Artificial Intelligence Supported Manet and Dumbo Net: Reliable and Better Controlled Networks

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Abstract: **The role of telecommunication decline especially in disaster is serious problem in the world. In order to improve the timely and fully controlled flow of important information needed for appropriate assistance to be delivered before, during and after the disaster. The breakdown of communications is one of the major problems of all disasters. The breakdown of communications infrastructure, due to the fall down of antennas, buildings, power etc. is the usual impact of disaster. Rather than applying a lot of human interventions in network administration, if cognitive computing strategy is used in proper ways then the performance of the system can be increased and can become self-manageable up to some extent. Cisco Meraki, Cisco Umbrella and other relevant network administration solutions may help the network administrator in many ways to minimize the post effects of disasters by utilizing the pre-processing functionality in some ways. The cognitive computing based management of all the network nodes and load balancing are the powerful as well as user-friendly approaches of networking which will help the network administrators in many ways. The most favorable characteristic of cognitive computing is that it is self-manageable in nature. Such system will definitely help us to save lives and attacks of disasters and can make our daily life more congenial than ever before by utilizing its key functionalities such as dynamic configuration, System stability, robustness, resilience, correctness, built-in validation, ability to handle common failure etc. Moreover, being cognitive in nature once experienced, the system will never repeat a similar mistake. In this paper Mobile Ad hoc Network (MANET) and DUMBO (Digital Ubiquitous Mobile Broad-band OLSR) are considered as communication medium and role of technologies for better management of network nodes especially for disaster management. A mobile ad hoc network is formed dynamically by mobile nodes that are connected via wireless links without using the existing network infrastructure. The architecture of DUMBONET combines mobile ad hoc networks (MANET) and a satellite IP network. The easiness of deployment and infrastructure less nature of the network is the main reason to recommend MANET and DUMBONET in disaster area. Further, with the support of the artificial intelligence the MANET and DUMBONET becomes more reliable in most of the circumstances especially by cognitive behavior of network administration.**

Keywords: ***Artificial Intelligence, Cognitive computing, Disaster management systems, MANET, DUMBONET.***

I. INTRODUCTION

A network that can dynamically adapt their real time based parameters as per the need of its client is concerned can be said a cognitive network. A cognitive network is a network that equally works well in a situation where the conditions of the system changes time to time. It continuously attempts to provide a reliable connection to its nodes. Such network develops a knowledge corpus to develop a rationale behind the decision making.

On the other hand, a disaster is a tragedy that negatively affects society or environment. It may be natural such as tornadoes, hurricanes, tsunamis, floods, earthquakes etc. or human-made such as riots, terrorist attacks, war, etc. The most striking examples of recent disasters are a multi-day cloudburst in Uttarakhand, June 2013 in which, more than 5,000 people were "presumed dead", according to figures provided by the Govt. of Uttarakhand, the tsunami that struck Thailand on December 2004, flood and the September 11 World Trade Center attacks. Disasters result in loss of life and property, and disrupt economic activity, besides causing immense misery to the affected population. All existing infrastructures are suspected to be destroyed by the disaster, including communication infrastructures. Thus, interventions on disaster areas are obviously made difficult.

Disaster management is the discipline of developing strategies for reducing the impact of disasters and for giving assistance to the affected population. Disaster management encompasses mitigation, preparedness, response, and recovery efforts undertaken to reduce disasters impact.

Mitigation is the efforts to reduce the physical and social impact of future disasters. It includes building structures that resist the physical forces of disaster impacts and efforts to decrease the exposure of human populations to dangerous situations. Preparedness includes development, deployment, and testing of disaster management systems. Response is the direct intervention in the disaster area for the immediate protection of life and property and minimizing the effects of the disaster. Finally, recovery is the process and activities intended to ensure operation continuation of vital systems.

Recently, the use of IT in disaster management has emerged in several research and development projects. The survey presented in this paper is motivated by the initiation after disasters develop a communication system immediately. In this paper two communication systems MANET and DUMBO are discussed and support of artificial intelligence is summarized for improving their reliability and self-manageability. Moreover, the cognitive network is taking multiple leaps towards the more perfect solution by utilizing its cognitive power.

II. ROLE OF TELECOMMUNICATION IN THE CONSEQUENCES OF DISASTER

The occurrence of disaster events cannot be prevented fully but their impact can be reduced by preparing appropriate advance operational plans, establishing warning systems, training emergency response personnel, educating citizens and testing emergency procedures. Information collection and communication to disaster area is most important to extend help in that area. Telecom plays this important role by communicating and disseminating disaster information to residents as promptly as possible, as well as ensuring the restoration of a speedy communication system after a disaster occurs. This requires establishment of links between disaster coordinators, telecommunication authorities and service providers on each level. As the Telecommunication is the lifeline for the Rescue and Relief operation, it should be planned to withstand the effect of Disaster for providing uninterrupted services.

III. MOBILE AD HOC NETWORK

MANET is a collection of independent mobile nodes that can communicate to each other via radio waves. The mobile nodes that are in radio range of each other can directly communicate, whereas others need the aid of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the help of any infrastructure.

Figure 1: Mobile Ad hoc Network

The key characteristics of these Mobile Ad hod networks are summarized as:

a. Communication via wireless means.
b. Nodes can perform the roles of both hosts and routers.
c. No centralized controller and infrastructure.
d. Dynamic network topology. Frequent routing updates.
e. Autonomous, no infrastructure needed.
f. Can be set up anywhere.
g. Energy constraints
h. Limited security

Since, MANET is used in various areas, currently the support is given to it by applying machine learning to it. Moreover, cognitive intelligence will make the MANET more robust and self-manageable. Some of the applications of MANETs where it is functional are:

a. Military or police exercises.
b. Disaster relief operations.
c. Mine site operations.
d. Urgent business meetings.
e. Robot data acquisition etc.

It is easy to imagine a number of applications where this type of properties would bring benefits. One interesting research area is inter-vehicle communications. It is one area where the ad hoc networks could really change the way we communicate covering personal vehicles as well as professional mobile communication needs. Also, it is area where no conventional (i.e. wired) solutions would do because of the high level of mobility. When considering demanding surroundings, say mines for example, then neither would the base station approach work but we must be able to accomplish routing via nodes that are part of the network i.e. we have to use ad hoc network.

Such networks can be used to enable next generation of battlefield applications envisioned by the military including situation awareness systems for maneuvering war fighters, and remotely deployed unmanned micro-sensor networks. Ad Hoc networks can provide communication for civilian applications, such as disaster recovery and message exchanges among medical and security personnel involved in rescue missions.

IV. DUMBONET

Digital Ubiquitous Mobile Broad-band OLSR is an emergency network platform developed by three main research groups. These are AIT's intERLab 1 laboratory, INRIA2 institute, and the WIDE Project3 team. They were motivated by the tsunami in 2004 which devastated several areas in countries along shores of Indian Ocean, and caused the breakdown of telecommunications infrastructure. DUMBO is developed to provide multimedia communication among field members and with a distant command

headquarter. It is designed for collaborative simultaneous emergency response operations deployed in a number of disaster affected areas.

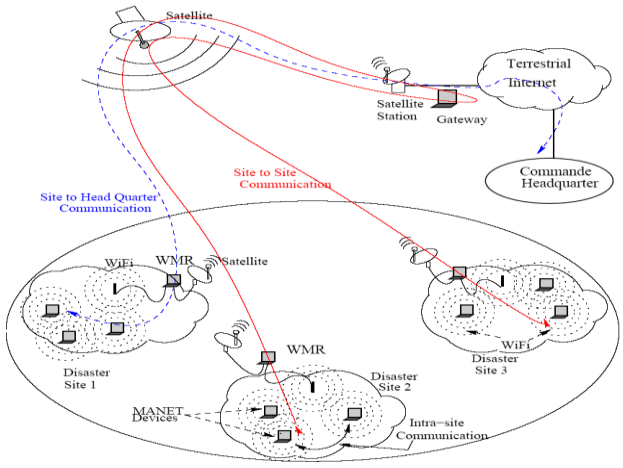

Figure 2: Typical architecture of DUMBONET

The architecture of DUMBONET is given in figure 2. It combines MANET and a satellite IP network. A MANET is deployed on each isolated disaster site and satellite access allows multimedia communication between different sites and with the distant command headquarters.

We distinguish three categories of bidirectional communications which are known as intra-site, site-to-headquarter, and site-to-site communications. Site to site traffic must pass through a terrestrial satellite gateway. Further, three main applications are deployed on DUMBONET which are:

- **a.** Multimedia applications including video, voice, and short messages;
- **b.** Sensor applications for measuring and identifying environmental and potentially harmful factors that may affect the rescue operation, such as: temperature, humidity, rainfall, wind speed, etc;
- **c.** Face recognition application that allows a rescuer to compare face images captured from the site to a database of known faces.

V. USING BP-ANN IN DISTRIBUTED MANETS FOR BETTER RESULTS

Back Propagation- Artificial Neural Networks are one of the best supervised machine learning approaches. They could be utilized in developing the Mobile Ad hoc networks which are the collection of multiple nodes interconnected through wireless links..E. M. Royer and S. B. Chai-Keong Toll [12] described about how to utilize Artificial Intelligence to model MANET routing for three different routing protocols. These protocols are Dynamic Source Routing(DSR), Ad hoc on-demand Distance Vector(AODV) and Optimized Link State Routing (OLSR). The result shows that these AI based models are more accurate and presentable than traditional mathematical equations. So, the support of Artificial Intelligence to MANET and DUMBONET will drastically improve the performance of the network administration. On the other hand, such network has no central controlling system and must need security from attackers. So, intrusion detection system is a vital role here for the purpose of providing security to the MANET.

VI. SELF MANAGING NETWORKS

In the networking scenario of today, manual administration of the networking devices is getting deprecated day by day. Centrally administrated networking environment is on hits where you need not to physically go to set up and install various components. From a study conducted by Qusay H. Mahmoud [16], University of Guelph, Canada 40 percent of service outages is caused by human errors. It implies that if we could replace machines with human then that error rate will drastically decrease. This is the reason why machine learning is so much popular in networking these days.

“IBM research has used the term ‘autonomic computing’ as a distributed system where a set of software/network components can regulate and manage themselves in areas of configuration, fault, performance and security to achieve some common user defined objectives”- Says IBM Research. The word ‘autonomic’ originates from the autonomic nervous system that acts as the primary conduit of self-regulation and control in human bodies”. This mechanism is based on self-configuration, self-optimization, self-healing and ultimately self-protection. These features of autonomic computing may help the MANET and DUMBONET specifically in case of disaster. These machine learning approaches may help in proving the system more reliable. This concept not only gives rise to the self-managing networking system but also provides opportunity to apply cognitive computing to make the system more reliable and self-informative.

Noteworthy in the above mechanism is the challenges which come along with the system. Few challenges include continuous monitoring of the system to validate if it is performing expectedly or not. Managing the knowledge corpus on which the decision making is based is also of key importance. We also need to understand the fact that stability, robustness, resilience and correctness is a challenging task in this process too. Because the environment here is dynamic in nature, all new challenges must be kept intelligently so that such future encounters could be solved easily and the efficiency of the system could be increased.

VII. COGNITIVE NETWORK IS THE FUTURE NETWORK

With the advent and the impact of the cognitive intelligence, it has been observed that cognitive networks will become the networks of future. In the future networks, we need to focus on network configuration rather than installing the router at their physical locations. Cisco is doing marvelously good in this regards. Few of its products in this area are Cisco Meraki, Cisco Umbrella etc. These products and their equivalent products are growing at a rapid rate where a network administrator is going to sit at a particular machine and traverse all of its nodes and perform troubleshooting from his desk. Moreover, addition and deletion of the nodes, load balancing, implementing cryptographic algorithms,

conditional traffic flow and other relevant processes may also be very easily managed from his system only. Scalability is not a big deal these days due to arrival of such latest technologies. Also, by using the cognitive intelligence in this technology, the network management becomes more flexible.

VIII. SUPPORT OF MACHINE LEARNING FOR COGNITIVE NETWORKING

Clark, Partridge and Ramming [4] [5] proposed a new vision for computer network management – the Knowledge Plane. This would boost the today's system of low-level data collection and decision making. Learning with experience is the key to machine learning and this mechanism is going to followed by the networking systems today. The more the age of the cognitive network, the more the reliability factor will become.

IX. INTERPRETATION AND UNDERSTANDING THE DISASTER USING SUPERVISED MACHINE LEARNING

All disaster has great impact on telecommunication supply and demand by creating additional temporary needs at a time of reduced availability and overload of the permanent networks. In such situations, the operating agencies have not only to make best use of available telecommunication networks but may have to build up additional; capacity.

The impact of disaster on telecommunication infrastructure is manifold, e.g. the buildings collapse, power supply gets disrupted, roads are blocked, fire breaks out, telephone exchanges get overloaded, towers get twisted, cables get washed away etc. In the case of disasters, the machine learning can help to robustly control the nodes by its techniques. These techniques are classification and regression. Both of these techniques are examples of supervised learning. Few of the algorithms used for supervised learning are Back propagation Artificial Neural Network, Forward Propagation Artificial Neural Networks, Support Vector Machines etc. Each of the above algorithms may be used to develop the solution models for classification problems.

Now, the question is that how this supervised learning is going to help in disasters? Obviously, this learning is useful in classifying the problems and then selecting the more perfect solution based on the response of the problem classifier.

X. CONCLUSION

In this paper mainly two communication systems are discussed for establishing the emergency communication in disaster areas i.e. MANET and DUMBONET. Both communication systems are very effective in disasters areas. Mobile ad hoc networks have some limitations like it has a very limited geographical area for communications and it can transmit only text massages. On the other hand, DUMBO is developed to provide multimedia communication among field team members and with a distant command headquarter. It is designed for collaborative simultaneous emergency response operations deployed in a number of disaster affected areas.

Further, Artificial Intelligence based cognitive machine learning is summarized for providing the reliable solutions. Self-manageable network administration is the key of the AI based networking which is the future of the networking where very less human intervention is required. Consequently, the error rate will drastically reduced by two important approached. First is the involvement of the machine in place of human for managing the network administration. Second, cognitive artificial intelligence will make the system more robust day by day as such system learn by experience. Also, the challenges to cognitive artificial intelligence are still open to explore.

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