The Investigation of MANET and Various Applications

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Abstract - Mobile ad-hoc network (MANET) is a collection of mobile devices (such as laptops, PC, mobile phones etc.,) in which the communication occurs through wireless links. It is a self-configuring infrastructure less network which moves independently in any direction, and changes its links to other devices frequently [1],[4]. It can route traffic unrelated to its own use. The necessity in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. This type of network may be operated by its own or may be connected to the Internet. MANETs are a kind of Wireless ad-hoc network that usually has a routable networking environment on top of a Link Layer ad-hoc network. Different protocols are then evaluated based on measures such as the packet drop rate, the overhead due to routing protocol, end-to-end delays, network throughput etc.,[5]. A review of applications of MANET such as detecting and querying events related to farm animals, emergency communication and information system for natural disasters and road transport system is included in this paper.

Keywords: Disaster Rescue, MANET, Farm animals, VANET, On the Road (OTR) Beyond Line of Sight (BOLS) shop experience.

I. Introduction

A general mobile network consists of wireless access networks and interconnecting networks. All mobile terminals are connected to the base stations by wireless access networks and the base stations are connected to wired networks. These are drawbacks to the systems when large-scale disasters, such as earthquakes, occur then the base stations or other systems of the infrastructure comprising the networks may be damaged by disasters and communications may be impossible.

Even if the infrastructure is not damaged, spikes in traffic and congestion may render communication virtually impossible. It is essential to restore communication networks in large-scale disasters by repairing the infrastructure as quickly as possible and taking appropriate measures to control congestion. Communication and sharing of information in emergencies are also possible via ad-hoc networks, that take full advantages of the features of wireless communication including rapid and temporary setup and outstanding terminal portability and mobility[1]. Ad-hoc networks can enable communication among temporarily assembled user terminals without relying on the conventional communication infrastructure. Hence it is important to configure a network that offers sufficient QoS after a catastrophic disaster using an ad hoc network to help protect people. The paper is organized in the following way.

Section 2 explains various challenges that are faced during communication in Ad-hoc network.

Section 3 describes detecting and querying events related to farm animals.

Section 4 defines emergency communication and information system for natural disasters using MANET.

Section 5 defines road transportation system using MANET.

II. Challenges in Ad-hoc network

Reduced bandwidth: Wireless links have significantly lower capacity than infrastructured networks. Moreover the throughput of wireless communication also reduces due to the effect of multiple access, fading, noise, and also the interference conditions.

Problem in Routing: In this network the nodes changes it location more frequently. Hence, routing the traffic through the nodes is an overhead.

Hidden terminal problem: It is a collision of packets that occur at the receiving node when it transmits simultaneously and that are not within the transmission range of sender.

Packet losses: In these network greater packet losses occurs due to increased collisions, in presence of hidden terminals, interference, Uni-directional links and frequent breaks in the paths due to mobility of the nodes.

Battery constraints: Since mobile devices are used in this network, there are restrictions on power source in order to maintain portability, size and weight of the device.

Security threats: MANETs have several challenges to the network design as the wireless medium is not suitable to eavesdropping and ad hoc network functionality is established through cooperation between the nodes, mobile ad hoc networks are intrinsically exposed to numerous security attacks like worm hole, black hole, rushing attack etc.

III. MANET on Detecting and Querying Events Related To Farm Animals

The animals have to be monitored or observed by farmers more frequently in animal farm during reproductive processes such as pregnancy and oestrus for breeding the animals while using technologies such as artificial insemination. Attention must be paid on health or welfare of the animals otherwise it leads to reduced productivity and death of stock. The farmers

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do not find time and resources to observe animals regularly. An approach has been proposed that utilizes available network infrastructure as well as the fully ad hoc less infrastructured network. MANET is also used to detect and query events related to farm animals such as oestrus, animal diseases and reduced efficiency of pastures. The cattle monitoring system has an animal mounted device of collar form with in-built accelerometer to measure intensity of feed intake. The walking intensity is measured using pedometer on the animal's leg. The impulses are counted for every two hours and the measurements infrastructure pedometer are acquired by collar over the wireless communication. The measurements from the meters are stored and processed by the collar every two or at most four hours to detect oestrus, pregnancy and animal diseases. The collars have wireless network interfaces and transmit measured value and detected diseases or oestrus to the farm servers through gateways. The farm servers store the present and past data and detect user defined events and issue notifications to users mobile phones or message boards mounted in farm buildings or offices. These events are defined as logical functions of the data calculated by the collars, as in Fig .1. The cow X on the pasture 1 will be ready for insemination in 4 hours. The users can query the data stored on servers with data either on farm or over Internet using a PC or a WAP enabled mobile phone[1]. The data stored on servers can be accessed selectively and can be used for business counterparts which help to evaluate the animals before purchase. Collars, leg mounted pedometers and optionally stationary gateways are battery powered and recharged by solar cells. The changes in the animals health, reproductive status and welfare are noted using this approach so that the manpower is reduced and the decision making process is enhanced.

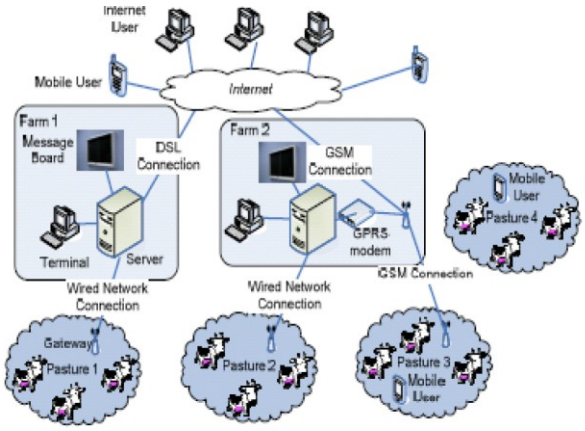

Fig.1 Example deployment

IV. Emergency Communication and Information System for Natural Disasters using MANET

The emergency rescue operation is very difficult during catastrophic natural disaster such as earthquake, hurricane, typhoon, tsunami, etc. There is a possibility for the survival of the people trapped in the disastrous areas under collapsed buildings or landslides, if they can be saved within 80 hours. People who have moved out of their residence jammed in highways wishes to communicate to each other for many reasons. The rescue operation becomes too difficult due to loss of communication systems and many people loss their lives before they are rescued. The urgent communication and information system using MANET is proposed such that it can supports a large number of rescuing people under disasters. An idea for implementing the "Autonomous P2P Ad-Hoc Group Communication Systems (P2Pnet)", which is a local wireless intranet based on P2P and MANET technologies is also stated so that communication need under temporary server less infrastructure-less Internet blocked environments such as natural disastrous area, battle-field can be fulfilled[8]. The Wi-Fi ready notebook PCs of rescue volunteers are used to construct a MANET and then P2Pnet technology is used to form a higher level mission-specific network for supporting communication needs such as VoIP, Push-to-Talk, and Instant Messaging, and mobile social network, etc.

System architecture

The temporary group communication and information network can be supported using *P2Pnet which* is a server less peer-to-peer communication network based on MANET.

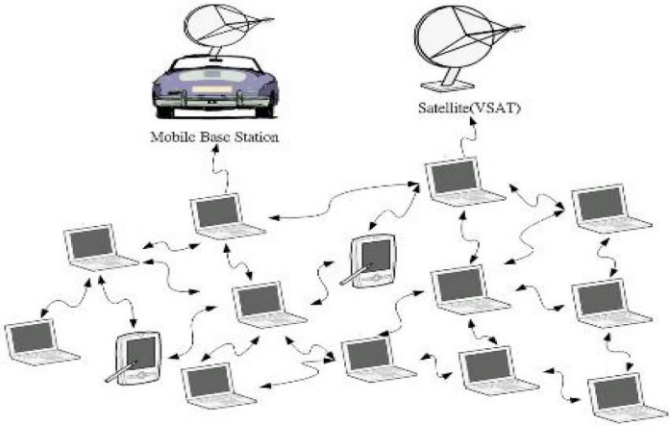

Fig. 2 Architecture of P2Pnet

As shown in Fig.2, few nodes may have satellite communication capability so that it performs gateway functions and other nodes can access Internet through gateways if they have such capability. The three communication modes are

Uncontrolled Single-Hop Group Communication Network (U1Net)

Every node broadcast data to nearest nodes in one-hop distance and authorization is not enforced in this mode. This mode supports short range communication and is easy to construct this network. This mode is used in the early hour of disasters when no organizational effort has been taken place

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Uncontrolled K-Hop Group Communication Network (UKNet)

Every node broadcast data to nearest nodes in K-hop distance and authorization is enforced here in this mode. This mode supports long range communications and can be used in the early hour of disaster when no organizational effort is in place yet. However, more effort is required to construct this network as it is little more complicated than U1net

Controlled K-Hop Group Communication Network (CKNet)

This advanced mode supports Unicast type services such as VoIP and also requires more organizational efforts such as assigning unique IP addresses, for constructing this network. It is not easy to construct this network in the early period of disaster.

V.MANET Based Road Transportation System

The Road transportation systems are characterized by how efficiently and effectively they direct traffic in a non-congested manner towards their destinations.

With the emerging trends in wireless communications and networking technologies, the transportation would be the one that is information-driven and wirelessly enabled. The vehicular communication is limited in which the cars can communicate via centralized control towers. And the communications among vehicles are made possible through ad-hoc wireless networks.

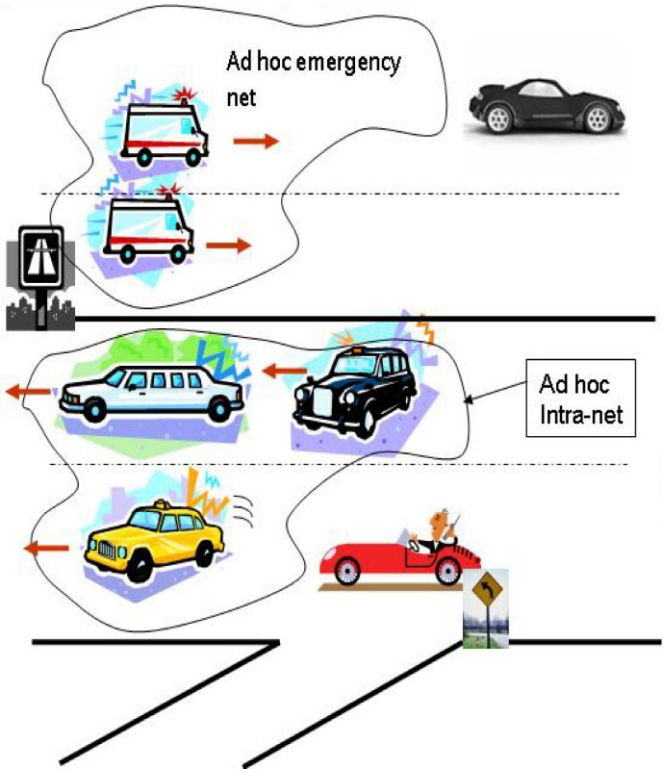

Fig.3 Ad Hoc Enabled Car Communities

A **vehicular ad hoc network** (**VANET**) uses MANET in which cars act as mobile nodes to create a mobile network. The cars in VANET act as a router or a node. The cars approximately in a distance of 100 to 300 meters connect with each other thus creating a network of wide range. When one car leaves the network due to out of signal range the other cars can join the network and connecting vehicles with one another so a mobile internet is created. Police and fire vehicles can communicate with other vehicles for safety purposes.

On road ,not all the vehicles are associated with cars or passengers. Some drivers like police cars and ambulances have specific goals while driving such as speed, mission and time. Many police cars can form a community and so that they can be connected via wireless multi-hop network as illustrated in Fig.3. Likewise ambulances on a congested road can also form a wireless multi-hop network so they coordinate their mission better. The firemen can form a community on the road while driving through a disaster site.

Car Traffic Flow & Congestion Control

With the improvement in car navigation a greater comfort and safety can be achieved. The most critical event on the highway for the drivers is to change few lanes on highway. When done properly the driver can exit in a timely and safe manner otherwise there is a risk for accidents[6]. The most essential elements are speed, distance, the lane in which the car is residing , the density and speed of the neighboring cars.

If a car needs to exit from the highway, it must sense and check the surrounding and traffic condition only then it must reduce its speed. Safe exit can be facilitated using ad hoc network by detecting the speed of the neighboring cars in the localized area. The car that is exiting changes it lane and also informs the neighboring cars through a signal or a message wirelessly.

Another application is that when an earthquake occurred and if the highway was broken the vehicles can be halted[6],[7]. The vehicle at the front transmits the alert information about the incident wirelessly to the vehicles which are several meters behind it. The vehicles should slow down and search for the alternate route to exit the highway to avoid traffic. This ad-hoc enable network can be applied to scenarios like accidents, breakdown, road blockage, heavy rain etc.

The highways enabled with ad-hoc could allow vehicles to gather information about the available services at the shops and retail stores along the roads or highways. Each shop with wireless base stations can emit information about their services, items on sales etc.,. This information can be received by the nearest lamp post which acts as an ad-hoc router and relayed to other lamp posts. Hence the vehicles which are away from the shops can also receive the information and if the driver is interested he can make use of the services by visiting the shop. This is called as On-The-Road (OTR) Beyond-Line-of-Sight (BLOS) shopping experience.

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The service software is embedded in the car system so that it can further process the received information and also filters some specific information. This yields greater conveniences to the driver and avoids being overwhelmed with advertised information. The service architecture would have to be supported by the propagation of beacons carrying advertisement information. Advertisement beacons emitted by shops will eventually be propagated to drivers. The frequency of such propagation and the radius of its propagation would be interesting topic for future research. The advantages here include the real-time propagation of sales and services information and the ability to locate the shops quickly.

VI. CONCLUSION

In this paper, a study of MANET for detecting and querying events related to farm animals has been made. This approach makes use of the available networking infrastructure but can also work in a fully ad hoc infrastructure-less conditions. The Notifications can be sent to mobile phones and displayed on message boards together with ability to query the real time and historic data from home and office PCs or a mobile phone makes the stockmen always up to date with the situation on the farm. Therefore, they can take care of the animals whenever it is necessary. The things we observed from various disasters are that mobile communication system is vulnerable and the loss of communication system can have catastrophic consequence. A P2Pnet that uses notebook PCs to construct a MANET based emergency communication and information system is proposed. Moreover, the mini-notebook PC consumes small amount of power than regular notebook PCs and the fuel consumed by P2P net is small fraction of the total fuel consumption. The ad-hoc networks in cars can form the community to achieve a specific or a common mission. The information about the congestion can be can be propagated to neighbouring cars in various directions wirelessly.

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