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Universal Acessibility to the Grid via Metagrid Infrastructure

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This paper discusses the concept of universal accessibility [1, 2] to the grid within the context of selected application domains involving social interaction such as e-hospital, collaborative engineering, enterprise, e-government, and the media. Based on this discussion the paper proposes a metagrid infrastructure [3] as an approach to provide universal accessibility to the grid.

Universal accessibility is rooted in the concept of Design for All in Human Computer Interaction[1, 2]. It aims at efficiently and effectively addressing the numerous and diverse accessibility problems in human interaction with software applications and telematic services. So far, the key concept of universal accessibility has been supported by various development methodologies and platforms [4, 5]. Various application domains benefited from research and development in this area, including among others interactive television and media [6, 7]. Porting the concept of universal accessibility to the grid is faced by major obstacles attributed to the following: (a) the lack of an underlying functionality similar to that of a desktop operating system allowing the plug and play of resources and the direct user interaction with these resources; (b) the dilemma between hiding the grid versus making it more transparent; and (c) the software engineering practice adopted in grid middleware development, where the bottom up approach that is predominant [8] conflicts with the ethos of universal accessibility that considers accessibility at design time.

These obstacles and their impacts on universal accessibility to the grid are discussed with reference to four application domains including collaborative applications such as e-hospital, collaborative engineering, enterprise applications, the media, and e-government. In collaborative applications the key obstacle for universal accessibility to the grid is provision of interactivity while respecting various Service Level Agreements (SLAs). Several efforts are underway to resolve this issue [9, 21], but no versatile solutions have emerged so far. In the enterprise the major concern is the management of an integrated data centre [10]; the key obstacle confronted is that while already offering data-intensive computational power the grid is quite immature in its provision of permanent storage of data. This is very much a live issue in grid middleware development. In the media the major challenge is the direct access to remote external devices at the grid boundaries. For e-government accommodating various forms of interaction [11], such as government-to-government (G2G), government-to-citizen (G2C), and government-to-business (G2B), is paramount, whilst devoting a major focus on data semantics, not just structure.

So far universal accessibility to the grid was addressed from various perspectives. Efforts undertaken involved: (a) the development of grid middleware supporting interaction with heterogeneous mobile devices [12, 13]; (b) the use of operating system mobility for configuring grid application on a PC and then migrating the entire application together with the operating system instance onto the grid [14]; (c) the development of a shopping cart system based on the Web Service Resource

Framework WSRF [15]; (d) the design of an approach for middleware development, based on wrapping the computational and resource intensive tasks, to allow the accessibility to the grid via hand held devices [16, 22]; (e) the development of common web-based grid application portals allowing the applications' users to customize their interfaces to the grid [17, 23, 24]; (f) the development of application models for the grid [18]; and (g) addressing security issues raised by granting grid accessibility via various media delivery channels (such as wireless devices) [19].

While each of these efforts towards universal accessibility to the grid does address the problem to some extent, none of them enables a complete solution. This paper proposes an approach, based on a metagrid infrastructure, that can potentially host solutions to all issues related to universal accessibility to the grid. This metagrid infrastructure was used thus far in the context of grid interoperability [3]. Our proposed approach extends the notion of interoperability to embrace grid application interoperability (interactivity and universal accessibility). While heavily based on existing grid middleware services and architecture such as EGEE, Globus, CrossGrid, GridPP and GGF [25, 26, 23, 27, 28], the metagrid infrastructure hosts one or more target grid techologies (e.g. it has been demonstrated simultaneously hosting WebCom, LCG2 and GT4) while also supporting its own services that provide things like universal accessibility that the target grid technologies do not. By doing so it firmly places the user within the metagrid environment rather than in any one target grid environment. The user obtains universal accessibility via the metagrid services, and the target grid technologies are relieved of the need to support direct user and device interactions.

By way of example, services currently offered by the metagrid infrastructure include a transparent grid filesystem [26] that supplies a vital missing component beneath existing middleware. The grid filesystem can support universal accessibility by supporting all forms of data access (r/w/x) in the course of collaborative interaction (collaborative engineering and e-hospital), by providing a logical user view of grid data (to support integration of the data centre in the enterprise), and by helping locate (discover) data in the course of interaction in media applications. In so doing it can improve the utility of, for example, the EGEE middleware. As further examples, proposed future services include special purpose discovery services to support various forms of interaction especially in media applications; and intelligent interpreters to support e-Government data semantics.

The paper is divided in five sections. The first section introduces the concept of universal accessibility and its relevance to the grid. The second section discusses existing obstacles facing universal accessibility to the grid in application domains involving social interaction. The third section overviews existing efforts towards universal accessibility to the grid. The fourth section propose an approach for universal accessibility to the grid based on a metagrid infrastructure and prototype services offered by this infrastructure. The paper concludes with a summary and a future research agenda.

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