Developing smart campuses – a working model

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Abstract - In 2008 Birmingham City University (BCU) embarked on an ambitious new city centre campus development scheme. The scheme is materialising into two new campuses of circa 18000 and 24000 square metres respectively; as the main part of a £180m investment by BCU. The first campus is open and operating, the second is being built and due to open in September 2015. From the initial planning stages of the developments BCU wanted the campuses to be “intelligent-buildings”.

This paper will explain and document how BCU have interwoven “intelligence” into its new campuses to improve business-processes, reduce energy use and carbon emissions and enhance the occupant experience. The focus of this paper will be upon integrating multi-protocol business and building-systems through an Enterprise Service Bus (ESB) to compliment an existing Service Orientated Architecture (SOA). The result is a university-wide suite of systems that are scalable, extensible, integrated and orchestrated. The resulting cost-savings and service enhancements will also be examined and discussed. In addition a roadmap of further developments will be outlined to compliment the developments already achieved.

Keywords: Intelligent-buildings, systems-integration, sustainability, Service-Orientated-Architectures, Enterprise-Service-Bus.
I. INTRODUCTION

The intelligent-building industry is a relatively new area of construction. This is reflected in the absence of international standards to formulate the process of developing intelligent-buildings; and in the many definitions that exist. The European Intelligent Building Group defines intelligent building as:

“Intelligent building is one that incorporates the best available concepts, materials, systems and technologies, integrating these to achieve a building which meets or exceeds the performance requirements of the buildings stakeholders, which include the owners, managers and users, as well as the local and global community.” [1]

Despite this lack of establishment, the intelligent buildings industry has many drivers running in parallel to help speed its development; amongst them the increasing global awareness and pressure to reduce pollution. The construction industry is a major polluter. “In the United States in 2007 construction activity accounted for 38.9 percent of the country’s total carbon dioxide emissions”.[2]

This is a scenario reflected across the globe, often being more pronounced in developing nations.

Information technology, from sensors to software reporting tools is helping developers and users alike to re-think building design processes, operations and usage. This is demonstrated in the heavy use of technology in the design phase to produce computer-aided-designs, 3D rendering, virtual fly-through animations and the growing use of Building Information Models. The systems that operate buildings control, environmental and security systems are becoming more networked and sophisticated. The data gathered from the combined systems also serves to provide a useful insight into usage and preferences.

When Birmingham City University started to plan-out what was to be delivered in its new campuses, a key pre-requisite was that they would be “intelligent” to realise the many benefits outlined above. With no de-facto industry guidance on what constitutes an “intelligent” building and after researching thoroughly in the market BCU took a novel approach.
II. APPROACH

BCU already have a long-standing strategy of integrating business-systems to improve the sharing and processing of data. Organising an estate of systems in such a way is known as a Service Orientated Architecture (SOA). BCU’s SOA allows for incorporation, scalability and orchestration across all systems that sit within it. The advantage of this arrangement of systems also extends to visibility across all systems and the potential to mine the data and information from them for business-intelligence. Furthermore, BCU’s SOA allows local technical staff to re-configure the ICT estate to reflect the needs of the university in an agile and cost-effective way.

After extensive investigation and consultation within the building management systems and integrator market place, the BCU project team could not find a product that met all of BCU’s intelligent-building requirements. The BCU project team found that the building systems control market did not offer one product that encompassed building management, environmental and security systems in an out-of-the-box product; effectively, a system that incorporated a suite of systems to make a building intelligent. Even if such an “intelligent building suite” of systems did exist there could be an inherent risk of being dependent upon one vendor. Contractual issues may also have arisen as relating to novation within the contract supply chain.

In consideration of the aforementioned factors, BCU took the approach of incorporating the building management, environmental and security systems into its existing Service Orientated Architecture (SOA). Rather than attempting to define in great detail cause and effect matrices of systems interdependencies, BCU took the approach of assessing whether building related systems would integrate with BCU’s existing Enterprise Service Bus. BCU has implemented Microsoft’s BizTalk Server as the university’s Enterprise Service Bus (ESB).

BCU’s ESB accepts a wide range of IEEE and ISO standards and protocols through its use of “adaptors”; including RESTful web-services and commonly used building management system protocols, such as, BACnet, OPC and ODBC. By taking this approach BCU has been able to insure that business-process changes can be quickly reflected in the business rules engine and overall configuration of the ESB. Not only does this approach allow BCU technologists to work in an agile and responsive manner it also means that re-configurations can be completed by in-house experts at local rather than external consultant rates of pay. The many good reasons for adopting an SOA approach to enterprise ICT provision are discussed at the “TOGAF open-group” [3]

III. COST SAVINGS AND SERVICE ENHANCEMENTS ACHIEVED

Infrastructure and SOA

The decision by BCU to deploy one network infrastructure that caters for both business and building systems within the new campus saved BCU approximately £250000. This sum comprised of the wiring and switching hardware required to provide a separate network; and the related professional fees that would have been incurred.

Other savings and enhancements have been made in the areas of design and life-cycle costs by using natural ventilation in the vast majority of the building. Extensive use of sensors has been deployed through-out the building to turn-off services when no presence is detected in spaces. Carbon-dioxide sensors have also been fitted in the buildings 250 seat lecture theatre for capacity detection to improve comfort and optimise the use of services and energy.

Energy Management

The city centre campus replaces an existing building. Substantial energy savings can be shown when comparing the two buildings; including an improved energy rating from F to B, a 40% reduction in CO2 emissions and energy cost savings of £140k per year.

A saving of at least £150000 per year, across the BCU estates, has also been forecast by deploying energy management policies to PCs on the BCU domain, eventually to building-
systems. This project is a collaborative effort managed by BCU’s ICT and Estates departments.

**Interdepartmental Collaboration**

A less tangible benefit of deploying one network was the effect of bringing university departments together to assess and survey their individual, but co-dependent network requirements. This interdepartmental co-operation has led to a greater understanding of other university departments’ business requirements by those involved. The result has been more collaborative working and the development of cross-departmental workflows that have improved business-processes; examples being the sharing, reporting and display of building usage and energy data between interested parties. The integration of the fire-safety system with display screens to enhance evacuation alerting; each system would have previously been independent and the responsibility of a department working in isolation.

Integrated workflows are helping to improve services at BCU in the area of student pastoral care. The BCU Student Attendance Monitoring system or SAM has links to the departments responsible for student welfare, alerting them to any activity that may require intervention to help insure that BCU students receive the best student experience possible.

**Reporting and improved management information**

BCU’s Service Orientated Architecture of integrated systems lends itself to being mined for data by business-intelligence software. Reports have been set-up using Microsoft SQL server reporting tools to produce management information for managers in university departments. Reports that show building occupancy and patterns of usage have been built by comparing and contrasting data from access-control, room-booking and student attendance monitoring systems. BCU also produce reports on energy usage from building and ICT devices and there is a drive within the university to use this data to make continued improvements. “Big-data echoes from energy to waste-management, from street maintenance to air quality”. [4]

**IV. FUTURE TECHNOLOGY AND INTEGRATION ROADMAP**

BCU has developed a solid technology platform and strategy to build upon over recent years. Any new technology systems under consideration for purchase by BCU need to integrate with the university Service Orientated Architecture. Future developments in this area will focus on reducing energy usage and costs and improving business-process workflows between university systems. In the near-term and under test is a mapping system that uses floor layouts extracted from the BIM and rendered in Microsoft SharePoint. The floor-layouts are accessible from QR codes located on walls that users can scan from a smart-phone to see where they are and what services are near to them.

BCU are also in the process of scoping a project to procure a new integrated multi-department helpdesk system. Once implemented, the system will act as a key part of a supply chain that will log-calls at one end, build a profile of user queries,
collect audit data and link to procurement re-inventory workflows.

Another key area of development will be building in feedback mechanisms such as voting and surveys to our processes to monitor and improve services. By collecting this type of data we can understand better what our customers want and give it to them. Eventually these services will enable BCU to tailor our services towards particular groups and even individual users.

“There is a huge explosion today of 'sentiments' available from social media including Twitter, Facebook, message boards, blogs, and user forums.”[5]

V. CONCLUSION

BCU has built a strong foundation of technologies that is and will serve its customers well. The deployment and continued development of BCU’s Service Orientated Architecture allows the university to meet its business needs in a scalable, cost-effective and agile way. At the centre of BCU’s technology architecture is the Enterprise Service Bus which enables the integration and orchestration of systems through adaptors and a business rules engine.

As our customers’ requirements change and the pace of that change quickens BCU is in a good position to cater for those changes that can be serviced by technology. More than ever BCU’s focus is on sustainability, customer engagement and satisfaction, providing more tailored services quicker and constantly working to improve quality and value. BCU has invested £180m in facilities and technology to underpin the university’s future and that of its user-community.

REFERENCES