A SHORT OVERVIEW OF SERVICE DISCOVERY PROTOCOLS FOR MANETS

MUHAMMAD ZAKARYA¹ AND IZAZ UR RAHMAN²
¹Department of Computer Science, Abdul Wali Khan University, Mardan
mohd.zakarya@awkum.edu.pk
²Department of Information, Computing & Mathematics, Brunel University, London, UK
izaz.rahman@brunel.ac.uk

Revised July 2013

ABSTRACT. MANETS (Mobile Ad Hoc Networks) are infrastructure-less, temporary wireless networks, consisting of several stations. No specific topology is defined in MANETs. MANETs have various applications in computer networks, such as providing communication in a domicile lacking network groundwork and proper infrastructure. In a MANET, a data packet may crisscross numerous hops until reaching its target location, making it exposed to various network attacks. The packets in a MANET are exposed to various packet dropping attacks. Mobility is there but security is the main issue still. The technology used for finding, advertising services to other nodes in the network is Service Discovery. Different Protocols are available for Service Discovery. Our focus in this paper will be on Service Discovery, available Service Discovery Architecture & their modes of operation, some proposed protocols. We will discuss Mobile Service Discovery Protocol (MSDP), which have steady performance & reduced massage overhead. Currently there is a diversity of service discovery protocols, most important Jini, SLP, Salutation, MSDP, Chord and UPnP. Bluetooth has also a slightly modest service discovery protocol. We have compared these tactics and listed their benefits and weaknesses.

Keywords: MANETs, MSDP, Service Discovery, Protocols, Adhoc Networks

1. Introduction

MANETs (Mobile Ad Hoc Networks) are infrastructure-less, temporary wireless networks, consisting of several stations. No specific topology is defined in MANETs. Mobility is there but security is the main issue still. MANETs are applicable in hazardous areas where cabling is an issue, i.e. disaster relief operations, battlefields etc. MANETs have low construction cost and can be built more rapidly as compared to other networks. In these types of networks a node may be a server, a client or it may be a router. A client is requesting for services, server is a service provider, and a router is working as a communication point i.e. interconnecting other nodes in the network. “A Service discovery is defined as a process enabling networked entities to [1]

- Advertise their services
- Query about services provided by other entities
- Select the most appropriately matched services
- Invoke the service”

Due to the mobility nature of MANETs some challenges arise. For example node mobility may affect availability of different services, frequent disconnection of server or client may result in change of path / rout etc. In MANETs a node sends out a service request packet for searching a specific service. The request may be forwarded by
other nodes in the network. If the request for the service is matched with a specific node, the node will reply with a service reply packet, which will be forwarded to the service looker w.r.t other nodes in the network [2].

A definition of service discovery is given by Wikipedia [10]: “Service discovery protocols are network protocols which allow automatic detection of devices and services offered by these devices on a computer network.”

Service Discovery is a critical challenge in the design of MANETs. An efficient service discovery protocol is one which has fast request success rate, good response time and low network resource consumption. Peer to Peer networks & MANETs share some characteristics. “Therefore recent research works show that deploying P2P networks directly in MANETs will induce heavy message overhead. [3]”

The rest of the paper is organized as given. Section 2 gives details about Service Discovery and some related work in this field. Section 3 will tell you about Service Discovery Architecture & their modes of operation. Section 4 contains a brief overview on different Protocols for Service Discovery. At last Section 5 concludes this paper & some about future work in this area.

2. Related Work to Service Discovery

In this section we provide a brief overview of those pioneering service discovery approaches developed and adopted by different industries. Some of them are as follows.

- **JINI**: - Jini is service discovery architecture, providing service discovery between Java enabled devices. Lookup Server acts as service directory which is used for storing services, published by service providers. Jini supports leases [1, 4, 13, 14, 15].
- **SALUTATION**: - This architecture was primarily designed for small offices & for home and enterprise environment, enabling devices, services, and applications to advertise their services and discover and access each other. Salutation Manager SLM is used for storing services & capabilities. Different devices with SLMs communicate with each other using Salutation Manager Protocols [22].
- **UNIVERSAL PLUG AND PLAY**: - like Salutation this architecture was also primarily designed for small offices & for home and enterprise environment. Using this architecture, devices first advertise their presence in the network, and upon request they present their capabilities using XML. This architecture uses Simple Service Discovery Protocol SSDP [1, 20]. “A special feature is that through AutoIP, UPnP devices automatically receive an IP address even when a Dynamic Host Configuration Protocol (DHCP) server is absent.”
- **BLUETOOTH SERVICE DISCOVERY PROTOCOL**: - Bluetooth SDP is an SDP for Bluetooth enabled devices. This protocol addresses only service discovery (Service Searching & Service Browsing), and does not address service advertising, service access, or service caching in registries [5, 9].
- **BONJOUR**: - Bonjour technology was developed by Apple to provide service and device discovery among computers, and other networked devices (e.g., printers, fax machines, etc.) [18, 19, 20].
- **SERVICE LOCATION PROTOCOL**: - Service Location Protocol (SLP) is an IETF’s standard and is embedded in many commercial products. “SLP addresses only service discovery and leaves service invocation unspecified. [21]”

3. Service Discovery Architecture & Modes of Operation

There are three different types of architectures that a service discovery approach can adopt, namely

- Directory Based Architectures
- Directory Less Architectures
- Hybrid Architectures

**DIRECTORY BASED ARCHITECTURES**: -

In this architecture a node may be a server, a client or it may be a service directory. A client is requesting for services, server is a service provider, and a service directory is working as a communication point i.e. interconnecting other nodes in the network i.e. service providers & requesters. A directory may be implanted as either centralized or distributed. A centralized directory is not for MANETs, because no node will always be reachable [1]. Jini is a distributed approach, where the lookup server acts as directories. But there is no communication among lookup servers therefore it is to the service provider to publish their services to more than one directory and looks for their updates as will. Global Discovery [1] is not supported as services are only advertised only in the lookup server area. Examples include Jini by Sun Microsystems, Universal Description, Discovery and Integration (UDDI) [6] by OASIS Consortium and Salutation [7] by IBM. This approach is suitable for infrastructure-based networks or when changing topology is not an issue (as in
1-hop wireless networks) but not suitable for MANETS where the topology of the system keeps on changing due to the mobility of nodes. The directory-based architecture is divided into two classes i.e. Centralized Directory architecture and Distributed Directory architecture [11]. The centralized directory architecture consists of one or a few centralized directories but in the distributed directory architecture, directories are distributed and deployed dynamically. The distributed directory architecture is divided into two subclasses depending on whether directories reside on mobile ad hoc networks or on infrastructure-based networks. One is Infrastructure-less distributed directory architecture and the other is Infrastructure-based distributed directory architecture.

DIRECTORY LESS ARCHITECTURES: -

In this architecture there is no service coordinator. Clients contact service provider directly by flooding the service query. These results in a high overhead produced due to flooding. The flooding of the query message consumes lot of bandwidth, computational and battery resources, which are already scarce in MANETs thus making this architecture unsuitable for MANETS. Examples of this architecture include Service Location Protocol (SLP) [8] by IETF and Universal Plug and Play (UPnP) [9] by Microsoft Corporation.

HYBRID ARCHITECTURES: -

This architecture is hybrid of directory-based and directory-less architectures. In this architecture servers may either register their services with DAs (if they are available) or wait for the client service query. The client may send a service query to DAs (if they are available) or directly to service providers using flooding. This architecture is again not suitable for MANETs for the reasons method in the previous two architectures.

4. Service Discovery Protocols

GSD is a group-based distributed service discovery protocol for mobile ad hoc networks [5, 13]. It is based on the concept of peer-to-peer caching of service advertisements and group-based intelligent forwarding of service requests to reduce the broadcast storm problem. It does not require a service to register to a lookup server. For service description the semantic capabilities offered by the DARPA Agent Markup Language (DAML) are used to effectively describe the services and resources present in the network. This language supports ontologies to achieve flexibility in service matching and is therefore well suited for the heterogeneity of services in mobile ad hoc networks. The services present on the nodes are classified into hierarchical groups. Each node advertises its services to its neighbors within a defined number of hops. Thus DAML is used to reduce network flooding.

The problem of efficient location was solved by Chord, a peer-to-peer protocol. A chord is a simple but powerful protocol. Chord locates a key with a small number of hops, by using routed queries. That key stays small even if the system has a large number of nodes. What distinguishes Chord from other applications is its simplicity, its provable performance and correctness. Chord supports just one operation: given a key, it maps the key onto a node. Data localization can be implemented by associating each key with a data item. Decentralization, availability, scalability and load balance are some of the basic properties of this peer-to-peer Algorithm.

Distributed Service Discovery Protocol (DSDP) architecture is used for locating and registering available services within a dynamic network topology. DSDP is a distributed service discovery architecture which relies on a virtual backbone for locating and registering available services within a dynamic network topology [11, 12, 14, 15, 16]. The proposal consists of the formation of a virtual backbone, as well as distribution of service registrations, requests, and replies. The dynamic virtual backbone is formed from a subset of the network nodes, such that each node in the network is either a part of the backbone or one hop away from at least one of the backbone nodes. The nodes in the virtual backbone act as service brokers and form a mesh structure that is interconnected by virtual links. Each non backbone node is associated with at least one service broker in the backbone. Services have to be registered to at least one service broker in the backbone. When a node requests a service, it sends a request messages to its service broker, wherefrom the messages is forwarded further in the backbone, which has the distributed knowledge of all available services in the network. The main perspective of the MSDP (Mobile Service Discovery Protocol) is to maximum assist users that can avail the required services in MANETS. MSDP consist of two important categories. One is formation dynamic clusters and the second is caching & service discovery. According to MSDP (Mobile Service Discovery Protocol) each node consists of a unique identifier, which can be created to apply an identical hash function on the required string. To form a dynamic cluster each node performs the given stages i.e. unknown, member, head. The cluster head is achieved from the radius of the cluster i.e. CSIZE. The countdown timer is mounted on each node that has a maximum value i.e. TIMER_MAX in seconds. In each HELLO intervals i.e. in second the HELLO message is broadcasted w.r.t. One value of the TTL.
<table>
<thead>
<tr>
<th></th>
<th>Chord Protocol</th>
<th>MSDP Protocol</th>
<th>DSDP Protocol</th>
<th>GSD Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Message overhead</strong></td>
<td>Low</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Collisions</strong></td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Message size</strong></td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>No of requests per session</strong></td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>Storage of service description</strong></td>
<td>N/A</td>
<td>Cache database in head node</td>
<td>Home backbone node</td>
<td>Packet spreading and caching</td>
</tr>
</tbody>
</table>

**Table 1:** Comparison between different protocols when number and speed of nodes are average

<table>
<thead>
<tr>
<th></th>
<th>Chord Protocol</th>
<th>MSDP Protocol</th>
<th>DSDP Protocol</th>
<th>GSD Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Message overhead</strong></td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Collisions</strong></td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Message size</strong></td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>No of requests per session</strong></td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td><strong>Reply to query ratio</strong></td>
<td>Slightly better</td>
<td>Excellent</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Table 2:** Comparison between different protocols when number and speed of nodes is slow

<table>
<thead>
<tr>
<th></th>
<th>Bluetooth SDP</th>
<th>SLP</th>
<th>Jini</th>
<th>GSD Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traffic overhead</strong></td>
<td>Low</td>
<td>High</td>
<td>Average</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Collisions</strong></td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Message size</strong></td>
<td>Small</td>
<td>Average</td>
<td>Average</td>
<td>Small</td>
</tr>
<tr>
<td><strong>Central repository</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Optional</td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>Authentication</td>
<td>Authentication</td>
<td>Java Security</td>
<td>Authentication &amp; Authorization</td>
</tr>
<tr>
<td><strong>Directory operation</strong></td>
<td>Possible</td>
<td>Possible</td>
<td>Lookup table required</td>
<td>Possible</td>
</tr>
<tr>
<td><strong>Code Mobility</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Table 3:** Comparison between BT SDP, Jini, SLP, GSD
5. Conclusion & Future Work

Service discovery will be a significant feature in future network developments, e.g. in self organizing ad-hoc networks. With service discovery, devices may robotically realize network services together with their properties, and services may broadcast their survival in a dynamic way. From the user's perspective, service discovery is about coming to an anonymous network atmosphere with a mobile device and then discovering the available services according to one's need [27, 28, 29, 30, 32, 33].

In this paper, we explored several architectural choices for service discovery in mobile ad hoc networks. We discussed the existing service discovery protocols and compared those protocols with one another. MANETs (Mobile Ad Hoc Networks) are infrastructure-less, temporary wireless networks, consisting of several stations. The technology used for finding, advertising services to other nodes in the network is called Service Discovery. The directory-less architecture is in accord with the nature of mobile ad hoc network that is infrastructure-less but its communication overhead limits its scalability. The centralized directory architecture is suited to wireless infrastructure-based networks. However, the service discovery process is dependent upon the availability of the central directory, resulting again in scalability problem. Therefore infrastructure-less distributed directory Architecture is proposed for MANETs Service Discovery, to overcome the problems of directory-less architecture & centralized directory architecture. We also compared different service discovery protocols. A comparison is shown in Table 1, Table 2 & Table 3 accordingly. We conclude that service discovery flexibility & adaptation and interpretability require much more research work yet. Security [34] and power consumptions [15, 17, 23, 31] are a widespread problems that has not been overlooked by service discovery protocols. We in this paper did not discuss any security or power consumption issue. Sometimes this issue is so important that is part of the main design strategies. Major security constraints include authentication, authorization, trust, confidentiality, integrity, and non-repudiation. Our future work includes security in service discovery in MANETs. With the rise of new computing era i.e. green computing, there is a need to reduce the power consumption of mobile devices to extend its battery life, as these devices are battery operated. The underlying communication protocols are needs to be less power consumption and more reliable [35].

REFERENCES:
