The Potential of Grid for Mobile e-Learning

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Abstract

In this paper we present the potential advantages of using the Grid for mobile e-learning, describe our experiences with implementing a mobile e-learning Grid client using current Grid technologies and look toward the next generation of Grid technology in order to assess whether it will fulfil the loosely coupled requirement of mobile e-learning.

1 Introduction

Mobile e-learning is an exciting new trend in learning technologies that has resulted from advances in ubiquitous and mobile computing. Simultaneously there is a move in distributed computing towards Service-Oriented-Architectures (SOA), and in particular the Grid as a vision of secure Web Services for sharing resources across virtual communities and organisations (Foster, 2001). We argue that the Grid offers not only advantages for e-learning, but specific advantages for mobile e-learning. We describe our attempts to create a mobile e-learning client using Grid technologies and look toward the next generation of Grid technology to see if it fulfils the requirements for mobile e-learning that we have identified.

2 Why Grid for Mobile e-Learning?

The advantages of using a SOA are:

- **Modularity**: as the services are dynamically coupled at runtime.
- **Interoperability**: due to standardisation of the service interfaces.
- **Extensibility**: due to the relative ease with which new services can be incorporated.

There is already interest in developing SOAs for e-learning, such as the UK's E-Learning Framework (ELF). The Grid offers a number of advantages for this.

While Grid services were originally conceived to facilitate the combining of distributed computational resources, they also provide benefits in distributed knowledge management, offering functionality beyond a normal SOA that is essential for serious e-learning applications, such as security and state awareness.

The Semantic Grid is the idea of applying Semantic Web technologies to the Grid, including the use of those technologies to describe Grid services (De Roure, 2005). This opens up new possibilities for automation. For example, in an extensive Grid environment, such as the proposed E-Learning Grid Infrastructure (ELeGI) it would be possible to automatically incorporate new services into a local learning environment.

Loosely coupled secure Grid services would be particularly useful in a mobile context as mobile devices change their networks and neighbours far more frequently than ordinary computer installations, and would therefore benefit from being able to find and use services that were local to the device (for example, to utilise a nearby screen to show information that couldn't be crammed onto a handheld display). Mobile devices also usually have much less computing power than static devices, and could benefit from the Grid's ability to move computation to a more powerful system.

3 Experiences with Mobile Grid

As part of the ELeGI project's investigation into requirements for an e-learning Grid infrastructure, work was undertaken by the University of St Andrews to convert their existing e-learning system, Finesse (Finance Education in a Scalable Software Environment) (Power, 1998) into a set of Finesse Grid Services (FIGS). Finesse offers a variety of tools that allow students to manage on-line portfolios and buy and sell shares using real-time market data. At Southampton we want to ensure that the Grid infrastructure developed by ELeGI is broad enough to

support novel mobile and ubiquitous learning applications. So we decided to work on a mobile interface for FIGS that would make the portfolios accessible via a PDA as a first step to achieving this.

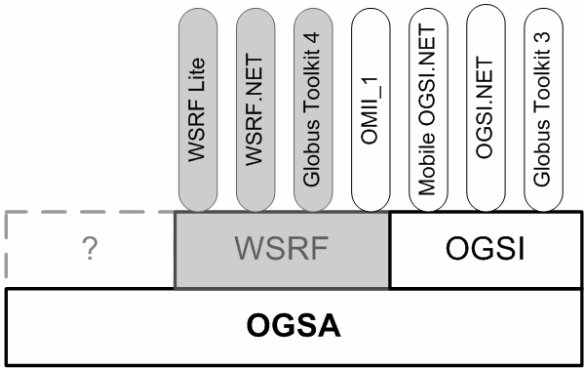

Figure 1: Grid Technologies

Figure 1 shows the Grid Technologies that we investigated. They all run on top of the Open Grid Services Architecture (OGSA). Those in grey are still in development and may only have partial releases or support. Our findings are detailed in Millard (2005), but in summary our conclusions were that none of the technologies currently available (those shown in white) can currently support Grid Clients on a Mobile Device. This is because they make assumptions about the capabilities of their host environment, for example OGSI.Net will not work with .NET CF and Globus Toolkit 3 assumes too high a level of Java support.

In the end we were forced to implement our mobile Grid client using a proxy, i.e. a browser on the PDA that accessed Grid services running on a Web server. We feel that this is a disappointing result that does not leverage the advantages of Grid technology as outlined in section 2. This raises the key question as to what subset of functionality is required on mobile devices in order to achieve the benefits of the Grid model.

4 Emerging Grid Technologies

The existing service view on OGSA is the Open Grid Services Infrastructure (OGSI). Other infrastructures for Grid services are now attracting effort, most notably the Web Services Resource Framework (WSRF). There are a number of WSRF implementations at various stages of completion, including new .NET and Globus versions.

However we do not believe that WSRF solves the problem for mobile devices. Both OGSI and WSRF are designed for building enterprise level virtual organisations, and are too heavyweight for the loosely coupled mobile applications needed in the e-learning domain. This is even before we tackle the problem of whether the API can be used on a mobile device.

Lightweight implementations of these (such as Mobile OGSI.NET) are providing a sensible subset of the enterprise services, rather than an entirely new light-weight view. Although these may be possible to run on a PDA (particularly new WSRF interfaces) in our opinion it is a completely different interface onto OGSA, the "?" layer in Figure 1, that is needed to support the type of e-learning mobile Grid applications that we have described.

5 Conclusions

SOAs for e-learning are a hot-topic in the research community, with both web service and Grid-based approaches being taken (ELF and ELeGI). Mobile e-learning is particularly well-placed to benefit, due to the changing system context of mobile devices. However the current set of Grid technologies does not fit well with the loosely coupled requirements of mobile e-learning and are often too heavy-weight to fit on a mobile device. Unless this is addressed it will make the emerging e-learning Grid infrastructures inaccessible to mobile devices, and stunt the development of novel mobile e-learning applications.

6 Acknowledgements

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7 References

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