



**ViBRANT**  
*Virtual Biodiversity*

## **D 2.3 Financial sustainability**

Report on options for the ViBRANT financial sustainability model  
including selection of preferred model and accompanying  
Service Level Agreements (SLA's).

Date: 31 May 2013

Work package: WP2 'Technical architecture'

Partner: NHM

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<http://vbrant.eu>

EU Contract No 261532

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## Context

The ViBRANT project was designed to be a network of compatible services rather than a single resource. Such a design benefits from robustness of many linked nodes and no single point of failure. The research landscape in biodiversity informatics is accelerating, like so many others in modern science. This pace of change means that a static design is likely to have a short useful life. It is therefore appropriate to review the context within which the services developed by ViBRANT will be sustained.

Biodiversity information in digital form is a comparatively young resource, characterised by a "long tail of dark data" (Heidorn, 2008). The potential for these data is undisputed and a spectrum of projects have focussed on ways to exploit these resources, particularly how to aggregate them into a modest number of portals.

By its nature, project funding is time-limited and sustainability has most commonly been achieved by rolling one project into another, with four notable exceptions. First, the European Bioinformatics Institute, part of EMBL (<http://www.embl.org/>), makes data from life science experiments freely available, covering the full spectrum of molecular biology. Second, the GBIF Secretariat was established as a central body by means of an intergovernmental Memorandum of Understanding and is supposed to be funded continuously. Third, some natural history collections are making their holdings available on-line as part of their core-funded activities. Fourth, the Ocean Biogeographic Information System (<http://www.iobis.org>; OBIS) was adopted by the Intergovernmental Oceanographic Commission of UNESCO, as one of its activities under its [International Oceanographic Data and Information Exchange](#) (IODE) programme. Therefore, the funding horizon of OBIS goes far beyond that of a normal 3-5 y project. OBIS has established a number of regional nodes. One of these nodes is the EurOBIS, which was established in the context of the MarBEF Network of Excellence.

During the summer of 2012 a public consultation on biodiversity informatics (Hardisty *et al.*, 2013) established the community's priorities for the field in the coming decade. The vision for sustainability for both data and services was that they needed to be underwritten by institutions with their own stable funding. This approach divides the services into two phases. First, grant funding was essential to develop the service and to bring it to a level of maturity. Second, the [potential] host institution can evaluate the fit and contribution of a service to their overall mission. Potential hosts reasonably require several years track-record of costs associated with a service and that such costs have to be after the primary development phase, so typically between 5 and 10 years after project initiation. This is well out of kilter with the usual grant funding rounds of between 3 and 5 years, so services can be expected to require support through at least 2 rounds of grant funding. We are now beginning to see the first of these services being adopted by well-founded institutions. For example, the development of Naturalis, formed in January 2010 by the merger of Naturalis (itself formed by the merger of [Rijksmuseum van Natuurlijke Historie](#) and the [Rijksmuseum van Geologie en Mineralogie](#)) with the [Zoölogisch Museum Amsterdam](#) and the National Herbarium of the Netherlands creating Europe's second largest natural history museum. This on-going development and rationalisation naturally requires a strong digital presence to further its mission. [ETI Bioinformatics](#) is an NGO founded by the University of Amsterdam and UNESCO and is a source for reliable taxonomic and biodiversity information ([World Biodiversity Database](#), [World Taxonomist Database](#)) and the Linnaeus II software modules. It recently merged with [Naturalis](#), providing added value to both partners and further structures the field of biodiversity research in The Netherlands. Naturalis, as national biodiversity centre, wants to build a strong biodiversity informatics component and data management infrastructure, ETI's expertise and software fit into the plan to realise this. Naturalis has vast biological collections and an enormous amount of taxonomic expertise, so they can offer opportunities for quality information services and e-products published by ETI. Naturalis is the new host for the Species 2000 Secretariat and will facilitate the Catalogue of Life services in the coming five years. Hosting and ICT facilities will be offered to other important international information providers in the biodiversity community (such as Zoobank) to ensure they will remain available. Naturalis hosts an installation of the EDIT Platform for Cybertaxonomy in combination with ETI's Linnaeus NG software to support user in sharing information and to create quality information services. Naturalis is an outstanding example of institutional support for a swathe of biodiversity informatics projects that are mature enough to offer services beyond a small cadre of researchers.

Large natural history institutions in Europe (and outside) must collaborate and take (joint) responsibility for the informatics instruments that were created to accommodate the work of the community. Commitment comparable with Leiden, detailed below, have been made by the Natural History Museum in London (Europe's largest natural history museum), the Botanic Garden and Botanical Museum in Berlin-Dahlem (holding Germany's largest botanical collection, and amongst the largest in the world) and the Université Pierre et Marie Curie-Paris 6 / Muséum National d'Histoire Naturelle (UPMC-MNHN) in Paris.

It is also noteworthy that while other Museums, such as Museum für Naturkunde (MfN) in Berlin (one of the world's main zoological museums and leader of the EU BON project), are moving in the same direction, hiring permanent staff to plan the infrastructure that will give the Museum an appropriate place in the digital landscape.

The MfN, encouragingly, has recognised the suitability of the Scratchpads (a ViBRANT product) as a potential alternative editing tool for Fauna Europaea experts, where Fauna Europaea is itself hosted in the CDM (also a ViBRANT product). This is a good illustration of the integration between different services and we anticipate that such integration, e.g. with the production of data papers (Pensoft) and vocabulary terms (GBIF) will arise as and when they are needed.

## Sustainability objectives

'Services' in this context refers to an accessible resource on the web, i.e. the provision of data, analytical tools or virtual research environments.

*A service will be considered sustainable if it is both available and continues to be used on an open-ended basis.*

The most important drivers of sustainability are user confidence, judged by users' willingness to invest time and effort into using the services, and user demand, judged by access rates, which provides the foundation of political support for the service. The service should also be developed by more than one individual team, as is the case for open source software. It is not implicit that a service will continue to grow or evolve to be sustainable. Some services will have a natural lifespan and will disappear when they cease to attract users.

## Service Level Agreements

Service Level Agreements (SLAs) are commonly seen as instruments to imbue user confidence, but the nature of an SLA is bipartite and embodies some form of penalty, usually financial, for failure of the service. SLAs are not appropriate instruments for open data and open services, as envisaged by the infrastructure of projects like ViBRANT, because they are not scalable to a large number of users and there is very rarely any financial obligation on, or return to, the data provider.

A better method is to use a Service Level Description, often expressed as a service policy, for instance the Scratchpad policies (<http://scratchpads.eu/about/policies>). The purpose of the policy is to provide a clarification of the responsibilities of the service provider and that of the service consumer. In the case of the Scratchpads, this agreement is explicit, bound into the terms and conditions to which users agree when getting their accounts. Others are implicit, being open to examination at any time. Casual users, occasional consumers of services, generally have access without the need to accept the policy. This represents an appropriately flexible work environment intended to encourage use of the services without being unreasonably onerous for the service provider.

## LifeWatch

The European Strategy Forum on Research Infrastructures (ESFRI), [http://ec.europa.eu/research/infrastructures/index\\_en.cfm?pg=esfri](http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri)) is a strategic instrument to develop the scientific integration of Europe and to strengthen its international outreach. LifeWatch (<http://www.lifewatch.eu/>) is the ESFRI designed to support biodiversity research and will integrate access to a variety of data, analytical and modelling tools as served by a variety of collaborating initiatives. ViBRANT, alongside other European projects, has been collaborating with the nascent LifeWatch, now in its construction phase, with a view to piloting services that LifeWatch will need. We anticipate that LifeWatch will want to adopt some, perhaps all, of the services developed in ViBRANT, but will do so through a series of SLAs between LifeWatch and the service provider, the latter being the organisation that takes responsibility for that service, as described below. Such agreements can only take place when LifeWatch is formally constituted, i.e. when the constituent Governments have signed the legal framework for a European Research Infrastructure Consortium (ERIC), expected to be in the summer of 2013. Once signed, LifeWatch will have a budget and can convene its board of Directors. The Directors can then prioritise the services most needed to make LifeWatch a practical reality for the European research community.

While ViBRANT anticipates that this will all come to fruition, to achieve sustainability the services have to be administered by a body able to enter into a legal agreement. It would be imprudent to consider adoption by LifeWatch as a the sole basis for sustainability at this stage.

## ViBRANT services

### 1 Scratchpads

**Status: secure**

The Scratchpads program was initially developed as part of the European Distributed Institute of Taxonomy (EDIT, <http://www.e-taxonomy.eu/index.php>), an FP6 Network of Excellence programme. It was extended by major funding through the EU FP7 research infrastructures programme (ViBRANT, <http://vbrant.eu/>) and UK research council funding (e-Monocot, <http://e-monocot.org/>) through to December 2013. Scratchpads have seen logarithmic growth in both the number of sites and the number of registered, active users since their inception in 2007 (<http://scratchpads.eu/explore>). The Scratchpad code is open source (<http://scratchpads.eu/develop/repository>) and is being installed by various people around the world. While significant extension of Scratchpad functionality will require further grant funding, active development by other groups or individuals is already starting to appear. It would hardly be credible for Scratchpads to offer a guarantee of permanence, but data entered into a Scratchpad are secure for the foreseeable future.

A mirror server run by the bioinformatics group at the Botanic Garden and Botanical Museum Berlin-Dahlem (BGBM) provides a synchronous copy of the Scratchpads servers. This group (part of the ViBRANT consortium) have signed a written agreement to archive, maintain and sustain access to this mirror service until 2016. Scratchpads have been incorporated into the Natural History Museum's (NHM) digital strategy (as indicated by the Museum's [Strategic Plan](#)) and as such are now supported by tenured staff. Whilst not guaranteeing future enhancement of the Scratchpads, it does guarantee access to the Sites with current levels of functionality for the foreseeable future.

The value of Scratchpads to the NHM is based on their continued use, part of which means growth of user numbers. The reputational gain to the NHM requires that the information present in the system is of high quality and that is ensured by firmly tying the information quality to the person entering those data, for which we provide citation and usage metrics. Data quality counts for little if the data are not accessible, so Scratchpads invest a substantial part of their resources into mechanisms for data access. Within this strategy we also need to train users so that they organise their data in efficient structures. Scratchpad training, funded under ViBRANT, has been by traditional face-to-face small group sessions, but within ViBRANT we have developed an extensive context-sensitive help system, implemented an integrated issue-reporting system accessible to any registered user and we are now working on distance-learning tools that can remove the major costs, i.e. travel, of providing training. Finally we have established a system of Ambassadors, local experts willing to give advice to local users and to run training courses. The Ambassadors have preferential access to the development team and are first to be told about upgrades and other leading-edge developments. This structure, having been established by ViBRANT funding, can now be affordably delivered by the NHM.

Scratchpads are fully open source and the code is available from our GIT repository (<https://git.scratchpads.eu/>).

### 2 Platform for Cybertaxonomy

**Status: secure**

The EDIT Platform for Cybertaxonomy (<http://www.cybertaxonomy.org/>) was also initially developed as part of the European Distributed Institute of Taxonomy (EDIT, <http://www.e-taxonomy.eu/index.php>), an FP6 Network of Excellence programme. It was extended by major funding through the EU FP7 research infrastructures programme (ViBRANT, <http://vbrant.eu/>), i4Life (<http://www.i4life.eu/>), EU-BON (<http://eu-bon.eu>) and by grants from the German GBIF programme (Ministry of Science), the research council (DFG) and the Federal Agency for Nature Conservation.

The Platform supports taxonomic research in the BGBM, Royal Botanical Gardens (Kew), Naturalis, the Museum für Naturkunde (Berlin) and the Belgian National Botanic Garden in Meise, with their respective international partners. Among others it hosts Euro+Med Plantbase (<http://www.emplantbase.org/>) and Fauna Europaea (<http://www.faunaeur.org/>), both developed in EU funded projects and part of the Pan-European Species directories Infrastructure (PESI, <http://www.eu-nomen.eu/pesi/>), which in turn is sustainably hosted by the Flanders Marine Institute (VLIZ).

The Freie Universität Berlin - BGBM have recognised the reputational and research value of hosting the Platform in a similar way to, and at much the same time as, the NHM. FUB-BGBM have made

two part-time permanent appointments, supported by a full position of data custodian, to maintain the Platform and provide further product development.

### 3 Biowikifarm

**Status: secure**

The biowikifarm is a comparable infrastructure to Scratchpads, in that it supports multiple independent wiki instances. Like Scratchpads, content of individual wikis is the property and responsibility of the data creator and can be updated or extended as often as the owner considers necessary.

The major function of the Biowikifarm is to host projects devoted to building ontologies for data management within the biodiversity domain, built on Semantic Media Wiki. This has led to the construction of the biowikifarm-based GBIF Terms service (<http://terms.gbif.org>), in cooperation with the GBIF-TDWG Vocabulary Management Task Group (VoMaG) (<http://community.gbif.org/pg/groups/21382/>). VoMaG is also proposing that the GBIF Terms service be adopted by TDWG and rebranded as <http://terms.tdwg.org> although it is likely to be in late 2013 before such a decision can be taken.

Sustainability of the biowikifarm will be achieved by transfer of the brand from ViBRANT to Plazi. The operational costs will then be split as follows:

1. *Basic technical/infrastructural operation (energy, network, server hardware);*  
Two German museum institutions, BGBM and Staatliche Naturwissenschaftliche Sammlungen Bayerns (SNSB), recognise that the preservation of digital biodiversity data is part of their corporate mission as biodiversity museum institutions and have assumed responsibility for the basic technical operation.
  2. *Legal responsibility management;*  
Plazi (<http://plazi.org/>) will take the formal legal responsibility for the Biowikifarm and has resources to take action should such be legally required.
- and
3. *Software maintenance;*  
Supported by Plazi and in-kind contributions from all projects sharing the biowikifarm (harvesting synergies).

### 4 PWT & Scratchpad publication tool

**Status: secure**

The Pensoft Writing Tool (PWT, <http://www.pensoft.net/services-for-journals>) is an integral part of the submission system to Pensoft's journals, developed for the *Biodiversity Data Journal* (<http://biodiversitydatajournal.com/>). It is an on-line collaborative platform in which authors write their manuscript, structured using templates provided by the journal. By structuring the content in this way, Pensoft can validate the text, lay out the journal pages automatically and send the manuscript to reviewers all without human interference. The staff time necessary to handle a manuscript is consequently much reduced and starts when the manuscript returns to the office with referee's comments. Once accepted, the production system can then render the manuscript into the various formats for publication, including PDF, HTML, XML and, if necessary, paper. The resulting cost savings in processing the manuscript mean that Pensoft can charge a minimal fee, probably of the order of a few hundred Euros, per paper to be published fully open access, irrespective of length.

In parallel with the PWT a module has been developed for the Scratchpads that performs essentially the same function, except that rather than writing content into the tool, content is assembled from material already on the web site.

The result of the investment by ViBRANT has positioned Pensoft in the vanguard of open access publishing. The importance of publishing content in parallel formats cannot be over-stressed. The XML format in particular allows content to be mined and re-used, as required by many funding bodies. Pensoft also publish under a simple licence (CC-BY) that leaves ownership of copyright with the authors, but allows the work to be freely re-used, in sharp contrast to the major publishing houses.

Pensoft is an SME and the tools described here contribute to their commercial model. As such we can have confidence that the publishing pipeline will be sustainable for the foreseeable future.

**5 Nodes Portal Toolkit Startup****Status: secure**

The Nodes Portal Toolkit Startup (NPT, <http://www.gbif.org/participation/participant-nodes/nodes-portal-toolkit/>) is a software tool similar to Scratchpads, based on the same code, designed to help GBIF Nodes to deploy national, regional or thematic biodiversity webportals using GBIF data. The NPT provides a standardised data structure while permitting local customisation necessary to develop a community identity. Overall this enhances engagement of countries with Nodes and encourages the liberation of more data into GBIF. The NPT Startup is explicitly focused on those GBIF Participant countries that have no, or only a limited, web presence.

The need for a tool of this kind has been established by the Nodes (national representatives) themselves, so GBIF is committed to providing and maintaining the tool. ViBRANT provided the opportunity to develop the code, and by sharing the Scratchpad development environment and code library, the development cycle was quite short. Currently, through the GBIF community, additional funding is levered into the development and deployment of the NPT Startup. Through a JRS foundation project INBio (the Costa Rican GBIF Node) and GBIF Benin are adding functionalities to the first version of the NPT Startup to allow connections to the GBIF adopted standards in publishing species occurrence data (e.g. through DwC-A). Developments within this project contribute to an initial biodiversity information site for Benin. Also, through the GBIF mentoring programme, a project will start to deploy the NPT Startup in several West African countries

GBIF will maintain the tool for the foreseeable future, in line with its international strategy. GBIF will also set up in 2013 the framework to enable GBIF Participant Nodes that are already planning developments in Drupal and on top of NPT Startup and Scratchpads jointly to plan and execute developments (see <http://www.nodesportaltoolkit.org>),

**6 OBOE****Status: uncertain**

The Oxford Batch Operation Engine (OBOE; <https://vibrant.oerc.ox.ac.uk/>) is, as far as we are aware, a unique service that offers a drop-and compute facility through a single API. The single API is the unique factor and is likely to be instrumental in opening access to a much wider range of potential users. OBOE's user numbers are growing logarithmically. The nearest comparable service is offered to students at the University of Oslo (<http://www.biportal.uio.no/>).

The services offer Scratchpads users a cloud computing service according to the latest standards for efficient data processing. We are, in particular, proud to facilitate the development of such a service as it is a flexible, reliable and green way of data computing, three core values with which ViBRANT identifies itself.

The prototype of OBOE was developed on a cluster of desktop machines, but such an environment will not be robust and will require dedicated management of both the hardware and software environment. For long-term stability OBOE was transferred to a virtual machine in Oxford that can be expanded or contracted depending on demand within the entire environment. This does, however, attract a real annual cost. Some of the computing power that OBOE used to process tasks was provided by the Oxford Supercomputer Centre, funded as a trial application. No mechanism has been devised to allow individuals to be charged for the CPU time used in the Centre.

A significant amount of work needs to be done to secure sources of funds to pay these charges.

**7 RefBank****Status: reasonably secure**

RefBank (<http://vibrant.ipd.uka.de/RefBank/search>) is an effort to build a comprehensive bibliography for biodiversity, the Bibliography of Life. In its first full year of operation it had accumulated 160,000 references. It runs on a number of parallel servers at Karlsruhe Institute of Technology, the Open University, Pensoft and Plazi. A list of current nodes is shown in Appendix 1. It is a core component of the Pensoft Writing Tool as a data resource for their ReFinder component. RefBank is being used in the EU funded projects, EU.BON (<http://www.eubon.eu/>) and pro-iBiosphere (<http://www.pro-ibiosphere.eu/>). RefBank will be installed at Missouri Botanical Gardens shortly when they have completed their current server upgrade.

Academic interest in RefBank continues after ViBRANT. For example, it features in a bid being developed jointly by the Open University and Free University, Amsterdam, to provide a data source for their proposed investigation into the evolution of research communities.

To open the data to researchers outside the biodiversity community, systems to replicate RefBanks' indexes in IBM Domino for query and analysis have been created, as well as systems to import RefBank's data content into BibServer (the Open Knowledge foundation's bibliography tool <http://bibserver.org/>). This work will indirectly assist RefBank's sustainability through it becoming a recognised data source.

The core RefBank functionality is being investigated as the basis for a taxon name bank, working title *BinomialBank*, in conjunction with the Global Names project (<http://www.globalnames.org/>), which represents another potential stream of continued support to the development and maintenance of the software.

After the funded period of ViBRANT, responsibility for RefBank will be shared by Pensoft Publishers and Plazi.

RefBank is open source software and the source code is available from our GIT repository (<https://git.scratchpads.eu/>).

## 8 GoldenGATE Status: reasonably secure

Traditional publication has led to a vast quantity of valuable data being effectively trapped in paper documents. The GoldenGATE editor has been developed with Plazi to assist in the mark-up of OCR-ed (Optical Character Recognition) biosystematics documents into XML content.

The software application is available in a variety of forms. As a single stand-alone desktop product (<http://plazi.cs.umb.edu/GgServer/Downloads/GoldenGATE.zip>) or as a web-based solution in which each function is a separate service, the open source code can be downloaded from the Scratchpad GIT servers (<https://git.scratchpads.eu/>). The services are also available through OBOE (see 6 above).

The further use of these services is being investigated in the EU funded agINFRA project (<http://www.aginfra.eu/>). The pilot port of a service to agINFRA's GRID infrastructure is due at the end of May 2013. This extension of the use of GoldenGATE into agricultural science will bolster its continuing support.

After the funded period of ViBRANT, responsibility for GoldenGATE will revert to Plazi.

## 9 Xper2 Status: secure

Identification keys are widely used by scientists to identify taxa. Xper2 provides a mechanism to create single-access (dichotomous) keys on demand from a descriptive data stored as SDD format. The software is available for download (<http://lis-upmc.snv.jussieu.fr/lis/?q=en/resources/software/xper2>) as a stand-alone product, as a direct web service (<http://identificationkey.fr/>) and as a service through OBOE (see 6 above). It is currently being integrated into the Platform for Cybertaxonomy (see 2 above).

Xper2 pre-dates the ViBRANT consortium and, unlike other ViBRANT software products, is not open source but is released under a Creative Commons BY-NC-ND licence. Only the core single-access key generating web services developed for ViBRANT is available as Open Source.

After the funded period of ViBRANT, responsibility for Xper2 will be taken back to Université Pierre et Marie Curie-Paris 6.

## 10 GeoCAT (GEOspatial Conservation Assessment Tool) Status: secure

GeoCAT (<http://geocat.kew.org/>) is designed to produce rapid species level conservation assessments based on IUCN Red List Categories and Criteria (<http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria>). Through an easy to use interface, users can upload primary occurrence data for a species and, at the click of a button, calculate values relating to the specie's geographical range. The software can connect to different Biodiversity resources such as GBIF or overlay datasets like the World Database on Protected Areas to help determine the endangered status of species more quickly and with greater precision.

The tool is being used by hundreds of scientists as well as for training by the IUCN itself. There have been more than 15 publications citing the tool and there is a user forum to share experiences. The code is open source and anybody can use it freely, either on the web as a service or run locally.

The tool was initially prototyped with funding from Kew Gardens. ViBRANT expanded it and moved it into production. A new EU FP7 project, EU BON, will continue further developing the tool. From an infrastructure perspective the tool was designed to require the minimum resources with most computation done on the user browser. Therefore the application is currently running on free hosting provided by Heroku (<https://www.heroku.com/>) and the on-going maintenance cost is negligible.

Vizzuality and Kew Gardens are committed to promoting the tool through new projects, expanding the significant user base, the future of the product is secure.

## 11 CartoDB

**Status: secure**

CartoDB is a geospatial database on the cloud that lets you visualise big, real-time data on maps. Its geospatial technology is accessible to anybody so they can create powerful applications and beautiful visualisations with data.

The tool was developed, partly with funding from ViBRANT, to help scientists do better data visualisation of their biodiversity data. It is also used together with GeoCAT. It is now being used by more than 15,000 users worldwide and is growing with more than 100 users per day. Vizzuality, the company that developed it, has created a hosting solution for it with different pricing plans to support the product. It has now attracted clients like NASA, Wall Street Journal, Harvard University, Yale, National Park Service, UN and many more. The business is self sustaining and has contracts for service for more than 3 years now.

## 12 COMBER

**Status: reasonably secure**

"Citizen science" is a burgeoning area of interest and presents commercial opportunities for eco-tourism. The inclusion of marine systems, especially those within reach of recreational divers, have hitherto been under-represented in citizen-scientist initiatives. COMBER (<http://www.comber.hcmr.gr/>) was created to address that shortcoming. Five diving clubs offered attractive discounts (20-25%) to divers who'd like to follow COMBER's underwater activities and also a discount for a ticket to the Cretaquarium and to an exhibition on Climate Change. Visitors to the Cretaquarium, on the other hand, had the option of a free tour and training on the fish species living in the tanks of the facility and illustrated in the FishCard ([http://www.bio-watch.com/index.php?option=com\\_virtuemart&Itemid=95](http://www.bio-watch.com/index.php?option=com_virtuemart&Itemid=95)). The discount rate offered by the Cretaquarium was 50% of the ticket for both the aquarium and the Climate Change exhibition.

COMBER's web site and functionality are based on Drupal and modified from the Scratchpads code-base in an independent installation. Further development of the functionality will be covered by additional grants. Specifically, all partners in CIGESMED (a project funded under SeasEra (ERANET) project) agreed to use COMBER at their kick-off meeting in April 2013.

Responsibility for COMBER will be assumed by HCMR at the end of the ViBRANT's funded period.

## References

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## Appendix 1

### **Current availability of RefBank services**

#### **Publicly accessible RefBank nodes**

RefBank-Boston-Dev	<a href="http://plazi2.cs.umb.edu/RefBank/">http://plazi2.cs.umb.edu/RefBank/</a>
RefBank-Boston-Live	<a href="http://plazi.cs.umb.edu/RefBank/">http://plazi.cs.umb.edu/RefBank/</a>
RefBank-KIT-IPD	<a href="http://vbrant.ipd.uka.de/RefBank/">http://vbrant.ipd.uka.de/RefBank/</a>
RefBank-KIT-Idaho	<a href="http://idaho.ipd.uka.de/RefBank/">http://idaho.ipd.uka.de/RefBank/</a>

RefBank-Pensoft-Sofia <http://pensoft.net:8080/RefBank/>  
www9.open.ac.uk <http://www9.open.ac.uk/RefBank/>

There are also test nodes, such as RefBank-OU, <http://mct-vibrant.open.ac.uk:8080/RefBank/>, and refinder.dev, <http://refinder.dev:8080/RefBank/rbk>, but these are not publicly accessible.

**Publicly accessible BinomialBank development nodes**

GNUB-Test-Boston-Dev <http://plazi2.cs.umb.edu:8080/gnubTest/>  
GNUB-Test-Idaho <http://idaho.ipd.uka.de/gnubTest/>