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Systematic design of secure Mobile Grid systems

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ABSTRACT

Grid computing has arisen as an evolution of distributed systems mainly focused on the sharing of and remote access to resources in a uniform, transparent, secure, efficient and reliable manner. It is possible to join Grid technology and mobile technology in order to create one of the most promising technologies and developments to appear in recent years, in that they enrich one another and provide new solutions that solve many of the limitations and problems found in different technologies. Security is a very important factor in Mobile Grid Computing and is also difficult to achieve owing to the open nature of wireless networks and heterogeneous and distributed environments. Success in obtaining a secure system originates in incorporating security from the first stages of the development process. It has therefore been necessary to define a development process for this kind of systems in which security is incorporated in all stages of the development and the features and particularities of the Mobile Grid systems are taken into consideration. This paper presents one of the activities of this development process, the design activity, which consists of defining and designing a security software architecture. This architecture will be built from a security architecture, defined as reference architecture, in which security services, interfaces and operations are defined with the purpose of defining a reference security architecture which covers the majority of security requirements identified in the analysis activity. The design activity will build the system architecture that will be the input artefact for the subsequent activity in the process, which is the construction activity.

1. Introduction

Grid computing has emerged to cater for the needs of computing-on-demand (Jana et al., 2009) resulting from the advent of distributed computing with sophisticated load balancing, distributed data and concurrent computing power using clustered servers. The Grid enables resource sharing and dynamic allocation of computational resources, thus increasing access to distributed data, promoting operational flexibility and collaboration, and allowing service providers to scale efficiently in order to meet variable demands (Foster and Kesselman, 2004). Security is considered to be the most significant challenge for Grid computing (Foster et al., 1998; Humphrey et al., 2005; Nagaratnam et al., 2003; Ramakrishnan, 2004; Welch et al., 2003; Zhou et al., 2005), since the resources that are shared between organizations are expensive and may range from computers and other hardware facilities, to potentially valuable, sensitive and confidential data files.

In recent years the mobile computing community has been successful in utilizing academic and industrial research efforts to bring products to the commercial market. We have seen a proliferation of consumer electronic devices that take advantage of wireless technology and enrich our daily lives with increased productivity thanks to higher connectivity. Mobile computing imposes a degree of complexity inherent to the environment (Giguhre, 2001), such as dynamic environments, mobility, computational resource limitations, latency and instabilities in data transfer, energy supply limitations, and input/output interface limitations. This degree of complexity signifies that security is more difficult to implement on a mobile platform owing to the limitations of resources in these devices (Bradford et al., 2007), and is even more critical owing to the open nature of wireless networks. Therefore, in a mobile computing environment, it is necessary to have a robust security and trust infrastructure (Talukder and Yavagal, 2006).

In the purview of Grid and mobile computing, Mobile Grid is a heir of the Grid, which addresses mobility issues, with the added elements of supporting mobile users and resources in a seamless, transparent, secure and efficient way (Guan et al., 2005; Jameel et al., 2005). It is able to organize underlying ad-hoc networks and offer a self-configuring Grid system of mobile resources (hosts and users) connected by wireless links and forming random and

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