RESEARCH -IN-COMPLETION

Decentralised Disaster Management Information Network *(DDMIN)*: Research Discussions on the inherent Technological and Strategic Implementation Issues and proposed Solutions

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Abstract
The objective of our work is primarily to investigate computer-mediated disaster communication system using rapidly deployable mobile computing and wireless communication technology and to realize a prototype of a Decentralized Disaster Management System and Information Network. Our Decentralized Disaster Management Information Network proposes to use concepts of wireless infrastructure and ad hoc networking based technologies towards a technology-management solution to an issue, which is of prime concern over the ages.

New concepts as well as the customized adaptations to the methods and techniques are also being used like *FMEA*, *ETVX* and the proposed *d-ERP* approaches.

1.0.0 INTRODUCTION

The present research work extends to our earlier proposed concept of 'Mobile Governance' (mGov) [Scalem & Bandyopadhyay, 2002] facilitating the enhanced technologies incorporating new management propositions including inherent aspects like effective real-time information sharing, transparency, security, implementation through wireless/mobile/AdHoc/Distributed networking schemas. The present research on the area of 'Disaster Management' forms the application of that concept.

In the context of our work and scope, Disaster Management (DM) is defined as *"...a superset of direct actions and processes designed to prevent and/or lessen disastrous effects before, during and after a disaster"*. Other than posing an ever-present challenge to public emergency services and ever-so-important human lives, the importance of effective DM can't be underplayed, especially in today's technologically advanced age. To address disasters in a fast and highly coordinated manner, the optimal provision of information concerning the situation forms an essential pre-requisite [GoI report, 2004].

To make the whole exercise the most effective and coordinated, stakeholders, players and organizations involved have to react not only efficiently and individually, but also in a coordinated manner. This highlights the need for both Intra- and Inter-Organization communications at several stages. A lack/lag in communications implies lack/lag of information flows between the level players thereby hindering the critical resource usage and its effective and efficient management. There hence arises a need for an Integrated Communication and Information Network for Disaster Management that provides efficient & reliable exchange with real-time processing of relevant information.

The first thing that goes off and that is so critical is the communication backbone as in the hours and even days following an event, communication is often limited because existing infrastructure was destroyed or the event occurred in an area without infrastructure. Voice service may be severely restricted because of the environmental or non-infrastructure issues. During emergencies when terrestrial telecommunication networks are damaged or severely impaired, alternative and flexible networking arrangements become critically important to ensure ongoing and effective coordination of emergency response and relief efforts. Thus, there is a recognized need for wireless communications, including high capacity wireless, for emergency management [FEMA Report, 2001].

The international counter-disaster community today is increasingly considering computer-mediated networking as a powerful tool for improving disaster communications. Central to this trend is a belief that computer-mediated communications capabilities, both inter-organizations and intra-organization level, can improve disaster management practice to a large extent [USA Report, 1997 & Farley et al, 1999].

Since Disasters themselves are unstructured in scope and hence difficult to be managed centrally, there is a need for a user centric decentralized, hierarchy-independent approach wherein even the end user is empowered accordingly for quick and effective results. The main objective here is to match the available resources at any time with the needs, at the right time and to the right people. This forms the objective as also the scope of our research in the field of Technology enabled, real-time activated and strategically enhanced Disaster Management [Scalem at al., 2004]

2.0.0 MANAGEMENT ISSUES AND DISCUSSION

As could be pointed out the existence of the wireless communication infrastructure alone does not ensure efficient and effective disaster management. The existing Disaster Management (DM) approaches are quite unstructured and are usually centralized in nature with the instructions following some sort of fixed hierarchy. This results in the poor resource management and hence causes inefficiency. Since disasters themselves are unstructured in scope and hence can't be managed centrally, there is a need for a user centric, decentralized, hierarchy independent information-exchange approach wherein even the end user is empowered accordingly for quick and effective decision-making and this also promotes efficient resource sharing [Scalem et al., 2004].

The main management structure of approaching towards our DM solution is on the lines of the structure reproduced below:

- Identification of base model or base region for specific analyses, implementations and test runs
- Identification of the chief stakeholders in the DM phenomena
- Identification of the existing 'As-Is' Processes in Disaster Management Practices
- Collection and collation of major Information flows along with preparation of DM Case studies of different countries
- Identification of the best practices and analyses of the research gaps
- Proposition of 'To-Be' processes against the analyses above
- Simultaneous prototype design and simulations
- Dry Runs, mock drills, etc at the ground zero level

The types of information that need to be shared during disasters are as follows:

- An ongoing assessment of what the disaster situation is and what disaster countermeasures need to be undertaken
- An ongoing determination of what resources are needed to undertake the countermeasures; what resources are present, assigned and out-of-service; how they can be obtained, their capacity and how long will it take for them to arrive
- A determination of the priority of needed disaster countermeasures (and, therefore, resource allocation)
- A determination of what persons and organizations will be responsible for the various tasks necessary to accomplish the countermeasures

The project aims to develop an integrated architecture and a suite of mobile applications to satisfy the above-mentioned information services in order to assist mobile teams of safety/security and emergency response-workers in crisis management during an emergency situation. The system will use advanced techniques in workflow management along with distributed information access and dissemination for effective resource management, integrated with location and presence services, operating transparently on wide area and local wireless networks. It is intended to run on off-the-shelf state-of-the-art mobile phones (Nokia 9500 communicator, for example) or equivalent and laptops and palmtops.

2.1.0 ENTERPRISE RESOURCE PLANNING (ERP)

ERP (Enterprise Resource Planning) can be defined as a *"…software solution that addresses the needs of an enterprise, taking the process view of the organization to meet the organizational goals tightly integrating all functions of an enterprise."* ERP systems help to integrate the various functions of an entire organization [Palaniswamy & Frank, 2000]. Basically an enabler across an organization, ERP attempts to integrate all departments and functions thereof onto a single system that can serve all those different departments' particular needs. It vanquishes the old standalone computer systems in distinct functional areas viz., finance, HR, manufacturing and warehousing, and replaces them with a single unified software program divided into software modules that roughly approximate the old standalone systems. Taking a step further, a definition of a web-

enabled organization ERP was given wherein Internet was proposed to be the enabler [Norris et al., 2000].

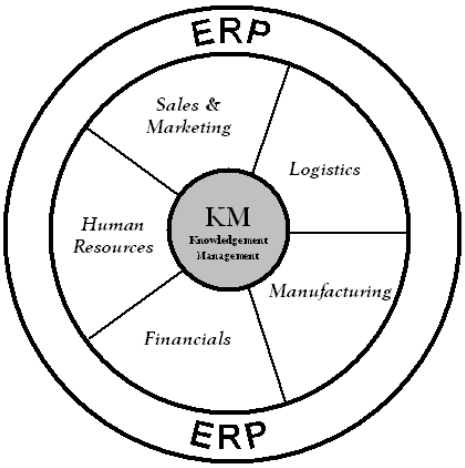

Fig. 1. Basic ERP Schematic

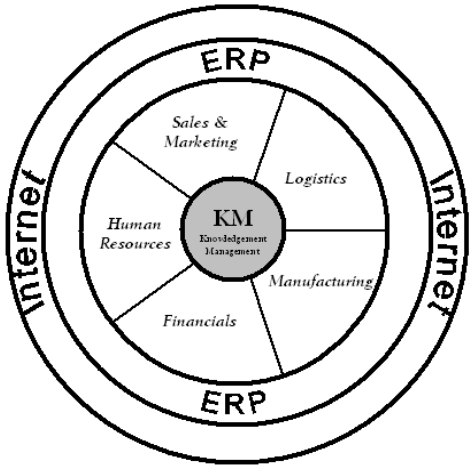

Fig. 2. Adaptation of web ERP

Our work further explores the ERP solutions and studies the multiple effects of new economy communications under the distributed computing environment *(esp. Mobile/Wireless/ICT/Satellite Technologies)* in the *Heterogeneous* space *(Geographical regions like City, Country, Continent, etc)* as against the commonly researched upon *Homogeneous* one *(like Organizational IT impact, Industry impact, etc)*. The main difference between the two atmospheres lies in the degree of "uniqueness" [U] and "adaptability" [A] of the target audience; e.g., in the *Homogeneous* environment, the degrees are: [U, A: LOW, HIGH] while for *Heterogeneous* environment, the degrees are: [U, A: HIGH, LOW]. As such the rules and norms are totally different in both cases and hence one can't apply the same set of rules/technology/etc of *Homogeneous* environment to *Heterogeneous* one. Herein lies the USP of our research, which is both technical as well as managerial.

We are proposing a new concept 'd-ERP' (distributed ERP) in heterogeneous environments and its details and technological issues are discussed in section 3.2.0 ahead.

3.0.0 RESEARCH ISSUES

The research agenda is three fold:

(a) ***Management:*** 'As-Is' & 'To-Be' mappings through analyses and modeling
(b) ***Technology:*** Technological implementations, simulations and tests
(c) ***Techno-Management:*** Strategic modeling, Feasibility Studies & Field reports

3.1.0 MANAGEMENT ROADMAP

The outline of the "Management" agenda is as per the following structure:

- Identification of the major stakeholders as per the primary and secondary field research studies
- Understanding the stakeholders' version of current disaster management system and how they are measuring the system
- Identification of different disaster scenarios and the entities impacted for disasters

- For each type of disaster scenario and covering each entity, chalking out the existing processes (As-Is) and sub-processes recursively to the extent we are satisfied. *{Capture of both the documented process (process that you think it is) and the process that is followed (process that actually is)}*
- Enlisting the outputs of each of the critical processes and the inputs it requires.

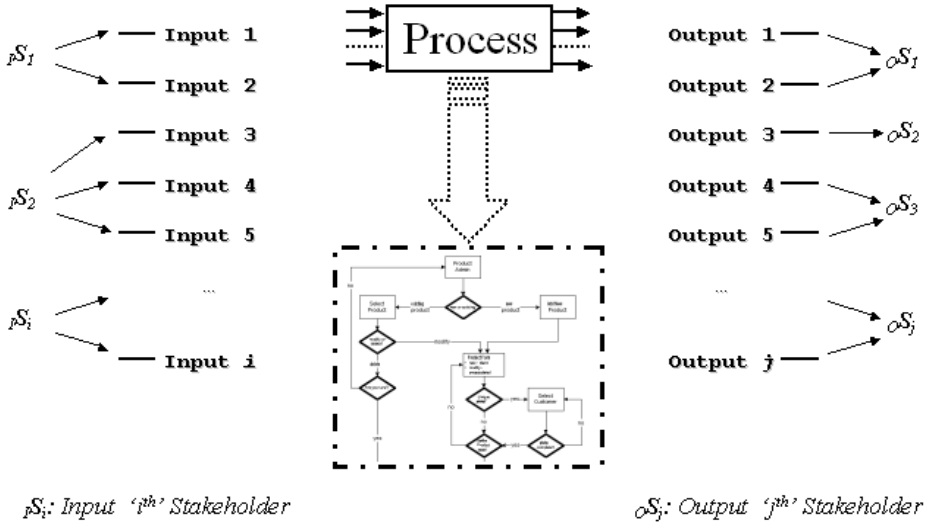

Fig. 3. Process Modeling

- Identification of the gaps between the expectation of the stakeholders and the existing processes, coming up with a 'To-Be' solution towards improving the process. *(Through customized industry standard FMEA model)*
- For each of the process end users, creation of specific action-sheets covering the activities before, during and after disasters. *(As per the industry standard 'ETVX format'; Entry-Task-Verification & validation-eXit)*
- Establishing test communication systems between the stakeholders and decentralizing the activities. The feeding of information and querying of information will be decentralized and repository of information will be both centralized and/or decentralized based on the requirement *{Use of customized industry standard Dynamic Systems Development Method 'DSDM' approach and simulations of test prototype}*
- Testing of proposed plans through mock drills and identify process gaps
- Instituting a monitoring scheme, which will constantly update the activities based on the feedback from the stakeholders.

3.1.1 Analysis of Failures using FMEA (Failure Mode and Effect Analysis)

The propensity of managers and engineers to minimize the risk in a particular system, design, process, and/or service has forced an examination of reliability engineering, not only minimizing the risk, but also to define that risk whenever possible. FMEA has extracted the basic principles without the technical mathematics to give a dynamic holistic approach along with the tool committed for continual improvement [Stamatis, 2003]. The FMEA *(Failure Modes And Effects Analysis)* technique considers how the failure modes of each system component can result in system performance problems and ensures that the appropriate safeguards against such problems are in place. It is a bottom–

up analytical process that identifies process hazards and evaluates possible process failures along with the risks associated with them [NASA Report, 2000]. The FMEA model is used to build a plan for reducing or eliminating the risks involved.

We are utilizing the FMEA approach as an integral part of early design process of system functional assemblies which and shall be updated to reflect design changes. The analysis shall be used to assess high-risk items and the activities underway to provide corrective actions throughout the preliminary to the final design. The discrete steps involved in our FMEA approach are as follows:

(a) Define the system to be analyzed. The system shall be broken down into critical processes and they would have the information mappings.
(b) Construct the information mapping block diagrams. All stakeholder system interfaces shall be indicated.
(c) Identify all potential items and interface failure modes and define their effect on the immediate section, on the system, and on the task to be performed.
(d) Evaluate each failure mode in terms of the worst potential consequences that may result and assign a severity classification category.
(e) Identify failure detection methods and compensating provisions for each failure mode.
(f) Identify corrective design or other actions required to eliminate the failure or control the risk.
(g) Identify effects of corrective actions or other system attributes, such as requirements for logistics support.
(h) Document the analysis and summarize the problems which could not be corrected by design and identify the special controls which are necessary to reduce failure risk.

To illustrate with an example, a self-explanatory section of the FMEA analysis in the context of our System Analysis is as per the following table:

Item/ Process Step	Potential Failure/Error Mode	Potential Effect(s) Of Failure	Severity (S)	Potential Cause(s) Of Failure	Occurrence (P)	Current Controls	Detection Score (D)	RPN=S*P*D	Recommended Action
Pre Disaster Situation	**No Inventory**	Cannot Supply on Demand	**8**	No assessment done	**6**	No control / Need based	**3**	**144**	Assessment for minimum requirement in hand to meet disaster.
			8	No Infrastructure available	**6**	Inspections	**3**	**144**	Look for minimum infrastructure required for inventory.

Table. 1. Example model of FMEA

3.1.2 ACTION ITEMS USING ETVX (ENTRY-TASK-VALIDATION-EXIT)

We are also utilizing the ETVX (Entry-Task-Validation-Exit) process definition paradigm that was introduced by IBM to document their processes [Radice, 2002]. While 'E' stands for the entry criteria which must be satisfied before a set of tasks can be

performed, 'T' is the set of tasks to be performed, 'V' stands for the verification & validation process to ensure that the right tasks are performed, and 'X' stands for the exit criteria or the outputs of the tasks.

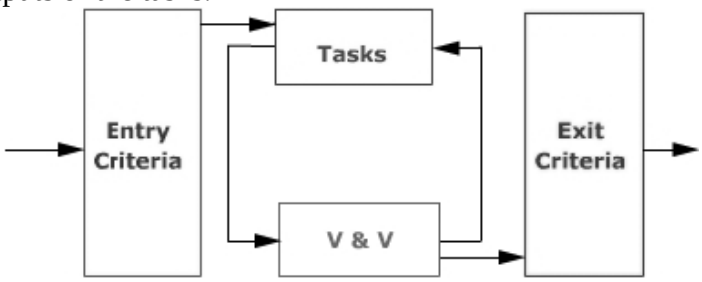

Fig. 4. ETVX Model

If an activity fails in the validation check, either corrective action is taken or a rework is ordered. It can be used in any development process. Each phase in the process can be considered as an activity and structured using the ETVX model. If required, the tasks can be further subdivided and each subtask can be further structured using the ETVX model. The following table illustrates a sample entry in our ETVX model of Disaster Management Information Network mappings.

Entry	Task			V & V	Exit	Time to Resolution
	Who	What	How			
- Information from DM's office - Receipt of test results from laboratory.	Block Development Officer	Re-assess resources	Checking inventory, communicating with NGOs.	Immediate Requirement of drinking water received	Alerted DM Office, alerted NGOs,	24 hours

Table. 2. ETVX Sample Table

3.2.0 TECHNOLOGY ROADMAP

As per the existing supply-demand dynamics, our work is contributing towards the issue of touching upon the Distributed Enterprise Resource Planning (*d*-ERP) approach. While the existing ERP approaches are limited in their scope by addressing the homogeneous components, our novel approach of *d*-ERP is addressing the validity and scope in the heterogeneous space.

As an introduction to our *d*-ERP proposition, we are working to study the multiple effects of new economy communications *(esp. Mobile/Wireless/ICT/Satellite Technologies)* under Heterogeneous atmosphere *(Geographical regions like City, Country, Continent)* as against the commonly researched upon *HOMOGENEOUS* atmosphere *(like Organizational IT impact, Industry impact).* The main difference between the two atmospheres lies in the degree of "uniqueness" [U] and "adaptability" [A] of the target audience; e.g., in the Homogeneous environment, the degrees are: [U, A: LOW, HIGH] while for Heterogeneous environment, the degrees are: [U, A: HIGH, LOW]. As such the rules and norms are totally different in both cases and hence one can't apply the same set of rules/technology/etc of Homogeneous environment to Heterogeneous one. We are proposing a unique concept of '*d*-ERP'; an ERP in heterogeneous, decentralised and distributed environments. The hierarchy and related enabling are as per the figure below.

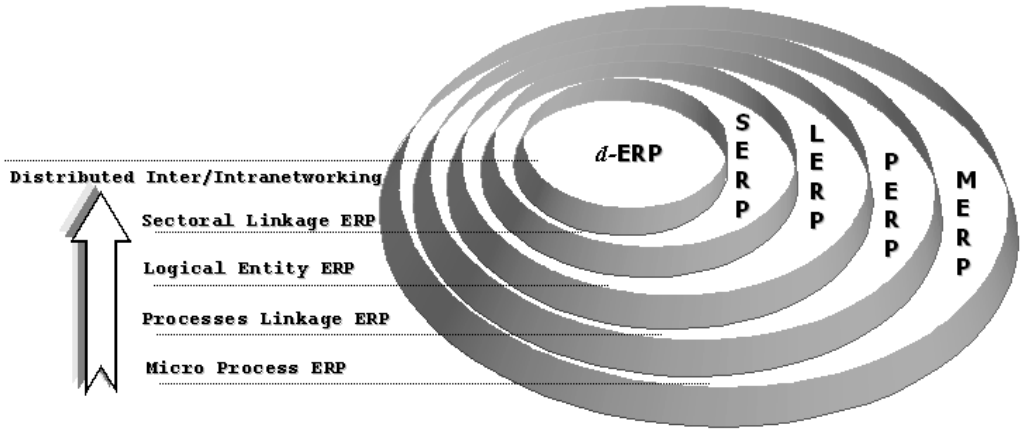

Fig. 5. *d*-ERP Hierarchy

Once all the sectors have been activated through technology, the distributed and decentralised enabling would lead to the overall *d*-ERP system. The enabling procedure and the structured approach as detailed under would be in steps. First of all the micro processes would be mapped thereby paving way for enabling the major macro processes of the logical entities (discussed in detail in section 3.3.0). Once the entire entity has been enabled on a real-time ERP, the sectors involving the inter-linkages and sectors would be taken in thereby giving the d-ERP structure.

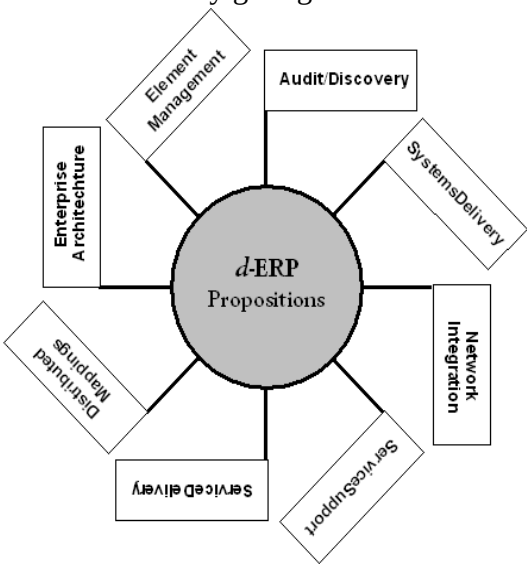

Fig. 6. d-ERP Concept

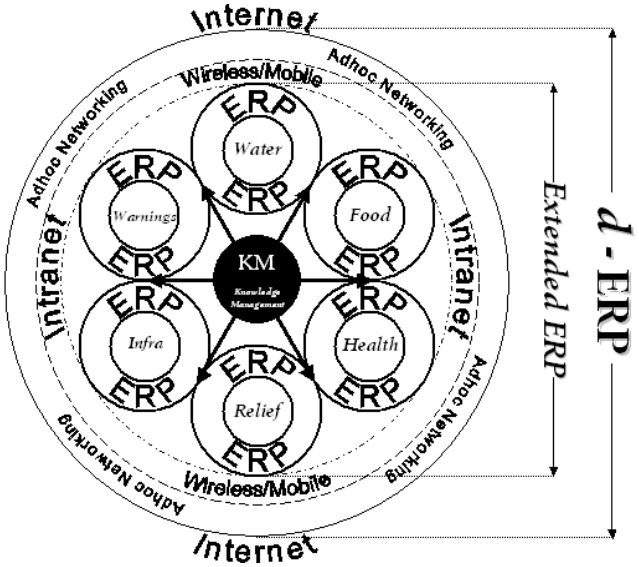

Fig. 7. Detailed d-ERP layers

In the context of our distributed solutions to Disasters and Disaster Management that are characterized by having no distinct functional components, the regular ERP approach could not be applied. Rather the setups being heterogeneous functional groups that are interconnected, there needs to be a system which can integrate these groups in a totally decentralised and distributed manner. As per the existing supply-demand dynamics, our work is contributing towards the issue of touching upon the Distributed Enterprise Resource Planning (*d*-ERP) approach. All the six logical entities (water, food, health, etc) are enabled through the technological tools within adhoc networking setups, which

eventually are inter-networked thereby giving a real-time Disaster Management Structure.

While the existing ERP approaches are limited in their scope by addressing the homogeneous components, our novel approach of *d*-ERP is addressing the validity and scope in the heterogeneous space. We are extending the definition of enterprise by taking the heterogeneous geographical and demographic regions as a distributed enterprise connected through a real-time network/system. The technological components of our research is as per the following roadmap:

- Develop an integrated architecture and a suite of mobile applications to assist mobile teams of safety/security/emergency response workers in an emergency situation.
- Use off-the-shelf state-of-the-art mobile phones or similar handheld devices to develop:
    - *Peer-to-peer workflow management*
    - *Location and presence services*
    - *Transparent communication layer over wide area and local wireless networks to allow proper resource management and information sharing.*
    - *Establish common understanding of each other's position within the area of interest*
    - *Messaging service (text, image, voice and video clips)*
    - *Compute dynamically a resource allocation plan*
    - *Distributed information access and dissemination for efficient resource management*
- Test and assess the prototype in mock emergency scenarios.

A list of the enabling technologies that are taken into investigation for feasibility during the course of research is as follows:

- Configuring the Heterogeneous Network using off-the-shelf state-of-the-art mobile phones or similar handheld devices and devices for wireless connectivity to establish communications locally within the disaster site, within the local regions, and nationally
- Intelligent Routing Strategy for Coordinated Information Exchange in Mobile and Wireless Environment: Point-to Point Routing, Point-to-Multipoint Routing, Content-based Routing, Location-based Routing
- Handling Disconnected Operations in wireless environment
- Topology Discovery and Location Tracking

3.3.0 TECHNO-MANAGEMENT ROADMAP

There is a recognized need for rapidly deployable wireless communications, including wireless ad hoc networks that can be formed among the relief workers carrying handheld devices or laptops for emergency management [Midkiff et al, 2001 & Meissner et al, 2002]. However, the formation of a wireless communication infrastructure alone does not ensure efficient and effective Disaster Management (DM). In a typical DM scenario, the most common problem is the inefficient management of resources (basic commodities like food, drinking water, medicine etc.) due to poor co-ordination and lack of

communication among the heterogeneous groups participating in relief operations. In fact, the nature of necessity and degree of devastation may vary even within the affected area; thus, the relief requirement cannot be analyzed a priori. As a result, the initial relief is distributed in random manner with a follow up of urgent demands. This clearly indicates that a proper approach needs to be adopted for efficient management of relief operations that should be capable of assimilating the information regarding inventory of resources from different participating groups and disseminate it over the distributed network in a fully decentralized manner.

For the purpose of modeling the structure, we had to research upon the existing hierarchy setups and found out that these are reflected similarly across the developing countries. The hierarchy structure of West Bengal state in India forms the backdrop for our prototyping purposes which consist of the following levels: District Level, Sub-Divisional Level, Block Level, Gram Panchayat Level and Booth/Volunteer Level. To take into account the different levels of usage and responsibilities, the information flow would have the following four sets of headers:

(a) To feed Information - UPDT
(b) To see Information – CHCK
(c) Instruct for info – INSTRCT
(d) To seek instructions - SEEK

Upon extensive research, whereupon we proposed the concept of 'Thematic/Logical Entities' rather than the established entities to develop our model we found out that out of the earlier proposed eight a couple are rendered redundant by the respondent stakeholders in the context of actual field dynamics. The six main logical entities being taken finally into consideration are as follows:

1) *Water & Sanitation (WaTSaN)*
2) *Health (HLTH)*
3) *Food (FD)*
4) *Relief & Rescue (RSCUE)*
5) *Infrastructure (INFRA)*
6) *Warnings (WRNG)*

The DDMIN has three main zones: Pre-Disaster Stage *[P]*, Disaster Stage *[D]* and the Post Disaster Stage *[PO]*. Each stage has been broken into the 3-4 critical key information processes that have been researched upon through country analysis and the relevant terrain/situations.

$$\mathbf{I_p = E_n T_e Z_i C_n} \qquad \textbf{… … … … … … … … … (1)}$$

The entire information set could be depicted as [P, D, PO] and the entire probable information points, for design purposes, could be calculated as per the above equation. In the equation, E_n represents the number of entities, T_e represents the Sub-themes of the entities, Z_i represents the number of zones and C_n represents the critical information sets of information.

The figures ahead showcase the concept.

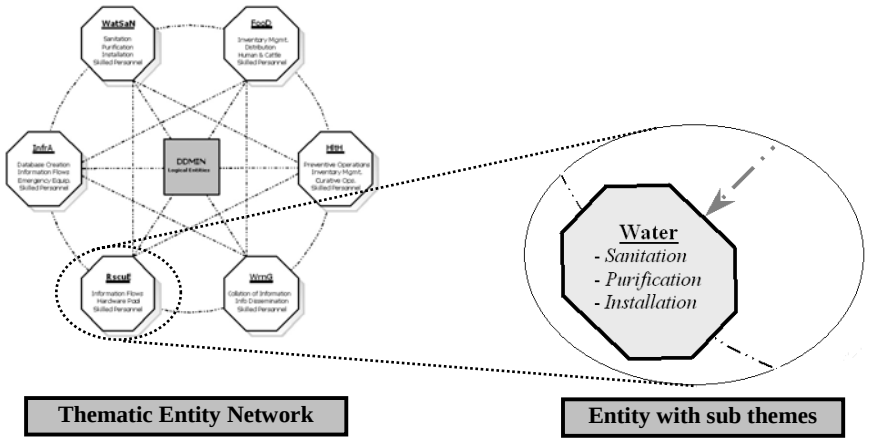

Fig. 8. Thematic Entity and its break-up

Since the number is dependent of several factors like, type of disaster, geographic situations, environmental atmosphere, technology spread, etc, it is indeed a huge research problem whose address promises to contribute to the immense DM proportions worldwide. The internal hierarchy design of the DMIN system is as per the following schematic layered structure.

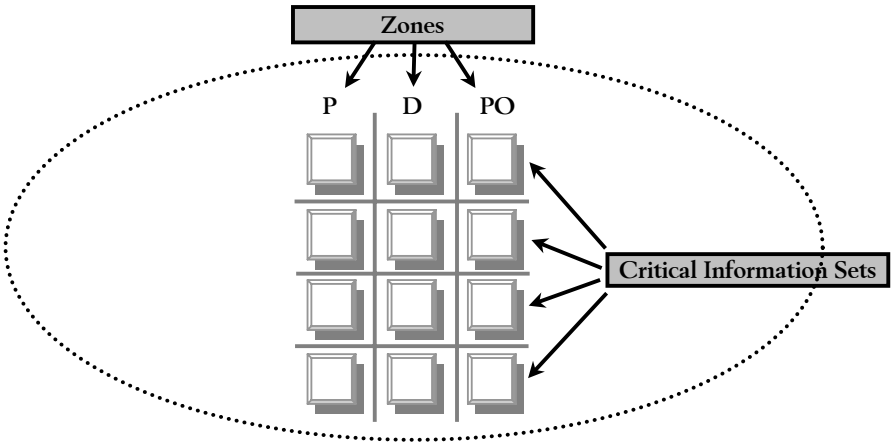

Fig. 9. DMIN internal structure

The proposed DMIN utilizes the concept of Mobile Multi-Agent Systems. Broadly speaking, a mobile agent is an executing program that can migrate during the execution from machine to machine in a heterogeneous network atmosphere [Brewington at al, 1999]. Mobile agents are especially attractive in a dynamic network environment involving partially connected computing elements [Gray et al, 1996]. Mobile agents could be effectively used for multifarious purposes ranging from adaptive routing [Di Caro et al, 1998], distributing topology information [Minar et al, 1999], offline messages transfer [Bandyopadhyay et al, 1999] and distributed information management [Dale, 1997)]. One of the most important factors in our mobile agents' aided network is to collect all topology-related information from each node in ad hoc wireless network and distribute them periodically (as updates) to other nodes through mobile agents [RoyChoudhury et al 2000]. Once topology has been mapped the other two relevant

aspects remain as Information retrieval and Information dissemination taking in the concepts of link stability, information aging, etc. A depictive self-explanatory implementation set up is as shown in figure below for quick reference.

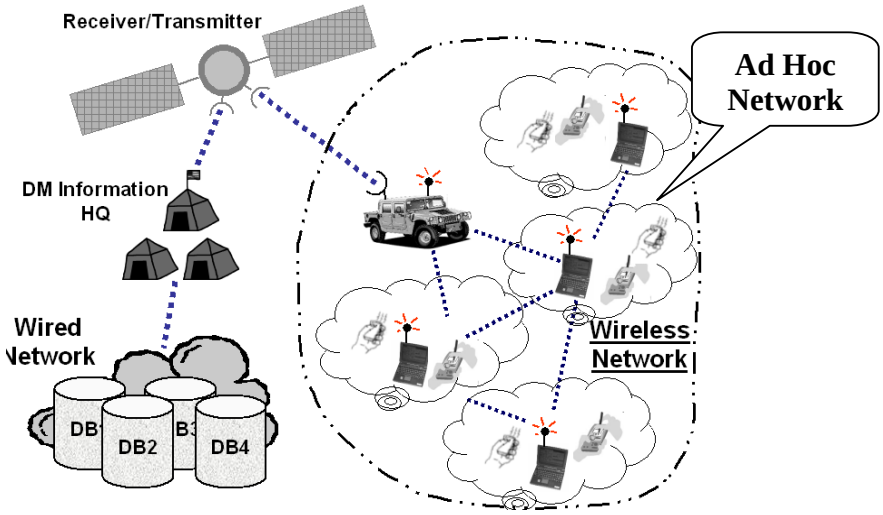

Fig. 10. Depictive Implementation setup

A centralized management is characterized by restricting important decisions to one or a few nodes on a given sub network wherein these special nodes become performance and administrative bottlenecks in a dynamic system [Kramer et al, 1999]. A decentralized and fully peer-to-peer architecture like ours, on the other hand, offers potential advantages in scalability as also the scope. There is a growing interest in using mobile agents as part of the solution to implement more flexible and decentralized network architecture [Pham et al, 1998 & Appeleby et al, 1994]. DMIN uses Flags/Emails/SMS for both off-line messaging and on-line instant messaging schemes [Minar et al, 1999]. While the front-end is being made simple to use for obvious reasons, the back end of the proposed application is highly complex with regards to the issues involved like complexity of the systems involved, networking issues, algorithms involved and the technology frontiers.

The pilot implementation is under process and would involve a simulated run on a particular disaster. The system being developed is also benefiting by the author getting the SAARC fellowship towards visiting the countries where the DM systems are in place for extrapolation purposes. The benefits accruing by the DMIN are immense, given the scenario where even a 10-20 % savings of the existing losses in life and equipment during a disaster could amount to huge monetary and human values. The user feedback so far has been very good.

Please refer to the following figure for an example query on health inventory status utilizing the usage of mobile-agents for the underlying self-explanatory approach.

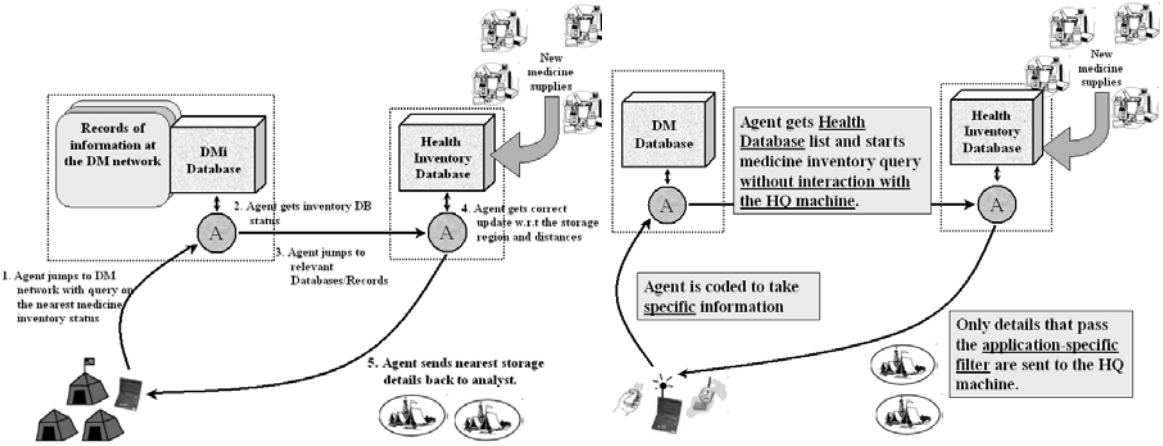

Fig. 11. Typical agent query system and an internal view of Agent-based query

Our work underlines the need and importance for the content based searching as well as routing in the context of a fully distributed Decentralised Disaster Management Information Network (DDMIN). For example, let us assume that a relief worker urgently requires some amount of cholera vaccine. In such cases, there is a high need of getting right things in right amount at right time from a right place i.e. a place that is physically near and accessible in such an emergency situation. In a distributed network with only wireless connectivity and no centralized control, these kinds of random searches (the node issuing the query have no prior idea about the location of the destination) can only be handled using content-based routing scheme.

We have developed an intelligent multi-hop information retrieval system supported by a ***content-based*** network where the query itself will lead the search process to get the proper information from the nearest available destination through the novel concept of utilizing a two-layered approach of content-based searching using ***narrow-casting*** superimposed over a broadcasted ***information-fading*** layer. The objective of *information-fading* is to make a node aware of information content of other nodes in the network through broadcast-based multi-hop percolation of information; however, the preciseness of knowledge about a node decreases or fades away with hop-distance, thus reducing the information overhead.

The term fading of information actually implies propagation of progressively summarized information based on a semantic classification of information. In such a knowledge-network, our content-based query retrieval process becomes quite effective and uses *narrow-casting* (as opposed to broadcasting) to access the prospective destination through the relevant set of nodes only.

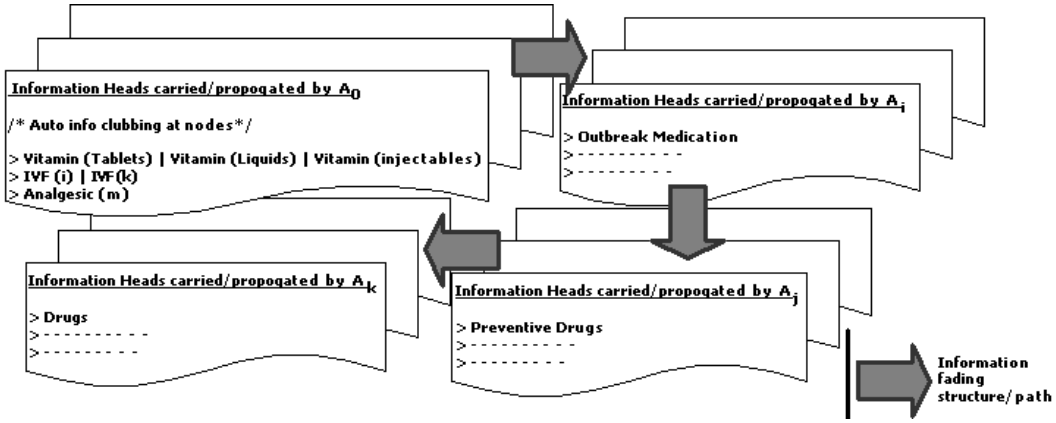

Fig. 12. Typical internal information mapping structure

The per-hop narrowing of the search space will eventually reduce the unnecessary visit of irrelevant nodes. The benefit of narrowcasting with information fading will be more pronounced in large network and with frequent searches. The information flows are intelligent in nature with the inflows and outflows following the faded information paths. The scaling down factor is tremendous with the simulation and running results showing a remarkable reduction in the search domain by a factor as high as 2.5 times. The basic concept of our information-faded network is showcased below.

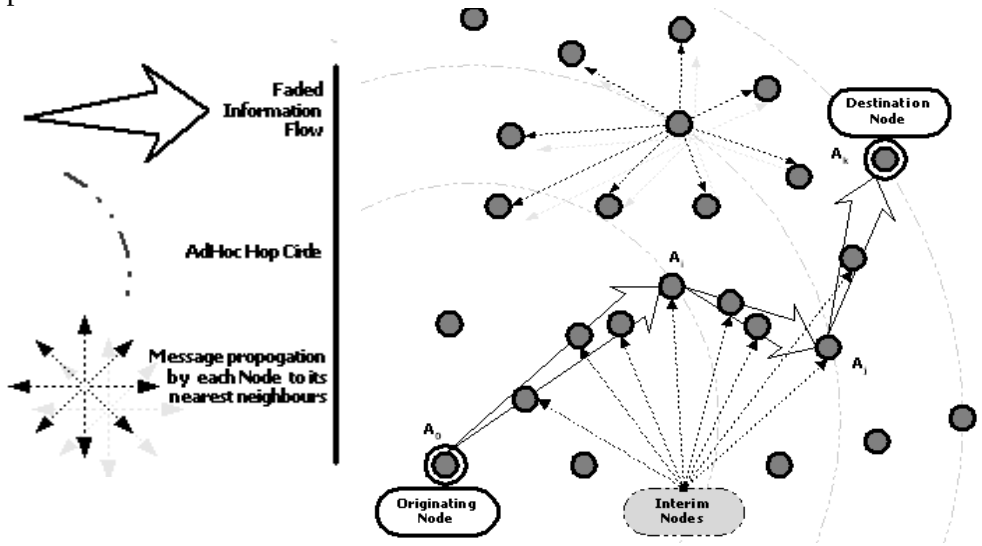

Fig. 13. Typical dynamics of information flows/retrieval

Some salient issues that the intelligent solution takes into account are as follows:

- Navigation Strategy of Mobile Agents for Coordinated Information Exchange: *Strategies for optimal navigation of mobile agent depending on availability of computing and communication resources*
- Handling Disconnected Operations using Mobile Agents: *Methodology and algorithm for handling disconnected operation*
- Topology Discovery and Location Tracking: *Efficient algorithm for topology discovery and location tracking in presence of dynamic ad hoc and infra-structure-based mobile network*

- Security Issues: *Complete requirement specification for the security of data in the nodes and in transit*
- Configuring the Heterogeneous Network: *Strategies and algorithms for auto-configuration and dynamic reconfiguration of the following three-tier infrastructure; a) Local connectivity, e.g., using wired and wireless local area network (LAN) technology; b) Backbone connectivity, connecting those LANs in multiple sites; c) Wide area network (WAN) connectivity in the form of the global Internet or a private network*
- Intelligent Routing: *Through Location Aware Routing (LAR) & Content Based Routing (CBR). While in LAR, the messaging is based on the coordinates specific to a particular sector, i.e., transmitting node routes to receiving node (s) that s/he knows who is present towards his/her east, in the CBR scenario, the data is received and, based on its content, forwarded to the proper location. In the context of the Information system, it is like gathering the information based on the contents*
- Optimized Placement of Routers for Ensuring Connectivity: *Optimal router placement for survivable network connectivity*
- Efficient Power Control Algorithms: *Self and neighbor power-aware algorithms for routing and resource management*
- Security Issues in a Decentralized Environment: *Suitable real-time algorithm and key management techniques for different segments of the network for confidentiality, integrity, availability, authentication, non-repudiation, etc.*

4.0.0 METHODOLOGY ADOPTED

The methodology towards our research is a mix of structured questionnaires, unstructured interviews, country case studies, regional case studies, interactive discussions with the stakeholders and technological development including simulations. The results are validated through respondents (all stakeholders) direct feedback. Sampling is done as per the standard approaches.

5.0.0 CONCLUSION & FUTURE SCOPE

This paper outlines the research work being carried out in the context of Disaster Management. While we have incorporated the mobile technologies in the DMIN set-ups, the prime issues of interest remains the Service Delivery, democracy, governance and law enforcement [Di Maio, 2002]. Application development is another aspect that has an immense scope for research. The applications as also the end product should be so developed so as to take into account the literacy levels, technology adaptability, ease of usage, effective GUI techniques, etc. Standards of technology and the effective bandwidth allocation are considered to be two of the most important aspects of wireless applications and their full potential [Chang et al, 2002] as also the security and authorisation policy matters.

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