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Channel Aware and Dynamic Source Routing in MANETs with Route Handoff

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Abstract- Mobile ad hoc networks consist of several wireless mobile nodes which dynamically send data among themselves without the reliance on the fixed base station or a wired backbone network. Due to the limited transmission powermultiple hops are need for a node to send information with any other node in the network. So route discovery and route maintenance is a problem in MANETs. Nowadays multipath routing also taken into consideration.Multipath routing allows the establishment of multiple paths between a pair if source and destination node. It is typically proposed in order to increase the reliability of data transmission or to provide load balancing and has received more attentions. Multipath routing protocol based on AOMDV protocol, which incurs only 2n control packets for a route discovery and does not require new types of control messages over AOMDV. We propose a scheme to improve existing on demand routing protocols by creating a mesh and providing alternative routes. Their algorithm establishes the mesh and multipath without any extra control messages.The proposed Channel-Aware AOMDV used to find the stable links for discovery of paths by utilizing the channel average non fading duration. We can maintain reliable connection by applying preemptive handoff strategy and use of channel state information. Using the same information we can reuse the paths instead of being discarded.The Improved CA-AOMDV provides better performance than AOMDV.

Index Terms- Mobile Ad Hoc Network, Routing Protocols, Channel Adaptive Routing.

1 INTRODUCTION

1.1 MANETs

The next generation of mobile communication systems, there will be a need for the rapid deployment of independent mobile users. Significant examples include establishing survivable, efficient, dynamic communication for emergency or rescue operations, disaster relief efforts, and military networks. Such network scenarios cannot rely on centralized and organized connectivity, and can be conceived as applications of Mobile Ad Hoc Networks. A MANET is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change rapidly and unpredictably over time. The network is decentralized, where all network activity including discovering the topology and delivering messages must be executed by the nodes themselves, routing functionality will be incorporated into mobile nodes.

The set of applications for MANETs is diverse, ranging from small, static networks that are constrained by power sources, to large-scale, mobile, highly dynamic networks. The design of network protocols for these networks is a complex issue. Regardless of the application, MANETs need efficient distributed algorithms to determine network organization, link scheduling, and routing. However, determining viable routing paths and delivering messages in a decentralized environment where network topology fluctuates is not a well-defined problem. While the shortest path (based on a given cost function) from a source to a destination in a static network is usually the optimal route, this idea is not easily extended to MANETs. Factors such as variable wireless link quality, propagation path loss, fading, multiuser interference, power expended, and topological changes, become relevant issues. The network should be able to adaptively alter the routing paths to alleviate any of these effects. Moreover, in a military environment, preservation of security, latency, reliability, intentional jamming, and recovery from failure are significant concerns.

1.2 Handoff

In cellulartelecommunications, the term handover or handoff refers to the process of transferring an ongoing call or data session from one channel connected to the core network to another. In satellite communications it is the process of transferring satellite control responsibility from one earth station to another without loss or interruption of service.

In any mobile phone conversation your call is passed from one cell to another in order to keep the signal strong. This process of handing the call from one cell to another is called a handoff (or handover in some countries). It is howthis transfer takes place that defines the difference between soft and hard.

CDMA supporters will tell you that this soft approach has three primary advantages over the hard approach. The first is a much lower incidence of dropped calls during the handoff process. However, considering the low number of dropped calls reported by GSM users, one has to question if this advantage truly exists in practice.

The second advantage is that soft handoffs do not have a detectable impact on the audio. When you use a phone near a cell boundary, handoffs can rapidly occur between one cell and the other. This phenomenon is known as "Thrashing". When trashing occurs on a hard handoff system, the call quality can be severely compromised. In practice, this does seem to work.

The third advantage is that soft handoffs allow a phone to combine the signals from two sites simultaneously. Under very weak signal conditions this can translate to more error-free data recovery than either of the two sites could yield on their own.

1.3 Channel Aware Routing

Routing is a critical issue in mobile ad hoc networks (MANET) because of their dynamic network topology (mobile station interconnection is achieved via peer level multi hopping technique) and scarcity in the network resources (bandwidth and battery life). Although routing design is greatly impacted by the fading mechanisms in the wireless channel, existing routing protocols for MANET consider typically only the path-loss effect as far as propagation impairment is concerned while ignoring the deleterious effects of channel fading and shadowing. Link breakages in wireless networks can severely deteriorate network throughput and routing performance. Another significant impediment of existing routing protocols for wireless ad hoc networks is that the considerable differences in the communication channels between nodes (due to the differences in propagation/interference characteristics and differing capabilities of the heterogeneous nodes themselves) are rarely considered, which can directly impact the network lifetime. For example, some nodes in the network may be equipped with an antenna array while certain other nodes may impose a tight maximum transmit power constraint (due to limited battery life). Route outage probability metric, if used to select optimal route paths, is perhaps more appropriate for MANETs than the conventional minimum hop-count metric because it is much more desirable for a packet to reach its destination with a high success probability even if it involves a few additional hops than it be lost while traversing a route with fewer hop counts (i.e., the cost of each hop is represented by link outage probability rather than just uniform integer value of “1” for each link used as in conventional routing protocols). An interesting attribute of the “route outage probability” metric is that it allows the abstraction of the physical layer characteristics of the communication link for decisions at higher layers of the protocol stack. Thus one may incorporate the node capabilities (e.g., number of array elements used for diversity combining, remaining battery life) along with the knowledge of the propagation channel using this metric alone.

2 ROUTING PROTOCOLS

The existing system discusses our experience while implementing and deploying two distance vector MANET routing protocols. We examined both a public domain implementation of the Ad Hoc On-Demand Distance Vector (AODV) routing protocol and implemented our own version of the Destination- Sequenced Distance Vector (DSDV) routing protocol. The choice of routing protocols was pragmatically based on what (little) was available at the time this work was carried out. The AODV implementation was the freely available MAD-HOC implementation. This implementation was based on an earlier draft of the AODV protocol and includes some MAD-HOC specific extensions. Where AODV is referred to in this paper we mean the MAD-HOC implementation unless otherwise stated. At the time our work was carried out this was the only public domain MANET routing protocol implementation that had a license suitable for our

use and those we could get to compile, run and work on our network. Faced with no other available public domain code and reluctant to base our work solely on one protocol implementation we coded an alternative. DSDV was chosen due to its relative simplicity and the fact that it is a table based protocol rather than an "on demand" protocol like AODV.

2.1 Ad hoc On Demand Vector Routing (AODV)

The Ad-hoc On-Demand Distance Vector (AODV) routing protocol is designed for use in ad-hoc mobile networks. AODV is a reactive protocol: the routes are created only when they are needed. It uses traditional routing tables, one entry per destination, and sequence numbers to determine whether routing information is up-to-date and to prevent routing loops. An important feature of AODV is the maintenance of time-based states in each node a routing entry not recently used is expired. In case of a route is broken the neighbours can be notified. Route discovery is based on query and reply cycles, and route information is stored in all intermediate nodes along the route in the form of route table entries. The following control packets are used: routing request message (RREQ) is broadcasted by a node requiring a route to another node, routing reply message (RREP) is unicasted back to the source of RREQ, and route error message (RERR) is sent to notify other nodes of the loss of the link. HELLO messages are used for detecting and monitoring links to neighbours.

2.1.1 Drawbacks of AODV

It is possible that a valid route is expired. Determining of a reasonable expiry time is difficult, because the nodes are mobile, and sources' sending rates may differ widely and can change dynamically from node to node. Moreover, AODV can gather only a very limited amount of routing information, route learning is limited only to the source of any routing packets being forwarded. This causes AODV to rely on a route discovery flood more often, which may carry significant network overhead. Uncontrolled flooding generates many redundant transmissions which may cause so-called broadcast storm problem. The performance of the AODV protocol without any misbehaving nodes is poor in larger networks. The main difference between small and large networks is the average path length. A long path is more vulnerable to link breakages and requires high control overhead for its maintenance. Furthermore, as a size of a network grows, various performance metrics begin decreasing because of increasing administrative work, so-called administrative load. AODV is vulnerable to various kinds of attacks, because it based on the assumption that all nodes will cooperate. Without this cooperation no route can be established and no packet can be forwarded. There are two main types of uncooperative nodes: malicious and selfish. Malicious nodes are either faulty and cannot follow the protocol, or are intentionally malicious and try to attack the network. Selfishness is noncooperation in certain network operations, i.e. dropping of packets which may affect the performance, but can save the battery power.

2.2 Ad hoc On Demand Multipath Distance Vector Routing (AOMDV)

Ad-hoc On-demand Multipath Distance Vector Routing (AOMDV) protocol is an extension to the AODV protocol for computing multiple loop-free and link disjoint paths. The routing entries for each destination contain a list of the next-hops along with the corresponding hop counts. All the next hops have the same sequence number. This helps in keeping track of a route. For each destination, a node maintains the advertised hop count, which is defined as the maximum hop count for all the paths, which is used for sending route advertisements of the destination. Each duplicate route advertisement received by a node defines an alternate path to the destination. Loop freedom is assured for a node by accepting alternate paths to destination if it has a less hop count than the advertised hop count for that destination. Because the maximum hop count is used, the advertised hop count therefore does not change for the same sequence number. When a route advertisement is received for a destination with a greater sequence number, the next-hop list and the advertised hop count are reinitialized.

AOMDV can be used to find node-disjoint or link-disjoint routes. To find node-disjoint routes, each node does not immediately reject duplicate RREQs. Each RREQs arriving via a different neighbor of the source defines a node-disjoint path. This is because nodes cannot be broadcast duplicate RREQs, so any two RREQs arriving at an

intermediate node via a different neighbor of the source could not have traversed the same node. In an attempt to get multiple link-disjoint routes, the destination replies to duplicate RREQs, the destination only replies to RREQs arriving via unique neighbors. After the first hop, the RREPs follow the reverse paths, which are node disjoint and thus link-disjoint. The trajectories of each RREP may intersect at an intermediate node, but each takes a different reverse path to the source to ensure link disjointness. The advantage of using AOMDV is that it allows intermediate nodes to reply to RREQs, while still selecting disjoint paths. But, AOMDV has more message overheads during route discovery due to increased flooding and since it is a multipath routing protocol, the destination replies to the multiple RREQs those results are in longer overhead.

2.2.1 Disadvantages of AOMDV:

The only drawback of Multi-Path Routing Load Balancing Protocols such as AOMDV and MSR is the use of a large number of control packets for calculating and maintaining multiple routes between a source and destination but such disadvantage is minimized in the network conditions as the rate of control packets generated by MSR or AOMDV is slightly higher than the rate generated by the Single-Path protocols at high load and density nodes. Ad hoc On-Demand Multipath Distance Vector (AOMDV) routing protocol to accommodate channel fading.

3 CHANNEL AWARE AOMDV

We introduce an enhanced, channel-aware version of the AOMDV routing protocol. The key aspect of this enhancement, which is not addressed in other work, is that we use specific, timely, channel quality information allowing us to work with the ebb-and-flow of path availability. This approach allows reuse of paths which become unavailable for a time, rather than simply regarding them as useless, upon failure, and discarding them. We utilize the channel average non fading duration (ANFD) as a measure of link stability, combined with the traditional hop-count measure for path selection. The protocol then uses the same information to predict signal fading and incorporates path handover to avoid unnecessary overhead from a new path discovery process. The average fading duration (AFD) is utilized to determine when to bring a path back into play, allowing for the varying nature of path usability instead of discarding at initial failure. This protocol provides a dual attack for avoiding unnecessary route discoveries, predicting path failure leading to handoff and then bringing paths back into play when they are again available, rather than simply discarding them at the first sign of a fade. Further, the same information is required to determine ANFD, AFD and predict path failure, enhancing efficiency. The overall effect is a protocol with improved routing decisions leading to a more robust network. Improvements in performance over AOMDV are around 25 percent for standard network performance measures. We call this protocol Channel-Aware AOMDV (CA-AOMDV). Note that this protocol is intended to improve on AOMDV in conditions where the channel can be reasonably allowed for. In conditions of high channel variability, there is little sense in even attempting channel prediction and other performance improvement methodologies will need to be utilized.

This paper finds both ANFD and AFD:

The mobile Rayleigh or Rician radio channel is characterized by rapidly changing channel characteristics. As the amplitude of a signal received over such a channel also fluctuates, the receiver will experience periods during which the signal cannot be recovered reliably.

If a certain minimum (threshold) signal level is needed for acceptable communication performance, the received signal will experience periods of sufficient signal strength or "non-fade intervals", during which the receiver can work reliably and at low bit error rate and insufficient signal strength or "fades", during which the bit error rate inevitably is close to one half (randomly guessing ones and zeros) and the receiver may even fall out of lock. It is of critical importance to the performance of digital mobile networks that the block length or packet duration is chosen taking into account the expected duration of fades and non-fade intervals. One of two approaches can take. The first one is to make the block length at least an order of magnitude longer than the average fade or non-fade period, and rely on error correction to cope with burst errors. This approach can be used for mobile reception of digital broadcast signals (e.g. DAB), particularly if the effect of fading is mitigated through using a wide transmission bandwidth and

appropriate signal processing. This approach would be impractical in indoor office communication (wireless LANs) with high bit rates and extremely small Doppler spreads, i.e., with very long fade or non-fade periods. The second one is to make the block length shorter than the average fade or non-fade period and retransmit lost data. This approach works best in full duplex mobile data systems and random access data systems. The effective throughput depends on two aspects: 1) The probability that a block runs into a fade and 2) The overhead bits required in block headers.

If the data block length is larger than the average non-fade period, almost all blocks will experience a signal fade and a corresponding burst of bit errors. This may result in an excessive packet dropping rate, unless powerful error correction codes are used. If the system supports a feedback signal with acknowledgments of received blocks, it is mostly advantageous to use only limited error correction coding, but to rely on retransmission of lost blocks. To minimize the number of retransmissions, one should choose the block length shorter than the average fade and non-fade period.

3.1 Average Fade Duration:

We use:

Outage Probability = Average number of fades per second * Average fade duration

Where the average number of fades per second is called the threshold crossing rate.

3.2 Average Non Fade Duration:

The probability of a signal outage should be equal to the threshold crossing rate multiplied by the average duration of a fade.

4 ROUTEDISCOVERY AND ROUTE MAINTAINANCE

4.1 Route Discovery

As in AODV, when a traffic source needs a route to a destination, the source initiates a route discovery process by generating a RREQ. Since the RREQ is flooded network-wide, a node may receive several copies of the same RREQ. In AODV, only the first copy of the RREQ is used to form reverse paths; the duplicate copies that arrive later are simply discarded. Note that some of these duplicate copies can be gainfully used to form alternate reverse paths. Thus, allduplicate copies are examined in CA-AOMDV for potential alternate reverse paths, but reverse paths are formed only using those copies that preserve loop-freedom and disjointness among the resulting set of paths to the source.

4.2 RouteMaintenance

Route maintenance in CA-AOMDV is a simple extension to AODV route maintenance. Like AODV, CA-AOMDV also uses RERR packets. A node generates or forwards a RERR for a destination when the lastpath to the destination breaks. CA-AOMDV also includes an optimization to salvagepackets forwarded over failed links by re-forwarding them over alternate paths. This is similar to the packet salvaging mechanism in DSR. The timeout mechanism similarly extends from a single path to multiple paths although the problem of setting proper timeout values is more difficult for CA-AOMDV compared to AODV. With multiple paths, the possibility of paths becoming stale is more likely. But using very small timeout values to avoid stale paths can limit the benefit of using multiple paths. In our experiments, we use a moderate setting of timeout values and additionally use HELLO messages to proactively remove stale routes. Thus, the timeouts in the current version of CA-AOMDV primarily serve as a soft-state mechanism to deal with unforeseen events such as routing table corruption and to a lesser extent for promptly purging stale routes.

5 CONCLUSION

By utilizing the average nonfading duration, combined with hop-count, we can select stable links which proposed a channel based routing metric. A channel-adaptive routing protocol, CA-AOMDV is introduced. In routemaintenance, the predicted signal strength and channel average fading duration are combined with handoff for avoiding channel fading and mainly to improve channel utilization.

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