Towards a Strategic Approach to the Integrated Information Environment

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JISC Services and Service Providers
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1 Introduction

1.1 In March 2007 the JISC Board adopted a pragmatic definition of the Integrated Information Environment (IIE) as the distinctive contribution of the JISC to UK educational e-infrastructure. The IIE, then, is central to the JISC strategic objective of continuing to develop a world-class infrastructure for UK Higher and Further Education. In this context, an extended dialogue that begins to articulate the scope and strategic path for the further development of the IIE is essential. Two examples illustrate the practical nature of this necessity;

- In 2006, a review of the value for money provided by the JISC identified that for every £1 spent on electronic resources, £26 were saved for the sector. The role of the Integrated Information Environment in ensuring that those resources can be readily discovered and integrated with academic practice is a critical factor in realising that benefit.
- As the discussion around the further development of UK e-Infrastructure to support research continues following the 2006 OSI report, and the HEFCE-promoted shared services agenda continues to develop, the experience of the JISC in building Shared Infrastructure Services supporting the domains of learning, teaching, research and administration equips it uniquely to offer insight into potential efficiency gains and cost savings in this area.

1.2 This document provides, then, an overview of the background of the IIE, including its antecedents, the Information Environment (IE) and Models Information Architecture (MIA) together with its relationship to those antecedents. It is intended to make a contribution to the formulation, elaboration and consolidation of a strategic approach to the further development of the IIE. This document is both the product of, and a contribution to, a necessary longer-term strategic conversation between the JISC and partner institutions and organisations in the Higher and Further Education Community.

2 The Information Environment - from conception to articulation

2.1 The Integrated Information Environment was conceived as an extension of the Information Environment. The essential premise of the IIE was that the principles embedded in the IE – of a distributed but coherent national infrastructure for Discovery to Delivery based around shared or common services - could be applied to a broader set of contexts supporting academic enterprise. The Information Environment was in turn a descendent of the Distributed National Electronic Resource (DNER). The approach underpinning the DNER was elaborated through a series of workshops organised by UKOLN in the mid-

late 1990s under the auspices of the e-Lib funded MODELS Project. The MODELS workshops drew together a range of participants, many of them from the Library community. They took as their task " ...strategic planning for achieving a managed environment, together with the technical infrastructure which will provide its basis ... in order to provide fully integrated end-user services, in place of the current set of stand-alone services". The architecture that emerged from these workshops, the Models Information Architecture (MIA), was designed around these objectives, and underpinned much subsequent planning. By 2001 this work had developed, largely led by Andy Powell and Liz Lyon of UKOLN, into the Information Environment Architecture. A widely used diagram, which may be found at Annex 2, provides a simplified perspective of core technical elements of the Information Environment as they were envisaged at that time. It should be noted that key to the conception of the IE and IIE is the development and use of shared or common services. These formed the basis of the subsequent JISC Shared Infrastructure Services Programme, which has underpinned the realization of the IE, and the IIE, to this point (2008).

2.2 The articulation of the DNER and Information Environment repeated the MODELS emphasis on the key characteristics essential to support a shared national infrastructure enabling managed and seamless access to quality assured resources. Thus, the DNER was described by Dempsey and Pinfield as ".. a managed information environment for accessing quality assured Internet resources from many sources." The first JISC Information Environment Strategy suggested that the "…Information Environment as it is proposed here aims to offer the user a more seamless and less complex journey to relevant information and learning resources". The Information Environment therefore had initial focus on those services pertaining to electronic resources which were described as supporting "D2D" - Discovery to Delivery. This focus has subsequently been expanded to include services supporting digital preservation and curation. The scope of the IE as it was conceived included the architecture the common specifications and standards supporting that architecture together with the projects and services required to deliver the overarching objectives outlined above. Verbs used commonly in the context of the IE include *create, publish, manage, curate, preserve, locate, request, access, and use*.

2.3 There are a series of explicit and implicit assumptions in the formative work that shaped the IE. It will be necessary to return to these assumptions, reconsidering and questioning them appropriately in the light of subsequent development, and changes in the broader environment. More specifically, the key expressions *managed*, *seamless* and *quality-assured*, should be re-examined from this perspective, as is the assumption that an architecture elaborated essentially around resource discovery and disclosure is applicable in a broader series of contexts.

3 Information Environment *and* Integrated Information Environment?

3.1 Before proceeding further, it is perhaps appropriate to deal with an issue of terminology. This is not an abstract consideration, but one that has some impact on both under-

standing the problem space, and communicating effectively with the sector. The similarity of the terms "Information Environment" and "Integrated Information Environment" is known to cause confusion within the sector. It makes sense to attempt to suggest simplification of these terms as part of the process of this review and, if possible, reduce the complexity of messages that are transmitted to the sector by their use.

3.2 The Integrated Information Environment, then, has been summarised as the contribution of the JISC to UK e-infrastructure 'writ large'. It takes forward the underpinning architectural approach of the IE by applying it to an area of considerably broader scope. The Information Environment, as has been illustrated, was initially conceived essentially as a set of services to support "discovery to delivery", and was gradually extended to encompass the areas of digital preservation and curation. It is possible to view the Information Environment, therefore, as a subset of services within the broader IIE.

3.**3** ***A radical solution to the confusion created by the use of such similar terms may therefore be to simply deprecate the term "Information Environment", and to locate specific service components within the broader frame of the Integrated Information Environment according to their function. Thus, for example, the more, familiar, focussed and arguably more comprehensible expressions "Discovery to Delivery", "Curation", "Preservation", etc could be retained, whilst providing the space to articulate more fully such concepts as "Shared Infrastructure Services", widening their ownership beyond what is often regarded as a "library" preserve.*** For the purposes of this document, then, the use of the term Information Environment, or IE, is limited to the past tense. Forward-looking statements refer to the Integrated Information Environment, which includes the services formerly comprising the IE. This repositioning of the IE services does not diminish their value or importance. It is, however, intended to simplify a message to the community, and contextualise these services squarely in the service of teaching, learning and research.

4 A "*managed*" environment?

4.1 It was never intended that the JISC "build" or "provide" every element or component the Information Environment required, although this incorrect inference appears to be occasionally drawn from the Information Environment Architecture diagram. What has sometimes been unclear, however, was *which* elements the JISC would provide, their priority, and *which* it was anticipated would be provided by other agencies. Similarly, the criteria by which these decisions might be reached have not always been clear. It is clearly beyond the scope of a document of this nature to provide a prescriptive list of such elements or criteria in order of priority. It is within scope, however, to suggest a methodology for approaching this particular problem area. A subsequent section of this document, relating the IIE to the e-Framework for Education and Research will indicate how the approaches developed by the e-Framework might contribute to the development of both criteria and priorities.

4.2 One aspect of the JISC's work is the provision of a range of services for the UK Higher and Further Education Community that it would not be cost effective, or would be too difficult, to provide by other means. The services or proto-services developed under the auspices of IE and IIE should be viewed from this perspective. The articulation of a more strategic approach to moving from development to service by the JISC over the last three years, and the development of a JISC "Sustainability Handbook", go a considerable way to providing clarity around the criteria for national service provision. Critically, this work acknowledges that the development of a nationally provided service is only one strand of a series of more matrix-like "Development to Sustainability" models that take into account commercial and community driven alternatives to nationally provided services. These might include take-up by a consortium, or by a company, or hybrid models in addition to funding as a national service.

4.3 The range of potential sustainability options for services supporting or augmenting the IIE is perhaps best illustrated by activity in the JISC Repositories Programme. In this Programme, software solutions ranging from open and community source (DSpace, Fedora, ePrints) to commercial and hybrid (VTLS) models intersect with a range of institutional, national or consortia based service provision models. These include long- term national services; the JORUM open educational resource repository, The Depot, provided as a temporary repository for staff at institutions without a current open access publishing solution in place, and the Juliet and Romeo directories sustained by the SHERPA Consortium of universities. By concentrating in the past on presenting a visualisation of a technical architecture, (frequently used as a free-standing visual aid), the multi-dimensionality of the IIE may occasionally be partially or wholly obscured. Visualisations representing models of sustainability, amongst others, may go some way to mitigating this effect and presenting a more holistic picture.

4.4 ***It is particularly important, given the cultural and other differences between library, learning and research communities, that as sustainability models are developed more completely they be applied to each problem space without prejudice. There should be no "default" position on the sustainability models of IIE components in advance (for example, that they become a nationally funded service), but a rounded judgment that progressively becomes more focused as their activity develops. This activity should both be informed by, and inform, the further development of the JISC "Sustainability Handbook".***

4.5 The issue of "which agency builds which component" brings into sharp relief a further characteristic of the IE as it was defined in the initial documentation; its conception as a *managed* environment. Whilst the term had a certain currency at the time the IE was being defined (Managed Learning Environments being a further example of use of the term), and few would doubt the requirement to *manage specific services* within the IIE, the use of the term in the context of the IIE as a whole may be misleading, as it may be interpreted as implying centralized management of the environment *as a whole*.

4.6 It may therefore be helpful in this sense to ***re-conceive the IIE as a negotiated environment***. The term recognizes the role of a range of partnerships between institutions, agencies, and commercial entities in the collective, distributed, provision of the IIE. This continues to recognize the leading role of the JISC in the development of the IIE as an evolving framework of services governed by an agreed set of technical and policy protocols. It does not imply that the IE represented, or that the IIE represents, a *closed* environment or "walled garden", but rather that it is bounded by a secure but permeable perimeter enabling interaction with external content and services. The same shared or common understanding of policy, process and technology that underpins the IIE as a whole governs these external relationships.

4.7 Examples of these supporting policies and processes might include the JANET Acceptable Usage Policy, a variety of sector-wide content licensing or rights arrangements, or the development of the UK Access Management Federation. JISC plays a critical strategic role in the development of the IIE by channeling strategic investment to establish shared infrastructure where this is more cost effective, and in negotiating boundary agreements regarding external content and services in more effective ways than those available to a single institution. The landscape is increasingly complex, however, with such arrangements being supplemented by an increased number of consortial agreements. These agreements include institutional collaborations to produce or provide software ("Community Source", the HEFCE Shared Services Programme), and provide or license content.

4.8 As a consequence, boundary agreements may be central or local. The Strategic Content Alliance (SCA), a partnership of governmental and semi governmental agencies initiated by the JISC, aims to encourage the use of publicly funded e-content by reducing barriers to that use, and to encourage inter-agency collaboration both to gain multiplier effects and reduce costs. The SCA clearly, then, aims to produce benefits both within and outwith the sector. Google Scholar, initiated by a commercial entity but involving partnership with several academic institutions globally, aims to provide a search facility across a considerable range of academic sources. It operates partially inside and outwith the academic environment. Participating institutions are constrained to an extent, however, by a variety of contractual obligations to Google, and, potentially, usage policies governing the use of infrastructure. As the scope of Google Scholar or similar initiatives extends, it is likely to be bounded by IPR regimes surrounding target collections, which may or may not have been produced with a variety of funding sources, and have, as a consequence specific considerations around access attached. These examples are drawn from the relatively straightforward ground of inter-organizational collaboration. The matrix of policy issues surrounding even these examples is complex and difficult for both institutions and agencies to navigate. When consideration is given to the issues arising from the growing advocacy and use of global applications based in differing legislative frameworks, or the IPR issues surrounding user-generated content, the level of complex-

ity grows further still. The interaction of UK and EU privacy legislation with an application based in the US and subject to the Patriot Act is an illustration of this. ***There is arguably a role for the JISC, then, in providing and facilitating advice for the institutions it serves, and in rendering these issues as transparent and comprehensible as is possible.***

4.9 The IIE, then, is both that aspect of UK e-Infrastructure provided, and directed by the JISC, and that which, by dint of its position, investments and partnerships, the JISC leads and facilitates. If, however, the term "*negotiated environment"* is more useful, and a more accurate and useful refection of the emerging reality of the IIE, it is desirable that further consideration should be given to governance issues, policy, and the extended partnerships required, together with due consideration of how these might be explicitly and coherently represented to the sector. ***Specifically; the provision of a policy map, matrix, or registry as a principle point-of-call for a range of stakeholders has been indicated as highly desirable by many of those consulted in the course of this review. This does not necessarily suggest that such a single point of call should take the form of a single repository – it may well be a referatory, repository, aggregator, or hybrid. The JISC should play a critical role, in facilitating this development; it will, however, by its very nature require input from several, distributed agencies.***

5 Environmental changes

5.1 Space precludes an exhaustive or detailed description of changes in the broader environment since the articulation of the Information Environment just over half a decade ago. It is necessary to at least survey salient changes in that broader landscape of direct relevance to the strategic direction of the Integrated Information Environment, however, in order to test the continued validity of its approaches. The following major developments are suggested as worthy of specific attention. It is not suggested that they are exhaustive.

5.2 The emergence of Open Access Publication, (largely concerned, to date, with Electronic Theses and Dissertations), and sharing Open Educational Resources, (the exchange of learning objects and Open Courseware). These tendencies have acted, to a point, to subvert, circumvent or augment conventional publication models, depending on the perspective of the actor concerned. Initiatives in this space have operated at sub-institutional, inter-institutional, national and international levels, and have been facilitated by the growth of a variety of digital repositories. Current tendencies in repository development, especially movement in the direction of workflow and lifecycle management, suggest continued changes - perhaps significant - in patterns of scholarly communications in the immediate future.

5.3 "Web 2.0"

5.3.1 Whilst precise definitions of the term "Web 2.0" remain elusive, the emergence of the phenomenon to which it refers cannot be avoided in any environmental scan. The characteristics of "Web 2.0" are summarised by Wikipedia in the following manner; "*Web 2.0 websites allow users to do more than just retrieve information. They can build on the interactive facilities of "Web 1.0" to provide "Network as platform" computing, allowing users to run software-applications entirely through a browser. Users can own the data on a Web 2.0 site and exercise control over that data.These sites may have an "Architecture of participation" that encourages users to add value to the application as they use it. This stands in contrast to very old traditional websites, the sort which limited visitors to viewing and whose content only the site's owner could modify. Web 2.0 sites often feature a rich, user-friendly interface based on Ajax, Flex or similar rich media. The sites may also have social-networking aspects.*"

5.3.2 The scope and scale of the distribution implied by the initial design of the Web are, perhaps, only now being made apparent through the phenomenon of "Web 2.0". "Web 2.0", then, may be seen either as a revolutionary change in the balance of "contribution" to "reception" in the Web, or as a logical stage in the realization of its initial promise. Whichever perspective is taken, the reduction of friction involved in web publishing, together with the enhanced facilitation and flexibility of networked communication that "Web 2.0" represents, are likely to have significant implications for traditional academic enterprise.

5.4 The promise of the Semantic Web

5.4.1 W3C describe the vision of the Semantic Web as "*...to extend (the) principles of the Web from documents to data. This extension will allow to fulfill more of the Web's potential, in that it will allow data to be shared effectively by wider communities, and to be processed automatically by tools as well as manually."* There is a focus, then, in the development of the Semantic Web in expressing content not only in natural languages, but also in those that can be understood by machine or software agents.

5.4.2 As a concept, the *Semantic Web* is arguably not new. Indeed, it is sometimes claimed that it is nothing more than Tim Berners-Lee's original vision of the Web's eventual nature. Regardless of this, a Semantic Web has so far, in actuality, not been realized. Recently however, the vision of a semantic web has been given new impetus, largely through advances in applying a more structured approach to the publication of documents and data on the Web. A more pragmatic notion of 'linked data' as "*.. about making links, so that a person or machine can explore the web of data."* is gaining currency. In addition, Web 2.0's emphasis on light-weight and open APIs together with the application of global-scale user classification of information, may increase the possibility of a web of semantically-linked data. Developments in the last twelve months, such as the creation of the Open Data Commons License, together with a burgeoning collection of public do-

main *microformats*, would tend to indicate an increasing potential for development in this area.

5.4.3 Whether or not this is realized, an emphasis on providing structured views of data in order to enable its potential re-use is very much in keeping with both the direction of the IE and IIE, and with the emerging resource-oriented nature of much of Web2.0 application design. It could be argued that these are necessary steps to realizing any implementation of a semantic web.

5.4.4 In her *Dealing with Data* report (2007), Dr. Liz Lyon makes the recommendation that the JISC should fund work to "create robust, bi-directional interdisciplinary links between data objects and derived resources". This recommendation is given in the context of repositories and OAI-ORE in particular, but it could, and perhaps should have a wider applicability in the IIE. ***It is recommended that the JISC, while monitoring developments in the semantic web and related technologies in general, focus on encouraging the linking of data-sets to other resources, bridging what might be seen as the divide between the old IE and the domain of e-Research.***

5.5 Access and identity management

5.5.1 The federated model of access control is a good fit for the principle characteristics of the IIE; a highly distributed, negotiated environment. The UK Access Management Federation has matured (recent hiccoughs with respect to the Athens gateway notwithstanding) to the point where it is plausible to apply it to many IIE services and applications. ***The Access Management Federation now needs to be considered when planning the development of any significant project within the IIE. Indeed, the default position for any project funded by the JISC should be that it incorporates access management, unless there is a specific justification why it should not.***

5.5.2 "Identity 2.0"

Identity developments must be placed against a backdrop of evolving relationships between users, institutions and publishers. There exists a relatively small but growing interest in concepts of 'personal' or 'user-centric' identity management – also referred to as 'Identity 2.0'. The early promise of Identity 2.0 suggests that it may empower the user to negotiate, from a position of greater control, with institutions and publishers for access to resources. Conceptually, Identity 2.0 is not precluded by the federated model: it is technically feasible to allow the user a greater measure of personal control over their 'identity' while inter-operating with a federated access control scheme. ***It is recommended that the JISC Development Group, in conjunction with JISC Services and Policy, maintain a close watching brief on Identity 2.0 developments.***

5.6 Common threads

It is possible to discern a number of common threads, if not a strategic tendency, running through these developments. To an extent, when the current landscape is compared with that of a decade ago, the changes reflect a change (either real, or expressly desired by many actors) in the *locus of control* of an extended publication process, whether of research data, outputs, or learning materials. It is notable that in many senses there is a tendency towards *increased distribution* and *increased, disintermediated, user participation, contribution, and comment*. The existing IE architecture, with its emphasis on federated services and open standards, provides a solid technical basis on which to develop adoption and interoperation with newer "Web 2.0" type services. ***The economic fragility, and "perpetual beta" nature of these services, however, together with policy and other factors should prompt the careful consideration of their adoption or advocacy by the JISC***. ***Additional services of a similar type, specific to UK Higher and Further Education, developed under the auspices and governance of the sector may in this context prove to be desirable and should be given consideration, as should the modification of existing services.*** Such services could provide similar functionality to common "Web 2.0" services, interact and interoperate with them where desirable and possible, but deliver specific, sector-focused added value and security for UK Higher and Further Education.

6 The IE Architecture

6.1 The Information Environment Architecture has proved a remarkably robust guide to the development of UK discovery to delivery infrastructure. It is, however, very much a product of the period within which it was created, and its usefulness should be reassessed from the perspective of recent experience and change in approaches to systems design, in addition to the external factors we have indicated. The Information Environment Architecture should be viewed in context of the surrounding, broader environment of web based services, and the *interconnections* with that broader environment emphasised. It is best viewed not as "*the*" architecture, but as *one expression* of an evolving *architectural approach*.

6.2 It is worth noting that the term "architecture" used in this sense is, of course, a metaphor or analogy. As such, it is one way of viewing a design or problem space by way of implicit or explicit comparison. Close identification with a single metaphor or analogy can occasionally obscure, rather than clarify a problem space. Reference to other metaphors or analogies can sometimes act as an antidote to this. In addition to considering architectural approaches to the IIE, it may also be useful to consider the IIE from the perspective of other metaphors. One potential approach might be to consider the IIE from the perspective of an *ecological* metaphor or metaphors. This may go further, perhaps, to suggest the objective of a living, evolving environment where centrally planned, enabling, services combine with more emergent activity to produce *innovation at the service of users*.

6.3 The Provision Layer

We have noted the broad theme of 'resource discovery' running throughout the original IE, which is reflected in its technical architecture, and which represents a sub-set of the activity we expect to find in the IIE. It is worth pointing out, however, that the IE technical architecture has, to a commendable degree, predicted the rise of the 'resource-oriented-architecture' in web service design. A strong characteristic of many Web 2,0 applications is the ReSTful design pattern, with the exposure of addressable, discoverable resources as a basic principle. These principles also underpin the notion of the *web of data,* which is gaining currency and which could be highly relevant to the sector.

6.4 The Fusion Layer

6.4.1 The IE Architecture contains a distinct layer described by the term "Fusion". In Ariadne 31, Liz Lyon and Andy Powell describe this layer as "… responsible for combining metadata records from one or more content providers, as a result of cross-searching, harvesting or alerting. Some fusion activity may be undertaken directly by portals and content providers. In other cases, stand-alone fusion services may be developed. In the case of cross-searching, such stand-alone services are typically referred to as brokers."
In the context of an application of the principles of the IE Architecture to other domains, it is necessary to consider "fusion" in broader terms than those of resource discovery. The development of the XCRI specification, and its practical use in exchanging course-related information provides an interesting validation and extension of the approach suggested by the IE. With its treatment of course descriptions as discrete and globally addressable 'resources', XCRI both expresses the core resource-discovery paradigm of the IE while embracing a contemporary, resource-oriented-architecture approach to service delivery. The resulting service is an illustration and validation of the approach taken by the IE, *outside* the area of resource discovery, with a growing number of institutional data providers making data available to an aggregation ('fusion') service.

6.4.2 It should be noted, however, that the tendency noted in the Ariadne article for aspects of "fusion activity" to be assimilated by portals and content providers has both continued and broadened. Indeed, the rapid rise in popularity and efficacy of the lightweight, Web 2.0 style integration or 'mashup' of resources and services has shown that the boundaries between 'layers' are anything but fixed. ***It would seem more profitable to recast the functionality represented by fusion in terms of the contemporary methods of analysis developed by the eFramework.*** We will return to this in section 7 of this document.

6.5 "Presentation" or "User Interaction"?

6.5.1 The initial conception of the Information Environment focussed to a considerable degree on a portal layer (either institutional, or some form of centrally provided portal) as the means of *seamlessly* presenting resources to the institutional or end-user. It is necessary to adjust this perspective, in the light of subsequent developments, on two principle

grounds. The first of these adjustments is concerned with the ethos of approach and how this is represented; the second is more empirically grounded in recent practice.

6.5.2 Significant aspects of the user experience of the web have changed in the last half-decade. These changes are not simply a matter of interface improvements, but of an overall experience based around encouragement to participate and contribute content. Such contribution becomes both an expectation of participation, and a significant aspect of the *value of participation*. "Presentation" of resources to learners, for example, implies a relationship between the two that runs in one direction only. This is now far from the experience that many learners and educators, have come to expect. ***"User interaction" is therefore suggested as a more accurate reflection of the more active relationship between learner or educator and resource that the IIE architecture should anticipate, and seek to stimulate and foster.***

6.5.3 Portals, whether institutional, or provided as some form of national or regional service, have matured considerably in the last half-decade. They are likely to remain one means – and for many users, the *principle* means – by which personalised access to resources and other services is managed or enabled. Whilst portals remain a significant factor in enabling user interaction with resources and services, they are now far from being the only such means. The diagram at Annex 3, "Refreshing Presentation; User Interaction" attempts to capture some recent developments and richness in this space, together with a representation of the significantly increased numbers of types of user agent, device and data.

6.5.4 At the same time, the notion of *seamlessness,* in terms of user interaction, now carries with it a richer array of possible interpretations. Where seamlessness might once have been confined to the presentation layer of the IE's technical architecture, describing a seamless integration or horizontally uniform presentation of disparate information sources (typically in a portal context), it can now apply vertically, across boundaries and between 'layers'. 'Seamless', in a contemporary sense, describes not so much the presentation of information sources, as interaction with information *re*-sources and data, from a variety of clients, platforms and devices with the objective of supporting *seamless academic discourse*. ***This added dimension to the idea of 'seamless' integration is made possible through the exploitation of open standards and APIs, an approach that has rightly been core to the IE (and the approach to development activity taken by the JISC) and should remain a key foundation of the IIE.***

6.5.5 The increased richness of user experience we have suggested carries with it increased complexity. This in turn might suggest a concomitant increase in financial cost. The suggestion is not entirely accurate, however. There are already sound, if limited examples of services which may be produced at a single point and "consumed" by a web browser (either through a portal/portlet or client side plug-in), desktop rich client or mo-

bile device. Similarly, the role of a portal framework as a layer transforming content and services continues to be extended and explored. ***The Andrew J Mellon Foundation funded "FLUID" project is one such example of this approach that should be monitored closely.***

6.5.6 The point here is not to argue the respective merits of either rich-client or web-based approach (which have occasionally been falsely polarised), but to find a viable means of supporting *both* to serve the greatest number of users in the greatest number of contexts. ***In an environment which is characterised by increased and increasing complexity, developing the practical re-use of data and services is of considerable significance in maintaining both long-term economic viability and flexibility of services for learners, educators and administrators. It is recommended that a specific – and perhaps major - strand of activity be focussed in this area.***

7.0 The IE, IIE and the eFramework for Education and Research

7.1 The e-Framework for Education and Research is an international initiative providing community-generated guidance to institutions on investing in and using information technology infrastructure. It advocates service-oriented approaches on both technical and economic grounds; to facilitate technical interoperability of core infrastructure and to maximise the effective use of available funding. The eFramework has articulated a series of approaches to service oriented analysis, design and development. These are based around the key concepts of Service Genres, Service Usage Models and Service Expressions. In summary, Service Genres identify collections of related behaviours that describe an abstract capability such as 'harvesting', Service Usage Models describe the relationships among technical components or services used to create a given type of software application such as 'authenticated harvest', and Service Expressions specify how a service genre can be realised with particular interfaces and standards, such 'harvest resource with OAI-PMH'.

7.2 The approaches to design and development suggested by the eFramework continue to evolve and incorporate lessons drawn from both the experience of the sector, including those drawn from implementing the IE architecture itself, in addition to the broader commercial environment. Whilst service-oriented in approach, the Information Environment architecture (unsurprisingly, given the period in which it was developed) diverges from more modern service oriented design principles in certain respects. Dependence on services that are essentially single points of failure remains a cause for concern, for example. It may be possible to avoid or mitigate risks associated with the brittleness these single points of failure introduce by using the more recent approaches to service-oriented design suggested by the eFramework.

7.3 Analysis and presentation of the architectural and practical work on which the IE and IIE have been based, using the methods and approaches suggested by the eFramework, would therefore seem to offer considerable benefits. Two related strands of JISC activity would be brought together in a consistent and coherent manner, not only enriching understanding of the IE and IIE, but also providing validation of the methodologies which the eFramework suggests. By deploying this common methodology, and significantly more neutral terminology, the approaches suggested by eFramework may also form a critical element in providing a bridge between the IE and the realisation of the IIE. This is especially true of the potential for the re-use of services and other software components in contexts other than those for which they were developed. ***Use of a common methodology will more readily identify services used in a greater variety of these contexts, and assist planning by suggesting development priorities and helping to identify gaps in component or service provision. It is therefore recommended that an appropriate – but preferably large - subset of IE and IIE services be analysed using the methodologies suggested by the eFramework to test the validity of this approach.***

8 Community Involvement: The IIE Demonstrator

8.1 Several key elements of the Information Environment have been developed to the point where transformation from project to service is being considered, and planning around the work involved in this transformation undertaken. Structured testing of prototype services in a variety of community contexts; institutional, discipline and modal (teaching, learning, research, administration) will be a critical element of any such service deployment, and will considerably enrich understanding of the practical benefits and obstacles to the re-use of shared services. It is from this perspective that the Information Environment Working Group began to elaborate the concept of an IE Testbed or Demonstrator.

8.2 The IIE Demonstrator is intended as an online presence for the Integrated Information Environment as it continues to develop. It will provide a consolidated and coherent online expression of services and prototype services as they develop and become available, together with the rationale for institutional engagement with those developments, and the means by which practical engagement might be accomplished. The Demonstrator will provide an environment where;

- Institutional managers can discover examples and narratives of the successful deployment of solutions involving integration with IIE services
- Institutional developers can explore, test and develop against interfaces to IIE services, including their integration with other environments such as VLEs and VREs

- A point of contact is established, where dialogue between managers and developers responsible for IIE service development, and those responsible for integration and implementation in the institutions and organisations it is designed to serve can take place.

Given the definition of the IIE agreed by the JISC Board referenced earlier in this paper, the importance of this visible and practical means of interaction with the IIE should not be underestimated. ***The IIE Demonstrator requires adequate levels of resource from National Datacentres, UKOLN, and the JISC itself. This level of resource should be carefully scoped and factored into the detailed IIE workplan as it continues to evolve.***

8.3 The focus of the IIE Demonstrator is, in the first instance, squarely on more generic issues involved in institutional integration and implementation, and on establishing a relationship with key institutions that enables the structured and detailed exploration of those issues. If the Demonstrator is to play a significant part in testing the validity of the IIE approach in practice, however, it will of necessity need to develop other strands of activity focussing on the specific domains of Research, Teaching and Learning, and Administration. Given the continuing discussion following the OSI e-Infrastructure report, and the policy imperatives surrounding the area of e-Research, the ways in which existing IIE activity can interact with, and support e-Research activity seems an appropriate and manageable priority. ***The following areas suggest themselves as being of specific interest and worthy of further exploration;***

- ***The extent to which user-facing IIE services are found useful in the context of virtual research environments supporting single and multi-institutional virtual research communities***
- ***The extent to which infrastructural IIE services, for example registries, are capable of meeting a range of research communities' requirements***.

8.4 The JISC 'Users and Innovation: Personalising Technologies Programme' has brought together a range of academic practitioners, administrators and software developers into communities of practice with the intention of "*transform(ing) practice by developing technologies and innovative processes based on the needs of individual users working within institutions across multiple domains"*. Although of a rather more speculative nature than the examples indicated in the context of e-Research, there may be a role for the IIE Demonstrator in relation to possible future iterations of this programme. In exposing data and services, bounded by appropriate security and acceptable usage policies, to the wider UK academic community, the IIE Demonstrator has the potential to relate centrally directed and planned initiatives more closely with edge-based innovation. ***Should a subsequent iteration of the Users and Innovation Programme be planned, due consideration should be given to the involvement of the IIE Demonstrator at an early stage***.

8.5 Structured testing of the benefits of elements of the IIE by academic discipline will rely to a large extent on embedding that activity in joint work with JISC Partner organisa-

tions. In the area of support of research, the topic should form part of the dialogue with the Research Councils and other appropriate organisations. In teaching and learning the JISC currently funds joint activity with the Higher Education Academy, and its network of Subject Centres through the HEA Distributed e-Learning Programme. ***It is recommended that the JISC/HEA liaison team be appropriately briefed on the IIE Demonstrator and involved in more detailed planning of how the Demonstrator might be factored into future joint activities***.

9 The Process of strategic renewal

9.1 Introduction

The JISC has made substantial progress in establishing a range of mechanisms to plan and manage project and programme level initiatives, and to measure the impact of those initiatives over a longer period of time. These methods range from experimentation with scenario based approaches to planning, through the maturity model based project and programme management methodology suggested by "Managing Successful Programmes", to independent review, often undertaken by external consultants. In both the planning and management of broad initiatives, such as the Integrated Information Environment, the JISC is still critically dependent on high-level synthesis conducted by members of the JISC Executive and validated by existing advisory bodies drawn from the community, principally the JISC Board and its sub-committees. ***Increased awareness amongst members of these bodies of the more formal approaches to scenario planning, together with the approaches to project and programme management being taken by the JISC would increase the level of shared understanding between the Executive and members and prevent the development of any potential "understanding gap"*** . ***It is recommended that elements of awareness raising and training in these areas are considered for inclusion in the annual Committee and Advisory Board calendar.***

9.2 Measures and Metrics

Various measurements, both qualitative and quantitative, suggest themselves for assessing the progress of the IIE, including usage statistics for specific services (institutional and individual), technical quality of code produced, and extended user feedback on the quality and benefits of services. It is worth noting in this context that the term "user", in the sense of users served by the JISC directly or indirectly is exceptionally broad, encompassing individual learners, academics, administrators, librarians and technologists within HE and FE institutions, but also, distinctly, the institutions themselves. Institutional interests and requirements are represented in a range of JISC advisory bodies (in a general sense; members of advisory bodies are appointed *ad hominem*, rather than "representing" their particular institution). The requirements, expectations and desires of individual learners, academics and administrators are less well understood. ***Further investment in enhancing understanding of these requirements, expectations and desires will help align JISC activity with the needs of the members of the communities it serves. It is also essential if comprehensive measures and metrics are to be established effec-***

tively. In the last analysis, even given further investment in user consultation, any qualitative analysis is likely to remain highly dependent on the opinion of experts drawn from the community that the JISC serves. ***It is recommended that a short-term, small cross sub-committee working group be established to consider appropriate measures and metrics for assessing the progress of the IIE as a result of the consultative processes following the publication of this document***.

9.3 Structuring existing consultative processes

JIIE has the primary responsibility amongst JISC advisory bodies for informing the development of the IIE, and monitoring both specific developments and overall progress. The shared nature of the infrastructure under consideration, however, indicates that a measure of structured dialogue between JIIE and other sub committees is essential to achieve necessary buy-in and engagement across JISC activity in this area. ***Two recommendations suggest themselves; firstly, that the JIIE agenda be structured to enable appropriate levels of prepared strategic review of progress and direction, on at least an annual basis. In the second instance, it may be advisable to consider extending the current joint sub-committee meeting arrangements to involve members of JSR, JLT, JCS and JOS in a strategic review of progress with the development of the IIE. An annual meeting would again suggest itself as the minimum affective period, although consideration should be given to specific bi-lateral sub-committee discussions in specific areas of interest within the IIE.***

9.4 External Consultative Processes

9.4.1 UK Internal Partners

JISC works with a variety of UK partner organisations with specific sectoral or domain interests. These range from agencies with a similar remit to the JISC, but working in other parts of the public sector, through associations of libraries and librarians, IT Directors to Research Councils. These organisations will continue have a role to play in validating either potentially shared or generic infrastructure, or domain specific services, and often form a route to the perspective of end users they serve or represent.

9.4.2 Despite the lack of exact analogues of the JISC internationally, partnership arrangements and associations with a range of international organisations with similar interests have been constructed over the last decade and a half. These organisations include the NSF and DLF in the United States, SURF in the Netherlands, and the Knowledge Exchange partnership in Northern Europe. The JISC also plays a leading role in the international e-Framework initiative, together with DEST in Australia, the New Zealand Ministry of Education and SURF. In addition, formal and informal dialogue is maintained with a range of other international organisations and entities through such bodies as IMSGlobal, study visits, etc.

9.4.3 National and international exchanges of perspectives are particularly valuable, given increasingly mobile lifelong learners, and the global nature of the HE landscape and ICT infrastructure that supports them. ***Despite differences of focus between the JISC and many partner organisations, certain activities, particularly scans of the environment including user expectations and requirements gathering, might gain a multiplier effect from an increased level of coordination, or, at the very least, reduce duplication of effort.*** Recent survey work on student expectations of ICT undertaken by MORI for the JISC in the UK, and by ECAR for Educause in North America are examples of related activity that may gain added weight from a measure of coordination. Formal and informal technical review by national and international partners, perhaps aligned with the suggestions for the calendars of JISC sub Committees indicated above, may also bring different perspectives and fresh insights and benefits. ***It is recommended that consideration be given to an exploration of conducting coordinated environment scans with national and international partners, and of exploring the potential for reciprocal technical review around an appropriate timescale.***

10. General Conclusions

It is important to note that we have not undertaken a detailed analysis of the work undertaken by the IE Programmes to this point. Elements of this are being provided in a separate paper to the February 2008 JIIE meeting, and further elements still are bound up in the current evaluation of the Shared Infrastructure Programme which we did not wish to pre-empt or prejudice. These comments should be taken in this light. Neither have we commented directly on a communications strategy for the IIE, although this is clearly central to the success of the project; elements informing a strategic approach to communications are implicit and explicit in the section of this paper on the IIE Demonstrator. One intention in this paper's suggestion of the more effective alignment of distinct strands of JISC activity is that this provides the basis for more integrated and effective communications and dialogue with the sector.

The underpinning approaches taken to this point in constructing the IE, and by extension the IIE, appear to have proven their worth, and also appear flexible enough to be adjusted appropriately in ways which we have suggested. Some of these adjustments are concerned with more effectively relating what might appear to some as discrete areas of JISC activity; the IIE and the eFramework, for example. Others, particularly those surrounding changes in the environment and "Web 2.0", are designed to refresh and modernise perspectives in the light of environmental changes, and focus to a greater extent on end-user expectations.

Whilst some of the adjustments we suggest appear, perhaps, as nuances of terminology ("presentation" and "user interaction"), they frequently represent a significant *cultural* in as well as technological shift. As the JISC progresses – assuming it does – to further test the hypotheses of shared infrastructure to support a number of modes within the aca-

demic enterprise, it should pay particular attention to the differing cultures of the communities it represents. No one community, whether library, teaching or research is likely to have a monopoly of correct *general* approaches to common infrastructure in this respect. By facilitating dialogue through the adoption of a shared approach and more neutral terminology – and again here the eFramework would appear to be key – a better understanding of both problem space and solutions will suggest themselves.

Annex 1: Relationship diagram approved by the JISC Board in March 2007

Annex 2: The Information Environment Architecture

Annex 3: “Presentation” Refreshed: User Interaction