

An Efficient Service Discovery in MANET Using Two-Hop Neighbour Information

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Abstract: Service discovery is essential in any network. When it comes to a self-sustained network like mobile adhoc network with limited resources it is even more essential. A service could be any hardware or software that the user is interested to access. The process of Service discovery should enable a consumer to discover a service provider and access those services in an efficient and scalable manner.

The AODV protocol was extended to perform service discovery along with route discovery. This protocol was further extended to include service advertisement by modifying the Hello messages. We propose a method to improve the performance of the network during service discovery by using hello messages to collect routing and service information of neighbour nodes at a two hop distance. Instead of storing the complete information about the services only the availability or non-availability of services are stored. So it does not increase the storage overhead. This information reduces the traffic in the network and thereby reducing the number of packets dropped.

Keywords: 2 HOP, AODV, MANET, Service discovery.

I. INTRODUCTION

A Mobile Ad hoc Network (MANET) operates without the support of a fixed infrastructure. Such networks can be deployed very quickly and are not expensive as they do not involve basic infrastructure costs. Applications of MANET cover various areas, such as post-disaster rescue operations, temporary collaboration at conferences, lectures, military operation, sensor networks, etc.

One of the most important issues in MANET is the discovery of services available around the vicinity of any node. A service can be any hardware, software or any other entity that a user might be interested to utilize [1]. Discusses how multimedia services can be efficiently offered in MANETS. Service discovery is the process of allowing the service providers to advertise

their services in a dynamic way and to allow the consumer to discover and access those services in an efficient and scalable manner [2].

The service discovery protocols for fixed networks are not suitable for adhoc networks due to the mobility of the nodes and the limited resources available with each node in the network. For this reason the nodes will have to use the resources available with other nodes and the service discovery process is inevitable. Since a reactive routing protocols establishes a route only when it is required and reduces the traffic in the network the AODV protocol is chosen to integrate service discovery. Now as the services are discovered the route to the service provider is also available.

We propose a method to store the service information of the neighbours at 2 hop distances so that the traffic in the network due to service discovery can be reduced.

Section II gives the work related to the service discovery in MANETs. Section III presents the proposed technique, section IV presents the implementation performance analysis and result, section V concludes it.

II. RELATED WORK

Many standards were developed for service discovery in fixed-infrastructure networks the most important of which is the Service Location Protocol (SLP) [3]. The centralized mode of SLP does not suit the ad-hoc nature of MANETs. An implementation of SLP by replacing the local broadcast with a broadcast flood resulted in a protocol similar to the Nom (Name space) a Resource Location and Discovery Protocol [4]. NOM protocol and SLP protocol which was used for service discovery in fixed infrastructure was made use in mobile Adhoc networks most of these solutions are not suitable for MANETs or sensor networks, since they are either centralized and not energy-aware and was not designed for mobile nodes.

After the services are discovered they do not provide an appropriate route to the service provider and a route discovery has to be initiated. Mobility of the node causes frequent route

changes. Because of the drawbacks of the existing protocols a protocol was required that suited specifically for MANETs which would address the issue of mobility of nodes and scarce resources like power and Bandwidth.

To design a service discovery protocol that suits MANET an attempt was made to perform service discovery at the network layer. The cross-layer approach [5] is more flexible and allows a more intensive feedback between layers. Service discovery is a function that is normally performed at the application layer, where services are found. However, the mobile adhoc network could benefit from carrying out this function jointly with routing, at the network layer [6]. The reason being, for a node to establish communication with another, a route has to be available. Once the route is established, in order to use a service offered by the recently discovered node, it has to use a service discovery mechanism to find out what services that node is offering. Both the routing and the service discovery protocols issue their own messages, which traverse the same path between the node which offers the service and the node that wants to use it. Therefore, the routing mechanism can be extended to not only find the route to a node, but also discover the services offered by that node.

Intentional Naming System (INS) [7] is one of the first proposals for service discovery in multi-hop ad-hoc networks. INS integrates routing and service discovery, but does so using an overlay network. To create the overlay network, a central component is used which turned out to be a drawback as it had a single point of failure. The second, drawback was keeping the service directory up to date, even when it is not used, and can incur significant network traffic.

Optimized Link State Routing (OLSR) [8] is an IP routing protocol which is optimized for mobile ad-hoc networks but can also be used on other wireless ad-hoc networks. OLSR is a proactive link-state routing protocol. The disadvantage with this method is that packets need to be sent to adjacent nodes continually to maintain up-to-date routing information. Each node needs to continually relay packets for this purpose, so the battery and other resources of each node is continuously consumed. The traffic resulting from these packets is always present in the network even when there is no request for communication. So the proactive protocols are not a good choice for service discovery.

The most well-developed reactive routing-protocol for MANETs is Dynamic Source Routing (DSR) [9] protocol and the Ad-hoc On-demand Distance Vector (AODV). The routing table of the DSR protocol contains route information for entire routes and not just the next-hop address for the different destinations. The DSR protocol uses source routes in its messages. Each message contains the untraveled part of the route to the destination. The main disadvantage with DSR is caching, and lack of mechanism to expire stale.

The AODV [10] [11] Routing protocol uses on-demand approach for finding routes, that is, a route is established only when it is required by a source node for transmitting data

packets. It employs destination sequence numbers to identify the most recent path. The major difference between AODV and other on-demand routing protocols is that it uses a destination sequence number (DestSeqNum) to determine an up-to-date path to the destination. A node updates its path information only if the DestSeqNum of the current packet received is greater than the last DestSeqNum stored at the node.

The AODV protocol uses the route request and the route reply message to find out routes to nodes to which it would like to establish communication [12]. The route request messages are extended to include service request information and are now called service request message (SREQ) and the route reply messages are modified to include the service reply information (SREP) and are now called as the service reply messages, so thus the AODV protocol is modified to include service discovery. As we discover a service provider that provides a service of interest a route to the service provider is also available but the nodes have to incur the additional overhead of maintaining a service table.

The paper in [12] does not take care of advertising services. Hello messages are used in AODV protocol to keep track of the one hop neighbours [2]. Hello messages were modified to include the service information. These messages are periodically broadcasted to the neighbours and the neighbours can know the services available in its vicinity. This method gave the nodes an ability to advertise its services. Both these proposals maintain a routing table and a service table to store the routing and the service information respectively [13]. Discusses how service discovery can be performed efficiently in vehicular network. Here it is considering the infrastructure report [14]. Conducted the Performance Analysis of Routing Methods Based on OLSR and AODV with Traffic Load Balancing and QoS for Wi-Fi Mesh Network. This paper was reviewed to get some insight into making the service discovery better.

III. PROPOSED TECHNIQUE

The different message types of the AODV protocol are Route Request (RREQ) with extension to service discovery is called the service request message (SREQ), Route Reply (RREP) with extensions for service reply is called (SREP), Route Error (RERR) and Hello Message.

When node S wants to access a service at node D, but does not know a route to D, node S initiates and floods SREQ message. It includes the last known sequence number for the destination. When the intended destination receives a service Request, it replies by sending a SREP. Link failures are propagated by means of RERR messages, which also update destination sequence numbers. Nodes that can communicate directly are considered to be Neighbours. A node keeps track of its Neighbours by listening for a HELLO message that each node broadcast at set intervals [2]. The hello messages are extended to include service information and are now called as UST (Update Service Table). When a node receives A UST both the service table and the routing table are updated.

The different information that can be maintained in the service table are listed in Table I.

TABLE I: FIELDS OF SERVICE TABLE

Service Id	Unique Id assigned to service
IP Address	IP address of the service provider
Expiration Time	Service expiration time
Provider	Service provider Name
Service Name	Name of the service
Service Type	The Type of the Service
Attributes List	Optional field Varies According to the services
Service Description	Details of service or a url where details can be found

The steps in the service discovery process are as follows:

Repeat steps till node is alive:

1. The incoming message is read.
2. Periodically temporary routes and temporary service information is deleted, caches are cleaned.
3. Switch (message type)

Case UST:

The routing information and the service information is updated.

Case SREQ:

- a. If it is a duplicate SREQ the message is discarded.
- b. If the request can be serviced from a local lookup a reply message (SREP) is sent to the requesting node.
- c. If the request cannot be serviced The SREQ Message is sent to the adjacent nodes.
- d. A reverse routing entry is added towards the source of SREQ.
- e. Next node is set to the source hop of SREQ.

Case SREP:

- a. If it is the reply of the nodes SREQ.
Then
 - i. Create forward routing entry towards the source of SREP.
 - ii. Set Source node equal to the source hop of SREP.
Else
 - i. Remove temporary nodes.
 - ii. Create Forward Routing entry towards source of SREP.
 - iii. Set Next node equal to the source hop of SREP.
 - iv. Forward SREP to upstream nodes.

Case RERR:

If Precursors are present

Then

- i. Inform precursors about deleted root.
- ii. Remove Route from routing Table.
Else
 - i. Broadcast to neighbours about route deletion.
 - ii. Remove route from routing table.

The message format of HELLO message of the AODV protocol is given in Table II.

TABLE II: FORMAT OF HELLO MESSAGES

Destination IP Address	The node's IP address
Destination Sequence Number	The node's latest sequence number
Hop Count	0
Life time	ALLOWED_HELLO_LOSS * HELLO_INTERVAL

This message format is further extended to include the service id to advertise the services and is now called UST (Update Service Table) message and the format is given in Table III. When a node receives UST message it updates its routing table and service table. To keep the UST messages light the remaining service information is not flooded. The nodes can unicast the destination node to collect the rest of the service information.

TABLE III: MESSAGE FORMAT OF UST MESSAGE

Destination IP Address	The node's IP address
Destination Sequence Number	The node's latest sequence number
Hop Count	0
Life time	ALLOWED_HELLO_LOSS * HELLO_INTERVAL
Service id	Unique identifier of the service that is offered by the node

Now we propose to further extend the message to include the services offered by the 2 hop neighbour and we now call the message UST1. When a node D is broadcasting a UST1 message it also includes the services available with all its 1 hop neighbour. When the node S receives the message it now has the service information of its 2 hop neighbours.

But if the node D has to include the list of IP addresses and service information of all its 1 hop neighbour the payload of the message increases drastically and the overhead increases. To overcome this overload and to make use of the service information we include only one extra field in the HELLO

message with length 8 bit. Each bit represents a service. So we can accommodate upto 8 service information. Only 1 bit per service.

If more than 8 services are available we keep a list of 8 most frequently accessed services. Starting from the MSB if the bit is 1 then service id with 1 is available. If the bit is 0 then the service with service id 1 is not available similarly each bit encodes the information regarding the availability or unavailability of the next seven services. The message format of UST1 is listed in Table IV.

When a UST1 message is received by S from D then the service at service id is updated into the service table with destination IP address as IP address of D and hop count 0. Then S scans the information at service_id1 from MSB to LSB, searches for all the bit that is 1 and updates the service table that these services are available at IP address D, but at a hop count of 1. So when a service is required the node can unicast the service request to D.

TABLE IV: MESSAGE FORMAT OF UST1 MESSAGE

Destination IP Address	The node's IP address
Destination Sequence Number	The node's latest sequence number
Hop Count	0
Life time	ALLOWED_HELLO_LOSS * HELLO_INTERVAL
Service id	Unique identifier of the service that is offered by the node
Service_id1	[00000000] one bit for each service for upto 8 service

In the UST1 messages only the availability or non-availability of a service at 2 hop is only transmitted. The rest of the information regarding the services is only stored at respective node, to avoid redundancy of information and reduce the storage overhead. So when a node S needs any information regarding the service it can access it from D. If the service is already available at hop count 0 then, 1 hop information is not stored in the service table.

IV. IMPLEMENTATION AND PERFORMANCE ANALYSIS

The Protocol is implemented for wireless ad-hoc network using network simulator (ns-2.33), C++ and the TCL scripts. The AODV protocol is modified to include service discovery and the modifications proposed. The system was simulated with 30 nodes and 50 nodes. Few nodes were chosen to provide services at random and up to 8 services were considered. After the simulations the data was analysed and it was found that the number of packets dropped reduced from 3% to 8%.

One of the main advantages with this system is the reduced storage overhead in the nodes where the complete information regarding the services at 1 and 2 hop is not stored at all nodes.

Earlier when a node has to access the service even at a distance of 2 hop it would generate an SREQ message which will be broadcasted to multiple levels increasing the traffic in the network. The proposed technique avoids SREQ messages when the services are available at 2 hop and the messages are unicast reducing the traffic in the network there by reducing the number of packets dropped and improving the service acquisition latency.

V. CONCLUSION

The technique proposed performs service discovery at the network layer along with route discovery. AODV protocol is extended to perform service discovery and to advertise the services. It was further extended with minimal overhead to disseminate the service information at a distance of 2 hop. This technique has drastically reduced the traffic in the network and also reduced the service acquisition latency.

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