Work Plan

Title: Efficient Routing in Opportunistic Delay Tolerant Network in a Post Disaster Scenario

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Abstract:
Delay Tolerant Networking (DTN) has been gaining interest of researchers in the recent past for applications in critical situations. DTN is a wireless networking approach that can be used in situations where end-to-end connectivity cannot be guaranteed, and where networks suffer huge disruptions because of external factors like wireless radio range limitation, sparse and mobile nodes, energy constraints, noise, etc. The interplanetary communication, tracking of wild-life animals, post-disaster communication, etc. are some of the examples of situations that make up good candidates for DTN. Providing ability to communicate in case of intermittent and opportunistic connections, DTN provides best solution for a post disaster situation analysis and resource management. The candidate has, in this synopsis, proposed 4-tier DTN network architecture suitable for implementation in a post-disaster situation. The architecture supports opportunistic peer-to-peer communication of information from source to destination. For making communication possible over such network, the candidate has proposed a suitable and novel DTN routing strategy (named DirMove) that takes advantage of the proposed 4-tier DTN architecture. The decision to forward a message to another node depends on its past fitness history and current direction of movement. DirMove is evaluated for its efficiency with existing DTN routing protocols. Further, to safeguard DTN communication from malicious attacks, the candidate has studied several security issues in DTN. The candidate has evaluated adverse effects of Selfish nodes and Black holes on routing performance of DTN. Thus motivated, the candidate has proposed a cooperative approach to mitigate harmful effects of malicious nodes in DTN. To increase further efficiency, the candidate proposes to introduce multi-staged data filtering strategies to filter unwanted and junk information. A feedback based mechanism will be devised to tune the bandwidth allocation based on needs from specific regions. This will help improve bandwidth enforcement and sharing, thus improving overall throughput and efficiency.

Different tasks that are proposed to be carried out have been divided into 4 sections:

[3] DTN security issues
[4] Data Filtering and tuned bandwidth allocation of information generated in DTN communication
1. Progress Report for 2014

- **DTN Architecture:** The candidate has proposed 4-tier network architecture to handle post disaster relief and rescue operation. The disaster affected area that needs to be covered is termed as the Activity Area (AA) (Fig. 1). The Relief Workers (RW) that constitute the tier-1 of the architecture divide into small groups (called Shelter points or SP) and work under their pre-assigned SPs. Each SP is having a local Control Station called a Throw Box or TB that forms the tier-2. It monitors the work of that SP. TB collects messages generated within the SP for transmission to a Master Control Station (MCS). The TBs of different SPs communicate with each other via data-mules (like cars, helicopters, Wi-Max towers, UAVs, etc.) that make up the tier-3 of the architecture. The MCS constitutes the tier-4. It is the only gateway of the AA to the outside world. MCS acts as the repository of the entire information. MCS is placed at a suitable location where connectivity to the outside world can be ensured and the backhaul is permanent. This network architecture has been implemented in the Opportunistic Networks Environment (ONE) simulator, where different agents are represented on a Map of a region with their mobility and tasks.

![Network Architecture](image)

*SP: Shelter Point; TB: Throw-Box; MCS: Master Control Station; Temp MCS: Temporary MCS.*

*Fig. 1: Network architecture designed for implementation in Post Disaster Relief Work*

- **Routing in DTN:** Based on the 4-tier network architecture, a novel routing protocol for intra-shelter point communication in DTN is proposed. The routing strategy (termed DirMove) tracks the recent direction of movement of a mobile node by measuring its consecutive distances from the destination at two different instants. If any node moves...
away from the destination between two consecutive instants, then it is very unlikely to carry its messages towards the destination. The fittest node is selected using parameters like past history of successful delivery and delivery latency, current direction of movement and node’s recent proximity to the destination. Issues related to routing such as fitness of a node for message delivery, buffer management and packet drop have been considered. The routing protocol has been implemented in the ONE simulator and is compared with existing standard DTN routing protocols for efficiency. It is found to reduce message delivery latency and improve message delivery ratio by incurring a small overhead.

- **Security Issues:** A DTN is prone to security threats, especially the Selfish and Black-hole attacks. A co-operative scheme is proposed that examines the malicious behaviour of a node (at the time of sending messages to that node) by inquiring other neighbouring nodes about the past performances of that node. Parameters like total number of sent and received messages to and from other nodes and created messages, are used for arriving at the decision of forwarding messages to that node. By the cooperation of other neighbouring nodes, a combined faith value (CFV) is calculated. If this value satisfies a pre-defined threshold, then the node is treated as valid for that moment. The process is performed every time a node wants to transmit a message to another node. Also, the calculated CFV is multicast in the neighbourhood for updating. The scheme has been tested on the Spray and Wait (S&W) DTN routing protocol with mobile nodes and fixed destination type architecture to prove its effectiveness. It is found to avoid malicious nodes and increase the trustiness of the network.

- **Data Filtering:** Junk data (by malicious nodes or simply not-required messages) eat up lot of storage, Bandwidth and time. This may make valid messages vulnerable to be dropped, owing to packet drop policies. Thus, this may delay delivery of valid messages. One solution to the above may be to filter the data in the intermediate stages of their transmission. The filtration is done according to the requirements. The requirements are more or less known beforehand, like flood-specific requirement, etc. The candidate is studying on implementing a 3-stage filtering strategy.

### 2. Plan of Work for the year 2015

- The candidate plans to construct a test-bed of the above described 4-tier network architecture and perform exhaustive testing of the working of the system. This will aid in providing efficient networking solution to minimize destructions caused by large scale natural disasters.

- Energy efficiency issues need to be checked for better performance of routing in post-disaster scenario. Efficient ways of devising alternative techniques to the energy hungry GPS need to be found out that uses the sensors from the Smartphone devices for better predictability of location information in absence of GPS, or by minimal use of GPS. Also, the candidate will explore Multicast routing protocols in DTN. Multicast supports the
distribution of data to a group of users. Multicasting in DTNs is a considerably challenging problem.

- The candidate will evaluate the performance improvement of our proposed DTN security strategy in other existing DTN routing protocols. Also, other DTN security threats, like the Wormholes, need to be studied further.
- The candidate needs to come up with a good solution to DTN data filtering using existing and new techniques. Based on that, the candidate plans to implement some kind of Tuning of need analysis and resource management at Control stations to aid in distributed snapshot integration to obtain global view. A feedback based mechanism will be proposed to tune the bandwidth allocation based on needs from specific regions. This will help in efficient post disaster situation analysis and resource management. The candidate also plans to perform Social data analysis, especially Twitter analysis to understand rumour patterns and use the same to help in data filtering strategies.

3. **Publications**


