solution is the initial outlay for infrastructure to support the system. (Requiring multiple networks) More hardware is generally required also to perform the integration/translation between protocols.*

Note: *For failsafe operation, always ensure you use hardware integration solutions, native or gateway devices, so you are not reliant on a computer for critical tasks. Many integration solutions may utilise a combination of hardware and software interfaces to minimise the inter-controller traffic, and using Native BMS software for monitoring and analysis.*

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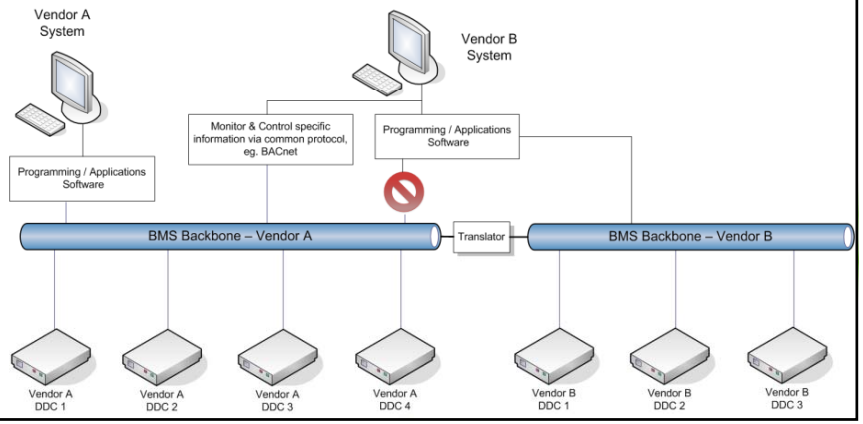
Open Systems - Interoperability

Proprietary System but Fully Interoperable – Open System



"Native" and "Open" are not the same

A Common Misconception

Many specifications request "**Native**" protocols and "**Open Technology",** and expect that by only allowing products of this nature will achieve the "**Open**" result for the client. These two terms should not be seen as one in the same. I will use BACnet as the example.

A native BACnet VAV, VSD or Chiller can be connected to the same bus as the other native BACnet equipment, and the BMS manufacturer can install and setup the devices themselves. With these field devices, only the addressing and pre-set function is modified, not the control logic within the device.
Where these devices may be interoperable between manufacturers, they are not necessarily directly interchangeable. (Different logic functions, BACnet pages etc.)

A native BACnet BMS also has the ability to sit on the same bus as another manufacturers equipment and the field devices above. However each manufacturer **cannot** alter the logic within the others controllers as this is done via proprietary programming utilities.

For example:
If Manufacturer A was no longer supporting a site, and Manufacturer B has the new contract and BMS being installed. If ten new VAV's were installed, these could be addressed and added to the network by Manufacturer B, however Manufacturer A would need to be contracted to alter the logic within their BMS controller, for high-signal select, reset functions or other energy strategies.

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"Native" and "Open" are not the same

A Common Misconception

Gateways/translator devices are often frowned upon and excluded from the specification. While it is true they may add another level of complexity to the system, they do offer a line of segregation between systems and can more often meet the requirements of the specification. Most manufacturers who use gateways can expose any points/objects on their network to the native protocol.

*Many native systems use sub-networks for second tier products, like smart sensors which are not the same native protocol as the primary device. These networks utilise the primary device as a gateway, but are **not** seen as proprietary networks. Remember that the native systems use proprietary software for programming, which is not available in the open forum, **therefore is it truly OPEN?***

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How to get the best for the client?

Suggested ways to achieve an "Open System"

- Don't allow the BMS provider to write the specification
- Create a "**Preferred Suppliers List**" reviewing each manufacturer, including:
  - The **protocol** used for their bus, and any standards they meet
  - **The BMS:**
    - Is the software available to others
    - Are there any ongoing software licensing fees
    - What are the software upgrade costs, and how often are they incurred
  - **Life cycle costs:**
    - Can the client use their own technicians for some service tasks
    - Estimate the service and maintenance costs for a 5 year period
    - How long has the product been supported locally
    - Where is it made, and where can it be purchased in an emergency
- Specify a protocol to be used on the project (I would suggest **BACnet**)
  - If specifying "**Native**", don't assume each manufacturer will be the same
  - Allow **non-native** offers, but ensure the intent and criteria is met
  - Ensure there is cohesion between the **Mechanical** and **Electrical** specifications, as well as **other services** stating the common protocol for all field peripherals

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How to get the best for the client?

Suggested ways to achieve an "Open System"

- For any BMS project, even with multiple manufacturers, it is a necessity for one manufacturer to take the lead role for integration of services, engineering, addressing, and maintaining the integrity of the BMS overall. Ensure it is known that this is a requirement **for the client**, and an expectation of the BMS within the specification.
- Ensure there is sufficient **documentation** in the project including:
  - Controller logic programs
  - Network Architecture and topology, including:
    - Protocols for each controller/device
    - Controller/device addresses, baud rates and BACnet Instance numbers
  - A report containing all exposed **BACnet Objects**, including names and Instance numbers
  - Description of Operation – complete
  - Maintenance and Validation schedules
  - Reports and Service Logs
  - A Disaster Recovery to ensure minimal down-time or data loss
- For "**Green**" projects, ensure:
  - There is an independent commissioning agent working on behalf of the client
  - Monthly validation and tuning is enforced, with all parties present
  - Calibrations and service/maintenance schedules are followed and not ignored

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Why are there ongoing costs?

Is the BMS manufacturer really required?

- In the days of a simple DDC project with basic supervisory software, a contractor could program the system and maintain it. However implementing a BMS/EMS requires time, expertise and good engineering, documentation and planning to ensure success for the client. This is why most BMS software is not accessible to the public. The theory that on-site programming "**on the fly**" can achieve the result has cost us as BMS providers a lot of time, money and more importantly, reputation.
- Integration between manufacturers requires **both manufacturers to co-operate**. It is not likely a manufacturer will pass on their programming utility to another., however it is in the interest of each manufacturer to know their system is functioning correctly. Before allowing multiple manufacturers on the one site, just because they speak the same language, "BACnet", look at the ongoing costs for the client, and complexity for service and maintenance. **Review if it is really in the client's best interest and go in with all the facts!**
- It is essential to ensure the BMS is calibrated and maintained to guarantee the performance and ongoing savings of the system. **A poorly maintained system can result in wasted resources and money.** A plan, schedule and log should be provided and maintained, as well as backups of all programs and any databases. Too often the service contractor is not providing this critical service for the client and it is seen as an unnecessary expense.

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Engineering Practices

Not all BMS manufacturers think alike!

With exposure to many markets, contractors, manufactures and retrofit projects, I often see shortcuts, or practices used to win projects regardless of the ongoing serviceability or impact to the client. I have also heard of contractors taking on BMS control lines (even **NATIVE** ones) specifically to tie up service contracts, giving all BMS manufacturers a bad name.

These are my experiences, and many may disagree.

- **Black Box Technology:**

Every BMS is different and not all have a HMI (Human-Machine Interface), however all BMS vendors have software. There should always be a window into the system for the client. Not having this locks out a client from **THEIR** system and causes a level of frustration, uncertainty and mistrust. (E.g. Schedules or set point adjustments)

- **Control at Low and High Level:**

High Level Integration allows a better level of analysis, alarming and control. Many BMS manufacturers believe there is no longer need for any low level switching or status.
I disagree with this and believe there is benefits to having a combination of both. Having some low level relay switching ensures a service technician, not skilled in integration can still get a system operational if needed. **This ensures failsafe control for the client, but does have an initial cost implication for a larger scale project.**

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Engineering Practices

Not all BMS manufacturers think alike!

- **Using unrelated spare I/O on field devices, like VSD's:**

Competing on BMS projects is competitive, and practices like this can save the initial outlay for the BMS manufacturer, contractor and builder. However, using the spare I/O for services that are unrelated to the function of the end device can be a service nightmare.

Most manufacturers have small point controllers that could be used for these functions (E.g. Lighting channels, or a sensor wired to an unrelated VSD), and in my opinion the BMS should not be reliant on a third party vendors equipment. We can only guarantee the integrity of our own system, and should therefore not risk the clients BMS on something we cannot guarantee or fix. **Smart quoting maybe, but smart engineering, I do not agree!**

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Engineering Practices

Control Loops

Control Loops are used on the most basic of analogue/electronic controls to DDC/BMS/EMS controllers, however the logic is still the same.

- A **SENSOR** is used to measure a medium (Temperature, Pressure, Humidity etc)
- A **CONTROLLER** is used to make a decision based on changes in the sensed medium, and outputs a signal
- A **CONTROLLED DEVICE** is then driven from the controller output to react to the change

If the control device (E.g. Actuator) is not driving, check if there is there an output from the controller. If not, is the sensor reading correctly? Many issues can be resolved without the use of a laptop, however if a BMS is present this logic is all to often forgotten.

- **Splitting of Control Loops:**

When using PID control, I also believe it is essential to ensure there is no possible impact on the control of the PID loop. Therefore the **sensor and controlled device** should be directly connected to the **controller.** Any external influences, communications issues could cause timing issues and poor response and control. Again, this is a failsafe approach for the client, but more costly for implementation.

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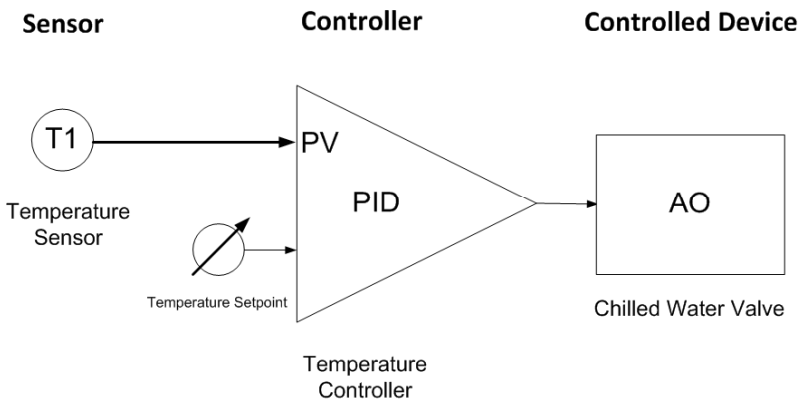
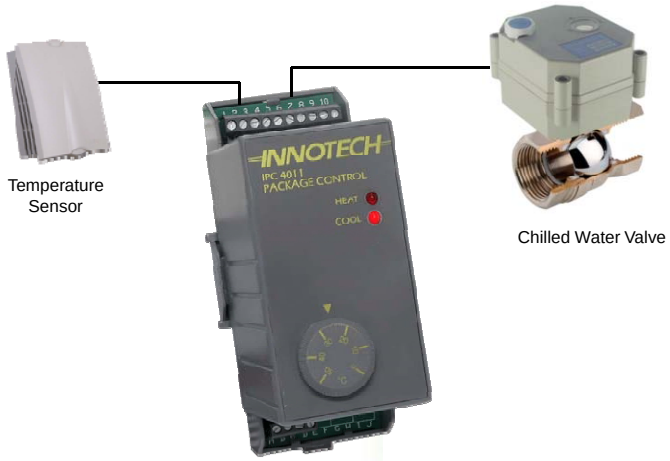
Loop Control



Analogue Loop Control

Sensor **Controller** **Controlled Device**

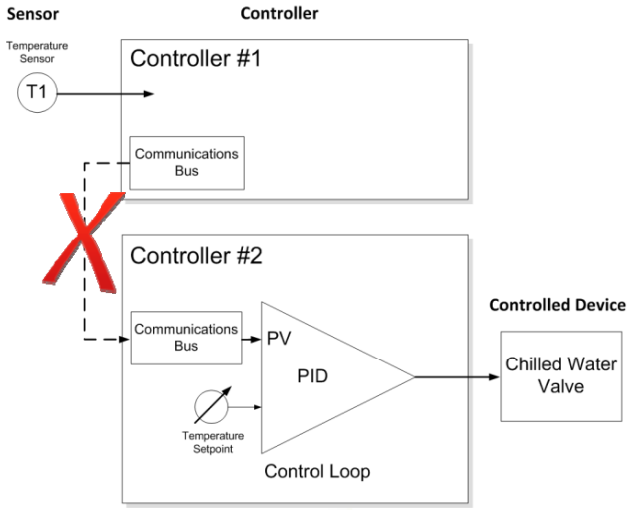


Temperature Sensor

Temperature Controller

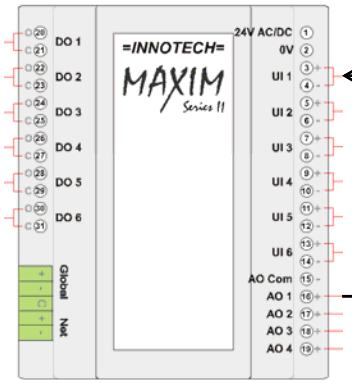
Chilled Water Valve

BMS Loop Control – Splitting the Loop



BMS Loop Control

Controller



Temperature Controller

Sensor

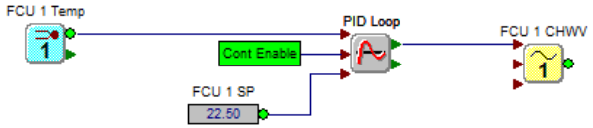
Temperature Sensor

Controlled Device

Chilled Water Valve

BMS Loop Control

Sensor **Controller** **Controlled Device**



Overview and Demonstration

Integration between manufacturers requires co-operation

The intent of "**Open Technology**" is a positive for our industry, and for our clients. I believe it is important to look past the architecture of the systems when accepting or declining a submission, and look at the benefits for the client and the project. (Long term)

I have also discussed this amongst industry colleagues who utilise native communications, and even though their system may meet the requirements of the specifications, the final project may not be what the consultant or client expects. There is often a level of dissatisfaction as there is a belief that once the native system is installed, any other manufacturer can also add their system, or simply replace devices.

The main points to this presentation are:

1. *To highlight that that each BMS has something to offer, however they are all different*
2. *Don't make blanket rules, but review the offers of each, and* ***their benefits for the client***
3. *Understand that integration between manufacturers requires both parties involvement, and a desire to achieve the result for the client*
4. *Any successful BMS does require some level of support from the manufacturer, initial and ongoing*

This demonstration of BMS integration between manufacturers has only been achieved by each vendor programming with their devices.

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Overview and Demonstration

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