Chapter 5.10

Survey on Grid Computing on Mobile Consumer Devices

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ABSTRACT

Grid computing offers exciting possibilities for mobile consumer devices. The sharing of resources makes new, demanding applications feasible and helps to exploit previously unused potential. As the number of mobile devices for communication and computation increases, so does the appeal of a mobile grid. However, transferring the paradigm of grid computing to the domain of mobile devices is difficult: limited resources, intermittent connectivity, increased heterogeneity, and network dynamics are some of the many complicating factors. There are different approaches to tackling the isolated facets of this task. These avenues vary according to management structure, network architecture, the kind of shared resources, and whether the mobile devices merely use resources or also contribute resources to the grid. This chapter introduces a scheme for classifying approaches to establishing mobile grids with respect to these aspects. Furthermore, it provides a survey of these efforts and identifies remaining challenges and future trends.

INTRODUCTION

Within the last decade, we have witnessed the development predicted by Mark Weiser in the mid-1990s in one of his essays about the rise of ubiquitous computing (Weiser & Brown, 1997): After the era of mainframes and personal computers, we will be living in a world where multiple computers serve a single individual. Undoubtedly, the number of computational devices that surrounds us is growing fast and steadily. While some of them are immobile and embedded into buildings and machines, a large fraction belongs to the class of mobile devices. Cell phones, personal

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digital assistants (PDA), notebooks, ultra-mobile personal computers (UMPC), and navigation appliances are accompanying us in our daily lives.

According to numbers provided by market research groups like Gartner and IDC, mobile devices already far outnumber personal computers in terms of sold units: In 2007, the 1.15 billion cell phones purchased dwarfed the 271 million PCs sold worldwide. And for 2008, about 50% of all PCs sold were expected to be portable devices like notebooks and ultra-mobile PCs (IDC, 2007). This trend is even increasing as ultra-mobile PCs continue to be developed, and intensifying competition among producers is creating a new low-price segment on the market. The growing number of these mobile devices, along with their increasing power in terms of computing performance, storage capacity, access to broadband data networks, and ability to hook up to utilities like GPS units and cameras, make them an enticing target for a technology that was originally designed with different devices in mind: grid computing.

Grid computing is a computing paradigm that was promoted during the last decade. It strives to create an infrastructure that enables generic and large-scale resource sharing: Providing, consuming, and accounting for resources across administrative domains should be as easy as utilizing the electrical grid. Extending the concepts of grid computing to mobile devices bears many advantages:

- Mobile devices significantly enlarge the range of shareable resources by contributing sensors (microphones, temperature sensors, and pressure sensors), actuators (e.g. speakers) and more (e.g. GPS units)
- Because they exploit mobility, mobile devices can bring utilities, processing, and data storage capacity to locations where the grid was not previously accessible
- Grid computing for mobile devices can enrich the features of a constraint mobile device by adding resources from the grid, e.g. massive computing power

As an example, consider a grid consisting of mobile devices carried around by a group of tourists. With a mobile grid, devices with an attached GPS receiver could offer this resource to other devices nearby. Thus, photos could be tagged with a location even if the camera owner does not own a GPS device himself. Furthermore, a mobile grid infrastructure would allow the photos to be easily shared among the group. Devices that possess special resources, for instance a network interface and a cheap plan, could serve to transport data. A mobile grid could even enable the use of resources beyond the mobile devices; for example, computationally intensive tasks like rendering video data out of pictures could be done by powerful servers that are accessed and controlled by small mobile devices.

However, mobile devices are limited by numerous hardware, software, and infrastructure constraints. These constraints make it difficult to transfer the paradigms of grid computing to the domain of mobile devices. Several research groups have made efforts to identify and understand these constraints and have tried to develop architectures and mechanisms to cope with the resulting challenges. To present these efforts in a coherent fashion, we offer a classification scheme for them and provide a survey of current research. The classification scheme consists of four dimensions: management structure, network architecture, resource type, and usage scheme. In terms of management structure, we distinguish between centralized, distributed, and hybrid structures. All management structures are possible, regardless of whether the mobile grid uses an infrastructure network or a Mobile Ad hoc Network (MANET) as its underlying network architecture. The type of shared resources can be a CPU or data storage unit as well as software and hardware utilities. In terms of the usage scheme, we distinguish between three scenarios, in which mobile devices