Chapter 8

CONCLUSION

Introduction

This thesis proposed a novel solution to service provisioning in the mobile networks. It proposed a framework named CASP (Context Aware Service Provisioning). Service provisioning is an essential task as it provides many advantages like reusing of existing services. In service Oriented Architecture the services developed by others may also be shared. It also facilitates late or loose binding between the requester and the service provider. If these facilities of service oriented architecture are provided in the infrastructure less environment such as mobile ad hoc networks, new challenging applications may be developed in these environments. And thus, this thesis focuses on the intersection of two major domains namely Service Oriented Architectures and Mobile Ad hoc Networks. This intersection makes the services of any node in the mobile ad hoc networks available to all the participating nodes. Service provisioning becomes very challenging in mobile ad hoc networks due to mobility and topology changes. Furthermore, the service provisioning framework and its related mechanisms and protocols should take into account of limited resources of mobile ad hoc network devices and the wireless link properties. Each of this aspect contributes to make this work a very stimulating and fruitful research work.

Though many middleware for service provisioning dealt with one or more of the problems of service provisioning none attempted a unified environment for service provisioning. This thesis focused on the advertisement of the services, context management and policy processing for service maintenance. This proposed framework concerned with a provision of services by giving facilities for (i) specifying functional and non-functional properties of the
services, the context of the requester & the environment during the provision time (ii) making aware of all the participating nodes, the services available in the mobile ad hoc network by advertisement and caching & forwarding technique (iii) provision to discover the available services and bind to them (iv) adaptation mechanism based on explicit and implicit events both from application layer and the environment.

8.1 Design of A New Discovery Protocol

Proposed protocol has used application layer service advertisement mechanism and each node will store and forward the advertisement. Every node will have a partial look of the available services of the mobile ad hoc network. The context of the providers’ is passed along with the advertisement so that while searching for service providers the framework can use this information to identify the best provider among the available providers. This thesis uses XML to describe the services compared to other schemes using XML is an advantageous one. The cache replacement policy used in this thesis depends on the user preference, like whenever a new entry is to be added in the directory, the service type which is not needed by the client will be replaced. Basing the advertisement scope on the user’s request makes best use of one hop neighbour’s provisioning. This in turn increases the overall network performance. Selecting the providers’ based on their context like battery and moving speed avoids unbinding of the providers frequently. In the proposed work the service selected with metrics shows 21% increase in the success rate compared to one without metrics. Similarly the proposed work shows that the system with metrics discovered 26% faster than the one without metrics.

8.2 Functional & Non Functional Properties Management
Mechanism has been provided for the service providers to define the functional properties and non functional properties of their offer. The non functional attributes are playing a major role in selecting the providers because many of them reflect the current execution context. They are divided into requirements and capabilities. Based on the importance of the properties the requirements are further classified as mandatory and secondary properties which defines the importance of the requirement to be satisfied. Similarly user or application developers are provided with a choice of specifying their requirements based on their preferences. These preferences will be of any type and mechanism is provided to evaluate each type of the properties. The ability to specify the user preferences on the properties make the search more accurate to the user’s need. To prove that the decision making algorithms has the ability to make decisions according to the user’s preference and the changing context, simulations were carried out and the results showed that the proposed service provisioning mechanism could make the way of service provisioning flexible and adaptable to the environment and the user’s requirements. The proposed work is implemented in java. The execution time for addition of each new context has been compared with the other work. The adequacy of the model has been evaluated using analytical method. The scalability of the proposed non functional modelling has been analysed using simulation. Compared to other protocols it is found that the recall ratio of CASP is above 70% whereas, Konark achieves 55% and adder achieves 20%. The precision is 55% over ADDER.

8.3 Context Aware Service Provisioning

Cross layer mechanism is used to access the nodes’ current execution status such as link quality, bandwidth and routes to a particular node, by defining adaptors in each of the layers such as MAC, PHY and Network layers respectively. The framework defines monitors a set of classes which are used to find the internal status of the nodes like battery power, speed, remaining memory. The application can define threshold values upon which the monitoring should be done and it will raise events to the required objects when the threshold is reached. Providing facility to access the context is the major advantage of this framework. Providing inquiry functions to the requester to know the status of the provider and to take appropriate
actions makes the framework more useful. None of in the work in the literature provided this useful component.

### 8.4 Adaptive Service Maintenance

As the node movement is a norm in mobile ad hoc networks the service provisioning should take care of the movement of both the involved parties namely the requester and the service provider. The dynamic service availability is taken care by rebinding to new service providers based on the choice. These choices are specified in the form of policies such as reselection policies and rediscovery polices. These service maintenance functionalities such as reselection and rediscovery process based on the policies have been designed and implemented. Components such as monitors for the internal and external context management have been designed and integrated with the policy management. The framework has been evaluated by simulation and compared with other protocols. It has been identified that the rebinding is the essential mechanism for service provisioning in mobile ad hoc networks. The revaluation of the service provider’s choice shows better performance and shows that this is the primary component in service provisioning for mobile ad hoc environments. The simulations showed that the proposed policies for reselection or rediscovery works well in mobility enabled scenarios. It shows in the heavily loaded environment throughput of CASP is 25% more than SLP-PING.

### 8.5 Unified Vision of Service Provisioning

A novel framework which takes into account of mobility has been proposed. The proposed model has been designed especially for mobile ad hoc networks, with no central entity and with lightweight protocols. The offered lightweight functions makes easier for the individuals who are using small devices. Moreover the functions provided can be discovered dynamically as needed, which makes the service provisioning flexible and well-adapted to mobile ad hoc networks.

The proposed CASP framework is designed at a high-level of abstraction, without focusing on a specific service technology or application. The framework has four modules: the
advertiser, context manager, resource manager and adaptation manager. Prototypes were created and implemented to demonstrate the feasibility of the solution. The results show that the delays are acceptable and that they can be enhanced. Different scenarios were defined and performance results show that performance of the architecture is acceptable and scales well in terms of number of requesters and the number of parallel service providers.

8.6 Limitations and Future Enhancement

Two types of improvements may be done to the proposed framework. One is by the framework by tackling some key points. Second one is the technical alternatives for some of the issues.

Interaction in All Dimensions

With the rapid development of the wireless technology, there is no doubt that more and more electronic devices will appear around one person and one can envisage that they will be connected via the communication networks in the future. Service provisioning in these kinds of networks with adaptability and user centric is the promising future concepts.

This thesis uses cross layer information access in order to know and act according to the environment. The choice of integration with lower layers may be fruitful at times.

At network layer, integration can be defined to provide seamless communication for all possible technologies. So that the framework can facilitate communication among the requester and the service provider regard less the mobility of hardware and software resources.

At the application layer, the integration is more users centric and allows users through natural interfaces such as speech, vision and touch to interact wherever he is within the network. Every application publishes a profile that depends strongly on the context and allows application to adapt depending on the context of the application. Thus the integrated interface which will provide the information of the application is to be studied. Though in this framework all the meta data information are converted into a unified way to process, other means of interactions of the user has to be facilitated.
Even though the provision of adaptors and intermediaters between the layers to get the needed information, the integration of interfaces between each layer and propose solutions to provide integrated environments to people may provide benefits. This may facilitate easy realization of end-to-end quality of service as requested by the user. To achieve this goal, both horizontal integration over multiple domains and vertical integration over the end user, application & middleware and network layer have to be researched.

Towards Ambient Intelligence

Ambient intelligence is environments that are sensitive and responsive to the presence of people. The information and intelligence to take actions according to the situation is hidden in the devices, network connecting these devices and the software deployed on them. In order to address this, the framework facilitates a way to provide this knowledge in the form of profiles and policies. Possible extensions of this framework are to make provisions for defining runtime modification towards the meta data. The challenges of inferring user’s mood and situation will aid the required ambience which can be realized by combining techniques of artificial intelligence.

Security

This work did not try to address security issues in the design of the service platform. In mobile ad hoc network environments, the most obvious measure is to ensure the authenticity of messages disseminating in the network. Authenticity is hard to implement in mobile environments, unless closed communities are created in order for them to identify each of their members, which tends to go against the nature of mobile networks. Still, some simple measures could be implemented. For example a sender could include its signature in its messages. Furthermore, the payload of messages could be encrypted for interactions between trusted friends, which does not hinder the dissemination of messages based on contents of their headers, yet relay nodes might not accept to relay encrypted messages. Another example might be using authorised service access at the provider nodes to control client invocations, which can hinder the performance of content-based invocations.
Adaptive Quality of service provisioning

The proposed service provisioning framework provided adaptation mechanisms at the selection stage where user agent selects the best provider according to the context properties. This adaptation can be further enhanced in order to enable a better service provisioning, where the needed quality of service properties is adapted to the available quality of service properties. Available quality of service can be defined based on hardware resources, network resources and context properties. Applications can declare their quality of service needs. Automated adaptation between needed and available quality of service gives place to a better provision process. Though the framework which can access the quality of service of the current situation the implementation for setting the lower layer decision variables for adaptation based on the current quality of service and the expected quality of service were not done.

The service adaptation takes care of the environment but the other aspect to be considered is service state. In this framework a transparent service revaluation namely reselection and rediscovery has been created. But the state of the service from where its execution should start is not saved. This information may be useful to restart the execution. The mechanism of state maintenance has to be implemented, so that when a new service is found for replacement the framework can specify the point from where the execution started

Possible Technological variations

The loose coupling between the components has to be considered in the alternative architectures to reduce the number of message. The possibility of implementing components and partial deployment of the user agent and service provider part may be devised. Also, it is strongly believed that each alternative should target a given network configuration and the application need. So having different alternatives, switching between alternatives should also be investigated.

One of the major challenges is billing and charging system. Since there is no central entity to control, offline charging could be used. Another issue is related to service continuity. The java serialization mechanism may used to migrate services if possible when the service
provider is leaving the coverage area of the client. Then the performance and the delay could be measured for comparative analysis.

This framework is designed based on service oriented architecture and XML. It will be interesting to investigate different service provisioning framework to evaluate how they can be used in developing new architectures. Next direction would be to identify measure and compare cost, performance and constraints of different architectures.