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SMART POLICING USING MLS- A LOCATION SERVICE BASED ON MANET

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Abstract

This paper introduces MANET LOCATION SERVICE (MLS), a geospatial information service designed specifically for police forces. It utilizes mobile ad hoc networks, wireless technology, and location services to cater to the needs of both on-duty officers and those in control rooms. The primary goal is to provide real-time support to mobile officers who are responsible for ensuring citizen security, response services, and investigative capabilities. The focus of the paper is to highlight the advantages of mobile ad hoc networks to society, which is demonstrated through the proposal and implementation of LOSAD.

1. Introduction

The law enforcement sector is under increasing pressure to perform effectively and efficiently. In recent years, rising urban crime rates, concerns about youth crime, and the looming threat of terrorism have led to a growing demand for security. Police and other law enforcement agencies are now expected to respond more quickly and implement better preventative measures. These demands are putting a strain on these organizations and requiring them to meet more rigorous standards than ever before. Effective information management has always been a cornerstone of police work. Timely and accurate information is crucial for law enforcement agencies to achieve their goals and determine the effectiveness and efficiency of their operations.

The current demands on the law enforcement sector have revealed the inadequacy of many existing information systems. Providing timely and accurate information to personnel in the field, tracking deployed resources such as vehicles and personnel, facilitating data communication during operations, and integrating multiple sources of information often exceeds the capabilities of current police IT systems. This gap must be addressed if law enforcement agencies are to meet the growing demands placed upon them. Additionally, there is a growing recognition that implementing more modern IT systems alone does not guarantee benefits to the organization. IT managers are under mounting pressure to justify the high costs of IT investments, which can result in costly implementation failures, extensive integration expenses, and never-ending upgrades.

MLS is a cutting-edge system designed to provide police officers operating in the field with mobile access to mission-critical information. This location-enabled system enables secure access to all police databases from a handheld device that exchanges data

with servers using ad hoc, cellular, and fixed telephone networks. MLS utilizes spatial information for spatial selections and overlays, to visualize locations and maps, and to geo-code and reverse geo-code addresses. The remainder of this paper is structured as follows: Section 2 explores related work, while Section 3 introduces ad hoc networks and their protocols. In Section 4, we propose the architecture for MLS, and Section 5 concludes the work.

2. Related Work

The Dutch Police have developed the P-Info system, which offers mobile, location-enabled access to mission-critical information for police officers working in the field. P-Info provides secure access to all Dutch police databases via a handheld device that exchanges data with servers using the GSM or UMTS telephone network. The system employs spatial information for spatial selections and overlays, visualization of locations and maps, and geo-coding and reverse geo-coding of addresses [1] .

The transmission range of wireless local area networks (WLAN) is relatively limited, but this coverage can be expanded by adding antennas. Users can operate in Ad Hoc mode to set up their own network without relying on access points. To address the challenges of mobile location services, it is necessary to integrate Ad Hoc networks into the system architecture [2].

3. Mobile Ad Hoc Network

A Mobile Ad-hoc Network (MANET) is a self-organizing and self-configuring wireless network that consists of a group of mobile devices that can communicate with each other without requiring any fixed infrastructure or centralized administration. In other words, a MANET is a temporary network formed by a collection of wireless mobile hosts that communicate with each other in a peer-to-peer manner. The structure of the network changes dynamically as the nodes move, and the network can be quickly deployed in situations where there is no existing communication infrastructure or where the infrastructure has been damaged. MANETs have applications in military, emergency response, and vehicular networks, among others. MANETs can be formed using various wireless technologies such as Wi-Fi, Bluetooth, and cellular networks. However, the limited bandwidth, energy, and processing capabilities of mobile devices, along with the dynamic topology of the network, present significant challenges for the design and management of MANETs [3].

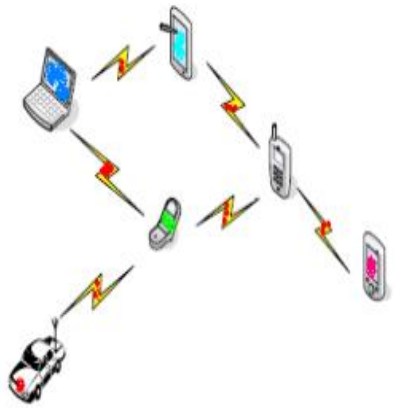

Fig 1. Ad-hoc Network

Mobile ad hoc networks (MANETs) [4] face several issues due to their unique characteristics such as mobility, distributed operation, and lack of infrastructure. Some of the common issues in MANETs are:

1. **Routing**: Due to the dynamic nature of the network topology, selecting efficient and reliable routing paths can be challenging.

2. **Security:** MANETs lack centralized control and are susceptible to various security threats such as eavesdropping, jamming, and attacks by malicious nodes.

3. **Quality of Service (QoS**): Providing QoS guarantees in MANETs is challenging due to the unpredictable network conditions and the lack of infrastructure support.

4. **Energy Efficiency:** The battery life of mobile devices is limited, and efficient power management techniques are needed to prolong the network lifetime.

5. **Scalability:** As the number of nodes in the network increases, the overhead of managing the network also increases, making it challenging to scale the network.

6. **Topology Control:** The dynamic topology of MANETs can result in network congestion, interference, and collisions. Topology control techniques are needed to manage the network topology and ensure efficient data transmission.

There are several routing protocols [6] for Mobile Ad Hoc Networks (MANETs), some of which are listed below:

A. **Ad Hoc On-Demand Distance Vector (AODV):** AODV is a reactive routing protocol that creates routes on demand, only when required by the source node. It is designed for use in networks with low to moderate mobility.

B. **Destination-Sequenced Distance Vector (DSDV):** DSDV is a proactive routing protocol that maintains a complete routing table at every node in the network. It uses sequence numbers to ensure that the most recent routing information is used.

C. **Dynamic Source Routing (DSR**): DSR is a reactive routing protocol that uses source routing, which means that the source node includes the entire route in each packet. This reduces the need for routing table maintenance at intermediate nodes.

D. **Optimized Link State Routing (OLSR**): OLSR is a proactive routing protocol that uses a distributed algorithm to optimize the routing tables at each node. It is designed for use in large networks with high mobility.

E. **Zone Routing Protocol (ZRP):** ZRP is a hybrid routing protocol that combines aspects of both proactive and reactive protocols. It divides the network into zones and uses different routing protocols for intra-zone and inter-zone routing.

F. Temporally Ordered Routing Algorithm (TORA): TORA is a reactive routing protocol that uses a distributed algorithm to maintain multiple routes between source and destination nodes. It is designed for use in highly dynamic networks.

These are just a few examples, and there are many other routing protocols that have been proposed for MANETs. The choice of protocol depends on the specific characteristics of the network and the application requirements.

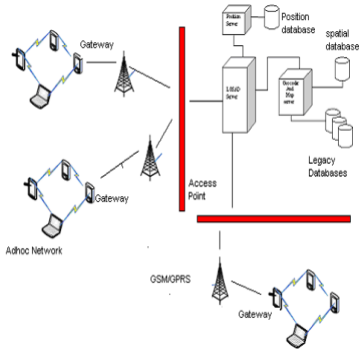

Fig 2. Block diagram of MANET LOCATION SERVICE (MLS)

4. MANET LOCATION SERVICE (MLS) Architecture

The proposed architecture of the MANET LOCATION SERVICE (MLS) system is shown in Figure 2. Mobile officers access the system through various handsets, such as PDA's, portable computers, or tablets, and data communication is currently based on the GSM-GPRS standard, which offers data transfer rates of about 40Kbps. The system is designed to be independent of the device and the bearer, and the interface uses pure browser-based access to prevent any content from being stored on the handset. Information is always accessed online and is never stored or cached in the mobile device. The MANET LOCATION SERVICE (MLS) portal and server provide access to the underlying components and route requests from the mobile users to the national gateway or the regional proxy. Services provided by the MANET LOCATION SERVICE (MLS) server include spatial search and geo functions, integrated search, and authentication & authorization. Legacy databases hold information [7] related to vehicle registrations, previous fines, parking tickets, search warrants, etc. The geo-coder performs normalization and geo-coding activities, while the map server creates maps by extracting spatial information from spatial databases. The access point ensures that only authorized devices can access the MANET LOCATION SERVICE (MLS) portal and server, which performs user authentication and authorization.

Here are the typical steps in data communication among various nodes of an ad hoc network [5]:

1. **Node Discovery:** Each node in the network discovers other nodes in its communication range by broadcasting beacons and listening to messages from other nodes.

2. **Route Discovery:** Once a node has identified its neighboring nodes, it determines the best route to transmit the data by exchanging route discovery messages with other nodes.

3. **Route Maintenance:** The nodes continuously monitor the links in the network and update the routing table

to ensure that the data is delivered along the most optimal path.

4. **Data Transmission:** Once the best path has been established, the data is transmitted from the source node to the destination node via intermediate nodes, using a routing protocol that ensures efficient and reliable delivery of data.

5. **Congestion Control:** As the number of nodes and traffic in the network increase, congestion may occur, leading to packet drops and network performance degradation. Congestion control techniques such as flow control, rate control, and congestion avoidance can be employed to mitigate this problem.

6. **Security:** Ad hoc networks are vulnerable to various security attacks, including eavesdropping, message tampering, and denial-of-service attacks. Therefore, security mechanisms such as authentication, encryption, and intrusion detection are crucial to protect the network and its data.

The MANET LOCATION SERVICE (MLS) interface (as depicted in Figure 2) consists of three modules that provide three main services to users: data services, location services, and office automation.

The data services module enables access to a wide range of regional, national, and police databases, allowing mobile users to perform simultaneous searches in multiple databases using predefined query forms, such as entry code, person, license plate, date, address, and time. The search results are provided in a single form, providing a comprehensive overview of the situation, such as information about a suspect car collected from all relevant databases.

Fig 3 MANET LOCATION SERVICE (MLS) Interface

The location services module enables officers to locate their position on a map, optimize information and proximity searches, and locate colleagues and other resources in the field. This functionality also helps in optimizing resource allocation in the field, and includes a street guide that can be consulted directly to locate an address and display it on a map. Figure 4 shows an example of the result of a location service query.

The office automation module provides access to regular office facilities of the police through wireless connectivity, including e-mail, a calendar, contacts, and tasks. It enables officers to maintain communication with their colleagues in the field, check appointments, and receive documents and notifications while working in the field.

Fig 4 Result of a location query

5. Conclusions

The paper presents LOSAD, a location-based service designed for mobile police officers in adhoc networks. It covers various adhoc networking protocols, the basic architecture of LOSAD, and the interface and services it provides. LOSAD aims to enhance the efficiency and effectiveness of police authorities by delivering necessary information to officers on the move, even in areas with no mobile connectivity. It also aims to improve connectivity between duty officers and control rooms. Additionally, the paper explores the possibility of using a GIS on adhoc networks. However, adhoc network protocols present both advantages and disadvantages, and issues such as device power efficiency and wireless transfer of spatial data need to be addressed.

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