AODV based Service Discovery Protocol with Two Hop Neighbor Information

Smitha Kurian, Loganathan R

Abstract: AdHoc networks are self-sustained infrastructure less networks which survives on mutual cooperation by sharing resources. To share the resources as services it is important to be able to advertise available services and discover the required services. Service discovery that is performed in application layer can be benefitted when performed at network layer since it reduces the control message. Therefore the message format of AODV protocol was extended to include service discovery and service advertisements. We propose a method to extend the hello messages of AODV protocol further to include the service information available with the 2-Hop neighbors. To reduce the storage overhead every node would only store the availability of a particular service. Thereby to access the services available at a 2-hop distance the process of service discovery is not required only a uncast message can be sent. This approach has been able to reduce the service acquisition latenc.y

Keywords: Adhoc Network, AODV, Service discovery, Two HOP.

I. INTRODUCTION

Mobile AdHoc Network (MANET) does not demand a fixed infrastructure and centralized control; therefore they can be set up quickly with minimal cost. MANET finds its application in several fields that demands immediate deployment with minimal available infrastructure like defense operations, rescue operations, conferences etc.

One of the most important requirements in MANET is the discovery of services that are required by a node. A service can be any resource that is not available with a node and would be interested to utilize. Service discovery is a process that facilitates the services to be advertised and discovered [1],[2]. Multimedia services can also be efficiently offered in MANETS [3].

The service discovery protocols of fixed networks does not fit the requirements of AdHoc networks due to the non-availability of a central control, mobility of the nodes and the availability of limited resources[4]. Since a reactive routing protocol establishes a route only when it is required and reduces the traffic in the network the AODV protocol is chosen to integrate service discovery [1],[2].

We propose a method to store the service information of the neighbors 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 results and discussion and section V concludes the findings.

II. LITERATURE SURVEY

Many standards were developed for service discovery in fixed-infrastructure networks the most important of which is the Service Location Protocol (SLP). The centralized mode of SLP does not suit the AdHoc nature of MANETs[5]. 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 [6]. NOM protocol and SLP protocol which was used for service discovery in fixed infrastructure was made use in mobile AdHoc networks and was not suitable for AdHoc network as it was not energy aware and required centralized control[1].

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.

Intentional Naming system (INS) [7] was one of first protocol designed to perform service discovery in AdHoc network. The drawback of this protocol was that it required a central component which resulted in a single point failure. The second draw back was that the service directories were kept up to date even when it was not used, this resulted in unnecessary network traffic.

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 is flexible and allows rigorous feedback between layers. It is beneficial to mobile AdHoc network if service discovery is performed at network layer The reason being, when a route is established to a node for communication the services available with the node is also discovered, this can reduce the control messages traversed in the network [8], [9]. Therefore the routing mechanism can be extended to find the route to a node, and the services offered by that node.

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* Correspondence Author
Smitha Kurian*, Department of CSE, HKBKCE, VTU ,Bangalore, India, smitha.nikku@gmail.com
Dr. Loganathan R. department, Department of CSE, HKBKCE, VTU ,Bangalore, India,drloganathanr@gmail.com

Optimized Link State Routing (OLSR) [10] is a routing protocol for mobile ad-hoc. Considering OLSR protocol for service integration was not suitable as OLSR is a proactive link-state routing protocol. The disadvantage with this method is that it maintains up-to-date routing information even when communication is not taking place. So the proactive protocols are not a good choice for service discovery

The most extensively used reactive routing protocol designed for AdHoc network was the Dynamic source Routing Protocol (DSR) and the Ad-hoc On-demand Distance Vector (AODV) routing protocol. The DSR protocol maintains the complete routing information its routing table where as the AODV protocol only stores the next hop address. The DSR also lacked the mechanism to discard expired data so the AODV protocol was a better choice for integrating service discovery [11], [12].

Dynamic Source Routing (DSR) is a reactive routing protocol. The storage overhead of the DSR protocol is high as it stores the complete route information the routing table and in its messages and it also does not take care of invalidating expired data [11]. The next choice of reactive routing protocol is AdHoc On Demand Distance Vector routing protocol

In the AODV node-S finds a route to node-D only when node-S(is willing to establish communication with node-D. The sequence numbers helps to identify the newest path. Higher the sequence number the newer the path is. Each node maintains the destination sequence number [12],[13].

The AODV protocol uses the Route request (RREQ) and the route reply message (RREP) to find out routes to nodes to which it would like to establish communication[13].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[2]. Fig 1 illustrates the process of service discovery. If node_S is willing to access the services of node-D it initiates the SREQ message, when the node D receives the request and send response in the form of SREP. When the same SREQ message arrives at node_D second time it recognizes duplicate message from the sequence number and does not send a reply message repeatedly.

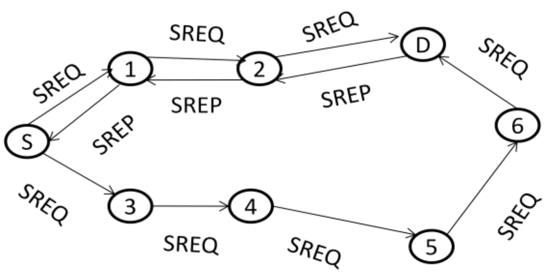

Fig 1: Service Discovery along with Route discovery

The paper in [2] does not take care of advertising services. Hello messages are used in AODV protocol to keep track of the one hop neighbors[13]. Hello messages were modified to include the service information. These messages are periodically broadcasted to the neighbors and the neighbors 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[1].

Service discovery can be performed efficiently in vehicular network also. Here it is considering the infrastructure report[14]. The routing in Wi-Fi Mesh network can be analyzed and the (QoS) parameters considered were the traffic load balancing and the quality of service [15]. This paper was reviewed to get some insight on parameters for service discovery. A web service discovery protocol that disseminates semantic web service information during routing process using cross layer routing techniques is proposed in [16]. The overhead during flooding can be reduced using a query Localization protocol [17].

III. Proposed Technique

Nodes that can communicate directly with one another are considered to be one- hop neighbors. Every node periodically broadcasts the HELLO messages which will be tracked by all its neighbors. Similarly every node receives the HELLO messages broadcasted from its neighbors and maintains a list of its 1-Hop neighbors [13]. The hello messages are extended to include service information and are now called as UST (update service table). On receiving a UST both the service table and the routing table are updated[1].

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

[1]Table-I: Fields of service table

Serv_Id	Unique Id assigned to service
IP Address	IP address of the service provider
Expiration Time	Service expiration time
Provider	Service provider Name
Serv_Name	Name of the service
Serv_Type	The type of the Service
Attributes List	Optional field Varies According to the services

When a node receives the four types of messages ,SREQ,SREP,UST and RERR the following actions as described by the steps are taken by the node

Repeat steps till node is alive

1. Read incoming message
2. Periodically temporary routes and temporary service information is deleted, caches are cleared
3. Switch (Message type)
   Case UST: update route and service table
   Case SREQ:

a. If it is a duplicate SREQ the message is discarded
b. If the request can be serviced from a local lookup send a(SREP) message.
c. Else forward the SREQ o the adjacent nodes
d. A reverse routing entry is added towards the source of SREQ
e. Next node values is assigned as the source hop value 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. Assign 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 node
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.

[12]Table-II: Format of Hello messages

Destination IP Address	The node's IP address.
Destination Sequence Number	The node's last known 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 it 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 last known 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 neighbor and we now call the message UST1. When a node-S is broadcasting a UST1 message it also includes the services available with its entire 1 hop neighbor. When the node-D receives the message from its 1- Hop neighbors it now has the service information of its 2 hop neighbors also.

But if the node-D has to include the list of IP addresses and service information of all its 1-hop neighbor 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 up to 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.

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

Considering node S and D are the source and destination nodes, 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.The service_id field will have the list of nodes that are available with D. Then S scans the information at service_id1 from MSB to LSB, searches for the bit that is 1 and updates the service table that these services are available with one-hop neighbors of D.

So when a service is required that is available at D or one-hop neighbor of D the node S can unicast the SREQ to D.D will return a SREP message for the service available with itself or it one- hop neighbor.

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

IV. Results and Discussions

The Protocol is implemented for wireless AdHoc 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 message formats of AODV protocol is modified to include service discovery as proposed in [2]. The Hello messages are further modified to include the service availability of 2 hop neighbours. Fixed number of nodes was designated as servers and the numbers of client nodes have been varied periodically to request access for services. The FTP protocol is used to indicate the access of service.

The node configurations used: the channel was set to the wireless channel, Mac 802_11 was used. The antenna was set to the Omni Antenna. Number of nodes used was 30. The routing protocol was AODV. The data rate was set to 1MbPS. The simulation was run for a total of 30 seconds. The trace files generated was analysed to compute the service acquisition latency. For every 5 seconds the average service acquisition latency is computed and tabulated in Table V and plotted in Fig 2 . The Graph in Fig 2shows the service acquisition latency without the 2-hop neighbour information and Fig 3 shows the service acquisition latency with the 2- hop neighbour information the tabulated data is shown in Table VI. It is visible from the graph that the service acquisition latency is lesser with the proposed modification. During certain interval the difference is not prominent. This could happen when the nodes have moved away from the servers are not available at 2- Hop distance

Table-V: Tabulated Service acquisition latency without the 2-hop neighbour information

Time	0-5	6-10	11-15	16-20	21-25	26-30
Service acquisition Latency	0.2	0.3	0.3	0.3	0.4	0.35

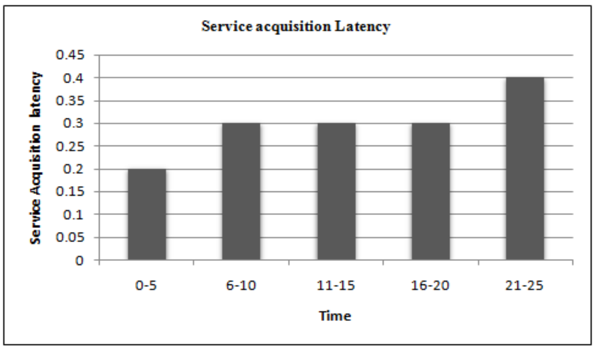

Fig 2: Service acquisition latency without the 2-hop neighbour information

Table –VI: Tabulated Service acquisition latency with the 2- hop neighbour information

Time	0-5	6-10	11-15	16-20	21-25	26-30
Service acquisition Latency	0.1	0.2	0.2	0.3	0.4	0.3

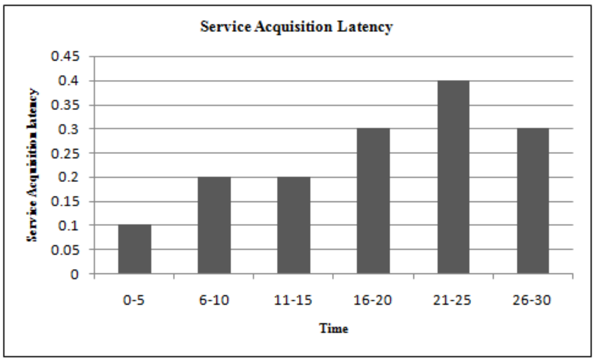

Fig 3 Service acquisition latency with the 2- hop neighbour information

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 unicasted reducing the traffic in the network there by improving the service acquisition latency. The service acquisition latency improved on an average from 0.31 seconds to 0.25 seconds

V. Conclusion

The technique proposed performs service discovery using the cross layer approach at the network layer. AODV protocol which is a route discovery protocol is extended to perform service discovery it also takes care of the process of advertising the services. It was further extended with minimal overhead to disseminate the service information at a distance of 2 hop.

This approach avoided the process of discovering a service which was available around the 2-hop vicinity. So the process could acquire the services faster and has been able to reduce the service acquisition latency.

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AUTHORS PROFILE

Smitha Kurian: Received B.E. in CSE from SJMIT, Kuvempu University, M.Tech from VTU and is currently a Research Scholar at VTU. She is Currently working as Assistant Professor, in the Department of CSE HKBKCE. She has 15 years of Academic experience and published papers in reputed conferences and journals in the field of Wireless AdHoc networks, Artificial Intelligence and Machine Learning.

Dr. Loganathan R. Received B.E in CSE from Bharathiar University, Coimbatore, M.TECH IN CSE from Visvesvaraya Technological University, Karnataka. And he was awarded PhD in CSE from Sathyabama University, Chennai. He is now working as Professor and HOD Department of CSE, HKBK College of Engineering, Bangalore. He has 20 years of Academic experience. He has published his research work in several reputed journals and conferences in the field of Image Processing, Wireless Networks.