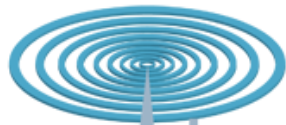


JISC



Project erewhon [er-uh-hwon]
[ere, 'hwon]

Final Report

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Tim Fernando - Project Manager

Please see <http://erewhon.oucs.ox.ac.uk> for the latest copy of this document and links to all outputs.

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We believe the outputs of Erewhon have been ground breaking and of utmost significance to the HE/FE community in this time of radical change in the IT industry. Realising these outputs at Oxford would not have been possible without the exceptionally strong support from our Director of Computing Services and Systems, Dr. Stuart Lee and Head of Department Prof. Paul Jeffreys here at Oxford University Computing Services.

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The Team

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Core Team

Project Manager & Researcher - Tim Fernando

Lead Developer - Alexander Dutton

Developer & Researcher - Arno Mittelbach

Researcher - Janet McKnight

Developer - Tim Pizey

Architects

Principal Investigator - Sebastian Rahtz

Research Coordinator - Sue Fenley

Project Architect - Adam Marshall

Erewhon Advisory Committee

The Erewhon Advisory Committee was set up as a steering and focus group to both make sure we were heading in the right direction and providing views and insights from across the University of Oxford and Open University's. Thanks go to them for their service through the project.

Medical Sciences - Anne Bowtell

Public Affairs Directorate - Susannah Wintersgill

Bodleian Library - Nick Millea

Archaeology - Gary Lock

Computing Laboratory - Andrew Martin

University Disability Office - Peter Quinn

Open University - Non Scantlebury

St Cross College - Paul Trafford

OSS Watch - Rowan Wilson

Organisations

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2. Executive Summary

2.1. Introduction

Erewhon was designed to investigate the possibilities and uses of geo-spatial and mobile computing in the HE/FE institute environment. In particular it looked sustainable approaches to storing an institution's geo-spatial data with temporal sensitivity as well as providing demonstration mobile applications, methods and advice to best use the rapid proliferation of mobile computing technology.

2.2. Overall Approach

The staggering growth in the mobile computing industry has triggered change and developments at a rate previously unseen in the IT industry as a whole. During the execution of Project Erewhon, we had to stay on the pulse of ever-changing technologies and adapt our work regularly to provide sustainable yet ground-breaking outputs. Making regular adjustments to our plans as the industry and technology dictated we made sure that our work was relevant and have thus bettered our understanding and products for the community to use.

2.3. Major Achievements



Advocacy

We have presented at over two dozen conferences and events (including major international events) through the life of the project¹; Topics have included best practices on storing geo-spatial data, the future of mobile computing and how to build sustainable solutions in the era of open data.

Best Practice Information and Advice

Through blog articles², personal contact via telephone and e-mail the project has disseminated solutions to particular problems and listened to the variety of scenarios in the community that need to be solved.

The Gaboto Open Source Project³

The lack of an effective way of storing and representing an academic institution's geo-spatial data led us to create Gaboto. The open-source software project written in Java allows complex multi-campus institutions with temporal sensitivity to be represented in RDF. We believe Gaboto is unique in its nature and features. Furthermore, it allows the output of its data-store in over seventy data formats.

The Molly Open Source Project⁴

The mobile computing revolution brought on by Apple's iPhone has shown that there is a need for tailor-made mobile internet services from academic institutions. Being able to check timetables, search for books in libraries and book tutorials are but a few of the myriad possible applications for portable location-aware mobile devices. Though



¹ See Appendix for complete list

² The Erewhon Blog - <http://oxforderewhon.wordpress.com>

³ The Gaboto Project - <http://sourceforge.net/projects/gaboto/>

⁴ The Molly Project - <http://mollyproject.org>

there have been various implementations of institutional mobile systems, these either have not been truly community driven open source or have been limited to one mobile platform. To fulfil the perceived needs, we created the Molly Project that is now fast-growing with several institutions choosing it over commercial locked-in solutions.



Mobile Oxford

As its first deployment and proving ground, we created Mobile Oxford - a mobile web service based (the basis of the Molly Project) to provide tools and information to the staff, students and general community around the University of Oxford. It has thus far been launched as a 'beta' service, providing location-aware library searches, real time bus information, University maps and POI, full access to the University's iTunes U catalogue and much more.



2.4. Major Findings

Industry growth and usage changes

The mobile location and environmentally aware internet device is to the PC as the PC is to the mainframe. The ability to hold a significant amount of connected computing power in one's hand with a simple user interface to conduct day to day tasks has spawned massive growth⁵ ever since the introduction of Apple's iPhone in 2007. For years technology had slowly refined, but few realised that the desktop user interface design paradigm would never apply to small devices with limited screen space. Apple's introduction has been quickly replicated and imitated by others, some to great effect. The result is that people are using these devices for applications never thought possible even a few months ago.

"Apps to be as big as internet" - BBC News⁵

Location is the future⁶

The location and environment sensing capabilities of modern devices is often underplayed. 'Sat nav' is what most think when GPS is involved, but the context of location opens up a vast array of applications that have never been thought up before. Foursquare, Google Latitude, Yahoo! Fire Eagle and Twitter are but a few big names in the location industry and our community needs to keep a keen eye on these technologies as they develop in the future. There is a great opportunity to produce lightweight location sensitive applications that will be a significant part of the day to day lives of our institution's members in the future.

"Location is the 'secret sauce' of mobile computing"
- Mary Meeker, Internet Analyst at Morgan Stanley

Smartphones are not just elite devices

Many view Smartphones as 'elite' devices, owned by the affluent to keep them in the loop, however the economy and generic usefulness of Smartphones have shown⁷ that even low income families consider them as essential devices. The cost of a music player, a telephone and a camera as separate items inevitably add up to a similar price of a single Smartphone device and as quality has improved the decision has become more of a 'no-brainer'. However, even the low-end of the mobile telephone market has become saturated with features. Today a £20 pay-as-you-go device contains a camera, colour screen and even a simple web browser making it a potential portal to mobile internet services provided by an academic institution.

⁵ Example article: <http://www.reuters.com/article/idUSTRE5AJ06020091123>

⁶ <http://techcrunch.com/2009/10/20/mary-meeker-economy-is-recovering-mobile-is-exploding-and-the-iphone-is-awesome/>

⁷ Low-Income Families purchase iPhone
http://www.pcworld.com/businesscenter/article/153104/lowincome_users_latch_on_to_iphone.html

Web 3.0 - Open Data is key

The 'Semantic Web' and 'Web 3.0' are terms now commonly being used to refer to emerging web technologies. Both are often left rather ambiguous and for the purpose of this report, I will define them as follows. The Semantic Web is perhaps the original vision by Sir Tim Berners-Lee of the World Wide Web i.e. a web of data as opposed to documents, it allows the free flow of information as opposed to formatting which allows information, however small, to be reused and be part of a greater whole. 'Web 3.0' tends to refer more to the emergence of Web APIs which can interconnect easily. Although there is overlap with the definition of the semantic web, the emphasis is different.

“keep our institution’s data available through secure, open-standards based web services”

As we move towards the world of Web 3.0, it is important to note that it is not web pages and individual services that are becoming key, but more the APIs that interconnect them facilitating the creation of services much more than the constituent parts. A fantastic example is the start-up company 'Siri'⁸ who have produced an iPhone App that interconnects a number of Web APIs including OpenTable, Yelp and Twitter and combines them with their own voice recognition technology. The result is that a user can simply make a request such as “I would like a table for two at Browns restaurant for 3pm on Tuesday” and the application will make a request for a booking and returns a confirmation. The confirmation page will then use Google Maps to show you a route to that restaurant from wherever you are. Likewise, you could ask for the “best Italian in Oxford” and it will use another API to find the best rated Italian restaurant in Oxford. This is all possible thanks to the open, documented, standards based APIs that these various companies are providing.

It is therefore clear that we need to keep our institution’s data available through secure, open-standards based web services which allow the free flow of critical and non-critical information across a University. Only then can we start to build the tools



that can really benefit our institution’s members. During the lifetime of Erewhon, I can say that our primary hindrance in creating useful mobile applications has been the lack of accessible data in good standards such as XML or JSON. Many institutions’ systems are bought in from large corporations as monolithic pieces of software that require expensive maintenance contracts and

massive fees to create modifications. Although commercial providers of software are undoubtedly required in our field, we need to ensure that they have appropriate interfaces to allow for unforeseen uses and contractual clauses to ease any modifications required. In short, the traditional software development cycle of strictly following a set of requirements based on current use is not necessarily appropriate.

Other JISC projects we have been in contact with through the Institutional Innovation strand have all taken a similar view to open data, especially TWOLER, BRIL, Steeple and TAG.

⁸ <http://siri.com>

3. Background

3.1. The new mobile era of computing

In the past few years, many discrete technologies have been converging into single devices to create powerful, multifunctional and mobile computers. Most advances in convergence have been manifested in the form of 'Smartphones'. The prevalence of this particular type of platform is precipitated by the need of the vast majority to own a mobile telephone and thus extensions to its functionality are only natural and easy to sell. In addition to this, these platforms have been made accessible to both the hobbyist and professional developer, letting them harness the power of its CPU, graphics processing and abundance of sensory/location sensors. In effect, a new era of computing has begun with staggering growth⁹.

3.2. Fast, simple access to relevant data

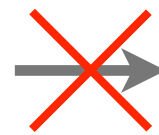
Powerful and user-friendly modern mobile devices have brought about a new line of connected services that provide users with fast access to small but relevant amounts of data. Examples include the weather, live bus times, being able to find the nearest point of interest.

“Any system which cannot be well taught to a layman in ten minutes, by a tutor in the presence of a responding setup, is too complicated.” – Ted Nelson, Computer Lib 1974

As these devices become more and more common on the market and easier to use, students/staff come to expect similar services from their HE/FE institution as they do from the service providers they use for their day to day lives, such as Facebook and Google. “Where is my next lecture?”, “When is X coursework due?”, “How many parking spaces are left at my department’s car park right now?” are a few possible applications.

3.3. Mobile-optimised desktop sites don't work

Familiar arguments often include “newer devices handle regular websites fine” or “a standard website with a mobile skin do”. Unfortunately this is rarely the case as the most common situations where users want to access information warrant short attention spans¹⁰ e.g. whilst walking, in the company of other people or “killing dead time”. Devices must therefore be able to supply the most relevant data with minimal effort. In an academic context, I believe that this needs to be provided via a consistent interface for all the



not good!



⁹ AdMob Mobile Metrics March 2010- <http://metrics.admob.com/2010/04/march-2010-mobile-metrics-report/>

¹⁰ S.R. Subramanya, B.K. Yi . Enhancing the User Experience in Mobile Phones. Computer, Volume 40, Number 12 (December 2007), pp. 114-117, <<http://ejournals.ebsco.com/direct.asp?ArticleID=4677BA5721CCEC1FFF9C>>

institution's systems thus speeding up a user's interactions through predictability.

The advantages are particularly acute for those with impaired sight, where navigating a range of inconsistently designed websites can be particularly arduous. Furthermore, traditional websites are usually suited for the desktop form factor with the expectation of mouse input. Unfortunately the desktop user interface design paradigm does not work well on mobile devices due to the lack of screen real estate, the nature of touch screens and the lack of physical size.

3.4. Location based services need location data

To provide Location Based Services (LBS), one needs to have core data to provide to users. In the context of HE/FE institutions we need to know where buildings are geographically, how they are linked politically and thus personally relevant to a member of the institution. In addition to being able to store this information, it needs to be accessed in effective machine-readable formats that can be reused and are sustainable.

"Thanks to the iPhone 3G and, to a lesser extent, Google's Android phone, millions of people are now walking around with a gizmo in their pocket that not only knows where they are but also plugs into the Internet to share that info, merge it with online databases, and find out what – and who – is in the immediate vicinity...Simply put, location changes everything. This one input – our coordinates – has the potential to change all the outputs. Where we shop, who we talk to, what we read, what we search for, where we go – they all change once we merge location and the Web." – Mathew Honan, WIRED magazine. 19th January 2009

4. Aims and Objectives

4.1. The Plan

"Erewhon aims to help create a dramatic increase in the range and types of access to information in the University of Oxford for students, researchers, administrative staff and teachers. It will do this by firstly creating a comprehensive geo-location database capable of handling complex relationships detailing ownership of buildings (including special cases such as co-ownership), relationships between disparate campuses, with a temporal dimension.. Erewhon will also improve access to University resources by designing a mobile interface for the institution's VLE and provide demonstration designs for various other applications and thus provide a framework in which other departments or indeed institutions can quickly create powerful mobile applications."

4.2. Changes

"demonstration" to "production"

After analysis of the solutions currently in production, we felt we could make a more significant contribution to the community by creating a true service ("Mobile Oxford") to the University and consequently an open source framework project ("Molly"). We felt that demonstration applications would be unlikely to be used by other institutions and the parity of standard systems such as LDAP made it feasible for us to create a system with universal connectors.

"mobile interface for the institution's VLE" to "mobile interface for the institution"

Likewise, we decided that a single mobile interface for our implementation of Sakai would not be ideal as it would go against our findings that multiple websites in an organization are not suited to the shorter usage patterns that mobile devices command. Thus we implemented it as part of Mobile Oxford which provides the added advantages of generic services such as mapping, further enhancing the VLE experience on mobile devices.

5. Methodology and Implementation

5.1. Overall

Erewhon kept inline with JISC's project management guidelines, but did not go as far as formalizing the PRINCE2 methodology. This was due to the nature of having a small team and effective communication throughout, which we believed negated the overhead that a more formal approach would have created. Effective calendaring, agile programming/design, subversion/git repositories and task lists as well as regular design discussions were among the key practices during the project.

5.2. Analysis

Hardware Market

We would not have had a need to create mobile information solutions unless the hardware market place hadn't commanded it. Likewise to ensure sustainability, we needed to make sure that the solutions we created matched what was envisaged for the next few years of hardware development. Watching technology news and developments in the field were key to design decisions. We found that large news corporations such as the BBC contained watered down and sometimes incorrect information and watching technology blogs such as TechCrunch¹¹ and Engadget¹² were far more effective in gaining up to date information.

"...the rate of change in the market place is tremendous, thus the most sustainable approach for developing institutional mobile applications is to target the mobile web as opposed to native applications."

Our most significant conclusion was that the rate of change in the market place is tremendous, thus the most sustainable approach for developing institutional mobile applications is to target the mobile web as

opposed to native applications. A typical example includes Apple's tremendously successful iPhone OS which in the past three years has had as many versions of its operating system. Each time the OS has changed, developers have had to re-write their code to suit the next generation and although the work is not always large it is tangible and often an unforeseen expenditure.

Geo-APIs

During the course of Erewhon, geo-spatial APIs and tools have refined and grown in number. Their availability and often commercial ties have implications on how we can design Location Based Services in the HE/FE environment. The following are some of the major APIs we investigated and the implications of each.

Yahoo! Fire Eagle¹³

Fire Eagle is designed as a 'trusted source' for a person's location. The API allows for third parties to either gain or set an individual's location (when authorized), its design has key privacy features that institutions keen to implement LBS should study.



¹¹ <http://techcrunch.com>

¹² <http://engadget.com>

¹³ <http://fireeagle.yahoo.net>

Google Maps API¹⁴

This is undoubtedly one of the most comprehensive and easy to use geo-APIs around. Static as well as 'slippy' maps are easy to obtain, the reverse geo-coding systems are powerful and scalable.



However we ran into three significant problems. Firstly, services cannot be 'mixed and matched' i.e. one cannot use their reverse geo-coding service without using their maps. Secondly Google charges a not-insignificant amount for enabling Google Maps services over SSL which was a pre-requisite for producing authenticated location based services. Lastly, the quality of maps for the Oxford region were not of high enough quality to be effectively used. Our city is suited to walking and cycling neither of which Google's systems did very well, missing most pathways and cycle paths and at the time of writing did not have a cycle routing system for the UK.

Bing Maps API¹⁵

Bing's big advantage over Google is that it provides a 'birds eye' view i.e. four low altitude 45° angled photographs of a location which is superior than a satellite view for identifying buildings. Like Google however, there are issues with lock-in and detail of local maps.



Cloudmade API¹⁶

As OpenStreetMap¹⁷ contained the highest quality maps of Oxford we considered its use. Unfortunately it does not natively contain APIs as it is primarily a data store, however Cloudmade is a company set up to provide advanced API services for it and fills this gap. We have been using them since October 2009 and have not had any significant issues. Additionally, as they use crowd-sourced OpenStreetMap data we have the ability to add or modify data in the data set instantly.

Ordnance Survey

At the time of writing, the government has decided to open up the Ordnance Survey Maps archive possibly creating a national 'places' database as well as providing mapping tools for the country. Although this is still in the early stages, we envisage this as a preferred source of mapping for the future.



Geo-spatial storage

A key deliverable was to create an institutional geo-spatial storage system, i.e. to represent where places were and the relationships between them. To do this we first analyzed existing solutions such as traditional SQL databases (e.g. postGIS) then considered maintenance, expandability and sustainability implications. We concluded that there wasn't an effective open-standards solution currently in existence nor was there one that could be modified to suit our long term needs - hence we created the Gaboto project. This was created using RDF to represent the data models and Java as its software language which provided the flexibility necessary for the abstract relationships and temporal sensitivity we envisaged. Examples include being able to model a building which houses two departments and has multiple entrances, with multiple rooms and a number of desks in each.

¹⁴ <http://code.google.com/apis/maps/>

¹⁵ <http://www.microsoft.com/maps/developers/>

¹⁶ <http://developers.cloudmade.com/>

¹⁷ <http://www.openstreetmap.org/>

5.3. Mobile Internet Frameworks

To avoid replicating what others had already done, we considered the existing available software solutions/frameworks for providing mobile internet services. At the time of analysis, there was only one significant open source project named MIT Mobile Web¹⁸ from the Massachusetts Institute of Technology. Unfortunately the code has been placed in the open source arena but without community-side development we considered it inappropriate.



Similarly we did not consider some of the proprietary solutions such as oMobiel's CampusM and Blackboard Mobile appropriate due to a number of reasons. Both solutions involve an aspect of lock-in as well as the likelihood of unforeseen redevelopment costs due to the aforementioned rapid changes in mobile device operating systems. At the time of writing there is also limited support for the multiple varieties of devices and thus it did not appeal to the entire audience of our institution. Lastly, considering the analysis we have done of the market place we did not see either solution as part of a long term institutional strategy.

5.4. Existing Mobile Deployments

We analyzed the work of other institutions (mostly based in the US) who had already deployed mobile internet services during the construction of our own. Below is a list of known deployments at the time of writing.

MIT Mobile Web - <http://m.mit.edu>

University of Iowa - <http://m.uiowa.edu>

University of Indiana - <http://m.iu.edu>

Abilene Christian University - <http://m.acu.edu>

University of Warwick - <http://m.warwick.ac.uk>

University of Central Lancashire - http://www.uclan.ac.uk/information/services/lis/iphone_service.php

University of Bristol [JISC]- <http://mca.ilrt.bris.ac.uk/>

University of Bradford - <http://www.braduni.mobi/>

Stanford University - <http://studentapps.stanford.edu/>

Of the systems we found and analyzed, most had created a web based solution which was fairly Universal. MIT's system was the most comprehensive, accessible from every web capable mobile phone and providing some authenticated services. A particularly novel application was implemented by the University of Iowa to show the current status of washing machines and driers in student halls of residence. Transport and finding the locations of particular buildings featured throughout.

5.5. Software Development Practices

Judging Requirements

Discussions to create a set of basic requirements led us to similar aims to that of MIT's Mobile Web. Its accessibility and user interface appealed and we set out to create a system that contained many of its attributes. However, our institution's data was spread out across many disparate places so obtaining the correct data to make particular applications happen was quite difficult. We thus created a list of data sources and what applications could be created by combining them. Location sensitive library searching was one of the popular ideas and upon creation we believe it was the first of its kind. The development of Mobile Oxford has continued in this fashion and has gained support from a number of departments via existing innovating work.

Agile Development

The size and expertise of the team and the frequently changing problems suited an agile software development methodology. Software development was centered around individuals, but led by an overall architect who considered more social and usability issues. This allowed the rapid turn refinement of code and has led to greater usability.

¹⁸ <http://sourceforge.net/projects/mitmobileweb/>

Effective Feedback Mechanisms

Molly in particular has had effective feedback mechanisms by way of session tracking and anonymous bug reporting with a single click. This has resulted in a high return of bug reports from users and has allowed us to both thank them and let them know their problem has been fixed through an anonymous messaging system.

"mobile site is great - congratulations! it'd be really good to be able to request a book from the stacks once you found its listing using the mobile site. at the moment, you find the shelfmark and then can't do anything with it unless you find a pc to log into solo with. or have i missed the bit where you can order books?"

- Feedback from user on a Nokia E71

Continuous Integration

During the development of Gaboto we used Hudson¹⁹ to create an automatic testing environment as code was committed to our repository. This allowed flagging up of problems in code early on and allowed them to be fixed. Similarly with the development of Molly we have used Python's unittest²⁰ system in conjunction with Hudson to achieve the same result.

Multi-platform testing

We purchased a number of mobile devices representing the major mobile device manufacturers, technologies and form factors. This allowed us to test our standards-based software with real devices and real life situations, e.g. checking the real time bus information whilst walking to a bus stop.

5.6. Geo-data gathering

Gathering the geographical coordinates of each and every building within the University was a significant task for which we hired two part time staff. They cycled around the city photographing buildings whilst recording a GPS track and noting down relevant metadata about what they saw. Upon return, we merged the GPS tracks with their photographs and created entries for each political and physical entity respectively based on the data they gathered. The photographs are used to show a user what to expect, we suspect this will be especially useful for users with certain disabilities.



We primarily used a Garmin eTrex HCx²¹ for GPS recording and a variety of cameras. The Java Open Street Map editor was heavily used as well as various home-made scripts for importing data into our Gaboto/OxPoints system. One of the advantages of the eTrex HCx is its sensitivity to WAAS (Wide Area Augmentation Systems) namely EGNOS²² in Europe which accounts for atmospheric distortion and improves accuracy.

5.7. Geo-data file formats

To make sure every conceivable use could be handled, we wanted to make sure that we could output in almost any geo file format imaginable. An example scenario: a University member wants to send a prospective employee the location of their offices. The prospective employee uses a TomTom sat nav device and would like to have the location easily transferable to it in its native format.



We went about implementing this by creating native serializers inside of Gaboto to first convert to KML (Keyhole Markup Language - the primary file format used by Google and perhaps the most prevalent).

From KML we integrated GPSBabel²³ to convert to the multitude of file formats it supported.

¹⁹ <http://hudson-ci.org/>

²⁰ <http://docs.djangoproject.com/en/dev/topics/testing/>

²¹ <http://gdgt.com/garmin/etrex/vista-hcx/>

²² http://en.wikipedia.org/wiki/European_Geostationary_Navigation_Overlay_Service

²³ <http://www.gpsbabel.org/>

5.8. Handling the vast array of mobile devices

Setting ourselves the goal of being accessible from every web capable mobile device on the market was not trivial. The market has massive fragmentation and although WebKit browsers are now becoming more standard, even they have significant differences between them²⁴. WURFL²⁵ (Wireless Uniform Resource FiLe) aims to solve some of this by providing a regularly updated list of mobile devices along with their often uniquely identifying HTTP request header and each device's capabilities. We integrated this as a key feature of Molly and used it to detect in real-time what sort of browser had hit our site. We further analyzed the generic capabilities of a number of devices and created two class definitions, one was called 'featurephone' the other 'smartphone'. Molly would then return a page suited to each class of phone which was almost guaranteed to work. At the time of writing iPhone OS, Android, Symbian S60, Palm Web OS and Blackberry OS devices all received the smartphone pages and all others (including Windows Mobile) received the featurephone pages.



5.9. Skepticism of new applications

Whilst we had full support within our department, other parts of the University were not as confident. Early in the data gathering sessions, one of our staff was removed from a University site as it was deemed a threat to security to compile a list of the university's buildings' geo-locations. Likewise when we initially approached certain departments about providing data for Mobile Oxford, many could not see the point or understand the motivations. There were further security concerns expressed by the Estates department which we had to address and ensure sensitive data was not exposed. Branding has also been a concern as the mobile form factor did not lend itself to traditional brand marks.

It was when we started to create working prototypes with crude methods such as screen-scraping that people started to understand the value of the work. We found that putting what we thought to be a useful application in a person's hand often removed the skepticism around it. We noted from colleagues at Birmingham City University

5.10. Relationship Modeling

Modeling the relationships between time, physical and political entities was perhaps the most theoretical part of Erewhon. Gaboto had to be able to handle these complex queries using a RESTful interface and thus provide a predictable and consistent API. An example query to find all entities related to OUCS codes 'mans or ball' (Mansfield and Balliol colleges) in 1950: <http://oxpoints.oucs.ox.ac.uk/hasOUCSCode/mans|ball?date=1950>. The details of its development can be found on the Erewhon blog, including details on how the limitations of RDF were overcome to allow for time to be represented with named graphs. The data model was constructed in consultation with the JISC BRILL project, the University Estates department and the staff of the Bodleian Libraries.



5.11. Evaluation

Our initial evaluation plan of regular written evaluations by a social-scientist did not happen due to lack of staff availability and a lack of user-base early on in the project. We thus conducted evaluation based on regular comparison with other products and projects, peer-review, i.e. discussing our projects with other Universities and by the special feedback mechanisms in the user-facing side of the projects. Overall I feel the evaluation could have been better conducted, but I believe as our products are user-centric, user-feedback and traffic analysis has undoubtedly been one of the greatest tools in assessing this work.

²⁴ <http://www.quirksmode.org/webkit.html>

²⁵ <http://wurfl.sourceforge.net/>

6. Outputs



Molly's outputs are undoubtedly revolved around its two major open source projects Molly and Gaboto, and their two successful counterpart services Mobile Oxford and OxPoints running for the University of Oxford. Advocacy and ad-hoc advice has featured highly with Erewhon presenting in a large number of places on a wide range of geo-spatial and mobile topics.

6.1. Molly and Mobile Oxford

Mobile Oxford was launched on 5 October 2009 as a 'beta' service providing the first mobile internet services for the University of Oxford. Since then it has been steadily growing with an average of 1700 unique page views per day and has had positive press in the Times Higher Education supplement, the BBC and others. Feedback from the service has been

regular and many new features are scheduled to be implemented and added to the service and the underlying Molly Project.

The Molly Project was set up at the beginning of 2010 and has had its first partner Oxford Brookes start deployment. Brookes aims to have a prototype service running by mid June 2010. We have made an effort to make sure that all further development in Oxford is conducted 'in the open' so that other institutions can gain from our work. This should help combat the tendency for some groups to work behind closed doors for months on end pushing large batches of changes, thus not having taken the community's views or problems into account.



6.2. Gaboto and OxPoints

Prior to Erewhon, a simple version of OxPoints was produced at Oxford University Computing Services. It was deemed too inflexible and thus part of Erewhon's plan was to create something that fulfilled a number of new criteria. The new OxPoints has been running since early 2009 based on the Gaboto framework and has a number of users from other departments and colleges. Its primary user is Mobile Oxford due to its wealth of location based services which are dependent on OxPoints' data.

Due to Gaboto's theoretical nature, we have not had significant interest outside of RDF research centers such as the University of Bristol. In the future we hope to refine the software further, to make it easier to deploy.



6.3. Advocacy, blog articles and advice

As mentioned above in this report, our team has presented at over two dozen events and conferences, including major events such as the Institutional Web Managers Workshop, the UCISA Conference, and the Eduserv Symposium. Besides the obvious value of dissemination, conferences have helped us to find individuals at other institutions with whom we share work and possible collaborations. Through these and other channels we have had requests for advice on how to implement mobile internet services, geo-spatial queries and many more. The Erewhon blog has helped to disseminate findings further and there are many articles which look at solving particular problems and general information about the direction of technology.

7. Outcomes



Our objectives were to create a flexible and powerful institutional geo-spatial database, advise and gain knowledge on mobile technologies and provide a dramatic increase of mobile access to institutional services. I believe the creation of Mobile Oxford and

Molly, OxPoints and Gaboto along with our blog and other methods of dissemination, we have achieved even more than that. Our evaluation process has left something to be desired, but we now have a 'real' mobile information service and geo-spatial store hosted by the University and are a well known contact for advice in these areas of speciality.

The impact of Mobile Oxford is well seen by the fact we are currently experiencing approximately 1700 unique page views per day (excluding bots), yet have not started an advertising campaign. Feedback (most of it arriving through our built in feedback system) has been very positive. The location based library search and access to real time bus information features have been especially popular. This is undoubtedly the first step and a solid framework to help create a fully 'connected' University where all relevant information is easily accessible in the palm of a user's hand.

Although OxPoints is more of a 'back-end' service, it is key in providing the location services of the future. In time, we hope to develop a comprehensive routeing system which not only can provide a cycling route from a user's current location to his or her lecture, but also a ramp-to-ramp access routeing system to effectively help those with mobility disabilities.

In short, we believe that this work has the potential to affect almost every member of an academic institution as it can streamline most daily tasks significantly and create new exciting applications which many will want to take part of.

8. Conclusions

8.1. Mobile IT is the new IT

The market is changing and desktop computing is starting to die. Users are becoming comfortable with location technologies and advanced social technologies from large companies and they will start to expect similar services from Universities.

Use of small skilled development teams

As the market moves so rapidly, small agile teams can adjust to user demands more quickly than larger teams.

8.2. Commercial products can fall short

The commercial products we analyzed had limited long term sustainability options and significant lock-in and redevelopment issues.

8.3. Augmented Reality

Although augmented reality has a big buzz to it currently, there are still few applications applicable in the HE/FE sector. Most applications we considered had more application to tourists and visitors than the day to day members of the institution.



8.4. 2D Barcodes

Citizens of Japan have long been using two dimensional barcodes to do many tasks such as share personal information or report a broken lamp post²⁶. We are starting to see a greater use of these in the UK on many food items such as soft drinks. Oxfordshire County Council recently contacted us regarding the barcoding of all bus stops across the county and we expect that uses such as these will increase over the next two years.

8.5. RFID

Like 2D barcodes, RFID can be used to transfer personal information and location information. A major project at the University of Washington²⁷ highlights what can be done. In the UK we are likely to see a surge in RFID thanks to payment systems such as Visa Wave being brought into mobile devices²⁸.

9. Implications

9.1. Mobile Information Services

Molly

Deploying Molly in as many institutions as possible will help to refine the software further, providing more connectors thus making it easier for subsequent partners to deploy. In essence, the larger the Molly community becomes the cheaper it becomes to run in each institution. It could become a central aggregation point for a university and a portal to all types of devices.

Other Systems

There are many data sources across an academic institution and most are relevant for access from mobile devices. Examples include exam results, club memberships, car pool groups and many more. These could be developed into new applications.

Other Devices

Computing power has progressively become cheaper and recently a number of tablet-esque devices have been emerging. Along with the more obvious incarnations such as Apple's iPad, work could be carried out on 'glance' devices such as the OpenPeak OpenFrame (branded in the UK as the O2 Jogger²⁹). These devices provide another form of information delivery that has so far been largely untouched.

²⁶ <http://livinginosaka.net/archives/cool-use-of-2d-barcodes-qr-codes-in-osaka>

²⁷ <http://livinginosaka.net/archives/cool-use-of-2d-barcodes-qr-codes-in-osaka>

²⁸ <http://www.engadget.com/tag/contactless+payments/>

²⁹ <http://yourfamily.o2.co.uk/o2familyjogger/>

10. Recommendations

10.1. To the community

Create a database of your institution's geo-coordinates

Location Based Services are dependent on having high quality geographical information. Finding the geographical coordinates of all an institution's buildings and storing them in an accessible format should therefore be a priority. Our open source product Gaboto could be a solution for that.

Encourage the use of open standards data systems

Our biggest challenge in creating Mobile Oxford was finding appropriate data from around the University. We found that many systems were closed off, or had proprietary formats and were hard to interact with. Thus I would recommend that significant thought be given to how information systems (e.g. student information) are designed. Well documented and open APIs using standard interchange formats such as XML facilitate unexpected uses of data.



Join the Molly Community

As creators of the Molly Project we invite other institutions to join in and share the gained knowledge of the community. This is currently best done through the Molly mailing lists available through its website at <http://mollyproject.org>. As well as free advice, OUCS can provide consultancy to set up a production service.

Understand implications of commercial solutions

Commercial solutions for deploying mobile internet solutions are attractive as they provide a solution out of the box with seemingly little effort. At the time of writing we only know of native platform applications available from commercial

providers. With this in mind there are a number of implications that are worth considering before signing contracts. 1) Check to see if there are fees associated with updating the application to the latest version of the host OS. 2) Understand how bugs are reported and what your service contract will entitle you to in terms of support. 3) Understand how your institution's brand will be effectively communicated through the app. 4) Check which systems will be integrated and if additional functionality will be created as well through merging of data sources e.g. providing location based library searches rather than a separate maps section to a library search system. 5) Ask for a data flow audit, to see exactly what data is traveling where. For more advice on this matter, we would encourage contacting the erewhon team (erewhon@oucs.ox.ac.uk).

Consider privacy implications when developing LBS

Recently '<http://pleaserobme.com/>' was featured in the press as a simple system which analysed common phrases from social network users to programmatically conclude whether a user was in their home. If they were not, it invited visitors to rob them. This simple example highlights the implications of sharing one's location with others and because of this it is advisable to pay careful attention to how a user's location is used in applications. As a rule of thumb, it's advisable not to store a user's location server side in the event of a security breach.

Aim to cater for all platforms first, then specialize

As the iPhone has grown in popularity, several institutions have decided to produce applications specifically for it. The assumption is that the iPhone will become the de-facto device for mobile internet users. Although the market share of

iPhone OS has been increasing steadily, Android has recently taken over in the US³⁰ as the dominant platform. This shows that the marketplace is far from stable and that an institutional investment in a single platform risks being obsolete in a short time. The web however will undoubtedly have a long life due to the prevalence of its standards and its backwards compatibility, thus it seems logical to invest in mobile solutions that use the web. It should be noted that although native applications to provide far greater access to a device's hardware, we are currently not aware of any institution-wide applications which harness this power. The announcement of Google's Chrome OS App store based on web standards such as HTML5³¹ further cements the conclusion that HTML5 will suffice for most applications.

"As an app developer to reach 70% of mobile users, you need to be available on 375 devices, 70 different families from 8 manufacturers" - Tom Hune at Eduserv Symposium 2010

10.2. To the JISC

Continue to fund 'blue sky' innovation projects

We are in an age when tools and software can be created by skilled, small groups of people that can have implications throughout the sector. The talent is certainly inside our institutions, but the grind of the daily 'needs and necessities' often stifles innovation. JISC's Institutional Innovation strand has facilitated these ideas, products and concepts to surface and I have no doubt that the cost savings across the sector due to these projects are greater than the cost.

Facilitate ad-hoc community creation

The JISC could greatly benefit the HE/FE community and thus create savings across the board by being a facilitator for community creation. One of the hard parts of being inside an academic institution is keeping up with what is being done outside it, I believe the JISC could play a great role in watching the country's work and making the connections between institutions and projects so that they can share relevant knowledge and projects.

³⁰ <http://www.engadget.com/2010/05/10/npd-android-ousts-iphone-os-for-second-place-in-us-smartphone-m/8> via NPD group

³¹ <http://www.intomobile.com/2010/05/19/how-googles-chrome-web-store-impacts-smartphones.html>

11. Appendices

11.1. Publicity

Times Higher Education Supplement - <http://www.timeshighereducation.co.uk/story.asp?storycode=408716>

University Business article - <http://www.universitybusiness.com/viewarticle.aspx?articleid=1515>

University of Oxford press release - http://www.ox.ac.uk/media/news_stories/2009/091012.html

Bodleian Libraries press release - http://www.bodleian.ox.ac.uk/news/2009_oct_23

Don't waste your time eLearning blog - <http://www.dontwasteyourtime.co.uk/elearning/mobile-website-oxford-university/>

Resource Shelf newsletter - <http://www.resourceshelf.com/2009/12/10/oxford-universitys-mobile-library-catalog-using-location-sensing-technology/>

Cherwell News article - <http://www.cherwell.org/content/9162>

BBC Oxford Radio Interview - 5th October 2009

Jack FM News item - 5th October 2009

11.2. Talks and Presentations

All slides and materials are available via <http://erewhon.oucs.ox.ac.uk>

Date	Event	Topic	Speaker(s)
5th December 2008	Erewhon Workshop	Improving Mobile Productivity	Tim Fernando
5th December 2008	Erewhon Workshop	Intro to Erewhon	Sebastian Rahtz
15th December 2008	Oxford Webmasters Forum	RDF Modeling for Oxford University	Arno Mittelbach
15th December 2008	Oxford Webmasters Forum	Mobile Sakai	Matthew Bucket
15th January 2009	OUCS Staff Day	What is Erewhon?	Sebastian Rahtz
10th February 2009	Oxford Transport Studies Unit Presentation	Erewhon and transport implications	Tim Fernando
3rd April 2009	Beyond Conference	Erewhon and how to facilitate mobile computing	Tim Fernando
27th April 2009	Presentation to Oxford Public Affairs Directorate	Erewhon and Mapping the University	Sebastian Rahtz and Tim Fernando
22nd May 2009	Erewhon Workshop #2	Implementing ideas with OxPoints	Tim Fernando
22nd May 2009	Erewhon Workshop #2	Gaboto	Tim Pizey
22nd May 2009	Erewhon Workshop #2	A simple OxPoints mashup	Janet McKnight
22nd May 2009	Erewhon Workshop #2	OxPoints: The Next Generation	Sebastian Rathz

Date	Event	Topic	Speaker(s)
2nd June 2009	Presentation to Oxford's Archaeology Department	Erewhon	Sebastian Rahtz
1st July 2009	Oxford Webmasters Forum	Microsoft Bing Maps	Tim Fernando
8th July 2009	UCISA Symposium	Support for mobile devices and geo-spatial services	Tim Fernando
15th July 2009	Oxford ICTF Conference	Support for mobile devices and geo-spatial services in Oxford	Tim Fernando
July 2009	Institutional Web Managers Workshop	The Erewhon Project, Managing ontologies for modelling the physical and political structure of a University	Sebastian Rahtz
July 2009	Institutional Web Managers Workshop	Collecting geographical metadata, Working with OxPoints	Janet McKnight
July 2009	Institutional Web Managers Workshop	Geo-Locating Ducks	Janet McKnight and Sebastian Rahtz
7th September 2009	Erewhon Advisory Committee Meeting Presentation	Supporting mobile devices and emerging needs	Tim Fernando
10th September 2009	OUCS Talks Day	m.ox.ac.uk	Tim Fernando
22nd September 2009	UAS Conference	Accessing information on mobile devices	Sebastian Rahtz
24th September 2009	Open University Library Seminar	The Erewhon Project and m.ox.ac.uk	Tim Fernando and Sebastian Rahtz
19th October 2009	Mobile Oxford Launch Event	Mobile Oxford (m.ox.ac.uk)	Stuart Lee and Tim Fernando
12th November 2009	JISC SSBR Elluminate Event	Mobile Oxford (m.ox.ac.uk)	Tim Fernando
9th December 2009	TAG UCLan JISC Assembly	Mobile Oxford (m.ox.ac.uk)	Tim Fernando
21st January 2010	OUCS Staff Day	Mobile Oxford (m.ox.ac.uk)	Alexander Dutton
28th January 2010	JISC SSBR Innovation Exchange	Molly, Gaboto and advice	Sebastian Rahtz, Tim Fernando and Alexander Dutton
2nd February 2010	Oxford University Library Services presentation	Accessing information on mobile devices (Mobile Oxford)	Sebastian Rahtz
21st February 2010	PyCon 2010 (via OUCS)	Mobile web in Django!	Tim Fernando
21st February 2010	PyCon 2010 (via OUCS)	Dealing with unsightly data in the real world	Alexander Dutton
26th January 2010	Stanford University Sakai team presentation (via OUCS)	Molly and Mobile Oxford	Tim Fernando
23rd March 2010	OUCS Senior Management Group Meeting	Molly and Mobile Oxford	Tim Fernando
25th March 2010	OUCS Research Projects presentation	Mobile Oxford and Molly	Tim Fernando and Sebastian Rahtz
29th March 2010	OUCS Linked Data Workshop	The Evolution of OxPoints	Alexander Dutton

Date	Event	Topic	Speaker(s)
13th May 2010	Eduserv Symposium	The Molly Project & Mobile Oxford	Tim Fernando

11.3. Output Locations

Erewhon Home and Presentations

- <http://erewhon.oucs.ox.ac.uk>

The Molly Project

- <http://mollyproject.org>

The Erewhon Blog

- <http://oxforderewhon.wordpress.com>

The Gaboto Project

- <http://gaboto.sourceforge.net>

11.4. Glossary

- Agile software development - Software development methodology - http://en.wikipedia.org/wiki/Agile_software_development
- Django - Web framework based on Python which followed a Model View Controller pattern.
- GPS - Global Positioning System, a network of orbital satellites emitting low power radio signatures which can be picked up by GPS receiver devices which triangulate their position by measuring the time it takes each satellite's transmission to arrive.
- Java - High level object oriented programming language.
- LBS - Location Based Services, a term used to describe services where geographical context is of importance.
- PostgreSQL - An open source relational database system.
- PostGIS - An open source system which allows the storage of geographic objects onto the PostgreSQL database.
- Python - High level scripting language known for fast development times.
- RDF - Resource Description Framework, a metadata model designed by W3C - http://en.wikipedia.org/wiki/Resource_Description_Framework
- RESTful - http://en.wikipedia.org/wiki/Representational_State_Transfer
- Reverse Geocoding - Used when the name of a place is required when a latitude and longitude are known.
- RSS/OPML - Really Simple Syndication/Outline Processor Markup Language - XML formats often used for the interchange of news and podcasts.
- Slippy Maps - Sometimes defined as the OpenStreetMap moving map system, but here used to mean a system which allows the free scrolling of a map whilst maintaining browser focus.
- WURFL - Wireless Uniform Resource File, a database of mobile devices and capabilities.

