JISC Final Report

Before completing this template please note:

- Text in blue italics is explanatory and should be deleted in completed documents.
- The Project Management Guidelines (www.jisc.ac.uk/proj_manguide.html) explain the purpose of final reports.

<table>
<thead>
<tr>
<th>Project Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Identifier</td>
</tr>
<tr>
<td>Project Title</td>
</tr>
<tr>
<td>Project Hashtag</td>
</tr>
<tr>
<td>Start Date</td>
</tr>
<tr>
<td>End Date</td>
</tr>
<tr>
<td>Lead Institution</td>
</tr>
<tr>
<td>Project Director</td>
</tr>
<tr>
<td>Project Manager</td>
</tr>
<tr>
<td>Contact email</td>
</tr>
<tr>
<td>Partner Institutions</td>
</tr>
<tr>
<td>Project Web URL</td>
</tr>
<tr>
<td>Programme Name</td>
</tr>
<tr>
<td>Programme Manager</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Document Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author(s)</td>
</tr>
<tr>
<td>Project Role(s)</td>
</tr>
<tr>
<td>Date</td>
</tr>
<tr>
<td>Filename</td>
</tr>
<tr>
<td>URL</td>
</tr>
<tr>
<td>Access</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Document History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>1.0</td>
</tr>
<tr>
<td>1.7</td>
</tr>
<tr>
<td>2.3</td>
</tr>
<tr>
<td>Final</td>
</tr>
</tbody>
</table>

Page 1 of 32
# Table of Contents

1 ACKNOWLEDGEMENTS ................................................................................................................. 4  
2 SUMMARY .................................................................................................................................. 4  
3 VRE PROGRAMME OVERVIEW ................................................................................................. 4  
4 LITERATURE REVIEW ................................................................................................................ 5  
   4.1 INFRASTRUCTURES AND COMMUNITIES ............................................................................ 6  
   4.2 USER ENGAGEMENT .......................................................................................................... 7  
   4.3 VRE IMPACTS ................................................................................................................... 7  
   4.4 SUSTAINABILITY ............................................................................................................... 7  
5 RESEARCH DESIGN ..................................................................................................................... 9  
   5.1 FIELDWORK: METHODOLOGY AND SELECTION OF PROJECTS ........................................ 9  
      5.1.1 ViCo-VRE and follow-on ViCoX (VRE3); OneVRE (VRE3); CritterVRE (VRERI) – University of Manchester ........................................................................................................ 10  
      5.1.2 IBBRE, VRIC and follow-on ViewMyVRIC (VRE3) – University of Southampton ......... 11  
      5.1.3 TextVRE and its follow-up Text.Link (VRE3); gMan (VRERI) – Centre for e-Research, KCL; German TextGrid project; D4Science Initiative .................................................... 12  
      5.1.4 SERPent (VRERI) – UCL .......................................................................................... 12  
      5.1.5 VRE-CI (VRE3) – University of Oxford, RIC (British Library & Microsoft Research) ...... 13  
      5.1.6 AMI (VRERI), University of Cambridge ................................................................. 13  
      5.1.7 The Brain project (VRE3), University of Coventry ..................................................... 13  
   5.2 LANDSCAPING STUDY ........................................................................................................ 14  
      5.2.1 Approximation ........................................................................................................... 14  
      5.2.2 Fitness ...................................................................................................................... 14  
      5.2.3 Openness .................................................................................................................. 14  
6 MAIN FINDINGS ........................................................................................................................... 15  
   6.1 INFRASTRUCTURES AND COMMUNITIES ........................................................................... 15  
      6.1.1 Choice of Technology ............................................................................................... 15  
      6.1.2 Institutional Buy-In ................................................................................................. 15  
      6.1.3 Key Stakeholders ...................................................................................................... 16  
   6.2 USER ENGAGEMENT ......................................................................................................... 16  
   6.3 IMPACT ............................................................................................................................... 16  
      6.3.1 Impact So Far ........................................................................................................... 16  
      6.3.2 Potential/Future Impact ........................................................................................... 18  
   6.4 MISCELLANEOUS FINDINGS .............................................................................................. 19
6.5 SUSTAINABILITY ISSUES ............................................................................................................. 19
6.5.1 Landscaping Study .................................................................................................................. 19
6.5.2 Case Studies ............................................................................................................................. 21
6.5.3 Sustainability Approaches ........................................................................................................ 22
6.5.4 Business Models ...................................................................................................................... 22
6.6 DISSEMINATION EVENT FEEDBACK ......................................................................................... 22

7 RECOMMENDATIONS .................................................................................................................. 26
7.1 USER ENGAGEMENT .................................................................................................................... 27
7.2 COMMODITISATION AND CONFIGURATION .......................................................................... 27
7.3 CAPACITY BUILDING IN SUSTAINABILITY PLANNING AND IMPLEMENTATION .................. 28

8 BIBLIOGRAPHY .............................................................................................................................. 29

9 APPENDICES ................................................................................................................................... 31
9.1 LIST OF DELIVERABLES ............................................................................................................. 31
9.2 LIST OF INTERVIEWEES PER CASE STUDY .......................................................................... 31
1 Acknowledgements

This project was funded under the JISC Digital Directions: Research programme. We would like to thank to Chris Brown, the JISC manager, the interviewees and participants in the dissemination workshop for their valuable contributions.

2 Summary

The aim of this project was to perform a synthesis of the tools and developmental work performed in the JISC VRE programmes to determine what impact they have had, and might have, within the community. The work was one of synthesis and the project set out to be forward looking rather than just provide an evaluation of the programme. Previous phases and the Rapid Innovation projects have been assessed, but the main emphasis was on the VRE3 programme. A key objective has been to determine how to build a sustainable model for VREs.

The project was structured around four main activities, the results of which we report here: 1) desk-based research to summarise VRE project status, and a systematic synthesis of evidence of VRE sustainability issues, barriers and enablers; 2) interviews with participants in VRE programme projects to investigate their impact and reasons for success or failure; 3) based on 1 and 2) identification of a coordinated set of responses to sustainability issues; 4) dissemination event to present findings and recommendations.

The report sets out to provide advice and guidance as to how JISC can better support VREs that have already been developed and ones that are being developed in the latest call. One objective is to determine how to build a sustainable model for VREs. JISC is currently working with InfoNet to develop a VRE Starter Kit. The report sets out a series of recommendations to complement this activity, including encouraging more effective user engagement practices by ICT support services in academic institutions, promoting the use of commodity solutions to researchers’ collaborations needs where appropriate, the creation of an advisory service to assist in the translation of generic lessons for sustainability into practical steps by user communities and the investment in continuing efforts to track VRE adoption and impact.

3 VRE Programme Overview

The JISC funded ‘Virtual Research Environment (VRE) programme’ \(^1\) started 2004 in the UK with the vision to “involve all sectors of the research community and recognises the need to support research activities within and across disciplinary boundaries.” Within JISC’s e-Research group, the programme ran in three main phases until September 2011 and is now (“Beyond Phase 3”) part of the ‘Digital Infrastructure: Research programme’ \(^2\), under the header ‘Research Tools’.

While recognising that the concept of VRE is constantly evolving (and that such technologies, tools and frameworks de facto are also subsumed under and overlap with other terms and programmes in general), the JISC VRE programme established the following definition:

“A VRE helps researchers from all disciplines to work collaboratively by managing the increasingly complex range of tasks involved in carrying out research.”

---

\(^1\) [http://www.jisc.ac.uk/whatwedo/programmes/vre.aspx](http://www.jisc.ac.uk/whatwedo/programmes/vre.aspx)

\(^2\) [http://www.jisc.ac.uk/whatwedo/programmes/di_research.aspx](http://www.jisc.ac.uk/whatwedo/programmes/di_research.aspx)
The four different phases have been building on each other and had/have the following foci:

- **Phase One (VRE1, 2004-2007)** was technology and experiment driven with diverse design and development approaches, funding 14 projects.

- **Phase Two (VRE2, 2007-2009)** focussed strongly on use and research practice with integrated pilots via iterative development and unified design approaches in four projects.

- **Phase Three (VRE3 & RI, 2009-2011)** consisted of 14 VRE3 projects (10 plus four follow-on projects) aiming at broadening use across institutions and disciplines, with diverse development and design approaches driven by community needs; the strand also had projects focussing on technical interoperability, nationally and institutionally. This phase also included 14 Rapid Innovation (RI) projects with shorter lifetimes, making use of rapid innovation development approaches across the research lifecycle in a solution driven way (“scratching itches”) and through business community engagement.

- **Research Tools (current programme from 2011 onwards)**: “The aim of this strand is to ensure the research community is fully informed of the potential that IT and IT infrastructure can offer the research process. Researchers will benefit through access to compute facilities and tools for research that facilitate collaboration and communication, improve research processes and enable new research findings (...) VREs take a coherent approach to joining up tools to serve particular or generic aspects of the research lifecycle.”

JISC commissioned a number of studies to evaluate impact and synthesize the outcomes of the VRE programme. We address findings of those studies and from other relevant literature on VREs in the following section.

### 4 Literature Review

We have described the vision, definition and aims of the JISC VRE programme, including its different phases, in the previous section. In this section we reflect on key aspects and challenges around VRE in practice from the relevant literature – which is still "somewhat scarce", as already pointed out in the 'Virtual Research Environment Collaborative Landscape Study' (Carusi & Reimer, 2010). For a wider overview of the genesis of the VRE concept within the area of e-Research see Voss & Procter (2012).

A VRE can be described as an integrated e-Infrastructure to support researchers across the research lifecycle and according to their needs, enabling collaboration within and beyond their communities – thereby improving research practice and scholarly communications (Voss & Procter, 2012), fostering/supporting inter-disciplinarity and addressing different scales, from domain specific tools and tool-sets to institutional infrastructures and general frameworks. The aforementioned VRE landscape study (Carusi & Reimer, 2010) provides a comprehensive overview on the use of the term VRE and others used synonymously, e.g. “CVE (Collaborative Virtual Environment), Cyberinfrastructure/e-Infrastructure, Collaborative e-Research Communities, VRC (Virtual Research Community), VO (Virtual Organisation)”. Historically, the term VRE is “widely used in the UK, mostly due to the impact of the JISC VRE programme” (ibid.) although, even here, the term VRE does not figure prominently in the current funding strand which is giving continuity to the VRE programme. Research Data Management (RDM) infrastructures, an area which has been attracting substantial funding with programmes in the UK, US, Australia and Europe over the last years present another example providing significant overlap with the concepts of the VRE.

---

3: [http://www.jisc.ac.uk/whatwedo/programmes/di_research/researchtools.aspx](http://www.jisc.ac.uk/whatwedo/programmes/di_research/researchtools.aspx)
The aim of a VRE is to provide an integrated environment that supports the work of a community of collaborating researchers. That is, a VRE brings together previously separate tools needed for conducting the research and for collaboration, support for which is increasingly recognised as an integral aspect of researchers’ work rather than something that can be added on as an afterthought (Voss and Procter, 2009). This general description gives an indication of the range of services or tools that researchers may make use of in their work:

- authenticate using an authentication service,
- communicate and collaborate with colleagues,
- transfer data,
- configure a resource,
- invoke a computation,
- re-use data and give credit to the original producer,
- archive output data and runtime data,
- publish outputs, both informally through blogs or wikis and formally through conference or journal papers,
- discover what resources are available,
- monitor the state of a resource or process,
- maintain awareness of who is currently doing what,
- find out where particular data has come from and how it was processed (provenance),
- find out who has access to a resource and what they can do with it (authentication and authorisation).

However, the examples of VREs that we looked at in this study suggest that what qualifies as a VRE is rather flexibly interpreted in practice; it is certainly not the case that typical VREs embrace the whole research life cycle. This expectation that they would may, perhaps, be put down to the inflated expectations that accompanied the launch of the UK e-Science programme and, arguably, are a recurrent feature of innovation processes, successful or otherwise.4

In the UK, the JISC funded Managing Research Data programme (JISCMRD & JISCMRD02)5 features a number of examples of VRE projects with antecedents in earlier VRE programmes. The support of the research process in general and in respect to institution-wide endeavours, for example, research administration, covered by JISC under its Research Information Management (RIM)6 programme, is a common denominator here.

Nevertheless, there are common key aspects as well as challenges to be found throughout the research VRE literature and JISC VRE programmes. An analysis by Connaway and Dickey (2010) of JISC Virtual Research Environment and Digital Repository Projects identified very similar themes. We summarise these below.

4.1 Infrastructures and Communities

VREs might be defined as simply the technical infrastructure supporting Virtual Organisations (VOs) within research practice (Andronico et al., 2011) but this ignores the reciprocal relationship that exists between community and infrastructure. “VREs are not only technical innovations per se, they are also practice-led innovations, which are designed to

4 http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp
6 http://www.jisc.ac.uk/whatwedo/themes/informationenvironment/researchinformgamt.aspx
function in context." (Junge et al., 2007) VREs are socio-technical configurations (Procter and Voss, 2012) and building an effective VRE depends on achieving an alignment between the needs of the community, with its research practices on the one hand and the capabilities of technologies, tools, frameworks and standards on the other. This isn’t possible unless VRE project teams involve the right mix of expertise. “Key to the success of the VRE Programme in its various phases was the pairing of technical and domain expertise.” (Miller, 2010). Similarly, the landscape study recommended that “VREs need to be conceptualised as community building projects rather than technology projects.” (Carusi & Reimer, 2010).

The administration of VOs can present significant challenges, especially where multiple institutions are involved as providers of services and resources. Issues that need to be addressed include management structure and responsibilities, policies for accounting for resources provided and used, and monitoring compliance with their rules of use, and one would them be the subject of VO governance agreements. In practice, these seemingly key issues are often dealt with through more informal, ad-hoc arrangements that rely on trust between key individuals and groups, especially in small VOs (Bos, 2007; Cummings et al., 2008; Barjak et al., 2013) and our interviews corroborate this. Informal arrangements have both advantages and disadvantages: they enable more fluid collaborations, but make VOs more vulnerable to the consequences of inter-institutional disputes and the impact of key individuals or groups withdrawing. Hence, it is not an approach that is likely to be viable when a VRE transitions to a sustainable service.

4.2 User Engagement

The community-technology aspect also has a strong influence on the design and development methodologies best employed to ensure good user engagement. Whereas a “multitude of approaches” (Junge et al., 2007) were used in the first phase of the JISC VRE programme, it became evident that the “participatory mode of development” (Carusi & Reimer, 2010) via user-driven and iterative processes has been the most effective way to address research communities’ needs. This might not always be valid or possible in the fullest extend for shorter projects (in the more recently funded JISC VRE/Research Tools strands) and development processes might hence be more technology-driven in some cases; still a community is necessary for uptake and impact of what is developed.

4.3 VRE Impacts

Creating and sustaining a VRE is a collaborative endeavour in itself, which requires and, in the best case, fosters mutual understanding across disciplines, communities and institutions. VREs generate impact through the development, embedding and evaluation of novel tools and frameworks for and within communities and therefore improve research and methodologies via (faster and better) access to data, tools, computational resources and collaborators. There is an international dimension as well, in part due to collaborations beyond the national context in some cases, but also increasingly because of the need and promise of VRE to “integrate resources from different origins.” (Carusi & Reimer, 2010).

The landscape report further points out the usefulness of VREs as infrastructure for the facilitating role of libraries, especially those more research-oriented, to “support researchers throughout the whole research lifecycle.” (Carusi & Reimer, 2010). We can see a similar development at the moment in the context of Research Data Management, where a number of libraries are playing a leading support role.

4.4 Sustainability

Sustainability remains a major challenge for any tool, infrastructure and framework, especially in a funding context where projects reach a ‘natural cliff’ at their end date.
Addressing communities’ needs via participative development processes and adequate usability (customizable and lightweight tools) is a prerequisite to get a VRE into actual use and to broaden uptake. Active community and stakeholder buy-in is necessary to make this possible in most cases – and “institutional buy-in and embedding remains an enormous challenge.” (Junge et al., 2007). But even if this is achieved, a business plan and sustainable costing model are desirable and, in most cases, crucial to keep a VRE running, not to speak of trying to develop it further or to establish some sort of (institutional) service.

Different needs in different domains are addressed through the bottom-up and user driven approach most VRE projects have been taking; at the same time, such complexity remains a challenge, especially for the international arena, where better co-operation and alignment of such basic requirements between the individual researcher or research group vs. the institution of which they are members (Procter and Voss, 2012).

The landscape report emphasises the “need to gain clarity on legal, ethical and other policies and frameworks that govern the sharing of data and other resources, and to communicate these clearly to researchers and developers” (Carusi & Reimer, 2010), especially for the international arena, where better co-operation and alignment of such basic conditions is necessary.

Other challenges and barriers mentioned include security, privacy concerns and integration with other (existing) systems (see e.g. Connaway & Dickey, 2010).

Following Molina (1997), we can map the issues and risks (and, implicitly, the interventions) to a number of different areas that bear upon the sustainability of VREs (Voss et al., 2007). The figure demonstrates how the sustainability issues and risks identified above can be mapped to a number of areas of concern that an analysis of sustainability should consider. The graphical representation provides a convenient way to assess whether all the areas of concern have been covered in the analysis.
State of implementation does not provide the well-defined, robust, useful and usable services required for wider uptake.

Lack of professional support for many technologies involved and support available is often ill-matched to users’ needs, e.g. in terms of level of skills assumed.

Lack of availability of technical skills required to develop and operate VREs are not widely available.

Lack of demonstrable benefits needed to secure further investment.

Lack of critical mass of active users and routine usage.

Unresolved methodological issues in some research communities, for example, about the status of different sources of data (transaction data versus panel surveys).

Uncertainty about development and standardisation of technologies.

Uncertainty about funding caused by short-term funding models and lack of diversity of funding sources, leading to an exposure of multiple efforts to the same risks.

Lack of Standardisation in many areas means those standards that are available are not mature, widely accepted and have interoperable implementations.

Licensing issues may prevent the use of commercial software.

Incompatible Open Source Licenses

5 Research Design

5.1 Fieldwork: Methodology and Selection of Projects

The fieldwork7 focused on the third phase of the JISC VRE programme (VRE3 including VRERI), taking into account project dependencies and trajectories back to VRE phases 1 and 2 and to other JISC funded and otherwise funded projects. VRE3 funded 28 projects in three stages: 10 projects were funded under the three areas ‘Tools’, ‘Frameworks’ and ‘Interoperability’ with four follow-up projects commissioned in a next step. Stage three funded 14 Rapid Innovation projects (VRERI) with shorter lifetimes.

The aim was to provide a comprehensive overview, covering a feasible number of projects through interviews with project stakeholders under the remit of the following research questions:

- Which VRE projects had/have an impact within communities and why?
- How do projects benefit from previous projects (VRE1, VRE2) and/or other collaborations and how does this have implications on sustainability, community building?
- Which VRE are actively used, to what extent and by which communities?
- What enables and hinders the impact, uptake and use of VRE?
- What are useful models to sustain VRE and which other factors contribute?
- What recommendations for successful projects, funding streams and sustainability routes have VRE practitioners/projects – and what does not work in this context?

7 See Appendix for a list of interviewees per case study.
Overall, 14 phase three (VRE3/VRERI) projects were selected, grouped into seven case studies, each of which included one or more individual projects (one covering four, two covering three and four covering one phase three projects). Criteria for selection were based on areas identified in the Literature Review, including collaboration (strong trajectories and dependencies between projects, project partners and people), impact factors, sustainability questions, domain and project type (i.e. institutional vs. community based or discipline specific), technology solution, project documentation and outputs.

Interviews were conducted with VRE project managers, representatives of their user (and non-user) communities. We used ‘snowball’ sampling techniques to identify the latter (early, late adopters) and non-users (potential and non-adopters) to investigate reasons for adoption/non-adoption and their implications for sustainability.

Twenty five interviews were conducted between 13 November 2012 and 5 February 2013, with 26 interviewees (23 via phone/Skype, 2 f2f, 1 group interview with 2 interviewees); the average length was just under 40 minutes (39.18 min/interview; 16h 22min total time). All interviews were recorded, transcribed and then analysed, structured, aggregated and written up according to the study’s areas of interest. Quotes when used were put in context of the respective study, but not directly referenced to individual interviewees.

Interviewees included various stakeholders of each project, starting with Principal Investigators (PI) and Project Managers (PM), then snowballing to other project members and people affiliated to it with different roles like developers, project partners, domain/community experts and actual users from the respective research communities.

Interviews were structured along the following topics:

- Formation and focus of projects, including project trajectories, dependencies and stakeholders
- User communities and engagement, project approach and methodology
- Impact: outputs, potential (community) uptake, community awareness and dissemination
- Barriers and enablers (cross-cutting theme)
- Sustainability: approach, models, success, plans
- Take aways/lessons learned, future plans
- Recommendations to JISC and overall

5.1.1 ViCo-VRE and follow-on ViCoX (VRE3); OneVRE (VRE3); CritterVRE (VRERI) – University of Manchester

Selection criteria: A portfolio of projects with repeated continuation funding across the first three VRE phases; strong collaborations outside the VRE programme; different types of projects with different outputs and levels of community engagement; very interdisciplinary.

Summary: The four projects are all part of the University of Manchester’s VRE Project Portfolio (led by former Manchester Research Computing Services, with various local partners), which started in the first JISC VRE phase with two projects (Memetic and CSAGE). Since then this VRE research and development has been grounded in making use of the Access Grid (AG) for various domains and with different foci. The development

8 [http://wiki.rac.manchester.ac.uk/community/vre3](http://wiki.rac.manchester.ac.uk/community/vre3)
10 [http://www.jisc.ac.uk/whatwedo/programmes/vre1/sage.aspx](http://www.jisc.ac.uk/whatwedo/programmes/vre1/sage.aspx)
of AG recordings and the further processing and annotation of such recordings has been a major theme throughout.

The Video Conversion for Virtual Research Environments (ViCoVRE) project built on previous projects and user requirements for the development of a video conversion tool for AG recordings into web-based formats, while at the same time ensuring e-Framework interoperability of the tool through a service oriented architecture.

The relatively short follow-up project ‘A ViCoVRE Library for X-Ray CT users’ (ViCoX) continued the work with the Material Sciences user community in order to embed two specific tools from the ViCoVRE library into their discipline specific, shared Joomla! content management system (CMS)\(^\text{12}\).

The One VRE to Join Them All (OneVRE) project sought to enable data and application sharing across existing VRE based on portal environments like Sakai. To this end a Virtual Organisation (VO) security model and identity management concept in connection with the web-based Portlet Access Grid (PAG)\(^\text{13}\) was developed to enable users of different VREs to collaborate with each other using their portal within the OneVRE VO.

CritterVRE again had a shorter project lifetime as it was funded under the JISC VRERI strand. It built on the VRE2 CREW\(^\text{14}\) project to enhance the annotation data for recordings in the CREW database with Twitter feeds.

5.1.2 IBBRE, VRIC and follow-on ViewMyVRIC (VRE3) – University of Southampton

Selection criteria: A portfolio of projects with repeated continuation funding across the first three VRE phases; strong collaborations outside the VRE programme; different types of projects with different outputs and levels of community engagement.

Summary: The three projects all address needs within the medical domain, especially behavioural sciences, as well as explicitly e-Social Science.

Building on the VRE1 Core\(^\text{15}\) project, the Internet-Based Behavioural REsearch project (IBBRE)\(^\text{16}\) developed a VRE for collaboration in sharing and reviewing of internet-delivered Behavioural Interventions (BI) thus becoming an integral part of LifeGuide\(^\text{17}\), “an open source software platform that allows researchers to easily and flexibly create and modify internet-delivered interventions and to collaborate across research groups”.

The Virtual Research Integration Collaboration (VRIC)\(^\text{18}\) project aimed at building a framework to better manage the research lifecycle in the area of clinical research and basic science, addressing needs of hospitals and integrating with national systems like the NHS.

The follow-up project, ViewMyVRIC\(^\text{19}\), aimed to extend use of VRIC for other areas of the health community, giving them access to existing data and integrating mobile devices for better data collection in the field.

\(^{12}\) http://www.joomla.org/

\(^{13}\) http://www.rcs.manchester.ac.uk/research/PAG

\(^{14}\) http://www.crew-vre.net/

\(^{15}\) http://www.core.ecs.soton.ac.uk/

\(^{16}\) http://www.ibbre.ecs.soton.ac.uk/

\(^{17}\) https://www.lifeguideonline.org/

\(^{18}\) http://www.vric.ecs.soton.ac.uk/
5.1.3 TextVRE and its follow-up Text.Link (VRE3); gMan (VRERI) – Centre for e-Research, KCL; German TextGrid project; D4Science Initiative

Selection criteria: A portfolio of projects with repeated continuation funding across the first three VRE phases; strong collaborations outside the VRE programme; different types of projects with different outputs and levels of community engagement; international collaborations in VRE projects; (digital) humanities domain.

Summary: The three projects at KCL’s Centre for e-Research were located in the Digital Humanities/e-Humanities domain and were conducted in collaboration with international partners.

TextVRE aimed at supporting the complete research lifecycle of digital textual studies, collaborating closely with the State and University Library Göttingen, Germany and building upon tools developed under the German TextGrid initiative. Sheffield and, later, Edinburgh were UK project partners.

The follow-up project TEXT.Link was a collaboration with the University of Applied Sciences Worms, Germany, which developed a Text-Text Link Editor tool (TTLE) based on a detailed technical and functional requirements specification provided by KCL and its textual studies user community. Following on from this, TextVRE secured funding from the Software Sustainability Institute (SSI) to carry out enhancements that would lead to increased uptake: “streamline the process of installing and configuring an instance of the software, which currently can be time-consuming; (ii) develop a virtual machine image that will allow a TextVre installation to be run “out of the box”; and (iii) carry out modularisation of the source code to make the software more robust, sustainable and reliable.” (TextVRE Final Report, 2012).

gMan, a VRERI project in collaboration with the University of Strathclyde, addressed needs in the classic and ancient history community for deploying VREs within existing UK and European research infrastructures, looking at new ways to integrate existing data resources. It made use of the gCube environment, which was developed as part of the EU-funded D4Science Initiative.

5.1.4 SERPent (VRERI) – UCL

Selection criteria: This project explored and tried to foster the use of existing Open Source tools/standards; strong collaborations outside the VRE programme; strong health science community.
Summary: The Secure Epidemiology Research Platform (SERPent)\(^{29}\) examined a pre-existing set of software tools and standards (Data Documentation Initiative, DDI\(^{30}\)) for creating metadata catalogues to assess usefulness and adoption by the epidemiology and population health research community.

5.1.5 VRE-CI (VRE3) – University of Oxford, RIC (British Library & Microsoft Research)

**Selection criteria:** Collaboration with British Library (BL) and Microsoft Research; built on existing VRE with RIC and in connection to this use/dependencies/challenges of commercial technological framework (SharePoint).

**Summary:** A Virtual Research Environment Framework for Cancer Imaging’ (VRE-CI, also sometimes called Cancer Imaging VRE\(^{31}\) aimed at developing a framework to allow researchers and clinicians to share information, images and algorithms for cancer imaging. The project incorporated the Research Information Centre (RIC)\(^{32}\) platform and Trident workflows into its development (using SharePoint as a platform), collaborating with Microsoft Research\(^{33}\) and the British Library (BL).

5.1.6 AMI (VRERI), University of Cambridge

**Selection criteria:** Prototype proof-of-concept development of hardware and software; collaboration with commercial partner.

**Summary:** This project developed an ‘intelligent fume cupboard’ for automated chemical synthesis. AMI\(^ {34}\) had a major commercial partner in Unilever.

5.1.7 The Brain project (VRE3), University of Coventry

**Selection criteria:** Institutional project; community building as part of remit; drawing on experiences from earlier JISC endeavours.

**Summary:** The Building Research And Innovation Networks (BRAIN)\(^ {35}\) project sought to facilitate building of communities of research and innovation at their institution (and those it works with), foster collaborative processes and provide necessary support by creating an institutionally embedded, sustainable VRE framework. The University of Leeds was a project partner. The project used Semantic Web and Pattern Language approaches and created a number of web-based tools to develop and maintain communities and hence foster networking, find expertise and useful contacts.

\(^{29}\) https://wiki.ucl.ac.uk/display/ICHPaedUniSERPent/Secure+Epidemiology+Research+Platform+%28SERPent%29
\(^{30}\) http://www.ddialliance.org/
\(^{31}\) http://www.oerc.ox.ac.uk/research/vre-ci
\(^{32}\) http://www.bl.uk/reshelp/experthelp/science/ric/ric.html
\(^{34}\) http://www.ucc.ch.cam.ac.uk/projects/ami
\(^{35}\) http://project-brain.org/about/
5.2 Landscaping Study

OSS Watch studied the sustainability aspects of the communities around the software tools that were developed during the successive JISC VRE programmes. This activity used the ‘SSMM’ or Software Sustainability Maturity Model, a blend of existing external software evaluation methodologies and some internally developed OSS Watch analysis methods.

The SSMM presents a phased approach to evaluation of projects. The first two stages, approximation and fitness, are designed to reduce an initial list of candidates for assessment. The later stages, openness and reusability, focus on identifying strengths and weaknesses in both the management and technical aspects of projects. The final phase, capability, is a deeply involved and detailed evaluation of development practices. For this project, given the available resource and the number of projects to be evaluated, the first three stages of the five-stage process were iteratively applied to VRE programme outputs and some selected external projects of a similar profile. A full description of the SSMM’s five stages can be found in the SSMM documentation in the Appendix to this report.

Below, we summarise the three stages used.

5.2.1 Approximation

An initial evaluation of project sustainability in its entirety. This phase is crude and lacks detail. However, it is quick to apply. The goal of this phase is to reduce a potentially large initial list of projects to a more manageable list of projects that appear to provide a sufficiently strong technical argument for re-use within the clients’ ecosystem. This step employs the methodology described in the Cabinet Office’s “Assessment of Software for Government.”

5.2.2 Fitness

An evaluation of a project’s likely ability to satisfy short, medium and long term strategic and tactical objectives. The goal is to ensure that a project is sufficiently aligned to both the current and near future goals of the organisation. Projects that have a sufficient fit to the client’s overall strategy will progress to the next phase. Where projects do not currently fit certain strategic goals this evaluation provides an early warning, which allows project teams to take corrective action if necessary. For this step, SWOT and Business Model Canvas analyses are conducted for both the organisation (in this case JISC’s overarching VRE programme) and the software projects. These are then compared to determine which projects best fit the programme’s objectives. Later in the process, the top scoring projects after the three evaluation steps are again analysed using this methodology to determine common success factors among VRE projects.

5.2.3 Openness

An evaluation of project development and management processes. The goal here is to ensure that a project is managed in a way that is compatible with the needs of users and third party developers reusing the software. This evaluation allows the project team to identify risks and define risk mitigation strategies. This step uses OSS Watch’s internally
developed Openness Maturity Model used in supporting JISC projects. Using these three evaluation techniques, the following steps were undertaken:

1. SWOT and BMC analyses of JISC VRE Programme conducted with JISC staff
2. Approximation evaluation of all VRE projects
3. Fitness evaluation of top scoring 20 projects from step 2
4. Freedom evaluation of top scoring 10 projects from step 3
5. Seven highest scoring projects from step 4 have new SWOT and BMC analyses done to determine common success factors
6. Ten external (non-JISC VRE-related) projects receive approximation evaluation
7. Top scoring seven projects from step 6, plus all JISC VRE projects dropped at step 3 are given new fitness evaluation using SWOT and BMC generated at step 5
8. Freedom evaluation for top scoring projects from step 7
9. Deliverable reports generated using top scoring projects from steps 1 and 2

6 Main Findings

The barriers and enablers for the development and embedding of VRE revealed by our case studies broadly align with observations made in the research literature.

6.1 Infrastructures and Communities

As suggested by the literature review, the reciprocity between Community and Technology is a key enabler for the development, embedding, impact and sustainability of VRE. The conditions around the latter factors are responsible for how successful and realistic uptake and use of VRE can be assessed. Barriers and enablers are cross-cutting themes along the following categories.

6.1.1 Choice of Technology

The choice of technology is obviously a determining factor in building a VRE and can foster or hinder this process. One lesson learned comes from the VRE-CI project where the dependency on the RIC VRE framework, which again was using MS SharePoint (fitting well into the institutional IT landscape at Oxford), delayed the development in the project. The release of the next version of SharePoint was postponed and in combination with added functionality not included in the previous version, the project team had to wait. Continuing development under the previous framework would have meant incompatibility with the next release and no chance to implement the necessary functionality for the VRE. This dependency meant that only an initial prototype could be developed, but not properly tested or advanced in the project end, with no tangible benefits for the user community.

A positive example is the use of available Open Source standards in the SERPent project, which, from the start, set out to explore a set of existing standards and tools, namely the DDI standard, to create metadata catalogues for health studies. Drawing upon the experiences and resources of the Open Source community enabled the project to adapt to user needs swiftly and efficiently.

The BRAIN project experienced a different flavour of dependency, as their well-received VRE could not gain support for sustainability at the University due to the institution’s commitment to SharePoint and therefore lack of resources for a different framework.

6.1.2 Institutional Buy-In

The BRAIN example also reflects on the intricacies of crucial institutional buy-in for VRE, not only for sustainability but also for developing and embedding software in the first place. From previous endeavours, BRAIN had gained substantial high-level institutional buy-in (e.g.
support by two Pro-Vice Chancellors), which helped the project immensely with its community and stakeholder engagement and achieving its goals. However, at the end of the project, support in one area had diminished due to one project ‘champion’ leaving their position. This further (together with the lack in resources due to the different institutional IT framework) impeded the chances of getting sustainability funding post-project. The VRE (as a community building and social networking tool) is still maintained with minimal resources. This means it can be accessed via its website and secure login area, but the resources are static and information is not generally updated. Integrated tools cannot be fully used and development is not continuing at present.

Hence, this presents a very interesting case, showing the ups and downs of institutional buy-in at the same time. In general, high-level institutional buy-in has been underdeveloped, especially in making the case for successful sustainability funding.

### 6.1.3 Key Stakeholders

We saw in the last example that the departure of key stakeholders can change the circumstances and impact factors of a project significantly. The VRIC and follow-on ViewMyRIC projects had to deal with the leaving of two key people, hampering its success. The main developer had to leave the project due to illness, making a substitution very difficult as resources could not be made available for the position in the project. Near the end, an important phase for community evaluation and impact of the developed VRE, they also lost their main user domain stakeholder. The set-up of the whole user community changed and it proved very difficult to re-establish a foothold.

ViewMyVRIC owed its success to a very strong user community and especially one domain stakeholder. Benefiting from other overlapping projects, the IBBRE VRE project played a key role in establishing LifeGuide as a platform for internet-based interventions. The portfolio of Manchester projects had a similar experience with the Arts & Humanities Dance Performance community, which has been using a system for the digital enhancing and recording ever since.

### 6.2 User Engagement

According to the literature, usability – together with making software as customizable and lightweight as possible – is one of the main factors for transitioning VREs into sustained use. In recognition of this, all the projects reviewed were committed to following a user-driven, iterative development approach for engaging with their communities, gathering requirements and evaluating software.

However, usability in itself did not appear to be a factor in uptake and impact of the projects we investigated. What was more consequential was the quality and persistence of the user engagement. Those projects that encountered problems in initiating and/or maintaining user engagement (e.g. due to time constraints, disconnect with the community, loss of project ‘champion’ or lack of buy-in from major stakeholders as outlined in the previous section) experienced poor community uptake. It can take time for mutual understanding and trust to develop between project partners, so if there were no prior relationship, then a project would struggle.

### 6.3 Impact

#### 6.3.1 Impact So Far

Projects and portfolio of projects in most of the case studies demonstrate the benefits of continuity of project teams, which were able to build on retained expertise, lessons learned and established networks of users and other stakeholders to build on their achievements.
projects stressed the benefits of ‘soft’ impact from knowledge gained, contacts, expertise and lessons learned through their endeavours. This extended to collaborations between project partners across domains, institutions and, in some cases, national borders.

The Manchester computer graphics community, namely the ACM SIGGRAPH Manchester Professional Chapter39, has been actively using outputs from various projects for AG recordings since CREW (recording/sharing seminars, lectures, events), benefiting from further developments in ViCOVRE and VICO-X, while also acting as a dissemination channel and providing user feedback and requirements.

The tool-kit developed by Memetic/CREW is heavily used by mathematicians in the MAGIC group40 for recording and annotating of lectures as video streams at 19 UK Universities. The 2011/2012 autumn and spring terms had 562 student registrations across all nodes. They produce about 450 hours of recordings for lectures per year, stored on Janet resources; the recording and annotation processes work automatically with the installed systems in the AG nodes. At the same time, MAGIC has a support agreement with the Manchester group and the 19 member Universities to fund technical and administrative support, with some additional EPSRC funding over the next four years, after which the whole model will be reviewed (the aim is full self-funding by the consortium).

The e-Dance41 project presents a particularly successful collaboration, although not funded under the VRE programme. It benefited strongly from outputs, resources and ideas of the Manchester VRE projects – and vice-versa; and the partners still actively work together. The physical theatre with the AG setup (i.e. cameras, hardware/software enabling recording and integration into performance practice) developed during the project (and constantly refined thereafter) is used for performances, research and teaching on a regular basis. Significant impact lies in the innovative choreographic methods, which bring the discipline “into new territory”, generating strong interest throughout the community.

The need of the behavioural science community – already engaged in the LifeGuide project – for collaboration and sharing support was the driver for the IBBRE project at Southampton. This was successful and has contributed to the longevity of LifeGuide, which continues to provide a service for creating, discussing and sharing internet-delivered interventions, maintained by continuation funding from various grants on the research group’s own servers including maintenance (“in the medium term everything looks brilliant” – but with the danger that grants might not be available in the future to cover the service, in spite of a critical mass at the moment). The overall number of registered users (practitioners like GPs and patients enrolled in interventions) on the LifeGuide system at the time of the interview was close to 20,000 and rising. Activities have also been spread out across five European countries through an European study on “General practitioners’ views on the acceptability and applicability of a web-based intervention” (Anthierens et al., 2012). Institutes in Palo Alto and the Netherlands are also planning to use LifeGuide extensively.

The digital humanities user community of the German TextGrid initiative, a partner of the TextVRE and Text.Link projects at KCL are accessing and re-using the outcomes of the projects via the TextGrid infrastructure, but no statistics are available at present as to the extent. At KCL, the software developed is available on a server maintained through the overall digital humanities departmental budget (for technical infrastructure). It is used by about 30 researchers within the department who are using digital tools for textual studies.

39 http://manchester.siggraph.org/
40 http://maths-magic.ac.uk/index.php (including MAGIC annual reports with metrics of usage)
41 http://projects.kmi.open.ac.uk/e-dance/welcome/
However, uptake is “not as much as one might anticipate” due to lack of integration into the overall institutional landscape.

The outputs of gMan\(^{42}\) are integrated into the D4Science framework and, although there are no numbers on use or re-use (direct impact), international queries about this piece of work come in occasionally at KCL.

The metadata catalogue created in the SERPent project is still available and used at the MRC Centre of Epidemiology for Child Health\(^{43}\), with a smaller number of people from other institutions using it. About 20 people (data managers and researchers working on the studies) have benefited directly from SERPent.

The AMI project developed a proof-of-concept solution, the software source code was disseminated but no other impacts have been discovered. However, there was a perception that “the JISC projects were really not about delivering software at all. They’re actually delivering people” – and doing so very successfully. Knowledge and experience gained helped members of the research group significantly in their future career paths.

The BRAIN project coincided with a phase of research strategy restructuring at the University (around eight key ‘Grand Challenge’ themes), which opened up opportunities for BRAIN to provide support through project work, while helping formulate strategic plans.

During BRAIN, activities were also successfully tied in with initial work done in the DINCoP project\(^{44}\) (a previous project at Coventry on ‘Developing Innovation Networks and Communities of Practice’, DINCoP within the JISC Emerge programme\(^{45}\) in interviewing a number of individuals and conducting group sessions on various topics. This added up (including meetings held during DINCoP) to around 150 sessions, providing a lot of very useful information and community engagement.

Although not fully supported, most of the tools and the website BRAIN developed are still frequently used, perceived as very useful and user communities would like to see more sustainable support.

6.3.2 Potential/Future Impact

After the completion of SERPent it is planned to continue work using the DDI3 format, which is easier to use and therefore would take less time to document and manage studies, in the MRC/ESRC funded UK Birth Cohort Study\(^{46}\). This is a collaboration with the UK Data Archive (UKDA)\(^{47}\). This large, longitudinal study is currently in the design phase (itself taking one and a half years), with DDI3 enabling the development of more structured and versionable documentation. This will make it possible for later data collections to be added to the current data catalogues. This also might help to make the case for a general support of data documentation in the Centre.

\(^{42}\) [http://www.d4science.eu/node/631](http://www.d4science.eu/node/631)


\(^{45}\) [http://www.jisc.ac.uk/whatwedo/programmes/usersandinnovation/emerge.aspx](http://www.jisc.ac.uk/whatwedo/programmes/usersandinnovation/emerge.aspx)

\(^{46}\) [http://www.esrc.ac.uk/funding-and-guidance/tools-and-resources/research-resources/surveys/bcf.aspx](http://www.esrc.ac.uk/funding-and-guidance/tools-and-resources/research-resources/surveys/bcf.aspx)

\(^{47}\) [http://data-archive.ac.uk/](http://data-archive.ac.uk/)
The MRC Centre of Epidemiology for Child Health (which ran SERPent) will be one of four e-Health Centres of Excellence hubs devising research catalogues supporting record linkage. In connection to this the plan is further “to use what we know from DDI across UCL to assist in the creation of these catalogues.”

VRE-CI had been delayed by technical dependency issues, but the team is very keen on acquiring funding to finally test the software release and develop it further: “it would be a minimum of six months to a year I think to test the software, deploy it and start data the process with the users to get it in an optimum stage for them to use.”

The AMI PI now leads a project called AMI2, based around an intelligent chemical thesis system; if funding routes emerge for AMI itself, it might continue with a proper follow-up.

There has been some sustainability through activities or projects at Coventry University that were able to make use of one tool or the other or learn from BRAIN’s experiences, e.g. in the OpEx programme or “an area called human security which is a sort of wider area of security.”

6.4 Miscellaneous Findings

All interviewees professed a very positive view of the JISC VRE programme and JISC as a funder across its various programmes in general. JISC’s remit was assessed as very innovative, i.e. in supporting endeavours across disciplines, institutions, themes and, in part, internationally.

Communication with JISC in the programme has been perceived as lightweight and functional, although some interviewees point to a brief period at the start of phase three (transition between programme managers) when there was an absence of direction and advise.

In terms of transition, it is recognised that JISC is going through a transformation towards a new entity and set-up. There has been some disquiet about the lack of information on what to expect post transition.

Events held during the VRE programme mostly received good marks, especially for providing projects with an overview of each others’ activities and as dissemination forums. However, a number of interviewees stressed that they would find some kind of way of interaction post-project very useful to catch-up on further progress and developments coming out of a respective strand. Across the board, it was mostly the PIs, PMs, developers and other typical project personnel attending programme events, whereas user communities and domain experts seem to have been rarely involved. This was often justified by lack of time but, if there would be a stronger effort to engage user communities and domain experts (and the JISC Engage programme was mentioned as a good example) this might reap benefits for engagement. It was acknowledged that this would require quite additional resources.

6.5 Sustainability Issues

6.5.1 Landscaping Study

The analyses conducted on the software project outputs of the JISC VRE programmes highlighted numerous sustainability issues. These are covered in detail in the Community Recommendations Report and Sustainability Recommendations Report and the Software Sustainability Maturity Model definition document (see Appendices).

48 http://www.seriousgamesinstitute.co.uk/research.aspx?section=14&item=486
As discussed above, the Landscaping Study evaluated VRE projects with software outputs according to a cut down of the Software Sustainability Maturity Model developed by Open Directive and OSS Watch.

The first two stages of this process, approximation and fitness, were designed to reduce an initial list of candidates for assessment. In order to assess the extent to which assessed projects fitted into the JISC’s vision for outputs for their VRE programme, SWOT and Business Model Canvas (BMC) analyses were created for the programme through consultation with JISC staff. For the purposes of this study, the final assessment was a freedom rating.

The JISC VRE projects were assessed alongside a semi-random selection of non-JISC VRE software projects obtained through guided searches and desk research. In general these external projects scored more highly than the JISC-funded projects, which is to be expected given that the high profile of these projects is largely due to their maturity and demonstrable sustainability. This was borne out by the initial approximation evaluation of the projects, both in the raw scores and the weighted scores, which attempt to give greater significance to factors of importance to the programme. Here the JISC VRE projects scored 52% (un-weighted) and 59% (weighted) while non-JISC VRE projects scored 77% (un-weighted) and 84% (weighted).

In the fitness evaluations, which rate how well a project accords with the funder’s conception of the aims of the VRE programme, the external projects again outscored the internal. JISC projects scored 27% (weighted and un-weighted) and externals scored 44% (un-weighted) and 61% (weighted). This helps to validate that the model derived from the SWOT and BMC analyses created in consultation with JISC, in that mature, sustainable global projects in this space accord well with it. It should also be noted that, as measured against the initial SWOT and BMC, there was no incremental improvement in scoring over the three phases of the programme, which is a disappointment in that it would be expected that subsequent funding rounds would build upon capacity and experience from the earlier programmes.

The freedom evaluations, as might be expected, showed that the internal projects were at an earlier stage of maturity and sustainability than the external. Freedom levels are scored between 1 and 9. JISC projects scored an average of 3 and external projects scored an average of 7.8.

The Software Sustainability Maturity Model as used for this report is a progressive assessment, passing the highest scoring candidates from each stage to the next in a bronze-silver-gold progression. Seven JISC projects gained gold status (CSAGE, Kepler Workflow Interface, Sakai VRE Demonstrator, CREW, MyExperiment, ViCoVRE, CIVRE/VRE-CI). Overall, these best scoring JISC projects shared certain properties with each other and the evaluated external projects. The full list of these properties, arranged in the form of a SWOT analysis, can be seen in the Community Recommendations Report. From this profile it is possible to derive some general lessons about successful sustainable VRE development.

**Produce early, usable, quantifiable results** Many projects indicated that keeping users engaged with a project was difficult. This is, in part, because each project was an early stage, experimental project and thus could not promise measurable results for users. Successful projects tended to engage the user community with frequent predictable releases.

**Build upon existing systems or resources** This relates both to the technological underpinnings of the project in terms of standards and code, and also functionality of the systems, which will be more sustainable if it adds value to existing valuable assets via (for example) annotation, preservation or syndication.
Identify and exploit collaboration opportunities While there were no fully realised commercial collaborations among the JISC projects, willingness to identify and investigate opportunities to collaborate with external entities seemed to correlate with maturity and sustainability.

Do not neglect community and ecosystem development Successful projects generally communicated well and often with their user community, and were able to offer value in the form of collaboration and/or code to other projects in their domain.

6.5.2 Case Studies

Sustainability is a very crucial factor for wider VRE adoption. A number of research groups and cross-institutional teams have been able to make good use of continuation funding or use funds from other activities to keep software, servers and/or minimal support running. However, this does not guarantee that outputs can be properly sustained post-project, integrated into existing institutional landscapes, wider uptake fostered or further development enabled. In some cases, sustainability works via funds from follow-on projects, but it remains notoriously difficult to get business plans, sustainability models and crucial high-level stakeholder buy-in at institutions (the JISC MRD programme requires such from projects in their current strand of infrastructure projects – the final decision still rests with the institution). It has to be said that this is mainly down to institutional factors and not JISC, as a funder only has limited leverage here.

Project durations have been seen as mostly too short in the Rapid Innovation strand. This can work if a project is very focused and builds on previous work, but at least nine months to a year seems to be the minimum time necessary to realise project goals, in particular, if development is involved. Also, short projects make it sometimes hard to get continuation funding as planning gets more difficult and administrative overhead is quite substantial.

There are recommendations for sustainability of software outputs that JISC could help with:

- funding a maintained and supported repository for software;
- put mechanisms in place to move software outputs post-project towards sustainability; Open Source is not the universal solution, and does not hinder more commercially viable routes. Resources for maintenance and support are mostly not available in a robust way, if there is not already an established developer community connected to a ‘product’.

A commercial arm for software is seen as a good way to try to make proper use of invested funding, which otherwise often just vanishes; lessons learned and knowledge transfer and proof-of-concepts are important, but to actually have a supported VRE would benefit the community even more - and maybe allow even more long term evaluation of systems in use.

Such an approach might also help with some perceptions of the JISC VRE programme having been ‘ahead of the curve’, leading to no adoption because communities are not able to respond quickly enough. Technological innovation is not an effective driver if the community is not at the right stage and time; awareness raising and diffusion evidence of benefits takes time and, most probably, more funding in future rounds, which at the moment seems to be hard to come by.

Another point made reflects the audience of funding calls and subsequently communities supported; UK arts and humanities communities stress that funding for their discipline areas seems to have been in decline in recent years. Hence, there is a feeling that “there should be a programme catering for arts and humanities/social science, in particular”. Having such a programme run by JISC would be very beneficial, as JISC brings in the interdisciplinary aspect and communities to learn from as well.
6.5.3 Sustainability Approaches

The Software Sustainability Institute has developed a list of possible approaches for sustaining research software. This can serve as a basis for the development of sustainability approaches for NeISS but, since the outputs of VRE projects may be services rather than software products, the model provided by SSI needs to be extended. Sustaining the software underlying a service is a pre-condition for sustaining a service, so each of the models for sustaining a service goes along with a number of options for sustaining the underlying software. As services are often composed of a number of different software components, different sustainability options may apply to each of them.

The main elements of service sustainability are operational support (system administration) and user support (Procter, Poschen and Voss, 2012). If both are in place, it is possible to distinguish a first set of sustainability options by considering who provides each of these elements when a service is maintained in full operational form (see Table 1). In addition, a full sustainability strategy would also have in place a plan for continuing development of tools and resources.

Clearly, these options are partly overlapping and can be used in combination. For example, when using the Backburner approach (just leaving a system running), it makes sense to create an image like in the 1* Freezer approach to ensure against hardware failure. It is also clear that the value each of them provides and the cost involved differ greatly but can ultimately only be fully assessed against the state and requirements of each individual service.

When choosing a sustainability option it is important to think about possible future developments and to ask whether the choice made today precludes other choices being made in the future. That is, choosing an approach should not consider simply a single choice but a potential sequence of options that can lead to a desired outcome. For example, choosing the 3* Freezer option opens up the possibility of establishing new hosting and support arrangements in the future.

6.5.4 Business Models

The JISC-sponsored Models of Sustainability Workshop (JISC, 2007) produced a set of business models for sustainability. These are summarised in Table 2. The report from workshop breakout sessions also pointed to the inherent contradictions in relying on academic researchers to take the lead in ‘translation’ i.e., the embedding of prototype services in the wider user community:

“Academia provides an optimal model for the proving of concepts, and can, under specific circumstances, demonstrate that highly integrated approaches are achievable. However, the incentive structure … demands both ongoing reinvention and a measure of isolationism and one-upmanship; the model is developer focused and does little to reward productisation of concepts that have already been proven.”

Translation marks a change in purpose from one that is primarily research oriented to one that must focus on the provision of a service. For this to be successful, responsibility needs to be handed over to those who have expertise and experience in service provision (Barjak et al., 2013).

6.6 Dissemination Event Feedback

The afternoon of the dissemination event was devoted to a discussion about sustainability issues raised by the study. One of the key discussion points was the relationship of projects with their institutional hosts, focusing on a) senior management and b) HEI IT support services.
<table>
<thead>
<tr>
<th>What?</th>
<th>How?</th>
<th>Option Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>Ongoing hosting and provision of support by the original developers.</td>
<td>NoChange</td>
</tr>
<tr>
<td></td>
<td>Developers provide ongoing support but hosting arrangements are changed.</td>
<td>Hosting</td>
</tr>
<tr>
<td></td>
<td>A hoster takes over responsibility for both hosting the service and providing support.</td>
<td>Handover</td>
</tr>
<tr>
<td></td>
<td>Ongoing hosting by the developers but no ongoing user support.</td>
<td>Hob</td>
</tr>
<tr>
<td></td>
<td>Hosting by the developers without admin support or user support.</td>
<td>Backburner</td>
</tr>
<tr>
<td></td>
<td>New hosting arrangements but no ongoing support.</td>
<td>Réchaud</td>
</tr>
<tr>
<td></td>
<td>Termination of service with resources being turned off but kept in place.</td>
<td>Fridge</td>
</tr>
<tr>
<td></td>
<td>Termination of service with (virtual) machine image in place to allow re-creation.</td>
<td>1* Freezer</td>
</tr>
<tr>
<td></td>
<td>Termination of service with configuration management in place to allow re-creation</td>
<td>3* Freezer</td>
</tr>
<tr>
<td></td>
<td>Termination of service with arrangements in place that allow users to re-create the service, e.g., in the cloud.</td>
<td>ReadyMeal</td>
</tr>
<tr>
<td></td>
<td>Termination of service with report available on lessons learned.</td>
<td>Recipe</td>
</tr>
<tr>
<td></td>
<td>Termination of service.</td>
<td>Bin</td>
</tr>
<tr>
<td>Software</td>
<td>No change to the software, hope that it will not become obsolete.</td>
<td>Technical preservation</td>
</tr>
<tr>
<td></td>
<td>As above but with an emulation layer that insulates against changes in the operating environment.</td>
<td>Emulation</td>
</tr>
<tr>
<td></td>
<td>Investing into bringing the software into line with a new operating environment.</td>
<td>Migration</td>
</tr>
<tr>
<td></td>
<td>Opening up development, adding effort available and spreading knowledge across institutions.</td>
<td>Cultivation</td>
</tr>
<tr>
<td></td>
<td>Preparing software so that it can be resurrected at a later point in time.</td>
<td>Hibernation</td>
</tr>
<tr>
<td></td>
<td>If there are no resources for the above then this may be the only option.</td>
<td>Deprecation</td>
</tr>
</tbody>
</table>

Table 1: Sustainability options for software and services
Table 2: Business Models for Sustainability (JISC, 2007).

It was noted that making a case for institutional buy-in post-funding is often very difficult for academics to do. The end of project funding is typically too late and, ideally, buy-in needs to be in place from the start. It was suggested that JISC could make criteria for institutional buy-in more stringent in future programmes, while accepting also that this would not suit all kinds of programmes or projects. The group acknowledged that academics are not very experienced or skilled in making business cases to institutional management and it was felt that they needed support (and incentives) to do this effectively. A business case 'how to' guide would be a start but some form of advisory service would be more effective for providing advice on dealing with local contingencies.

The participants were interested to understand why the sustainability score for VRE projects was less than the non-JISC VRE ‘bench mark’ projects and questioned whether this suggested that JISC was not putting in place the right criteria. It was noted that the JISC
Managing Research Data Programme\(^{49}\) required a business case and a sustainability plan, together with a clear statement of institutional buy-in.

Following the institutional sustainability pathway will typically mean reliance for maintenance and ongoing operational support being placed in the hands of institutional IT support services. The participants had concerns, however, about the capacity of HEI IT support to deliver this effectively. In particular, HEI IT support was seen as being too out of touch with users to understand and act on users needs. As one participant put it “[xxx] became less of a useful tool when IS took over … it became a commodity service and less functional because of that.” The lowest common denominator often takes precedence on an institutional-wide level. Part of the problem stems from the trend for institutional IT support to become more centralised (and hence more remote from users) and to focus more on commodity services rather than “pushing the boundaries” of research infrastructure – or, as one participant put it, “the institution is a late adopter” in such cases. Hence, the views of the group appear to be at odds with the conclusions of the JISC-funded review of HEI IT support models (Hawtin et al., 2010), which questioned whether moving IT support closer to users actually does deliver better results, and more in tune with the findings of the e-Uptake Follow-on study (and the evidence of the IT services research literature more generally), which suggested strongly that it does. The e-Uptake Follow On report noted:

“Fostering the adoption of innovations is a process whose support needs to change over time. At its inception, a new service demands close engagement between technical experts and users, but as it matures and becomes more widely adopted, then the benefits of this close engagement become harder to justify, while the costs of providing it increase with the growth in the number of users. As a consequence, which of the localised or centralised support options is most appropriate for a given service will change over the adoption lifecycle.” (Procter and Voss, 2010)

However, there is no formula for deciding when the transition to commodity support is appropriate. This can only be determined if there is a good relationship between IT support services and their users. Unfortunately, the evidence is that this cannot be relied upon, so users (and researchers in particular) have become progressively more accustomed to looking elsewhere. For example, the Research Information Network (RIN) report on the adoption of Web 2.0 services in scholarly communication concluded

“The adoption of Web 2.0 services has often by-passed central HEI computing and information services – reflecting the importance of local support and innovation by research groups … These observations suggest the need to reconsider institutional support structures and approaches.” (RIN, 2010, p. 52)

The consensus was that there is a need for HEIs to build capacity in IT support services, but whether JISC is in a position to encourage this was unclear. It was also noted that existing institutional cultures, as reflected in politics, norms and processes, always plays an important part – changes here need to be driven from the inside and take time. Finally, the issue of the innovation lifecycle and whether this had a bearing on what steps should be taken was raised. In particular, would it be more relevant to for JISC to provide support for ‘crossing the chasm’ (i.e. encouraging adoption of VRE innovations – or even commodity solutions) rather than more ‘leading edge’ innovation. This raised the question as to whether JISC should actively promote some of the more mature VRE solutions. In this vein, it was suggested that, in the future, JISC might contribute to development and interoperability in

\(^{49}\) http://www.jisc.ac.uk/whatwedo/programmes/di_researchmanagement/managingresearchdata/infrastructure.aspx
the sector by working with commodity solution providers such as Dropbox and funding work to create sector-specific extensions for supporting research. It was also noted that funding development around specific open standards might be a fruitful approach to the creation of sustainable, cross-institutional toolsets. This could conceivably be tied into the Cabinet Office’s current work via the Open Standards Hub to identify relevant interoperability standards in all areas of public software procurement to prevent lock-in and promote reuse.

7 Recommendations

We begin this section with a summary of possible responses to the issues presented in Figure 1 (Voss et al., 2007), then examine in more detail specific responses to issues that came out of the fieldwork and conclude with recommendations that would conceivably fit within what we understand to be JISC’s remit.

**State of implementation** does not provide the well-defined, robust, useful and usable services required for wider uptake. **Response**: development of organisational structures that support the further development of software to meet commercial software engineering standards (e.g. SSI).

**Lack of professional support** for many technologies involved and support available is often ill-matched to users’ needs, e.g. in terms of level of skills assumed. **Response**: provision of support through national centres of excellence for specific research areas and in combination with local provision at research institutions.

**Lack of availability of technical skills** required to develop and operate VREs are not widely available. **Response**: development of specific training programmes such as the Master in e-Science offered by the University of Edinburgh.

**Lack of demonstrable benefits** needed to secure further investment. **Response**: increase degree to which activities are self-sustaining (i.e. open source model); the fact that people are willing to invest effort and resources proves that there are benefits.

**Lack of critical mass** of active users and routine usage. **Response**: active support through user engagement, co-development of services and provision of education and training events aimed at researchers.

**Unresolved methodological issues** in some research communities, for example, about the status of different sources of data (transaction data versus panel surveys). **Response**: discipline-specific initiatives need to engage with methodological discussions in targeted research areas.

**Uncertainty about development** and standardisation of technologies. **Response**: provision of forecasting reports and roadmaps for technical development by experts in the field and increased outreach activities by institutions such as SSI, OSS Watch and JISC.

**Uncertainty about funding** caused by short-term funding models and lack of diversity of funding sources, leading to an exposure of multiple efforts to the same risks. **Response**: negotiations with funding organisations to provide longer-term funding opportunities, subject to regular review. Transition of software/services to a commercial environment, which develops, maintains, and sells the services/software.

**Lack of Standardisation** in many areas means those standards that are available are not mature, widely accepted and have interoperable implementations. **Response**: strengthening the role of organisations like the SSI, developing certification programmes, improving dissemination activities.

**Licensing issues** may prevent the use of commercial software. **Response**: negotiation of licensing arrangements suitable for the use of software and data in grid environments, at different levels: community, national and international.
Incompatible Open Source Licenses. Response: definition of an acceptable license or an acceptable set of compatible licenses for new developments.

7.1 User Engagement

As VREs mature, the focus shifts from technical problems of distributed computation to the embedding of these technologies into organisational settings, into arrangements within research communities and into the wider societal context. VREs need to be understood as socio-technical arrangements whose success depends on having both the right technical and human infrastructure in place (e.g., Edwards et al. 2007; Procter and Voss, 2012).

Divisions of labour and organisational structures can create barriers to adoption and effective use of VREs (Procter and Voss, 2012). Higher Education Institutions (HEIs) need to foster closer collaboration between local support services and their users so that the former have a better understanding of the latter’s requirements and the latter have a better grasp of the opportunities available to innovate research methods and practices. HEIs need to share user engagement practices, identify what works and resolve issues in their implementation.

Bringing about changes to divisions of labour and organisational structures is made more difficult because, compared to the level of investment in VRE development, investment in human infrastructure has been modest. This imbalance must be addressed if investment in VRE programmes is to bear fruit. One lesson that we might draw is that VRE sustainability ‘begins at home’: i.e., if VRE projects and their host institutions don’t have plans and the right support structures in place from the beginning, then no amount of external enablers will compensate for this deficiency.

The problem of user engagement features strongly in the BIS review of e-Infrastructure. Focusing on the challenge of ‘crossing the chasm’ (i.e. achieving wider adoption of e-Infrastructure innovations), the review observes:

“One way of achieving this objective [crossing the chasm] is to encourage the use of mixed teams in e-infrastructure related projects. This would bring together researchers, research technologists and IT specialists who collectively can share their experience of best practice, reuse and re-purpose existing e-infrastructure and deliver products that meet the needs of the research community.” (BIS, 2010, p18)

Similarly, the recent RIN report on e-Infrastructure observes: “There is widespread concern about the low numbers of people available with specialist expertise to support researchers, to run the infrastructures, to manage data or computing services; and the lack of career paths for such people … The key problem that such people face is that there is no obvious and scalable career structure for them in the research and HE sectors,” (RIN, 2010, p. 20-21) This emphasises the importance of HEIs reviewing how they might increase incentives and provide career structures for people to take on hybrid roles (Hawtin et al., 2010).

More recognition needs to be given to research outputs other than scientific papers and HEIs need to recognise the value of encouraging innovation and create career pathways that will encourage the development of ‘hybrid’ expertise. One of the key issues for sustainability at the host institution level is the guarantee of continuity of local ICT support. HEIs need to put in place the support structures that enable users to draw on technical expertise when they need it. JISC has, by virtue of its acknowledged capacity to bring together stakeholders from HEIs, service providers and Research Councils, an important role to play in encouraging funders and HEIs to tackle these issues.

7.2 Commodification and Configuration

In any VRE, there are some components that are generic and can potentially be used by researchers in many disciplines. Commodification offers the opportunity for reuse on a large
scale and thereby to avoid duplication of effort where supporting tools already exist. For example, synchronous and asynchronous collaboration support can be provided through integration of tools like instant messaging, wikis, blogs, feeds, calendars, document repositories, etc. Their general applicability leads to wide support for their development and, consequently, it does not make sense to re-invent them. In addition, re-use of components facilitates skills transfer by technology and service providers as well as the end user. If every VRE came with its own authentication system, for example, this would hinder uptake significantly, so re-use of common solutions such as Shibboleth is important.

As technological innovations achieve maturity, the stock of commodity computing components will increase. Providing advice and assistance on how to make best use of these would seem to us to go some way to avoiding some of the obstacles to wider adoption and sustainability of VREs.

JISC should work with commodity solution providers such as Dropbox and fund work to create sector-specific extensions for supporting research. Funding development around specific open standards would be a fruitful approach to the creation of sustainable, cross-institutional toolsets. This could be tied into the Cabinet Office's work via the Open Standards Hub to identify relevant interoperability standards in all areas of public software procurement to prevent lock-in and promote reuse.

The cost-benefits and risks of different models of service provision need to be better understood. The range of outsourcing options available to researchers will continue to expand as third-party providers develop their service offerings for, e.g. compute, data hosting, etc. However, decision-making is currently hindered by lack of clear evidence of the benefits and pit-falls (Hammond et al. 2010). There is a role for JISC in gathering and disseminating such evidence.

7.3 Capacity Building in Sustainability Planning and Implementation

It seems clear from the results of both the fieldwork and landscaping study that the academic research community has not progressed significantly in its capacity to develop sustainable outputs from project funding. The principles for sustainability, as outlined above, are not, in themselves, complex. Indeed, we suspect that they are already quite well-known and understood by the community as a whole, and certainly to those of its members who have been involved in JISC VRE programmes. We might conclude that academics are simply not that interested in tackling the challenges of sustainability.

Many academic researchers might argue that they are not in the business of providing services. We note that the academic culture and, in particular, its reward system, does not generally encourage putting significant effort into software outputs. However, the evidence from the case studies paints a somewhat different picture. Here, we find not lack of interest on the part of the academics involved, but frustration with the obstacles in their way and a lack of relevant experience on how to tackle them. This, coupled by fluctuating institutional commitment and support (both at the level of ICT service provision and higher-level management), seems to us to be a more accurate explanation for failure. In summary, managing the transition from project to stable VRE provision demands particular skills that are not possessed by the typical academic.

There are, however, evidently examples of VREs that have been successful in meeting sustainability challenges and their lessons need to be communicated to a wider audience. We must conclude that not enough is yet being done to facilitate knowledge transfer and this is a gap that JISC is well-placed to fill. Lessons learnt by different projects can, of course, be collated into a guide or template format spell out a sustainability roadmap, outlining sustainability options and the steps that need to be taken to realise them, e.g. scaling up, administration and governance mechanisms, and business models (Barjak et al., 2013). This
certainly needs to be done, but relying on this exclusively as a knowledge transfer mechanism risks glossing over the nuances and context-specific issues that may, in practice, make the difference between success and failure. We suggest that what is needed to accompany such generic guidance is an advisory service that can help translate the generic lessons into context-specific actions and, most importantly, broker relationships between the different actors whose collaboration would be needed for success. This is not a new idea, as the quote below confirms:

“A collaborative pipeline, where end users partner with developers, academic institutions and public funders to attract commensurate public sector capital and rigour, might best enable productisation of e-Science platforms.” (JISC, 2007)

We envisage that the advisory service would complement – while also drawing on and coordinating – support already offered by stakeholders with relevant experience and expertise of knowledge transfer\(^{50}\), including that provided by Software Sustainability Institute for the software development process and by OSS Watch on business models for exploitation. While OSS Watch specialises in free and open source related models, this service would necessarily cover both. It should be supported by training workshops where community leaders can present their experiences first hand.

Finally, planning of future VRE programmes needs to be informed by mechanisms for factoring evidence gathering within research communities. JISC is well placed to ensure that intelligence about VRE usage continues to be gathered and analysed, the findings disseminated and acted on, and the outcomes tracked and evaluated – and to encourage individual service providers to do the same. Top-down vision and planning needs to be complemented by continuing encouragement of bottom-up innovation and it is to be hoped that JISC will have the resources to continue to fund the piloting and development of VRE innovations. In this respect, the fact that JISC is said to be looking at a ‘co-design’ approach to the specification of future programmes and selection of projects to fund is encouraging.

8 Bibliography


BIS (2010). Delivering the UK’s e-Infrastructure for Research. Available at http://www.rcuk.ac.uk/research/xrcprogrammes/eInfrastructur/eInfrastructure/Pages/home.aspx


\(^{50}\) JISC Business and Community Engagement Programme.


9 Appendices

9.1 List of deliverables

<table>
<thead>
<tr>
<th>Output / Outcome Type</th>
<th>Brief Description and URLs (where applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VRE projects overview</td>
<td></td>
</tr>
<tr>
<td>Research design</td>
<td>This report</td>
</tr>
<tr>
<td>Impact report</td>
<td></td>
</tr>
<tr>
<td>Barriers and enablers</td>
<td></td>
</tr>
<tr>
<td>Community Recommendations Report</td>
<td>Due March 22nd</td>
</tr>
<tr>
<td>Sustainability Recommendations Report</td>
<td>Due March 22nd</td>
</tr>
<tr>
<td>Software Sustainability Maturity Model</td>
<td>Completed</td>
</tr>
<tr>
<td>definition</td>
<td></td>
</tr>
</tbody>
</table>

9.2 List of Interviewees per case study

ViCo-VRE and follow-on ViCoX (VRE3); OneVRE (VRE3); CritterVRE (VRERI) – University of Manchester

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helen Bailey</td>
<td>University of Bedfordshire</td>
</tr>
<tr>
<td>Jitesh Gajjar</td>
<td>University of Manchester</td>
</tr>
<tr>
<td>Andrew Rowley</td>
<td>University of Manchester</td>
</tr>
<tr>
<td>Tobias Schiebeck</td>
<td>University of Manchester</td>
</tr>
<tr>
<td>Martin Turner</td>
<td>University of Manchester</td>
</tr>
</tbody>
</table>

IBBRE, VRIC and follow-on ViewMyVRIC (VRE3) – University of Southampton

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simon Grange</td>
<td>University of Alberta, Canada</td>
</tr>
<tr>
<td>Alejandra Recio Saucedo</td>
<td>University of Southampton</td>
</tr>
<tr>
<td>Gary Wills</td>
<td>University of Southampton</td>
</tr>
<tr>
<td>Lucy Yardley</td>
<td>University of Southampton</td>
</tr>
</tbody>
</table>

TextVRE and its follow-up Text.Link (VRE3); gMan (VRERI) – Centre for e-Research, KCL.
<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peter Gietz</td>
<td>DAASI International GmbH, Tübingen, Germany</td>
</tr>
<tr>
<td>Mark Hedges</td>
<td>KCL</td>
</tr>
<tr>
<td>Marc Wilhelm Küster</td>
<td>University of Applied Sciences Worms, Germany</td>
</tr>
<tr>
<td>Charlotte Rouché</td>
<td>KCL</td>
</tr>
<tr>
<td>Thomas Selig</td>
<td>University of Applied Sciences Worms, Germany</td>
</tr>
<tr>
<td><strong>German TextGrid project; D4Science Initiative</strong></td>
<td></td>
</tr>
<tr>
<td>Tito Castillo</td>
<td>UCL</td>
</tr>
<tr>
<td>Spiros Denaxas</td>
<td>UCL</td>
</tr>
<tr>
<td>Rachel Knowles</td>
<td>UCL</td>
</tr>
<tr>
<td>Andy Ryan</td>
<td>UCL</td>
</tr>
<tr>
<td>Aida Sanchez</td>
<td>UCL</td>
</tr>
<tr>
<td>Anthony Thomas</td>
<td>UCL</td>
</tr>
<tr>
<td><strong>SERPent (VRERI) – UCL</strong></td>
<td></td>
</tr>
<tr>
<td>Stephen Andrews</td>
<td>British Library</td>
</tr>
<tr>
<td>Maria Susana Avila Garcia</td>
<td>University of Oxford</td>
</tr>
<tr>
<td><strong>VRE-CI (VRE3) – University of Oxford, RIC (British Library &amp; Microsoft Research)</strong></td>
<td></td>
</tr>
<tr>
<td>Brian Brooks</td>
<td>University of Cambridge</td>
</tr>
<tr>
<td>Peter Murray-Rust</td>
<td>University of Cambridge</td>
</tr>
<tr>
<td><strong>AMI (VRERI), University of Cambridge</strong></td>
<td></td>
</tr>
<tr>
<td>Paul Fairburn</td>
<td>University of Coventry</td>
</tr>
<tr>
<td>Jim Hensman</td>
<td>University of Coventry</td>
</tr>
</tbody>
</table>