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Collaborative & Integrated Network & Systems Management: Management Using Grid Technologies

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Abstract. Network and systems management platforms were based on simple centralized architectures. Centralized architectures have proved deficient in managing current complex networks, such as the Internet. This has led to more complex and distributed architectures for network and system management. Throughout their development, management platforms have passed through intermediate stages such as weakly distributed control systems, strongly distributed control systems, domain based systems, and active distributed management systems [1]. In order to facilitate the development of such a platform, we will build a management collaborative community around grid concepts, so that it supports the integration of multiple management tasks in parallel manner. Access to information of different management domains requires some computational resources that are provided through grid interface and virtual organizations. Some system prototype results are presented

Keywords: Grid, Network and Systems Management, Integrated Management, Virtual Organizations.

1. Introduction

Computing has extended from standalone PCs to Local Area Networks (LAN), and beyond the local network boundary to open networks including the Internet, Wide Area Networks (WAN), and wireless networks. With the assistance of decentralized and high speed networks, computing devices are able to communicate and collaborate with each other regardless of their geographic locations or device types (e.g. PCs, cell phones, hand-helds). Mergers and takeovers, as a result of globalization, very often require computing to be performed in a distributed, heterogeneous and complex environment. EServices also require service transactions to be conducted between systems over a distributed network e.g. the Internet.

New technologies such as Distributed Object Computing, Web Services, Peer-To-Peer, and Grid Computing [2] are designed to serve these purposes. The Open Grid Services Architecture (OGSA) has recently emerged as a 'second generation' distributed computing approach to Grid middleware that is taking Grid support forward from an era of ad-hoc platforms to a more architected approach built on service orientation and web services technologies Therefore, high performance computing should undergo considerable change since the connection performance of the Internet is not progressing as fast compared to computing speed. Applications that once were tightly coupled and complex are now decentralized, with collaborating components spread across diverse computational elements. Collaborative computing is an emergent trend that requires not only distributed computing capability but also faultless interoperability between different operating systems. Furthermore, interoperability necessitates standard communication protocols and a universal data exchange format. Therefore, we see that future network and systems management should inherit similar development trends.[14]

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1.1 Network and Systems Management

Hegering [5] defines network management as “all measures ensuring the effective and efficient operations of a system within its resource in accordance with corporate goals”. As defined by ISO, network management consists of five abstract areas: performance, configuration, account, fault, and security.

Over the last decade, network and systems management has increasingly evolved from centralized paradigms, to distributed paradigms [1]. Network management started with a simple centralized platform called SNMP [1]. IP networks have developed dramatically and support many applications that are distributed in nature. RMON, SNMPv2 and SNMPv3 [1] management frameworks are examples of the early stages of distributed management platforms. As IP networks develop and open new opportunities for new applications, new management paradigms are being proposed. For example, mobile code, distributed objects, collaborative paradigms, enterprise system, active programmable management and domain based management, and more currently grid based management [1].

Current high performance computing applications are decentralized, loosely coupled, and complex. These applications use collaborating components spread across diverse computational elements. Such distributed systems most commonly communicate through different exchange message formats and data structure. As a result of the mentioned growing trend, we propose a management platform that exhibits some emerging attributes such as, delocalization, collaboration, and is component based in nature.

1.2 *Grid Technologies*

Depending on many factors, grid is defined in different ways. Fosters [6] defines grid as “The sharing that we are concerned with, is not primarily file exchange but rather direct access to computers, software, data, and other resources, as is required by a range of collaborative problem-solving and resource-brokering strategies emerging in industry, science, and engineering. This sharing is, necessarily, highly controlled, with resource providers and consumers defining clearly and carefully just what is shared, who is allowed to share, and the conditions under which sharing occurs. A set of individuals and/or institutions defined by such sharing rules form what we call a virtual organization”.

The previous definition highlights four main components of a grid that is of network management interest: First, due to a wide variety of resource and resource types, grid integrates and coordinates resources and users that exist within different management domains [7]. For example, user’s desktop vs. central computing, different administrative departments of the same institution vs. those of different institutions. This coordination addresses the complications of security, policy, accountability, and ownership. Second, grid is assembled from standard and open multi-purpose protocols and interfaces that address security, resource discovery, resource allocation, and resource access [2][8]. Third, grid allows its available resource components to be used in a coordinated manner, such that various QoS can be provided. QoS are responsible for controlling delay, throughput, availability, and security of user’s applications [1][2][8]. Forth, grid environments are designed to provide access to the available resources in a faultless manner [2][8]. Clearly, the above listed grid features are of great support to build a collaborative and integrated network and systems management platform.

Generally, grid components can be categorized based on their purpose as a processing element, a network element, or a storage element. Processing elements very among single processor, multiprocessor, cluster, and parallel processing systems. Network elements are basically routers, switches, gateways, virtual private network devices and firewalls. Storage elements are network attached storage devices such as automated CD-ROM/DVD, data warehouse, or a dedicated database machine. Literature categorizes grid types into three categories, computational, data and service grids. Each of these will be used to facilitate the functionality of the new proposed management platform [13].

2. Network Management Using Grid

This paper presents a novel integrated and collaborative network management system using grid technologies. Given *n* number of management platforms on *k* different management domains [7] each with *p* number of different management tasks, we aim to develop an efficient and highly collaborative network management system that satisfies distributed administrative control. Network and system management information is growing in terms of complexity and size. Efficiency is a performance measure to indicate the effective utilization of bandwidth within the network [2]. Collaboration refers to how easily and accurately different distributed management domains share managerial information of each [2].

The new grid-based management system is composed of two dynamic servicing tiers. The user level tier consists of users that have some management tasks. Once the task is verified against the allowed operations stored in the domain virtual organization, the user contacts the service tier to request a completion of the task. The service tier accepts the submitted task and work on behalf of the user to complete the requested management task. A management task may require multiple domains to collaborate and operate their agents in a predefined sequence to obtain a successful user task.

3. Architecture Overview

Figure 1 presents an overview of the proposed architecture. In each ISP/Management domain there exists a management agent. This agent is a software implementation that is responsible to perform management tasks that are sent from the management applications.

It also consists of the several service implementations that perform designated tasks. Furthermore, it is responsible to monitor, gather, and share the domain management information that the domain agreed to provide based on virtual organization policy that get established. At the grid servicing layer there exist different management services such as monitoring, configuration, fault detection, resource management, etc. Management applications are launched on a format of grid application. The advantages of this approach consist of performing multiple and different management tasks in an autonomous and parallel manner.

Figure 2 illustrates some aspects of grid that is considered as an advantage to network and systems management operations. This example scenario presents a situation where a grid based management task wants to discover, monitor, and employ remote configuration, such that it assigns more resources to a certain high-bandwidth application. It uses selected domain management information from a number of distributed domains based on provided management information from established virtual organizations. From this scenario we observe that this management task requires some service composition associated with some optimization and queuing techniques. For now we will focus on the system interaction to accomplish such a task.

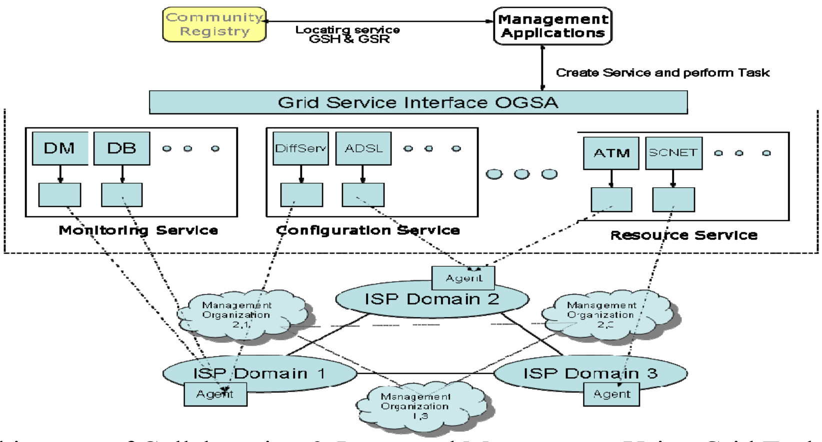

Fig 1: Architecture of Collaborative & Integrated Management Using Grid Technologies

Figure 2 illustrates the following steps:

1. The management application, which could be a program that acts on behalf of the user first contacts a community registry to obtain the information that is relevant to the required task. Keeping in mind that virtual organization maintains a record such that it identifies the service providers who can provide the required services. In our example the user requires services for monitoring and configuring a segment of a network.

2. The registry returns both grid service handler, which as we said earlier is unique, and grid service reference that identifies the factories for monitoring, configuring, and queuing a management tasks.

3. The user issues requests to monitoring, configuring, and task queuing factories specifying details such as the required monitored information, how to be performed, in what order the tasks are to be performed, and the format of the results.

4. Assuming that this negotiation process proceeds satisfactorily, three new service instances are created with specified initial lifetime stamp.

5. The monitoring service initiates monitoring request against appropriate remote monitoring service that is located in the desired domain.

6. Similarly to 5, the configuring service instantiates a configuring service that starts a connection with the designated device.

7. If the task in 5 passes correctly, results are returned from monitoring process to the configuration service.

8. Depending on the started lifetimes, the management application can keep issuing periodic *keepalive* messages to indicate continued interest in such a service. Monitoring or configuring delays may occur for several system reasons such as congestion, queuing. Management application can also subscribe to the task notification mechanism provided by grid standard implementation [11].

9. Once the monitoring process returns the required data, the management application terminates the instance.

10. The application then remains in control of the configuration task until it completes either successfully or an error message gets returned. In either case, new future scenarios might take place.

11. The task queuing service remains active to ensure the configuration commands get executed in a pre-defined and correct manner.

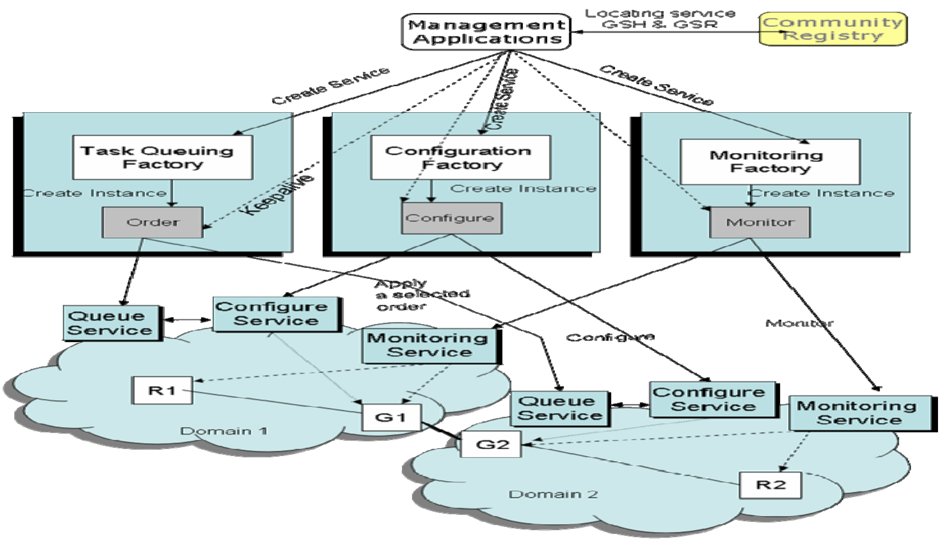

Fig 2: Monitoring & Configuration Management task scenario

The above illustrated management scenario can be implemented in several ways. The Grid standard facilitates a distributed implementation of the service registry. Furthermore, it allows an integrated service information gathering. For example, an intermediate service broker can be involved in service query and assignment. However, these details are abstracted from the management application and it will just get the relevant service and task information.

4. Conclusion

Architecture for collaborative and integrated network and systems management using grid technologies has been presented. The architecture is generic, flexible, and supports different systems and network technologies. The proposed architecture has provided several advantages to network and systems management. The following is a description of selected major features. First *scalability*, the usage of grid technologies facilitates a wider coverage of different management tasks and the deployment of different management protocols over a wider geographical area. Second *correctness,* the concept of virtual organizations eliminates management faults that are caused because of incorrect sequence of management job submissions. Third *adaptability*, the idea of services and service factories facilitate the adaptability of the system to different customized management tasks. Finally *anonymity*, the anonymous deployment and execution of management jobs simplify the architecture and keep the management information private to the domain and its registered users.

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