Design of Medium Independent Handover based Emergency Communication scheme Using Vehicular Technology

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***Abstract*— After a large-scale disaster in an area, the existing communication systems may not be available either due to physical damage or system overload. The loss of the communication systems and information networks makes the rescue and relief operation extremely difficult. The proposed system designs a heterogeneous network for emergency communication. The proposed system uses communication equipment such as smart phones - with Wi-Fi and GSM capabilities, and laptops- with Wi-Fi. Soon after a disaster happens, it is proposed that Access Points (AP) can be deployed in the disaster area. As emergency vehicles generally already contain a base station they can be used as the APs. The system uses satellite communication to carry the data outside the disaster area. If cellular coverage of an area is lost, i.e. in a disaster, this system can move communications to an available network ensuring continual communication without disruption.**

Keywords- Emergency communication, media independent handover (MIH), mobility management, network architecture, wireless communication, vehicular network.

I. Introduction

Every year earth is beaten by large scale disasters like earthquake, flood, typhoon, tsunami etc. There has been a continual increase in large scale disasters. Telecommunication failure is one of the major impacts of large scale disasters. There is no globally accepted way of emergency communication and organizing the reestablishment of a communication infrastructure in a post disaster situation. The losses of communication systems make rescue operation extremely difficult. It will take one or two months to reestablish the whole communication system again. Because of communication failure many people die before they get a chance to be rescued. And also the disaster area will be isolated from the other areas. The people trapped inside the disaster area cannot communicate with the people outside that place. In [1] and [2] the authors talks about the reasons for failure of communication systems. The main reasons are:

1. Base stations destruction
2. Trunks broken
3. Backup power generators failed
4. Cooling systems for critical equipments failed
5. Communication network traffic jams.

This paper aims at developing a complete communication solution that can be rapidly deployed immediately after the disaster.

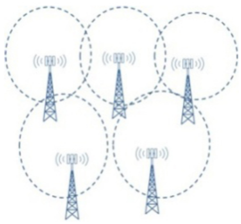

Figure 1 (a) Coverage area before disaster

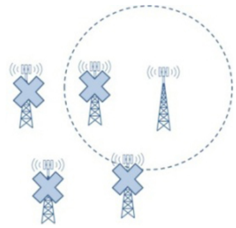

Figure 1 (b) Coverag area after disaster

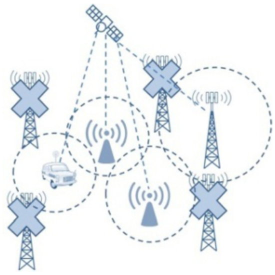

Figure 1 (c) Coverage area a using proposed architecture

Figure 1 (a) and (b) shows coverage in a place before and after disaster and figure 1 (c) shows coverage after disaster using the proposed design. In figure 1 (a) there are five cellular towers, but after disaster, four of the cellular towers have been destroyed and only one is working (as shown in figure 1 (b). Communication is not possible using only one cellular tower. However in figure 1 (c) we can see that the proposed design uses APs, satellite communication and vehicular communication is used and achieves better coverage than situation depicted in figure 1 (b).

The proposed system designs a temporary network for emergency communication using smart phones and laptops. The key advantage of this system, as opposed to existing systems, is that no unfamiliar new devices or technology is required. Existing systems require the use of satellite phones, which are not automatic and are complicated to use, rendering them ineffective in a disaster scenario unless a qualified operator is available.

The rest of the paper is arranged as follows. Section 2 describes related work in emergency communication. Section 3 describes the system architecture. Section 4

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describes about the algorithms used in the proposed system. Finally conclude in section 5.

II. Related Works

In [3] the authors proposed a low cost, easy to deploy, walkie-talkie like communication using laptops. Their proposed system in [3] creates a peer-to-peer network using laptops, and uses Wi-Fi for communication. The system in [3] uses multi hop data transfer. Their system is designed to support emergency communications in the early hours or days of a natural disaster. A useful advantage of their multi-hop system is the ability to easily bypass obstacles when face-to-face communication or wireless links are blocked.

In [4] the authors propose an integrated communication system by composing heterogeneous wireless networks. Firstly, a wireless sensor network (WSN) and a mobile ad hoc network (MANET) are deployed on the disaster site for local communication and information collection. To communicate with the outside world, a satellite gateway is used. Furthermore, a cellular gateway is used as an alternative remote communication means when the expansion of local networks reaches a working cellular base station. Their proposed system organizes heterogeneous communication networks inside and outside of disaster site. Emergency end users can select appropriate communication paths according to their locations and the wireless network coverage conditions.

In [6] the authors suggest a Hybrid Wireless Mesh Network (HWMN) that can be worked with heterogeneous networks for Internet connectivity. Their system can dynamically select the available cellular network and HWMN with respect to the availability.

III. Architecture for Media Independent Emergency Communication System

The proposed system provides an adaptive network for media independent handover through multiple networks such as cellular network, Wi-Fi, Satellite network etc. The network design of the proposed system is described in Figure 2.

This system uses:

1. Already available equipment, in the gadgets of emergency responders such as smart phones, laptops etc
2. The already available network
3. A temporary Wi-Fi which uses vehicular network technology.

In the event of disaster, cellular network may be tampered and it will become difficult to handle the most wanted emergency communication and emergency management. As soon as the cellular coverage is lost, the systems migrate adaptively to the newly available network and continue communication seamlessly. The proposed system achieves this capability by integrating interoperability between different networks, which plays an important role in emergency communication.

For achieving network mobility the system proposes to use the standard IEEE 802.21 medium independent handover. The main aim of this specification is to improve user experience of mobile terminals by enabling handovers between heterogeneous technologies while optimizing session continuity. The Media Independent Handover (MIH) functionality facilitates handover decision making by placing itself between the network dependent link layer and upper layers that make this decision based on messages from MIH Functions (MIHF).

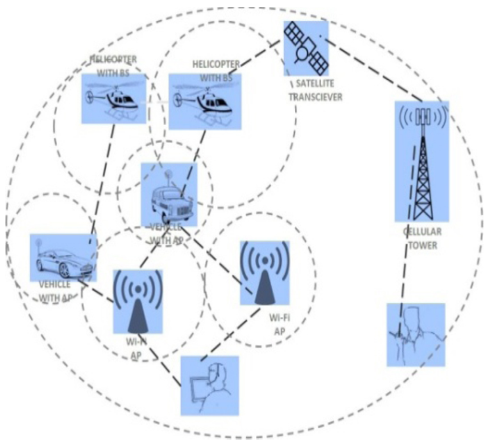

Figure 2: Network design

The network design is shown in figure 2. In the figure 2, three networks are shown, satellite network, GSM network and Wi-Fi network. For achieving heterogeneous handover service 802.21 media independent handover (MIH) is used. The architecture of the proposed system is shown in figure 3.

The user equipment should be equipped with the 802.21 service. So whenever the GSM coverage goes off and Wi-Fi coverage is available, the mobile device can switch to the available network and vice versa. After the internal routing inside the disaster area, data can be routed to the outside world using satellite communication.

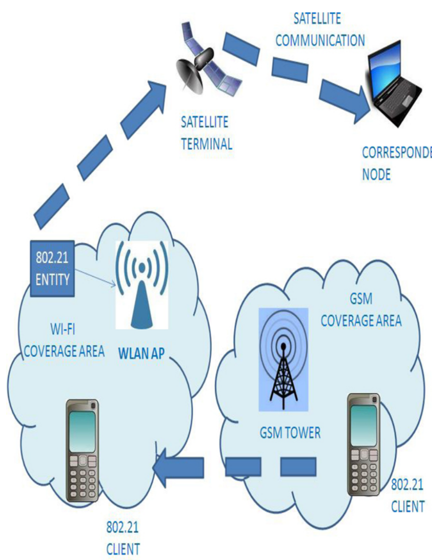

Figure 3: System architecture

As described above with the help of IEEE 802.21 media independent handover and vehicular technology the proposed system achieves seamless communication during disaster. Subsections A and B describes the MIH module and vehicular technology briefly.

A. Medium Independent Handover (MIH)

The IEEE 802.21 standard achieves seamless handovers by using three services[7]. The services are described below:

MIH Event Service: It detects change in logical link characteristics dynamically such as link status and link quality. It also initiates changes in physical, data link layers. It has two types of events: one type of event is 'link events' which originate from lower layers and proceed towards upper layers; the other type of event is 'MIH events' which are initiated by MIHF.

MIH Command Service: It facilitates controlling of a link state. Command services use commands for local events and remote events separately. Local events happen within the same protocol stack by local MIHF and remote events happen between local MIHF and remote MIHF subscribed by a remote node.

MIH Information Service: The information service provides the information which is required to perform handovers i.e. the information about available networks, signal strength etc., and is linked to each MIH enabled entities.

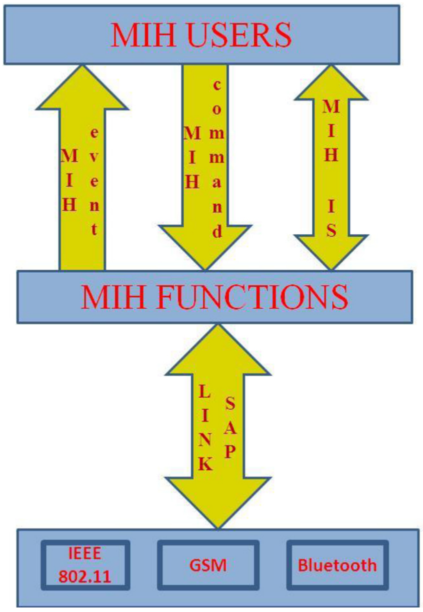

Figure 4: MIHF function for heterogeneous handover

Figure 4 shows the MIH function (MIHF) operation for heterogeneous handover [8]. IEEE 802.21 media independent handover services make use of Service Access Points (SAP) for implementing handover. Basically there are two types of SAPs:

1) Media independent SAPs and
2) Media dependent SAPs.

MIH-SAP is a media independent SAP and is used for communication between MIHF and MIH users. MIH LINK SAP is media dependent SAP and used for communication between MIHF and various link layer technologies: for e.g. IEEE 802.11, 3GPP, Bluetooth etc.

B. Vehicular Technology

Vehicular network is a new networking technology that has emerged in advances with wireless technology. Vehicular technology allows vehicle to vehicle communication and vehicles to nearby fixed equipments. Vehicular networks are formed among moving vehicles with communication equipment.

The proposed system makes use of this new promising technology for emergency communication. The system proposes that, we can use vehicles for data routing. Figure 2 shows data flow through vehicles.

IV. ALGORITHM DESIGN

Handover may happen because of the movement of mobile users or because of introduction of another strong network for stationary users. The proposed system makes use of the new 802.21 standard for heterogeneous handover.

The proposed system designs a mobile initiated handover algorithm between GSM and Wi-Fi network. In mobile initiated handover algorithm the network selection policy function is reside on the mobile node. And it directly uses set of MIH-MN-HO commands and indirectly uses some MIH-N2N-HO commands.

The algorithm for heterogeneous handover is described below.

1. *Start*
2. *Calculate SNR, packet loss and packet delay of mobile node (MN).*
3. *Calculate the MIH parameters using the medium independent command service (MICS).*
4. *If SNR<MIH-threshold-value, go to step 6 else go to step 5.*
5. *If QOS-parameter < MIH-threshold-parameter, go to step 6 else go to step 2.*
6. *Initiate handover.*
7. *Give the required parameters to the MIH user*
8. *Search medium independent information service (MIIS) for candidate network.*
9. *Select the new network based on cost and RSSI.*
10. *Execute handoff*
11. *Stop*

The proposed algorithm makes use of media independent event services, command services and information services. In steps 2 to 5 using the MIH event and command services MIH function calculate the possibility of handover. In steps 6 to 9 with the help of MIH information service it selects the best network available. And in step 10 the handoff is executed. The detailed sequence diagram of the handover procedure is explained in figure 5.

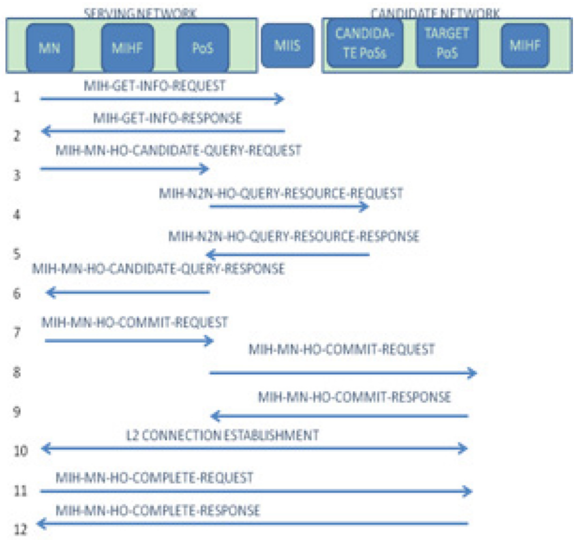

Figure 5: Sequence diagram for mobile initiated algorithm between GSM and Wi-Fi network

V. CONCLUSION AND FUTURE WORK

After a large scale disaster has occurred the communication system will be damaged because of many reasons like congestion in the network, damage of infrastructures like base stations etc. It is extremely apparent that cellular communication is not able to maintain satisfactory communication during and after disasters. Furthermore, an immediate temporary communication system is of the utmost importance during and following a disaster. Most existing systems require the use of satellite phones, which are not user friendly due to their complexity, thus making them ineffective in a disaster scenario.

This paper describes the development a network for emergency communication that can support a large number of rescuers and victims of disaster. The proposed system makes use of existing devices and the system is user friendly. The system creates an overlay network using the smart phones and laptops. And uses satellite communication to carry information from the overlay network to the cellular towers and vice versa. The interoperability of networks is crucial in emergency situations. This paper outlines the design of an efficient method for mobility between heterogeneous networks. IEEE 802.21 standard is used for implementing heterogeneous communication. An algorithm for heterogeneous handover, among GSM and Wi-Fi networks, and based on IEEE 802.21 media independent handover technique is described in this paper.

As a future work we will design efficient algorithms for data compression during handover.

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