

Does the Cloud have a silver lining?: The future of flexible IT service delivery

Dr Gill Ferrell¹, Patrick Bellis²,

¹JISC infoNet, Northumbria University, Hadrian House, Higham Place, Newcastle NE1 8AF, gill.ferrell@northumbria.ac.uk. ²JISC infoNet, Northumbria University, Hadrian House, Higham Place, Newcastle NE1 8AF, patrick.bellis@northumbria.ac.uk

Keywords

Cloud Computing, Enterprise Architecture, Flexible Service Delivery, Open Source Software, Service Oriented Approaches (SOA), Shared Services, Software as a Service (SaaS).

1. ABSTRACT

The IT industry is undergoing a period of significant change. There is a growing trend away from monolithic ERP (Enterprise Resource Planning) type systems and in-house development towards a diversity of approaches that capitalise on the new capabilities of web technology. The higher education sector has been relatively slow to respond to these changes yet difficult economic conditions mean universities are being required to deliver more with less investment of public funds and they are increasingly looking to IT to solve this problem. The purpose of this paper is to take a critical look at some of the service delivery options available and to consider the potential pros and cons of adopting such approaches within the sector. We will also summarize some of the work currently going on in the UK to pilot and evaluate new approaches to flexible service delivery.

2. INTRODUCTION

The IT industry is undergoing a period of significant change. There is a growing trend away from monolithic ERP (Enterprise Resource Planning) type systems and in-house development towards a diversity of approaches that capitalise on the new capabilities of web technology. The higher education sector has been relatively slow to respond to these changes. The last major wave of system replacements in the sector was prompted by the 'millennium bug' fears at the end of the last decade. Having invested significant sums in large-scale corporate systems, universities necessarily wish to get the most out of that investment and change is not undertaken lightly. Difficult economic conditions have also played their part in fostering conservatism. The natural response to the economic downturn in most cases is to delay hardware and software replacements. Extending the lifespan of system components is of course an approach that brings its own set of risks and organizations must look to develop strategies for the future before it is too late.

The purpose of this paper is to take a critical look at some of the service delivery options available and to consider the potential pros and cons of adopting such approaches within the sector. We will also summarize some of the work currently going on in the UK to pilot and evaluate new approaches to flexible service delivery.

3. ENTERPRISE ARCHITECTURE

Enterprise Architecture (EA) is, as the name suggests, an institution-wide approach to technical architecture. It is however about much more than technology. The real purpose of undertaking an EA approach is to align your ICT strategy and implementation with the overall organisation strategy. EA is therefore very much about business goals, business needs and business processes. EA can help your ICT services work together, evolve effectively and serve and enable achievement of the organisation's vision. Business Process Review is only about process, Service Oriented Approaches (SOA) are only about systems. EA brings it all together. In this way EA is a significant enabler of change. Implementing EA may put IT managers in the role of change agents who need to be as concerned with business process improvement and relationship building across the organisation as

with technology. In order to be effective enterprise architects IT staff must develop an understanding of the business processes that underpin their organization and must be able to communicate in terms that business users, especially senior managers, understand and can relate to.

In its simplest form EA means taking a structured approach to managing your ICT portfolio. The starting point is to map the portfolio. You may need to create a number of different views showing business processes, information and data flows, applications and services, infrastructure and security. The primary driver is however always the business processes. You may choose to use tools and approaches with which you are familiar or to adopt more formal EA approaches using established frameworks such as Zachmann or TOGAF.

Once you have mapped the existing portfolio the 'As is' situation you can begin to decide how you wish to move forward and design your desired future state. Key tasks include identifying areas of redundancy and duplication in your applications. You may wish to investigate how SOA can help with interoperability and issues of data duplication. You should also think about the replacement cycle for each system and consider where alternatives such as Open Source, SaaS, Shared Services etc may offer benefits.

From this you should be able to develop a governance model focused on ensuring the systems support key business goals. Such a model should empower senior managers to take effective decisions regarding investment in technology and will allow them to see the value of IT in supporting strategic objectives. From the outset you should look to scrap projects that don't meet these criteria and all new projects should be scrutinized to ensure they align clearly with business goals.

One way of looking at EA is to see the different layers as different states of matter: solid, liquid and gas. The data layer has to be solid. It needs strong governance and policies and defined standards. The Middleware layer which represents the business logic can be more liquid and new approaches mean you may be able to change from commercial to open source products relatively easily. The user facing layer is the gas: it can take any form and may change often as new portals are developed and mobile devices introduced etc, etc. One advantage of EA is that by helping you understand things in a holistic way it reveals the space where you can innovate.

Because EA has grown out of the IT arena it can often be difficult to show senior managers in other areas how it is relevant to them. This is a significant obstacle but one that has been overcome before. In many universities it was the IT function that introduced the concept of formal project management techniques to the institution at large. Just because project management is useful in IT doesn't mean it is only relevant to IT. The shared vocabulary of project management has escaped the IT department - EA now needs to do the same.

Many organizations are beginning to see real benefits from adopting EA. In the UK the government department for Children, Schools and Families is saving c.20% on ICT capital costs over a 5-year period as a result of its EA work and the resulting simplification of data and services. Universities are beginning to look at these approaches and pioneering work has taken place in the UK and Netherlands.

In 2008 four UK universities; Cardiff, Liverpool John Moores, Kings College London and Roehampton were funded to explore the potential in the EA approach and related industry frameworks, learning to 'do EA' on real projects. Their experience has been documented in two reports: '*Doing Enterprise Architecture: Enabling the agile institution*' and '*Unleashing EA: Institutional Architectures and the value of joined up thinking*.' As well as containing detailed case studies, '*Doing Enterprise Architecture*' contains an excellent introduction to Enterprise Architecture itself, industry frameworks such as TOGAF™ and Zachman, The Open Group and its Architecture Forum and to modelling and the emerging Archimate® open standard. '*Unleashing EA*' reflects on the experience and identifies the major issues and challenges institutions face when confronting change and looks at how EA can help.

4. Service-Oriented Approaches

'SOA' can stand for either Service Oriented Architecture or a more general Service Oriented Approach. It is an approach to IT architecture that replaces the traditional linkage between applications by separating data and the tasks and business processes that use it. Instead of bespoke software to join different applications and data sources together, the 'spaghetti' of integration,

data and applications are linked by a 'service layer'. This enables the reuse of common data and software in different ways at much lower cost and with the flexibility to meet new business requirements without the need to acquire bespoke packages. In this way we might describe applying an SOA approach as turning the spaghetti of point-to-point integration into a lasagna.

SOA works with existing software systems and replacement applications re-use the links already made and can plug in to the service layer without affecting other users of the data. New applications can be added and the data in each application is offered up as a service which any other application can consume. When the Service Oriented Approach is evolved in to a system-wide architecture, it allows connections and service sharing opportunities between organisations nationally and globally.

As an example, an institution might be tracking student debts, student complaints and the progress of disabled students. Typically they might use three different student datasets, and specialised applications, for example within finance, CRM and HR. In a service-oriented environment they are all examples of case management, where the basic service can be adapted easily to serve three different business needs, and using common data with managed access and editing rights.

SOA is always linked to and driven by business process change. The international e-Framework website <http://www.e-framework.org/> identifies and describes service components and provides blueprints and reference examples for those in the community who want to gain a greater understanding and knowledge of how to implement a Service Oriented Approach. JISC CETIS has also produced a useful online information pack on the topic.

SOA is a key enabler to underpin change and cost saving. It has reached a reasonable level of maturity both within the IT industry and within the higher education sector and is a means of allowing organisations to get the most out of their existing investments. It is possible to undertake EA without SOA and vice-versa but most universities would be well advised to consider these approaches when reviewing their technology portfolio.

5. SOFTWARE AS A SERVICE (SaaS)

Software as a Service (SaaS, typically pronounced 'sass') is a model of software deployment whereby a provider licenses an application to customers for use as a service on demand. It has its origins in payroll bureaux and HR applications still dominate the market. SaaS vendors may host the application on their own web servers or download the application to the consumer device, disabling it after use or after the on-demand contract expires. The on-demand function may be handled internally to share licenses within a firm or by a third-party application service provider (ASP) sharing licenses between firms. SaaS is usually taken to mean hosted services via the Internet.

SaaS breaks the link between machines and solutions, theoretically enabling firms to license only what they need. Because many firm use the same basic service there is a rich source of ideas for improvements and additional features. Upgrades are rolled out to all users at the same time (which may or may not fit your plans). A range of 'multi-tenancy' arrangements exist and your data may co-exist in the same space as that from other organisations.

The classic example of SaaS is the e-recruitment service www.salesforce.com which accounts for 15% of the market.

At the present time it seems that SaaS is generating a lot of noise whilst remaining a relatively small phenomenon. In other words the reality doesn't yet match up to the hype. It is only really mature in some aspects of HR and, increasingly, CRM and is unlikely to be the best model for end-to-end business processes in large organisations.

Whether or not SaaS can save you money may depend on your existing licensing agreements. If you already have campus-wide licences with a number of major software suppliers then you are unlikely to make great savings by moving to SaaS for the relatively small applications currently available under this model. You will need to consider the full lifetime cost of the application and be aware that 90% of existing SaaS offers are not genuinely 'pay-per-use'.

You also need to consider how well a particular SaaS application will fit with your existing architecture, systems and data. It is notable that the primary SaaS application is recruitment which is of course a business function where only a small sub-set of the data requires transfer to your core HR system. A notable trend is for SaaS vendors to talk direct to business users on the premise that 'the IT department doesn't need to be involved'.

Although there is not yet a compelling case for SaaS in core areas of university business it may be worth investigating in order to try out emerging technologies in areas that aren't mission critical.

6. CLOUD COMPUTING

Cloud computing is where most data, applications, processing power and services are provided and managed on remote servers and accessed via the internet or intranet. In its ultimate form the user just needs a simple PC as a terminal. Clouds may be 'public', 'private' or 'hybrid'. Web mail hosting and online banking are simple examples of cloud computing. In education Federated Access Management is a good example of a critical service provide from a private cloud.

Public and hybrid clouds are being provided by major suppliers like Microsoft, Google, Amazon and Cisco, who are all building huge server facilities. Google is leading the market at the moment - it is focused on services that make life easier for individuals whereas Microsoft still targets the enterprise market. Many of Google's free services provide useful data about user behaviour that it can sell to other companies.

The main concern at the moment is the extent to which a highly distributed and virtualised environment can ever be sufficiently secure for mission critical data. There have been some high profile failures e.g. Monster.com had 4.5 million customer CV records stolen. It is difficult to get enough data from vendors to adequately assess risk. The idea of SaaS/Cloud ESCROW is theoretically possible but not offered at present. Most trusted SaaS vendors are currently using non-cloud platforms.

The potential benefits of an approach that eliminates most of the capital costs associated with physical IT infrastructure are evident. Cloud computing is also often promoted as a 'Green' approach with implications for your institution's energy costs. The approach is also instantly (and infinitely) scaleable with additional computing power available on demand.

Therein of course lies the downside risk. Backing up an infinitely scaleable cloud isn't easy. Data interoperability is also an issue as standards are relatively immature in the proprietary services available at present. Security however remains the big issue. Encryption is only a partial solution as the data must be unencrypted in order for any transaction processing to take place.

The fact that in a cloud (or SaaS) environment you lose control of new releases to users may also be a downside for many IT departments. The approach means an end to the traditional cycle of testing and planned roll-out. The evidence from many social applications suggests that, on the whole, users will probably just get on with this and cope with the changes but the implications for IT support must be considered.

Despite the risks and concerns, the sheer volume of investment suggests that cloud computing is here to stay as a route to flexibility and low cost. It may well be that the HE sector opts for investment in private cloud space, particularly for research purposes, rather than favouring the public or hybrid approach.

7. OPEN SOURCE SOFTWARE

The term 'Open Source' applies to software whose source code is made widely available under a liberal 'public license' at zero cost. Anyone may exploit and adopt the software for their own and for commercial use. The ethos of Open Source is that users contribute back to the development effort, which usually results in much more rapid problem solving and quality improvement. Created as an altruistic movement by Richard Stallman, father of the GNU project and the Free Software Foundation, as a response to the commercialization of formerly 'open' software like the forerunner of UNIX®, BSD, and even early IBM software. Well known examples include Linux, Apache web server, the Moodle virtual learning environment, and Java.

While many developers use open source software because of the absence of licensing costs, the more important reason is quality and reliability, through access to the widest community of

developers. Open Source is also free from proprietary supplier lock-in which is often an attractive ethos in education. The absence of a license cost does not of course mean that the software is entirely 'free' in terms of total cost of ownership. Products like Red Hat, Ubuntu Linux and Moodle are supplied free by companies who charge for support and implementation. Where a university chooses to adopt open source software without a support contract of this type it will need to consider the implications for the skill-sets needed by its own staff. Following the lead of a small number of Open Source enthusiasts in your IT department can leave you exposed to considerable risk if those people leave.

In summary Open Source is definitely here to stay. Many universities have large-scale Moodle implementations. The Open University is the largest in the UK and it has adopted Moodle institution wide and reckons the change was cost neutral, what they save on licenses they spend on development and support. The end result is however that they end up with the developments they want.

The JISC OSS Watch Service provides advice and guidance on the use of Open Source Software: <http://www.oss-watch.ac.uk/>

8. SHARED SERVICES

The term 'Shared Services' means institutions cooperating in the development and delivery of services, sharing skills and knowledge, perhaps with commercial participation. These typically include services such as student records, timetabling, finance, estates, human resources, library management, virtual learning environments (VLEs) and customer relationship management (CRM).

Institutions may use a common, hosted service for these services, for example HR, student records and information. Their data is secure and some local variations can be accommodated. Shared services that interface with other systems and services within an institution need to be conceived within an overall architectural framework. The most sophisticated models of shared services involve establishing a completely new organisation, run and managed as an autonomous business. The term 'shared service' does not necessarily mean outsourcing and there are forms of sharing and partnering arrangements which do not necessarily involve a private sector provider.

One example of how shared services can operate effectively in a highly competitive environment is the development of large shopping centres or malls. The retail outlets within the shopping centre may be in direct competition with one another yet they benefit from sharing services such as car parking which would cost a lot more if each shop had to provide its own car park.

In the UK the economic and political drivers for shared services are strong yet the amount of shared service provision in place is generally small, in non-critical service areas and predominantly regional in nature. There are however some significant exceptions to this. Shared services that cover most or all of the four UK nations include:

- Universities and Colleges Admissions Service (UCAS)
 - Higher Education Statistics Agency (HESA)
 - The JANET network that connects all universities, colleges, research councils and regional broadband consortia (schools). Its success was recognised by winning the shared services category of the e-Government National Awards 2007
 - JISC also runs a range of UK wide Advisory Services via a not-for-profit company known as JISC Advance
 - RCUK Shared Services Centre Project, probably the largest shared service initiative in the sector, covers all seven Research Councils, HR, payroll, finance, procurement, IT, telecommunications and grants processing
- Other examples include:
- Association of Northern Ireland Colleges (ANIC) consortium manages the supply of CIS services to the country's six large multi-site FE colleges
 - M25 Consortium of Academic Libraries shares services for the benefit of students and researchers
 - University of the West of Scotland and South Lanarkshire Council shared data centre

9. FLEXIBLE SERVICE DELIVERY

Having looked at some of the new and emerging technology options available how might we apply these to the idea of Flexible Service Delivery? Flexible service delivery is about helping universities and colleges deliver new and integrated services through joining up disparate information systems such as library management, virtual learning, finance, student records, or timetabling.

By integrating and service-enabling these systems, coupled with optimising business processes, institutions can:

- Be more agile and be able to meet changing demands;
- Provide services more efficiently;
- Access business intelligence across the institution more easily, and
- Be able to share data and services within and across institutional boundaries.

To facilitate this in the UK, JISC is running the Flexible Service Delivery (FSD) programme supporting universities and colleges who wish to address the challenges and inefficiencies caused by the lack of interoperability in their systems and processes, and explore the possibilities and benefits of a more flexible information environment both within their institution and across institutional consortia. This includes exploring the practicalities of universities and colleges operating certain functions and activities through a flexible and shared service solution.

Flexible service delivery means different things to different people, and so different stakeholder groups have varying requirements and expectations. A key factor in success is understanding the needs of all of the stakeholders including senior managers, academics, IT managers and, not least, learners.

Each college or university will find itself at a different starting point in the process of adopting flexible service delivery. This may range from building understanding on the benefits of flexible service delivery within the institution, to scoping projects and initial exploration, to realising early organisational benefits and ultimately to embedding and managing a set of practices. The FSD programme is designed to help support strategic and IT management in navigating the step-by-step processes of implementing flexible service delivery across an enterprise. Benchmarking progress is a critical component and recognized in the programme design; like any kind of change process, investment in flexible service delivery must be guided by strategic priorities and demonstrate a measurable impact via performance indicators.

The FSD Programme Management Team has defined four key building blocks needed in supporting flexible service delivery:

- Senior management buy-in
- Service-enabling disparate legacy systems
- Cost baselining and modelling
- Opening up the market, unlocking inertia

The following organisations are together exploring how the delivery of corporate administrative services, student records and information management services, and student and academic services can be improved through flexible means of service delivery, including the possibility of operating certain functions and activities through shared service solutions. A cluster of HE institutions are also using, adopting or interested in the Enterprise Architecture (EA) approach to support strategic change and improvement.

Blackpool and The Fylde College is reflecting on its recent successes in business systems integration implementations and reporting these as a case study, to build the capacity and upskilling necessary to put in plans for a more business-led and service-oriented approach to interoperability across their corporate services. Alternatives to traditional software supply models, such as Shared Services, Open Source products, Cloud applications or SaaS, will also be considered.

Bloomsbury Consortium. This civic grouping of six non-competing institutions (Birkbeck College, The Institute of Education, London School of Hygiene and Tropical Medicine, the Royal Veterinary College, the School of Oriental and African Studies and The School of Pharmacy) is being funded to deliver a consortium-pilot project which builds upon their portfolio of shared licenses, and using service-oriented approaches. It aims to establish a shared media platform across the consortium, including working with Apple iTunes U to create a consortium site which interfaces openly with consortium data architecture and systems. This offers the programme references to excellent examples of license sharing and joint governance across consortia.

Cardiff University is seeking to develop a common and shared understanding within the university, and within the wider sector, on how to build the capacity and maturity to advance towards achieving an environment of flexible and shared service delivery, through the development of an FSD Maturity Roadmap.

Coventry University is baselining its current systems provision and identifying opportunities for the use of SOA.

De Montfort University and Southampton Solent University have delivered a SOA/Middleware demonstrator project focused around the scenario of student tracking and engagement. This project used a solutions provider (Fulcrum Ltd) to develop a working prototype of a web-based application system which demonstrates how SOA and Enterprise Service Bus (ESB) technologies can be used to gather information from multiple application systems across the two universities, irrespective of the vendor and versions, store it in a secure and consistent form, and create an integrated report instance.

Imperial College London is defining its FSD maturity roadmap and business case to help consider the relevance of EA as an approach for strategic change and improvement, so that the college's ICT department knows how best to deliver agile, flexible and cost-effective services to their customers within the college, and have a strategic approach to building an underlying Service Oriented Architecture.

King's College London is delivering a project that enables and positions the Centre of Research (CeRch) at KCL to learn of ways, and of the cost, risk and impact, of how research information systems and practice, and digital repositories, could all be made available as a flexible and shared service, achieved principally by identifying common services for sharing within the e-Research domain and demonstrating where flexibility can be exploited.

Leeds Metropolitan University is delivering a project that enables and positions the Academic Support and E-Services department to learn of ways, and of the cost, risk and impact, of improving their service delivery mechanisms for their current portfolio of student services, as well as for future service provisions.

North Hertfordshire College, in partnership with **City College Norwich**, **The College of West Anglia** and **SHM**, are investigating the practicalities of a Further Education College operating certain finance functions and activities through a shared service solution, and to pilot a shared service solution within a real consortium setting.

Nottingham University is currently participating in the programme to share their experiences and lessons learned in developing a long-term strategy and business case for the implementation of a new service-oriented student management system, with the aim that this new implementation will be capable of improving the service delivery mechanisms to both students and staff at Nottingham University and across their campuses in China and Malaysia.

RMAS HE Consortium: The six institutions, with the University of Exeter leading and partners University of Essex, London School of Economics and Political Science, the University of Kent, Bournemouth University and the University of Brighton, will receive support in making technical decisions, specifying the statement of requirements, and engaging with suppliers of a potential shared-service Research Management and Administration System solution. This HEFCE-funded shared service feasibility project provides an excellent example of a community-driven shared service under development. They are also looking to expand their FSD activity by assessing the business benefits from implementing such a solution and demonstrating the benefits of moving from the current mix of

research support systems to a 'cradle to grave' solution which uses open, interoperable and service-oriented (or modular) technologies.

Roehampton University is sharing the work they are doing in developing a 'shared services' roadmap, which addresses moving towards a process-led business environment which leads IT service development, and introducing the development of an EA approach using TOGAF.

SnUG Consortium. This consortium (Liverpool John Moores University, the University of Manchester, University of Cambridge, University of Derby, Queen's University Belfast and the University of Glasgow) is currently discussing shared service developments between the HEIs using/implementing the Oracle Peoplesoft Campus Solutions (CS) Student System. Developments being investigated include areas of interfacing (e.g. to VLEs), or in the development of required UK extensions to CS functionality, as generic shared services, which could lead to future collaborations with Oracle. The group is currently considering ways to work together to identify and deliver flexible/ shared services and would like to explore possibilities before embarking on pilots or trials. The FSD programme therefore offers an important support service to help the group formulate ideas not only for the group itself but also for the sector.

Staffordshire University is currently engaged in piloting Enterprise Architecture (EA) through JISC's Curriculum Design Programme. They are using this forum to share experiences and discuss common issues and practice with other institutions who have also adopted EA as an approach to strategic and technological change.

Thames Valley University is delivering a consortium-led project that scopes the demand and requirements for, and possible solutions to, an Intelligent Decision Support in HE (IDS-HE) as a shared service to the sector.

University of Bristol has as a strategic goal to better understand how FSD and EA can benefit the University and also to explore best practice techniques with other institutions around getting senior management support for a more strategic, architectural approach to systems development (the FSD business case).

University of Oxford is delivering a project to address the lack of provision in the area of assessment management. The project recognises that there has been little or no work done in terms of assessment management systems to support the process of marking and moderation by external examiners and review by examination boards, and that current student system providers do not address this requirement within their products. This means that these processes are managed (at significant cost) at departmental level in most universities - either through local systems, spreadsheets or very manual methods. The objective therefore is to address this and define the requirements for a service that could be plugged into any student system and provide the appropriate functionality. With this programme, the University is also delivering a project which identifies and pilots approaches to baseline costing of IT services so that it is possible to assess where cost savings and process improvements can be made.

The progress of these projects is being reported via the JISC infoNet website and the Flexible Service Delivery pages can be found at: <http://www.jiscinfonet.ac.uk/flexible-service-delivery>

10. A 10 POINT PLAN FOR MANAGING YOUR PORTFOLIO

We have looked at some new approaches to delivering IT services and at some of the risks and opportunities inherent in these approaches. We have suggested that managing your technology portfolio is best achieved by using an EA approach that takes a holistic view of your organisation and its strategies, processes and systems. We recognise that this is a challenging agenda. In practice EA thinking may be best promoted within your organisation by starting small and delivering some quick wins by using this type of approach before you try to 'sell' EA as a big idea or a means of driving strategy.

For those of you wanting to get started on improving the management of your technology portfolio and better aligning your technology choices with the university's strategic objectives here is a simple 10 point plan for the first 3 months:

1. Review a copy of your university's strategic plan and understand your Vice-Chancellor or Rector's main goals for the coming year.
2. Create a basic view of your IT Architecture showing the applications and services, the interfaces between them and the data transferred.
3. Identify any 'bloated' or redundant applications that consume resource far in excess of their actual value to the organisation and plan to phase them out. In time you will look at the business processes that drive this.
4. Then use the IT architecture conclusions as a starting point for discussion with management and teaching colleagues about architecture at enterprise level. Look at your main business processes, the weaknesses or 'pain points' in them and where they interact, and how this relates to your conclusions on IT architecture. Use this debate to build a roadmap of integrated process and ICT change.
5. Identify the likely lifespan and replacement cycle for the applications.
6. Consider how a service-oriented approach (SOA) to your data layer could streamline the architecture and reduce the need for interfaces/data retyping. Plan to turn the 'spaghetti' into a 'lasagne'.
7. Consider where approaches such as Shared Services, Open Source products, Cloud applications or SaaS could add value or reduce costs.
8. Produce a 'Roadmap' of how you hope to develop the Enterprise Architecture in conjunction with business colleagues. Relate this to the key business goals of the college.
9. Talk to others about this and keep an eye on developments coming out of the JISC Flexible Service Delivery programme.
10. Review your Roadmap regularly in the light of any changes to the university's strategic goals.

11. REFERENCES

Joint Information Systems Committee (JISC). (2008). *Study of Shared Services in UK Further and Higher Education*. Duke & Jordan. Retrieved 31 January 2010 from: http://www.jisc.ac.uk/whatwedo/programmes/programme_jos/ssprev.aspx

JISC CETIS (2009) *Technology change in higher and further education: A service-oriented approach* Retrieved 31 January 2010 from: <http://soa.cetis.ac.uk/soa-pack>

JISC Technology & Standards Watch (2009) *Doing Enterprise Architecture: Enabling the agile institution*. Retrieved 31 January 2010 from: http://www.jisc.ac.uk/media/documents/techwatch/jisc_ea_pilot_study.pdf

JISC Technology & Standards Watch (2009) *Unleashing Enterprise Architecture: Institutional architectures and the value of joined-up thinking*. Retrieved 31 January 2010 from: http://www.jisc.ac.uk/media/documents/techwatch/jisctsw_ea_synthesis.pdf