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A Study Of Disaster Management System With View Of MANET Application

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ABSTRACT

In the modern era, Disaster Management has become an important field of study. With the advent of telecommunication system and their possible integration with the existing disaster management system, it is possible to minimize the after effects of disaster. In this paper we present a study of available and possible disaster management system based on wireless mobile telecommunication. In order to use such a system in the actual world security requirements such as availability, accountability, integrity and confidentiality must be ensured by the disaster management system.

Indexing terms/Keywords

Disaster management cycle (D.M.C.), Mobile ad-hoc networks (MANETs), Public safety, Emergency response, 2-layered basic architecture for D.M., Recent tools & technologies for D.M., Emergency support functions (ESFs), Real time application model.

Academic Discipline And Sub-Disciplines

Mobile Ad Hoc Networks, Disaster Management

SUBJECT CLASSIFICATION

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TYPE (METHOD/APPROACH)

Survey paper

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1. INTRODUCTION

Disasters can be caused by natural reasons or man-made. Promptly notification and evacuation of the people who are endangered by the disaster is especially desirable in order to save as much lives as possible. In the case of disaster management - Disaster relief teams cannot rely on existing infrastructure because there is high probability of bursting of whole communication infrastructure, so we must have to rely on quick & rapid deployment network. The Primary candidate to achieve this purpose is push to talk networks and secondary being the mobile ad-hoc network. A mobile ad hoc network (MANET) is a group of wireless nodes that are dynamic and self-organize themselves [3] [2]. Mobile ad-hoc network provide a platform in the case of emergencies by interconnecting several heterogeneous multi-operator networks.

In the recent years we have seen lots of application of Manets. The manet application mainly deals with the management of catastrophic events by using autonomous sensor networks. The sensor network targets the development of custom designed sensor technologies that will eventually be applied on the ground with a view to improve disaster management, This involves better management of the huge number of casualties that arise from such events. The rescue operation shall be optimized and the casualty's chance of survival will thus be increased. Many projects dealt with technical and scientific problems like scalability, robustness, localization with sensor networks and application problems like instrumentation, power supply, operability, incorporation in the existing processes and lifespan.

2. BACKGROUND

After a disaster our main motive is, how quick can we respond and recovery be done. It's a staggering process requiring a wide range of resources to ensure the safety of the population and the recovery of the affected area. The Gujarat Earthquake disaster response and recovery effort, to date, required 5 thousands Crore in disaster response and recovery funds and over 5,000 central and state emergency users deployed throughout the region(according NIDM –India) . t-tsunamis disaster response and recovery required 5,573 military support personnel ; 10022 contractors and 5900 volunteers. Estimated the cost to exceed 3.2 thousands Crore [11].

The earthquake triggered a devastating Tsunami across the Nations: Indonesia , Sri Lanka , India , Thailand , Maldives ,Somalia , Myanmar , Malaysia ,The total loss of life in all these countries exceeded 280,000 with major brunt taken by Indonesia. The magnitude of these disasters in terms of government resources and lives affected demonstrates the need for fast, efficient response and recovery.

Disasters can be classified in general into two major types - although with the understanding that the boundary between environmental problem and disaster could be transitional, implying that a breakdown of the environment may lead to a disaster; Mainly two types of catastrophic disasters; natural disasters, such as an earthquakes, tsunamis, and floods, and Anthropogenic (Human-Induced Disasters) such as war and terrorism. Effects of these disasters could be extremely damaging to the infrastructures, causing environmental degradation, disease, hunger and death. Here, we mainly focus on sudden natural disasters, such as an earthquake. Different response measures and information are appropriate depending on the amount of time elapsed since the onset of the disaster.

Figure: 1

3. INFORMATION & COMMUNICATION REQUIRED AT THE TIME OF DISASTER

Information and Communications are vital for effective management and execution of disaster response and recovery efforts: emergency response personnel must be able to exchange information with each other from anywhere, at any time, for this it must have communicational architectural way. A Disaster Area Architecture designed by *Phillip in 1994 to meet these requirements.

Crisis-related information needs			
Information for preparedness	Information for immediate response	Information for recovery and restoration of services	Information for the public
Physical, social, and economic attributes of the community Likely threats and vulnerabilities Resources and capabilities for response Action and coordination plans for foreseeable events Business continuity plans	Immediate and ongoing assessment of damage and danger Knowledge about continuing or ancillary threats Availability and capability of response assets Deployment and coordination of responders	Nature and extent of damage to infrastructure and services Identification and assessment of needs and problems Availability and capabilities of recovery and restoration assets in the wider community Deployment and coordination of assets and status of recovery	Immediate and emerging threats to civilians and guidance for personal protection Ongoing advisement of continuing threats and what to do Ongoing advisement of recovery and restoration activities Continuing awareness and education

Table: 1

Effective disaster risk management depends on the informed participation of all stakeholders. The widespread and consistent availability of current and accurate data is fundamental to all aspects of disaster risk reduction. Exchange of information and easily accessible communication practices play key roles in this exercise. Data is also crucial for ongoing research, national planning, monitoring potential hazards, and assessing risks. Neglecting information management and the early warning system in disaster management may augment serious consequences for the victims.

For correct decision-making at any stage of natural disasters – from prediction to reconstruction and rehabilitation – a considerable amount of data and information is necessary. The most important procedures relating to information for disasters are monitoring, recording, processing, sharing, and dissemination. Experience has proved that information technology facilitates the receiving, classifying, analyzing, and dissemination of information for appropriate decision-making. [9][10]

The main data and information critical for an efficient and robust disaster management system are those made available from:

- Observatory stations
- Satellite/s observed
- Centre-to-centre
- Classified experiences
- Research results
- Training contents
- Reports and news

Major role of communication technology:

The available data and information should be effectively transmitted from the supplier to the end user, passing through several stages. The role of communication technology in disaster management is to keep the flow of real-time data and information during all these phases. [6] Communication system through the Mobile ad-hoc network (MANET) to help out in disaster response and management within the built environment. A dynamic communication system would serve to integrate many different communication categories such as:

- Data transfer from observatory stations;
- Data exchange among suppliers and users;
- Exchange of information and experience;
- Training and video conferences; and
- Tele-control (commands).

4. BASIC ARCHITECTURAL VIEW OF DISASTER MANAGEMENT

The basic Architectural view designed by *Phillip in 1994 provide the way of response and recovery from the disaster site. Its Di-layer architecture, Bottom layer has five entities are fully connected to each other. The top layer has six entities and one strong process entity; all entities are tightly coupled with process-entity. Bottom Emergency support functions (ESFs) entities are responsible to forward information to ESFs national Organizations in the top layer and Disaster field office (DFO) is fully duplex connected with FEMA-EICC.[12][13]

In the bottom layer communication can be possible through any fast and self configurable network like ad-hoc network. [1] In accordance with the federal resource plan (FRP), disaster response and recovery is divided into 13functional areas, or ESFs: 10 primary ESFs and 3 support ESFs. ESF 3: communications is responsible for providing communication capabilities to the other ESFs.

The ESFs are the primary mechanism to provide Federal response assistance to State and local response and recovery activities during a federally declared disaster. Prior to the formal activation of the ESFs, the lead officer for the disaster response and recovery effort, the Federal Coordinating Officer (FCO) along with the ESF managers leads the Emergency Response Team (ERT). The ERT staffs the DFO to provide administrative, logistic, and operational support to field response activities. The DFO is the primary facility in each affected state for the coordination of response and recovery operations and is typically located on the fringe of the disaster area. The DFO is established as soon as possible, but often takes from three to seven days to become fully operational. Once operational, the DFO assumes operational control of the support effort from the FEMA Regional Operations Center (ROC). The DFO becomes the hub for all Federal relief activities in the disaster area.

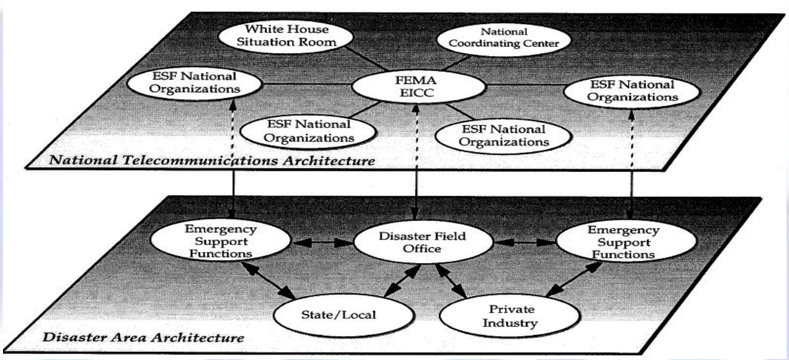

Figure 2: Basic Architectural view

5. RECENT TOOLS & TECHNOLOGIES FOR DISASTER MANAGEMENT

Disaster management has been an area of intense research in recent years, resulting in the development of many new and advanced systems which could be helpful in early warning, forecasting, and mitigating the impact of natural disasters. Some of these technologies are briefly presented here.

a. Satellite-based Weather Warnings

Disaster preparedness has long been a part of development work, but now World Vision, India, plans to take advantage of new technology in disaster-prone development areas. For the first time, satellite weather warnings will give villagers a chance to react and respond before disaster strikes. The system works through a simple local computer network connected to television, internet, and the local public address system. During times of alert, all weather reports are aired in the local language through multiple loudspeakers, and the internet is monitored for the latest weather patterns.

As a back-up, World Space Radio connects the early warning centers, submitting messages as well as forwarding computer files. This means warnings can be communicated to many destinations even when internet communication has been suspended.

b. Tsunami Warning System

Indian scientists have unveiled a tsunami early warning system (National Early Warning System) for tsunami and storm surges in the Indian Ocean. The tsunami warning centre, which has been set up at the Indian National Centre for Ocean Information Services (INCOIS), aims to issue alerts on the killer waves within 30 minutes of an earthquake. The Centre will generate and give timely advisories to the Ministry of Home Affairs (MHA) for dissemination to the public: to accomplish this work, a satellite-based virtual private network for disaster management support has been established. This network enables an early warning centre to disseminate warnings to the MHA as well as to the state emergency operations centers'.

Scientists have installed two bottom pressure recorders (BPR), which are key sensors that indicate the generation of tsunami off the Gujarat coast in the Arabian Sea. So too, a set of four BPRs which had been installed in the Bay of Bengal region were put to the test on 12 September 2008 when a massive undersea earthquake hit southern Sumatra. INCOIS, in association with Tata Consultancy Services, has generated simulations of 550 possible scenarios triggering a tsunami after massive earthquakes.

c. Disaster Tool - I

IBM's India Research Laboratory has developed the Resiliency Maturity Index (RMI), a framework that quantitatively assesses an organization's ability to recover from a variety of disasters such as floods, power outages, software glitches, epidemics, and terrorist attacks. Components of the system include the network, the e-mail system, and even the transportation system. The RMI tool is expected to be useful for companies outsourcing work, as they can now use it to assess the resiliency of their service providers. Companies outsourcing work typically worry about the ability of their suppliers to withstand threats and recover from disasters. Service providers can, in turn, use the RMI tool to assess and improve their ability to cope with disasters.

d. Mobile Communication System

In an effort to assist communities and organizations affected by natural disasters or major communications disruptions, Catalyst Telecom, a sales unit of Scan Source, Inc., USA, has set up the Avaya Mobile Communication System (MCS). The MCS is a stand-alone system designed to quickly deploy emergency response communications during relief/recovery operations from disaster, and for temporary operations when communications have been lost or are unavailable. The pre-configured MCS is readied for connection to a satellite service provider receiver or available terrestrial network facility and consists of two environmentally hardened cases: one containing an uninterruptible power supply (UPS), a configured G350 media gateway, and a S8300 media server, and the other with up to 12 digital handsets.

e. Tsunami Disaster Information Alert System

Bangalore-based Geneva Software Technologies Limited (GSTL) has developed a Tsunami Disaster Information Alert System which sends messages on mobile phones in 14 Indian languages to a tsunami-prone area in less than 50 seconds. Designed to reach the maximum people in the minimum time, it is programmed to help especially the rural people and fisherman community to receive messages in their local language. Comprehensible public alert that is on time can save many people who would otherwise be caught unawares in a calamitous situation.

The new system, which is based on the National Disaster Information System (NDIS), works on the following principles:

LBLMS – Location-Based Language Message Service

Automatic message translation into 14+ Indian languages, Dynamic message formatting for SMS, EMS, CBS, etc, and Dynamic location identification based on Area (or BTS). And Automatic tagging of language SMS.

DVTS – Dynamic Voice Translation System

Automatic text-to-speech conversion within a few seconds for 14 Indian languages, Accent matching for Indian dialects, Speech engine with highest degree of phonetics, specially built for Indian languages and Audio streaming compatible to all telecom networks.

WPAS – Wireless Public Address System

Wireless audio to remote areas, Automatic activation, Remote diagnosis and maintenance, Minimal battery usage, and supplemented by solar power

6. DISASTER MANAGEMENT-INDIAN MODEL VIEW

The unique geo-climatic conditions of India have made it highly vulnerable to natural disaster. In India, 54% of landmass is prone to earthquakes, 40 million hectares of landmass is prone to floods, 8000 km of Coastline is prone to cyclones and almost 68% of the total geographical area is vulnerable to drought. The occurrence of Tsunami in 2004 left a devastating blow on the country (Mohanty, ET al.2010). Complete prevention of natural disaster is beyond human capabilities but the involvement of the state-of-the-art technology and communication technology systems are panacea for implementing a reliable disaster prevention measures.

Through the Mobile Ad-Hoc Network (MANET), [7][8] propose a distributed communication system for disaster management as shown in figure 5. A Mobile Ad Hoc Network, MANET, is a collection of wireless mobile devices (nodes) that are equipped with a short range radio interface (Bluetooth and Wi-Fi). Mobile devices in a MANET can connect to each other within one another's transmission range, without any preexisting fixed network infrastructure. MANET provides a quick, self-configurable and inexpensive communication infrastructure for email, text communication and instant messaging in other to enable all the parties involved to interact continuously. This model in figure 5 is highly appealing because it is self configuring and independent on infrastructure inherent in the connecting devices. It does not require preexisting infrastructure and it is used extensively all over the world for disaster management.

7. REAL TIME APPLICATION MODEL FOR DISASTER MANAGEMENT: [4]

(a) A very fine and tuned research work ensued at AIT in Thailand have developed an emergency network platform based on a hybrid combination of mobile ad hoc networks (*MANET*), a satellite IP network operating with conventional terrestrial internet. It is designed for collaborative simultaneous emergency response operations deployed in a number of disaster-affected areas. The architecture of the network is called **DUMBONET** [5].

It's effective in real physical disaster-affected fields. Its goal is to provide information to rescue teams who may simultaneously explore physically isolated disaster fields with mobile ad hoc multimedia internet communication among field team members and with a distant command headquarters. Its multimedia internet capabilities allow rescuers to collaborate more effectively by sending and receiving rich and crucial multimedia information. Rescuers may also consult with case experts via the internet for the know-how necessary for the operation. DUMBONET is a single, mobile, ad hoc network comprising a number of connected sites, each with a Variety of mobile nodes, end systems, and link capacities. A node on the net can communicate with any other node belonging to the same site, or with a node at another site a distance away, as well as communicate with a remote headquarters on the internet. Within each site, nodes share relatively similar network conditions, whereas between sites a long-delay satellite link is used to accommodate long distances. The headquarters is considered a special site, with communication access to every site on the net and sometimes broadcast messages to all sites. A normal site of DUMBONET can maintain a communication channel with the headquarters while possibly opening up communication channels with other selected peering sites on the net, based on demand.

Mainly two applications are deployed on DUMBONET: Multimedia applications and Sensor applications for measuring and identifying environmental and potentially harmful factors that may affect the rescue operation, such as: temperature, humidity, rainfall, wind speed. Here a virtual private network (VPN) is used to hide network heterogeneity that arises from the use of different networking technologies comprising satellite, MANET, and terrestrial internet. OLSR protocol is used to route traffic among the devices that may not have direct wireless contact but are located within the same aforesaid private IP subnet. The entire DUMBONET is a single OLSR-driven network which includes local MANETs, and inter-site links via VPN and satellite.

To form MANET, every mobile device is set to use the ad-hoc (peer-to-peer) Wi-Fi mode and to run the Optimized Link State Routing (OLSR) protocol. OLSR is a link state routing protocol; OLSR protocol uses a special mechanism called Multi-Point Relay (MPR) to reduce the number of flooded messages. Every mobile device is set to use the ad-hoc Wi-Fi mode. All the nodes in disaster site 1 were assigned with IP addresses pool below 100 and other site was assigned with IP addresses above 100. The network in headquarter were assigned with IPs above 200. Each MANET communicates with each other using a geostationary satellite, known as IPStar with ku-band satellite symmetric channels with 500 kbps bandwidth from site1 to site2 and 300 kbps bandwidth from site2 to site1. Any traffic from a site's transceiver to headquarter goes to IPSTAR gateway using satellite channel, then from IPSTAR gateway to AIT Network using terrestrial network, or vice-versa. The IPSTAR architectural design makes all the communication from any IPSTAR transceiver (ground station) is routed through IPSTAR gateway (ground station). As a result, the communication from a transceiver to traditional Internet requires 1-hop satellite communication. And, the communication between two transceivers requires 2-hop satellite communication.

IPSTAR has mobile satellite transceiver which allows us quick (within a few hours time) restore of internet connectivity in the disaster affected areas, proved extremely beneficial to the search and rescue operation where traditional terrestrial communication infrastructure is severely disabled.

Test pattern:

1. Experimental test-bed, setup one IPSTAR transceiver at the 1 Elephant Camp creating the MANET site1. Setup another IPSTAR transceiver at 2ND Elephant Camp creating the MANET site2.
2. Human being spreading all over the camp and emulating end nodes while used elephant to carry our laptops or PDAs emulating mobile relay nodes to create multi-hop MANET.
3. Delay behavior of site-to-HQ network collected by using ping tools. A node in Elephant Camp pings to headquarter in every 5 minutes interval while it was 2-hop MANET and 1-hop satellite distance away.
4. Result in the huge fluctuation of RTT over the satellite which can be more than 4000 milliseconds (ms) sometimes but on average it is around 1184 ms. the delay behavior of intra-MANET which shows that the RTT can be near 290 ms sometimes while the average RTT is around 32 ms. We get the idea that the end-to-end (E2E) delay do varies over the time in a MANET or over the satellite

(b) ADRC (Asia Disaster research committee) developed the "**VENTEN"** system which stands for "Vehicle through Electronic Network" of disaster geographical information system; it is an Internet-based disaster management GIS platform for disaster management information acquisition that can be accessed by anyone from anywhere, using the rapidly expanding Internet. VENTEN- includes development of a disaster management information database with Interactive transmission of real-time disaster information. VENTEN system is to provide both a system and data (including analysis results).

The VENTEN system consists of a Web server, a GIS server, and a database server. First, an access request from the user is accepted by the Web server. The Web server specifies the necessary information, including the kinds of geographical data and the extents of areas, for the GIS server (multiple geographical data can be specified as required). The GIS server extracts the relevant data from the geographical data it stores (referring to the data server if necessary), and then uploads the data to the Web server in the form of raster images. The Web server adds other elements, such as a country selection menu, disaster management information selection menu, show/hide toggle button, scale and area management button, and then maps these elements and the raster image data provided by the GIS server onto a hypertext file, which is sent to the user.

Functions- the VENTEN system has a standard set of GIS functions: "display of selected areas at preferred scales", "buffering", "overlaying," and "search by location and attribute". Figure 9 shows a buffer area and the populations of cities in the area. The buffer has a radius of 50 km with Narita International Airport at the center. The names and populations of the cities in the area are extracted and displayed in the table. The shortest route analysis function helps determine the shortest route for evacuation or transportation of supplies. More specifically, when a data extraction process is performed with the source of the supplies specified as the starting point S and the affected zone as the destination E, the shortest route is selected out of many possible routes and displayed as a bold line. This function is useful for determining the shortest route. Used in combination with the buffering function, it also functions as a practical tool for searching detour routes to avoid affected zones. As described above, the VENTEN system provides only raster data to the user terminal unit, but it accepts requests from the user to perform various processes on the vector data stored in the server.

8. TELECOMMUNICATION TECHNOLOGIES-LIMITATIONS/BENEFITS FOR EMERGENCY RESPONSE COMMUNICATIONS

In This section we differentiate several technologies used for massive communications, focusing on their short-comings and limitations, as well as on their benefits for emergency communications. We put in table below for better understandings.

Technology	Limitations/shortcomings	Benefits
Cellular	low to medium bandwidth, centralised architecture, high cost of infrastructure deployment and maintenance	high mobility, high coverage, high penetration of smart phones, broadcasting mechanisms for audio and video transmission
Satellite	asymmetrical transmission rates, high cost of equipment, heavy weight of equipment	immune to terrestrial congestion, coverage in even sparsely populated areas, high transmission rates
TETRA	centralised architecture, low transmission rates	a good established and mature technology, expansion to many countries
Wi-Fi	limited coverage, intra and inter-channel interference	high transmission rates, use of unlicensed spectrum, rapid proliferation of Wi-Fi-enabled devices
WiMAX	centralised architecture, licensed spectrum use, high cost of infrastructure deployment and maintenance	high transmission rates, proliferation of WiMAX-enabled devices (e.g. smart phones, femtocells)

Table 2

9. CONCLUSIONS AND OPEN ISSUES

In this paper we provide descriptions of several disaster management I&C technologies which proposed for ad hoc mobile networks with GIS feature, described several requirements regarding efficient architecture, security, network deployment, and traffic-user prioritization. In addition, we described recent tools and technologies for D.M., real time application model and approaches that can be adapted to retake communication resources owned by independent individuals, for use by an emergency response network (in the case of resource shortage).Current technologies used for emergency response operations mainly provide voice-centric services. These networks are more infrastructure-less & minimally infrastructure-based. Future emergency networks are envisioned as architectures that provide more advanced applications such as live video streaming, voice-over-IP, location information, status, etc. All these applications require high bandwidth demands at the time of disaster that current networks cannot provide, so we must have to concentrate on rapid deployment of network as well as mass bandwidth of information networks.

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