Collaborative Mobile Device based Data Collection and Dissemination using MIH for Effective Emergency Management

Aiswaria Ramachandran, Balaji Haiharan

Abstract—The importance of our country's communication system is noticeable when a disaster occurs. The communication system in our country includes wired and wireless telephone networks, radio, satellite system and more increasingly internet. Even though our communication system is most extensive and dependable, extreme conditions can put a strain on them. Interoperability between heterogeneous wireless networks can be used to provide efficient communication for emergency first response. IEEE 802.21 specifies Media Independent Handover (MIH) services to enhance the mobile user experience by optimizing handovers between heterogeneous access networks. This paper presents an algorithm to improve congestion control in MIH framework. It is analytically shown that by including time factor in network selection we can optimize congestion in the network.

Keywords—Vertical Handoff, Heterogeneous Networks, MIH

I. INTRODUCTION

A WELL coordinated and effective response set up after a disaster minimizes loss of life and property and also facilitates early recovery. An effective response system includes forecasting and early warning system for disaster, rapid evacuation of threatened communities and quick deployment of specialized response forces. To provide all the above mentioned services we need efficient communication. In this paper we have tried to introduce some technologies to provide efficient and effective communication for disaster management. For a disaster we have the following phases: Preparedness phase, Early Warning phase, Response phase, Relief phase and Restoration stage. In the preparedness phase and early warning phase, initially the messages should be passed to local people and then to the local administration and then to the other higher authorities. For passing the message to local people we have chosen the message type as icons since it doesn't cause any language barriers and easily understood by everyone. For example, if a fire occurs we can pass a message with fire icon. Along with the icon we can send details about the disaster as text messages. When a disaster occurs, either all the communication lines become busy or communication line is cut off. So it becomes difficult to provide communication for early warning phase and response phase. While designing the architecture and technology for wireless network we should take care that it fulfills the user requirements such as Always Best Connected (ABC). We suggest vertical handoff among existing networks to provide seamless communication

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to users during a disaster. In [1], the authors propose a vertical hand off Scheme where they first design a mechanism to detect the ongoing hand off. Then on the basis of TCP migration they show how a connection is migrated from old communication system to new one. Vertical hand off scheme also includes a handoff aware TCP adaptation mechanism for link adaptation to accommodate with different network characteristics.

II. RELATED WORK

This part gives comprehensive explanation of standards and ongoing works of Media Independent Handover.

In [2], effects of inter-cell and intra-cell handoff hysteresis margins and log-normal shadowing on the residence time in different quality zones in mobile cellular systems with link adaptation are evaluated. Contrary to the inter-cell handoff margin that refers to a difference of received signal strengths, intra-cell handoff margin refers to a difference of Signal-to-Interference ratios, which is used to determine whenever intra-cell handoff is required.

An implementation of MIH middleware in Linux platform has been designed in [3]. Based on the MIH software, authors have developed a high quality VoIP system which integrates Stream Control Transmission Protocol (SCTP), two MIH-IS based user motion detection services and an adaptive QoS playout algorithm. The MIH services, multi-homing capability and Dynamic address configuration extension of SCTP are applied in the VoIP system to perform seamless handoffs. In order to optimize vertical handover between wireless networks, IEEE 802.21 Wireless Group has been developing MIH standardization from 2004. It defines the link layer handover framework supporting network transparency and fast triggering on handover events [4].

Mobility management in heterogeneous networks can happen in different layers of the OSI protocol stack reference model such as network layer, transport layer and application layer. Several mobility protocols have been proposed for next-generation all-IP based wireless system in [5] and [6]. In [11], a handoff decision is made based on the RSSI, available bandwidth, delay, user preference, and so forth.In [11], a handoff decision is made based on the RSSI,available bandwidth, delay, user preference, and so forth. In order to quickly and accurately detect the signal decay, [11] proposed a signal decay detection approach referred to as the FFT-based decay detection.

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III. SYSTEM ARCHITECTURE

This whole paper discusses on providing efficient communication in a disaster hit area. From various surveys in newspapers, it is seen that climate related disasters result in 9 to 13 per cent of loss of GDP in India by 2010 and will be a key factor in preventing the economic growth. The natural disasters in the region leave a trail of tragedy and destruction and arrest long-term development programmes. Disasters also cause supply deficits which lead to increase in inflation and affect the poor people. But nature alone cannot be blamed for disasters and loss of life. Factors like poverty, inappropriate political decisions, and inappropriate disaster management facilities also contribute to the losses caused by disaster. In Fig.1, it is shown that the communication will be down in a disaster hit. A GSM base station is shown in disaster hit area which has lost its connectivity. We have other mobile devices like laptop and mobile phones with Wi-Fi or Bluetooth connectivity.
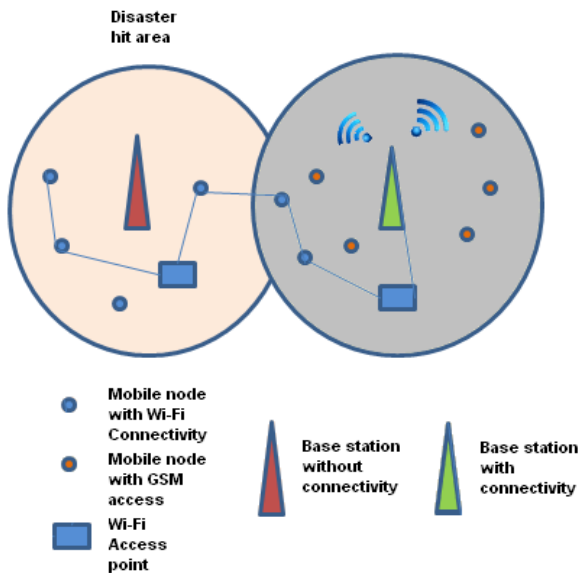

Fig. 1 Network Architecture for Communication in Disaster Hit Area

In such a scenario, Media Independent Handover (MIH) introduces a technology wherein we can use all the available wireless connections for communication. MIH allows vertical handover i.e. handoff from a GSM to Wi-Fi network or Wi-Fi to Bluetooth network. In Fig.1 we have mobile nodes with Wi-Fi connectivity which are communicating to an access point and from access point communication is being handoff to GSM base station. In the disaster hit area we are creating a temporary network using Wi-Fi or Bluetooth connection and communication is handed over to nearby congestion free networks. Since it is possible to perform handoff among heterogeneous networks using MIH, the whole communication load is distributed among various networks. The effort to develop such heterogeneous networks, especially seamless roaming, is linked with many technical challenges including seamless vertical handoff across WLAN and CDMA technologies, security, common authentication, unified accounting and billing, WLAN sharing, consistent QoS,

service provisioning, and so forth [8]. For implementing the vertical handoff in heterogeneous wireless networks, the mobility management represents a main challenge. It relies on two main problems which are location management and handoff management [9, 10].

In this paper we have introduced an algorithm for network selection which avoids congestion since during disaster there will be high network traffic. The proposed algorithm helps in congestion control in MIH.
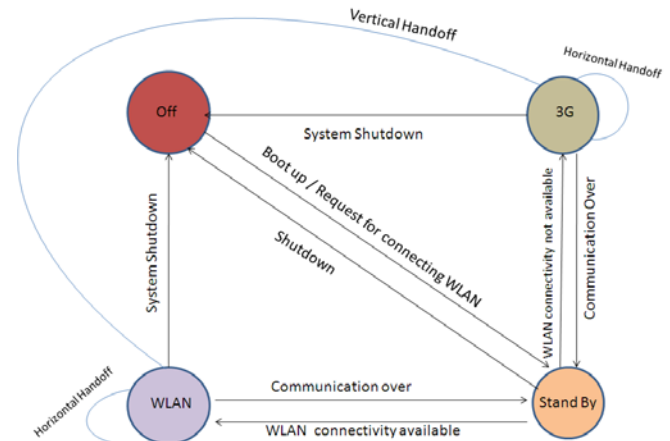

Fig. 2 State Transition Diagram to show communication among mobile nodes

Figure 2 explains the transition diagram of a mobile node. Initially a mobile node is in OFF state. When a mobile node is on, it goes to standby state to save power or if communication is needed, mobile node requests for 3G connection. If 3G connection is not available, it searches for available connection and requests for establishing communication using the available network. If a mobile node loses its 3G connectivity, it searches for available connection and switches to it. When a mobile node does handoff from 3G to WLAN, it is called vertical handoff. If mobile node does handoff within same network, for example, within 3G network itself, it is called horizontal handoff as shown in transition diagram.

IV. A NEW APPROACH FOR NETWORK SELECTION

A) Overview of MIH

IEEE 802.21 standard [7] defines a middleware architecture including a cross layer communication protocol and three services, MIH-ES, MIH-CS and MIH-IS to optimize the handoff process between heterogeneous networks. Figure 2 shows the reference model of MIH. In Figure 3, layer 2 and below protocol modules trigger local or remote events to the higher layer protocol modules and services by MIH-ES for notifying the state change of the lower layer protocols. For example we check the received signal strength of existing network in which communication is ongoing and if it is below a particular threshold MIH-ES triggers upper layer services to perform handoff or network management.Layer 3 and above protocols can issue local or remote commands to control the lower layer protocols by MIH-CS. For example, the mobility management module can use MIH-CS to configure a handoff threshold in the link layer, retrieve the candidate access network list and execute the handover procedure.

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International Journal of Electronics and Communication Engineering
Vol:5, No:4, 2011

The MIH-IS is designed to provide network state information and user customized information, such as link layer resource information and capabilities of access points (APs) or base stations, to indicate to the higher layer services for handoff decision and network management. The MIH-IS uses the extensible mark-up language and type-length-value to represent the data structure of information. Thus each of the layers can utilize this information to decide handoff policy.
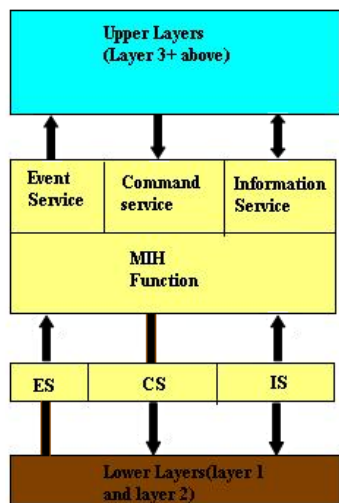

Fig. 3 MIH Reference Model

However, the development of MIH-IS are not limited in the MIH standard. System developers and operators can also provide customized information services to mobile users and communication system for handoff optimization.

B) Vertical Mobility

In Figure 4, looking from a top down perspective we can distinguish between resource management, mobility engineering and service management categories in the system architecture design.

Resource management is comprised of both direct (channel and bandwidth allocation) and indirect (network capacity and performance optimization through various ways) resource allocation in a multiple heterogeneous wireless network environment. Resource allocation affects directly the experienced QoS, but the end-to-end QoS requires other management, such as prioritizing packets in the routing, using header compression over wireless links and buffering packets in the terminals and routers.

Mobility engineering comprises integrating heterogeneous access networks and services, providing mobility management, and designing and implementing various protocols and middleware solutions in the different layers of OSI protocol stack. At the core of whole system architecture is mobility management.

Service management includes providing mobile services, location management and provisioning mobile applications. Figure 5 shows heterogeneous network architecture. The convergence of cellular and computer industries has opened ways for lot of new exciting services and applications. In a wireless domain, macro-, micro- and pico cell often have

overlapping coverage area. Using MIH a user is able to move along these heterogeneous networks in a seamless manner.
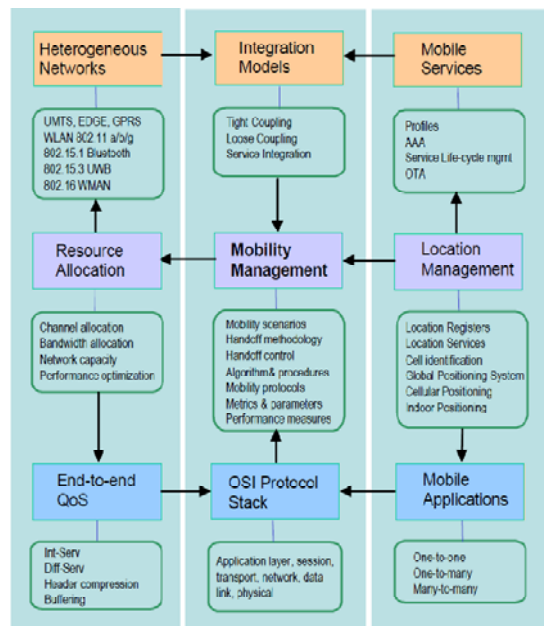

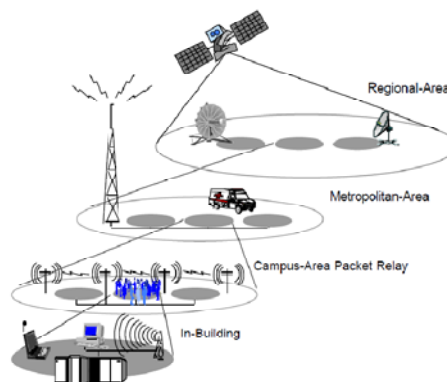Fig. 4 System Architecture for Vertical Mobility

Fig. 5 Heterogeneous Network Architecture

C) Parameters For Network Selection

Table I shows the parameters considered for network selection in the information server. SSID and MAC address are basic information associated with access point. Neighbors give the information about neighbor access points with which mobile node can later associate. Mode defines the mode of connection like GSM, UMTS and so on. Connection number defines the number of mobile nodes associated with access point. More the number of nodes more will be the error rate. The parameter reject states whether a connection should be rejected or not. Update time defines the last time when connection was updated. Energy is the parameter that will be discussed later in this paper. This is also taken as parameter for network selection since it helps in avoiding congestion.

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Vol:5, No:4, 2011

TABLE I
PARAMETERS IN INFORMATION SERVER

SSID	AP1
MAC Address	00-B0-D0-86-BB-F7
Neighbors	AP2
Mode	UMTS
Connection Number	12
FER	1.4e-4
Reject	yes
Update Time	116000
Energy Calculated(Decision Algorithm)	2.4 J

D) Algorithm for Network Selection

In MIH, we have to follow three steps to perform handoff i.e. handoff detection, handoff decision and handoff performance. Handoff decision can be done from network side or terminal side. From available set of networks, the most appropriate network satisfying given objectives has to be selected. So we consider factors like location, data rate, speed and user preference. Here we provide an algorithm for handoff decision where we have included the time factor to take care of congestion in MIH. Before going to our algorithm, Figure 6 gives a data flow diagram of basic MIH handoff algorithm. Figure 7 gives a data flow diagram of the proposed algorithm for network selection. The parameters considered for network selection are as follows:

p- NIC power consumption rate at each state of each network
t- Time required to deliver the required service (service time)
u-Users preference indicator (it can take values from 0 to 1.)

$$E = p*t*u \qquad (1)$$

Equation 1 calculates the energy of the network interface card which can be used for taking decision while selecting network for handoff.
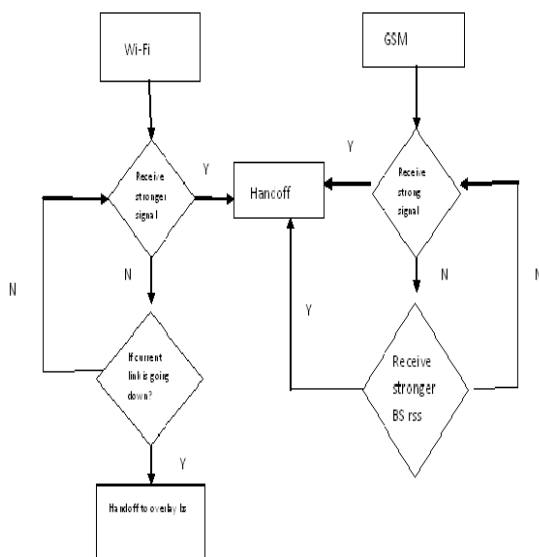

Fig. 6 Basic Algorithm for MIH Handoff

Algorithm:

1. Consider a mobile terminal working in WLAN network.
2. If in idle mode go to step 6.
3. If transmitting mode check for all the neighboring networks and get relevant information from them. (Here consider there is a GSM network available nearby).
4. Calculate WLAN NIC (EW) energy and GSM NIC energy (EG).
5. If EW < EG got to step 1 else go to step 6.
6. Perform handoff to GSM network.

Since we are including the time factor in the above algorithm, it helps us in selecting a network which is not having much traffic and also selecting a faster network.
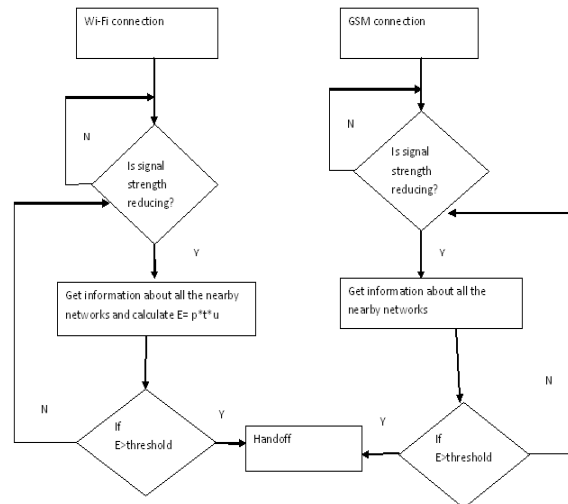

Fig. 7 Network selection Algorithm for MIH

V. CONCLUSION

In this paper we proposed a technology for efficient communication during disasters. In today's world we can see that lot of lives are lost during disasters mainly because of inefficient first response systems. If we are able to provide efficient emergency first response systems we can save more lives. This paper discusses on applying MIH for efficient communication during disaster which can make use of any existing network for communication. MIH can perform handover among heterogeneous networks. We have proposed an algorithm for network selection in MIH which considers congestion in the network. During disaster, mostly communication is not possible because of congestion in network. This algorithm helps in selecting a network which is congestion free. As the future work we can simulate this algorithm in NS-2 and study its performance. Also we can enhance this algorithm using mathematical models.

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