

Deployment and Testing of MANET on Android Devices

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Abstract: Mobile Ad-Hoc Network or MANET is an infrastructureless network which is created on-demand depending on the availability of nearby nodes / devices which support creation of a network. There are various protocols for routing in a MANET but very few applications that implement them in a real-world scenario. MANET applications have never been widely used mainly because there does not exist a standard for its protocols or connection establishment and there are various hurdles when it comes to deploying a MANET such as the mobility of a node and handoff management. In this research paper we evaluate the feasibility of deploying a simple MANET application in a real-world environment. We used Android capable devices with Bluetooth support to create an ad-hoc network between Android devices which is a real-world application for MANET's. The reason for choosing Bluetooth over the long-range WiFi is due to the fact that Android does not expose API's for creating Ad-Hoc WiFi networks and not many WiFi chips support creation of ad-hoc networks. Moreover, Bluetooth is widely used in Android and other mobile phones and can also be used on legacy devices which do not support WiFi. The results show that it is possible to create a MANET on Android capable devices with Bluetooth as the transmission medium. Albeit the range of a Bluetooth network is less than other technologies like WiFi but this shows that a MANET can be created by using just the legacy Bluetooth API's of Android without any additional software or hardware support from the device.

Introduction

Mobile Ad-Hoc Network (MANET)

Mobile Ad-Hoc Network or MANET for short is a robust and infrastructureless wireless network. It is capable of self-configuring itself depending on the surrounding devices that are capable of connecting to or running an ad-hoc network. A MANET can be formed either by mobile nodes or by both fixed and mobile nodes. Nodes randomly associate with each other forming arbitrary topologies. They act as both routers and hosts. The need for mobility in wireless networks necessitated the formation of the MANET working group within The Internet Engineering Task Force (IETF) for developing consistent IP routing protocols for both static and dynamic topologies. After years of research, MANET protocols do not have a complete formed Internet standard nor has any application been developed that has been widely used to create a MANET.

Android

Android is an operating system based on the Linux kernel, and designed primarily for touchscreen mobile devices such as smartphones and tablet computers. Initially developed by Android, Inc., which Google backed financially and later bought in 2005, Android was introduced in 2007. Over the years Android has seen widespread use and it has become the most used operating system for mobile devices. The open-source nature of Android has also made it immensely popular among developers and hackers alike. A lot of custom operating systems for mobile devices have been developed which are based on Android's source code, most notable CyanogenMod which offers users some additional functionality and performance improvements over stock Android.

Problem Statement

Since the advent of computer networks and the Internet, researchers have been searching for new ways to exchange information between computers. Now, in this age of mobile devices and smartphones where each mobile device is capable of acting like a portable computer with an almost equivalent amount of processing power like everyday desktop computers, there is a need to connect devices together in an infrastructure-less manner. In areas where there is no means of connectivity

like cellular networks or areas affected by natural calamities like floods etc. Can use a MANET to exchange information between mobile devices and can be immensely helpful in disaster management. Also, self-configuring devices which can establish connection between each other automatically and exchange information can be immensely helpful to reduce infrastructure cost.

Methodology Used

This project uses Android as a base for facilitating the creation of a MANET so that multiple Android devices with this application installed can act as it's nodes. For device interoperability and the lack of API functions to provide direct access to low-level WiFi hardware in Android it was decided that Bluetooth API's of Android be used instead so that older devices or devices without a WiFi chip can also benefit from this application. The programming language which was chosen for this project is Java because of it's native support on Android and it's support for multi-threading as well as sockets and streams. For parsing of messages a serialization framework developed by Google Inc. Called Protocol Buffers was used as it provides an easy way to serialize Java objects into text and or bits so that it can be transferred easily over a Java stream. It also provides validation of messages which is an added benefit.

Choosing a routing protocol which decides where the packets are to be routed between devices was most important part of the project. There were various protocols that were considered but the recently developed and the most simple and the most practical to use was the Better Approach To Mobile Ad-Hoc Networks protocol, also abbreviated as B.A.T.M.A.N and is developed by the Freifunk community. BATMAN is a protocol which seeks to replace the Optimized Link State Routing (OLSR) protocol and provides much more benefits than OLSR which include dynamic routing and less storage capacity required on the device. It also supports large MANET's with thousands of nodes without much overhead.

Simulation

The application for creating a MANET which runs on the Android platform is the base of this project. It runs on top of the Android Bluetooth stack and exposes services for other devices to connect to. The application has two major components which are as follows:

MANET Service

An Android service is used to create a background process which acts as the server as well as client for the MANET. The service is run at the first launch of the application and continues to run in the background until it is explicitly stopped by the user or the device is rebooted. At the start of the service, 8 Bluetooth service records using service UID's (which are hardcoded in the application) are created so that other devices may discover the MANET and connect to it. Since there is a limit to one device per UID and Bluetooth can only support 8 simultaneous connections there is a limit of 8 service UID's per device. Each service ID has it's own thread so that it can listen for incoming connections and handle them asynchronously without blocking the main application.

The MANET service also maintains a table of routes and nodes which are stored in the device's memory. Once a new node is discovered and connected to, the service stores it in the nodes and routes tables. The service also exposes various functions for the MANET application to call and retrieve the status of the service and any new nodes which have been discovered or added are notified to the main application or any other service through Broadcast messages.

MANET Application

The main MANET application acts as an interface between the MANET Service and the user. It provides the user a list of connected devices and also provides easy access to see the debug log of the service and start or stop the service at will. A simple chat application runs on top of the MANET Application which provides the user the ability to use the MANET for sending and receiving chat messages. Each chat message is stored in a small SQLite database for future retrieval. The UI design of the messaging application is done based on the design of the default Android SMS application.

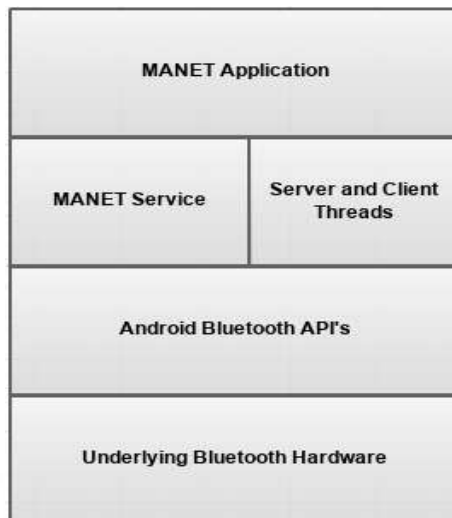
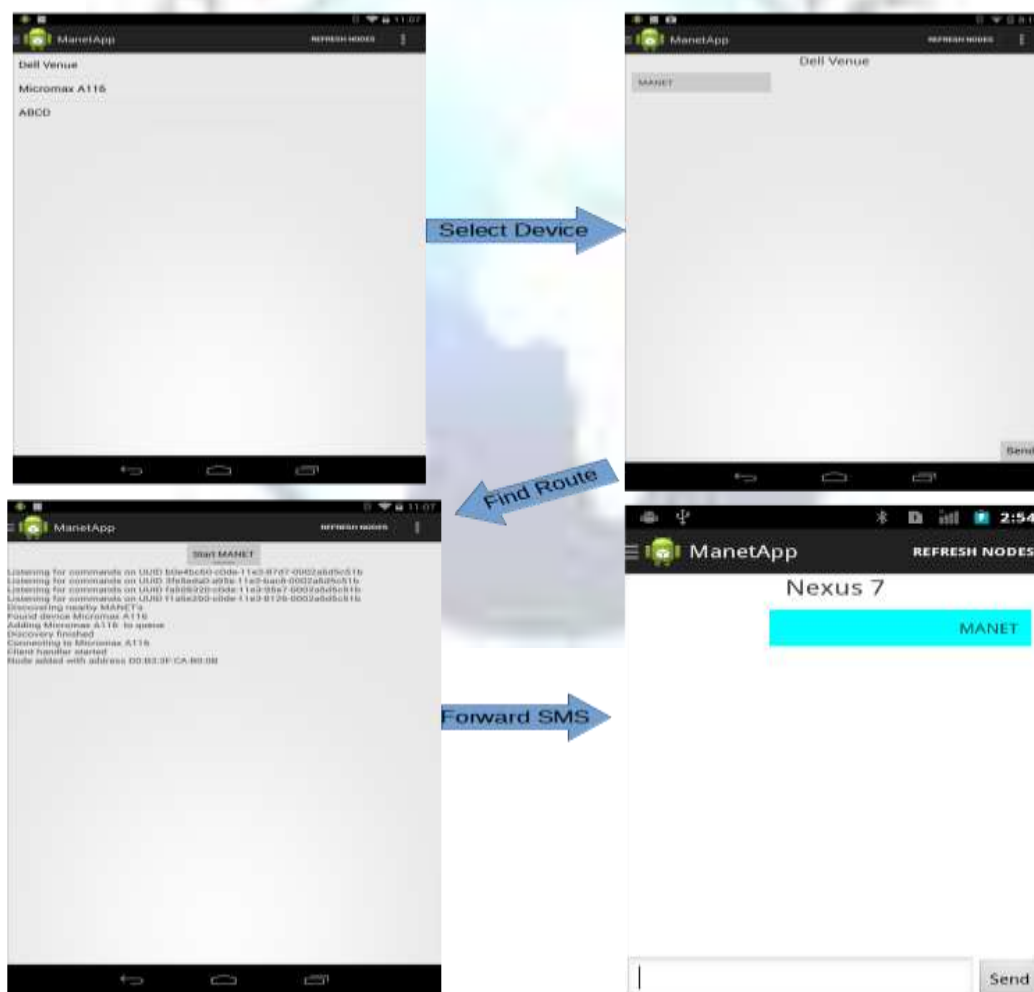


Figure-1: MANET Application Architecture

Snapshots



Results

The Deployment and Testing of a MANET application on an Android device resulted in a successful creation of a small MANET based on the core bluetooth technologies and Android Bluetooth API's. Each device was capable of discovering nearby devices which were running the MANET service and were able to connect to them for sending and receiving messages. Once the devices running the MANET application were within Bluetooth range of each other, the discovery and establishment of connections was done. This resulted in each node in the network to become aware of it's nearby devices and other devices which were connected to it's neighbors. The BATMAN routing protocol was also successful in routing packets between devices which were not directly connected with each other. After the initial connection setup and routing was done, user's were able to send and receive simple messages to / from other devices.

Conclusion and Future Work

In this report we have evaluated the feasibility of a Mobile Ad-Hoc Network (MANET) application on an Android device and were successful in developing and deploying a simple MANET application running on top of the Android Bluetooth stack. We used the Android Bluetooth API's and the Service Discovery Protocol (SDP) for the actual discovery and connection establishment of MANET capable devices. For routing we used the B.A.T.M.A.N routing protocol and we also used Java's multithreading API's as well as Sockets and Streams API's for the actual transfer of data between connected devices. The Android application itself used Android services to run the main MANET server and used Broadcasts for passing messages between the main application and the MANET server. Finally, it was discovered that the development and deployment of a MANET application is feasible on Android devices without any additional requirements, albeit with the short range of Bluetooth.

Future Work

Future work for this project would include adding additional functionality to the MANET application like adding voice support to the main application so that along with textual data voice data can also be sent so that voice calls can be made between devices in the MANET. Ability to route packets from the Internet can also be added so that each device can share their internet connection with other devices. Support for additional operating systems other than Android can also be added in the future so that devices running different operating systems can also communicate with each other in the network.