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Original Research Paper

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TO ESTABLISH COMMUNICATION IN POST DISASTER ENVIRONMENT USING DELAY TOLERANT NETWORK

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ABSTRACT The delay-tolerant network (DTN) architecture envisions a protocol suite addressing many open issues in networking and extending far beyond the current Internet suite's capabilities. Delay-tolerant networking (DTN) is an approach to computer network architecture that seeks to address the technical issues in heterogeneous networks that may lack continuous network connectivity. Examples of such networks are those operating in mobile or extreme terrestrial environments, or planned networks in space. Recently researchers are proposed to use DTN in post disaster environment. This paper proposes how to establish communication in post disaster environment using DTN. ONE simulator is used for simulation purpose.

KEYWORDS : Delay Tolerant Network, Post Disaster Communication, mobility model, Routing.

INTRODUCTION

Delay-tolerant networks (DTNs) were introduced in 2003 for fighting the enormous delays involved in deep space communications (in the order of minutes, hours, or even days) [1-5]. Such delays cannot be handled with existing (terrestrial) networking technologies and thus must be handled at the application level. Extending the concept of delay tolerance, it may be possible with the same design to handle long-term disruptions as well. Disruptions (intentional or unintentional) can be considered as unplanned delays. Depending on the context and application scenario, a DTN may be a "delay-tolerant," a "disruption-tolerant," or even a "delay- and disruption-tolerant" network. More than a decade after its introduction, DTN is still lacking a killer application that will help it unveil its potential and result in wide adoption. This is a point of concern for the research community (Lindgren and Hui, 2009). However, a killer application is not a panacea; the now successful Transmission Control Protocol/Internet Protocol (TCP/IP) suite of network protocols did not have a killer application for more than 11 years. In this chapter, we survey the breadth of applications in which DTN is already tested, solving actual, real-world problems related to intermittent connectivity and harsh operational environments around our planet. The wide applicability of DTN in such diverse environments indicates that DTN is, in fact, an enabling network protocol stack and technology for building next-generation applications and apps for smart mobile devices that can cope transparently with long disconnections. The chapter concludes with an outlook for the future [5].

Related Works

Delay-Tolerant Network (DTN) is such a kind of network that cannot possibly maintain continuous connections among source and destination nutshell the while and exploits mobility of nodes for message propagation. DTN uses store-carry-forward approach were message travels from source to destination node through intermediate nodes by opportunistic contacts due to node movement. These intermediate nodes keep the message in their buffer, carry it while on the move and forward it to the next intermediate node encountered. Eventually, the message gets delivered to the destination node. An important application of DTN is considered to provide for emergency message delivery to key personnel in a disaster-stricken area. The main challenge of DTN is to adopt an appropriate routing technique to deliver messages in the most efficient way. In this work, we look into the performance of DTN routing techniques such as Epidemic, MaxPreps, Spray-and-Wait, and Spray-and-Focus by considering the campus area as it is one of the key points of importance for higher education and research in Bangladesh. Our goal is to evaluate the performance of DTN routing techniques for emergency message circulation in the campus area in case of disaster when regular communication networks are not available [6]. We use the Opportunistic Network Environment (ONE) simulator for the simulation of above scenario.

Post Disaster Mobility Model

A. *Network scenario*

In a disaster scenario, devices have no Internet connection and cannot build a network with end-to-end connectivity between all devices. Each device may be, for example, a smartphone, tablet or specialized rescue component [7]. Devices of pedestrians have limited battery life while devices installed on vehicles have unlimited battery life. We assume the same storage capacity for all devices. We call a node any device capable of receiving and forwarding messages in the network. Messages can be sent according to three scenarios:

1. All nodes send messages to any other participant node.
2. All nodes send messages to a command center. This scenario describes a situation awareness phase, where devices act as sensors and inform a specialized center of the situation around them.
3. Only command centers send messages to other command centers, assuming there is no direct connectivity between them and mobile devices relay their messages.

We assume that nodes collaborate by forwarding messages to their neighbours according to a defined DTN protocol. The presence of malicious nodes in the system is out of the scope of this work.

B. *Analysis of DTN protocols*

We ran our experiments on the One simulator using the PDM mobility model proposed by. Our main goal is to evaluate different DTN protocols and identify relevant characteristics to classify them as more suitable for explorer or exploiter nodes. Our default scenario has the following settings: 10 neighbourhoods with 20 people each, 5 ambulances, 5 patrol cars, 1 road repair unit, 20 rescue workers, 1 command center, 60 houses, 1 police center, 1 hospital, 1 coordination center and 1 relief center. The mobility model is PDM: people move in a neighbourhood while ambulances and patrol cars move between centers and neighbourhoods providing connection from clusters of people to the entire scenario. The communication messages have an average size of 500 KB and are generated every 120 seconds. Every node has a buffer size of 50 MB. Notice that this is a conservative value if we consider that most smartphones nowadays have at least 4 GB of storage. Another important parameter of our scenario is the message time-to-live or TTL. We set the TTL value at 360 minutes. Each of our tests covers 172, 800 seconds. For protocols like Spray-and-Wait and Spray-and-Focus, the number of message retransmissions is limited to 20 copies per node.

C. *Post-Disaster Relief Operation*
The goal of this project is to help in rescue those people who got stuck in disaster situation and is not able to contact with anyone by establishing hop-by-hop communication. For communication Bluetooth have been used in this project. Using Bluetooth as a medium network message can be transferred from one node to another node. The main objective of this project is to help in the rescue operation by establishing hop-by-hop communication. Using Bluetooth as a medium network the message can be transferred from one node to another node. We are using delay tolerant network (DTN) in this project and DTN uses Bluetooth to communicate with nodes and establish secure and reliable communication.

D. *Centres*
a. Control Station
For disaster recovery using a delay tolerant network, the situation that is proposed is there will be one control station which is stationery. This is acting as a base of the recovery center. This center will have direct communication with the operation head of the recovery [6]. They will be communicating with the distant centers outside the disaster zone. The main function of the control station is to forward messages coming from the outer disaster rescue zones to the shelters and volunteers, evacuating the rescued people and providing resources and help to other volunteers and shelters.

b. Shelters
The model also consists of five shelters. Each shelter will be associated with 20 volunteers each. The shelter will be stationery. The shelter sends the details of the people evacuated from the disaster and provides them with temporary aid and energy resources. The shelter broadcasts messages from the volunteer to the control station and vice versa.

c. Volunteers
The volunteers are twenty in number for each shelter. The volunteers are mobile and they carry the messages. They look for people to be rescued and thereafter transfer the messages to the other volunteers which in turn send the message to the shelters or control station.

E. *Interaction among agents*
Moving nodes are equipped with communicating devices that are capable of transferring data when they are within the range of each other. There are usually short-range radio (say, 50m range) with a very low data transmission rate. Generally, nodes have the information using of which they can rescue the people they are looking for and then they can send massages to other nodes and finally send massages to the respective shelters. Each shelter or control station is also consisting of similar communicating [2] massages which opportunistically relays massages among nodes when they pass.

RESULTS
Prophet Router is used in simulation using Opportunistic Network Environment (ONE) simulator.

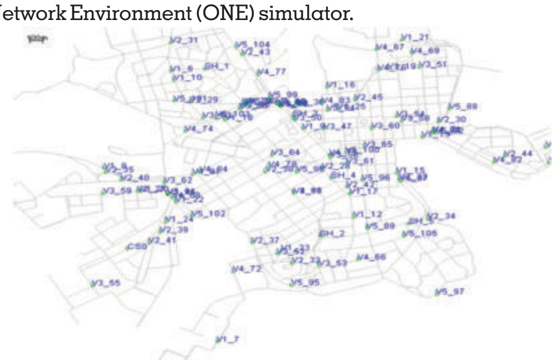

Fig. 1: Playfield Graphics for prophet router at 8h

Fig. 2: Playfield Graphics for prophet router at 10h

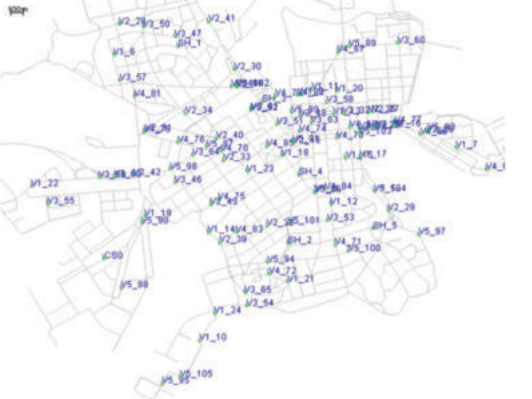

Fig. 3: Playfield Graphics for prophet router at 12h

The fig. 1 to 3 represents the playfield graph from time t = 8h to 12h. The volunteer nodes communicate with each other and send, receive messages. For each simulation, we get delivery probability, overhead ratio and latency and compute the graph from these values.

Simulation
We have run this project over four routers [7]. They are –

1. Prophet Router
2. Epidemic Router
3. Spray and Wait Router
4. Energy Aware Router

Here we have shown the simulation, delivery probability, of Prophet router.

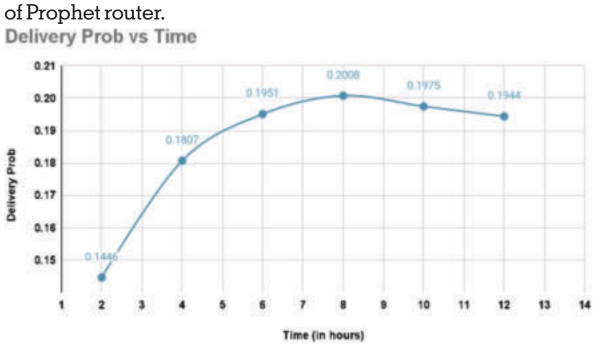

Fig. 4: Delivery Probability with Time for prophet router

From the delivery probability vs time graph fig. 4, for the prophet router, we get to see that the delivery probability increases with time and after attaining a peak it starts to decrease. For the time period of 2h, the delivery ratio has increased. After the time period of 8h, it attains the peak delivery probability and then gradually decreases. In conclusion we can say that the delivery probability increases, attains the maximum value and then decreases with time in case of prophet router [1].

CONCLUSION

In this work we have proposed the used of hybrid DTN protocols for disaster scenarios, where nodes with different mobility patterns can apply different routing rules, in order to improve the exploration of an area searching for a destination,. These protocols have a better trade-off between delivery rates and overhead of message in the network. The latter is especially important because it impacts the energy spent by the mobile devices. Energy is a scarce resource in a post disaster scenario, and in our case, it determines the survival of the communication network. The simulation results confirm that hybrid versions of traditional DTN protocols provide an interesting trade-off between delivery ratio and message overhead, as we stated earlier. In our best results, the hybrid version allows reducing the total overhead by up to a 92%, while the delivery ratio decreases only up to a 10%. The combination of the Prophet and Spray-and-Focus protocols provides the best results for the proposed scenario and based on the PDM model.

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