i2e2
Innovation for Ireland's Energy Efficiency

RESULTS FROM TESTING OF A "CLOUD BASED" AUTOMATED FAULT DETECTION AND DIAGNOSIS TOOL FOR AHU'S

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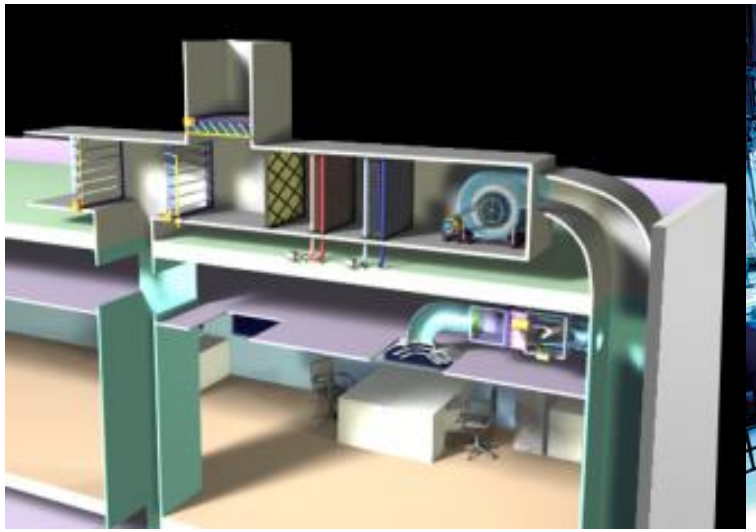

UCC
Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

National University of Ireland, Galway
Ollscoil na hÉireann, Gaillimh

Agenda

- What is i2e2?
- Why does industry need this work?
- Why HVAC?
- An automated solution…..
- AFDD techniques
- Early Results

What is i2e2?

- i2e2 is an industry/academic collaboration under the Irish government's Technology Centre initiative
- Focus on research with a direct impact on industry
- UCC's task, in collaboration with NUIG, is to provide Appropriate Working Environments
- i2e2 companies provide access to their operations

intel
DePuy companies of Johnson & Johnson
Pfizer
ANALOG DEVICES
Boston Scientific
EMC²

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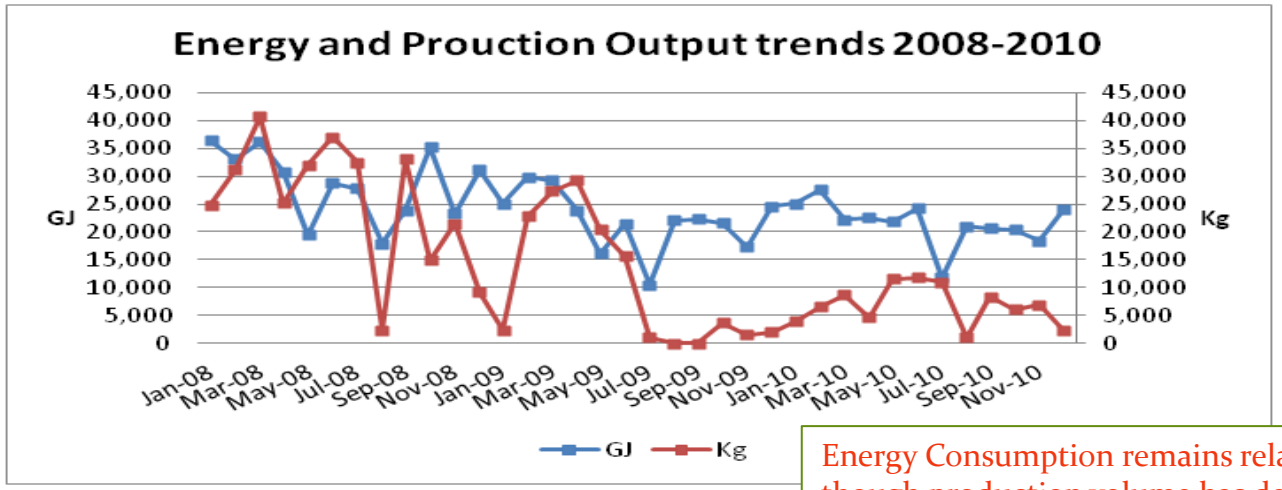
Why does industry need this research work?

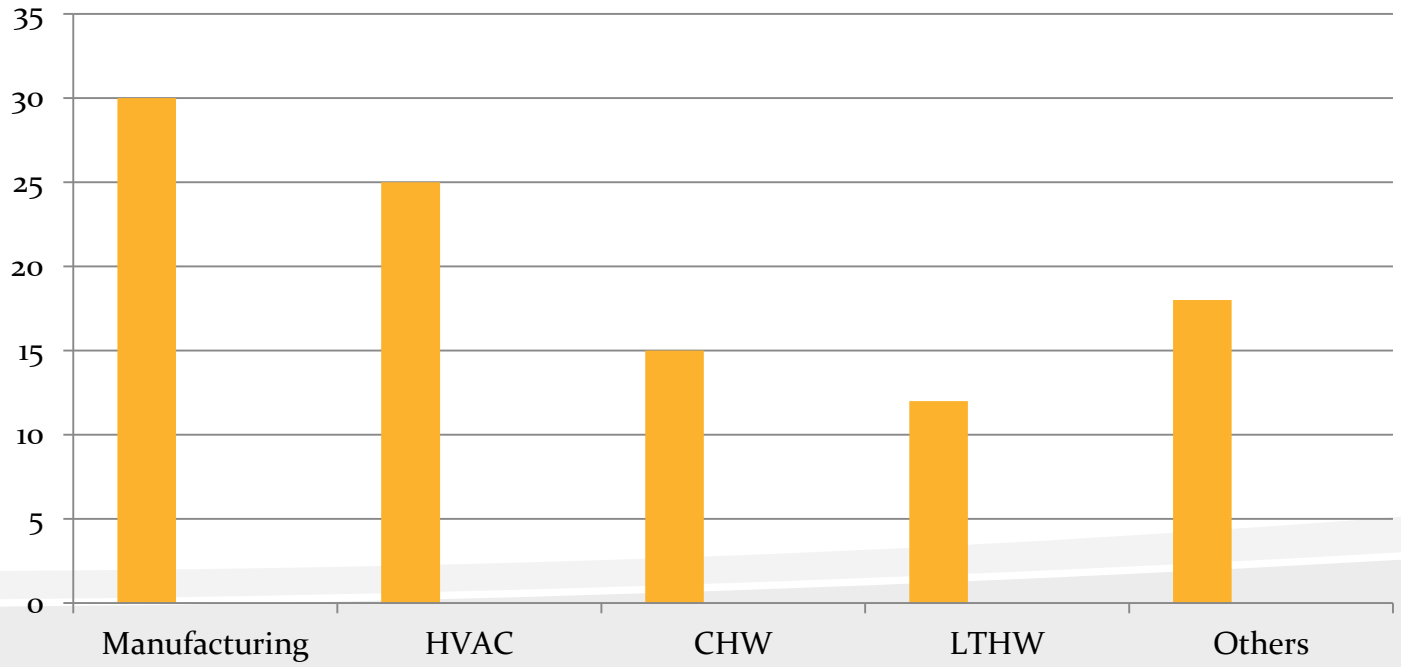


Energy Consumption remains relatively constant though production volume has decreased significantly

- Focus on production output in lieu of efficiency
- Difficult to track efficiency due to islands of information
- Competition from lower cost economies for investment

Why Focus on HVAC Systems?

- Typically greater than 20% of an industrial site's energy consumption
- HVAC systems get less efficient over time
- 20-30% energy savings are achievable by re-commissioning HVAC



How can AFDD help save HVAC Energy?

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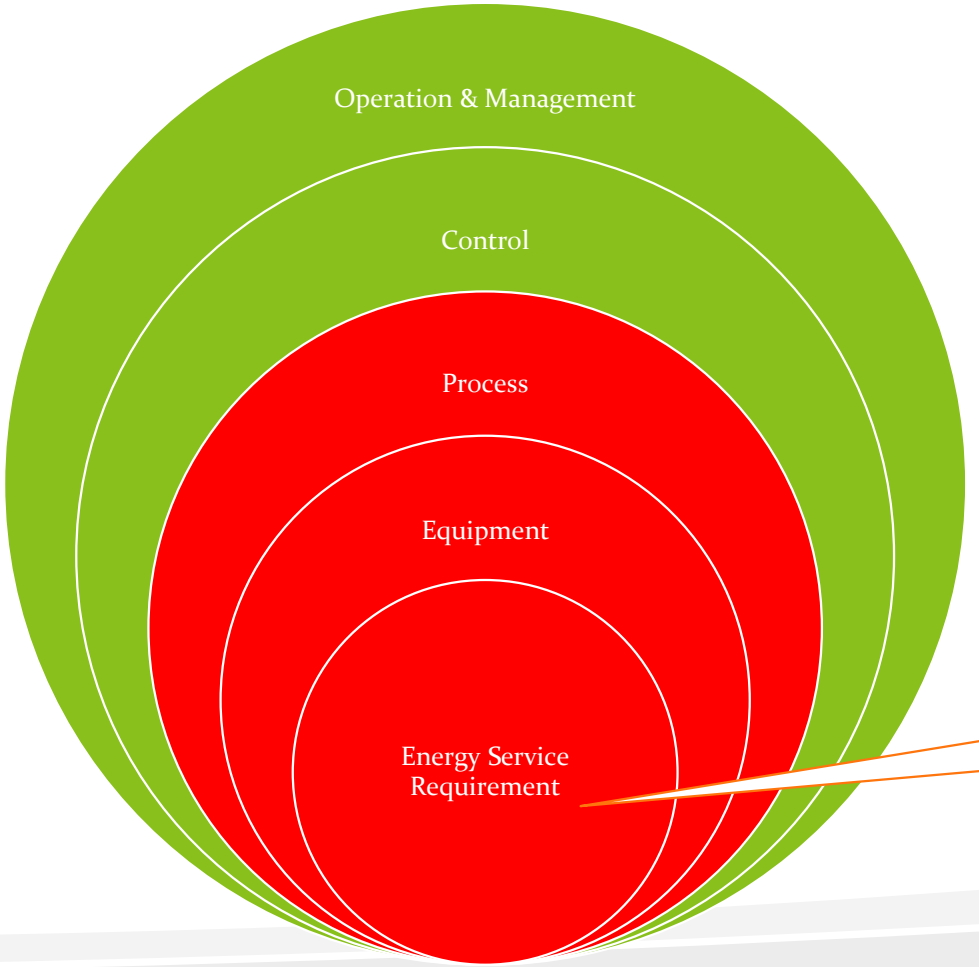
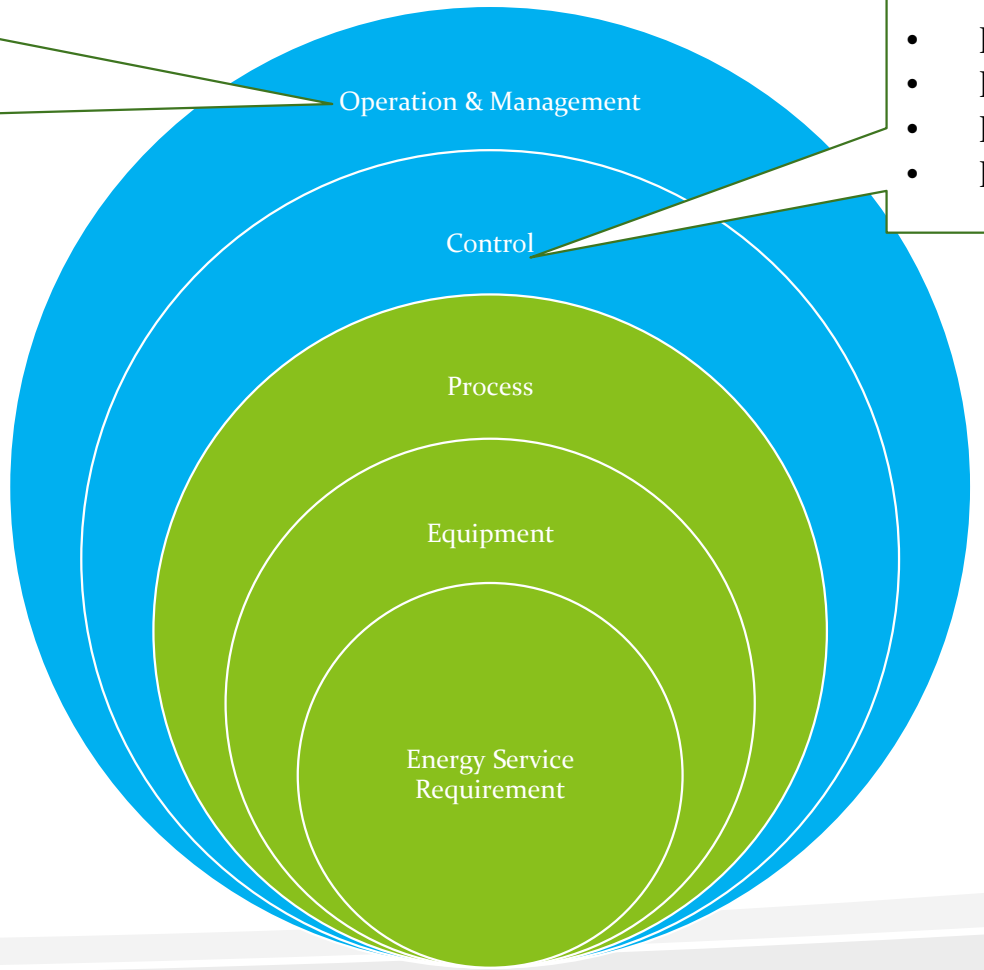


Air Change Reduction

How can AFDD help save HVAC Energy?

- Simultaneous heating & cooling
- Set point adjustments
- Manual operation
- Sub optimal performance of equipment



- Inefficient control strategies
- Poor loop tuning
- Free cooling
- Incorporation of Deadbands

Why an automated tool?

20 to 1

Knowledge

Complexity

AFDD tool requirements

Prioritisation

Minimal False positives/negatives

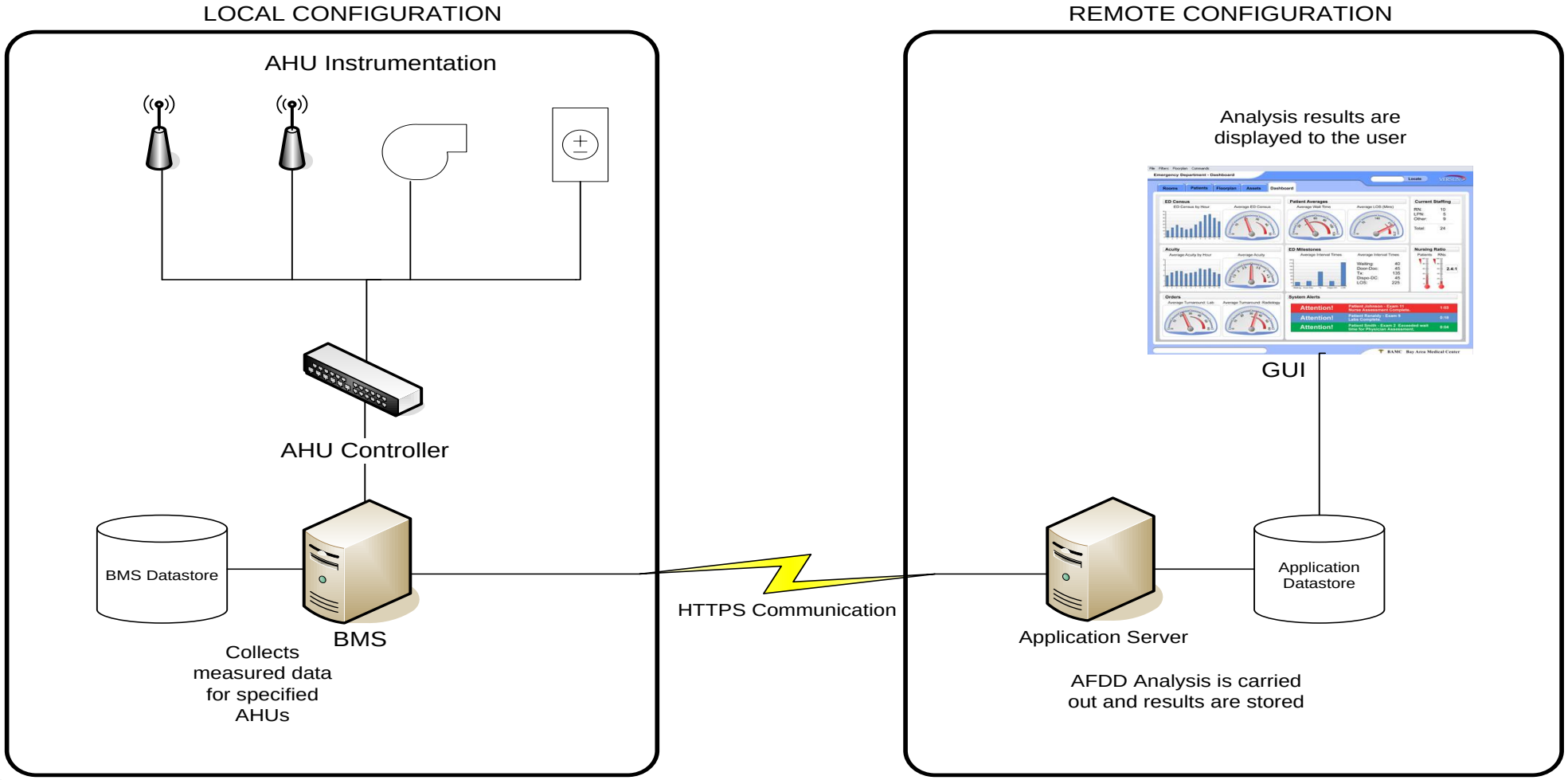
Rapid Setup

Use existing instrumentation

No sensor/instrument dependencies

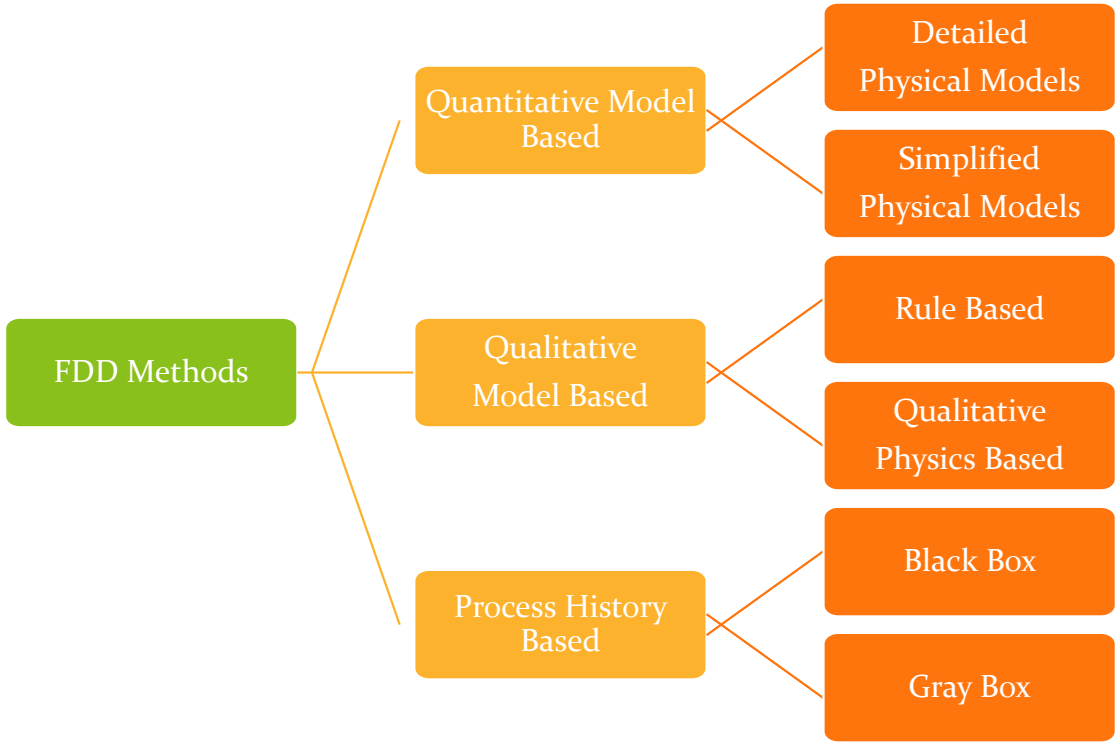
BMS Flexibility

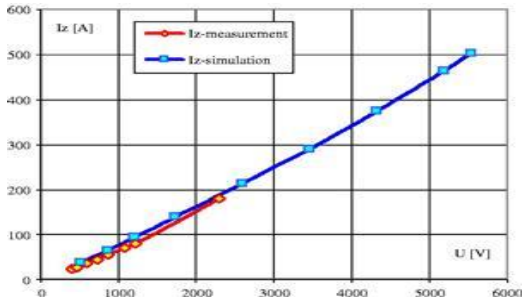
AFDD tool requirements

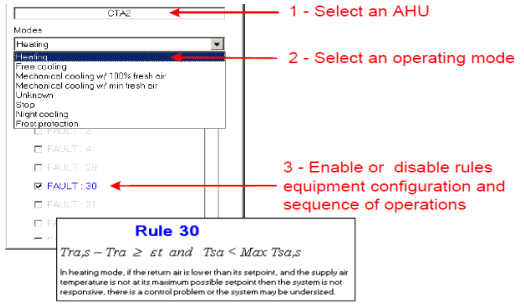


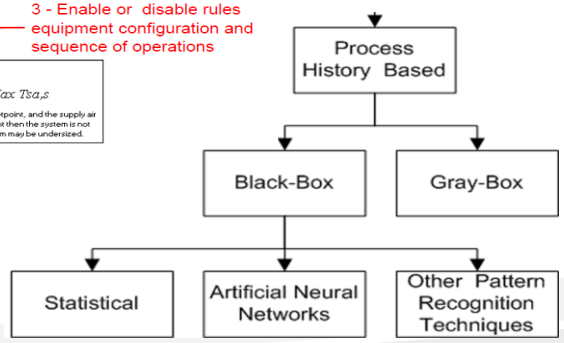
FDD Techniques

- FDD automates the process of detecting and diagnosing faults







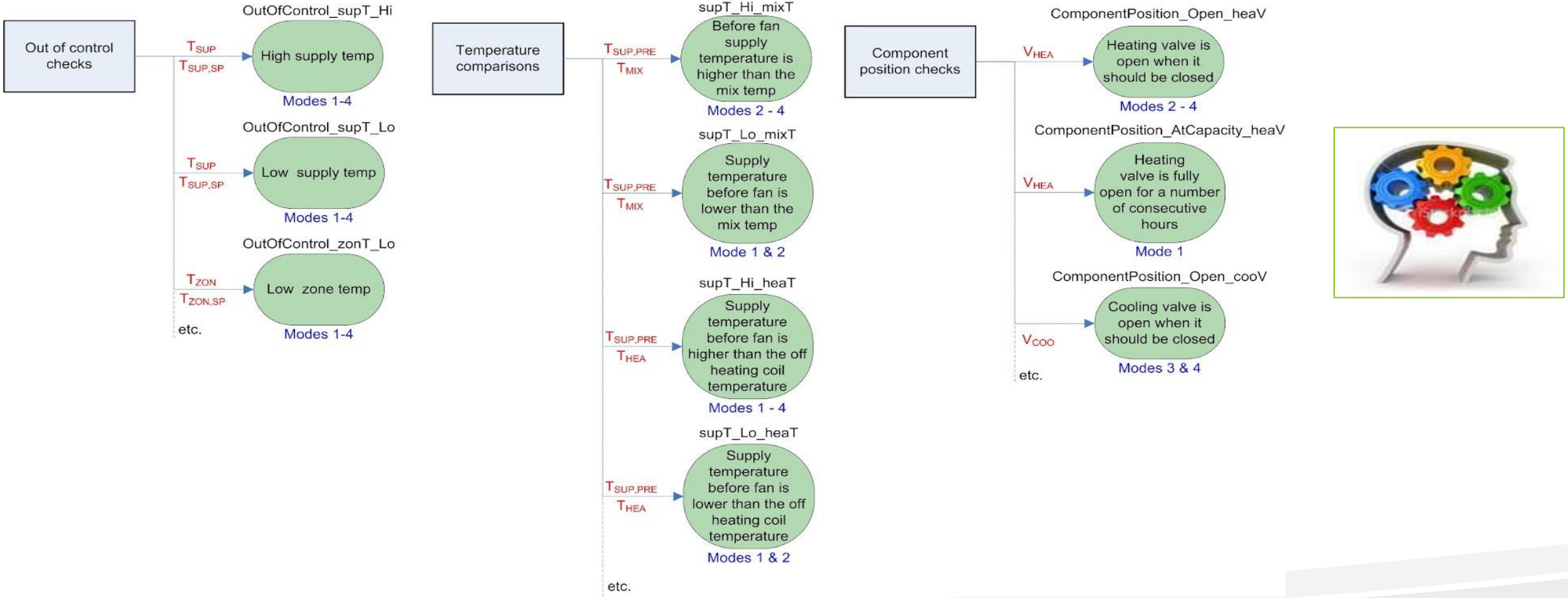


- A rule based FDD tool can be developed and implemented in industry relatively quickly utilising existing equipment

The Business Layer

- Business layer expanded on existing knowledge based rule sets by;
  - Applicable fresh air & recirculation AHU's as well as return air units
  - Detecting issues when the AHU is off
  - Calculating virtualised readings
  - Improved error threshold calculation
- A server side application performs the mode checks, calculates the virtual values, applies the business layer rules, and stores the results in the database

The Business Layer

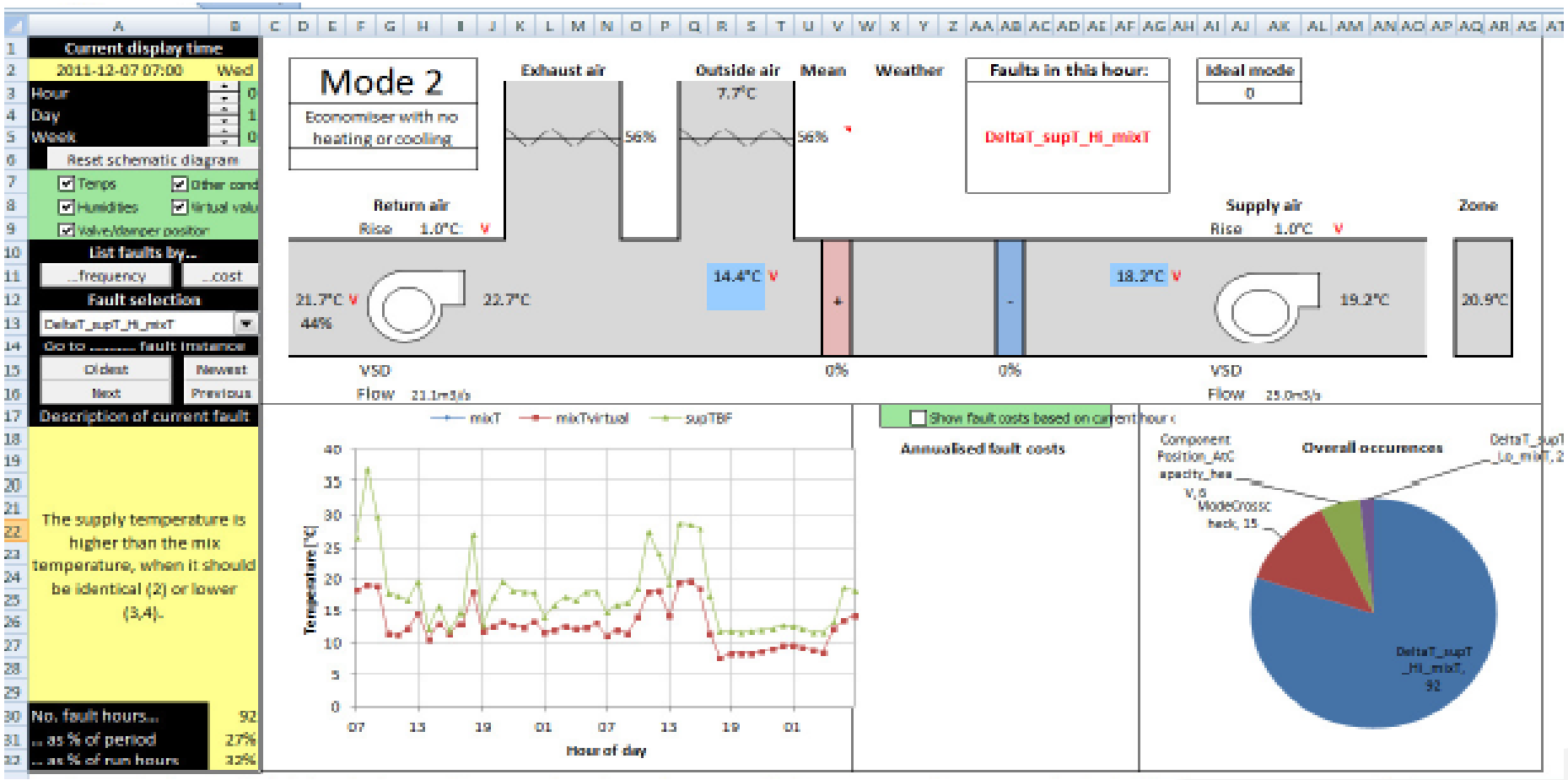


Design of Test Study

- > 100 AHU's available on 4 industrial and commercial sites
- AHU's were selected with
  - Different component and sensor layouts
  - Varying levels of instrumentation

Site	No. AHUs	Type	Design airflow [m3/s]	Type of zone(s) supplied	Operating hours per annum	BMS Software	Frequency of logged data
1	2	Constant volume	14	Office & canteen	8760	Trend	15 minutes
2	4	Constant volume	20	Production area	8760	Tridium	15 minutes
3	9	Variable Volume	13	Manufacturing Floor	6240	Cylon	15 minutes
4	3	Variable Volume	8	Commercial office space	6240	Schneider	15 minutes

AFDD tool in Alpha testing



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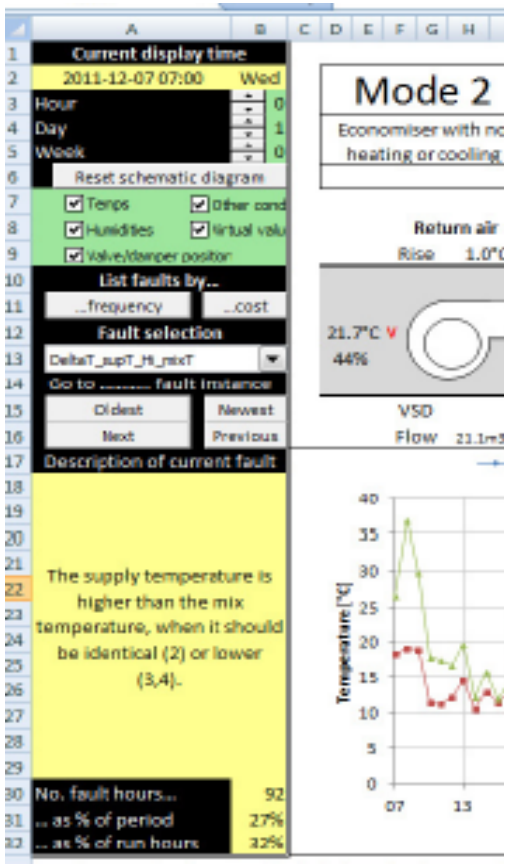

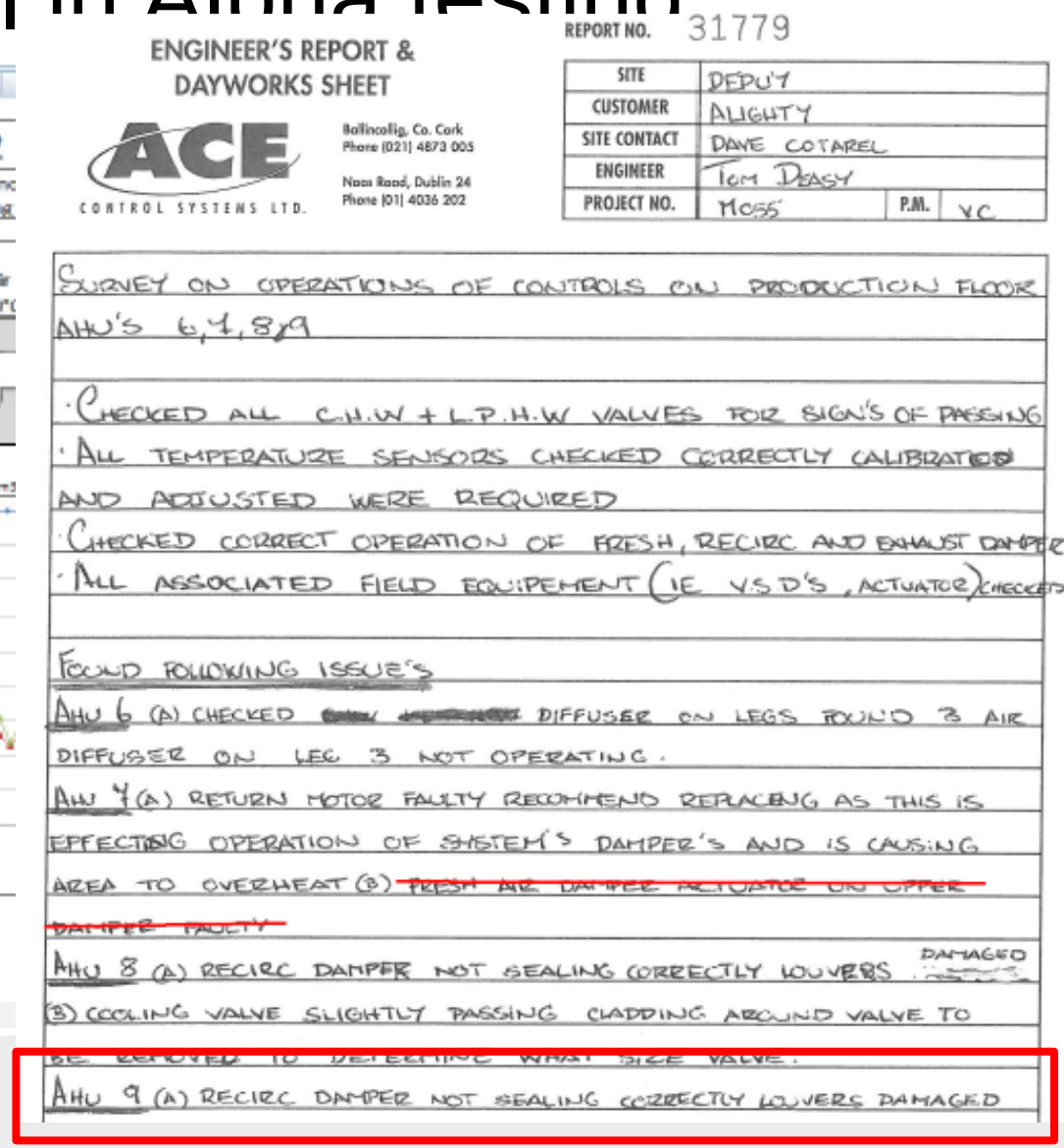

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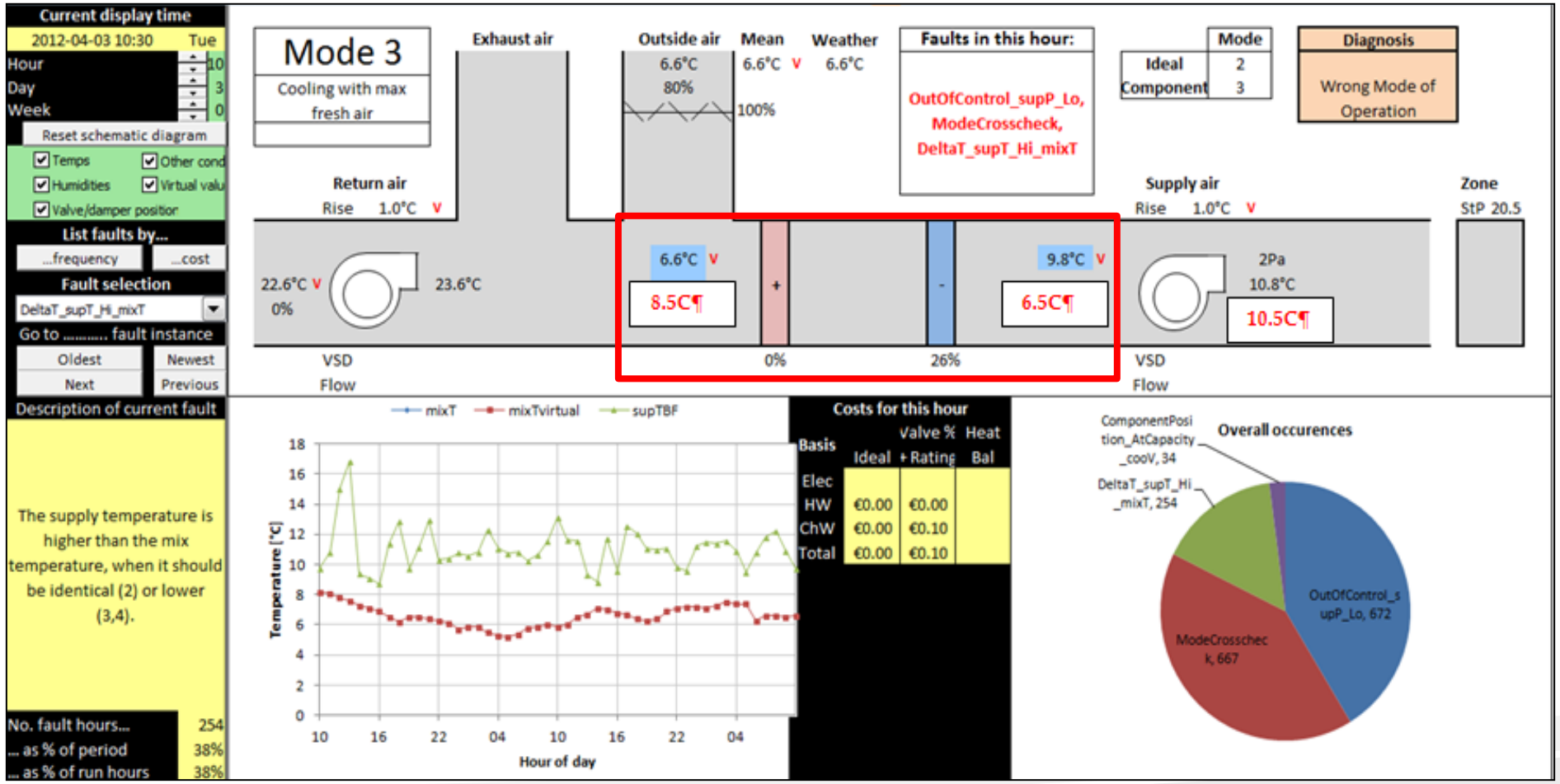
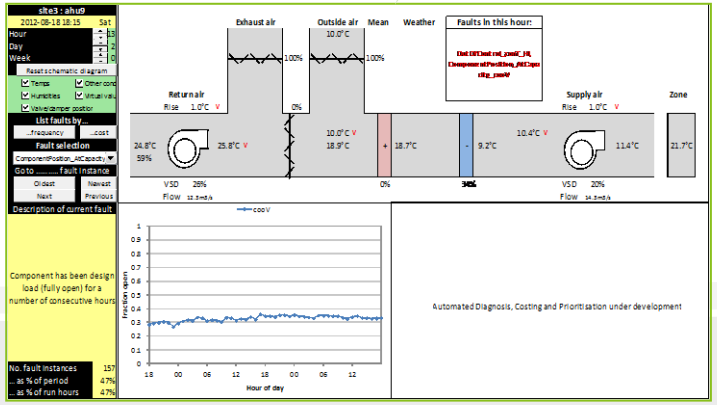
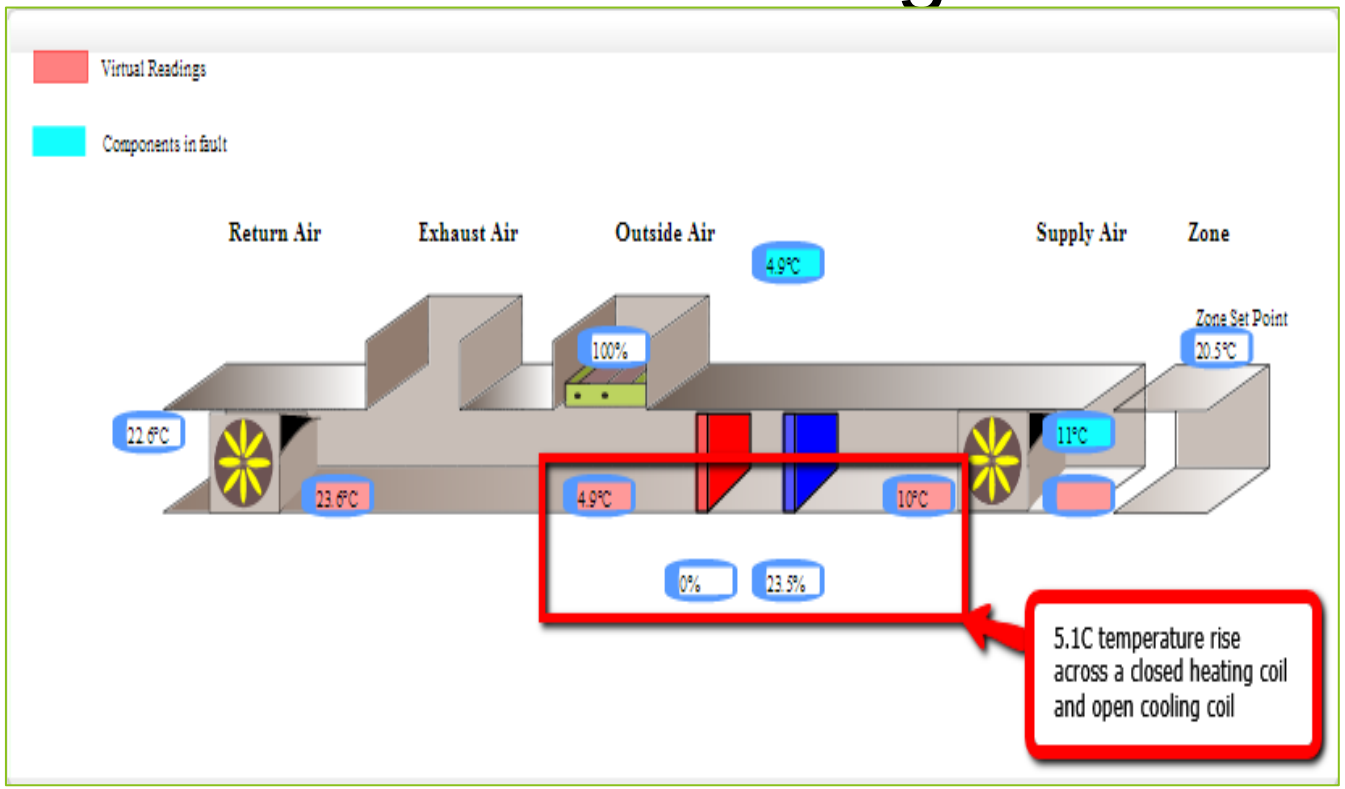


Alpha to Beta Testing

- Secure HTTPS communication
- Development of web based configuration tool
- Browser based GUI



AFDD tool in Beta testing



April 2012

November 2012

February 2013

March 2013

AFDD tool in Beta testing

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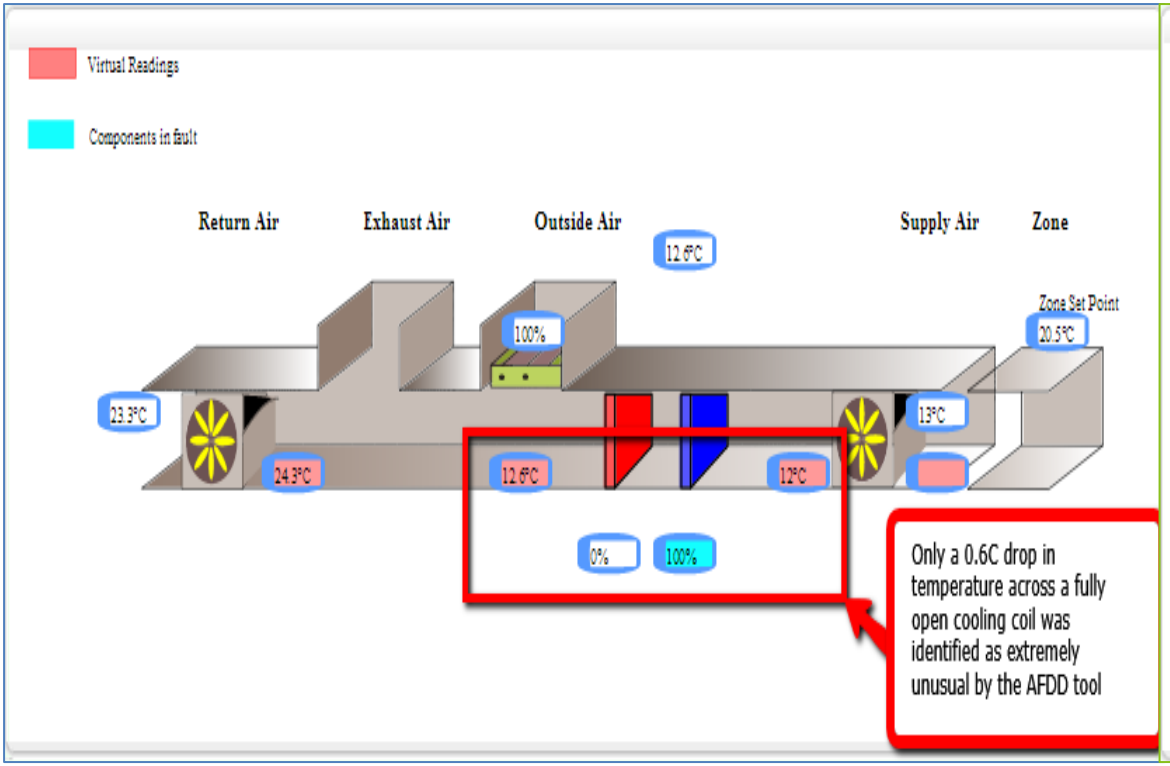

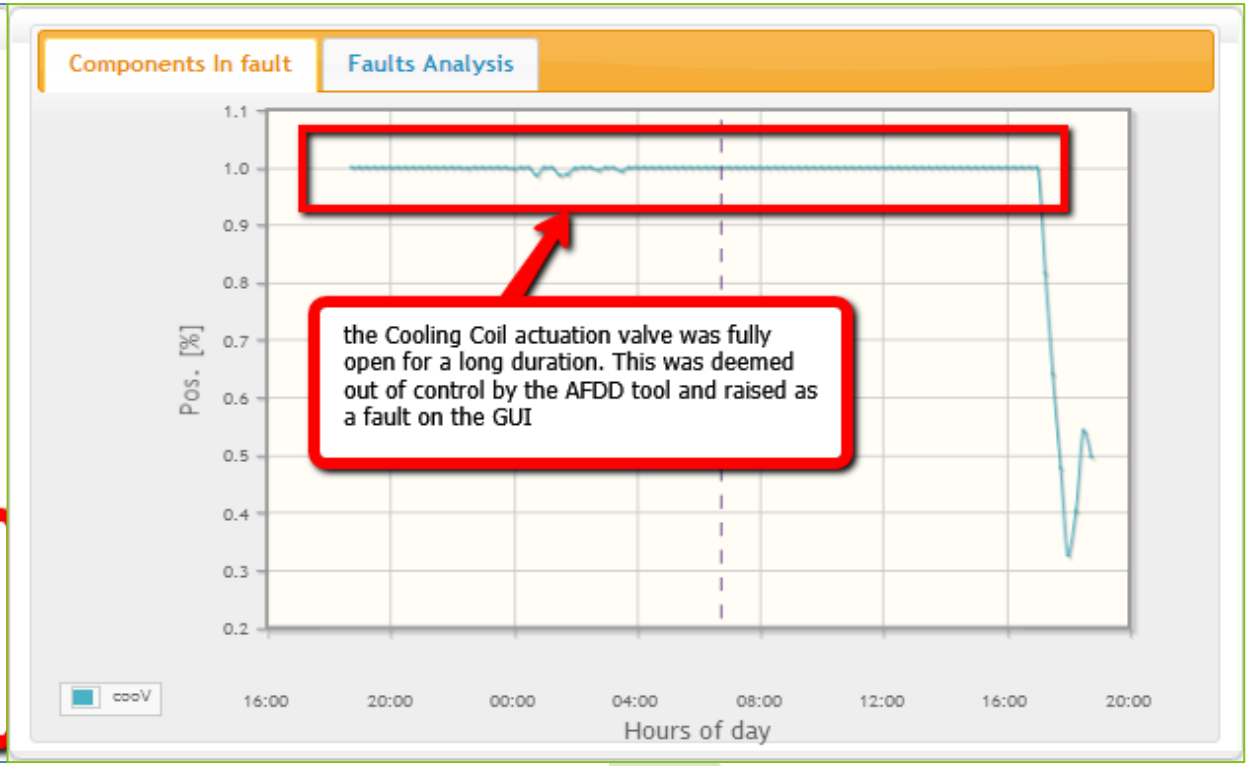

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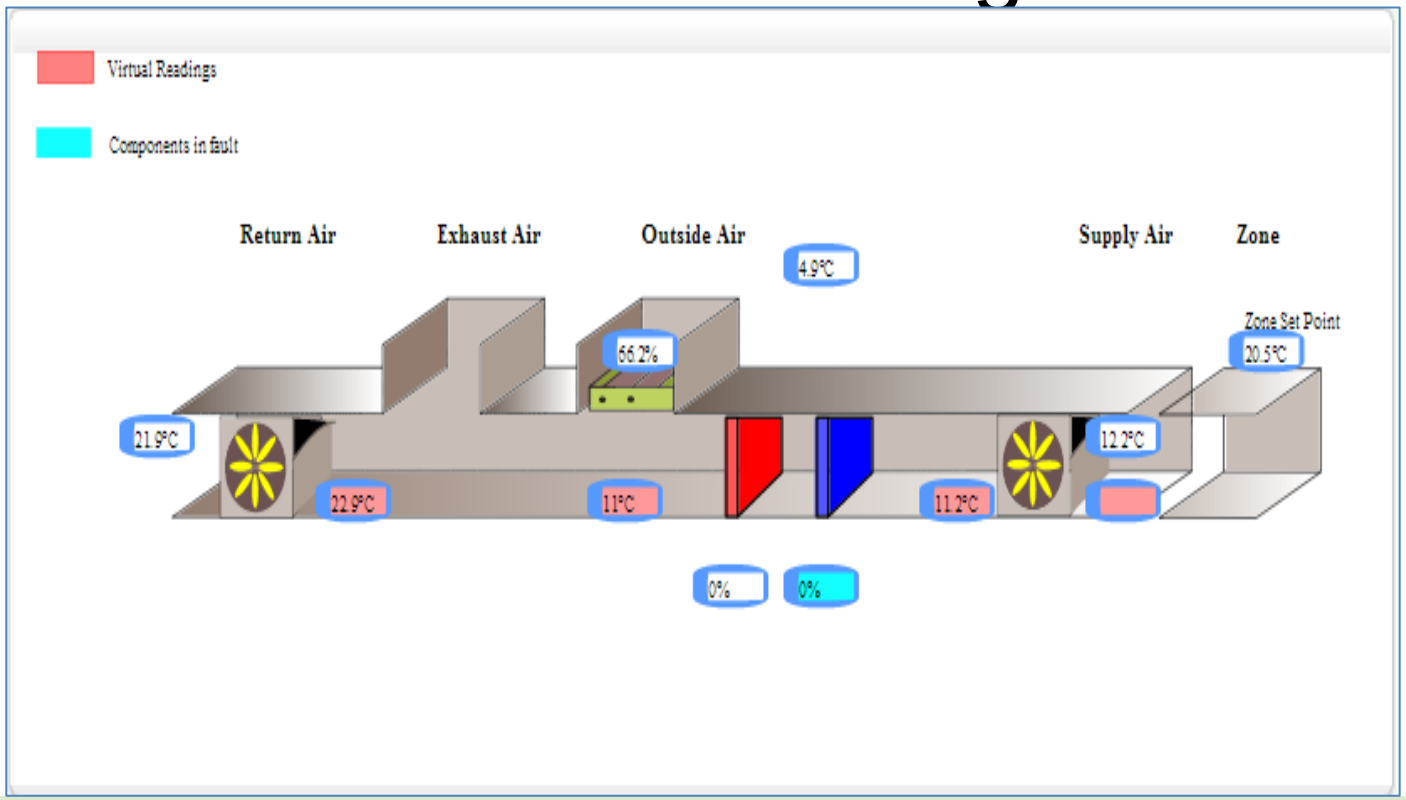

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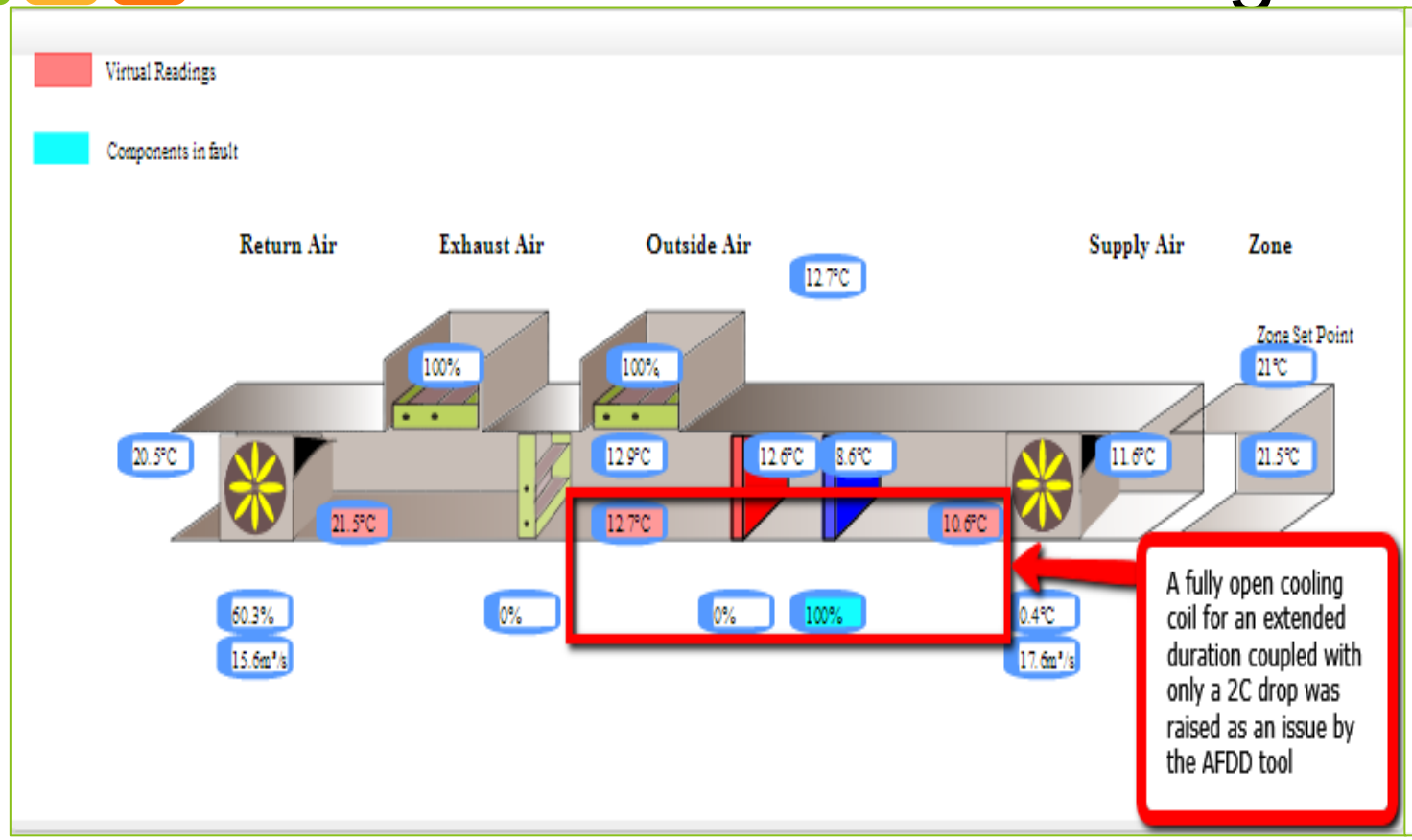
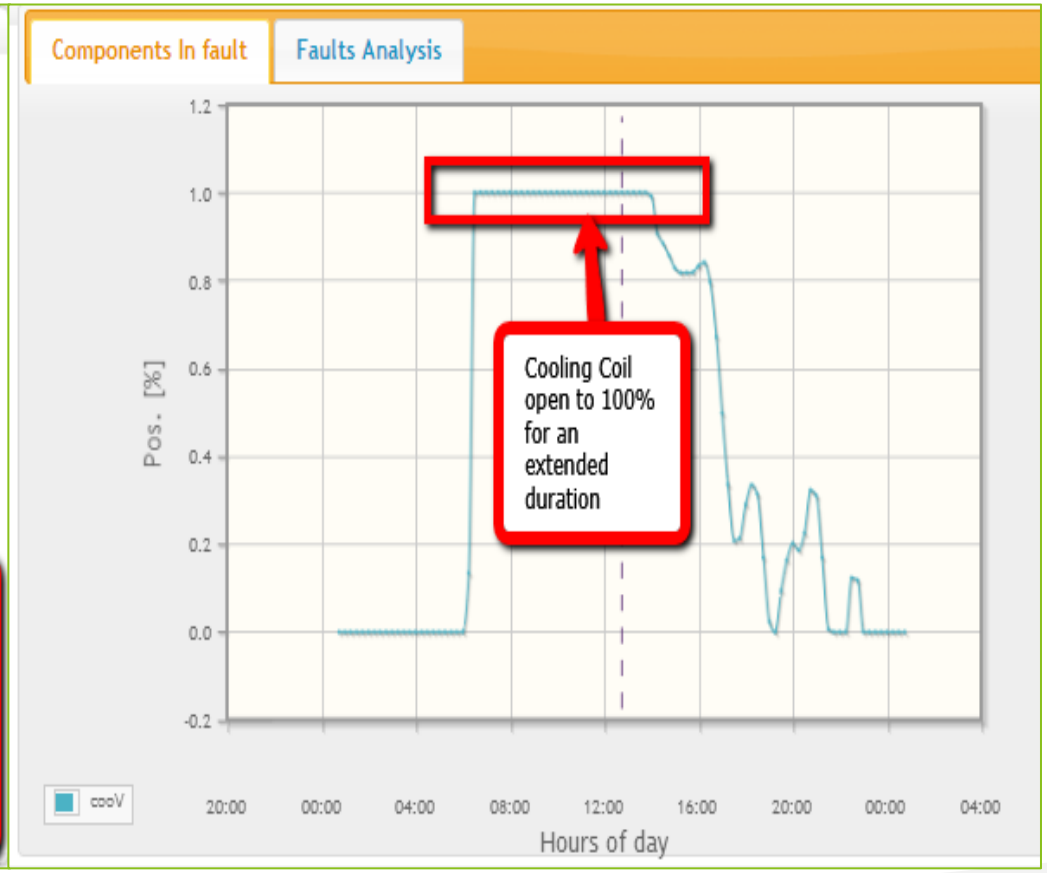
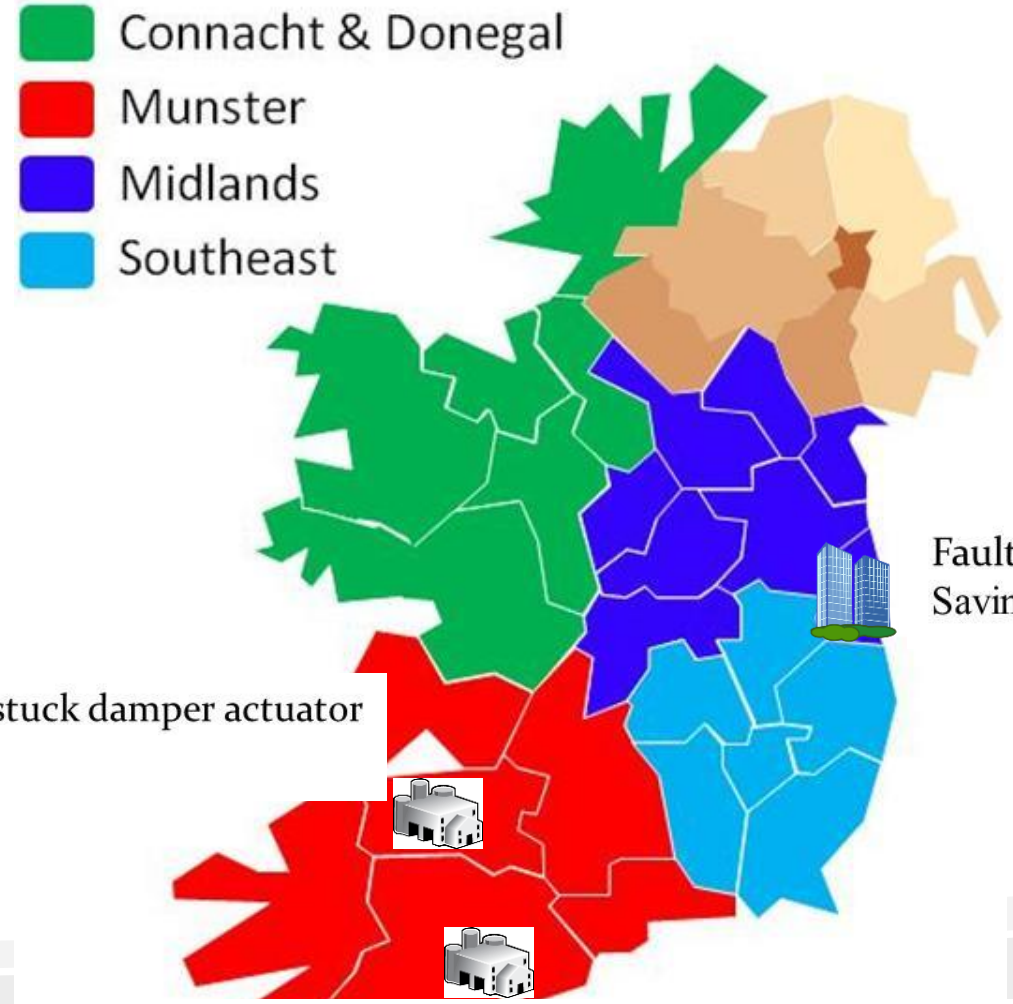




Requirements Versus Developments

Rationale	Requirement(s)	Framework/Tool Developed
Data Access Layer Flexibility	Compatibility with any BMS type or age	A generic data access tool was developed
Business Layer Flexibility	Compatible with various combinations of sensors and components	Calculation of virtual values coupled with "rule libraries"
Reliability	Low number of false positives/negatives	A error threshold applied to each rule based on rule makeup
Usability	User friendly graphical user interface (GUI)	A browser based GUI was developed
Fault Priority	Quantification and prioritisation of the diagnosed faults	Each fault is prioritised in terms of cost and frequency of occurrence
Scalability	Rapid setup time per AHU	A web based site configuration tool was developed
Low Cost	Ability to use existing measurements	First principal techniques and engineering computation utilised to calculate readings where none are present

Results



Faults: Passing coils, design issues
Savings: €26,000

Faults: Passing heating coil, stuck damper actuator
Savings: €74,000

Faults: Damaged dampers, high supply temperature, passing cooling coil
Savings: €53,000

Next Steps

- Extend the data access platform
- Minimise design data required
- Expand the business layer to incorporate humidity control AFDD
- Expand the prioritisation methodology
- Improve diagnostic capabilities
- Link to planned maintenance systems

If we knew what it was we were doing, it would not be called research, would it?

Albert Einstein

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