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Efficient Routing Using Prefix Matching In Hybrid Ad Hoc Networks

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Abstract

Research in Hybrid Ad hoc networks has grown over years to address the issues regarding efficient connectivity and transfer of Internet data to mobile Ad hoc networks from Internet host in fixed networks. This paper focuses on various issues of hybrid networks such as connectivity and routing performance. We have proposed a model for extending Internet connectivity to Mobile Ad hoc networks together with providing efficient routing between mobile devices in Hybrid Ad hoc networks. Our model uses prefix matching for finding if destination node is mobile node or internet node. Default route maintenance on hop by hop basis to forward packets from mobile node to Internet node, and intermediate node handling route request for default route setup have also been proposed in our model.

Introduction

Ad hoc networks consist of a number of mobile nodes that are free to move and
Communicate one with each other wirelessly. These mobile nodes have routing capabilities that allow them to create multi hop paths connecting nodes which cannot directly communicate. These networks are extremely flexible, self configurable, and do not require any infrastructure for their operation. However, the idea of facilitating the integration of mobile ad hoc networks (MANETs) and fixed IP networks has gained a lot of momentum in recent years.

In such integrated scenarios, commonly known as Hybrid Ad hoc networks, mobile nodes are witnessed as an easily deployable extension to the existing infrastructure. Some ad hoc nodes act as gateways that can be used by other nodes communicate with hosts in the fixed network.

Due to recent development in mobile data communication increased possibilities for this technology have grown. Users are being provided connectivity to the Internet when they bring their laptops or hand held devices to airports, universities or other public areas, which offers Internet access through Internet Gateway (IGW).

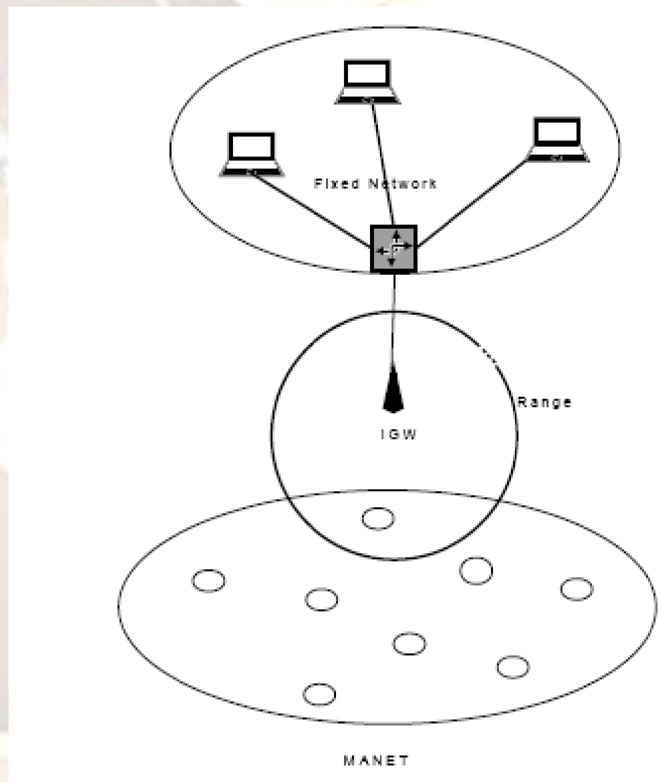


Figure 1: Hybrid Ad hoc network

Background and Related work

There are a number of proposals to provide Internet connectivity for MANETs. One of the first proposals was by Broch et al. [4]. It is based on integration of Mobile IP and MANETs employing a source routing protocol. MIPMANET [5] followed a similar approach based on AODV, but it only works with Mobile IPv4, because it requires foreign agents (FAs). Ammari et al. [6] analyzed the performance of mobile gateways in a MANET based on the DSDV routing protocol.

The proposal from Singh et al. [7] defines the gateways as those nodes that are one hop away from the access router. Access routers are expected to be equipped with a wireless interface. The first node becoming a gateway is called the default gateway, and is responsible for sending out periodic gateway advertisements.

WAKIKAWA

The IETF draft Global Connectivity for IPv6 Mobile Ad Hoc Networks [2] defines how a mobile node can derive an IPv6 global address based on a prefix from a gateway and use it to communicate with nodes in the Internet. Wakikawa proposal defines two different mechanisms to discover the gateway:

• Periodic flooding of gateway advertisement (GWADV) messages from the gateways

• Reactive flooding of a gateway solicitation (GWSOL) message from the node and subsequent unicast GWADV from the gateway the first approach is completely proactive, whereas the latter is completely reactive.

According to the IETF draft (Globalv6), these messages can be implemented by simply adding an I flag to existing RREQ and RREP messages, indicating that this particular route refers to external connectivity. However, the specification allows for the use of other special control messages such as ICMP packets. A GWADV message contains the global IPv6 address of the gateway, the network prefix advertised by the gateway, the prefix length and the lifetime associated with this information.

When a node receives a GWADV message proactively or reactively, the mobile node is able to derive an IPv6 address which belongs to the advertised network prefix.

After that, the mobile node creates a default route in its routing table, pointing to the selected gateway. In addition, it also adds a host-based route toward the IPv6 address of the gateway. These route entries are updated periodically to guarantee a seamless interworking.

JELGER

C Jelger et al. proposed an Internet draft entitled Gateway and Address Auto-Configuration for IPv6 Networks [3]. This proposal is a proactive approach in which the gateways advertise themselves by periodically flooding gateway information (GW INFO) messages. Unlike other approaches, the flooding of these messages is based on the idea of prefix continuity.

Related work

There is an AODV implementation developed at Uppsala University- Sweden, for Internet connectivity to Hybrid Ad hoc networks.

Overview of AODV-UU

AODV-UU is Linux implementation of ad hoc routing protocol which is developed by UPPSALA University, Sweden. It contains all the feature of AODV.

Features of AODV-UU

- Routing Table
- IP Route Resolving Mechanism
- On-demand Route Discovery
- Routing Table Soft Table

Proposed model

Determining Node's location

Internet gateway and MANET nodes uses same subnet prefix IP address. By using prefix match MANET node know that destination node is a mobile node (located in MANET) or fixed node (located in the Internet).

Gateway Discovery

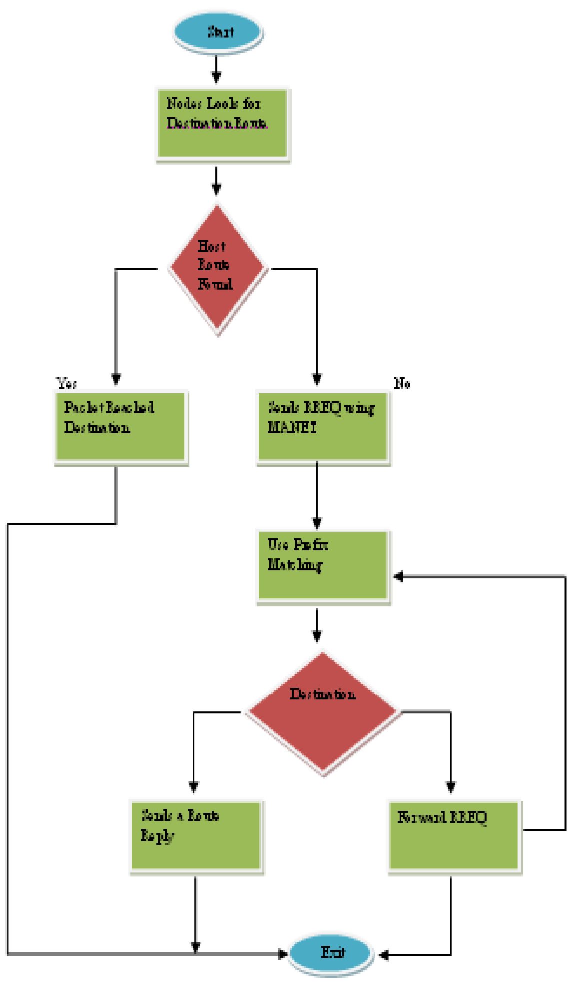
Mobile node uses default route on hop by hop basis to send packets to external nodes, it get this default route by broadcasting RREQ with packets external destination address, nodes receiving this route request first check for destination address locality, if requested destination is MANET node it response accordingly to AODV. Or if it is external node it replies with default route entry. Or if this route request reaches to IGW, Internet gateway send route reply with default route entry.

Forwarding

Mobile node sends packets to external node using default route on hop by hop basis.

Default route contain default route entry and next hop towards gateway. Mobile Node checks packet destination address locality, if this packet is destined to external node then forward packet to next hop of default route entry. This process

Repeats until it reaches to gateway and gateway forward this packet on fixed channel.



Performance Evaluation

The NS-2 (Network Simulator) is a discrete event driven simulator used for implementation and simulations of various network protocols. It is freely distributed, open source and is widely used for academic and research from the past 10 years. It is a de facto standard in networking research.

Simulation topology

We use NS-2 version 2.26 and the NS-2 AODV-UU implementation of AODV, to implement and compare our proposed model. We scale the number of nodes from 2 to 12 mobile nodes, incrementing by two at a time.

Simulation Parameters

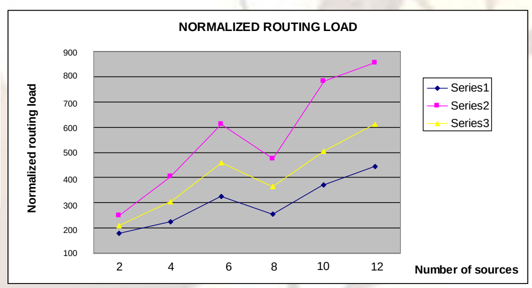
Parameter Used	Value of the parameter
Traffic	TCP
Number of nodes	20
Maximum Connection	2-12
Simulation Time	200 Seconds
Simulation Grid Size	500m X 500m
Packet Size	512 Bytes

Result

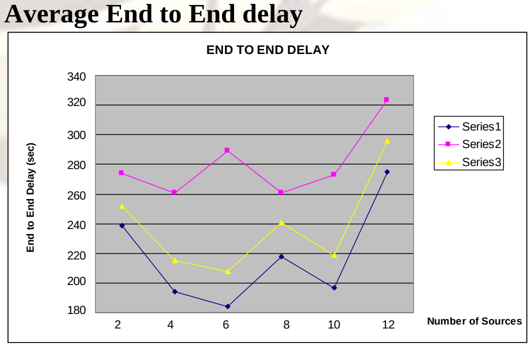
The results are computed by tracing the output files generated by NS-2 simulator during simulation. This approach outperforms AODV-UU with default route setup using TCP traffic in terms of routing load and end to end delay.

Normalized routing load

Our proposed model uses locality check with prefix matching for finding if a destination node is mobile node or node in fixed network, rather than doing network wide search in Wakikawa model, a complete network wide search has been avoided. And Intermediate node response to acquire default routes, instead of IGW response in Wakikawa model for default route acquisition results in improved performance.



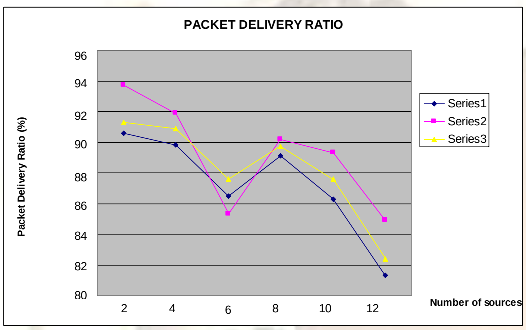
Average End to End delay



If link breaks occur while source node is transferring packets to Internet node default route is invalidated and in Wakikawa model to get new valid default route source node has to send route request up to IGW and IGW response but in our model we get new default route from intermediate nodes, which is decreased route discovery delay as compared to the Wakikawa model.

Packet Delivery Ratio

Packet delivery ratio in our model decreased slightly as compared to Wakikawa model. Reason behind this is when link breaks occur in Wakikawa model it gets new default route from IGW, so IGW also learn a route to the originating node. But in our model IGW is not learning new route of originating node because of intermediate node responses, which is the cause of acknowledgments losses from IGW for TCP connection.



Conclusions

Using locality check with prefix matching for finding if a destination node is mobile node or node in fixed network, a complete network wide search has been avoided resulting in improved performance with routing load. By implementing intermediate node response to acquire default routes, overhead with default route acquisition from IGW has been removed. By shortening the lookup procedure better performance with end to end delay has been achieved.

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