Post Disaster Relief Operations Communication Using Grid Location Services in Smartphone

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Abstract: ***During any large-scale disasters like flood and cyclone have severe impact on communication Infrastructure. The availability of the Internet is ruled out in this case, mobile phones are not fully usable in some selected regions. Devices for maintaining minimal services are mostly expensive satellite phones or specialized point to point radio communication systems. One of the major problems during disasters is that the rescue and relief operations are not coordinated well. For this reason, there is a need of system that will help in the efficient distribution of rescue and relief to disaster-affected areas. In contrast to the vulnerable fixed network infrastructure, it is very likely that battery powered wireless personal mobile communication devices will survive in disasters. Currently, those devices are having powerful processors and high storage capacity with GPS and multi radio interfaces. Such devices are therefore, promising candidates to contribute in forming peer-to-peer wireless network structure to support disaster communication. Mobile nodes communicate with each other in peer to peer mode. At the same time the mobile volunteers also exchange information among one another in a peer to peer mode, thus integrating field information intelligently and autonomously using auto configurable mobile-phone-based peer to peer communication.***

Keywords: mobile phone, location, grid, communication, services, satellites

1. Introduction

An Ad-hoc is a local area network or some other small network, especially with wireless or temporary plug in connections, in which some of the devices for network are also in network only but for some duration of a communications session. It allows new network devices to be quickly added. Each node having a unique network address that is recognized as the part of the network. A Collection of nodes that does not rely on a predefined infrastructure. Auto configurable network and Self organizing. Nodes are mobile and hence have a dynamic network topology. Nodes in adhoc networks play both the roles of routers and terminals. Routing protocol required.

The objective of this paper is to develop a dynamic virtual star topology with the static central control station as the root node and static shelter points as end-nodes. The connectivity between the root node and each of the end-nodes is achieved using mobile volunteers opportunistically as message ferry. At the same time, the mobile volunteers also exchange information among one another in a peer to peer mode, thus integrating the field information intelligently and autonomously using auto configurable mobile phone based peer to peer communication. Basically mobile volunteers act like end devices. The major focus of this study is to come up with a framework for post-disaster resource requirement analysis, resource allocation and distribution, which involves on-going determination of what resources are needed, what resources are present, what resources need to be acquired and how long will it take for them to arrive. Using peer to peer communication, eventually the entire network will appear as virtually connected, delay-tolerant network with every node knows the approximate information about other nodes, including resource need. Thus, the system enables coordinated relief operation, where no shelter will be having excess resource, nor it will be under-resourced.

2. Related Work

"VSAT technology", which is particularly useful when terrestrial infrastructure has been destroyed provides a powerful tool to mitigate damage incurred by disasters. The deployment of VSAT is typically seen as the last option for obtaining access to larger communications network and the Internet. It is often necessary for organizations operating in remote areas. However, VSAT Technology is expensive and its deployment is complex in nature. Technical support is critical for VSAT deployment after disasters, because in the disaster area the people are much more focused on helping people than messing with technology. VSAT is often deployed in the context of establishing new field offices and thus is primarily deployed for development purposes, rather than for emergency response, or direct post disaster relief.

Prototypical Crisis Information Management System (Iannella, 2007) [8] is a conceptual framework to support two challenges: incident notification and resource messaging. The mantra for Crisis Information Management Systems is to "deliver the right information to the right people in the right format in the right place at the right time". These five variables, coupled with the stress of a major disaster make coordinated information management one of the greatest challenges for the disaster coordination sector. However, this system assumes that a strong ICT infrastructure is in place in order to enable cooperation between a large number of organizations and integration with these organizations. A similar collaborative mechanism has been proposed by Marrella (2011) [9], where the communication is executed on top of mobile networks. However, the collaboration strictly depends on the possibility that operators and their devices can communicate with each other using some communication backbone.

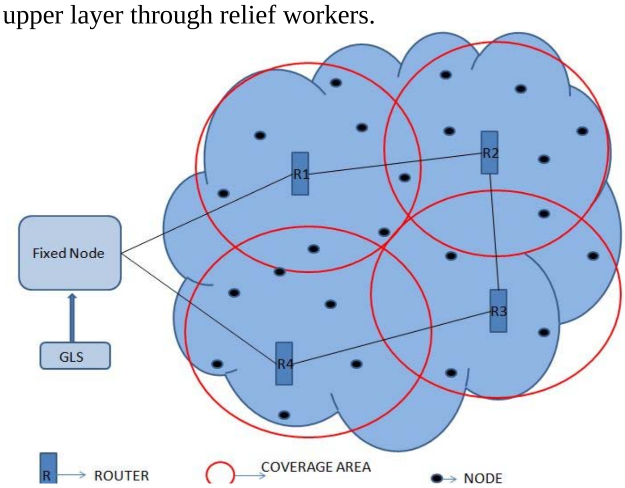
Starting from collected user requirements and their generalization, WORKPAD architecture (de Leoni 2007) [10] is based on a 2-levels peer-to-peer (P2P) paradigm: the first P2P level is for the front-end and the latter level is for the back-end. The need of such two P2P levels arises from the analysis of user requirements, as there exist back-end central halls where the chiefs of involved organizations are located, as well as several front-end teams which are sent to the affected area. This architecture is based on a stable centrally connected network where all the information percolates and centrally managed. If the entire connection disrupted then the efficiency level will decrease drastically.

Multiple Criteria Decision Technique, together with a coordination strategy and a communication strategy have been deployed in order to assure that the decision making process has the appropriate information upon which to perform the resource distribution (Silvia, 2003). The coordination strategy allows distributing resources to the victims that need the most urgent rescue. The role of the moving agents is to gather information about victims and the role of the fixed agents is to pass on this information to the fixed stations. Here, some Communication infrastructure has been assumed. However, if there is no communication at all between agents, then results show that moving agent get lost in the rescue scenario and cannot find victims.

3. System Architecture

3.1. System Description

During coordination of post-disaster relief operations and distribution of resources are shelter-centric through the relief-workers working at those shelters. These relief workers are exchanging their presence,field information and shelters requirements by using their smart phones in an opportunistic network. These shelters are operated by a Shelter Coordinator who will periodically coordinate with nearest relief workers autonomously for analyzing field need and informing shelter need through smart phone. Another role of shelter coordinator is to control the navigation pattern of nearby relief workers with an objective to spread the information to other shelters and eventually to Central server. Thus the information percolates from lower layer to upper layer through relief workers.



3.2. Formation of Smart phone based Opportunistic Network

In the decentralized Disaster Management scenario, relief workers are exchanging their presence, field information and shelters requirements by using their smart phones in an opportunistic network. Opportunistic network as one type of challenged networks where network contacts are intermittent or where link performance is highly variable or extreme. In such a network, there does not exist a complete path from source to destination for most of the time. In addition, the path can be highly unstable and may change quickly. Therefore, in order to make communication possible in an opportunistic network the intermediate nodes may take custody of data during the blackout and forward it when the connectivity resumes. Thus, in this context Opportunistic Network framework provides potential platform for information communication. In opportunistic networks, the devices spread across the environment by relief workers and form the network. In this type of networks, the mobility of devices is an opportunity for communication rather than a challenge. Mobile nodes communicate with each other even if an end-to-end route connecting them never exists. Any node can opportunistically be used as the next hop, if it is likely to bring the message closer to the destination(s).

Currently, those devices or Smart Phones are having powerful processors and high storage capacity with GPS and multi radio interfaces (Cellular, Wi-Fi and Blue-tooth). These Smart Phones are not only useful for making telephone calls, but also adds features that might be found in a personal digital assistant or a computer. Smartphone also offers the ability to send and receive messages on peer to peer basis using GPS or Wi-Fi, Blue-tooth technologies and edit Office documents. Such devices are, therefore, promising candidates to contribute in forming ad-hoc wireless network structure to support disaster communication

3.3. Decentralized Information between Peer to Peer

The coordinator sends information by using Smart Phone to nearer relief worker. This information contains sender ID, location and sending time which will help to review the information time and identification status. Relief worker also has the option to forward that received information from shelter coordinator to another relief worker by updating its part of information like:

- Id
- Location of work
- Status of work
- Navigation status
- Infrastructure information
- Information related to difficulties faced
- Necessary resource requirement

Fixed node will get the entire disaster zone related information from different relief workers periodically and will create a broad data base depending on that information in its system. This data base will be circulated to outside world for their knowledge and for asking necessary support from outsiders. The formation of check in area is an activity of central server which will work as a central wire house for keeping relief resources systematically and send them periodically towards disaster zone when these are required. This check in area will work as a manager for the distribution of resources properly. It is an area where initially all relief workers will accumulate and then will spread out to whole disaster zone. To reduce the pressure on

Central Server this Check in Area will work as a coordinator between central server and main disaster zone. The segregation of work will standardize the pattern of distribution and communication in a decentralized disaster environment. However, there is no fixed network established in the disaster area.

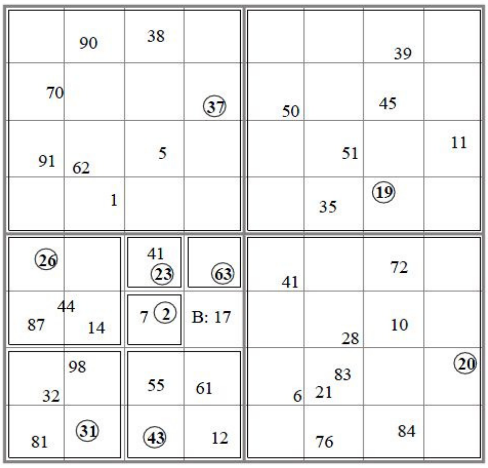
4. Proposed Work

4.1. GLS (Grid Location Service)

GLS is a new distributed location service which tracks mobile node locations. GLS merged with geographic forwarding that allows the construction of adhoc mobile networks that scale to a larger number of nodes than possible with previous work. GLS is decentralized and runs on a mobile nodes themselves and it doen not require any fixed infrastructure. Each mobile node oftenly updates a small set of other nodes with its current location. A node sends its current position updates to its location servers without knowing their identities, assisted by a predefined ordering of node identifiers and a predefined geographic hierarchy. Query for a mobile node's location also use the predefined identifier ordering and spatial hierarchy to find a location server for that node. GLS is based on the idea that a node maintains its current location in a number of location servers distributed throughout the network. These location servers are not specially designated each node acts as a location server on behalf of some other nodes.The location servers for a node are relatively dense near the node but sparse far-there from node; this ensures that anyone near a destination can use a nearby location server to find the destination, it also limiting the number of location servers for each node.

4.2 Geographic Forwarding

We use a simple scheme for geographic forwarding that is similar to Cartesian routing. Each node determines its own geographic position using a mechanism such as GPS positions consist of latitude and longitude. A node announces its current position presence and velocity to its neighbors by broadcasting periodic HELLO packets. Each node maintains a information table of its current neighbors identities and geographic positions. The header of a packet designed for a particular node contains the destination’s identity as well as its geographic position.. It then forwards the packet to that neighbor which itself applies the same forwarding algorithm. The packet stops when it reaches the destination. A packet may be reach a node that does not know about any nodes closer than itself to the ultimate destination. This dead end shows that there is a “hole” in the geographic distribution of nodes. In that case, the implementation described in this paper gives up and sends an error message to the packet’s source node. Recovering from dead-ends is possible using the same neighbor position table used in geographic forwarding.



Grid Location Service

4.3 Effect of Density

Geographic forwarding works best when nodes are dense enough that dead ends are not common. We present a simple evaluation of the effects of node density using the *ns* [6] network simulator. The simulated nodes have 2 Megabit per second IEEE 802.11 radios with ranges of about 250 meters; each node transmits HELLO messages at 2 second intervals, and routing table entries expire after 4 seconds. Nodes move continuously at 10 m/s; each node moves by selecting a random destination, moving toward it, and selecting a new destination when it reaches the old one. Each node sends packets to three destination nodes selected at random; each conversation starts at a time selected randomly over the 300 second life of the simulation. A conversation involves sending 6 packets of 128 bytes each at quarter second intervals.

4.4 Updating Location Information

GLS maintains two tables in each node. The location *table* holds the node’s portion of the distributed location database; each entry consists of a node ID and that node’s geographic location. The location *cache* holds location information that the node learns by looking at update packets it forwards. A node only uses the cache when originating data packets. Because each node uses the neighbor table maintained by the geographic forwarding layer to learn about other nodes in its order-1 square, the node does not need to send normal GLS updates within its order-1 square. As a node moves, it must update its location servers. Nodes avoid generating excessive amounts of update traffic by linking their location update rates to their distance traveled. A node updates its order-2 location servers every time it moves a particular threshold distance = since sending the last update; the node updates its order 3 servers after each movement of !_= . In general, a node updates its order-> servers after each movement of !_?@# _=. This means that a node sends out updates at a rate proportional to its speed and that updates are sent to distant servers less often than to local servers. In addition, nodes send location updates at a low rate even when stationary. Location update packets include a timeout value that corresponds to the periodic update interval, allowing the servers to invalidate entries shortly after a new entry is expected. The time at which the location update packet is generated is also included in the update packet so that the freshness of location information obtained from different nodes for the same destination can be compared. GPS receivers can provide every node in the network with closely synchronized time. When forwarding an update, a node adds the update's contents to its location cache. The node associates a relatively short timeout value with the cached entries regardless of the recommended timeout value carried in the update packet.

4.5 Simulation Scenario

The simulations use wireless extensions for the *ns* simulator. The nodes use the IEEE 802.11 radio and AC model provided by the extensions; each radio's range is approximately a disc with a 1000 meter diameter. Simulations without data traffic use 1 Megabit per second radios; the simulations with data traffic use 2 Megabits per second radios. Each simulation runs for 300 simulated seconds. Each data point presented is an average of five simulation runs. The nodes are placed at uniformly random locations in a square universe. The size of each simulation's universe is chosen to maintain an average node density of around 100 nodes per square kilometer.

One reason for this choice is that we intend the system to be used over relatively large areas such as a campus or city, rather than in concentrated locations such as a conference hall.. The GLS order-1 square is 250 meters on a side. For a network of 500 nodes which is the biggest simulation we have done, the grid hierarchy goes up to order-5 in a square universe 2900m on a side. Each node moves using a random waypoint model. The node chooses a destination and moves toward it with a constant speed chosen uniformly between zero and a maximum speed (10 m/s unless noted otherwise). When the mobile node reaches the destination, it chooses a new node as destination and begins moving toward it immediately. These simulations do not involve a pause time.

5. Conclusions

In this paper, we have proposed an effective scheme of providing a coordinated post disaster relief operation. Assuming the absence of a network infrastructure, we tried to incorporate the notion of opportunistic network by using peer-to-peer communication between relief workers. We investigated the schema by varying key parameters that affects the performance of the system. The simulation results of the system shows that even if the entire coordinated operations are centralized and is monitored far away from the affected area, the operations yields positive results in the overall resource present at the affected area. We have also shown that the perception of resource pattern bears a similar trend to the actual resource pattern at the affected area proving the fact that information is percolated and perceived properly. Furthermore, we have found out the optimal relief worker count and proved that this optimal value has a direct impact on the convergence of static information throughout the affected area as information is dispersed quickly. We have also shown that resources are effectively distributed as and when demand arises at the shelters. The findings of this paper suggests that even in the absence of a network infrastructure, using peer-to-peer communication and message passing can eventually form an intermittent opportunistic network which performs effectively even if the key parameters are varied widely. This study thus reveals the applicability of the scheme in smart-phones which can be used to form peer-to-peer wireless network during relief operations

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