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A Comprehensive Analysis on Routing and Multicasting Schemes in Wireless Networking

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ABSTRACT

Wireless networking is an emerging technology that will allow users to access information and services regardless of their geographic position. In contrast to infrastructure based networks, in wireless ad hoc networks, all nodes are mobile and can be connected dynamically in an arbitrary manner. All nodes of these networks behave as routers and take part in discovery and maintenance of routes to other nodes in the network. This feature presents a great challenge to the design of a routing scheme since link bandwidth is very limited and the network topology changes as users roam. This thesis investigates the behavior of existing traditional routing algorithms and proposes and implements a new routing approach for ad hoc wireless networks: Fisheye Routing. Fisheye Routing is similar to Link State routing, but uses a fisheye technique to reduce the consumption of bandwidth by control overhead.

INTRODUCTION

With the advance of wireless communication technology, portable computers with radios are being increasingly deployed in common activities. Applications such as conferences, meetings, lectures, crowd control, search and rescue, disaster recovery, and automated battlefields typically do not have central administration or infrastructure available. In these situations, ad hoc networks, or packet radio networks consisting of hosts equipped with portable radios must be deployed impromptu without any wired base stations. In ad hoc networks, each host must act as a router since routes are mostly multihop. Nodes in such a network move arbitrarily, thus network topology changes frequently, unpredictably, and may consist of unidirectional links as well as bidirectional links. Moreover, wireless channel bandwidth is limited. The scarce bandwidth decreases even further due to the effects of multiple access, signal interference, and channel fading. Network hosts of ad hoc networks operate on constrained battery power which will eventually be exhausted. Ad hoc networks are also more prone to security threats. All these limitations and constraints make multihop network research more challenging.

Challenges in routing and multicasting

Routes in ad hoc networks are multihop because of the limited propagation range (250 meters in an open field) of wireless radios. Since nodes in the network move freely and randomly, routes often get disconnected. Routing protocols are thus responsible for maintaining and reconstructing the routes in a timely manner as well as establishing the durable routes. In addition, routing protocols are required to perform all the above tasks without generating excessive control message overhead. Control packets must be utilized efficiently to deliver data packets, and be generated only when necessary. Reducing the control overhead can make the routing protocol efficient in bandwidth and energy consumption. Multipoint communications have emerged as one of the most researched areas in the field of networking. As the technology and popularity of Internet grow, applications, such as video conferencing, that require multicast support are becoming more widespread. In a typical ad hoc environment, network hosts work in groups to carry out a given task.

Therefore, multicast plays an important role in ad hoc networks. Multicast protocols used in static networks (e.g., Distance Vector Multicast Routing Protocol (DVMRP) Multicast Open Shortest Path First (MOSPF), Core Based Trees (CBT) , and Protocol Independent Multicast (PIM) do not perform well in wireless ad hoc networks because multicast tree structures are fragile and must be readjusted as connectivity changes. Furthermore, multicast trees usually require a global routing substructure such as link state or distance vector. The frequent exchange of routing vectors or link state tables, triggered by continuous topology changes, yields excessive channel and processing overhead. Hence, the tree structures used in static networks must be modified, or a different topology between group members (i.e., mesh) need to be deployed for efficient multicasting in wireless mobile ad hoc networks.

Multicast Protocols

Many different protocols for multicasting in mobile wireless networks have been proposed in recent years. Acharya and Badrinath were the first to address the issue of wireless multicast. Their protocol uses Mobile Support Stations (MSSs) to interconnect static networks with mobile hosts via wireless links. MSSs execute the protocol instead of mobile hosts to lessen the computation, memory, and power load on mobile hosts and wireless links. However, the protocol assumes that mobile hosts can only receive the multicast packets and senders are on the wired network. A similar protocol that is built on top of a user location strategy has been proposed for Personal Communication Service (PCS) networks in . The protocol in structures MSSs as a de Bruijn network. It guarantees exactly one delivery without broadcasting. Mobile hosts can act both as a multicast receiver and sender. Mobile Multicast (MoM) protocol uses home agent functionality of Mobile IP to extend IP multicast to mobile hosts. It improves scalability by using Designated Multicast Service Providers (DMSP), but it suffers from routing latency. In addition, in order for MoM protocol to work properly, home agents and foreign agents need to be static. A group-based multicasting in wireless networks with incomplete spatial coverage (the union of all cells may not cover the location where mobile hosts reside) is illustrated in. All of the protocols introduced above are designed to extend multicast from wired to wireless networks using stationary base stations or mobile support stations.

ROUTING IN WIRELESS NETWORKS- GENERAL CONCEPTS

A wireless ad-hoc network is a collection of mobile nodes with no pre-established infrastructure. Each of the nodes has a wireless interface and communicates with others over either radio or infrared channels. Laptop computers and personal digital assistants that communicate directly with each other are some examples of nodes in an ad-hoc network. Nodes in the ad-hoc network are often mobile, but can also consist of stationary nodes.

Figure 1 shows a simple ad-hoc network with three nodes. The outermost nodes are not within reception range of each other and thus cannot communicate directly. However, the middle node can be used to forward packets between the outermost nodes. This enables all three nodes to share information and results in an ad-hoc network.

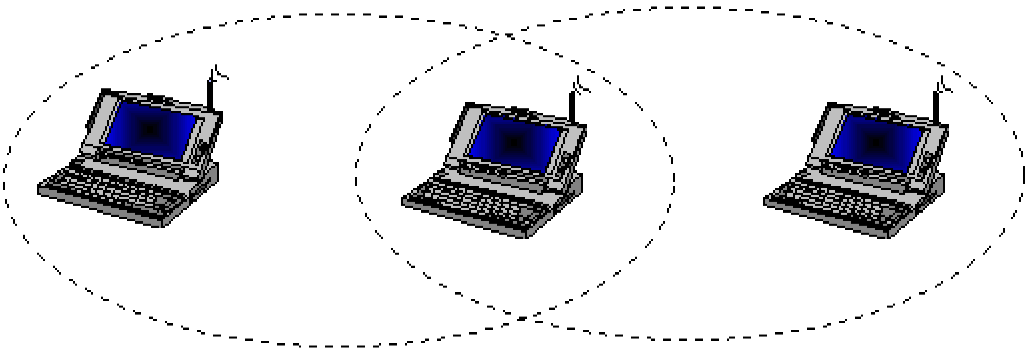

Figure 1: Example of simple ad-hoc network.

An ad-hoc network uses no centralized administration. This ensures that the network will not cease functioning just because one of the mobile nodes moves out of the range of the others. Nodes should be able to enter and leave the network as they wish. Because of the limited transmitter range of the nodes, multiple hops are generally needed to reach other nodes. Every node in an ad-hoc network must be willing to forward packets for other nodes. Thus every node acts both as a host and as a router. The topology of ad-hoc networks varies with time as nodes move, join, or leave the network. This topological instability requires a routing protocol to run on each node to create and maintain routes among the nodes.

ROUTING

Routing is a function in the network layer which determines the path from a source to a destination for the traffic flow. A routing protocol is needed because it may be necessary to traverse several nodes (multi-hops) before a packet reaches the destination. The routing protocol's main functions are the selection of routes for various source-destination pairs and the delivery of messages to their correct destination. In wireless networks, due to host mobility, network topology may change from time to time. It is critical for the routing protocol to deliver packets efficiently between source and destination. Routing protocols can be divided based on when and how the routes are discovered into two categories: Table-Driven and On-Demand routing [RT99].

In table-driven routing protocols, each node maintains one or more tables containing routing information to every other node in the network. All nodes update these tables so as to maintain a consistent and up-to-date view of the network. When the network topology changes the nodes propagate update messages throughout the network in order to maintain a consistent and up-to-date routing information about the whole network. Routing protocols in this category differ in the method by which the topology change information is distributed across the network and the number of necessary routing-related tables. The two main types of table-driven routing are: Distance Vector and Link State [PB96].

In on-demand routing, all up-to-date routes are not maintained at every node, instead the routes are created when required. When a source wants to send to a destination, it invokes a route discovery mechanisms to find the path to the destination. The route remains valid util the destination is unreachable or until the route is no longer needed. A typical type of on-demand routing is Source Routing [BJ98].

DISTANCE VECTOR

Distance vector routing is sometimes referred to as Bellman-Ford, after the people who invented the algorithm. In the distributed Bellman-Ford algorithm [Per00], every node **i** maintains a routing table which is a matrix containing distance and successor information for every destination **j**, where distance is the length of the shortest distance from **i** to **j** and successor is a node that is next to **i** on the shortest path to **j**. To keep the shortest path information up to date, each node periodically exchanges its routing table with neighbors. Based on the routing table received with respect to its neighbors, node **i** learns the shortest distances to all destination from its neighbors. Thus, for each destination **j**, node **i** selects a node **k** from its neighbor as the successor to this destination(or the next hop) such that the distance from **i** through **k** to **j** will be the minimum. This newly computed information will then be stored in node **i**'s routing table and will be exchanged in the next routing update cycle.

Figure 2 shows an example of Distance Vector Routing. This example focuses on everyone's distance to destination D. D transmits its distance vector (next(D)=D) with cost 0 (dist(D)=0) to node 1. Now, Node 1 calculates its distance vector to D as one (dist(D)=1) through D (next(D)=D) and transmits this information to nodes 2 and 3. This process continues until all the nodes have a cost and next hop information to D.

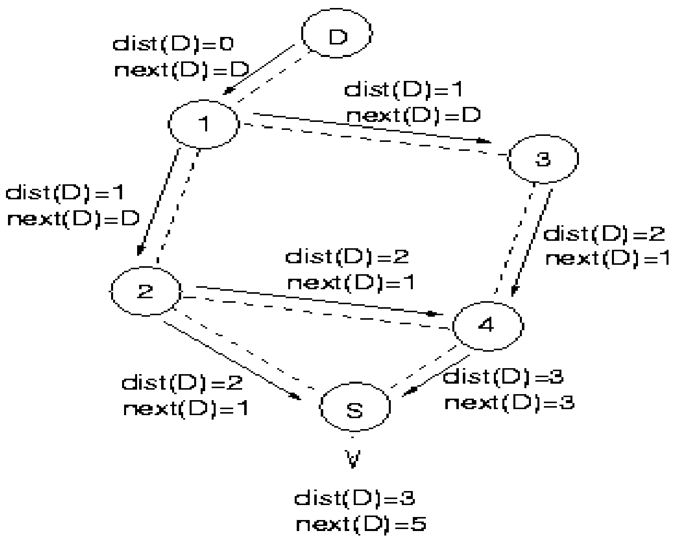

Figure 2: Example of Distance Vector Routing

The advantages of Distance Vector are its simplicity and computation. However, the chief problem with distance vector routing is its slow convergence when topology changes [BG87]. The primary reason for this is that the nodes choose their next-hops in a completely distributed manner based on information that can be stale. While routing information has only partially propagated through the network, routing can be seriously disrupted. This may lead to formations of both short-lived and long-lived routing loops [Per00].

Improving UDP and TCP performance in mobile Ad Hoc networks with insignia

Research and development of mobile ad hoc networks (MANETs) is proceeding in both academia and industry under military and commercial sponsorship. A number of military research projects (e.g., the Army Research Office Focused Research Initiatives, the Army Research Laboratory Federated Laboratory and the DARPA Global Mobile Information Systems (GloMo) program [59]) are developing new MANET technologies. While a considerable amount of research is sponsored by the military there is considerable commercial interest too. A number of companies are developing fully distributed self-configuring wireless networks that support services on-demand. As a result mobile ad hoc networking techniques are being readily applied to new fields such sensor networks, scatter networks (i.e., interconnected personal area networks), mobile robotic networks and deeply embedded networks. Collectively, these new technologies are promoting a world of smart spaces, and pervasive computing and communications. Delivering services in mobile ad hoc networks is intrinsically linked to the performance of the routing protocol because new or alternative routes between source destination pairs are likely to be recomputed during the lifetime of on-going sessions. A number of efficient routing protocols have been proposed in the IETF MANET Working Group over the past several years including, Ad hoc On-demand Distance Vector routing (AODV) Dynamic Source Routing (DSR) and Temporally Ordered Routing (TORA) among others Common features of these protocols are that they are lightweight, and provide loop free operations and responsive routing information.

The working group has focused on standardizing routing protocols suitable for supporting best-effort packet delivery in IP-based networks. A number of comparisons can be found in the literature reporting on the performance of AODV, DSR and TORA in the context of best-effort networks. The contribution of this chapter is as follows. Section 3.2 reviews the INSIGNIA signalling system, and Section 3.3 describes our ns-2 simulation environment used for the evaluation of the system. We evaluate the performance of INSIGNIA to seamlessly interoperate with AODV DSR and TORA showing that signalling system supports good operational transparency. We evaluate the performance improvement gained using INSIGNIA with the AODV, DSR and TORA routing protocols and present the performance improvements for UDP and TCP in Sections 3.4 and 3.5, respectively. Performance of the restoration algorithm relies on the speed at which routing protocols can re-compute new routes between source-destination pairs when no alternative route is available after topology changes. In this case, some routing protocols outperform others in support of delivering QOS. In each case, we compare the performance of the INSIGNIA system to the baseline best-effort system (i.e., AODV, DSR and TORA without INSIGNIA) as a basis to best understand the achievable performance improvements under a wide variety of network load and node mobility conditions. Section 3.6 discusses our results and presents some concluding remarks.

Fast Reservation

To establish reservation-based flows between source-destination pairs, source nodes initiate fast reservations by setting the appropriate fields in the INSIGNIA IP option field before forwarding packets. A packet carrying a reservation request is characterized as having its service mode set to reservation mode (RES), and its payload set to base QOS (BQ) or enhanced QOS (EQ). Each IP packets is self-contained in that it carries all the necessary state information to establish and maintain reservations. This includes an explicit bandwidth request, Reservation packets (i.e., data packet with the appropriate IP option set) traverse intermediate nodes executing admission control modules, allocating resources and establishing soft-state reservation at all intermediate nodes between source-destination pairs. A key aspect of building QOS in mobile ad hoc networks is the ability of the MAC layer to deliver service quality. INSIGNIA is an end-to-end IP-based reservation mechanism that is designed to map down and operate over a wide variety of MAC layers.

However, the stronger the assurances given by the MAC layer the better the end-to-end performance offered to applications. In Section 3.3, we outline a modification to the IEEE 802.11 [50] MAC distributed control function (DCF) that offers a simple set of differentiated services that INSIGNIA is build on. A source node continues to sends packets with the reservation request bit set until the destination node completes the reservation set-up phase by informing the source node of the status of the reservation establishment using a QOS reporting mechanism. When a reservation packet is received at a destination node, the status of the reservation phase is determined by inspecting the service mode bit in the IP option field. The service mode bit could be set to RES for reservation or BE (best-effort) for Figure 3-1(a) illustrates fast reservation where a source-destination pair (S, D) establishes a 'min-reserved' flow. The destination host inspects the INSIGNIA IP option of delivered packets and determines that only a minimum reservation can be support along the current path.

In this case, the base QOS packets are received with their service mode bit indicating RES but enhanced QOS packets are delivered in best effort mode (i.e., the service mode is set to BE). The scenario shows that the bottleneck node M1 is unable to support enhanced QOS packets and 'toggles' the bandwidth indicator in the packet's IP option to MIN and sets the service-mode bit of EQ packets to BE. In this scenario, the maximum reservation is provided between the source and bottleneck nodes and a minimum reservation between the bottleneck and destination nodes. We describe this as a 'partial reservation'. Packets received at the destination indicate that a partial reservation has been established where only a minimum reservation service is supported on an end-to-end basis (i.e., between the source and destination nodes). The destination host informs the source node of the result of the reservation phase (i.e., minimum reservation in this case) using a QOS reporting mechanism. QOS reports traverse back toward the source node but not necessarily along the reserve path, as illustrated in Figure 3.

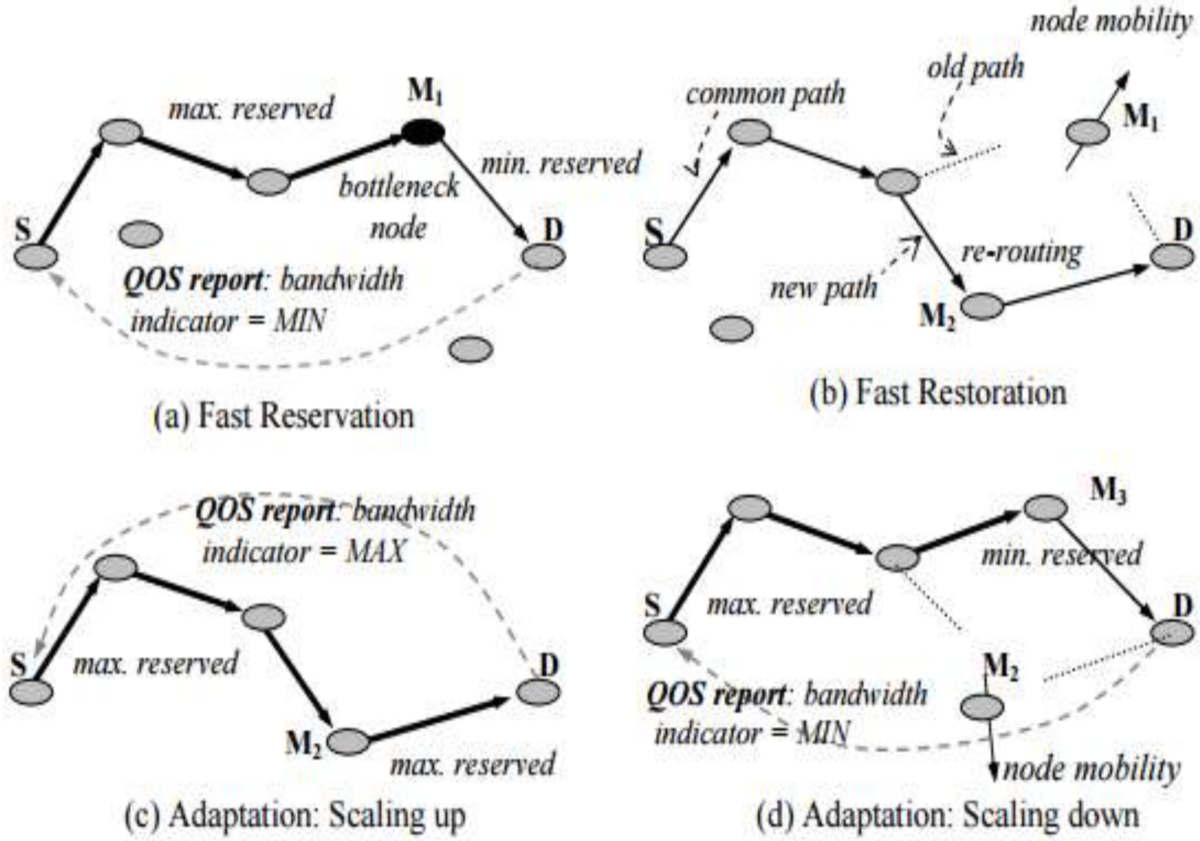

Figure 3: Examples of INSIGNIA Operations

Fisheye Wireless Routing Protocol

In this chapter, a new routing scheme for ad-hoc wireless networks is presented. The goal is to provide an accurate routing solution while the control overhead is kept low. The proposed scheme is named "Fisheye Routing" due to the novel 'fisheye' updating mechanism. Similar to Link State Routing, Fisheye Routing generates accurate routing decisions by taking advantage of the global network information. However, this information is disseminated in a method to reduce overhead control traffic caused by traditional flooding. Instead, it exchanges information about closer nodes more frequently than it does about farther nodes. So, each node gets accurate information about neighbors and the detail and accuracy of information decreases as the distance from the node increases.

Table-Driven Design

Fisheye Routing determines routing decisions using a table-driven routing mechanism similar to link state. The table-driven ad hoc routing approach uses a connectionless approach of forwarding packets, with no regard to when and how frequently such routes are desired. It relies on an underlying routing table update mechanism that involves the constant propagation of routing information. A table-driven mechanism was selected over an on-demand mechanism based on the following properties:

- On-Demand routing protocols on the average create longer routes than table driven routing protocols [ICP99].
- On-Demand routing protocols are more sensitive to traffic load than Table-Driven in that routing overhead traffic and latency increase as data traffic source/destination pairs increase.
- On-Demand Routing incurs higher average packet delay than Table Driving routing which results from latency caused by route discovery from new destinations and less optimal routes.
- Table-Driven routing accuracy is less sensitive to topology changes. Since every node has a ‘view’ of the entire network, routes are less disrupted when there is link breakage (route reconstruction can be resolved locally).
- Table-Driven protocols are easier to debug and to account for routes since the entire network topology and route tables are stored at each node, whereas On-Demand routing only contain routes that are source initiated and these routes are difficult to track over time.

For these reasons, a table driven scheme for the ad hoc routing protocol was chosen. Link state was chosen over distance vector because of faster speed of convergence and shorter-lived routing loops. Link state topology information is disseminated in special link-state packets where each node receives a global view of the network rather than the view seen by each node’s neighbor. Fisheye routing takes advantage of this feature by implementing a novel updating mechanism to reduce control overhead traffic. The algorithm for Fisheye routing is described in the next sections.

IMPLEMENTATION

The Fisheye routing protocol was implemented in the Composable Network Software (CNS) environment developed by the Digital Communication Networks Group at MITRE Corporation. CNS is a scalable design environment for network systems. Since most network systems are being built using a layered approach similar to the OSI layer network architecture, CNS uses the same approach. Modules can be built between the different simulation layers. This will allow rapid integration of models developed at different layers by different people. The protocol stack supports models for the channel, radio, MAC, network, transport, and application layers. CNS is programmed in C++ to take advantage of the Object Orientated Programming paradigm. Each module developed in the CNS environment has a well-defined interface to pass data between modules. Modules in CNS can also be used to generate traffic, setup network topologies, introduce link/transmission characteristics, debugging, or any other function. The composable network stack for the Fisheye routing protocol is shown in Figure 4.

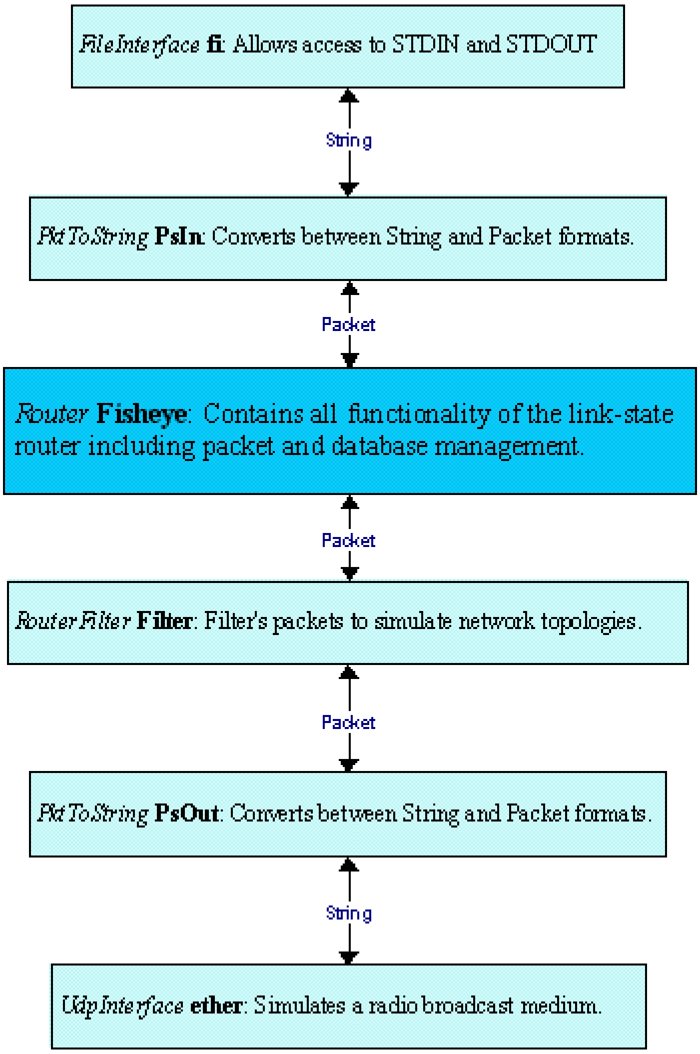

Figure 4: Composable Network Stack for Fisheye Routing Protocol

The routing protocol is entirely implemented in the **Router Fisheye** module. The other modules offer a simulated network environment to test the functionality of the routing protocol. **FileInterface fi** allows user to insert packets into the Router module (such as test and data packets). **Router Filter Filter** simulates a network topology. **UdpInterface ether** simulates a radio broadcast transmission medium. **PktToString PsOut** and **PsIn** allows interface between different modules.

CONCLUSION

The author presented a comprehensive analysis on routing and multicasting schemes in wireless networking. Wireless mobile ad hoc networks present difficult challenges to routing and multicasting protocol designers. Mobility, constrained bandwidth, and limited power cause frequent topology changes. Routing protocols must construct and maintain multihop routes in dynamic ad hoc networks effectively and efficiently. Various routing and multicasting approaches in this paper. The main lesson learned from our studies is that on-demand protocols are well suited for mobile ad hoc networks, especially when the mobility rate is high. Efficient utilization of control packets is the primary reason of good performances.

REFERENCES

[1]. A. Acharya and B.R. Badrinath, \A Framework for Delivering Multicast Messages in Networks with Mobile Hosts," ACM/Baltzer Mobile Networks and Applications, vol. 1, no. 2, October 1996, pp. 199-219.

[2]. S. Agarwal, A. Ahuja, J.P. Singh, and R. Shorey, \Route-Lifetime Assessment Based Routing (RABR) Protocol for Mobile Ad-Hoc Networks," Proceedings of the IEEE International Conference on Communications (ICC), New Orleans, LA, June 2000, pp. 1697-1701.

[3]. G. Aggelou and R. Tafazolli, \RDMAR: A Bandwidth-Efficient Routing Protocol for Mobile Ad Hoc Networks," Proceedings of the ACM International Workshop on Wireless Mobile Multimedia (WoWMoM), Seattle, WA, August 1999, pp. 26-33.

[4]. P. Agrawal, D.K. Anvekar, and B. Narendran, \Optimal Prioritization of Handovers in Mobile Cellular Networks," Proceedings of the IEEE International Symposium on Personal, Indoor and Mobile Radio Communication (PIMRC), The Hague, Netherlands, Sepember 1994, pp. 1393-1398.

[5]. I.F. Akyildiz, W. Yen, and B. Yener, \A New Hierarchical Routing Protocols for Dynamic Multihop Wireless Networks," Proceeding of the IEEE Conference on Computer Communications (INFOCOM), Kobe, Japan, April 1997, pp. 1422-1429.

[6]. D. Baker, et al., “Flat vs. Hierarchical Network Control Architecture,” ARP/DARPA Workshop on Mobile Ad-Hoc Networking, March 1997.

[7]. R. Bagrodia and et. al, “Parsec: A Parallel Simulation Environment for Complex Systems”, Computer, Vol. 31, October 1998, pp. 78-85.

[8]. J. Broch, D. Johnson, and D. Maltz, “The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks,” IETF Internet draft, Dec. 1998.

[9]. D. Bertsekas and R. Gallager. Routing in Data Networks, chapter 5., Prentice Hall, second edition, 1987.

[10]. J. Broch, D. John Johnson, and D. Maltz, “The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks”, IETF Internet-Draft, draft-ietf-manet-dsr-00.txt, Mar. 1998.

[11]. VINT Project, The NS Manual Formerly NS Document, http://www.isi.edu/nsnam/ns/nsdocumentation.html, 2005.

[12]. B. Kalaavathi, et. Al, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1470874 Raj Kamal, Mobile Computing, Oxford University Press, 2009.

[13]. Proceedings IT in Academics, Sinhgad Institute of Management, Pune, India, 2009.

[14]. R. Patil, A. Damodaram and R. Das, Cross layer AODV with position based forwarding routing for mobile adhoc network, Proc. of the 5th IEEE Conference on Wireless Communication and Sensor Networks, 2009.

[15]. N. M. Murad, Low energy clustering adaptation protocol for an adhoc wireless sensor network, Proc. of Conference on Wireless Telecommunications Symposium, 2009.

[16]. L. Zhang, H. Sun, Q. Sun, X.-Y. Hu and C.-J. Guo, Improvement of routing protocols AODV in wireless ad-hoc network, World Congress on Software Engineering, Hefei, China, 2009.

[17]. N. Sengottaiyan, R. Somasundaram and S. Arumugam, An modified approach for measuring TCP performance in wireless adhoc network, Proc. of International Conference on Advances in Recent Technologies in Communication and Computing, 2010.

[18]. S. Buruhanudeen, M. Othman, B. M. Ali and M. Othman, Performance comparison of MANET associativity based routing (ABR) and the improvisation done for more reliable and efficient routing, The 3rd Information and Communication Technology Seminar, 2011.

[19]. N. S. M. Usop, A. Abdullah and A. F. A. Abidin, Performance evaluation of AODV, DSDV & DSR routing protocol in grid environment, International Journal of Computer Science and Network Security, vol.9, no.7, pp.261-268, 2011.