Acta Scientific COMPUTER SCIENCES

Volume 5 Issue 3 March 2023

Research Article

Proposed AD-hoc Network for Disaster Management

Anirban Biswas[1] and Samir Kumar Bandyopadhyay[2]*

[1]*M.Sc. Bioinformatics, Pondicherry University, India*

[2]*Professor, Lincoln Research Institute (Under Lincoln University), UK*

***Corresponding Author:** Samir Kumar Bandyopadhyay, Professor, Lincoln Research Institute (Under Lincoln University), UK.

Received: January 20, 2023

Published: February 27, 2023

Abstract

Modern world has advanced in many areas with scientific research and innovation and developed many technologies to make modern life smooth and easy but till date in front of any kinds of unpredictable crisis that is not always predictable. It may be natural disasters like cyclone, crisis like e-commerce transaction failure, criminal offences like bomb blast, agricultural product supply chain disruption etc. Even developed countries equipped with modern technologies and machineries but cannot avoid or minimize the effect of such critical situations. It is possible to predict but still it can cannot be avoided the disastrous scenario always. Therefore, it is very essential and important to provide the area a low cost, low weighted, readily deployable secured network which will communicate the need of the affected area to the proper authority so that the helping hand can be extended quickly to alleviate the suffering condition of the affected zone. This paper studied an Ad-hoc wireless network which is easily deployable, low cost and low weighted having data security. The data security is achieved through data hiding techniques using steganography.

Keywords: Disaster; Steganography; DWT; DFT; Wireless Network

Introduction

Even developed countries equipped with modern technologies and machineries, they cannot avoid or minimize the effect of critical situations. The main focus of the paper is to design a secured, rapidly deployable Ad-hoc wireless network which can be used for any kinds of crisis management after disaster. The paper incorporates Command and Control system to make the designed network more effective and useful. It also helps in quick decision making as a result the crisis situation recovery can be done as early as possible.

The paper has two parts:

- Designing of Ad-hoc wireless network
- It concentrates on the algorithms to secure the communication channel using data hiding techniques.

It is found that sometimes the causalities and devastation that happened after disasters is much more than during the disasters occur. So, it is more important to deal with the scenario after the disaster happens, rescue and sending help to the affected area is more important as it is not possible to avoid the entre disastrous scenario.

It is our objective to make advanced in communication technology and it may be infrastructure based or wireless based communication. During the scenario the affected zone disconnects from outer world and due to the unavailability of the basic needs people dies and materialistic losses occur.

Since the main aim is to design low weighted, rapidly deployable network so devices can be carried out, configured and deployed easily. After designing the network focus shifts on security of the

information to be communicated through the network. As, the data communicated are very sensitive, data hiding techniques are used to secure it. Here, we have used steganography for data security: mainly spatial, frequency and network domain steganography are used. While steganography algorithms are implemented so it must be the robustness, imperceptibility and capacity are addressed.

Ad-hoc wireless network has been essential part of our modern edge communication system. But it is going through different challenges as well. Beside infrastructure-based communication system and Ad-hoc wireless network communication system are used widely in different purposes like emergency Services such as to handle the crisis in corporate sector, mobile court, credit card verification, forestate agents and agricultural field.

Beside advantages of wireless network, it has some limitations. These will be discussed in the following paragraphs.

Mobile Internet access is generally slower than direct cable connections. Higher speed wireless LANs are inexpensive but have very limited bandwidth.

When working mobile, one is dependent on public networks, requiring careful use of Virtual Private Network. Security is a major concern while concerning the mobile computing standards on the fleet. One can easily attack the specific network through a huge number of networks interconnected through the line.

When portable generator or a power outlet is not available, mobile computers must rely entirely on battery power. Combined with the compact size of many mobile devices, this often means unusually expensive batteries must be used to obtain the necessary battery life.

Objective of this paper is to study wireless network which is readily deployable, flexible, scalable, cost effective and having secured communication channel.

Literature Review

A number of researches have been done to design secured wireless network and purpose of each research established their objectives. Many research works concentrated on only establishing the communication to an area where there is no telecommunication set up. Many researches have been done to establish the communication network with secure communication and many has their goal to establish a low cost, easily deployable network.

Robert Dourandish., *et al*. [1] proposed a suitable model for the first seventy-two hours of a major incident that focuses on rapidly deployable military and civilian Command and Control infrastructures for relief operations jointly. They also discuss technical requirements, like communications, network inter-operability and messaging. They also analyze unique civilian elements such as responders, emergent volunteers, role of law, partial or total disintegration of civilian command and local customs. Some researchers have picked up random way point mobility model [2] and the general performance characteristics is analyzed in those papers.

Meissner., *et al*. [3] developed requirements-based technology for integrated disaster management information system and communication. They addressed configuration of network data management issues and scheduling during the response and recovery phases.

A Graph based approach was used by Stepanov., *et al*. [4] tries to establish a network with instantiation of the Graph Walk Mobility Model. This is similar to the random way point mobility model. This network tries to solve problem of survivability in spatial environment. An area map containing its topological elements is provided by the model. This model is efficient enough for communication but database handling is not up to the mark.

Kraaier., *et al.* [5] used a pixel-oriented approach for mobility modeling. In this model mobility parameters like transition probabilities are calculated to reach the existing stationary user distribution. The testing area is divided into small region and performance is evaluated.

Kim., *et al.* [6] follows a trace-based method. Here, one mobile device traces another estimating physical location. Focusing on movements among popular regions and based on the mobility characteristics extracted mobility model is developed. Although the communication in a particular region is noticeably good here but the data sent through the communication channel is not organized and secured.

Mecella., *et al*. [7] developed an innovative software infrastructure (software models, services etc.) in 2006 to support collabora-

tive work of the people engaged in emergency/disaster scenarios. Here two-level hierarchy is created. In high level, computation and data processing, information integration takes places and lower level provides the services to working region using the ad-hoc wireless network. But the problem here is in high level the people should have technical knowledge which is not always possible to provide at the time of crisis.

In 2008 a work pad architecture consists of two layers (front end and back end) was proposed by Catarci., *et al.* [8]. Fronts end is for exchanging information by a collaborating team with coordination. The front end gives the opportunity to interact with the working people or organizations in affected area to the operational centres and help them in exchanging information mutually. Actually, in work pad network user-centric techniques from human computer interaction paradigms are employed.

Jang., *et al.* [9] analyzed the causes that made whole communication systems collapsed in Taiwan earth quack after that they proposed a MANET based communication platform that includes a Rescue Information System for Disaster support. The system deployed notebook PCs to construct a multi-hop ad-hoc wireless network, which we can call as basic wireless intranet. The system also implements a information management system consists of Fastest Rescue Route Generation, Disaster Assessment, Wounded Victim Arrangement, Health Care and Relief Resources Integration as Subsystem.

N. Minar., *et al*. [10] uses Flags/Emails/SMS for both on-line and off line instant messaging schemes. Front-end of this network is much simple and user friendly and back end is supported with network hardwire components, algorithms involved and networking issues.

A dynamic system [10] which follows centralized management system which restricts all nodes to access important information means those nodes are kept away from important decision. These make a bottle neck in the communication channel. On the other hand, decentralized system provides peer-to-peer communication among peer nodes. This [11,12] architecture gives more flexible communication distributing the payload among peer nodes.

Steganography is the widely used technique for hiding data in different media, such as image, text, audio, video or network packets. Different techniques are used in different domains to achieve the goal. Spatial domain, frequency domain and network domains are such domains, whereas Least Significant Bit (LSB), Multi-LSB, Bit Plane Complexity Steganography (BPCS) etc. are the different techniques. In LSB technique, LSB of the cover images are replaced whereas, in BPCS steganography uses block replacing techniques. In transform domain technique, Fast Fourier Transform (FFT), Discrete Cosine Transformation (DCT), Discrete Wavelet Transform (DWT) and Integer Wavelet Transform (IWT) are used to transform cover image or secrete data into frequency domain, then embed-ding techniques are used to form stego image. In case of network steganography protocols are exploited.

The standard LSB technique is very easy to implement where the Least Significant bit of a pixel/samples of cover media is replaced with target bit.

The low robustness problem due to embedding at higher bitplane is solved by decomposition the intensity into another number system which uses more bits to represent the number in the range 0 to 255.

The major problem in steganography is the negative effect on the visual quality. Region based steganography solves this problem by embedding data at certain region selected based on the characteristics of HVS and image attributes. Most of the structural properties of Human perception can trace easily the changes in smooth area than the changes in noisy area [13,14]. This helps in the increase of capacity of stego media by embedding more data at the noisy region.

Transform domain embedding algorithms are more robust data hiding technique. The message bits are embedded in coefficients which are calculated from the cover image or blocks of image. Therefore, message bits are in significant areas of the cover image which make them robust to attacks like compression, cropping and some image processing compared to spatial domain techniques. There are a number of mathematical functions available to transform an image from spatial domain to frequency domain, such as Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), Discrete Wavelet, Transform (DWT), Integer Wavelet Transform (IWT), etc. Among all the transformation techniques, DCT is the most popular transform function in image because of the avail-

ability of DCT based image format in public domain as well as common output format of digital camera.

A large number of designs have been proposed by many researchers to develop ad hoc wireless network for many purposes and each network has their specific target.

Many proposed networks tried to build a good user interface in the front end to improve the interactions with users. These networks used different types of devices starting from wi-fi gadgets to WiMax, satellite etc. A large number of papers on ad-hoc wireless network and steganography has been surveyed to understand the loopholes and challenges.

Authors present a simulation-based comparison of proactive, reactive, and multipath routing protocols in mobile ad hoc networks (MANETs) [15]. The performance of different protocols are evaluated and analyzed in the presence of varying the number of mobile nodes, pause time, and traffic connection numbers. Throughput is measured to conduct a performance comparison between three routing protocols.

This paper analyzes the performance of the Optimized Link State Routing Protocol concerning various random and group mobility models. The simulation scenarios were conducted over four mobility models, specifically the Random Waypoint model), Random Direction model, Nomadic Community model, and the Reference Point Group Model with a low as well as high random range mobility of the nodes [16].

Proposed Method

During the last few years India has witnessed several unfavourable and devastating incidents like floods, earthquake and tsunami etc, as in Figure 1 which do have considerable detrimental effect on global economy and society at large. Since, such adverse incidents are seldom predicted beforehand and chances of prevention are very rare, it is mandatory to have an efficient system to mitigate the aftermath.

It has been observed for several decades that lack of timely and right information from the incident area leads to an undesirable delay in the procedure of mitigation resulting in an increase of death toll and loss of property. Due to lack of efficient management makes the total disaster scenario worst which is irreversible. So, an efficient communication channel is the need of time to handle disaster scenario in a better way.

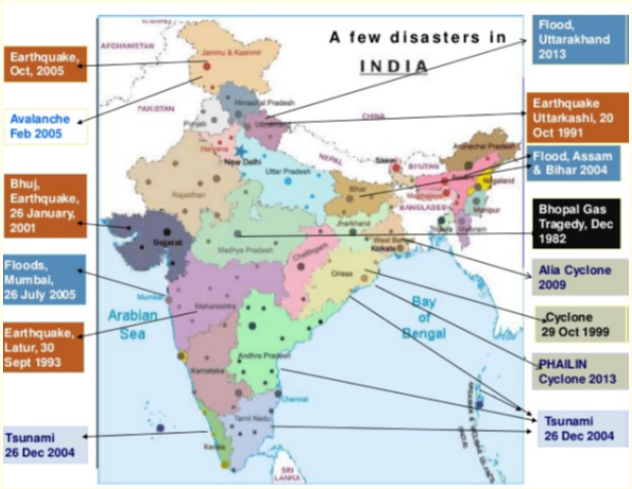

Figure 1: Few Disasters in India.

The following design is used network to serve during catastrophe. Here the main motto is to try to establish rapid communication to Command and Control Headquarter to mitigate crisis situation. Figure 2 describes the Hierarchical Administrative System levels.

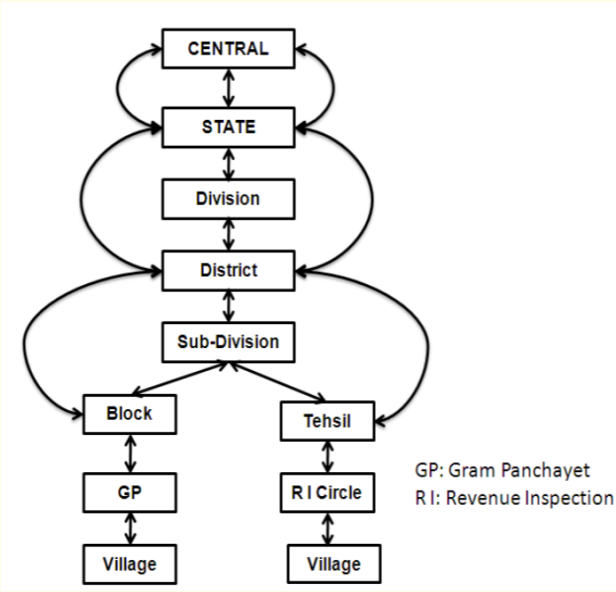

Figure 2: Hierarchical Administrative System levels.

If any negative impact arises when the commands are executed in the disaster zone as in Figure 2, the feedback system will be activated to rectify the impact, as revealed in the figure 3.

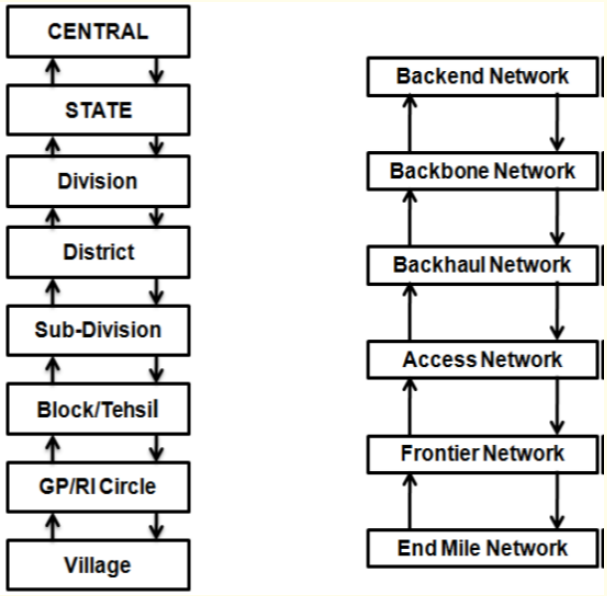

Figure 3: Classification of Disaster Affected Area.

The proposed network has different layers which increases the length and area of communication coverage. Actually, the target of this paper is not only to give communication to the affected area but also to connect upto the unaffected infrastructure-based communication system. So that a command-and-control line can be opened up for dialog with the administration. These different levels also segregate the whole communication system into parts and each levels works independently hence the efficiency increased.

The proposed method above concentrates on the improving the capacity or pay-load in the cover image. The main goal to implement the steganography algorithms here is to send more data through communication channel with hiding techniques. Although the main purpose is to increase the capacity but we need to addresses other challenges of steganography like imperceptibility and robustness. Using spatial domain, it is seen that the capacity is augmented with the cost of the security and imperceptibility which is not desired. If imperceptibility is not maintained the communicated messages may be on suspicion which will lead to the attacks. So, in the next chapter, this thesis concentrates on the algorithms which will take care of robustness keeping the imperceptibility intact.

Command and Control (C2) and its counterpart Direction and Control are a cumulative process of exercising command and planning while directing operations towards a successful conclusion. As a process, Command and Control (C2) detects and warns, establishes strategies and tactics, develops plans and monitors their completion and reports result. As a process, it has an inherently neutral value when modeled in a system model. So, Command and Control (C2) is the means by which a commander recognizes what needs to be done and sees to it that appropriate actions are taken. Figures 4 to Figure 6 presents the proposed activities.

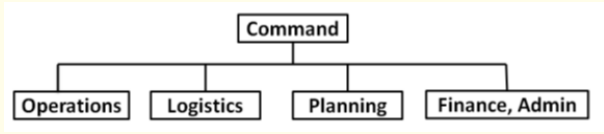

Figure 4: Command Structure.

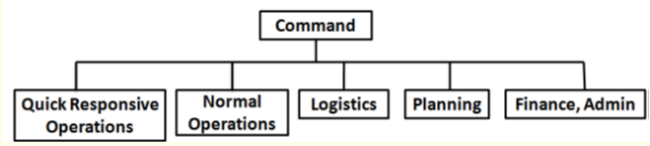

Figure 5: Proposed Command Structure.

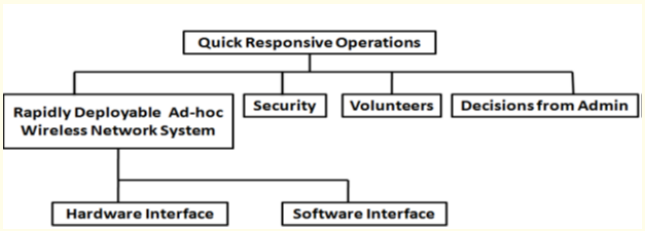

Figure 6: Quick Responsive Operations.

The method deployed network for testing in different geographical locations like Metro as well as village areas. as In case of high population density, due to reflection, the availability of the radio frequency is very high in the Network which gives comparatively large coverage but in case. The steganography part is mainly used for hiding data during transmission of message for controlling the disaster.

Comparisons with existing Methods

Initial objective of the proposed method is to provide the area a low cost, low weighted, readily deployable secured network which will communicate the need of the affected area to the proper authority. So it is possible o extended quickly movement to alleviate the suffering condition of the affected zone. Ad-hoc wireless network is easily deployable, low cost and low weighted having data security. The data security part is made the best steganography method. There are many challenges like line of sight. Also other challenges are strength of antenna, survivability of the network, power of the devices etc. come up in the use of existing Ad-hoc wireless network methods. The target is to overcome all these challenges efficiently keeping all inherent characteristics of wireless communication.

The drawbacks identified in the existing research papers are:

- Command and control system which can be very affective in the security system. Only command is used to control affected zone.
- Most networks are not readily deployable and area covered by the proposed network is not large.
- Devices used in the network are costly and heavier and power consumption is high.
- Research papers presented network that did not gone through survivability test.
- Data communicated through network are not secured since encryption part is not properly made.

In the proposed method short comings of research are considered and removed

- Embedding in lower bit-planes results in low robustness, the researcher can easily identify the data bits from those LSBs.
- Multi-bit embedding causes lower error rate.
- Spatial domain approaches are not image format and it is independent of easily susceptible to inherent attack.

Result Analysis

In this case the encrypted data is sent through only the data field of the TCP packet. So, the receiver has to extract the data field of the captured packet and use the decryption part of the RSA/DES algorithm on it to obtain the plain text. The Figure 7 shows a detailed analysis of the number of packets sent to the receiver, the number of packets successfully captured by the receiver and the successful packet transmission rate.

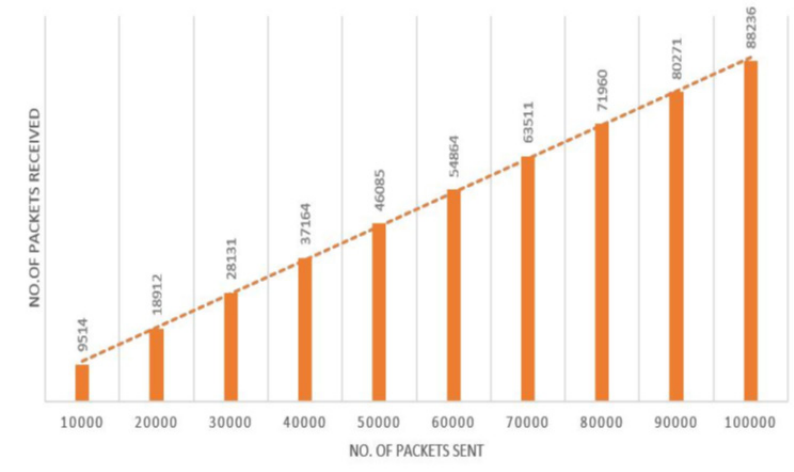

Figure 7: Result Analysis Bar Chart shows number of packets sent and received.

Conclusions

The proposed network initially identified the disaster area and messages are sending using network Steganographic methods. So these messages for actions are becoming harder to detect. New and new data carriers could be developed. It must be highlighted that more advanced steganographic method evolve the data trace of genuine internet users.

Bibliography

1. Dourandish B., *et al*. "Command and control during the first 72 hours of a joint military-civilian disaster response". Twelfth International Command and Control Research and Technology Symposium (12th ICCRTS), 19-21 June 2007, Newport (2007).

2. Bettstetter C. "Smooth is better than sharp: A random mobility model for simulation of wireless networks". Proc. ACM Intern. Workshop on Modeling, Analysis, and Simulation of Wireless and Mobile Systems (MSWiM), Rome, Italy, (2001).

3. Meissner A., *et al*. "Design Challenges for an Integrated Disaster Management Communication and Information System". The First IEEE Workshop on Disaster Recovery Networks (DIREN 2002), IEEE INFOCOM 2002, New York (2002).

4. Stepanov I., *et al*. "A Meta-Model and Framework for User Mobility in Mobile Networks". Proc. of the 11th International Conference on Networking 2003 (ICON 2003) (2003).

5. Kraaier J and Killat U. "Calculating Mobility Parameters for a Predefined Stationary User Distribution". Proc. of the 12th IEEE Int. Conf. on Networks (ICON 2004) (2004).

6. Kim M., *et al*. "Extracting a mobility model from real user traces". Proc. of the IEEE INFOCOM (2006).

7. Mecella M., *et al*. "WORKPAD: an adaptive peer-to-peer software infrastructure for supporting collaborative work of human operators in emergency/disaster scenarios". Proc. Of the International symposium on collaborative technologies and systems (CTS 2006) (2006).

8. Catarci T., *et al*. "Pervasive Software environments for supporting disaster responses". In IEEE Internet Computing 12.1 (2008).

9. Minar N., *et al*. "Cooperating mobile agents for dynamic network routing". In: Alex Hayzeldon (ed.), Software Agents for Future Communications Systems, Chapter 12, Springer-Verlag, (1999).

10. Kramer K H., *et al*. "Mobile software agents for dynamic routing". *Mobile Computing and Communications Review,* ACM SIGMOBILE publications, 3.2 (1999).

11. Pham V A and Karmouch A. "Mobile software agents: An overview". *IEEE Communication Magazine,* July, (1998).

12. Appeleby S and Steward S. "Mobile software agents for control in telecommunications networks". *BT Technology Journal* 12.2 (1994).

13. Chen M., *et al*. "Deep Learning Regressors for Quantitative Steganalysis". *Media Watermarking, Security, and Forensics* (2018).

14. X Yang., *et al*. "Fast spectral embedded clustering based on structured graph learning for large-scale hyperspectral image". *IEEE Geoscience and Remote Sensing Letters* (2020).

15. AH Wheeb and M T Naser. "Simulation based comparison of routing protocols in wireless multihop ad hoc networks". *International Journal of Electrical and Computer Engineering* 11.4 (2021): 3186-3192.

16. A H Wheeb and N A S Al-Jamali. "Performance Analysis of OLSR Protocol in Mobile Ad Hoc Networks". *International Journal of Interactive Mobile Technologies (iJIM)* 16.1 (2022): 106-119.