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# AIMING FOR ULTRA-SCALABLE EPORTFOLIO DISTRIBUTION USING PEER-TO-PEER NETWORKS

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## Abstract

In this paper the authors discuss how peer-to-peer technology offers a practical solution to building highly scalable Europe-wide and worldwide ePortfolio networks over existing network infrastructures. This solution also offers the effect of empowering individuals through moving the management and storage responsibilities onto the portfolio owners, decoupling users from any single institutional ePortfolio service provider

The authors do not present this solution as the single way forward, but as an alternative to what is seen as a mainly client-server and Web-based approach to ePortfolio development, and to encourage developers to explore the possibilities for ePortfolio integration with emerging and relatively immature technologies. A prototype implementation is reported and future developments described.

## Introduction

Today there are almost 500 million citizens in the EU. In order to even consider a system that can support the EuroPortfolio initiative's aim of enabling every EU citizen to have an ePortfolio by 2010 [1], one must consider the following desirable qualities of such a system:

- *Scalability* – The ability to allow a networked system to scale hugely without the need for additional network infrastructure to be introduced to accommodate growth. For everyone in the EU to have an ePortfolio, a system that can scale up to hundreds of millions of users may be needed.
- *Platform interoperability* – For such a large user-base, network and platform diversity will exist. In order to cater for this, technologies to allow interoperability between different network and operating system platforms must be present.
- *Device heterogeneity* – Diversity not only exists amongst network and operating system platforms, but also in the classes of hardware itself. Consider that if mobile technologies such as Personal Digital Assistants and Smartphones are growing in prominence today, by 2010 they may be commonplace and perhaps even a new breed of technologies may emerge.

Existing client-server computing models may not be able to support such a system where ePortfolio data is being constantly being generated, updated and searched for by millions of people. Organisations might have to add significantly to their hardware resources and support staff to maintain such a large and widely used service.

Researchers from the Centre for Advanced Computing and Emerging Technologies (ACET Centre) at the University of Reading are developing a knowledge management application that aims to incorporate the aforementioned qualities [2]. This application allows for search and metadata annotation for any resource document and thus is used as a basis for a distributed system for ePortfolio management.

## Ultra-scalable Technology: Peer-to-Peer

Peer-to-peer (P2P) computing has been around for many years now, and the popularity of file-sharing networks has put a spotlight on P2P technology. The P2P music file-sharing network Napster at its peak boasted a user base of over twenty six million users [3]. Napster enabled a large amount of pirated music sharing and the software authors were soon forced to stop supporting the software. However file-sharing networks such as Gnutella, Kazaa and BitTorrent are still extremely popular,

most of which are still used for unauthorised sharing of files. Despite the fact that these networks are used for much media and software piracy, the technology that enables them is extremely powerful for creating large scale networks.

P2P computing differs from the traditional client-server model of network computing. In the client-server model, all of the functionality of a service is centralised and performed by a server. The users accessing the service are called clients and have a more passive role in that they do not provide any service themselves, but only consume the service. Figure 1 shows how client desktop PCs connect to a server to access a service.

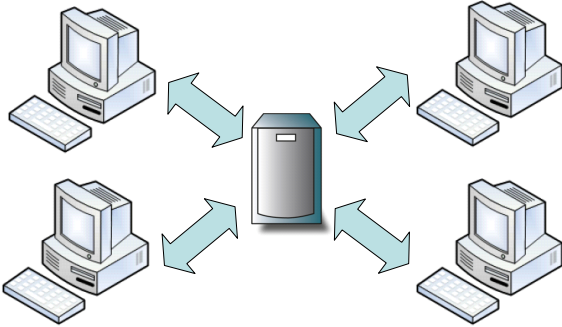


Figure 1. Centralised service provision (Client-server model)

With the P2P model, the service provision is completely decentralised. It is assumed that all participants in the network form a network of equals – each peer acts as both a client and a server at the same time. This allows users to utilise their own computer hardware to help maintain the networks itself and removes the reliance on any institution to provide and maintain a given service. Figure 2 shows us that communication in a P2P network is between desktop PCs with no single server (or set of servers) to provide any service.

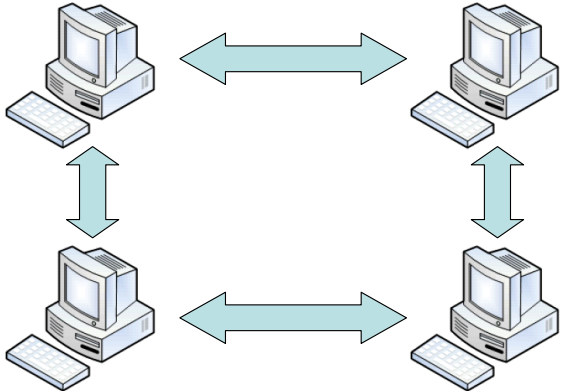


Figure 2. Decentralised service provision (P2P model)

P2P computing has been enabled for regular computer users because of the increase in accessibility of increasingly powerful computer hardware and the rise in bandwidth accessible to home users through broadband Internet connections. More powerful applications can make use of this extra computing power and speed of Internet connections, and P2P computing can exploit this for creating decentralised network services.

The decentralised nature of P2P networks brings specific advantages for creating networked services.

Decentralisation increases economic efficiency when providing a service [4]. Where there is no expensive server hardware to run, an organisation can rely on end-user hardware for service provision. Single points of failure are also eliminated as there is no one server or set of servers providing the service. When a centralised system fails, it is usually because of hardware, software and network

failures. In P2P networks any single failure is highly unlikely to cause a failure in the overall service provision as the service is replicated throughout on end-user machines.

Decentralisation also provides the important ability to scale networked services. Enterprise level centralised servers are able to handle huge numbers of users, but whenever the service needs to support a greater capacity, the only solution is to add server hardware. In a P2P system, the more users there are the more accessible, efficient and robust the service becomes as the more peers there are in the P2P network, the greater the hardware capacity of the system. A highly scalable service model is ideal for creating large-scale networks such as one that would provide ePortfolio services to a Europe-wide or worldwide user base.

### ***User Empowerment through Edge Services***

An added benefit to having a P2P ePortfolio service is that users might feel more empowered by having more control of their personal data when their portfolios are stored on their own computing device. By using centralised services, users must put their trust in organisations to adequately secure personal data and this may suppress the desire to add to their portfolios. There is also an issue of ownership of the portfolio data.

In the case of an institutional ePortfolio services, the user is always dependant on the institution's service. For example, a higher education college may encourage use of ePortfolios whilst a student attends the college, but what will happen to that data after the student graduates? The P2P solution pushes ePortfolio management and storage onto the portfolio owner at the edge of the network, where it is up to the discretion user who they share their portfolio data with.

### ***Coco: Solving Scalability, Robustness, Interoperability and Heterogeneity***

When considering ePortfolios in the context of P2P computing, we must look at what a portfolio is in terms of computing technology. The definition of an ePortfolio is constantly evolving; however a definition that is useful for defining technological requirements is as follows:

*“An ePortfolio is a digitized collection of artifacts, including demonstrations, resources and accomplishments that represent an individual, group, community, organization or institution.” [5]*

The important aspects of this definition are that it is a *digitized collection* and it can be representative of an *individual*, or a *group* of individuals (organisations and institutions can be considered groups). From this we abstract the notion of an ePortfolio network service as one that provides portfolio authoring and distributed collaborative authoring capabilities, and search and retrieval of remote portfolios with the possibility of restricting access to secure groups.

The *Coco* project developed at the ACET Centre provides a suitable starting point for creating an ePortfolio network. The aim of the *Coco* project is to develop a framework that supports collaboration enabling users to self-organise and communication, share tasks and content, and interact across multiple different computing platforms [6]. *Coco* is designed on a P2P network to address the aforementioned issues with scalability and resilience, and built on the platform agnostic technology, Java [7], and platform independent and P2P network protocols, JXTA [8], to make network services as highly available as possible. *Coco* provides group management and resource search facilities via the *Coco* content network [2], thus the *Coco* framework is used as the platform for creating a P2P ePortfolio network.

### **The P2P Portfolio Prototype**

The P2P Portfolio project is developing a peer-to-peer ePortfolio network application based on *Coco*. A first prototype is in development and at the time authoring this paper consists of two core applications: *Portfolio Publisher* and *Portfolio Browser*.

## Portfolio Publisher

Before considering searching and viewing portfolios over a P2P networks, users must be able to create a portfolio to publish to the network. Portfolio Publisher is currently a very simple application – essentially it is an HTML code editor with a preview window. At this stage it was decided to implement a publisher that is very free-form and allows for any kind of portfolio to be created. As many portfolios are currently implemented as Web-based media, it was decided to use HTML as the medium for portfolio publishing. Note that this is mainly for test purposes and throughout the development process; Portfolio Publisher is likely to evolve dramatically. Figure 3 shows a screenshot of the publisher editing window and preview window.

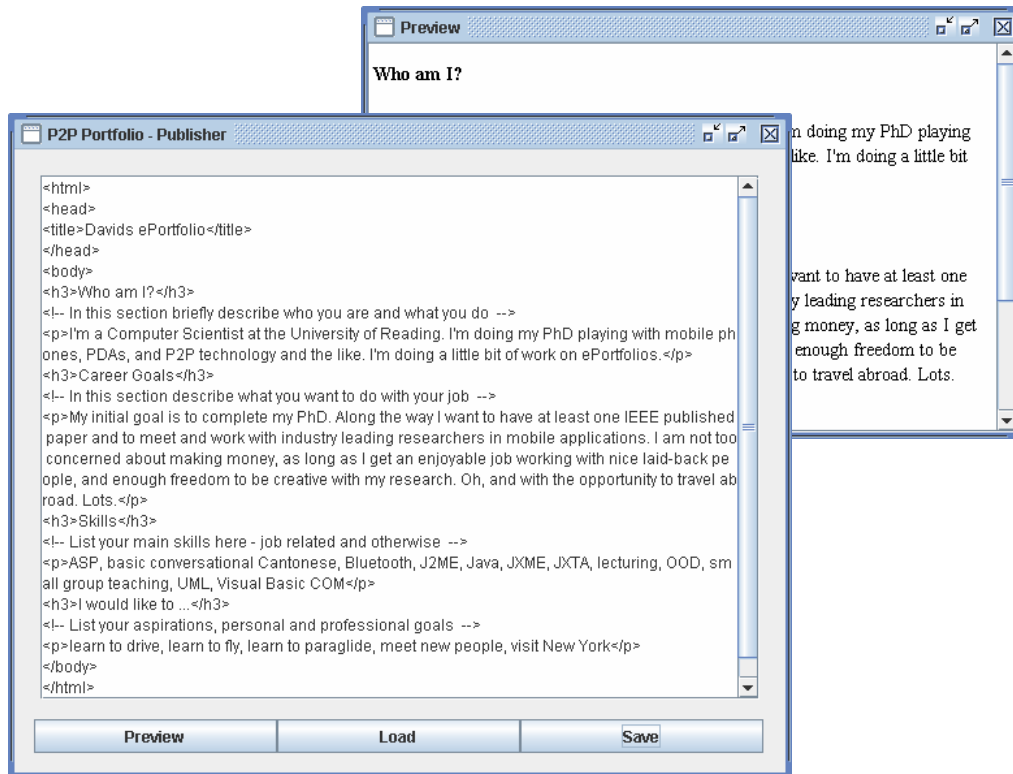


Figure 3. Screenshot of the P2P Portfolio Publisher application.

When saving a portfolio document, users are presented the opportunity to attach metadata to their document. This metadata forms the basis for what is searched for by users over the network, as the contents of the documents are not parsed. Users specify a list of keywords related to their document and a brief synopsis of themselves. As the document is authored in HTML, links to Web resources can be embedded. Once a portfolio document is saved along with its metadata, it is published onto the P2P network for people to search for and view. At this stage of development, users can only publish a single document each.

## Portfolio Browser

The Portfolio Browser application enables the searching for and viewing of portfolios. On starting up, the application handles all the necessary configuration for connecting to the P2P network. Currently, the browser application simply takes a search string and performs a sub-string pattern match with the metadata available for each file published on the network. The search algorithm utilises wildcard characters to enable less exact searches encouraging more search results. Search results are returned as a list of author names and the personal synopsis metadata. Clicking on the author's name spawns a window displaying their full portfolio document, as shown in figure 4.

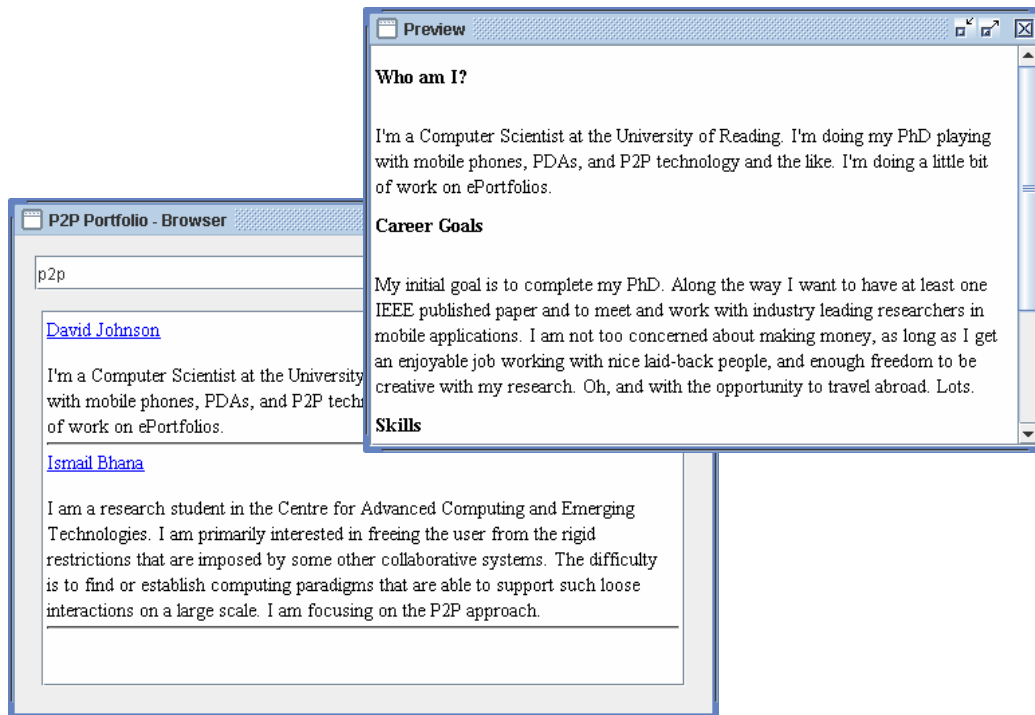


Figure 4. Screenshot of the P2P Portfolio Browser application.

## Ongoing Development

The P2P Portfolio prototype is far from complete and work is underway to implement a more complete ePortfolio system.

Rather than working on conforming to any particular standards for ePortfolios, the authors have decided to keep the portfolio as free-form as possible. In order to enhance the user-experience in publishing their portfolio, we propose Wikitext [9] support and rendering as an alternative to HTML publishing. A more advanced document editor similar to word processing software will also be included, but the documents themselves will be stored using Wikitext.

It is also proposed to create portfolio packages which will include a manifest of multimedia resources that can be directly linked to from portfolio documents. By packaging them into one file, a richer portfolio can be retrieved from the P2P network and viewed locally. Linking to Web resources will also be juxtaposed with direct linking to other resources residing on the P2P network.

Mobile devices will also be supported by building on Java and JXTA's mobile specific counterparts, J2ME [10] and JXME [11].

## Conclusions

This paper has outlined the rationale for creating decentralised ePortfolio networks. By leveraging peer-to-peer technologies, large scale network services can be created thus being a possible solution to enabling global ePortfolio networks. The P2P Portfolio applications have shown that decentralised ePortfolio network services are possible, and further development is being carried out to create a more advanced portfolio publisher that will be reported on in the near future.

## References

1. EUROPEAN INSTITUTE FOR E-LEARNING, *EP 2010 ROADMAP*, AVAILABLE ONLINE (RETRIEVED 8 SEPTEMBER 2006): [HTTP://WWW.EIFE-L.ORG/ACTIVITIES/CAMPAIGNS/EPREADINESS/ROADMAP](http://www.eife-l.org/activities/campaigns/epreadiness/roadmap)

2. I.M. BHANA, D. JOHNSON (2005) , *A PEER-TO-PEER APPROACH TO CONTENT DISSEMINATION AND SEARCH IN COLLABORATIVE NETWORKS*, LECTURE NOTES IN COMPUTER SCIENCE, COMPUTATIONAL SCIENCE – ICCS 2005, PROCEEDINGS PART III, 391-398
3. JUPITER MEDIA METRIX (PRESS RELEASE, JULY 20, 2001), *GLOBAL NAPSTER USAGE PLUMMENTS BUT NEW FILE-SHARING ALTERNATIVES GAINING GROUND*, AVAILABLE ONLINE (RETRIEVED 8 SEPTEMBER 2006): [HTTP://WWW.COMSCORE.COM/PRESS/RELEASE.ASP?ID=249](http://www.comscore.com/press/release.asp?id=249)
4. R. FLENNER, M. ABBOTT, T. BOUBEZ, F. COHEN, N. KRISHNAN, A. MOFFET, R. RAMAMURTI, B. SIDDIQUI, F. SOMMERS, (2003) *WHAT IS P2P?*, JAVA P2P UNLEASHED, SAMS PUBLISHING, 12-14
5. G. LORENZO, J. ITTELSON, D. OBLINGER (ED.) (2005), *AN OVERVIEW OF E-PORTFOLIOS*, EDUCASE LEARNING INITIATIVE, AVAILABLE ONLINE (RETRIEVED 8 SEPTEMBER 2006): [HTTP://WWW.EDUCAUSE.EDU/IR/LIBRARY/PDF/ELI3001.PDF](http://www.educause.edu/ir/library/pdf/ELI3001.pdf)
6. I.M. BHANA, D. JOHNSON, N.S. ALEXANDROV (2004), *SUPPORTING AD-HOC COLLABORATIONS IN PEER-TO-PEER NETWORKS*, PROCEEDINGS OF THE 17<sup>TH</sup> INTERNATIONAL CONFERENCE ON PARALLEL AND DISTRIBUTED COMPUTING SYSTEMS, SAN FRANCISCO, CALIFORNIA, USA, ISCA, 491-496
7. D. KRAMER, B. JOY, D. SPENHOFF (1996), *THE JAVA PLATFORM, A WHITE PAPER*, SUN MICROSYSTEMS INC., AVAILABLE ONLINE (RETRIEVED 8 SEPTEMBER 2006): [HTTP://JAVA.SUN.COM/DOCS/WHITE/PLATFORM/JAVAPLATFORMTOC.DOC.HTML](http://java.sun.com/docs/white/platform/javaplatformtoc.doc.html)
8. L. GONG (2002), *PROJECT JXTA: A TECHNOLOGY OVERVIEW*, SUN MICROSYSTEMS INC., AVAILABLE ONLINE (RETRIEVED 8 SEPTEMBER 2006): [HTTP://WWW.JXTA.ORG/PROJECT/WWW/DOCS/JXTAVIEW\\_01NOV02.PDF](http://www.jxta.org/project/www/docs/jxtaview_01nov02.pdf)
9. META-WIKI (2006), *WIKITEXT STANDARD*, AVAILABLE ONLINE: [HTTP://META.WIKIMEDIA.ORG/WIKI/WIKITEXT\\_STANDARD](http://meta.wikimedia.org/wiki/Wikitext_standard)
10. SUN MICROSYSTEMS, *JAVA 2 PLATFORM MICRO EDITION*, AVAILABLE ONLINE: [HTTP://JAVA.SUN.COM/J2ME](http://java.sun.com/j2me)
11. A. ARORA, C. HAYWOOD, K. SINGH PABLA(2002), *JXTA FOR J2ME: EXTENDING THE REACH OF WIRELESS WITH JXTA TECHNOLOGY*, AVAILABLE ONLINE (RETRIEVED 8 SEPTEMBER 2006): [HTTP://WWW.JXTA.ORG/PROJECT/WWW/DOCS/JXTA4J2ME.PDF](http://www.jxta.org/project/www/docs/jxta4j2me.pdf)

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