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Issues in Design and Deployment of Ad Hoc Networks

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Mobile computing is where the future is. This theme is not far fetched. We all want any-where any-time communication. Ubiquitous communication has been made possible in the recent years with the advent of mobile ad hoc networks. The benefits of ubiquitous connectivity not only makes our lives more comfortable but also helps businesses efficiently deploy and manage their resources. These infrastructureless networks that enable "anywhere anytime" information access pose several challenging issues. There are several issues in the design and realization of these networks. Mobility planning is tricky and needs to be designed more carefully. Keeping track of mobiles in the infrastructure, the problem more popularly known as the location management problem, is another key issue to be addressed. The load on the servers, for handling location updates and queries, needs to be balanced. Moreover, the operation needs to be robust due to a high probability of temporary or permanent unavailability of one or more of the intermediate nodes. The transport protocols also need to be robust as a high degree of interference and noise can be expected in such environments. Applications will have to designed to incorporate environment-specific features in order to make them more robust. We believe that satisfactory solutions to these problems are essential in order to create smart environments using ad hoc networking infrastructure.

While medium access in wireless networks still remains an active research area due to the limited availability of wireless bandwidth, the absence of infrastructure makes the problem more challenging. Mobility, being one of the inherent properties of ad hoc networks, results in frequent changes in the network topology, making routing in such dynamic environments complex. In short, the presence of wireless medium, mobility, and lack of infrastructure makes the problem of routing and scheduling far more challenging in ad hoc networks. Providing services in such networks while guaranteeing the performance requirements specified by the users remains an interesting and active research area.

This issue of MONET is dedicated to papers relating to this topic. These papers are selected from the papers published in the Proceedings of International Conference on Computer Communications and Networks, 1999. The papers were revised and reviewed again. In this special issue, we have selected seven papers covering various aspects of routing, multicasting, and Quality-of-Service in these networks.

The first paper by Tang, Correa and Gerla, "Effects of Ad Hoc MAC Layer Medium Access Mechanisms under TCP", deals with the issues in medium access control protocols in ad hoc networks. Using RTS/CTS/ACK signals, they show how to achieve high performance in these networks while maintaining fair sharing of network resources. They also demonstrate the trade-off between fairness and performance in terms of throughput achieved. They also discuss the effects of back-off schemes and yield time used by a channel before retrying the use of channel in case the last attempt to access the channel was not successful. They show that by use of less aggressive back-off timers or longer yield times, greater fairness can be achieved. Their results are validated using simulation studies.

The second paper by Pei and Gerla, "Mobility Management for Hierarchical Wireless Networks", considers the mobility management in large hierarchically organized multihop wireless networks. Their management of mobility is through the use of Hierarchical State Routing (HSR) protocol. They address the issues in node addressing in HSR, logical partitions, and location of a node. They evaluate the performance of HSR scheme and show that using address caches is a worthwhile effort. This is a very relevant result as the networks will continue to grow larger and hierarchical management is likely to be the only way to keep them tractable.

The next paper addresses the issue of using multi-path routing on-demand. This paper by Nasipuri, Castañeda and Das, "Peformance of Multipath Routing for On-Demand Protocols in Mobile Ad Hoc Networks," uses dynamic source routing and shows how intelligent use of multi-path techniques reduces the frequency of query floods in detecting multiple paths from a source to a destination. The key finding is that the multiple paths yield better performance than single path. However, not more than a few paths are really needed to reach that performance level. They also discover that making alternate path information available to intermediate nodes is much more beneficial than the alternate path information residing only at the source. I found their results interesting as we have also arrived at a similar result in alternate-path-routing and wavelength assignment in wavelength routed optical networks.

The fourth and the fifth papers deal with the issue of multicast routing in ad hoc networks. Lee, Su and Gerla in their paper "Wireless Ad Hoc Multicast Routing with Mobility Prediction" deal with the issue of on-demand multicast routing. They make use of mobility prediction scheme to arrive at an efficient utilization of routes and alternate routes whenever a route breaks. Mobility prediction help them anticipate topology changes and hence predict and plan for recovery from route

breaks efficiently. They also propose an adaptive selection of refresh interval to avoid using excessive control packets, thus saving bandwidth. Simulation results validate their findings.

The next paper by Chin and Kumar, "AMTree: An Active Approach to Multicasting in Mobile Networks", also addresses the issue of multicast routing. They use concepts from active networks and inject AN-programs in nodes that act as routers to extend the functionality of the new protocols. AMTrees are formed using such nodes to support multicasting. They show that using this approach, they are able to obtain much higher performance in terms of hand-off and end-to-end delay. This work assumes that some nodes are available to act as routers etc. and therefore depend on some infrastructure in ad hoc network.

The last two papers address the Quality-of-Service issues. Wu and Chuang in their paper "Dynamic QoS Allocation for Multimedia Ad Hoc Wireless Networks" use SCMA/CA medium access protocol with additional reservation and control mechanisms to guarantee QoS in ad hoc networks. Their QoS routing protocol is analyzed using simulation and analytical methods for single-hop and multi-hop infrastructures. They show that average packet delay is small in single-hop case but multi-hop case suffers from higher packet delay and losses.

Finally, Mahadevan and Sivalingam in their paper "Architecture and Experimental Framework for Supporting QoS in Wireless Networks Using Differentiated Services" study different factors such as signaling requirements, mobility, losses, lower wireless bandwidth, and battery power constraints to meet QoS requirements. They describe a framework for differentiated services. Using a testbed they show that overall their Diffserv framework is quite effective.

This collection of papers addresses several interesting aspects of wireless ad hoc networks. Enjoy them.

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