Location Aware Discovery Service and Selection Protocol in Cooperative Mobile Wireless Ad Hoc Networks

Janine Kniess*,†
†Computer Science Department
Santa Catarina State University
Joinville-SC - Brazil
Email: janine@joinville.udesc.br, jkniess@ic.uff.br

Orlando Loques*, Célio V. N. Albuquerque*
*Institute of Computer Science
Federal State University (UFF)
Niterói-RJ - Brazil
Email: loques,celio@ic.uff.br

***Abstract*—Service Selection in service discovery protocols has an important effect on wireless multi-hop ad hoc networks (MANETs) performance. This work proposes a service selection mechanism based on localization to reduce the redundant replies in these protocols. The mechanism dynamically selects the best resource providers during the reply transmissions taking into account geographic distance, speed and the number of service providers requested. Another issue addressed in this work is a service discovery mechanism that adjusts a search area for each request takes into account localization, the request response time and the nodes speed.**

I. Introduction

The potentially dynamic nature of wireless mobile ad hoc networks (MANETs) has motivated the development of applications in specialized areas such as, battlefields, emergency services, search and rescue after natural disasters, such as, floodings or earthquakes. With the demand of applications for MANETs, the number and the variety of offered services for these networks is continuously increasing.

Service discovery is an essencial component for the usability of such self-organizing networks on the grounds that service discovery enables devices to automatically locate network services with their functions and to announce their own functions to the network [1].

Some proposals for service discovery in MANETs consider solutions for these challenges integrating the functionalities of the service discovery with the routing mechanism of the MANETs. However, due to the dynamic characteristics of the network topology, it is hard to guarantee the consistency of the routing information. A common approach to service discovery in MANETs is, for clients to disseminate requests using a diffusion mecanism. A general survey is found in [2]. However, when the protocol uses a diffusion mechanism, it is often the case that multiple providers can offer the specified service. In this context, it is desired that the best providers are selected without user interference.

Many efforts have been concentrated in service discovery protocols. However, few protocols considered the development of service selection mechanism. Service selection is the phase that comes after service replies were gathered by the service requester. The distributed and automatic service selection allows the reply messages traffic to be filtered by intermediates nodes in the network before arriving at the service requester.

In order to reduce redundant replies in service discovery protocols for MANETs, this work presents an automatic, distributed and location aware service selection mechanism, named Location Aware Service Selection (LASS). The LASS mechanism takes into account aspects such as: the geographic location where the service provider is being requested; the maximum response time (is assumed that the service provider needs to arrive at the place where the service is required within a maximum time); the speed at which the service provider moves; and the number of service providers requested.

Another issue addressed in this work is a service discovery mechanism, named Location Aware Discovery Service (LADS). The LADS mechanism adjusts a search area for each independent request regarding the location where the service is requested, the maximum response time and the maximum node speed. This approach determined that only nodes capable of responding a request within a maximum time limit will be considered in the discovery process.

II. Location Aware Service Discovery Protocol

In this work, we are concerned about analyzing the service discovery in MANETs assisting specialized rescue teams (formed by vehicles, robots and human beings) in areas that have been struck by natural disasters. The nodes in the MANET are interconnected by a sensor network. Moreover, the nodes are able to offer a service and to request a number of service providers. Each node learns its geographic position through a location system, such a GPS, and has an associated speed.

A. Location Aware Discovery Service (LADS)

Supose a node in the network needs information about service providers and sends discovery messages. The mechanism Location Aware Discovery Service (LADS) limits the search diameter R, on the basis of the maximum speed, v_{max} (each type of resource knows this value), that a node can reach and the maximum response time for one request, t_{max}, composing a subgroup $S' \subseteq S$ (set of network nodes) for each discovery messages sent for a requester $i \in S'$. Using R, this mechanism prevents unnecessary reply transmissions in the network.

The diameter R is given by the equation:

$$R = v_{max} * t_{max}. \quad (1)$$

The mechanism defines the diameter using v_{max} so that the search area includes the biggest number of apt providers. Given the pair (*i*,*j*), being $i \in S'$ the requester and $j \in S'$ the provider, it is assumed that the speed (v_j) of this last one is known. Algorithm 1 describes this mechanism.

Algorithm 1 Service Discovery (LADS) $-$ node j

ProcessDiscovery(i, $cord_X$, $cord_Y$, t_{max}, s)
j receive message (*msg*) *ServDisc*( ) of node i,
i request the service s
if $d_{ij} > R$ **then**
  Discard(*msg*)
else if d_{ij} $/v_j$ $<= t_{max}$ **then**
  if FindResource(s) **then**
    if not *busy* **then**
      Send *ServResponse*()
    end if
  end if
end if

In the discovery message, ServDisc(), the requester node sends the following information: a node identification, its geographic coordinate, $cord_X$, $cord_Y$, the maximum response, t_{max}, the service, s and the number of desired service providers. If the node j receives a solicitation from node i, the algorithm verifies the Euclidean distance (d_{ij}) between two nodes. If $d_{ij} > R$, the request is discarded by j because this node is out of the search area. Conversely, if $d_{ij} \leq R$, the algorithm verifies the speed of the service provider j, if this provider offers the resource s and if the j is available at the moment. If the restriction given by equation 2 is be satisfied, node j sends a ServResponse() message to node i.

$$d_{ij}/v_j <= t_{max}. \quad (2)$$

If j has the resource, but v_j is insufficient, j does not send reply to i, and it only resends the request message.

B. Location Aware Service Selection (LASS)

LASS works as follows. Supose that an intermediate node, k receives the reply message from one of its neighbors, for instance m. Then, k verifies if it forwarded the maximum number of service provider messages requested. If the maximum number was reached, node k discards this reply. Otherwise, k compares the speed of the service provider m until the event local with the speed of the last reply fowarded for that request, for example, of node j. If (d_{im}/v_m)≤(d_{ij}/v_j) then, the reply is forwarded. Let d denote the Euclidian distance between two nodes. This restriction guarantees that the additional replies are discarded during the reply transmission from the network and the requesting node receives replies from faster nodes. It is assumed that the nodes have maximum speeds defined. The service selection provider mechanism is presented in Algorithm 2. In the ServResponse() message, the provider

Algorithm 2 Service Selection (LASS) $-$ node k

1: *ProcessResponse*(m, $cord_X$, $cord_Y$, v_j, $max_{providers}$)
2: k receive message (*msg*) *ServResponse* of node m
3: k stored last reply of node j
4: **if** $n_{provider} >= max_{provider}$ **then**
5:   Discard(msg)
6: **else if** $d_{im}/v_m <= d_{ij}/v_j$ **then**
7:   $n_{provider} = n_{provider} + 1$
8:   Forward (*msg*)
9: **else**
10:   Discard(*msg*)
11: **end if**

sends its geographic coordinate and speed. If the restrictions given in lines 6 and 7 of Algorithm 2 were satisfied, the requesting node sends the reply message to its neighbors.

III. Conclusions

In this work we have proposed a service discovery protocol for MANETs that involves service discovery and selection based on localization. The protocol is composed by two types of mechanisms. The first mechanism, LADS, acts in the service discovery phase, limiting the number of service discovery messages by not probing nodes that do not have enough speed to arrive in time at the point where the resource is required. The second mechanism, LASS, selects during the reply transmission phase the best service providers. Additional replies are discarded from the network. Note that LASS mechanism can be used independent from LADS mechanism. For example, the service selection mechanism could act on a diffusion-based discovery protocol. The only restriction is that the source node must send its geographic location as occurs in LADS. Prelimirary simulation results showed that LASS reduces significantly the number of reply messages without compromising the discovery process. As future works we would like to extend our store and forward strategy (e.g., understand the trade-off between network scalability and the period of time to keep the message stored in a node) and to investigate how our assumptions affect the energy consumption in sensor networks. Overall, we feel this initial work already offers significant opportunities for reducing the message reply overhead improving the network performance and helping in the decision of which provider to choose.

References

[1] R. Marin-Perianu, P. Hartel, and H. Scholten, *A Classification of Service Discovery Protocols*. Centre for Telematics and Information Technology, University of Twente, 2005.

[2] A. N. Mian, R. Beraldi, and R. Baldoni, "Survey of service discovery protocols in mobile ad hoc networks," Universit degli Studi di Roma La Sapienza, Via Salaria, 113 -00198, Rome, Italy, TR 4/06.