NOVEL DETECTION METHOD FOR DELAY TOLERANT NETWORKS USING RID AND VDTN FRAMEWORK

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Abstract

This research provides an introductory overview of Vehicular Delay-Tolerant Networks. First, an introduction to Delay-Tolerant Networks and Vehicular Delay-Tolerant Networks is given. Delay-Tolerant schemes and protocols can help in situations where network connectivity is sparse or with large variations in density, or even when there is no end-to-end connectivity by providing a communications solution for non-real-time applications. Some special issues like routing are addressed in the thesis and an introductory description of applications and the most important projects is given. Finally, some research challenges are discussed and conclusions are detailed. Vehicular Delay Tolerant Network (VDTN) is a special category of vehicular networks by incorporating delay tolerance in communication under the presence of disruptions in connectivity. When such delay tolerant network technology is used in vehicular environment, it is called Vehicular Delay Tolerant Network (VDTN). The Delay Tolerant Network (DTN) is an occasionally connected wireless ad-hoc network that allows the communication between the wireless nodes in the scenario where end to end connectivity can never be attained or when the delay related in relaying of data can be very high. The Delay Tolerant Networks plays the key role in the circumstances where the routes between any pair of nodes are not fixed. Examples of such kind of networks are in military battlefields, sparse networks, space communication. It does not require any prior knowledge of networks to forward the bundles from one node to other. It is based upon the store-carry-forward approach. This research effort explores how delay tolerant enabled routing protocols can be optimized in certain parameters like delivery probability, network overhead ratio for better optimality of results and it provides a comprehensive overview of all some algorithms for delay tolerant network. This research focuses on optimizing the information being disseminated to node vehicles which are in movement following a particular path symbolizing a scenario of an automotive network. The major objective of this research is to optimize the buffer of node vehicles in terms of information content. The proposed research work is an improvement over Epidemic routing protocol under certain mobility model so that the proposed algorithm gives optimized results in terms of parameters like network overhead ratio, average buffer time, median buffer time and increasing the delivery of messages and thus increasing the delivery probability also. The fast message delivery of messages will aid in emergency situations like accident which happens frequently in regular scenario during movement of vehicles on highways.

Keywords—Vehicular Delay-Tolerant Networks, Delay/Disruption-Tolerant Networks, Vehicular Ad Hoc Networks, Intelligent Transport Systems.

1. INTRODUCTION

1.1 Introduction

VANET is a unique category of ad-hoc network which is mainly known as vehicular ad-hoc networks. They have a number of vehicles or nodes that are equipped with wireless transceivers helping the vehicles or nodes in the network to communicate with each other [1-2]. Vehicular Ad-hoc networks (VANETs) are very organized network which inculcates meeting of nodes in intra node fashion in which nodes exchange information on a contract basis. Here, nodes being in motion result in less reliable data transmission. Though, VANET exhibit distinct features like High Dynamic Topology, Mobility Modeling and Prediction, Hard Delay Constraints [3]. The wireless ad hoc network is the most advanced network technology in the current scenario which allows information to be transmitted from one mobile device to another without a physical connection. For vehicle-to-vehicle (V2V) and vehicle-to road (V2R) communications, the companies have developed a wireless access network called Wireless Access for Vehicle Environment (WAVE) [4]. This wireless network's primary objective is to improve vehicle safety and provide viable solutions for traffic management [5]. In this situation, the communication and delivery of data becomes very important. It facilitates the communication of data from source to destination in an efficient manner [6-7]. A wireless ad-hoc network, facilitates better data transmission keeping in view the two most important factors, i.e. channel bandwidth and node energy. Thus, the mobile ad-hoc network (MANET) is also referred to as a mobile mesh network in which mobile nodes are connected without any physical media support [8-9]. MANETs have limited bandwidth, frequently changing topology and have limited energy.

1.2 Background

There are two types of VANET routing protocols: regional routing and topology routing. Delay Tolerant Network-based routing is the regional routing in which the DTN protocol uses neighboring location information for forwarding packets. The topology-based routing uses the route information pre-existing in the packet transmission network [17]. The FFRDV [18], DAER [19], VADD [7] and GeOpps [10] etc. are the important examples of DTN based VANET routing protocols. Bad road condition, heavy traffic due to congested roads and lack of driving knowledge become one of the causes of accidents in today's vehicle network scenario. To check this situation, the automobile companies have determined to connect together with government agencies for the development of on-board application console which can be used in data communication in highway traffic environment model [17]. On highways, vehicular communication device can be used for a wide range of applications to improve the road safety by diffusing warning message alert to drivers about condition of roads and accidents etc. [16] and to provide convenience of internet to commuters via routers along the road side units as shown in Figure 1.1.

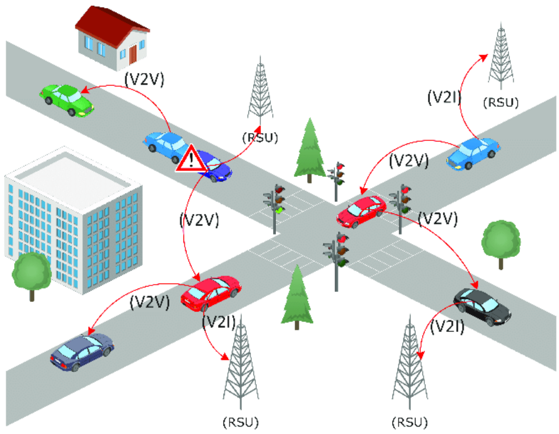

Figure 1.1 Architecture of VANET

However, the steering of data packets through the vehicular ad-hoc networks (VANETs) is a complicated problem along with network topology and communication circumstances. The data transmission plays a vital role for a vehicular network application. It is important to provide a realistic mobility model for vehicles in a vehicular network scenario [18]. In such cases, the simulation results will be suitable for indicating vehicles for safe driving.

1.3 Motivation

Nowadays, all-time and unlimited connectivity to the Internet seems to be fairly common for a great number of mobile and fixed devices. However, the truth is that persistent connectivity is not the rule everywhere or even in certain circumstances not necessarily mandatory. Thus, further research and technical solutions are needed in order to overcome the lack of connectivity to enable the communications between nodes and applications in disruptive scenarios. Delay-tolerant networking (DTN) allows communication of messages in scant ad-hoc mobile networks and other environments where standard networking and new routing and application protocols are necessary for communication of messages between network nodes [17].

1.4 DTN in VANET

In Vehicular ad-hoc networks vehicles can converse with each other without the assistance of any physical link. There exists a path which is recognized via multiple hops. The key efficiency of routing protocols is to recognize and set a capable path in between the source and destination nodes. Delay Tolerant Networks or Disruption Tolerant Enabled Network are true in various operational situations, including disconnected or interrupted networks and longer delays [18]. Messages in DTNs are distributed via store and forward method to destination nodes as there is no end-to-end link. This delay broadcast is only intended for applications that are sufficiently professional to withstand the wait.

1.5 Problem Statement

Vehicle networks ensure the safety of vehicles on the road by avoiding accidents and aiding in the control of traffic. Due to immense remoteness, low node density and complex network topology, these networks do not have point-to-point connectivity. To cope with limitations of networking, the Vehicular Delay Tolerant Network provides vehicle applications with delay-free and uninterrupted data passage. Vehicle networks ensure road safety by preventing accidents and assisting with traffic management. Due to large length, low node density and effective network topology, these networks lack point-to-point, multi-hop path connectivity. VDTN allows delay tolerant and non-continuous data traffic for vehicle applications.

1.6 Objectives

This research focuses on optimizing the information being disseminated to node vehicles which are in movement following a particular path symbolizing a scenario of an automotive network. The major objective of this research is to optimize the buffer of node vehicles in terms of information content. The detailed objectives of the following research are listed as follows:

1. To study Flooding based routing protocols for DTN i.e. Epidemic, Spray and Wait.
2. To perform feasibility analysis of Epidemic routing protocol under different Mobility models in Delay Tolerant Network.
3. To propose enhancement of Epidemic routing protocol based on objective 2.
4. To compare the performance of enhanced Epidemic routing protocol with the existing routing protocol using ONE Simulator and to find the optimal results that may be reliable and efficient for DTN.

The proposed research work is an improvement over Epidemic routing protocol under certain Mobility model so that the proposed algorithm gives optimized results in terms of parameters like network overhead ratio, average buffer time, median buffer time and increasing the delivery of messages and thus increasing the delivery probability also. The fast message delivery of messages will aid in emergency situations like accident which happens frequently in regular scenario during movement of vehicles on highways.

2. LITERATURE REVIEW

2.1 Literature Review

In order to carry out the proposed research work, literature review of around eighty research papers was done. Some of the research done in the area of Delay Tolerant Network in last fifteen years is being discussed below.

In **2002**, Lasermann et. al, investigated and evaluated greedy aggregation, the novel approach which changes aggregation points to increase the amount of sharing of routes, reducing energy consumption. Preliminary results indicated that under scenarios examined, greedy aggregation can achieve energy savings of up to 45percent over opportunistic aggregation in high-density networks without affecting latency [21]. Again in 2002, Papadimitratos et. al, focused on design data-centered routing scheme, comparing its performance with conventional end-to-end routing schemes and tracking the effect of source-destination communication, network density and data aggregation based delays [22]. The researchers demonstrated that data-centric routing offers considerable performance gains across a wide range of operational.

In the next year 2003, Dong et. al, explained a heuristic method to solve the data gathering problem with aggregation in sensor networks [23]. Results have demonstrated that the proposed algorithm significantly outperforms previous methods in terms of system lifetime.

In 2004, Papadopoulos et. al, provided accurate and estimated algorithms to find the minimum number of aggregation points to optimize the existence of the network. Their algorithms use a fixed wireless digital backbone at the top of physical topology. They also analyzed the tradeoffs between energy savings and the likely lag in the process of data aggregation [24].

In the context of year 2006, a set of mechanisms were proposed to use message aggregation and group communication by Nguyen et. al. The first explanatory class is based on asymmetric cryptographic primitives, the second class uses symmetric primitives and the third class combines the two [25].

In 2007, an approach was projected by Lochert et. al, which aggregates duplicate insensitive. This method raises above two vital problems for VANET applications in existing aggregation schemes. First, when multiple aggregates of some network observation of some data are available; they can be combined into an aggregate that contains all the information from the original aggregates [26]. This is radically different from current methods where one of the aggregates is typically chosen for further use, while the others are discarded [27].

Later in 2008, study of the CASCADE (cluster-based accurate syntactic compression of aggregated data in VANETs) data aggregation system was done by Ibrahim et. al, CASCADE categorizes known vehicles into clusters, which decide both the frame size which is used to allocate aggregated data and distance ahead of vehicles to other vehicles which constitutes the local view. Here, determination of the optimal cluster size is required to provide the stability for the trade-off between local view length and expected frame size [28]. A collaborative framework was developed in the same year to help coordinate adjacent traffic reports. In this work, the fundamental idea is that we can adapt the forwarding delay of individual reports so that they have a better chance of meeting other reports. Each and every vehicle concludes on the basis of local observations.

In the year 2009, Julien et. al, focused on the scheduling problem of data aggregation. A distributed algorithm created a collision-free aggregation agenda in wireless sensor networks based on total independent sets. [29]. Using a greedy strategy, the time latency of the aggregation schedule generated by the proposed algorithm is minimized.

In 2010, Chinyao et. al, introduced a hardware platform utilizing multi-purpose, multi-radio, scalable, solar-powered platform. This uses an approximate heuristic to solve the NP-hard problem of meeting an average power constraint while maximizing the amount of bytes the throw box transmits [30]. Researchers proposed a digital navigation interface to provide detailed route information to automate the process of forwarding and finally assessed the benefit of their approach, followed by simulations.

In 2010, Wolf Bastin et. al, proposed an online algorithm [31] utilizing unsupervised learning and spectral graph theory to deduce the appropriate graph structure and algorithm, enabling the node to locally adapt to the optimal point of operation, achieving good performance in all scenarios considered.

Later in the year 2011, Samras et. al, carried out interoperability tests and a detailed quantitative performance analysis of the implementation of the Linux system Bundle Protocol [32].

In 2011**,** Carlo et. al, based on the UDP / IP (i.e. BP / LTPCL / UDP / IP) convergence layer (LTPCL) adapter. Compared to two other DTN protocol stack options, BP / TCPCL / TCP / IP and BP / UDPCL / UDP / IP, the performance of BP / LTPCL / UDP / IP in realistic file transfer over a PC-based network test bed [33]. For the analysis of the experimental results, a statistical method of t-test is used. John Rush et. al, described an updated protocol version called PRoPHETv2 and conducted simulations to verify the protocol's mechanism and compare its performance with the original protocol version and other routing protocols as well. The simulation analysis is carried out using both traces of an actual DTN deployment and a model of synthetic mobility.

Next, paper addresses the use of DTN in future satellite networks and expands the DTN description together with the distinction of DTN from ordinary TCP / IP networking, contrasting DTN and PEP architectures and stacks that are the starting point for successive DTN output in LEO / GEO satellite scenarios [34]. Again in the same year, IBR-DTN, a lightweight, flexible and portable Bundle Protocol implementation and DTN daemon was provided by researchers. IBR-DTN is particularly suitable for embedded platforms, enabling the benefits of a Bundle Protocol daemon that is also cost-sensitive in distributed sensing applications.

3. DTN ROUTING PROTOCOL

3.1 Introduction

A wireless ad-hoc network which allows transmission of messages amongst nodes in a situation where end-to-end connectivity cannot be attained or where the delay related with data relay is incredibly high is called Delay Tolerant Network. The concept of Delay Tolerant Network was introduced in 1970, which was derived from the concept of Interplanetary Networks (IPN) for initiating communication between Mars and Earth. The DTN is an ad-hoc wireless network that tolerates sporadic node connectivity. In other words, DTN can be defined as sporadically associated wireless ad-hoc network, which bears the extended delay in receiving messages, as well as preventing the loss of data through a store-carry-forward approach.

4. PROPOSED METHODOLOGY

4.1 Introduction

This simulation tool and its methods are used to accomplish our objectives. The simulator should be well documented to facilitate modifications for simulations which can be introduced whenever required. It should be capable to sustain the expansion of on hand protocols and should also sustain establishment of new protocols. It starts with implementing our objectives using ONE simulator which is implemented in java.

4.2 Simulator

There are two well established simulators which are used for Delay Tolerant Network, i.e. Network Simulator (NS-2) and Opportunistic Network Environment (ONE). ONE is an event driven simulator and being an open source project it has a range of extensions and customizations. It was developed at Helsinki University of Technology particularly for DTN routing protocols. The information on ONE is the project web page which is having javadoc’s for all libraries and links to resources and tutorials along with the source code of simulator. Researcher’s worldwide use NS-2 and ONE for conducting simulations for protocols on Delay Tolerant Network [1]. NS-2 being a multi function network simulator includes all network layers and is used in modeling of network classes from MANET to DTN. Here we use ONE for our simulations. Simulator is a tool which is quite useful for majority of researchers to carry out simulations on large number of synthetic or real time data sets under different network scenarios. Simulation plays a significant responsibility in analyzing the performance of various VANET and DTN routing protocols. There are various simulators like NS-2 (Network Simulator, 2000), DTNSim (Delay Tolerant Network Simulator), OMNet++, OPNET and The ONE. The ONE stands ideal among the simulators in case of DTN protocols as the NS-2 simulator supports DTN partially and it supports only Epidemic routing whereas DTNSim does not supports movement models. OPNET and OMNet++ cater to specific research requirements and therefore these simulators have limited support available for DTN routing protocols. The ONE simulator is a discrete event based simulator. It is a java based tool which provides DTN protocol simulation capability in a solo framework. The latest version (1.5.1) was released in 2013. It is released under GPLv3 license [2]. ONE only accepts WKT elements that are LINESTRINGs and POINTs which represent vector shape-files i.e. each road is a series of map nodes (or vertexes). Each vector can be converted to WKT using the Simple WKT plug-in or the entire layer shape-file can be converted into WKT.

4.3 ONE Architecture

The coding of ONE is done in Java with a collection of packages which are compiled and are dependent on each other to run simulations. The association between these packages is shown [1]. These packages include routing packages, core and map movements. Each and every simulation is handled by a configuration file which provides various settings for each package. Simulations can be conducted in batches, sets of dependent variables which is pre-defined in the configuration file.

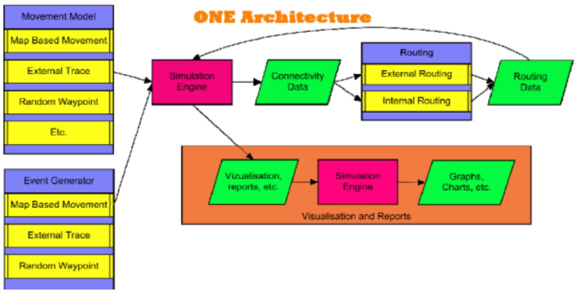

Fig. 4.1 ONE Simulator Architecture

The path to configuration file is given as a command line argument to ONE startup script, one.sh along with the batch size (no. of simulation which can be run in each set). Using ONE big batch of simulations can be run from the command line with the specification of batch mode with –b option. The syntax of the command is as follows:

- ***./one.sh –b [no. of simulations] [configuration file]***

The elimination of batch mode runs the simulation in GUI mode which is quite useful for designing custom mobility maps and for validation of first run of batch processing. The core package of ONE includes simulator's primary class, parsing batch mode operation, assessing command line arguments and finally to call constructors for a desired package. The classes in the core package manage basic simulator function like SimClock class that controls simulated time and the Connection class that facilitates node encounter during simulation. The movement package has classes for different kinds of mobility generators which are employed during the simulation time. The different kinds of mobility generators are Random Walk, Map Based Movement and ShortestPathMapBased Movement [3].

4.4 Simulation Model

The ONE simulator includes an extensible simulation framework which is responsible for generating different node movements using varied mobility models and is capable of routing messages in between nodes. The simulation model visualizes both mobility and events in its graphical user interface and it includes reporting node movement. ONE includes the function of importing data from real-world traces or other mobility generators also.

4.4.1 Node Characteristics

Each node acts as a store-carry-and-forward router [4] which is characterized by parameters like buffer space, transmit range and node speed. These parameters are configurable through the settings. Each link is characterized by a bandwidth. A link is modeled as First Come First Serve (FCFS) queue with some transmission time. DTN simulations enable wireless communication link in between nodes. The frequency and contact duration amongst nodes depends on the type of mobility model selected for a particular simulation.

4.5 Mobility Models

Node movement capabilities are executed via mobility models. DTN protocols can be implemented by a variety of synthetic mobility models. These models are developed on real life observations and are very useful for researchers to carry out simulations. The mobility models considered in the work for evaluation are Random Waypoint (RWP) model, Map-Based Mobility model (MBM) and the Shortest Path Map-Based Movement (SPMBM) model [3]. While nodes move randomly to a random destination in RWP model whereas MBM constrains node movement to predefined paths and routes are derived from real map data. The SPMBM uses the same map based data as in MBM but instead of moving randomly, it calculates the shortest path from source to a random destination using Dijikstra's shortest path algorithm and follows the shortest path. The last two models are used to model real world mobility.

4.6 Types of Mobility Models

All map-based movement models input data using formatted files which are called Well Known Text (WKT) files. These can be edited and generated from real world map data using Geographic Information System (GIS) programs such as OpenJUMP [5].

4.6.1 Map based Mobility Model

With map-based movement models, the nodes move using roads and walkways which are derived from map data. In addition, different node groups can be set to use only certain parts of the map, thus allowing to distinguish between cars and pedestrians so that the former do not drive on pedestrian paths or inside buildings. In the simple random map-based model, nodes move to randomly determined positions on the map but follow the roads as defined by the map data [6].

4.6.2 Shortest Path Map Based Model

The shortest path map based movement model, SPMBM uses the same map data but instead of wandering randomly around the map, nodes use Dijkstra's shortest path algorithm to calculate shortest paths from the current location to a randomly selected destination. Additionally, map data contains Points of Interest (POIs). POIs are places on the map area for each node group; separate probabilities can be defined for choosing POI from a certain group for node's next destination. These POIs can be used to model e.g. tourist attractions, shops, restaurants etc. Finally, some nodes may have pre-determined routes in the map that they follow. This route-based movement model uses the same map data but, instead of selecting destination map nodes in a random manner, nodes always select the next destination on the route they are currently traveling. This mode of movement is useful for modeling e.g. bus and tram routes. Both POIs and routes can be defined using any WKT compatible GIS-program [6].

4.6.3 Random Walk Mobility Model

Random Walk mobility model is the simplest mobility models available. This model involves movement of every node towards a new randomly selected location. A random speed direction is allotted to each node from a predefined range [7]. As and when a node reaches the destination location, a new direction is again assigned from predefined ranges. Here, the distributions of mobility parameters are a function of time.

4.6.4 Random Mobility Model

The Random Mobility model proposed in [8] has been used for simulation. In this model, nodes will start at a random place on the simulation area, pick a random direction, and follow it to the edge of the simulation area. They will then pause for some time and choose another direction to go in until they strike the edge of the simulation again. In the second variant of the Random mobility model in [9], when a node reaches a boundary of the simulation area, it instantaneously re-enters into the simulation area from the opposite boundary. It then continues to move with the previous speed and direction. In the third variant, presented in [10], nodes would bounce off and continue to move with the previous speed in a new direction when a node reaches a boundary of the simulation area.

5. RESULT AND DISCUSSION

5.1 Routing in DTN enabled VANET

The routing algorithm which is proposed in the existing research work i.e. "Epidemic

Routing in **D**TN-enabled **V**ANETs with **O**ptimization") is designed to provide efficient data transmission among different source and destination vehicles on roads by using the DTN architecture and effective node selection. The VANETs is partitioned often because of different vehicle speeds as shown in Figure 5.1.

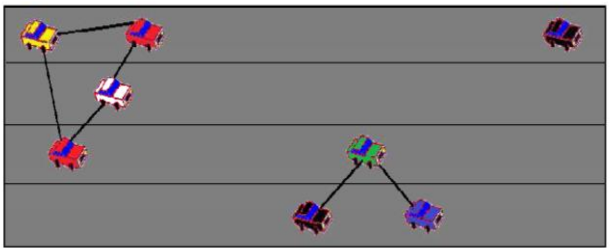

Figure 5.1: Example of DTN VANET

With GPS (Global Positioning System) operational in every vehicle the current location of vehicles is known to each and every vehicle in its proximity. In order to generate the logical blocks the geographical information is utilized and the road gets separated into sections and every vehicle is given the priority for data forwarding among vehicle following the vehicle. These logical blocks vary in size keeping in view of speed of vehicle. "HELLO" message will be broadcasted by every vehicle whenever they enter into their particular logical block of communication amongst themselves [1]. Every "HELLO" message holds the information about vehicle's speed and direction from which it has generated and the category of vehicle. If there is any vehicle with a high speed, "HELLO" message will be broadcasted by it very often because as the vehicle's speed increase it's block size will get decreased.

5.1.1 Occurrence of an event

Firstly, at the time of incidence of an event of mishap the vehicle node which meets the accident will generate emergency message and conveys that message to the vehicles following it. As shown in Figure 5.2, vehicle labeled as number 4 when meets an accident generates emergency or SOS message and broadcasts it to the vehicles following it and so on so that they can change their route accordingly instead of reaching the traffic jam epicenter. The marked lines represent blocks as shown in Figure 5.2.

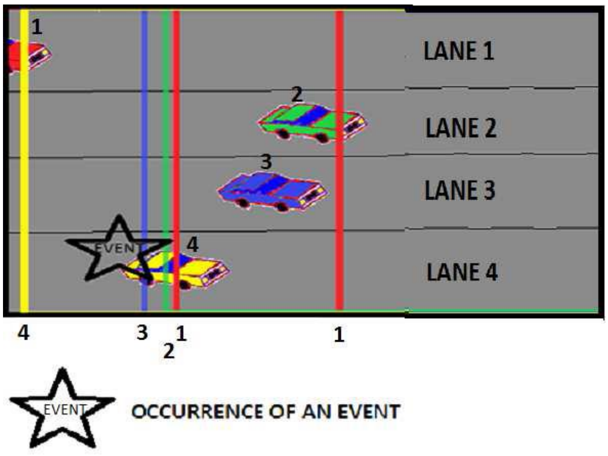

Figure 5.2: Occurrence of accidental event turning a node vehicle into message generating vehicle.

5.1.2 Sending Control Packets with minimum delay

In this procedure HELLO" packet will be sent by each vehicle in their block and the vehicle within communication range will receive this packet as shown in Figure 5.3. Each and every lane is separated into number of blocks having numerous and variable size. In this example Car-1 and Car-3 are entering into their own blocks. The information like vehicle's direction, speed and type are contained by "HELLO" packet.

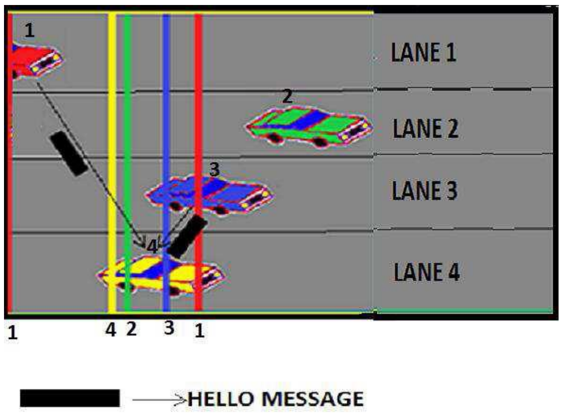

Figure 5.3: At the beginning "HELLO" messages are sent by vehicles

5.1.3 Bundle movement to following vehicle

In the matter of selection car-1 the car-4 will send the information to DF as indicated in the following Figure 5.4.

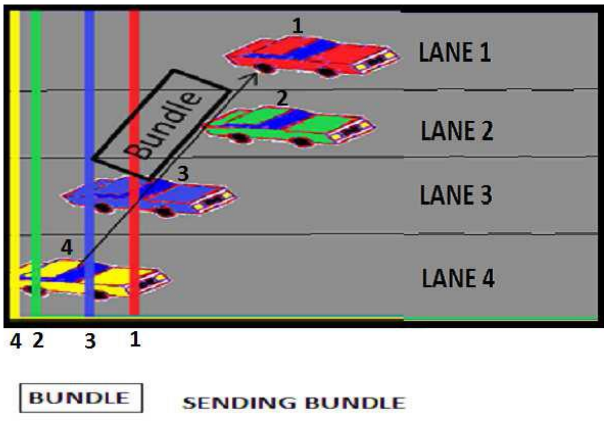

Figure 5.4: Bundle sent to designated car

A vehicle holding a bundle for transmission is known as carrier vehicle. At the point when the bundle is transmitted by designated vehicle [2], the vehicles following the carrier vehicle receive the message. In this condition, there is a limit of blocks for accepting "HELLO" packets from carrier vehicle as the following vehicles compare the node id of the messages being received. If they have the current message they will discard that message id otherwise it would accept that message therefore resulting in efficient buffer management of the node vehicle. The above process can be summarized in following steps:

1. **Step 1.** Generation of Logical blocks which is based upon speed.
2. **Step 2**. Broadcasting of HELLO or Control message having information about speed, direction and category of vehicle.
3. **Step 3.** Transfer Message to designated vehicle.

5.1.4 Broadcasting of HELLO/Control message

In this particular process every vehicle transmits "HELLO" message at the beginning of every fixed or variable size block, depending upon current speed of vehicle. The "HELLO" message has data about vehicle's present speed (km/hr), direction and category. Various routing protocols for DTNs in VANET have been proposed and projected by several researchers. These protocols make the most of the mechanism of store-carry forward. However they use distinguishing methodologies for selection of next intermediate vehicle to communicate the packet to its destination vehicle as and when a present vehicle meets with a number of in-between neighbor vehicles.

5.2 Evaluation of Epidemic Protocol Based on Node Movement Model

Epidemic routing protocol comes under the category of flooding based scheme [3-5]. In this flooding method, pair wise exchange of message amongst mobile nodes ensure deliverance of messages, which increases the messages deliverance rate and reduces message latency as well as number of resources consumed in deliverance of messages [6]. It focuses on forwarding of messages which depends on the least possibility of network topology and connectivity. Every node has a buffer which is being used for storage of messages received from other hosts nodes in a network [7].

The steps involved in initiating the simulation are as follows:

a) Firstly, the setup of ONE is downloaded from its source http://www.dtnrg.org.
b) As the commands for simulations can be executed in batch mode, where the simulations can't be visualized.
c) Therefore, installation of eclipse is important where the simulations along with their code can be visualized.
d) As eclipse is started, a new java project is to be started and uncheck the default location, then after clicking next menu is opened where order and export is selected then finish button is clicked.
e) The next step involves of building path by clicking on project name followed by adding external archives like DTN consoleconnection.jar and ECLA.jar. One of the external library i.e. junit-4.12.jar is also added to the project.
f) Thereafter, the project is run as java application, by default one scenario is executed.
g) Here, epidemic routing is executed and the results are captured, using two node movement models i.e. Shortest Map Based Movement Model and Random Waypoint Model. The simulation parameters are described below in Table 5.1.

Table 5.1 Simulation Parameters

Parameters	Values
Simulation Scenario	Helsinki Downtown(4500x3400m2)
Simulation Time	2 Hours
Number of Nodes	100
Node Movement	Shortest Map Based Movement and Random Waypoint Model
Moving speed	0.5~13 m/s
Transmission range	10m
Message size	250kb
Transmission speed	2Mbps

Apart from simulation parameters there are performance metrics on which the performance of a network is evaluated. The following metrics were used for performance comparison:

➢ **Network Overhead**: It is defined as the quantity of messages copied in a network compared to the number of messages which are actually delivered to the destination.

➢ **Delivery Probability Ratio**: It is defined as the proportion of total quantity of message transported to the total quantity of originated message. In our attempt, we have considered an urban circumstance. The actual records map is generated of Helsinki city in Finland which was imported from Open Street Map [13].In the experimentation simulation time of two hours is taken in account during which nodes travel on mapped paths with speed which ranges from 0.5~13 m/s . Every node has 1MB storage space. All the nodes are connected by Wi-Fi bond with a propagation data rate of 2mbps. Shortest Map based movement model and Random Waypoint model have been used in the simulation. Here, nodes travel randomly but all the time follows a passageway which is described by map data.'

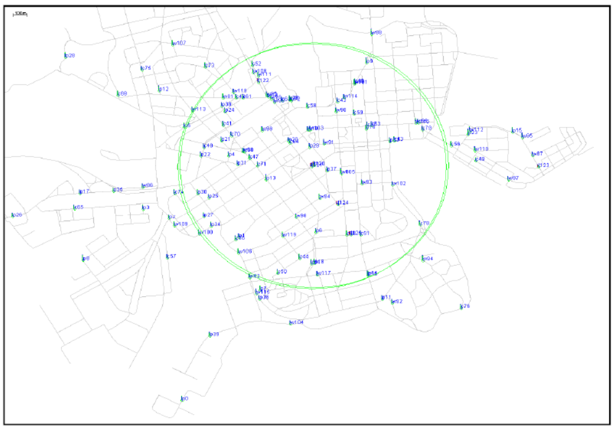

Fig. 5.5: Nodes arrangement in Epidemic Routing in playfield graphics

6. PERFORMANCE ANALYSIS

6.1 Epidemic Routing

In Epidemic routing protocol, each host is holding messages it has originated and messages it has received from other hosts. These messages may be for the current host or destined to some other hosts. Messages are stored and indexed in hash table in an efficient manner [1]. In addition, each host set a bit vector called the "summary vector (SV)" indicating entries in the local table. When two hosts come to transmission range of each other, the host with lower identifier initiates an "anti-entropy" session.

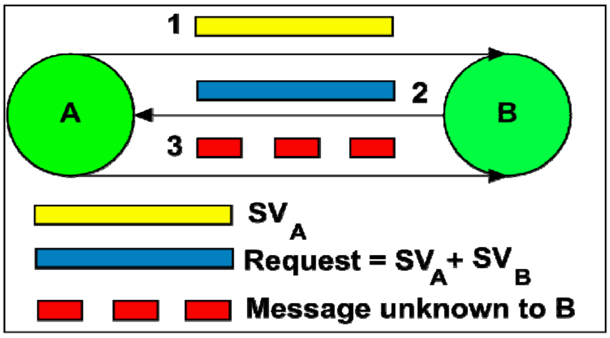

Fig. 6.1: Working of Epidemic Routing Protocol

Considering the case of Epidemic routing protocol in DTN enabled VANET, the Epidemic routing protocol is quite useful in implementation during emergency situations like accidents or traffic jam as the name "Epidemic" implies replication and transfer at a very faster rate. The existing Epidemic routing protocol needs to be optimized for better results which in turn will help in buffer optimization.

6.2 Simulation Environment & Parameters

Different performance metrics are used to assess the performance of routing protocols in various network environments. In this research, the four performance metrics i.e. network overhead ratio, packet delivery ratio, average buffer time and median buffer time are selected for the simulation process [2]. Application protocols in DTN should bear delays resulting from the challenged environment and the basic criteria for these kinds of protocols are successful delivery of messages. Therefore, usual performance metrics for evaluation of performance of DTN protocols are delivery probability and delivery latency. Overhead in transmission of the messages always results in additional energy consumption which needs to be minimized. As the mobile nodes in DTNs are constrained in terms of energy, the overhead is also one of the key metric. Here, the performance of proposed Epidemic routing protocol is evaluated based on the metrics like delivery ratio, overhead ratio, average buffer time and median buffer time [3]. Apart from these metrics, the buffer utilization and its impact on the buffer size performance is also scrutinized. These metrics are defined as follows:

- **Delivery probability**: It is defined as the ratio of the number of messages actually delivered to the destination and the number of messages sent by the sender.
- **Average delivery latency:** It is defined as the average of time taken by all messages to reach from source to destination.
- **Overhead ratio:** It is defined as the ratio of difference between the total number of relayed messages and the total numbers of delivered messages to the total number of delivered messages.
- **Buffer utilization:** It is defined as the ratio of total size of the buffer occupied and the total size of the buffer.

The metrics defined above are represented mathematically as follows:

- **Delivery probability** = $\frac{\text{\# of message delivered to the destination}}{\text{\# of message delivered to the source}}$
- **Average probability =** Average (Time taken by all messages to reach from source to destination)
- **Overhead ratio** = $\frac{\text{\# relayed messages \# of delivered messages}}{\text{\# of delivered message}}$
- **Buffer utilization =** $\frac{\text{total size of buffer occupied}}{\text{total size of the buffer}}$

6.3 Algorithm of Epidemic Routing Protocol

Procedure Name: ***On Contact_Epidemic***

1. ***Step 1:*** *Input: Node a, Node b, integer Contact_Duration*
2. ***Step 2****: Drop_Expired_Packets (a, b)*
3. ***Step 3:*** *ExchangeSummary_Vector (a, b)*
4. ***Step 4****: if (Contact_Duration)>0 then*
5. ***Step 5****: pkt=Get_Packet (a)*
6. ***Step 6:*** *if pkt then*
7. ***Step 7:*** *if NotReceived_Before (pkt, b) then*
8. ***Step 8:*** *if IsDestination (pkt, b) then*
9. ***Step 9:*** *Send_Packet (pkt, a)*
10. ***Step 10:*** *Consume_Packet (pkt, b)*
11. ***Step 11****: else*
12. ***Step 12****: Send_Packet (pkt, a)*
13. ***Step 13:*** *Store_Packet (pkt, b)*
14. ***Step 14:*** *end if*

15. ***Step 15:*** *Contact_Duration=Contact_Duration-size (pkt)*
16. ***Step 16:*** *end if*
17. ***Step 17:*** *end if*
18. ***Step 18****: end if*

6.4 Algorithm of Proposed Epidemic Routing Protocol

Procedure Name: On Contact_Proposed_Epidemic

1. ***Step 1:*** *Input: Node a, Node b, integer Contact_Duration.*
2. ***Step 2****: Drop_Expired_Packets (a, b)*
3. ***Step 3:*** *ExchangeSummary_Vector (a, b)*
4. ***Step 4****: if (Contact_Duration/2)>0 then*
5. ***Step 5****: pkt=Get_Packet (a)*
6. ***Step 6:*** *if pkt then*
7. ***Step 7:*** *if NotReceived_Before (pkt, b) then*
8. ***Step 8:*** *if IsDestination (pkt, b) then*
9. ***Step 9:*** *Send_Packet (pkt, a)*
10. ***Step 10:*** *Consume_Packet (pkt, b)*
11. ***Step 11****: else*
12. ***Step 12****: Send_Packet (pkt, a)*
13. ***Step 13:*** *GetNrOf_Copies (pkt, a, NrOf_Copies/2)*
14. ***Step 14:*** *GetNrOf_Copies (pkt, b, NrOf_Copies/2)*
15. ***Step 15:*** *Store_Packet (pkt, b)*
16. ***Step 16:*** *end if*
17. ***Step 17:*** *Contact_Duration=Contact_Duration-size (pkt)*
18. ***Step 18:*** *end if*
19. ***Step 19:*** *end if*
20. ***Step 20****: end if*

In step 4, of the above proposed algorithm the contact duration in between two nodes is reduced to half. As in case of working of Spray and Wait routing algorithm the broadcasting or transmission of messages is carried out in two phases i.e. Spray phase in which a particular number of nodes are transmitted and during Wait phase acknowledgement of nodes received by the destination is done, thereafter next Spray phase is carried out. The same concept of Spray and Wait routing algorithm is implemented in case of proposed Epidemic routing algorithm wherein the contact duration in between two nodes is reduced to half time.

6.5 Helsinki Scenario

This scenario is considered for above simulation is Helsinki scenario which is implemented in ONE and it is the most widely used and accepted scenario for simulation in DTN research. It's a combination of WKT files which is responsible for depicting a separate map layer of the city Helsinki, Finland [4].

6.6 Comparative Analysis of Epidemic and Proposed Epidemic Protocol

From the simulation results of the above two protocols, it can be inferred that the proposed Epidemic routing protocol shows better performance in terms of network overhead ratio, packet delivery ratio buffer average and buffer median. To validate our results we would be testing the proposed Epidemic routing protocol under various simulation scenarios, i.e. under different parametric conditions.

6.6.1 Result analysis for different host intervals (Epidemic)

Firstly, simulations are carried on the basis of the number of hosts i.e. 40, 50, 60. The parameters considered for performance evaluation of existing Epidemic routing protocol are number of packets delivered, overhead ratio and delivery probability.

Table 6.1 Result Analysis of Epidemic (Host basis)

No. of Hosts	No. of Packets Delivered	Overhead Ratio	Delivery Probability
40	343	89.3	0.23
50	359	99.3	0.24
60	376	109.3	0.31

6.6.2 Result Analysis for different Host Intervals (Proposed Epidemic)

Secondly, simulations are carried again on the basis of the number of hosts i.e. 40, 50, 60 for the proposed protocol. The parameters considered for performance evaluation of proposed Epidemic routing protocol are number of packets delivered, overhead ratio and delivery probability.

Table 6.2 Result Analysis of Proposed Epidemic (Host basis)

No. of Hosts	No. of Packets Delivered	Overhead Ratio	Delivery Probability
40	608	69.3	0.41
50	699	69.2	0.47
60	701	71.8	0.48

It can be clearly seen from the above Table 6.2 that proposed Epidemic protocol shows a quite improved performance in terms of number of packets delivered, overhead ratio and delivery probability.

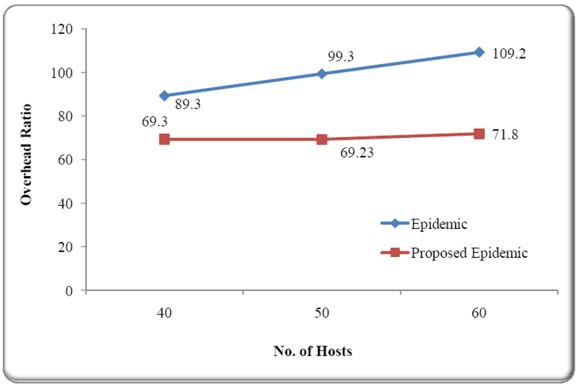

Fig. 6.3 Overhead Ratio vs. No. of Hosts

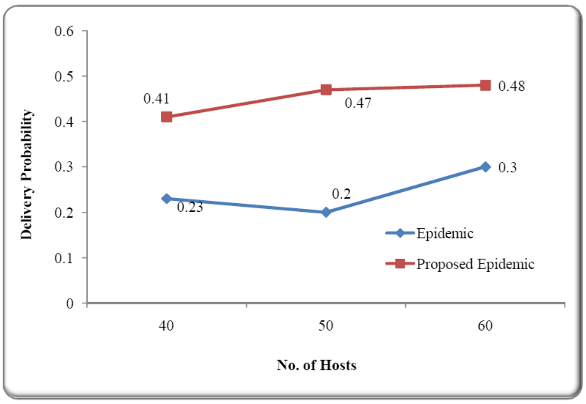

Fig. 6.4: Delivery Probability vs. No. of Hosts

From the Fig. 5.3 and 5.4, we can conclude that proposed Epidemic routing protocol produces optimal results in terms of number of packets delivered, delivery probability and network overhead ratio when compared to the existing one. The performance of the proposed Epidemic protocol has been evaluated using ONE [5]. The simulation is carried out for different number of hosts.

Table 6.3: Percentage Enhancement of Parameters in Proposed Protocol

Parameter	Epidemic	Enhanced Epidemic	Percentage
No. of Packets Delivered	343	608	77.2
Delivery Probability	0.23	0.41	78
Network Overhead Ration	89.3	69.3	22.3

From the table 6.3, it can be concluded that the proposed Epidemic protocol has a major improvement in terms of number of packets delivered and thereby improving the delivery probability considerably over the existing one. Along with, it optimizes the network overhead ratio to a quite extent.

6.6.3 Result Analysis for different simulation time (Epidemic)

The existing protocol must be executed under different parameters to test its performance in comparison to proposed one. Therefore, the existing protocol is simulated for three varied time intervals i.e. 6,9,12 hours.

Table 6.4 Result Analysis of Epidemic Protocol (Simulation Time)

Simulation Time (Hours)	No. of Packets Delivered	Overhead Ratio	Delivery Probability
6	158	98.4	0.2
9	237	97.5	0.2
12	343	89.3	0.2

In Table 6.4, simzulation is carried out for variable time intervals i.e. 6,9,12 hours. The results obtained clearly states that as the simulation time increase the deliverance of messages also increases but the delivery probability remains constant. Though, overhead ratio decreases as the simulation hours increases.

6.6.4 Result Analysis for different simulation time (Proposed Epidemic)

The proposed protocol must be executed under different parameters to test its performance in comparison to existing one. Therefore, the proposed protocol is simulated for three varied time intervals i.e. 6,9,12 hours.

'Table 6.5 Result Analysis of Proposed Epidemic Protocol (Simulation Time)

Simulation Time (Hours)	No. of Packets Delivered	Overhead Ratio	Delivery Probability
6	275	69.4	0.3
9	446	69.5	0.4
12	608	69.3	0.4

From Table 6.5, it can inferred that when the simualtion is run for the proposed protocol for three different intervals i.e. 6,9,12 hours the overhead ratio remains variably same whereas the deliverance of messages increases thereby, increasing the delivery probability.

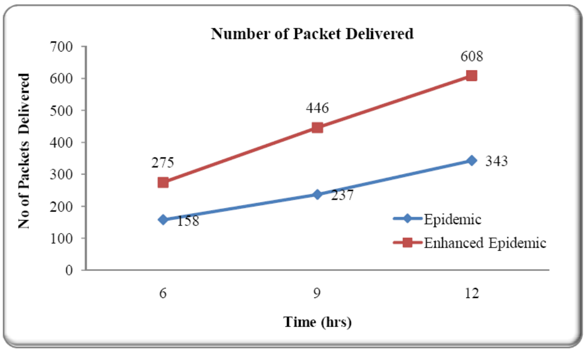

Fig. 6.5 No. of Packets Delivered vs. Simulation Time

From the Fig. 5.5, it can be seen clearly that the proposed protocol has a much better packet deliverance as compared to the existing protocol under different simulation time.

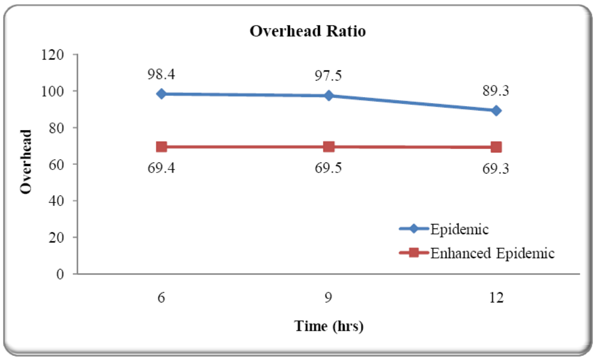

Fig. 6.6 Overhead Ratio vs. Simulation Time

From the Fig. 5.6, it can be clearly seen that the proposed protocol bears a less overhead ratio when compared to the existing protocol under different simulation time.

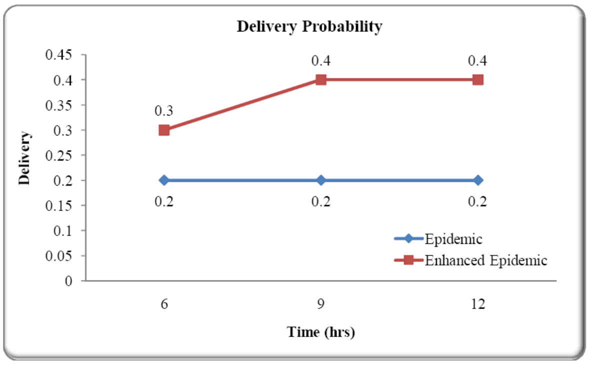

Fig. 6.7 Delivery Probability vs. Simulation Time

From the Fig. 5.7, it can be concluded that the proposed protocol has a far better delivery ratio as compared to the existing protocol under different simulation time.

CONCLUSION

From the consideration of all the above points researcher conclude that, Delay-Tolerant Networks and Vehicular Delay-Tolerant Networks is given. Delay-Tolerant schemes and protocols can help in situations where network connectivity is sparse or with large variations in density, or even when there is no end-to-end connectivity by providing a communications solution for non-real-time applications. Some special issues like routing are addressed in the paper and an introductory description of applications and the most important projects is given. Finally, some research challenges are discussed and conclusions are detailed. Vehicular Delay Tolerant Network (VDTN) is a special category of vehicular networks by incorporating delay tolerance in communication under the presence of disruptions in connectivity. When such delay tolerant network technology is used in vehicular environment, it is called Vehicular Delay Tolerant Network (VDTN). The Delay Tolerant Network (DTN) is an occasionally connected wireless ad-hoc network that allows the communication between the wireless nodes in the scenario where end to end connectivity can never be attained or when the delay related in relaying of data can be very high. The Delay Tolerant Networks plays the key role in the circumstances where the routes between any pair of nodes are not fixed. Examples of such kind of networks are in military battlefields, sparse networks, space communication. It does not require any prior knowledge of networks to forward the bundles from one node to other. It is based upon the store-carry-forward approach. This research effort explores how delay tolerant enabled routing protocols can be optimized in certain parameters like delivery probability, network overhead ratio for better optimality of results and it provides a comprehensive overview of all some algorithms for delay tolerant network. This research focuses on optimizing the information being disseminated to node vehicles which are in movement following a particular path symbolizing a scenario of an automotive network. The major objective of this research is to optimize the buffer of node vehicles in terms of information content. The proposed research work is an improvement over Epidemic routing protocol under certain mobility model so that the proposed algorithm gives optimized results in terms of parameters like network overhead ratio, average buffer time, median buffer time and increasing the delivery of messages and thus increasing the delivery probability also. The fast message delivery of messages will aid in emergency situations like accident which happens frequently in regular scenario during movement of vehicles on highways.

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