Abstract

The inception of ubiquitous computing goes back to late eighties, when the Research at the Xerox Palo Alto Research (PARC) started designing ubiquitous environment under the guidance of Mark Weiser. Ubiquitous computing integrates the computers in the physical world to enhance human activities. In ubiquitous computing environment many interconnected computers having several interfaces will be used in the background to provide relevant services to the users intelligently. Ubiquitous computing applications, like ubiquitous health care service, ubiquitous shopping complex, ubiquitous tourist guide systems, ubiquitous learning systems, provide adaptive, user-centric, context-aware services intelligently in healthcare, product purchase, tourism and education fields respectively. The underlying network which provides uninterrupted connectivity for Unodes in different technology-based subnetworks is called as ubiquitous network.

The objective of the work is to design solutions to the following issues in ubiquitous networks: monitoring ubiquitous application nodes, allocating resources to them, maintaining uniformly their QoS demand, and automatic service provision, in the ubiquitous networks. To solve the above-mentioned issues in ubiquitous network which consists of heterogeneous subnetworks and devices, we used agent technology as agents have the capability to take decisions by themselves on behalf of the user, migrate from device to device, and dynamically resolve the local problems. A node monitoring protocol monitors the health condition of a node by supervising the resource parameters, like data rate, delay, energy and throughput, as well as events, such as node failure, network failure and fault in the network. We have proposed a method to monitor the health condition and behaviour of a Unode (i.e., nodes running a ubiquitous application) in a ubiquitous network using static agent (SA) and mobile agent (MA). The MAs follow the Unode by migrating to the subnetwork (where the Unode is about to migrate), collect network utilization information of the Unode, and provide the higher level of information to the SA by analysing the raw network information, which reduces the network traffic and also workload of the main monitoring system. The past behaviour of the applications and networks, and history of the Unode and the predecessors are taken into consideration to help SA to take appropriate decision during the time of emergency situations, like unavailability of resources at the local administration, and to predict the migration of the Unode based on the node history.

It is difficult to perform resource allocation for a Unode with the agreed Quality of Service (QoS) requirement in a ubiquitous network, which consists of subnetwork segments of different technologies with different resource constraints and control. We have proposed a priority-based resource allocation scheme for the Unodes in a ubiquitous network. The protocol exploits the advantages of both Static and Mobile Agents, by deploying them in different subnetworks (as and when required) to help the local administration to provide required network resources to the Unodes, and to ensure that the Unodes get the required network resources—by continuously monitoring their resource utilization and taking proactive actions. The resources are allocated fairly, by the SA in the subnetwork where the Unode has started availing the service and by MAs in other sub networks based on the priority values assigned to the Unodes. The priorities of the Unodes are calculated—by considering the importance of the application running on them, their resource utilization history and the cost effectiveness of the resource.

A ubiquitous application needs QoS guarantee to provide the required services to its users efficiently. The ubiquitous applications demand QoS as per the current environment context. Providing QoS in a ubiquitous network is a challenging task as the ubiquitous network consists of subnetworks of different technologies and controls. We have proposed a QoS architecture framework to guarantee the promised QoS requirements of an application running in a subnetwork of a ubiquitous network. The proposed architecture uses agents to predict

the QoS requirements of applications running on a Unode by using the context information and history of the Unode and the subnetwork. The framework communicates with the local administration to allocate resources to the ubiquitous application running node. We have simulated the proposed framework in a ubiquitous network consisting several subnetworks. We have also modelled the proposed QoS architecture to analyse the average service time of different applications running on Unodes; and the effect of background load, i.e., nodes running the local applications, on Unodes. In a ubiquitous computing environment, a ubiquitous application provides personalized and adaptive services to a user. Web services paradigm provides the advantages of building distributed ubiquitous applications; hence, will be a better choice to be used by ubiquitous search mechanism to select and provide services, without any query setting, to the users as per their context. As the number of web services increases exponentially, selecting and providing the appropriate service among the vast number of required services become very difficult. Hence, to search the most relevant service, a correct query needs to be formulated. We have proposed a ubiquitous user query generation scheme for web services which helps the ubiquitous computing application to fetch and provide the most relevant web services to the users, at anyplace, anytime and on any device, by considering the context and profile information of the user, and history of search queries made by the users.

In summary, we have developed; 1) a ubiquitous node monitoring protocol which monitors the health condition of a node and the network resources utilization in different subnetworks of the ubiquitous network; 2) a resource allocation scheme, which distributes the available resources at a local administration among the contending Unodes; 3) a QoS support, which maintains the QoS requirements of each Unode by negotiating with the local administrations of different subnetworks; 4) A ubiquitous user query model, which queries the services automatically and fetches the information on behalf of the user. We simulated our proposed protocols and schemes in different ubiquitous simulation environments. The results obtained in simulation shows the importance of the approaches and the efficiency of the proposed protocols and schemes.