Having one's cake and eating it too: Better routes and lower control traffic for AODV

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***Abstract*—In this research we develop new techniques for optimizing the performance of a reactive routing protocol in operational environments characterized by high node mobility and long-lived connections. The question we seek to answer is whether in such environments, *reactive* routing protocols necessarily exhibit a tradeoff between control traffic and route optimality. More specifically, does a protocol which makes use of *less control traffic* (i.e. better) than standard AODV, necessarily exhibit connection routes that are *longer* (i.e. worse) than those achieved by standard AODV? We show that the commonly assumed tradeoff can be avoided, and that it is possible to "Have one's cake and eat it too". Towards this, we design an extension of the AODV protocol, and show through extensive ns2 simulation experiments that the new protocol both significantly reduces the control traffic overhead, while simultaneously improving the topological optimality of connections. These remarkable conclusions are seen to continue to hold scalably as one varies situational parameters such as network size, number of connections, and node mobility.**

I. Introduction

The problem of *routing* in mobile ad hoc networks (MANETs) has been a very active research topic in the networking community during the past two decades. There have been a tremendous number of routing protocols developed, each suited to particular settings and having its own merits and advantages over others. These routing protocols are commonly classified as either proactive, reactive, or hybrid (that is, a combination of the two types) depending on how and when routing information is obtained and maintained by constituent nodes.

Proactive routing protocols such as OLSR and DSDV follow in the footsteps of wired infrastructure routing protocols like OSPF: in such systems, nodes maintain next-hop routing information, regardless of whether route information is required by connection establishment requests. This route information is updated whenever a change in the underlying network topology occurs. In settings where nodes move frequently and connections are long-lived, these routing protocols may be inefficient due to high levels of routing-related control traffic generated in response to node movement that induces topological changes in the network structure.

On the other hand, reactive routing protocols such as DSR and AODV discover a routing information only when it is required (and cache discovered routes for a very brief interval of time). It is a common knowledge that reactive routing protocols are more appropriate for mobile ad-hoc networks in which node mobility levels are high and connections are long-lived, since these protocols delay systemic response to topology changes until routes are actually requested as part of the connection establishment process. Thus, in such settings, reactive routing protocols incur lower control traffic overhead than their proactive counterparts.

In this research we focus on the performance of reactive routing protocols. In view of the previous paragraphs, we will assume that the operating environment is indeed one which manifests high node mobility and long-lived connections. In a MANET, a reactive routing algorithm serves two functions: (i) to find an initial path between a source and a destination, and (ii) to maintain data forwarding between the two endpoints in the face of node mobility. We restrict our attention to (ii), and seek to reduce the operational cost of long-lived connection, vis-a-vis control traffic. More precisely, the research question we consider is:

> Is there an inherent tradeoff between route optimality and control traffic overhead, or is it possible to improve the performance of a reactive routing protocol with respect to both these metrics *simultaneously*?

Though most reactive routing protocols use similar triggering methods for the route discovery process, they show minor differences in the specific information maintained. For example, AODV keeps only the next hop for each requested destination (at each node) and does not embed any extra information into packet headers. In contrast, DSR uses a source routing strategy and inserts the whole transit list into packet headers. In this paper, for concreteness, we formulate our results as an extension to AODV.

II. Background

In AODV, when a node (source) requires a connection to another node (destination), a global route discovery operation is initiated by the source, resulting in a breadth-first flooding of ROUTE_REQUEST messages within the network. When (at least) one of these messages is received by the intended destination or by a node which has a route to the destination that is "fresh enough", a ROUTE_REPLY message is originated and sent back to the originator of the route discovery process. As the ROUTE_REPLY packet travels back towards to the originator of the request, each node along

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