EFFECT OF STAR VEHICLES ON PEER TO PEER COMMUNICATIONS IN VEHICULAR NETWORKS

T.S. Ravi Chandra, Kolla Raja Sekhar
Department of Information and Communication Technology,
ABV-IIITM, Gwalior, India

ABSTRACT:

Recent advances in Intelligent Transportation Systems and rapid development of applications in this field have attracted many researchers. In this paper we initially describe different source coding techniques for reliable packet delivery reasoning with incompatibility of TCP over wireless links. We use the concept of source encoding, optimistic routing techniques, along with STAR vehicles concept introduced in [25] which are very realistic, study the effect of these STAR vehicles over decrease in overhead, probability of successful packet transmission over different densities of distribution of vehicles. We finally compare proposed scheme with Code Torrent scheme in [24].

KEY WORDS: *VANET Communications, STAR Vehicles, Opportunistic multi hop adhoc routing, Erasure Coding, Network Coding, Digital Fountain.*

I. INTRODUCTION

Vehicular communications and peer-to-peer communications are in increasing popularity these days with the advances of technologies in vehicles. Automobile industries are in need to rely on research in these areas which helps in preparing a more reliable and user friendly communication systems among vehicles. The importance of STAR vehicles in this context needs necessary exposure. STAR vehicles operate on "Lend and Earn" policy. Use of suitable coding schemes along with STAR vehicles enhances reliability in communications.

We further discuss few characteristics of VANETs, different source encoding techniques, optimistic routing techniques in Literature Review, Section II. The proposed scheme is discussed in Section III. Later, we present the Evaluation of the Scheme, Results in Section IV. Conclusions have been drawn and discussed in Section V. And we later move on to our future work in this area of research in Section VI.

II. LITERATURE OVERVIEW

Dealing with vehicular communications these can be broadly divided into two categories based on the interaction between infrastructures. Those are

1. Vehicle to Vehicle communications(V-2-V)
2. Vehicle to Infrastructure communications (V-2-I)

Fore mentioned types of communications can be further divided on application purpose into [1]

1. One to One Communications (Unicast)
2. One to many Communications(Broadcast)
3. Many to Many Communications (Multicast/Geo-cast)

These three kinds of communications can be mapped with purpose of applications as in [2]

1. Active vehicular security applications –Broadcast mechanism
2. Public Service applications – Unicast mechanism
3. Improved driving – Multicast mechanism

4. Entertainment – Unicast, Broadcast, Multicast mechanisms

There are different kinds of techniques and technologies used to support above mentioned applications which include, protocols in VANETs.

1. Transmission Control Protocol(TCP)
2. User Datagram Protocol(UDP)
3. Network Coding.
4. Erasure Coding.

2.1 Characteristics of VANETS:

As discussed in [3] VANET, if we consider vehicles and infrastructure as nodes in the wireless environment. These nodes communicate in ad hoc manner, for provision of this ad hoc some standardizations have been made WAVE,DSRC,IEEE 802.11p .These will be elaborated in the next sections of the paper.

High Mobility:

High mobility is the most important characteristics of VANET. Vehicular nodes move with different speeds in different directions making it distinctive from MANET. Many studies [5],[6],[7] are on the impact of mobility in VANET ad-hoc communications.

Dynamic topology:

Because of the high mobility in vehicular nodes VANET topology is changing making it unpredictable. The connection time between two nodes in very short.

Intermittent connections:

Because of the above mentioned characteristics of the VANETs connections are intermittent making it prone to packet losses, random link failure. This intermittent parameter has a great weightage among the metrics which affects the performance of protocols.

Transmission medium:

Transmission medium available for communication between any nodes in VANETs is wireless medium, modeling of this medium effect the communication between the nodes [8]. Modeling of this medium takes care into many effects such as deep-fading of channel, interference due to environmental factors, effects of transmission ranges [9] of nodes. This wireless channel effects on the performance and operation of VANET protocols. Because of the efficient modeling techniques employed chaotic and unpredictable nature of wireless links can be reduced.

2.2 TCP in VANET communications:

TCP is designed initially to react for packet loss due to network congestion by altering window sizes, rate of transmissions according to the availability in the channels. So while applying TCP in wireless environments the problem is that it assumes all the packet losses are because of congestion, it assumes packet losses due to random effects of channels and inter-prates as congestion assuming that channel is overwhelmed with traffic which leads to improper channel handling, increase of waiting time at the sender side, performance degradation. TCP uses cumulative acknowledgement, for this case there occurs a situation in which there is a loss of acknowledgement instead of loss of data which incurs for the re-transmission of all the packets according to the window size. So, to avoid these misconceptions by TCP some modifications are done to TCP making it suitable for wireless environments. Many variants of TCP were proposed making it adaptable to the wireless environment by adding congestion predictors to differentiate between network dependent errors and react appropriately to the error occurred. [10] New techniques such as Network Coding, Erasure Coding which use raptor codes, Luby Transform codes, Online codes came into light performing better than modified TCP in terms of both overhead involved and packet delivery ratio[11].In short TCP cannot cop up with stochastic wireless links. As in [12] many researches during evaluation of TCP protocol in wireless environments ignore the effect of interference between Data flow and Acknowledgement. In simpler words can be said as interference because of bidirectional movement of data. This interference makes a significant change in practical and theoretical applications can be reduced significantly by using Network Coding techniques [12].

2.3 Opportunistic multi hop adhoc routing in VANET Communications:

Opportunistic routing is a very important scenario in adhoc vehicular networks. VANETs are best example for delay tolerant networks. Opportunistic routing is a method in which there is no need of continuous connection between sender and receiver. Some applications don't need continuous connection such as data sharing, emails, uploading data to the cloud. In Opportunistic multi hop routing scenario sender node will buffer the data instead of discarding it, intermediate nodes also act as a router with buffers. These nodes try to find out a best path for data transmission and then forwards the packets, it cannot find any possible route for destination alternative methods such as Carry on Move. In order to deal with dynamic topology, high mobility associated with vehicles, Opportunistic multi hop adhoc routing simply cannot solve this problem. In order to make efficient communications network coding techniques are also applied.

2.4 Erasure Coding:

Erasure coding is a technique used for reliable transmissions in intermittent connections, link failure, and dynamic network topology scenarios. Erasure Coding is technique which is used to send encoded data instead of plain data, in which blocks of data are combined and encoded. If a sender wants to send n packets of data it is encoded into k packets such that (k>>n), advantage of encoding is now receiver requires only set of n packets (any subset of n packets) to retrieve the data. If sender encodes n packets into k packets, during retransmission if some of the packets are lost and k` packets are received, n<k`<k. These k` packets are enough to retrieve the whole data. It is applied in reliable multicast protocols for wired networks [13].Since because of these Erasure Coding transmission time has reduced significantly, packet transfer became more reliable [14][15] and practically applicable. In erasure coding sender encodes the data, receiver decodes the data, and intermediate nodes just forward the data packets making no changes to it.

2.5 Digital Fountain:

Codes used for Erasure Coding are considered to be implementations of digital fountains, introduced in [17]. Sender node generates a Digital fountain, in which data is injected into the network by one or more nodes and nodes which require this data collect information according to their need. Implementation of digital fountain decreased the retransmission problem that is feedback implosion. Feedback implosion is a state in which many receiver nodes requests for retransmission of data, can be solved by digital fountain, through which in-spite of numerous retransmissions, sender creates a digital fountain through which all nodes can be served in a parallel manner.

2.6 Erasure Codes:

Different coding techniques are used to decrease the errors wireless communication. Different types of codes have been introduced for implementation of digital fountains. Firstly in [18], Red-Solomon codes are firstly introduced to implement digital fountains. Red-Solomon codes are special kind of linear codes, considers a n-1 degree polynomial whose coefficients are codewords generated by sender, It uses vandermonde matrices for encoding purpose(x) is a single codeword obtained at x.
$p(x)=a_0+a_1x_1+a_2x_2+a_3x_3+.....+a_{k-1}x_{k-1}$. As mentioned before it's a variant of linear codes in which complexity for decoding is of order O (k_2). Because of the complexity involved in Red-Solomon, decoding large data using it is resource constrained. To overcome defects of Red-Solomon codes fast, loss resilient Tornado codes were introduced in [18] by effectively decreasing encoding and decoding times, using multi-bipartite graph. Initial symbols are XORed with other initial symbols during the encoding process. But the major drawback in Tornado codes is n packets are not enough to recover all the sent packets, code efficiency is also not impressive. Encoding and decoding times complexity depends on number of edges in the graph, complexity involved is of order O (log (k).√k). Redundancy is put by the sender according to the estimation of loss probability which is time variant, over estimation of loss probability results in degradation of code efficiency, under estimation results problems in decoding of the received packets. Solving the problem of estimation of loss probability in Tornado Codes, Luby-Transform codes were proposed in[20].Complexity of decoding involved is O(k * ln(k/s)) ,0<s<=1.Major advancement made is, making encoding and decoding times dependent only on the size of the original data. During encoding process Luby-Transform codes use the same bipartite

graph, but it randomly choses the degree from a given distribution. Decoding is performed based on Belief propagation algorithm [21]. Raptor Codes sere introduced in [22] increasing the probability to decode the packets. Significant change has been done in raptor codes compared in the process of encoding and decoding, during decoding phase it doesn't consider the use of all edges of graph to decode the data. In encoding phase input data is precoded, some redundancy bits are added, Luby-Transform coding is performed on precoded data finishing the encoding phase. During decoding phase K (1+E), E>0 symbols are required to decode the data corresponding to K input symbols. Complexity involved raptor codes id of order O (k * log (1/E)).

2.7 Network Coding:

Coding is technique similar to adding redundancy to transmitted code making reconstruction of data possible after passage through noisy wireless links. Network coding is a technique which differs from Erasure coding in aspect of its goal, but differs only in one aspect of working, that is behavior of Intermediate nodes. Intermediate nodes placed in the route between sender and receiver also encodes the data known as recursive coding. Researches find out network coding to be a promising technology [16]. Concept of Network coding came into light for proper utilization of network resources by decreasing number of transmissions in dynamic network topology. In linear network coding data is considered as a vector over a certain base field, linear transformations are done at each node before forwarding it. A specific technique called Random linear network Coding was introduced in [23], that differs from linear network coding in one aspect that is choosing random values as coefficients.

2.8 Peer to Peer Communication:

It’s different kind of technique which differs from traditional client – server in which a client requests the server the data it requires, in partial contrast peer to peer networks requests those clients which possess these files to share them. In traditional architecture capacity of server i.e. hardware involved matter a lot, but in p-2-p networks capacity is scaled by the number of peers. It is very useful in transfer of very large files. In these p-2-p networks file is divided into small pieces called chunks, this is used to decrease the waiting time, because of this on receiving a chunk of file, receiver can start acting as peer unless waiting for the entire file to be downloaded. In peer to peer communications there exists a tracker which provides user to get information about the nodes possessing the file. It manages the requests by selecting, allotting, dividing the file chunks accounting the number of nodes owning the file.

III. PROPOSED SCHEME

We have been ignoring massive resources that we actually own, under estimating capabilities of vehicles. Every vehicle is equipped with onboard sensors, communication devices, resource rich hardware. In the mere future every vehicle is a resource full machine. Vehicular nodes contradict with the concept of sensor nodes, which are resource constrained devices. In the working days of a week vehicles spend most of the time idle in garages or in parking vehicles. During these idle periods vehicle can lend their resources to network for communication purposes, price is paid accordingly to the billing scheme. In the mere future while choosing a vehicle, resources it possesses will also have a weightage along with its features. It may lead us to a state of “Lend and Earn”. These vehicles get registered to RSU with their range of mobility, duration, type of resources. Such vehicles are known as STAR vehicles. As this concept of STAR vehicles is proposed in [25]. Our proposed scheme deals with the effect of star vehicles in P-2-P communications. STAR vehicles are those which are ready to act as cooperative nodes by lending their resources for communications among other nodes by following appropriate billing scheme. In this paper we find the impact of STAR vehicles on the P-2-P sharing of data, effect on throughput of network, effect on communication between vehicles based on distribution of STAR vehicles. The demand of entertainment in vehicular networks is going high these days. Peer to peer data sharing. We assume that every vehicle uses advanced navigation application to reach it's destination which provides optimized path by considering live traffic condition. Use of tracker in peer to peer communications is described above. In this proposed scheme, purpose of tracker in Vehicular networks adds some additional duties to estimating the changes in topology, along with the traditional ones. In this scheme STAR vehicle acts as a file tracker, additional duties are performed by summarization of data obtained from navigation application, estimating the geographical position of a node at an instance of time. The problem with peer to peer communication in Vehicular networks is, chunk of files possessed by a peer which are mapped by the tracker to the receiver cannot be transmitted to the receiver, if same situation occurs with many of the nodes then the file cannot be received. For this reason same file cannot be downloaded from many sources which results in waste of bandwidth, network resources. So in our scheme we use erasure coding technique along with advantage of distribution of STAR vehicles to improve peer to peer communication in Vehicular networks. Consider a file (F), which can be divided into K chunks, there are n nodes in a network. Number of packets queued at each source node for transmission depends on number of nodes possessing the file, hop distance of the peer node and the receiver. Hop distance is the number of hops by which sender and receiver are separated. Considering the above two conditions, applying erasure coding technique of encoding N packets to P coded packets. If size of selected number of chunks from each peer differs from N then by following a ratio of N: K packets are encoded. By following a certain ratio for encoding the file overhead involved in encoding and decoding can be reduced. One more action performed by STAR vehicles is if the number of peers are very less is, as smaller chunks of data is requested from those nodes which are about to leave the topology. STAR vehicles try to collect the information from these nodes and buffer it, since sometimes receiver may overhear the packet received. STAR vehicles have a great impact by using them for opportunistic routing purpose by allotting more probability while choosing the links between sender and receiver till a tolerable overhead involved. By dynamically allocating the chunk size considering the position of the node in the topology, buffering the data depending on the availability of peer nodes, simply acting as topology adaptable tracker the performance, applying opportunistic routing, erasure source coding for peer to peer communications in vehicular networks perform better than existing schemes.

IV. EVALUATION OF THE SCHEME – RESULTS & DISCUSSION

Evaluating the effects of usage of STAR vehicles are measured using simulation of the scenario in a 5000 sq.mt. In the simulation we consider each node of a fixed speed 40m/s. We consider all the links between vehicles are of capacity 7 Mb/sec. Effect of average time for transmission of a fixed size of file (1 GB) over different densities of STAR vehicles per square kilometer is shown in Figure.1

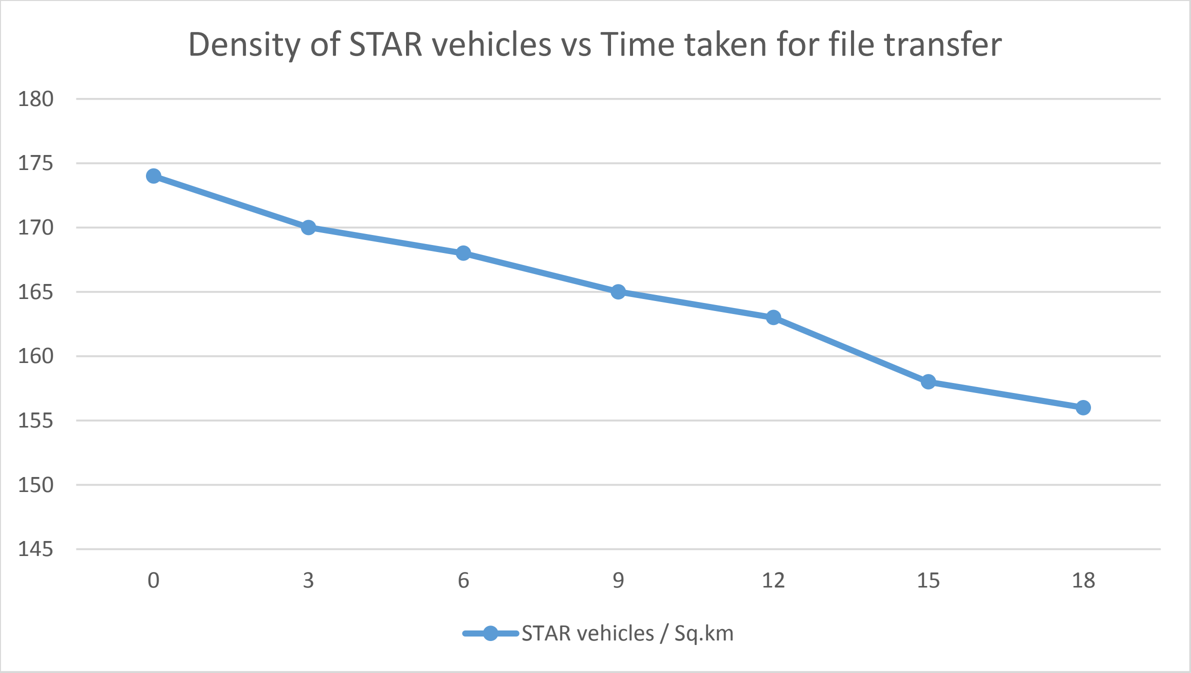

Figure.1 Density of STAR vehicles vs Time taken for file transfer

We consider different number of STAR vehicles per every 100 vehicles, taking distribution of vehicles as constant per square kilometer. Graph in Figure.2 represents the effect of distribution of STAR vehicles on probability of successful transmission of packet to receiver.

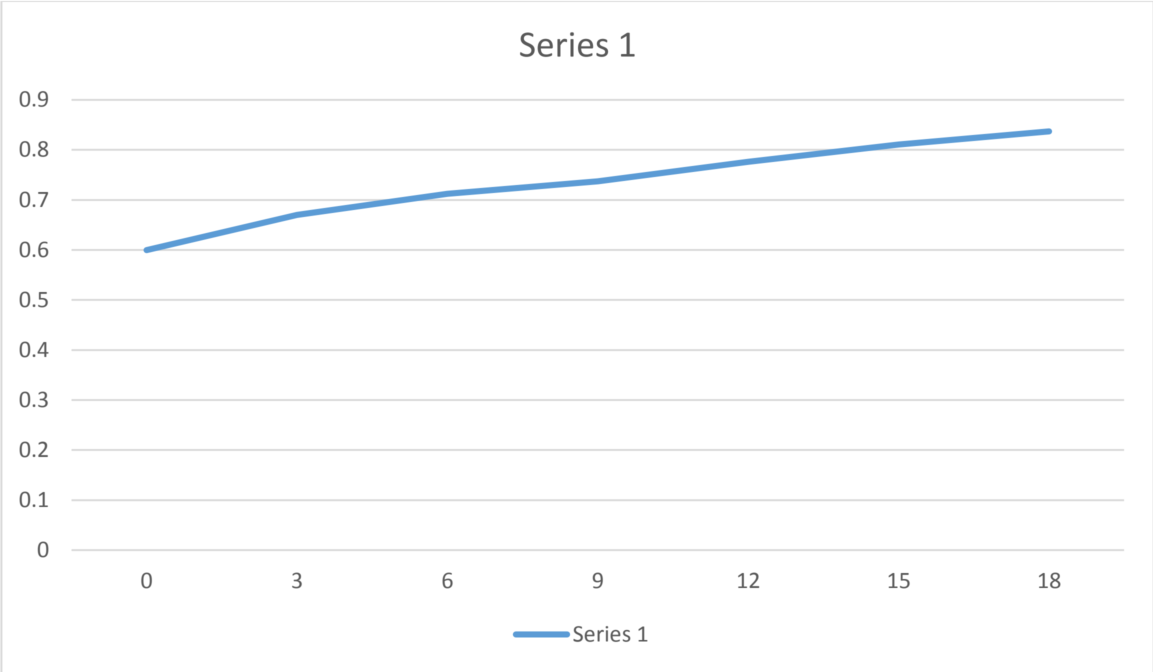

Figure.2

Comparison of proposed scheme with existing CODE Torrent[24] is done based on parameters average time taken to transfer a fixed size file in Figure.3 considering a constant 10% of vehicles as STAR vehicles in proposed scheme.

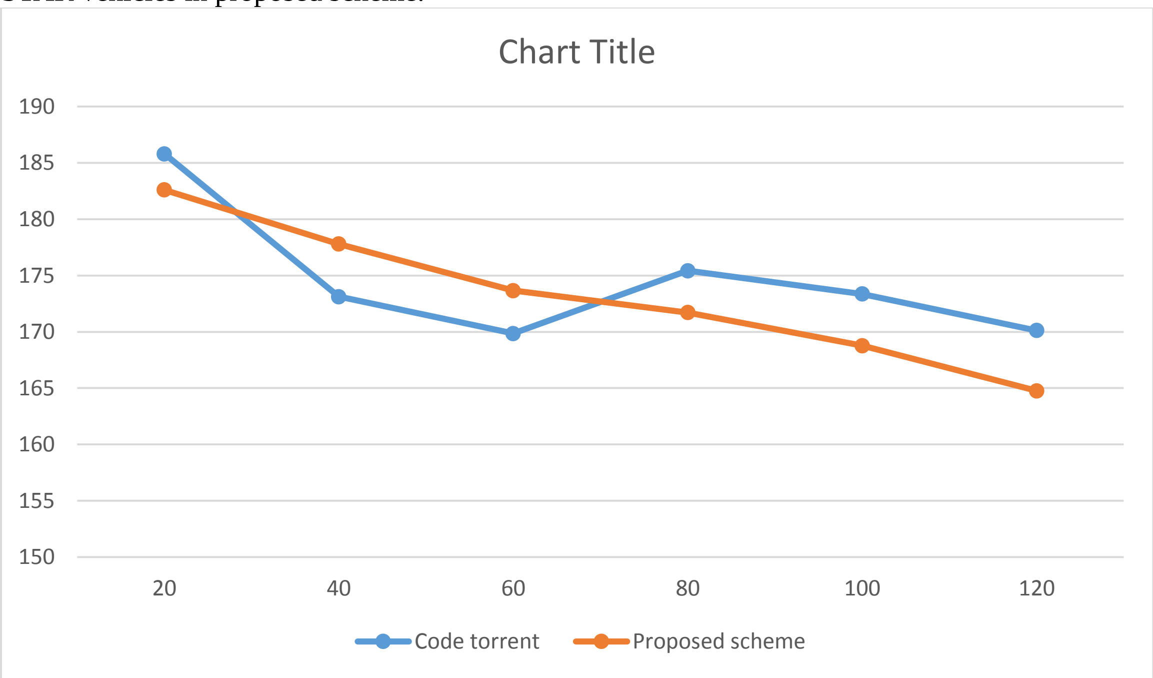

Figure.3

V. Conclusion

In this paper we presented the effect of using erasure coding technique for decreasing overhead involved at each node, impact of STAR vehicles in peer to peer file transfer, effect of dynamic allocation of file chunks based on topology on the probability of decoding the file by the receiver. Our studies prove that proposed scheme performs better than the existing CODE Torrent.

VI. FUTURE WORK

Security is the prime concern in any communication system. Secure and reliable communications are the need of hour for the automobile industries. Proper security schemes place the manufacturing firms ahead of their competitors. Implementing security schemes in Vehicular communications is a tedious work as we cannot specifically identify the attackers as they also are a part of the users. Locating attackers hence poses a considerable amount of challenges to the research community. Employing security schemes along with reliable communications summarizes our future work.

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AUTHOR'S BIOGRAPHY

T.S. Ravi Chandra is currently pursuing his Integrated post graduation course in Information and Communication Technology at Indian Institute of Information Technology & Management, Gwalior, India. His research interests include wireless networking, network security, information theory and coding, vehicular networks, sensor networks, network simulation and modeling. He has a research paper published in "International Journal of Advances in Engineering and Technology (IJAET)"

Kolla Raja Sekhar is currently pursuing his Integrated post graduation course in Information and Communication Technology at Indian Institute of Information Technology & Management, Gwalior, India. His research interests include vehicular networks, mobile ad-hoc networks, data and text mining, big data analysis, information theory and coding, intelligent systems and wireless networking. He has a research paper published in "International Journal of Advances in Engineering and Technology (IJAET)"