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Annex 1

DIGITAL

University Project

Building the Digital University

A Proposal to Information and Communications Committee

May 2001

BUILDING THE DIGITAL UNIVERSITY

PROPOSAL TO THE INFORMATION AND COMMUNICATIONS COMMITTEE

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Introduction

This document sets out the plans developed within Academic Services to begin to realise the concept of the Digital University, and specifically to launch the development of the Student Intranet. Members of Information and Communications Committee are invited to support these plans in principle, and to endorse the initial phases of the project.

1 Background and overall objectives

A great deal has been written about the electronic future of universities. This has been largely speculative, with some extrapolation of trends visible in the learning and teaching area; hence concepts such as ‘mega-universities’ and ‘virtual universities’. In the Corporate Strategy we recognise the need to transform the learning environment to make better provision for open and distance learning, and to develop greater flexibility in making learning opportunities available. However, we are rightly

cautious when it comes to the development of new electronic learning environments. It is recognised that in the coming planning period a substantial proportion of our students will continue to be campus-based, and will continue to be taught using predominantly traditional methods. It is also stressed that there is no single model for the effective provision of online learning. Across the sector we are still at an experimental stage.

Nevertheless, it is clear is that *any* new models will have to be based on effective and efficient use of C&IT. Hence it becomes clear that a prerequisite of any major new institutional direction is the creation of the *digital university*, or the *e-campus*. This is categorically not the same as creating a 'virtual university' for the purposes of delivering on-line teaching and learning. Creating a digital university means looking at all the key business processes of a university, and then recreating, reintegrating and enhancing these processes in an online environment. Building the digital university is an opportunity to re-invent our frequently archaic information flows and process controls in ways more applicable to modern day universities.

Through analysis of the fundamentals of the e-campus, we can identify five essential, interrelated components that together will create the rich working and learning environment we seek to establish.

- The Corporate Intranet, providing University staff with access to a widening range of information and communication resources, and to means of conducting an increasing amount of their business in a secure, online environment.
- The Student Intranet, providing students with access to student-centred information, learning resources, course management and communication facilities, as well as the ability to conduct financial and administrative functions online.
- The Digital Library, providing access for all our staff and students, wherever they are located, to networked information resources, which may in turn be disclosed locally, nationally or internationally.

- The public Web site, providing a key means of marketing the University and of communicating with a vast community of students, potential students, alumni and others.
- E-learning systems, providing the University with the capacity to enable learning and teaching in a flexible, place-independent, online environment, and enhancing the existing campus learning experience.

This does not mean presenting users of these systems with five apparently different interfaces. ***Central to the concept of the digital university is a single interface enabling access to a range of information sources, applications, and communications facilities.*** Certain of these sources and facilities exist already, or are under development. Examples within the university include our corporate databases, the functionality provided by virtual learning environments, information held on web pages, or in library catalogues. Other sources are externally sourced, such as library electronic resources available by subscription, or resources provided by national subject gateways and the developing DNER. The information and functions we describe will be bound together and integrated by a presentational layer forming an ***institution-wide portal***.

The United States Higher Education Java in Administration Special Interest Group (JASIG) has provided a series of characteristics which usefully define a portal in the context of Higher Education as a web enabled gateway which will:

- Provide access to all information and services through a single graphical interface;
- Support a single log-on to obtain authentication and authorization to all information resources and applications;
- Provide a framework where all elements of the university (academic, administrative and community) and all business applications can be integrated;
- Provide a convenient set of communications services which are web-based;
- Provide a one stop place where all members of the university community can perform all business transactions;
- Provide the ability to present information and access to services on an individual basis in a personalised manner;

- Provide each member of the community with the ability to customise the appearance, layout and information on an individual basis;
- Grant the university full control and self management of appearance and content;
- Be vendor independent (not locked into proprietary hardware and/or software;
- Be free of commercialization (no advertising or the sale of products unless university sponsored;
- Be flexible and be able to absorb new technology advances and new applications;
- Be available to constituents 24 hours a day, 7 days a week.

Such a portal will access and display aggregated multiple heterogeneous data stores, including relational databases, document management systems, e-mail systems, web servers and directories. The portal will enable a significant level of customisation and personalisation by the user, in order to present information which is relevant, appropriate and timely. It will also, of necessity, be adaptive, recording user preferences and channelling information according to those preferences.

An example of this approach to an information- based portal is illustrated in figure 1, Yalestation (page 5). This portal, created by a group of enterprising students in partnership with faculty and services, illustrates the concepts of customisation and personalisation. From selection of information “channels”, a portal user may select which appear, together with their priority. Yalestation then allows a degree of freedom in organising the presentation of those information “channels” on the page.

A potential structure of a portal approach adapted for the University of Hull is illustrated in figure 2 (page 6). From a start page occupying the topmost level of institutional web space, which is in part customised to present relevant information to the appropriate campus, the user may choose to authenticate or navigate to the university public web site. On authentication, a portal page appropriate to the user appears. Examples of three principle groups of users are provided in this visualisation. The scope exists to extend this approach to further specified groups of users when this is required.

figure 1: The Yalestation Portal (http://www.yalestation.org)

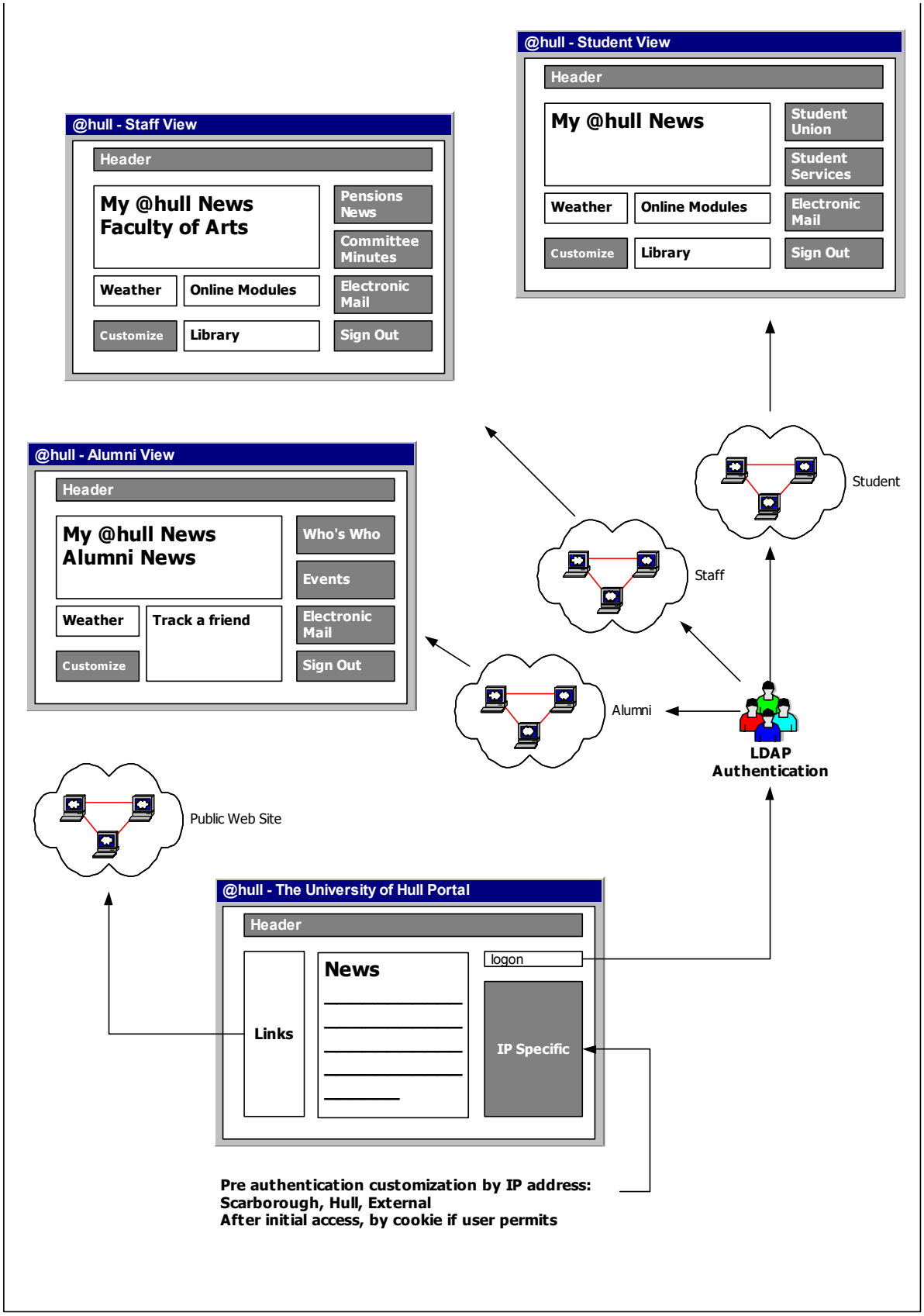


Figure 2: Visualising the structure of a potential Hull Portal

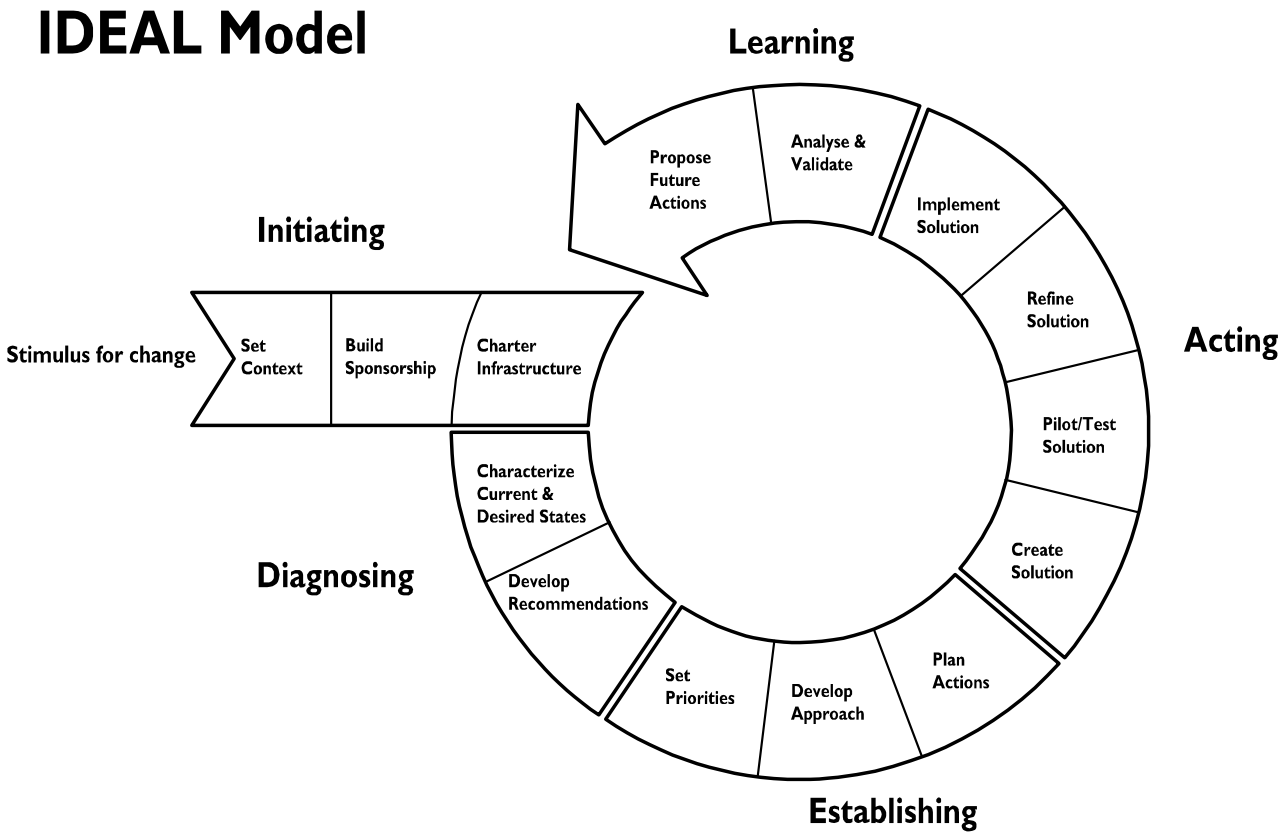
It should be emphasised that we are not alone in developing this approach. Very significant numbers of Higher Education Institutions, particularly in the United States, are undertaking portal developments of varying scope[i]. The opportunity exists to benefit directly from the experience of these "early adopters", and to explore potential avenues of collaboration.

This proposal sets out the first phase of the project to build the key element of digital university at the University of Hull; the development of an institutional portal with the working name "@hull". It indicates the general direction this development should take, and identifies key phases of this project throughout the current planning period of the University ending in 2004/05.

2 Methodology

@hull will draw together and integrate a variety of learning resources, applications and information sources. In order to enable access for both on-campus and remote learners using a variety of standard hardware, it seems certain for the foreseeable future that the most appropriate delivery method will be web-based, and that the client software accessing the system will be a web browser[ii].

Although the method of delivery is web-based, the development process has greater similarity to software development than to the creation of a series of conventional web pages. Consequently, models of software development can more usefully inform the creation of ***@hull***. One such model, the IDEAL model developed by the Software Engineering Institute of CMU, provides a useful framework[iii].



Guiding principles in the construction of ***@hull*** will be the practice of **user-centred design**, the **adoption or development of software conforming to common specifications and complying with standards where appropriate**, and the **re-use, where practical, of informational and other components**.

In practice, **user centred design** recognises that usability, visual design and interface design are integral to the development process, and are not to be regarded as "optional extras", to be added when the major architecture has been established and software development has taken place. ***Issues of equity and equality surround the provision of information and the communications resource we describe. As far as possible, these resources should be accessible to all our learners[iv]. They should not exclude users with disabilities, those from different cultures, or distance learners on low bandwidth and frequently temporary Internet connections. These design and implementation challenges will be integrated with our planning processes from the outset***.

The project team will establish a series of mechanisms to consult representative samples of users, and involve them from the outset in the process of definition, specification, development, review, and iteration. These will range from the establishment of formal user groups to on and offline questionnaires and informal observation.

These mechanisms are all the more essential as the users of the e-campus form a heterogeneous series of groups with large differences within each group:

- Students (both local and remote, young and old, of varying abilities, and from a variety of cultures)
- Academic staff (who may fall into the above categories, but in addition be providing modules online, or simply accessing information useful to their teaching and other duties)
- Administrative and support staff
- Alumni
- Target groups for outreach activities
- Potential students
- Potential employers
- Parents of students
- Casual browsers

Significant development strands running through the establishment of ***@hull*** are related to connecting information held in existing university systems to the functionality represented by virtual learning environments (VLEs), and presenting the result in a coherent manner. Where new systems are purchased and/or developed in-house (for example, to provide VLE functionality, or to make more rational and re-useable the information currently held in documentary form on static web pages) the ***@hull*** architecture group will carefully evaluate the conformance of such software with **common specifications, such as those developed by IMS**[v], **and standards ratified by the IEEE/ISO**. The degree of conformance afforded by particular vendors will not only facilitate the integration of the systems required, but will also act to prevent over-reliance on a particular vendor or vendors.

Where information required by learners and other users is not presently in corporate databases (such as that held in static web pages, faculty or SFU databases, or in conventional documents), we propose that the information be transferred into database enabled distributed content management and publishing systems with levels of security and authorisation appropriate to use. ***Such systems allow the distribution of publishing effort, and the appropriate use and re-use of suitably granular information. They go beyond the development of the @hull portal, however, and are a significant component in the integration and alignment of fundamental processes within the institution with the development of information and – ultimately - knowledge management in the digital university.*** We anticipate that the data sources this process establishes will be vital components of the institutional interface with learners, potential learners, staff, alumni and a broader community.

The human-resource implications of this process, and the transfer of information itself, require quality control, careful tracking and documentation. A planned re-alignment of training provision within the university will be required in order to meet the needs of new layers of active information providers.

3 Outline project phases and strands

It is necessary to delineate broad developmental sub phases within the overall development of an institutional portal. As far as possible, these are designed to run in parallel with, and leverage the infrastructural developments which have already been approved.

3.1 Validation phase

The methodology we have described will be tested in practice in a pre-project phase within Academic Services and Student Services, timed to conclude during August 2001 These organisational units provide a range of services and informational resources, some of which are facilitated by corporate databases, some which require new information repositories. The preliminary phase will involve an analysis of informational requirements for the public web presence of both units, and concomitant analysis of information more appropriately suited to the student and the staff intranet. In addition to providing a more rational, and distributed, framework for the continued development of the public web presence of both Academic and Student Services, this preliminary phase will aggregate a significant amount of information required by the Student Intranet and transfer it to a useful and maintainable format. It will also provide valuable data to assess more precise timescales for the more substantive changes we propose.

The prototype interface will therefore bring together:

- Resources provided by the Library, and in particular the Digital Library Focus
- An implementation of a typical specifications-based VLE, the Blackboard environment used for information skills training in addition to academic modules.
- Information currently held in static web pages maintained by Student Services and Academic Services.
- A degree of simple customisation (as a proof of concept).

3.2 Development Phase

3.2.1 The Student Intranet

The Student Intranet will contain elements of ***information delivery***, those perhaps best described as ***transactional,*** and elements dealing with the ***delivery of applications***. These three elements will be bound together by a coherent interface. Whilst the precise content developed during this development phase will be determined after a period of extensive consultation with students, their representatives, and staff, it is possible to identify key features required to initiate the development process.

(a) Information delivery:

The Student Intranet will provide students with a range of appropriate information geared towards helping them manage their learning, and their broader lives as learners. A considerable amount of information required for these purposes is not currently held in corporate databases, but is rather dispersed through a series of web pages and conventional documents. This information requires translation into a format useful to the Student Intranet. To create a further large, conventionally produced site consisting of static web pages, would create a significant maintenance problem. This would jeopardise the sustainability of the Student Intranet.

An approach to this problem can be found in development work undertaken for the Staff Intranet, which enables a ***distributed model of content development and management***. Essentially, the Staff Intranet stores information in a web-enabled database, and provides connectivity to appropriate elements of the university corporate databases. A simple and easy to use set of information editing tools are embedded in a series of secure web pages

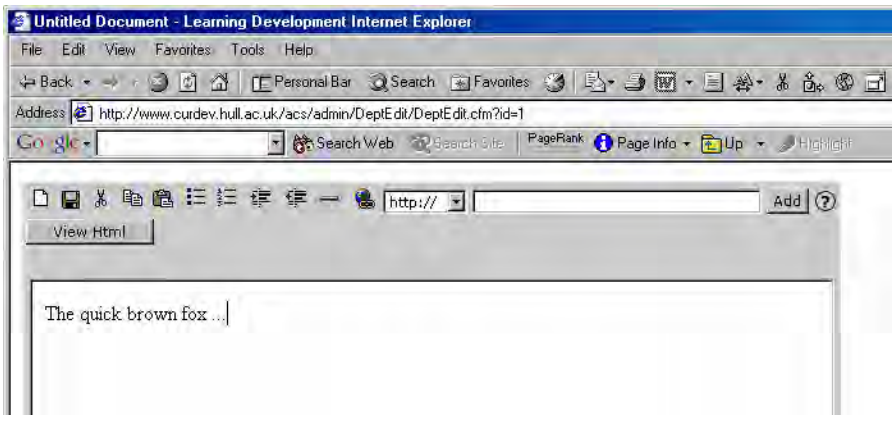


figure 3 the Staff Intranet toolset

The tools provided are a close approximation of the familiar tools provided in office applications. The information provider is thus freed from the need to learn complex web authoring software in order to edit, maintain, and publish basic information. The information provider is further freed from the necessity of developing expertise in visual design by working within a pre-designed and templated environment. In deploying this system, the Staff Intranet ensures that the ability to maintain correct information is distributed to those in the best position to do so.

Such a distributed system by its nature requires a large number of people to make a small step. The human resource implications of its deployment, appropriate documentation and publishing guidelines, and mechanisms for proofing and editorial control will be developed as a key part of this project phase.

Such a distributed system requires a series of checks to ensure the quality of content. (Quality, in this sense, ranges from the accuracy, propriety, and completeness of information to its timeliness, and can therefore only be determined in the context of the specific information itself). A possible workflow for such a system is illustrated in figure 4, below.

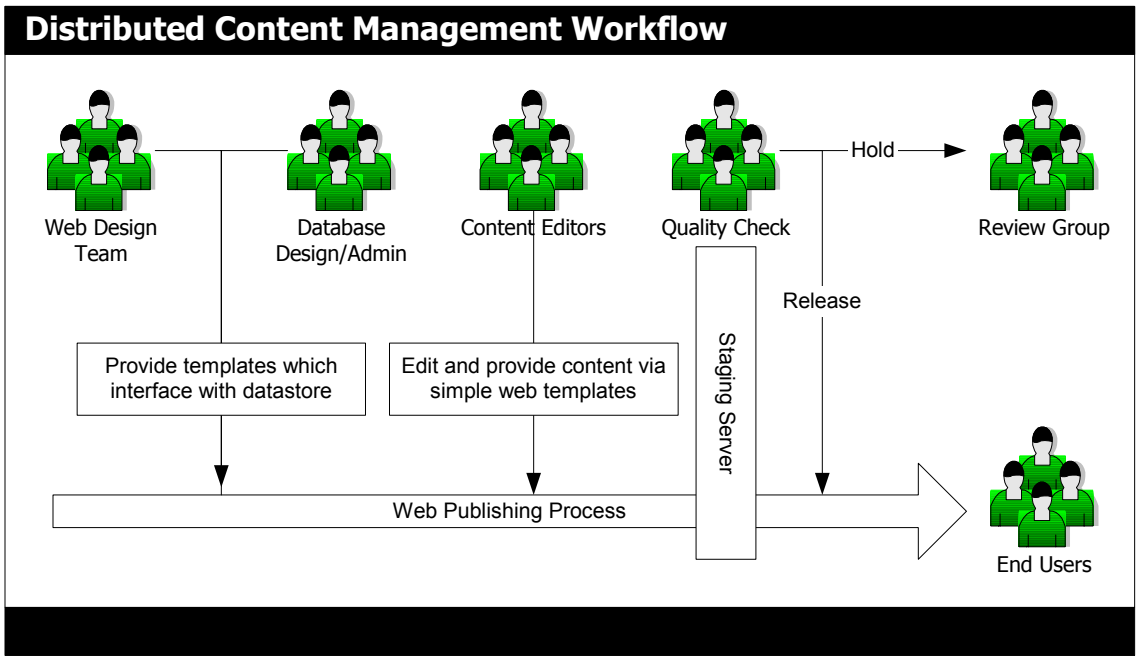


figure 4

In order to minimise the performance overheads in such a system, only time-critical information will be built dynamically in response to a client request. Other information will be stored and published as web pages in response to modification. These files will be published through a series of content templates. The purpose of these templates is essentially to format the html produced appropriately for a variety of devices and accessibility requirements. We should particularly note the latter issue in relation to recent changes in UK law increasing the ***legal*** obligation to provide accessible web pages. As personal digital assistants and WAP enabled mobile telephones become more widely used this is likely to be of increasing significance. By deploying such a system, the university is preparing the ground for later advances and adaptations. It is also eliminating a considerable, and wasteful, duplication of information entry. The method of publishing, in brief, exports content from a database through a series of extensible markup language template files using XSLT (Extensible Stylesheet Language Transformations). XSLT provides an implementation of a tree-oriented transformation language for transmuting instances of XML using one vocabulary into simple text, legacy HTML vocabulary, or instances of XML using any other vocabulary. In our proposed implementation of this system, the template therefore serves to optimise the output format for a particular device or user. The resultant web page might be designed specifically for a screen reader, or for a web browser on a personal digital assistant or WAP enabled mobile phone. The production method we indicate avoids many of the problems associated with design solutions which attempt to produce pages formatted for a variety of devices. Very frequently this compromised output does not work *well* with *any* of the devices for which it is intended. The remaining undefined area within this approach lies in the ability of the web page to successfully identify the type of client and redirect it to the most appropriate version automatically. Reaching this point will be a challenge for both the technical and design teams, but will be necessary to ensure maximum usability for the variety of end users.

Significant benefits are gained, in this model, by the transfer of information from static web pages into a publishing database. Information stored in such a database driven system may be re-used to a far greater degree than conventionally produced

web pages. It is also significantly easier to integrate such information into a subsequent portal framework.

b) Transactional elements

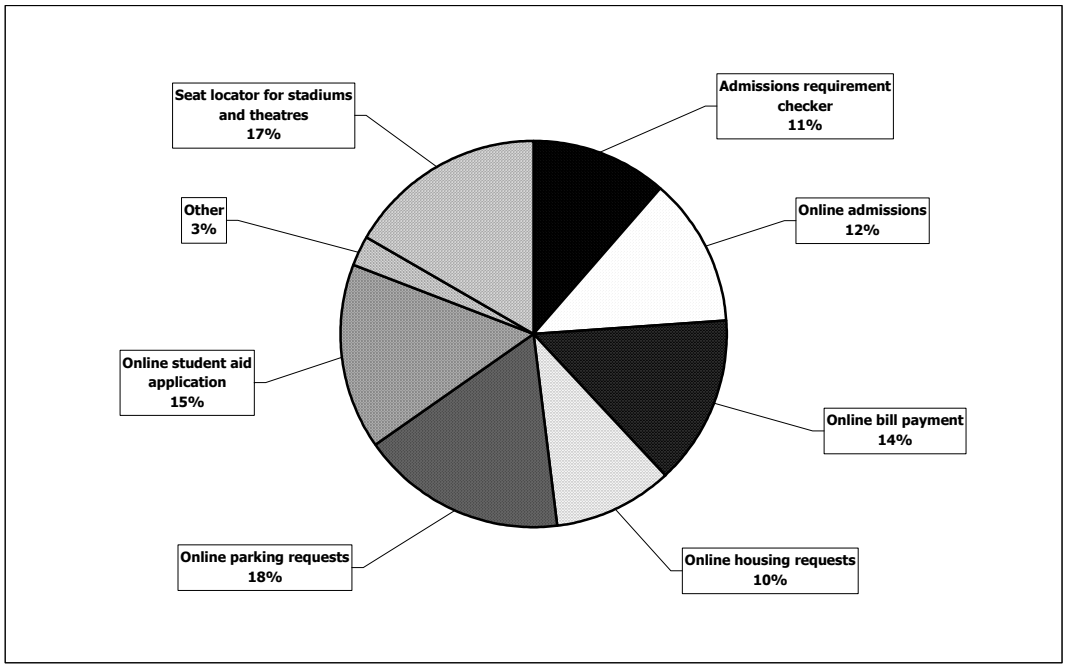
There is growing evidence to suggest that one the most significant attractions of a portal framework for students is the ability to conduct online transactions. Our students will increasingly arrive with experience of conducting transactions online, and expectations that the university will enable the same facility for services it provides. They may already be banking online[vi], have purchased books or CDs from Amazon, or clothes from gap.com. Many will have accessed a range of national or local government online services, or been made familiar with them through the National Grid for Learning or Peoples Network. Learner expectations in this area are likely to be considerable, and are set to rise with each additional cohort entering the university.

Usage statistics from existing portal implementations can provide an indicative view of the most used or demanded services. UCLA, for example report some 20 million of transactions within their student intranet equivalent for the period 1999-2000. The following statistics, drawn from analysis of the PAWS (Personalised Access to Web Services a framework adopted by Louisiana State University in 1997/8) portal, provide further detail of the nature of such transactions:

What services/resources do you use?

Course Listings	1318
Electronic reserves	543
Jobs ops	233
LSU Libraries	676
None	59
Other	66
Email	1447
People directory	1129
Press releases	148
Registration services	699

What services/resources would you like to see available through the LSU web site?[vii]



A cursory examination of this data provides an indication of possible directions, and it is interesting to note that ***all*** the named services requested by users are transactional in nature. There is clearly a great deal of work to be undertaken before certain of these systems could be fully implemented within our own university and integrated into the ***@hull*** framework. A viable e-commerce driven payment system, for example, should be approached with due caution, and after a careful evaluation of a still-maturing technology. Given adequate levels of security, however, the ability to ***view*** financial information should be provided and would in itself be of considerable value. By such a mechanism, a student could check their financial status with the university without a physical visit to the Administration Building. The ability to enter and amend selected records in corporate databases would provide benefits for both student and institution. The ability to enter an existing e-mail address, or mobile telephone number, or update accommodation information would greatly enhance the institutions ability to easily and cheaply communicate with its student population – an ability which, we have already noted, we are in danger of losing.

Clearly, the services the university provides will not only be determined by student preference, but by a combination of those preferences with institutionally determined priorities. A survey of the preferences of our learners in this area would form a good starting point, and some evidence base for this process to develop, however.

It must be recognised that the growth of the transactional services we have described or indicated will have an impact on the duties and responsibilities of many staff. As such, the development of those services will be approached with sensitivity. Many staff will recognise, however, that the disintermediation of a range of services will provide both an immediate improvement for the "customer", and create the prospect of time released to improve quality of service.

The provision of the transactional applications we describe has a range of further implications. These range from the transmission of potentially sensitive financial and other personal information over the campus network, requiring at the very least a measure of strong encryption and interception countermeasures, to the ergonomics of open access cluster deployment. Whilst the staff intranet is typically accessed by a user in an office or from home, students will almost certainly wish (at some point) to access their portal page from an open access cluster. Under these conditions, increased network security is of little use, if sensitive information could be viewed easily by a casual passer-by. We clearly cannot re-work the physical context of each existing open access PC instantly. We can, however, take these factors into account when establishing new clusters as part of the institutional ICT strategic plan, and include them in the training and awareness raising activities we plan.

c) Application delivery

As technology continues to develop, it will be necessary to re-evaluate the range of software applications we provide and how these applications are delivered to our users. In the context of the creation of the student intranet element of the ***@hull*** portal, a particular application, the email client, is of critical importance because it forms the central mechanism for communication with students in a digital environment.

The number of students using web based email services such as Hotmail around the campus begs the question as to *why* they choose to do this. There is no on-campus support for such services, a number of security problems surrounding them have been well publicised, and they typically connect a server located on the western seaboard of the USA - hardly the most rapid method of accessing email. Such services are, however, supremely convenient, by virtue of simplicity and integration with the general experience of web browsing. Although the browser interface has limited

functionality when compared to a dedicated email client, a layer of users is clearly willing to forgo the greater functionality and security provided by a dedicated client. In return the simplicity, convenience and integration represented by a web based email service is obtained.

A further reason for the popularity of these services is undoubtedly the fact that an increasing number of students arrive with existing email accounts. This tendency is likely to grow, and our systems should accommodate this by allowing students to register email addresses additional to the address we provide. If this is not implemented, the university may find it increasingly difficult to communicate effectively with its learners[viii]. The integration of email services with the ***@hull*** portal is therefore a key element in its development. The integration of ***the*** compelling service for many students within the ***@hull*** interface would provide a further reason for students to use the system as their ***personal*** portal.

We have emphasised that these elements – information provision, transactional elements and application delivery - will be made coherent and bound together by a unifying interface. This will be capable of adaptation, and customisation by the user. A likely method for delivering this customisation is by enabling the selection of "channels" of information delivered to the web browser without further user intervention. We have also emphasised the development of a design and structure which reflects the genuine needs and preferences of a range of users. At least part of the development process should go considerably further than this. It should examine ways in which granules of information, transactions and applications can be combined and recombined to meet the real-world needs of users. The example of modelling these clusters around “life events”, rather than relatively abstract and disparate sources spread between typical “departmental” pages, is worthy of close examination as part of the development process. With the basic architecture in place, a variety of such pathways through the information, transactions and applications we provide will be established much more easily.

3.2.2 The Public Web Site

The information currently provided by the university is at best a patchwork. This patchwork, though occasionally colourful, lacks a large number of pieces and is imperfectly stitched. A significant amount of information we provide for both an internal and external audience is theoretically accessible from the main university web site. This site, as a consequence, lacks focus and clarity of purpose. It is increasingly difficult to maintain, and notoriously difficult to navigate. The reason for this lies not primarily with the individuals or units servicing the site, but rather with a failure to integrate the site with the underlying processes of the institution. Bearing in mind the purpose(s), size and content of the site, the expectation of traditional print-based production model effectively delivering timely content to a web timescale is unlikely to be met. The methodology currently employed also runs contrary to the essential nature of the web as a ***distributed publishing environment***.

We therefore propose that the secure distributed content management system deployed in the staff intranet, and developed for the Student Intranet, should be extended further to encompass the public web site. It would clearly be a gross inconvenience to require an information provider to visit to two or three systems to modify what might be similar information. There is no reason, therefore, for separate systems, although there is a clear requirement for the interface presented to the information provider to clearly indicate the purpose and target of a particular publishing tool.

The following broad steps are required to initiate the redevelopment of the public web presence of the university. They create many of the "informational" pre-requisites of the student intranet and ***@hull***, and present the re-creation of the public web site as a constituent part of the overall process we outline. In this context, incorporation of this strand into the overall @hull development will avoid considerable duplication of effort.

1.1 Redefine and clarify the purpose of the university public web site.
1.2 Remove information made redundant by the current Staff Intranet, developing the Staff Intranet where necessary to accommodate further information..

1.3 Identify which information will be made redundant by the student intranet, and remove it as soon as this is brought online.

1.4 Redesign the public web site around a distributed content management model, consulting Faculties and SFUs extensively as part of this process.

1.5 In close liaison with Staff Development Office and the ICT Training Team, develop a human resources plan the development and implementation of a distributed content management system across the university.

3.2.3 From Virtual Learning Environments to Managed Learning Environment

We have previously noted the current period of experimentation with systems to enable online learning. Perhaps as a consequence of this period of experimentation Hull, in common with many HEIs, has not approached the development and deployment of virtual learning environments with a sense of strategy. Given the benefit to be gained from the integration of the information and service layer we have outlined with the provision of e-learning materials delivered by a VLE, some measure of stocktaking, assessment, and rationalisation of the experience to date is urgently required. In this context, it is critical that a rounded assessment is made of the pedagogical validity and flexibility of the environments we have deployed, together with their cost effectiveness, and the costs associated with their integration with other campus systems[ix].

Four principle virtual learning environments are currently in use within the university: Merlin, Blackboard, FirstClass, and Business First. In addition, individual members of staff use a number of other experimental systems. These virtual learning environments contain in most cases a mixture of communicative tools and repositories of learning materials developed by academic staff. Only in the case of Blackboard can these materials be extracted from the environment in a format conformant with specifications and emerging standards for learning materials. (Although discussion regarding the development of conformance for the Merlin environment has begun).

As a consequence, the potential for re-use of these materials is limited. The environments have, in at least two cases, either tenuous or non-existent connections to user and module information held in our corporate databases. The use of all these environments, to one extent or another therefore, involves significant duplication of effort.

Recently a view of the integrated ***managed learning environment*** has gained common currency within Higher and Further education. This managed learning environment builds on the experience of virtual learning environment deployment and practice, and addresses the lack of integration of the virtual learning environment with other institutional systems. Why, for example, should academic staff enter module and user information into a virtual learning environment module list or user database, when that information has already been entered into a corporate database by administrative staff? At its most rudimentary, a *managed learning environment* seeks to avoid this repetition and waste by building dynamic connections to corporate databases and implementing ***connected*** systems. ***We wish to emphasise that it is not the case that this view of a managed learning environment implies a monolithic approach to online teaching and learning.*** It is extremely unlikely that any one environment will meet either the requirements of every tutor in each discipline in which it is used, or the learning styles and needs of every learner in every geographical location. We therefore emphasise finer granularity of resources to encourage flexibility, a common architecture, to eliminate waste and redundancy, and a variety of implementations appropriate to the particular learning context[x].

The connection and integration of the managed learning environment with other university systems, and the presentation of learning materials in close proximity to a range of services and information in a structured, flexible and adaptive manner is the key to creating a informational and service driven "multiplier effect", and the development of a compelling ***@hull*** portal.

The inclusion of digital library resources, for example, within the portal will ensure that learners are directed to quality assured, timely and accurate resources, features that are ignored by the Web-based search engines and business-driven commercial portals currently used by many students. However, the digital library will never

completely replace the printed resources of physical libraries. Therefore the Innopac system will be a key component of the portal drawing together the digital and physical collections of Academic Services Libraries and Archives and presenting them to the users in a seamless and integrated manner.

Further integration of print and digital resources with the content of the MLE would enable learners to locate all learning material at the level of the course (or even potentially the module) without needing to search multiple locations. Links to digital library services such as online reservations or renewals, document supply, and electronic help desks or enquiry support will complete the process of full integration. Movement towards a managed learning environment is therefore a critical element in the development of the ***@hull*** portal, and the creation of the digital university.

3.2.4 Implementing an integrated portal

Before any consideration of specific software requirements is undertaken, it is necessary to re-iterate the primary underpinning elements around which ***@hull*** will be built. A common feature of any portal is the requirement that the user only authenticate once. Such one-step authentication requires a robust and developed set of authentication and directory services. The principle of wherever possible taking an approach based around open standards should inform the approach taken to this issue. A number of approaches suggest themselves for evaluation as a basis for authentication services. The most promising of these is Lightweight Directory Access Protocol, or LDAP. Initially developed at the University of Michigan, Lightweight Directory Access Protocol is now a standard for user directory services running over Internet protocols.

Documentation available in the public domain from existing portal projects tends to pose the major early project decision as “build or buy”. Given the scope of the project we have indicated, and the range of functionality and information we wish to aggregate, this is almost certainly a false polarisation. A hybrid solution involving the purchase of some elements, and the construction of others from available toolkits is far more likely to meet the needs of the university.

It would clearly be premature to specify in detail the software we will use to create ***@hull***. Using the methodology outlined earlier, however, it is possible to indicate a series of potential solutions, and eliminate others.
A variety of solutions recommend themselves as worthy of consideration. The following comments on potential solutions are intended to be indicative, rather than exhaustive. The ***@hull*** Technical Architecture Group will provide a closer examination of solutions against the criteria indicated in this document and collectively enhanced by the project working groups.

Vendor Provided Educational Portal Solutions
These tend to fall into two broad categories: those hosted on servers provided by the vendor, and those designed to be implemented on servers within the purchasing institution. The first are principally intended to be deployed by smaller institutions with little record of internal software development - typically Community Colleges or Schools and FE institutions. Services provided are basic. The ability to provide an institutional web presence and place learning materials online are typical features.

Those solutions intended for deployment within the purchasing institution tend to be richer in functionality. They range from adaptations of enterprise portal solutions - primarily concerned with the creation, distribution and discovery on information leavened with a limited range of applications, to those providing these facilities and adding the typical functionality of a managed learning environment. Examples of this latter type include Blackboard in its level three instantiation, and Campus Pipeline.

It should be noted that whilst these products allow varying degrees of customisation, this is often limited. Using such solutions alone is unlikely to meet either the full range of requirements, and may inhibit both the development of institutional "branding" and differentiation with the offerings of other institutions. Consideration of these solutions should carefully balance their cost effectiveness and functionality against these weaknesses.

Portal Toolkits
A number of toolkits are available for portal construction. These frequently base themselves around Java or Javascript components, with JDBC™ (Java Database

Connectivity) or Allaire ColdFusion™ providing a layer of database connectivity. Considerable experience of the practical deployment of solutions based around this technology exists within Academic Services.

A specific portal framework and toolkit are of particular interest to the development of @hull, the Java in Administration Special Interest Group Common Portal Reference Framework and associated toolkit. JA-SIG was formed from 20 leading HEIs in the US in 1999, with the sponsorship of Sun Microsystems. It had the specific intention of establishing a framework and set of tools to enable the creation of portals for Higher Education institutions. In the two years of its existence, JA-SIG has released two versions of the framework, and grown to 140 HEI subscriptions (together with several corporate members). An example of a portal created with JA-SIG CPR tools is provided as illustrated on page 5. Whilst not offering a complete solution, the work of JA-SIG is worthy of careful evaluation by the project workgroups against the criteria outlined in this paper.

Conclusion

The authors are convinced by both internal discussion, and observation within and without the sector, that the development of the comprehensive and coherent range of web enabled services outlined in this document is essential. It is essential both for the direct benefits it brings to our community of stakeholders, and as a key component of establishing the “top twenty” status of Hull. We cannot escape, after all, the fact that significant parts of the sector are developing their services in the direction we indicate. The University of Hull is well placed, given the experience of its staff, and formal and informal connections to agencies such as the JISC, to learn from these developments and establish integrated services which are second to none.

Appendix 1: Visualising "Information Readiness"

The diagrams contained in appendix 4 provide a visualisation of the potential development of what we have termed "information readiness" within the University of Hull. They also indicate possible mappings to ***@hull*** project phases. The diagrams use visual symbolism accessible to the widest possible range of stakeholders and potential stakeholders. It should be noted, however, that the red-amber-green visual convention is not simply symbolic of ***technical readiness***, but is also intended as a measure of the ***maturity of the underlying business processes and their degree of integration with technology***. We have hesitated at this point to indicate the timescales involved, other than in the general sense of around four years for the establishment of the ***@hull*** portal. The project working groups should provide both more detailed implementation plans and timescales within their specific areas of expertise.

Figure 1: Current

Figure 1 demonstrates the current state of information readiness. The Corporate Intranet, with distributed content management database and improved content editing toolset, is about to be re-launched. A significant amount of content is in "smart" format (ie, database driven). A VLE - Blackboard - has been deployed with connections to corporate module and user databases. The connection is at present manual. The level of financial subscription we have purchased drives this limitation, rather than any known technical issue. Issues surrounding the single authentication of users are in the process of resolution with the establishment of an institution-wide LDAP service. Although it would be prudent to anticipate teething problems with this service, it will be a key underpinning for later developments, and should have a significant amount of appropriate staff time allocated to its further development.
The right of the diagram, however, highlights a significant number of problem areas. By any measure, the public web presence of the institution contains a significant variance in quality of information, is poorly targeted, and is isolated from underlying business processes of the institution. The current methods of developing and maintaining the public institutional web presence simply cannot cope with the volume and range of information it contains.

Figure 2: August 2001

By August 2001 the fragmented information store for the public web presence of both Academic and Student Services has been replaced with a coherent distributed content management system. The process of replacement has provided a much clearer indication of the information requirements of the Student Intranet, and has moved the public web presence of both Academic and Student Services into clear alignment with the business processes of both units. The HR implications of the replacement have been measured and provide data to establish an indicative human resource costing for later stages of development.

Figure 3

The information provision aspects of the student intranet are in place, and a procurement exercise for an MLE/Portal layer has reached the point where the stakeholders agree a broad set of criteria and functionality. The LDAP authentication layer continues a measured deployment, and has reached the point where all students are using it to authenticate to an information-driven "My ***@hull***" equivalent. It is possible that by this point, the example of the Student Services and Academic Services distributed content management systems has led other parts of the institution to request a similar system. It is assumed, however, that the remainder of the public web site remains in its current condition.

From this point it is no longer possible to indicated potential development in a strictly linear manner. Three likely scenarios suggest themselves, however.

Figure 4 (Scenario 1)

This scenario assumes that an MLE/Portal layer has been specified and procured or developed. The degree of integration with informational elements is not yet high, however.

Figure 5 (Scenario 2)

This scenario sees the implementation of an MLE/Portal layer, integrating informational and pedagogical elements of a Student Intranet. By its very nature, this overlaps and enhances the functionality of the staff intranet, providing staff with

improved methods of making materials and interactions available online for local or distance based learners.

Figure 6 (Scenario 3)

Figure 6 Scenario 3 assumes the above, but also assumes that Academic Services has a greater degree of influence in the overall public web presence of the university. A significant amount of the fragmented information presented through that site has now been transformed into more useful and re-useable database objects, and the process of site maintenance and development is distributed and is moving towards integration with appropriate business processes. A pre-authentication layer is now in place. This provides appropriate information customised by user IP address. A combination of this system with server side cookies provides an individualised view for users who are not currently registered on university systems.

Figure 6 (Scenario 4)

Scenario 4 assumes that the above processes have been completed, and that underlying quality improvement mechanisms are in operation and under continuous review.

Appendix 1
Figure 1 Information Readiness: Current

Figure 2 Information Readiness: Stage 2

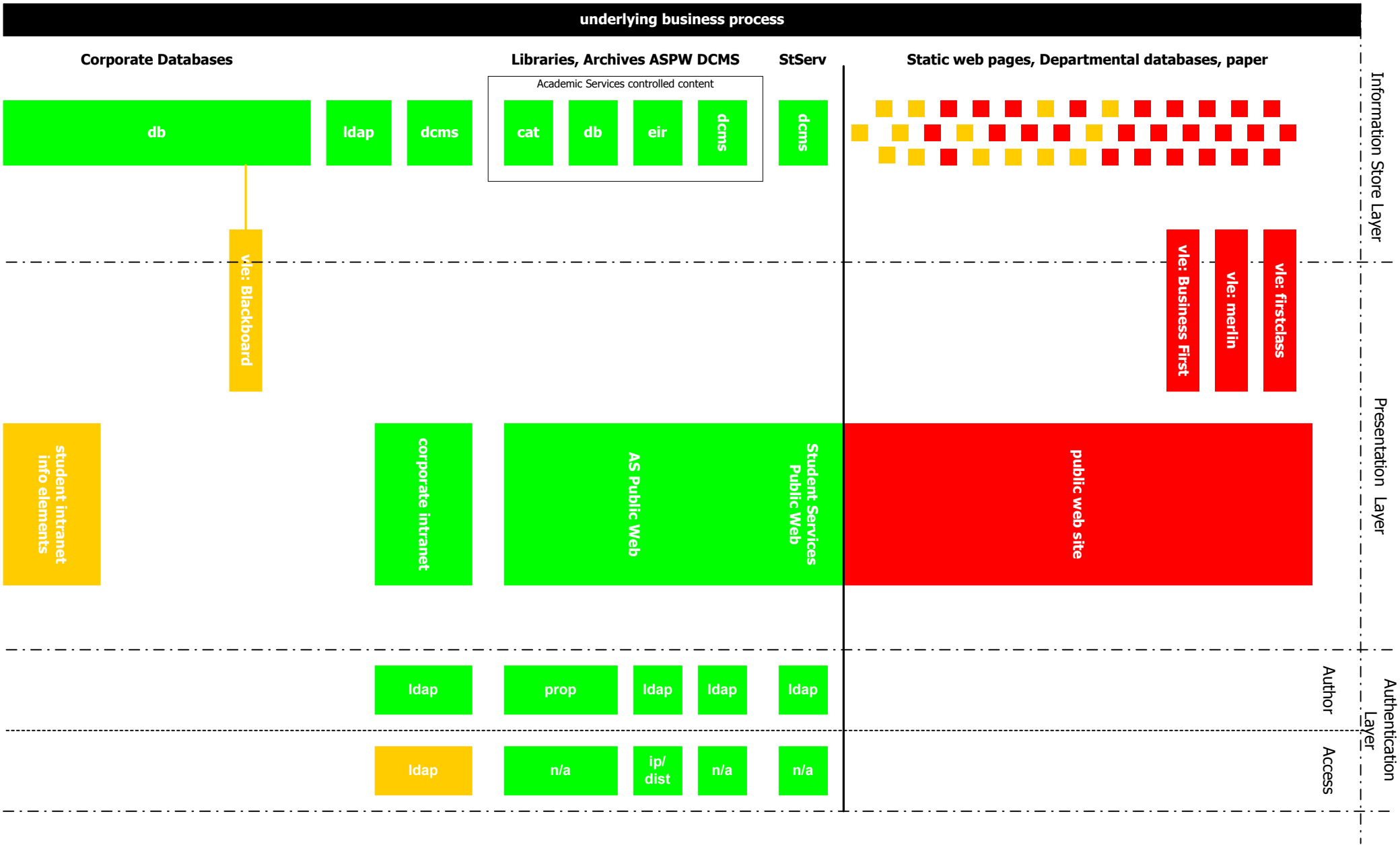


Figure 3 Information Readiness: Stage 3

Figure 4 Information Readiness: Stage 4 (Scenario 1)

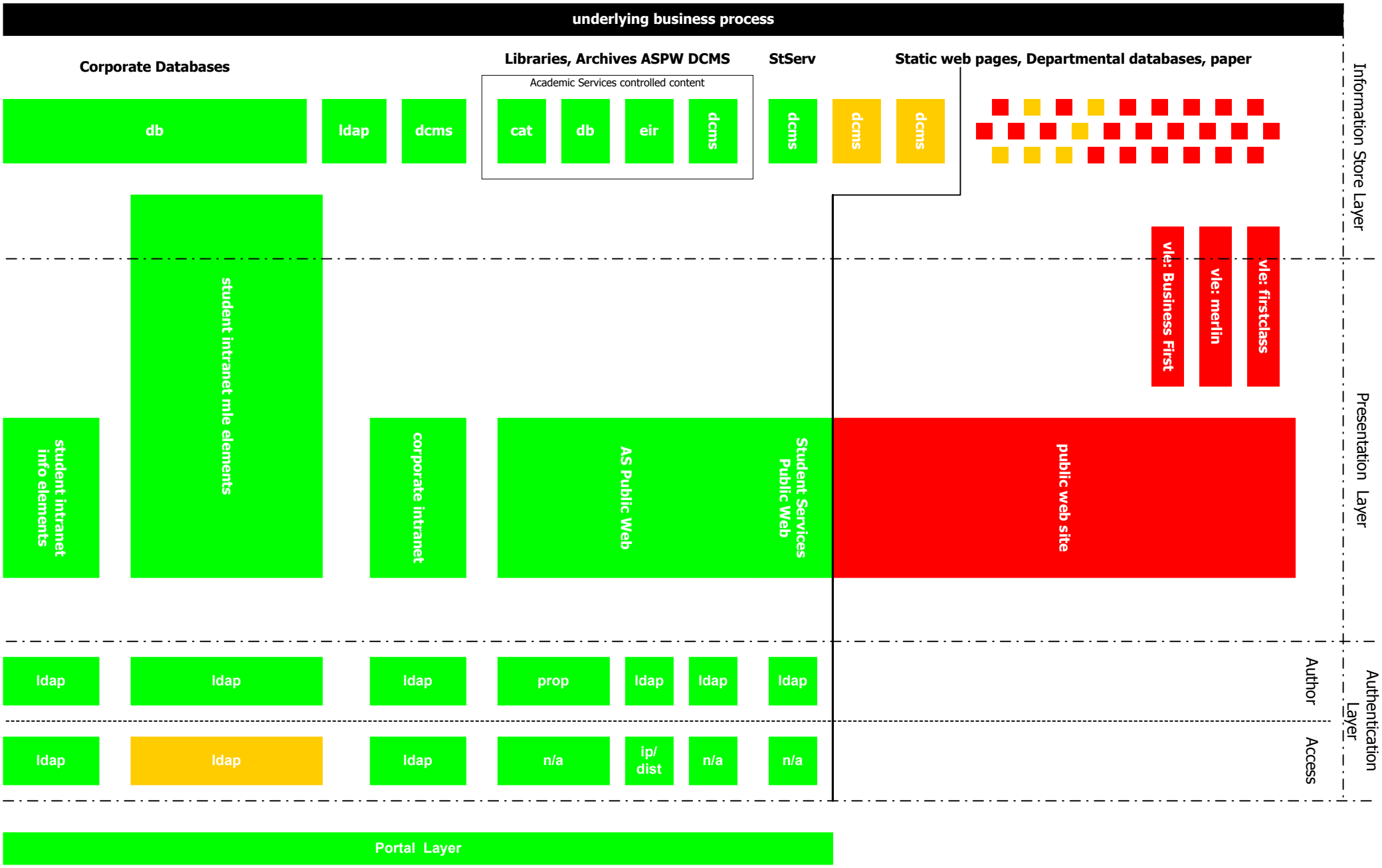


Figure 5: Developing the e-campus: Information Readiness: Stage 4 (Scenario 2)

Figure 6 Information Readiness: Stage 4 (Scenario 3)

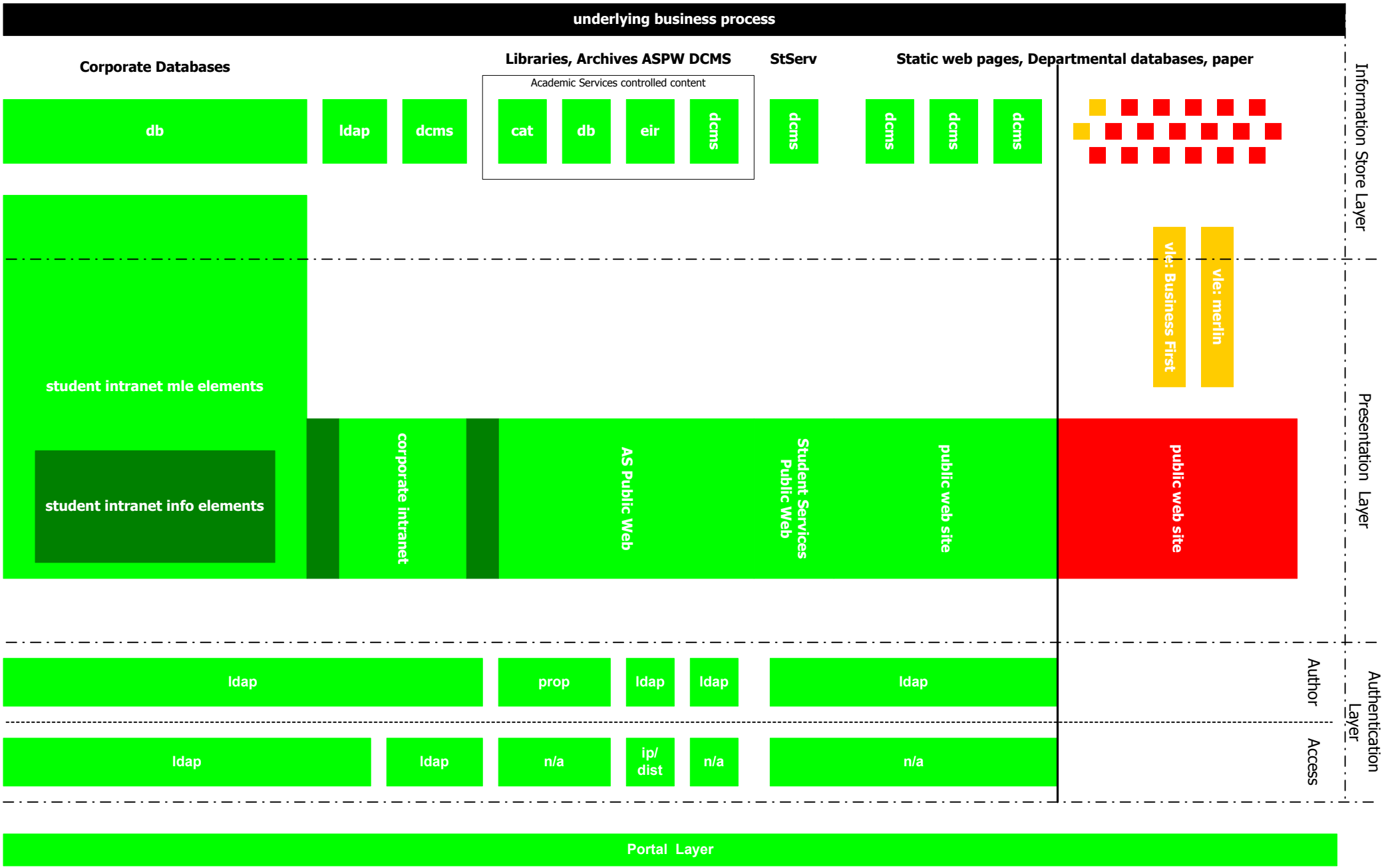
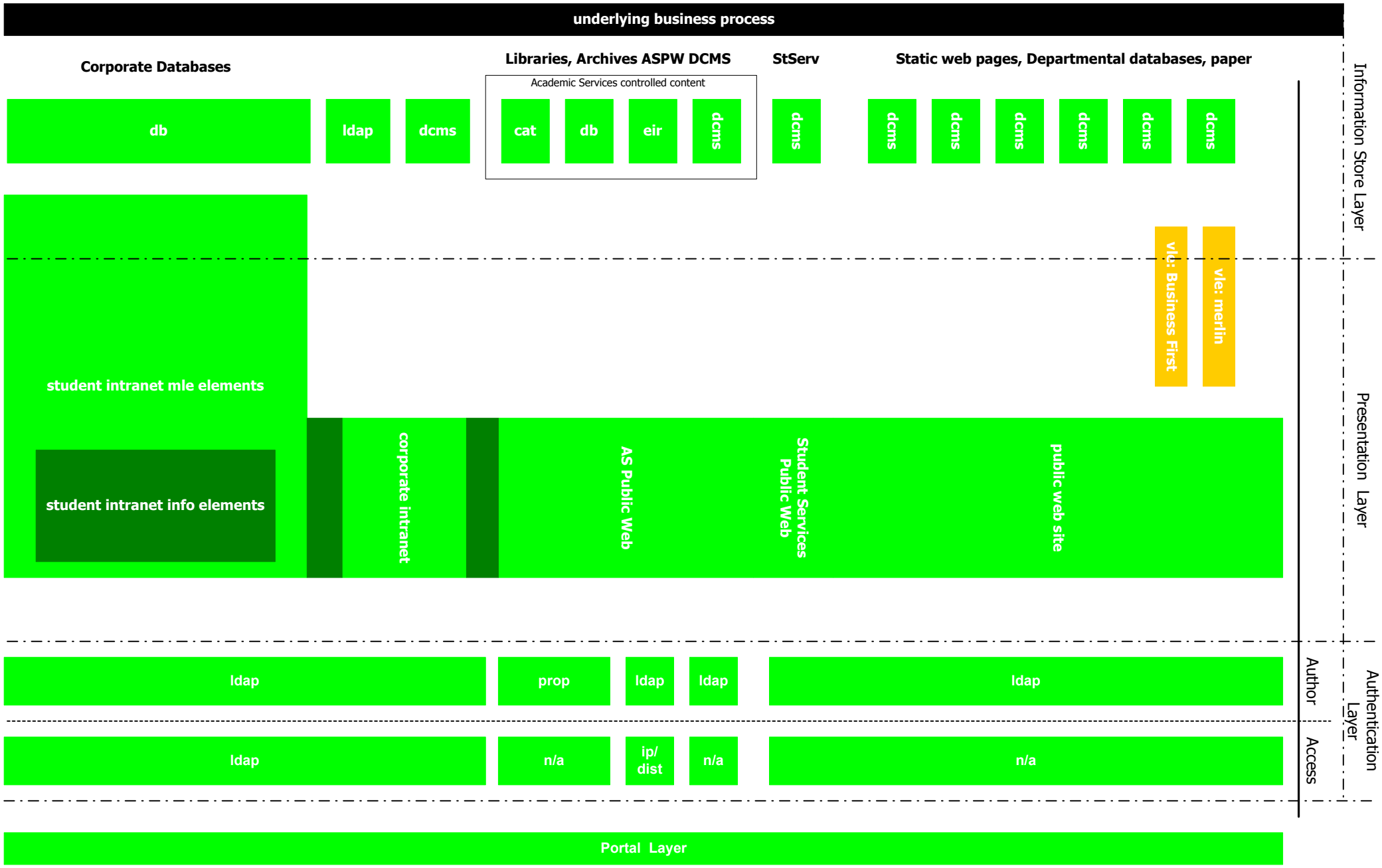


Figure 6 Information Readiness: Stage 4 (Scenario 4)



[i] The Java Special Interest Group, which is collaboratively creating a portal development toolkit for Higher Education has attracted a membership of around 140 HEIs. Many more are purchasing solutions from Blackboard, Campus Pipeline, eCollege or a seemingly endless chain of vendors.

[ii] The variety of devices on which this browser may be located is a factor which must be considered throughout the development of the project.

[iii] This model was adapted for the process of web development and suggested in the 1997 paper submitted to CWIS, "Reviewing Web Practice" By Martin Bull, Ian Dolphin, Sue Geale and Cris Woolston. The document is available on request.

[iv] Recent changes in UK law have serious implications in this area – providing accessible pages in no longer an option, but a legal requirement.

[v] Whilst noting the contribution of the global IMS project, it is important to recognise that

(a) IMS is NOT a standards body – IMS develops *specifications* rather than standards. A close relationship, however, exists in specific areas between IMS and IEEE (1484 Committee), particularly that of metadata development.

(b) IMS is not the "only show in town", there being a range of other bodies establishing specifications in broadly the same area, including ADLs SCORM in the USA, and work undertaken by CEN/ISS/Prometeus in Europe.

[vi] Online banking had 1 million UK users in 1999, rising to 3.1 million in 2001, with a predicted 5.4 million users by 2004. The dollar value of the transactions undertaken by these users rises from 99bn in 1999 to a predicted 395bn by 2004 (Source: Datamonitor – http://www.datamonitor.com/)

[vii] PAWs Data

Admissions requirement checker	715
Online admissions	785
Online bill payment	896
Online housing requests	624
Online parking requests	1086
Online student aid application	966
Other	163
Seat locator for stadiums and theatres	1049

[ix] JTAP Report 41, A Framework for Pedagogical Assessment of Virtual Learning Environments, and Bacsich et al "Costs of Networked Learning" provides useful reference points for this process. Work commissioned by HEFCE for the E-University Project, and undertaken by Cris Woolston, Paul Miller and Ian Dolphin may also usefully feed this process.

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[x] This is explored further in a paper submitted to ICC in the summer of 2000 by Academic Services. Entitled "The Learner Interface", this document deals in far greater detail with the issues, and the emerging relationship between VLEs, MLEs and *Interactive Learning Objects*. The document is available on request.

Annex 2

Criteria for Evaluating Portals

This rubric (1) is provided to indicate basic objective criteria to assist the evaluation of potential portal solutions for the University of Hull. It should be regarded as a working document.

	Insufficient	Adequate	Excellent	Score
I. Look & Feel **(This refers to the front-end itself, not the external resources linked to it.)**				
Aesthetics	0 points Static background with few or no graphic elements. No ability for variation in layout or typography.	1 point There are a few graphic elements and there is limited ability for variation in type size, color, and layout.	2 points UoH has full control of look and feel and changes can be made quickly.	
Ease of Use	0 points Counter-intuitive interface, requiring greater than two hours of user training.	1 point Somewhat intuitive interface, requiring two hours or less of user training.	2 points Intuitive interface, requiring little or no user training.	
II. Security				
Single Sign-on	0 points No authentication - lacking digital credentials when user logs-in.	1 point Requires multiple log-ins in order to access different databases - limited digital credentials e.g., Kerberos.	2 points Single sign-on for multiple functions from one central database. Ability to work with public key certificates.	

[1] Criteria adapted from a rubric developed by San Diego State University's Ad Hoc Portal Committee, with additions from the University of Hull Digital University Project Technical Working Group.

	Insufficient	Adequate	Excellent	Score
Access	0 points Single user type.	1 point User is allowed to access certain information based on their user type. There is a limit to the number of roles a user can have in the system.	2 points User is allowed to access and change certain information based on who they are and their user type. There is no limit to the number of roles a user can have in the system.	
Authentication	0 points No ability to authenticate to UoH LDAP Servers	1 points Possible to authenticate to UoH LDAP servers.	2 points Easy to authenticate to UoH LDAP servers	
III. Personalization				
Information Push	0 points User receives targeted information relevant to their constituency.	1 point User receives information relevant to the individual, but limited dynamically updated data available.	2 points User receives specific information relevant to the individual and available in real-time where appropriate. For instance, student-specific course-calendar, registration details.	
Information Pull **(Portal Editor)**	0 points No editing tool to customize the portal environment.	1 point Editing tool for customizing tabs, panel buttons colors, and fonts. Personalized view of all the information relevant to user-specific needs and preferences.	2 points Editing tool for full customization. User has ability to add/edit/remove information from a list of internal and external resources that the university approves.	

	Insufficient	Adequate	Excellent	Score
Link to Existing Virtual Learning Environment(s)	0 points No link.	1 points Partial integration with VLE/(s)	2 points Full interoperability with VLE/(s) (Dynamic and standards-based)	
IV. Interaction				
Email	0 points No email.	1 point Portal only accommodates proprietary email system.	2 points Supports multiple email standards and protocols e.g. IMAP or POP.	
Chat & Message Boards	0 points No chat or message board functionality.	1 point Only chat or only message board.	2 points Supports real-time chat and message boards.	
Electronic Balloting and Polling	0 points No electronic balloting and polling functionality.	1 point Criteria for balloting and polling are only partially supported.	2 points Electronic balloting and polling are fully supported.	
Multimedia	0 points No streaming audio or video.	1 point Options for streaming audio and video limited.	2 points Support for plug-ins that allow for streaming audio and/or video.	
V. Productivity Tools				
Search Engine	0 points No search engine.	1 point Limited search engine for university Intranet and/or Internet only.	2 points Natural language search engine for both Intranet AND Internet e.g., internal Ask Jeeves.	

	Insufficient	Adequate	Excellent	Score
Search Results Filter	0 points No results filter	1 point Limited results filter based on user profile.	2 points Full filter based on user profile.	
Groupware Integration	0 points Does not provide groupware functionality or support for integration with groupware products.	1 point Limited support for groupware functionality or limited support for integration with groupware products.	2 points Provides basic groupware functionality and support for integration with groupware products.	
Blank	0 points Blank	1 point Blank	2 points Blank	
Blank	0 points Blank	1 point Blank	2 points Blank	
VI. eCommerce				
Advertising Control	0 points Banner advertising on every page of portal or not able to control per user group.	1 point Banner advertising is optional.	2 points Banner advertising is optional, controllable, and can be targeted to specific user groups based on their role within the university.	
Advertising Revenue	0 points No advertising revenue possible.	1 point Advertising revenue is limited and shared with vendor.	2 points Advertising revenue goes directly to university.	

	Insufficient	Adequate	Excellent	Score
Transactions	0 points Cannot be integrated with campus systems offering web-based transactions.	1 point Can be integrated with campus systems to offer web-based transactions.	2 points Can be integrated with heterogenous campus systems to offer web-based transactions.	
VII. Workflow				
Forms Routing	0 points No forms routing.	1 point Forms routing available – paper documents can be replaced with Web-based forms.	2 points Forms routing available – paper documents can be replaced with Web-based forms. In addition, forms tracking software built in.	
VIII. Support				
Integration	0 points No fit with existing ODBC/JDBC and Ingres relational databases	1 point Some fit with existing ODBC/ JDBC and Ingres relational databases.	2 points Great fit with existing ODBC/ JDBC and Ingres relational databases.	
Implementation	0 points Vendor relies solely on UoH staff.	1 point Vendor provides implementation training to UoH staff and consultants for a fee.	2 points Vendor provides implementation training to UoH staff and on-site consultants for free.	
Maintenance	0 points No plan for ongoing support or maintenance.	1 point Weak plan for ongoing support or maintenance.	2 points Strong plan for ongoing support or maintenance.	

	Insufficient	Adequate	Excellent	Score
24/7 Help	0 points Vendor requires pay call during business hours. No email or Web-based help.	1 point Vendor provides email and Web-based help. No phone or fax help (24/7).	2 points Vendor provides email, Web-based and toll-free help (24/7) for free.	
Long-Term Viability	0 points Vendor is in pilot phase and has no experience or references. Small company with limited funding.	1 point Vendor has experience in higher education portal development, but has limited references and some funding.	2 points Vendor has significant higher education portal development experience, can provide numerous references, and is part of company with ample financial backing.	
IX. Standards				
API (Application Program Interface)	0 points Portal API cannot pass information to other applications, or is not available to campus.	1 point Portal API can pass some information to other applications and is available on a limited basis.	2 points Portal API can pass security information to other applications, seamlessly integrating multiple sources of information and campus can write their own interface e.g., providing a single sign-on environment.	
XML	0 points Portal does not offer facility to communicate using XML/XSLT.	1 point Portal offers limited facility to communicate using XML/XSLT.	2 points Portal offers full facility to communicate using XML/XSLT.	
Alternative Access	0 points Vendor makes no accommodations for those with special needs.	1 point Vendor has limited features for those with special needs.	2 points Vendor provides screen reader format output and other features for those with special needs.	

	Insufficient	Adequate	Excellent	Score
X. Administration				
Staffing	0 points Seven or more full-time UoH staff required for managing and maintaining system software. Vendor relies solely on UoH staff.	1 point Between four and six full time UoHstaff required for managing and maintaining system software. Vendor provides training to UoH staff and consultants for a fee.	2 points Three or fewer full time UoHstaff required for managing and maintaining system software. Vendor provides training to UoH staff and data migration/integration consultants for free.	
User Definition	0 points System will NOT allow UoH administrator to define custom user types.	1 point System will allow UoH administrator to define limited user types.	2 points System will allow UoH administrator to define custom user types.	
Information Channels	0 points System will NOT allow UoH administrator to define custom information channels.	1 point System will allow UoH administrator to define limited information channels.	2 points System will allow UoH administrator to define custom information channels. No limit to number of information channels.	
Time to Market	0 points *** TBC	1 point *** TBC	2 points *** TBC	

	Insufficient	Adequate	Excellent	Score
Hardware Resources	0 points Hardware requirements do not coincide with UoH standards.	1 point Hardware requirements loosely coincide with UoH standards.	2 points Hardware requirements coincide with UoH standards.	
Pricing	0 point Annual license fee and Service Level Agreement costs not based on fixed price schedule or exceeds budget.	1 point Annual license fee and Service Level Agreement costs based on fixed price schedule.	2 points Annual license fee and Service Level Agreement costs based on fixed price schedule and are under budget.	
Online Help, Documentation & Training	0 point No help putting portal applications into production.	1 point Plan for integration, but little documentation and training.	2 points Clear integration, with plenty of supporting documentation and face-to-face train-the-trainer training. Several online help features e.g., tutorials, job aids and FAQ's.	
Smart Card	0 point No support for Smart card technology.	1 point Limited support for Smart card technology.	2 points Full support for Smart card technology.	

Appendix : Scores for Portal Evaluation

This document accompanies the Rubric for Evaluating Portals. The scores have been produced following six weeks evaluation of XX and a short assessment of uPortal from JA-SIG. It uses a weighting scheme for the criteria, ranging from 1 (useful) to 3 (critical).

I Look & Feel

	Weighting	xx	uPortal
Aesthetics	2	1	2
Ease of Use	3	2	2

xx had some problems with the display of headers in its workplaces. Both use a similar interface for dealing with channels of information, e.g. minimize and detach.

Section total:	8	10

II Security

	Weighting	xx	uPortal
Single Sign-on	3	1.5	1.5
Access	2	2	2
Authentication	3	2	2

Single Sign-on requires development effort for both the portal and applications being integrated. Authenticating xx to UoH LDAP servers took a lot of effort and experimentation.

Section total:	14.5	14.5

III Personalization

	Weighting	xx	uPortal
Info Push	2	1	1
Info Pull (Portal Editor)	1	2	2
Link to VLEs	2	0	1

Neither portal achieves full information push as an out of the box solution. Both allow a great degree of personalization in information pull. WebCT and Blackboard (using Building Blocks) can now be integrated into uPortal. xx has no VLE specific integration experience.

Section total:	4	6

IV Interaction

	Weighting	xx	uPortal
Email	2	0	1
Chat/Message Boards	1	0	0
Balloting & Polling	1	0	0
Multimedia	1	0	0

uPortal has an IMAP Web email channel (as yet untested). Neither portal has the other functionality built in.

Section total:	0	2

V Productivity Tools

	Weighting	xx	uPortal
Search Engine	3	1	0
Search Results Filter	2	2	0
Groupware Integration	1	0	0

xx has the Verity (to be replaced by Autonomy) search engine. This has full filter of results from a security aspect and in terms of user interests. uPortal has no search engine. Neither provide groupware functionality.

Section total:	7	0

VI eCommerce

	Weighting	xx	uPortal

Advertising Control	1	0	0
Advertising Revenue	1	0	0
Transactions	2	1	1

Neither portal has advertising mechanisms included. Both can be integrated to offer web-based transactions but this will require development effort.

Section total:	2	2

VII Workflow

	Weighting	xx	uPortal
Forms Routing	1	0	0

Section total:	0	0

VIII Support

	Weighting	xx	uPortal
Integration	3	2	2
Implementation	1	1	1
Maintenance	2	2	2
24/7 Help	2	2	1
Long-term viability	2	1	2

IBS offer annual support contracts for uPortal but the details are under investigation. xx would include support in their licence. xx have no UK HE customers for xx and minimal HE experience with the portal.

Section total:	17	17

IX Standards

	Weighting	xx	uPortal
API	3	2	2
XML	3	2	2
Alternative Access	2	0	0

Both portals have a good API allowing you to communicate with the portal via XML or Java code. Neither appears to have considered accessibility issues by providing an alternative interface.

Section total:	12	12

X Administration

	Weighting	xx	uPortal
Staffing	3		
User Definition	2	2	2
Information Channels	2	2	2
Time to Market			
Hardware Resources	2	2	2
Pricing	2	0	2
Online Help, Documentation & Training	2	2	1
Smart Card	1		

Both run on the preferred Sun/Solaris platform. xx provides excellent help and documentation. Pricing for xx was c. £75k. The cost for uPortal will be an annual support contract (c. £5-7k).

Section total:	16	17

xx did not impress as much as was expected from the price tag. Integration with Ingres & LDAP proved to be a struggle although eventually achieved and the interface is not as flexible as we would require. xx does provide an excellent, integrated search engine and good documentation and support. uPortal has not been extensively tested yet but integration with Ingres and LDAP was quick

Annex 3

Web Services –
a Discussion Draft

Digital University Project

Ian Dolphin

December 2002

Introduction

The initial documentation establishing the Digital University Project set out a strategic and operational direction for the development of C&IT software infrastructure within The University of Hull. Considerable emphasis was placed on supporting the user through the creation of a coherent and integrated interface to internal and external information and applications. A secondary emphasis concerned the need to establish processes and software systems to manage the information presented to users through the medium of the World Wide Web, an area of considerable and visible neglect within the institution. Implicit and explicit in this approach was a significant measure of distribution and devolution of information management: whilst central systems might hold information, the responsibility for ensuring its accuracy and currency best lay with those handling the processes by which that information is created and managed.

The creation of the institutional portal, which aggregates, integrates, personalises and presents a variety of resources to users, together with the creation of a content management system for University web pages is underway[i]. This has involved the procurement of appropriate portal software, connection of that portal to our existing corporate databases, and creation and connection of key new systems for web content management.

Whilst the initial project documentation identified a need to establish an effective middleware layer which conformed to common specifications and standards to provide these connections, it remained agnostic on how to accomplish this. There was good reason for this agnosticism; despite the existence of environments such as J2EE[ii], there was an absence of formalised higher level specifications and standards suitable for this purpose at the time the documentation was prepared. There have been considerable developments in this area since that time. The growing requirement of businesses to conduct B2B and B2C transactions over the Internet, potentially between disparate and incompatible back-end technologies, have driven the development of a middleware layer which has been termed "Web Services".

The purpose of this discussion paper is to provide background on these developments, indicate how Higher Education is beginning to deploy them, and examine how in general terms they might inform both the strategic direction and operational planning of the University. This paper does not intend to establish the final word on these issues, but rather an introduction to a necessary discussion. It will be followed by documents indicating how the specific application of a Web Services approach could inform the development of e-learning systems.

What are Web Services?

Applications and the web

Given the enormous range of activities which are currently undertaken over the web, it is probably necessary occasionally to remind ourselves that the World Wide Web was initially designed as essentially a distributed stateless hypertext publishing medium for a research group. Over the last ten years, a number of efforts to overcome these limitations have resulted in additional media types, and a variety of technologies aimed at providing richer interaction for the user. Certain of these technologies are server-based, such as Common Gateway Interface (CGI), Active Server Page (ASP) or Java programs, providing a measure of integration and interaction between web pages and back-end (typically database) systems. These technologies are, however, not necessarily standards-based or conformant, and may operate in fundamentally divergent ways. This produces an overhead each time a web-based application is developed, deployed or integrated with others which do not use the same underlying technology. Clearly, for the effective use of the Internet as either a B2B or B2C medium, a common approach is required.

Architectures

Web Services have been developed primarily as a means to address these issues, and to enable inter-businesses communication using the Internet. By operating in a predictable and standards-conformant way, mature Web Services will allow organizations or systems to communicate data without intimate knowledge of internal and potentially diverse IT systems operating behind firewalls.

Web Services are enabling technologies which build on existing approaches to software development. Rather than being a fundamentally new architecture, Web Services provide a practical implementation of a Service Oriented Architecture approach to facilitate the creation and integration of Web-based applications.

In this context, it is possibly useful to review the characteristics of major systems architectures:

System Characteristics at Emergence of Major Systems Architectures[iii]			
ARCHITECTURE	**MAINFRAME**	**CLIENT/SERVER**	**SERVICE-ORIENTED**
PLATFORMS	Monolithic and centralised	Homogenous and controlled	Diverse and unpredictable
NETWORKS	Limited and closed	LANs emerging but isolated	Internet ubiquitous and interconnected
DATA FORMATS	Opaque and inaccessible	Binary and proprietary	Semantic and shared
TECHNOLOGY FOCUS	Operating system	Database	Interface
USERS	IT operators	Departmental employees	Suppliers, employees and customers
BUSINESS VALUE	Digitisation of data-centric operations	Putting data in the hands of business users	Enabling business agility and collaboration

The Stencil Group have indicated the four principle pillars on which a Service Oriented Architecture rests:[iv]

- "Service-oriented architectures are distributed. Functional elements of the application are deployed on multiple systems and execute across local and even remote networks. In particular, web services make use of existing, ubiquitous transport protocols like HTTP. By piggybacking on the same, well understood transport as web content, web services leverage existing infrastructure and can comply with basic firewall policies.

- The systems are characterized by loosely coupled interfaces. Traditional application design depends upon a tight interconnection of all subsidiary elements. The complexity of these connections requires that developers thoroughly understand and have control over both ends of the connection; moreover, once established, it is exceedingly difficult to extract one element and replace it with another. Loosely coupled systems, on the other hand, require a much simpler level of coordination and allow for more flexible reconfiguration.

- The connections are based upon vendor-independent standards. The development of generally open and accepted standards is a key strength of the coalitions that have been building web services infrastructure. Most previous efforts at distributed computing (e.g., CORBA, DCOM, RMI, and others) were very difficult to implement, because they were dependent upon a particular vendor's product offering, highly specified, or programmatically complex—usually all of the above.

- Systems are conceived from a process-centric perspective. By intent, services are designed with a task-orientation; they function as discrete steps in a larger workflow or business process. A well designed service describes its inputs and outputs in a way that other software can determine what it does, how to invoke its functionality, and what result to expect in return."

Standards and Web Services

Web Services operate as a middleware layer which is invisible to the human end-user of web-based applications. They are based around open standards which operate over an Internet Protocol network:

- XML (Extensible Markup Language) is used to tag data
- SOAP (Simple Object Access Protocol) is used to transfer data
- WSDL (Web Services Description Language) is used to describe services, including the embedded business logic of those services.
- UDDI (Universal Description, Discovery and Integration) conformant directory lists available services
- WSFL (Web Services Flow Language) may be used to describe the flow of data between web services, or aggregate fine-grained web services into effectively "new" services.

Industry analysts such as Gartner[v] are confident that a number of specifications will converge around a single, basic and uniform set of standards by 2003. These are likely to include SOAP, WSDL and UDDI. It seems probable that this initial, and basic, set of standards will be supplemented rapidly by a further range designed for a

significant range of specialist applications, a number of which are already under development.[vi] WSRP (Web Services for Remote Portals). Although designed to enable the integration of remote resources, may well prove useful not only in this respect, but in enabling the secure integration of diverse internal resources.

The specifications and standards comprising Web Services are normally visualized as a “stack”. This is useful in conceptualizing the layered architecture around which such services are constructed:

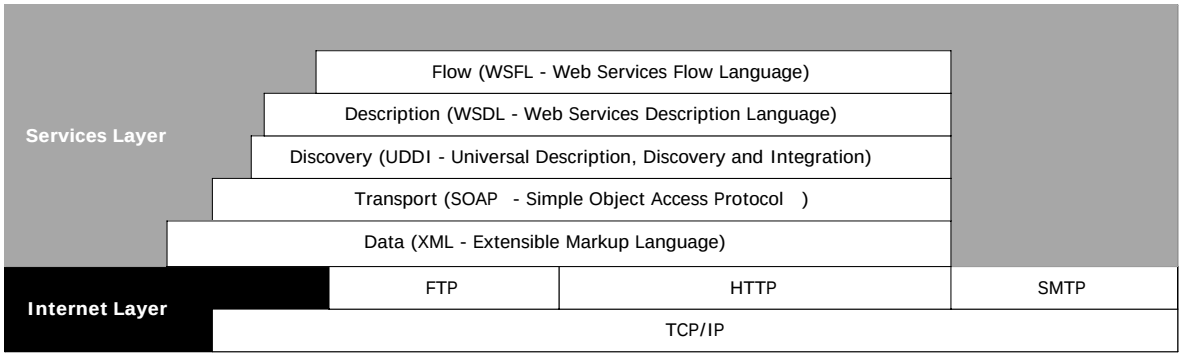

Figure 2: Web Services Protocol Stack

Although designed for purposes intimately connected with B2B and B2C interchange applications, Web Services are finding a range of internal uses. Many large organizations deploy diverse software infrastructures which, although not incompatible, are not entirely interoperable. Introducing a middleware layer based around data exchange in XML, together with common transport, description and discovery mechanisms, increases internal systems interoperability, and prepares for a greater degree of appropriate interoperability with external partners when standards mature.

This aspect of Web Services has not been lost on growing sections of Higher Education. Bernard Gleason, Internet Strategy Consultant at Boston College, has highlighted aspects of this potential in relation to existing and legacy systems; “Web Services eliminate the need for an institution to discard or architecturally modify existing core business or legacy applications, or move data and functions into a single operating environment to achieve integration[vii]”. The fact that, with varying degrees of speed and enthusiasm, major software vendors are adopting an architectural approach based on Web Services (IBM, Microsoft, Sun and Oracle, amongst others) tends to support this view. In the medium to long term, this is likely to modify the balance of power between vendor and purchaser, as monolithic systems are resolved into collections of interoperable component services. Further potential in this area will be explored in a subsequent case study dealing with Web Services, e-learning systems and Virtual Learning Environments.

Benefits

The benefits of moving to a standards-conformant internal development model are considerable and tangible:

Internally: A Web Services approach would maximize the effectiveness of distributed development efforts within the institution by describing components and services in a standard way (both on the level of business processes and APIs) and publishing these descriptions in a UDDI conformant directory. Although carrying an initial time and training overhead, the benefits of drawing development activities together around documented, recallable and reusable APIs and services would both

save effort in the long term, provide increased resilience for our internal development effort, and provide an easily understood operational framework for externally funded project-based staff. The process-driven nature of Web Services, in addition, creates significant potential for integration and synergy with institutional process mapping initiatives

Within the Higher Education community: HEFCE, through JISC, fund the provision of significant range of information services. These are being bound together, to a point, within the JISC Information Environment (formerly known as the DNER), the core architecture of which will be based around Web Services. The University is closely engaged with this activity through the JISC-funded Iconex and PORTAL projects. A clear opportunity exists to gain the maximum possible benefit for our students and staff by aligning our internal development effort with national developments. This alignment would also continue to enhance our not inconsiderable prestige as an institution in this area of work.

With business partners: Businesses are committing significant resources to the adoption of approaches based on Web Services over the next three years[viii]. Our own suppliers or other business partners will not be exempt from this movement. It would therefore also seem appropriate from this perspective to align the institution with a Web Services approach.

Tempering the vision

Although holding great promise, a balanced view of Web Services should examine a further range of issues and risks prior to reaching even tentative conclusions.

Web Services standards are at an early stage of development, with a handful ratified or close to ratification, and many existing as specifications awaiting further development and the ratification process. It is certainly too soon to consider the use of Web Services for the critical B2B applications for which they are ultimately intended, although sufficient progress has been made to conduct a serious practical evaluation of the other purposes this paper indicates.

Web Services offer to provide **one significant architectural element** the University requires to secure a greater measure of integration – but they are not the **only** such element. Without a robust authentication and authorization infrastructure involving the adoption of both data and technical standards, for example, neither service nor portal layer can conceivably work. The allocation of resources to the adoption of a Web Services approach should be viewed in this context, and clearly balanced with other requirements.

There are a clear range of staff development and training requirements associated with any change of software development direction. In this instance the change is evolutionary, rather than revolutionary, but change still requires funding. Similarly, it is likely that many of the software development toolsets used within the institution may require modification, or for additional purchases to be made. These costs can be quantified, however, and in the context this paper has outlined, are likely to be considered marginal.

[i] See the Digital University Project First Annual Report at http://www.digital.hull.ac.uk/keydocs.html

[ii] Webopaedia (http://www.webopaedia .com) defines J2EE as "..J2EE is a platform-independent, Java-centric environment from Sun for developing, building and deploying Web-based enterprise applications online. The J2EE platform consists of a set of services, application programming interfaces, and protocols that provide the functionality for developing multitiered, Web-based applications."

[iii] "The Laws of Evolution: A Pragmatic Analysis of the Emerging Web Services Market" The Stencil Group, April 2002, p8

[iv] Ibid, p10

[v] http://www.gartner.com/webletter/systemsunion_issue1/frame2/mainframe2.html

[vi] A number of other specifications supporting Web Services are currently being developed towards standards ratification, including ebXML for electronic business commerce, WS-Security for secure Web services, and WSIA for interactive Web applications. Further information can be obtained from OASIS (Organization for the Advancement of Structured Information Standards) at http://www.oasis-open.org/ or the World Wide Web Consortium at http://www.w3c.org/.

[vii] "Web Services in Higher Education – Hype, Reality, Opportunities" Educause Quarterly 3, 2002

[viii] According to a survey conducted by SWR Worldwide among 320 chief information officers and IT directors in Finland, France, Germany, Italy, the Netherlands, Spain, Sweden and the UK in 2002, 50% of European businesses have adopted a Web Services Strategy, and expect enabling technologies to be their highest spending priority for the coming year. The majority of CIOs expect their businesses to have adopted Web Services by 2005. (http://zdnet.com.com/2100-1106-960985.html)