Consistent Distributed Lookup Service Architecture for Mobile Ad-hoc Networks

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ABSTRACT

Mobile Ad hoc network is a self configuring network of mobile nodes. It allows mobile nodes to configure network spontaneously and share their services. In these networks, service discovery is very important because all nodes do not have same resources in term of memory and computing power. Nodes need to use different services offered by different servers. Some service discovery protocols have been proposed in last couple of years but they include significant traffic overhead and for small scale MANETS. In this paper, we present extensible lookup service scheme based on distributed mechanism. In our scheme neighboring nodes of service provider monitor service provider and send notification to lookup server when the service provider terminates its services unexpectedly. Lookup server can find other service provider or other alternative services in advance because of advance notification method and can provide consistent lookup services. In our scheme neighboring nodes also monitor lookup server and send notification to network when lookup server terminates unexpectedly. Simulation results show that our scheme can reduce up to 70% and 30% lookup failure as compare to centralize and simple distributed mechanism respectively.

Keywords: *Mobile Ad hoc network, Service discovery, Lookup service, Distributed mechanism.*

1. INTRODUCTION

Service discovery mechanism enables nodes to discover different services available in the network. In MANET, nodes do not have enough resources and need services offered by different nodes to complete their tasks. If any node requires service then it should know about service availability in the network. Service lookup mechanism for wired network is not appropriate for mobile ad hoc networks. Service lookup mechanism should consider the mobility factor in MANET to work properly. Many scenarios can occur due to mobility and limited resources of mobile nodes in MANET. For an example, lookup server can leave MANET, lookup server can die expectedly, lookup server can die unexpectedly, service provider can leave MANET, service provider can die expectedly, service provider can die unexpectedly, client can leave MANET, client can die expectedly and client can die unexpectedly.

Lookup service mechanism in MANET should cater these scenarios to provide reliable services. Last three scenarios do not affect lookup service mechanism but first six scenarios are important for lookup scheme.

There are two major categories to handle service lookup mechanism, Centralized and Distributed. Centralized mechanism is very simple and easy to implement. Every server will register its services to centralized node. This centralized node will behave as a server. Node sends request to cauterized server for services. Centralized mechanism leads towards single point failure. If centralized server wants to move or die due to shortage of resources then reelection of centralized server require a lot of bandwidth and during election nodes can not use services. Centralized mechanism does not cater all scenarios related to mobile ad hoc network.

Fully distributed mechanism may handle all scenarios occurs due to mobility. In fully distributed mechanism all nodes have the information about servers. But this scheme does not work well due to limited bandwidth of mobile ad hoc networks. To maintain data on each node not only requires bandwidth but also requires resources in term of memory and computing power. Due to rapid change in network and limited bandwidth, it is very difficult to maintain table at each node.

Partially distributed mechanism is suitable technique for mobile ad hoc network. In this paper we presents consistent service lookup scheme based on semi distributed mechanism. In this scheme different lookup server will be available. Service providers' information will be divided into these servers. In our proposed scheme, we divide the mobile ad hoc network into logical portions. Each logical portion is called ad hoc local area network (ALAN). Each ALAN must have one lookup server in it. In our proposed scheme there is one centralized server as well which maintains information about lookup server and list of available services in each ALAN. Logical portioning criteria could be geographical boundaries, number of hops,

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number of offered services or any other criteria.

2. RELATED WORK

F. Sailhan et al. [1] proposed a service discovery protocol aimed at large-scale mobile ad hoc networks. In this scheme, directories are distributed and deployed dynamically. The discovery architecture is structured as a virtual network. A virtual network is composed of a subset of nodes of the MANET acting as directories. These backbone nodes are responsible for performing service discovery. At least one directory is reachable in at most a fixed number of hops. Directories cache the descriptions of services available in their neighborhood. A client simply sends a query to the directory for local service discovery. If the description of the requested service is not cached by the local directory, the directory selectively forwards the query to other directories so as to perform global discovery. Selection of directories to which service queries are forwarded, is based on the exchange of profiles among directories. The directory profile provides a compact summary of the directory's content and a characterization of the host capacity.

U. Kozat et al. [2] proposed a distributed service discovery protocol (DSDP) architecture that is based on a virtual backbone for locating and registering available services. This architecture consists of two independent parts: backbone management (BBM) phase and distributed service discovery (DSD) phase. BBM phase, selects a subset of the network nodes to form a dominating set. BBM uses 1-hop broadcast control message for forming the backbone, creating virtual links between backbone nodes, and maintaining the backbone. The second part, DSD phase, is used to distribute the request and registration messages from clients and servers to the directories. These messages assist in forming multicast trees rooted at client and server nodes on top of the backbone mesh.

3. PROPOSED SCHEME

In this section we describe lookup scheme based on distributed mechanism. We divide network nodes into logical portioning as shown in fig. 1. This logical portioning can be based on any arbitrary criteria. We call each logical portioning "ALAN" (Ad hoc Local Area Network). Each ALAN consists of nodes, service providers and lookup server. We also maintain one centralized lookup server which is used to maintain information about lookup server and list of available services in each ALAN.

There can be three types of nodes in the network. A node can be a Lookup server, Service provider or Client. The purpose of the lookup server is to provide the information to clients about service providers. Each client sends request message to lookup server to find service provider in the network. The purpose of service provider is to provide services to clients. One node can be a lookup server, a service provider and a client at the same time.

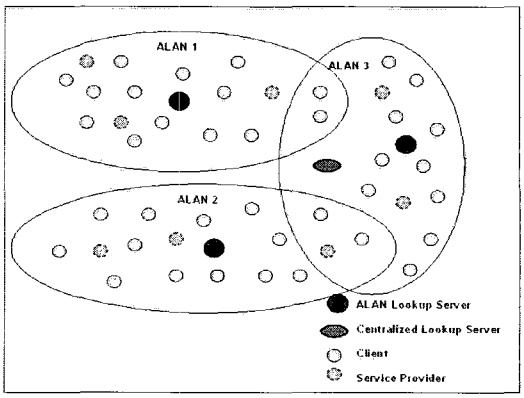

Fig. 1. Logical portioning of mobile ad hoc network

Each service provider within ALAN registers itself with available lookup server in ALAN by sending registration message. Service provider may register itself with more than one lookup servers depending on the network topology.

Centralized lookup server maintains the list of ALANs and their lookup servers. Each entry in centralized lookup server consists of ALAN id, unique list of available services in ALAN and ALAN's lookup server information. ALAN's lookup server maintains the lookup service mechanism and provides unique list of services to centralized lookup server. For an example, if ALAN has printing services available. It notifies centralized server about printing services. Centralized server does not know about the number of print servers available and their addresses. Whenever centralized lookup server receives any service request it checks available services in ALAN and forward request to that particular ALAN. Centralized lookup server will be notified by the ALAN's lookup server when uniqueness of services removes. For an example, printing service is no more available in the ALAN.

If service provider wants to move then it updates lookup server available in ALAN by sending a leaving message. After receiving leaving message from service provider local lookup server updates its list. If set of unique available services in ALAN modifies by moving service provider then ALAN's lookup server also modifies centralized lookup server. Any service provider can join the group at run time. When service provider joins the group then it registers itself by sending joining message to lookup server available in ALAN. By using leaving and joining message service provider mobility can be maintained in the network. ALAN's lookup server notifies centralized lookup server whenever unique service will be added in ALAN. For an example, if ALAN does not have print server and new node with printer joins ALAN then ALAN's lookup server notifies centralized lookup server about this new service.

Whenever any client requires services, it sends request message to lookup server available in ALAN. If requested service is available in ALAN then it sends reply message to client. If requested service is not available in ALAN then it sends message to centralized lookup server. Centralized lookup server sends message to ALAN's lookup server having requested service. ALAN's lookup server notifies client node directly without informing centralized lookup server.

If lookup server wants to move then it starts election for new lookup servers and after electing new server, lookup server moves. Election is local to the ALAN and remaining part of the network will be in working condition during election.

1-hop neighboring nodes of the service provider send periodic message to service provider. Service provider sends acknowledgement after receiving periodic message. If any node does not receive acknowledgement message then it repeats its message. If it does not receive any acknowledgement message then it notifies the lookup server available in the ALAN about service provider unavailability. Fig. 2. shows periodic checking mechanism.

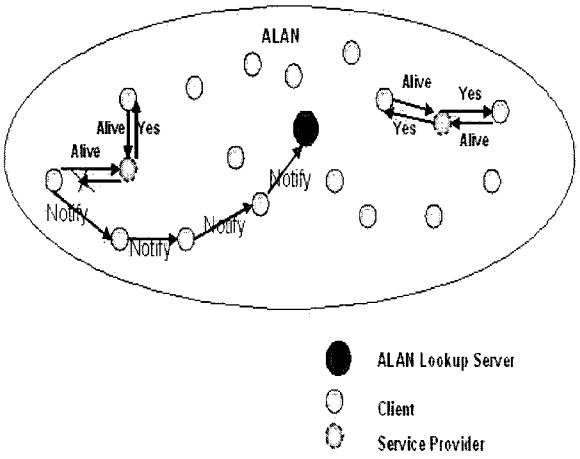

Fig. 2. Clients check service provider availability and notify lookup server in case of unexpected termination

4. PERFORMANCE ANALYSIS

In our simulation environment we use Glomosim [5] and customized C++ program. We perform each simulation for 50 seconds based on 100 nodes. Nodes are uniformly distributed in the area and any node can contact to another node with in 4-hop distance in ALAN. We have assumed that maximum bit rate is 1 Mbps. Fig. 3. shows the probability of lookup failure. In our proposed scheme, reliable distributed mechanism, probability of lookup failure is very low due to distributed mechanism and periodic checking mechanism of lookup server and service providers.

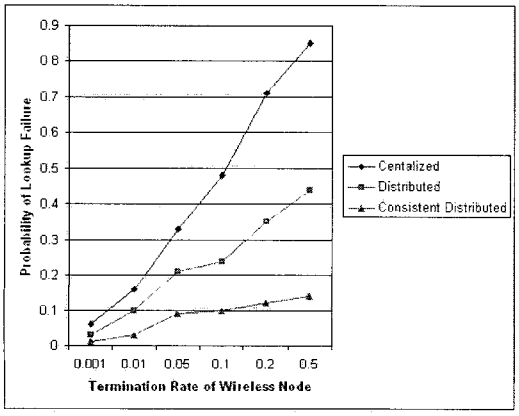

Fig. 3. Performance comparison(Lookup failure)

5. CONCLUSION

In this paper we present consistent distributed lookup service scheme to maintain lookup service information. In our scheme we use distributed mechanism to maintain lookup services information. In our scheme 1-hop clients are responsible to check availability of service provider periodically and notify lookup server in case of unexpected failure or service termination. 1-hop clients also monitor lookup serve and notify network about unexpected termination. Our simulation results show that lookup failure probability is very low in consistent distributed mechanism as compare to centralize and simple distributed mechanism.

REFERENCES

[1] F. Sailhan, V. Issarny, "Scalable Service Discovery for MANET," Proceedings of the 3rd IEEE Int'l Conf. on Pervasive Computing and Communications, 2005.

[2] U. C. Kozat, L. Tassiulas, "Service discovery in mobile ad hoc networks," An overall perspective on architectural choices and network layer support issues, Ad Hoc Networks, 2, 2004.

[3] E. Guttman et al, "Service Location Protocol, Version2," IETF, RFC2608, Jun. 1999.

[4] Helal, S., Desai, N., Verma, V., Choonhwa Lee, "Konark - A service discovery and delivery protocol for ad-hoc networks," Wireless Communications and Networking, WCNC 2003.

[5] http://pcl.cs.ucla.edu/projects/glomosim

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