ISAM

A Pervasive View in Distributed Mobile Computing

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Abstract: The next years will be characterized for high levels of mobility, heterogeneity and interactions among devices connected to global networks. These interconnected networks will use as much wired connections as wireless. The first researches involving wide-area distributed systems answered many questions concerning resource management, although they fail in treating questions related to heterogeneity and dynamic adaptation. More recent works, through technologies like CORBA and Java/Jini, deal with heterogeneity problem, but do not deepen into adaptability aspects. In this article, we propose inside of the project ISAM, a treatment of this subject. ISAM contemplates an integrated approach of software and execution environment addressed to the administration of adaptation in heterogeneous networks, supporting the logical (software) and physical (hardware) mobility, oriented to the execution of distributed applications in a global scale and based on software components.

Key words: mobile computing, adaptation, pervasive computing.

1. INTRODUCTION

The Mobile Computing is a vision of future that promises to modify the way how people work and interact today. It has emerged as a new field, distinct from conventional distributed computing by its focus on mobility and its consequence. The physical and logical mobility allows the creation of applications with new requirements: built-in mobility, adaptability and flexibility.

The adaptation is a fundamental concept for mobile computing [2]. However, adaptation is not easy for implementing. Traditional distributed

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systems were created based on suppositions about environment, such as permanent connection and resources availability, which is not true in the mobile environment. This fact prevents the direct usage of solutions from distributed system area.

With the motivation of exploring the concept of adaptation in pervasive environment is going on the ISAM¹ Project (*Infra-estrutura de Suporte às Aplicações Móveis* - Support Infrastructure for Mobile Applications). It aims the provision of infrastructure for developing and executing mobile distributed applications. Our system is designed to support multilevel collaborative adaptation at application level and system level. In ISAM, the system adapts to provide quality, while the application, if necessary, adapts until lowest quality level tolerated by the mobile user. The innovation of this project is the uniform treatment of adaptation, and its suitability for general-purpose mobile application.

This article describes the issues about adaptation process in the ISAM software platform. The remainder paper is organized as follows. Section 2 presents a summary of ISAM architecture and its adaptive behavior. Section 3 reviews the related works. Finally, we give some concluding remarks in section 4.

2. ISAM ARCHITECTURE

The most general scenario of the mobility is that provided by pervasive computing, which allows physical and logical mobility while it maintains the global network connection [3]. This scenario is the focus of ISAM Architecture. To developing distributed mobile applications at moment, we consider that mobile hosts must use the existing and accessible fixed network infrastructure, and they have to take advantage of the environment such as Internet. This situation is reflected in the basic elements of ISAM environment components, presented in figure 1.

2.1 Software Architecture

The adaptability support in all levels is the fundamental idea of the ISAM architecture. It is organized in layers with three abstraction levels (Figure 2). For organizational matters, the ISAM architecture is presented through modules. The adaptation module is virtual, because it is presented in the

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conception of many others modules. In our work, we are interested in providing a uniform adaptive behavior in all system, whereas that adaptation is the critical point of majority mobile applications. Another important aspect in the architecture is the adaptation decision - the core of ISAM architecture. Adaptation decisions, from application to scheduler, are based on the behavior profile of three entities: mobile user, application and the self-system, which are part of the execution context.

The higher layer is composed by distributed mobile applications, programmed with Holoparadigm abstractions [5] that express mobility in a natural way. Holoparadigm is being modified to adding new abstractions that allow expressing adaptability at application level (ISAMadapt). On the other hand, the lower layer is composed by existent distributed systems, such as the native operating systems and the Virtual Machine Java. Furthermore, the ISAM architecture was conceived assuming the existence of a mobile network infrastructure (wireless network + cabled network), which provides support to accessing network resources in global scale (pervasive computing).

Figure 1. ISAM Environment components

Figure 2. ISAM architecture

The middle layer is the functional core of architecture, and it is provided with three abstraction levels. Two modules of application compose the first level: Scheduling and User Virtual Environment. The scheduling is the key component of adaptation, and its main strategies were described in [6]. The User Virtual Environment is composed by elements that integrate the mobile user interface. It is formed by information, dynamically obtained, about user work, preferences, use patterns, physical movement pattern and user's hardware.

Another important module it's the monitoring, that obtains information by observing and registering both the application and the user behavior, every moment in every place. This information permits determining the historical and quantitative evolution of the monitored entities. Some works

considering four aspects of environment monitoring are being carried on: information about networking [7], dynamic information of application [8], information about system itself [9].

On the third level of the middle layer are the basic services of ISAM execution environment that provide the functionality needs to the second level.

2.2 Multilevel Collaborative Adaptation

In general, the adaptation requires the existence of multiple ways of execution for an application, or alternate configurations, which exhibit different utilization profiles of computational elements. We observe that adaptation in mobile applications can occur basically in four dimensions: temporal, spatial, personal, social [4]. Furthermore, adaptation can occur in levels relating to adaptation focus: resource, context and situation. These levels represent the computational elements in which the application is self-interested, and influences its behavior or performance.

Figure 3. Multilevel collaborative adaptation

One important design goal of ISAM Architecture is making the whole system as adaptable as possible for attending the needs of the mobile applications with adaptive behavior. For that, software architecture provides: (i) models for programming and interaction that express mobility and adaptability (ISAMadapt [10]; (ii) an execution environment that manages the adaptation process (EXEHDA [11]).

In the ISAM Multilevel Collaborative Adaptation model (figure 3):

- the system is responsible for some adaptations related to performance or resource management;
- the application is responsible for decisions concerning adaptations related to usage or specific to its domain;
- both are responsible for adaptation decisions negotiated in many cases.

The flexibility is achieved by language abstractions and by corresponding runtime support. The language elements work independently, or cooperate with the system to achieve the desired level of adaptability at runtime.

3. RELATED WORKS

Noble [2] has inspired our work. In his thesis, he proposes the application-aware adaptation that supports a collaborative relationship between application and system. However, that prototypal system is only based on network-aware application. Many other systems that provide an adaptive behavior to mobile applications were also analyzed, among them [1][12][13]. In general, these systems provide only the resource level adaptation. In contrast to ISAM, those systems cover a little range of adaptation possibilities, which are limited for expressing the flexibility needed to new types of applications that are context-aware.

More similar to the mobile environment viewer of ISAM Project is Grimm's. His work, One.world [1], also raises the question on how to structure systems that can support pervasive applications. As ISAM, One.world uses the Java language to provide a uniform and safe execution platform. However, a significant difference between One.world and ISAM is that the first requires that all resources be explicitly bound and leased, while ISAM support dynamic adjust to new state based on system-application negotiating.

4. CONCLUSIONS

The ISAM Project, differently from other systems, has as objective to deal with the adaptation of a uniform mode providing four dimensions: temporal, spatial, personal and social. Another key point is the collaborative behavior of adaptation. The system, as well as the application, collaborates to adaptation decision at load-time and at run-time. We argue that for simplifying the application implementation is necessary a programming style that express mobility and adaptability on natural way. The runtime language must provide mechanisms for specialized adaptive behavior. This way, it can attend the expressivity requirements of several applications. Our proposal architecture is broad and presents many challenges. At moment, several researches are ongoing, which approach various issues, such as: language, runtime, monitoring and integration with current technologies.

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