Towards Monitoring Security Policies in Grid Computing: A Survey

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***Abstract*—Grid computing systems are complex and dynamic systems and therefore require appropriate automated management, which would enable stable and reliable operation of the whole grid environment. The research community has addressed this requirement with a number of monitoring frameworks, which serve to collect data at various levels to support decision taking and management activities within grids. However, these existing solutions seem to implement little support for collecting security-related data and enforcing appropriate security policies and constraints in this respect. With an increasing role of network connections and users remotely accessing computational resources from various locations, grid systems are no longer seen as localised and isolated ecosystems, but are coming to be more open and distributed. In this light, it is becoming more and more important to enable monitoring frameworks with capabilities to collect security-related data and check whether these observations comply with certain security constraints. Accordingly, this paper presents a survey of existing grid monitoring systems with a goal to identify an existing gap of insufficient support for handling the security dimension in grids. The survey suggests that available grid monitoring frameworks are incapable of collecting security-related data metrics and evaluating them against a set of security policies. As a first step towards addressing this issue, the paper outlines several groups of security policies, which the authors expect to be further incorporated in their own research work, and by the wider community.**

Keywords*—*Grid; Grid computing; Monitoring System; Security policy; Policy enforcement; Survey

I. Introduction

Grid systems are traditionally seen as computational clusters, which serve to provide universal and steady access to the pool of resources, including computational power, data storage space, software support for deploying and running intensive computations, data analysis, etc. [1]. To a great extent, user interaction with a grid system is automated, and grid resources are allocated and provisioned automatically. It means that users are enabled to remotely access grid systems, run their computations or store their data themselves, avoiding interaction with the grid administrator. Moreover, grid users are also typically exempted from the underlying routines of handling task fragmentation and distribution, scheduling, data integrity checking, etc. All these background jobs are expected to be handled by the grid in a completely automated manner.

This flexible functionality, however, requires constant automated control and supervision to be executed by the grid administrators so as to support stable operation of the managed grid ecosystem. This in turn requires employing appropriate data collection and monitoring mechanisms, which would provide sufficient information for the interested party to take necessary actions. Broadly speaking, monitoring can be defined as a process of systematic collection of information about the current and past status of resources that are relevant in a particular scenario [2]. In the context of grid systems, which are characterised by their dynamic and complex nature, monitoring has become a particularly important task, which serves as a basis for providing reliable and cohesive services to users [3]. Since the emergence of grid computing, enabling automated monitoring capabilities has been identified as one of the key challenges and attracted attention and efforts both from the academia and the industry.

As a result, to date, grid computing in general and grid monitoring systems in particular have reached a considerable level of maturity. Moreover, grid computing is frequently seen as a precursor to cloud computing, which also results in employing already existing grid monitoring solutions to the emerging domain of cloud computing. For example, the two fundamental characteristics of cloud computing [4] – elasticity and load balancing – are supported by prompt and timely monitoring of the underlying infrastructure resources. These monitoring mechanisms were not developed from scratch, but rather relied on already existing, highly optimised and reliable solutions originating from the grid computing research.

Another recent extension to grid computing – namely, mobile grid computing [5] – can also potentially benefit from employing already existing techniques. Mobile grid computing is an emerging computing paradigm, which lies at the intersection of two research areas – namely, grid computing and mobile computing [5]. Its main concept is to extend the traditional capabilities of grids – that is, provisioning of a large pool of aggregated computational and storage resources in order to address computationally intensive tasks [6] – with computational capabilities of mobile devices over the network. From this perspective, mobile grid computing can be seen as an evolution of the grid concept from traditional, on-premises deployments to a distributed computing architecture, consisting of both computational clusters residing in a data centre and

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