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Network Aggregation and Long Term Proportional Fairness with Modified Quantum-Behaved Particle Swarm Optimization (LTPFMQ) Based Scheduler in Vehicular AD-HOC Networks

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Abstract--- The rapid evolution of wireless communication capabilities and vehicular technology would allow traffic data to be disseminated by travelling vehicles in the near future. Vehicular Ad hoc Networks (VANETs) are self-organizing networks that can significantly improve traffic safety and travel comfort, so the data dissemination in VANET environment is a challenging task. Due to its high bandwidth saving potential, aggregation plays a major role for VANETs. Network aggregation is proposed in this paper for VANETs which is any kind of multi-hop message dissemination where a number of vehicles collaborate to gain knowledge about real-world phenomena. In addition it also solves the inter-vehicle data dissemination problem based on a Wireless Access for Vehicular Environments (WAVE)/802.11p in VANET, using Scalar Algebraic Triangular Network Coding (SATNC). Then scheduling is done by using Long Term Proportional Fairness with Modified Quantum-behaved Particle Swarm Optimization (LTPFMQ) scheduler. Simulation results are presented that illustrate the severity of the inter vehicle data dissemination problem when applying common state-of-the-art techniques and parameters such as packet drop ratio, network load, End-to-End (E2E) delay and packet delivery ratio. The results of these experiments confirm the results obtained in the corresponding simulations.

Keywords--- Broadcast Protocol, Data Dissemination, IEEE 802.11, Modified Quantum behaved Particle Swarm Optimization (MQPSO), Scalar Algebraic Triangular Network Coding (SATNC), Network Aggregation, Vehicular Ad-hoc Networks (VANETs**).**

I. INTRODUCTION

Intelligent transportation systems (ITS) [1] can provide efficient solutions for road traffic problems by combining technology and improvements in communication, information systems and advanced mathematical models with the existing world of surface transportation infrastructure [2]. Vehicular Ad hoc Networks (VANETs) represent a major component of ITS, because of their potential to enable various applications to improve road safety and travel comfort. With the increasing number of vehicles being equipped with communication capabilities, large scale VANETs are expected to be available in the near future [3]. The novelty of VANETs with respect to other ad hoc networks has been recently highlighted, and detailed VANET requirements are specified in [4]and [5].

The technology used to enable VANET is called IEEE 802.11p/WAVE [6].This is an amendment to the IEEE 802.11 standard that contains several enhancements to improve performance under vehicular conditions. Examples are an increased output power, dedicated channel, and reduced channel bandwidth to account for the influence of Doppler spread. In contrast with other ad hoc networking use cases, VANET communication in general does not focus on unicast transmissions. Instead, the emphasis is put on the dissemination of information to all nodes located in a certain region. Typically, this functionality is achieved by

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combining Media Access Control (MAC) level broadcasting with geographic-aware forwarding schemes on the networking layer. In general, two different kinds of information messages are used: Cooperative Awareness Messages (CAM)[7] and Decentralized Environmental Notification Messages (DENM) [8]. Hence, CAM beacons are restricted to single hop broadcasts. The latter is applied when some specific piece of information regarding the environment, e.g., tail of traffic jam, slippery spot, obstacle on the road, etc. is to be communicated to all vehicles within a given area. Therefore, DENM messages are multi-hop broadcasted in the VANET. Moreover, the network is prone to frequent fragmentation leading to high variability of the connectivity. In addition, redundancy should be limited. For these reasons, providing data dissemination in VANETs is a challenging task.

Due to the absence of feedback in WAVE broadcasts, a common way of disseminating data still happens to be through gossiping [9] that mimics the spread of a rumour in society. In gossiping protocol, Network Coding (NC) is introduced to find unexploited redundancies due to the broadcast nature of wireless for more efficient data dissemination. LNC [10] may be applied in this simple case, it resulted in the high encoding and decoding computational complexities. To solve the problem of computational complexity, a Triangular Network Coding [11] is used in this work. Simultaneously, a scalar algebraic model is introduced for solving the problem of topology modifications in this work.

However existing VANET dissemination techniques can be classified into three models: push, pull and hybrid. In the push model, data is disseminated proactively using periodic broadcast, while in the pull model, data is disseminated on-demand [12], where a routing protocol carries data to relatively faraway distances. Such protocols also rely on broadcasting for data dissemination at each hop. There are few schemes that combine both dissemination models together so as to support different types of applications. The push-based model is often preferred for safety applications, when an immediate response is required, while the pull-based model is used for delay-tolerant applications, such as seeking a free parking slot or detecting congestion on far-away road. Compared to push-based model, pull model often requires less overhead, with less latency constraints. In delay-tolerant applications, the requester usually sends a query to the broadcast site, and gets a reply message from there. In such applications, users can tolerate more delays as long as a response eventually returns. This paper work analyses the V2V horizontal data dissemination part of data services in 1-D VANETs: ‘pushing’ Internet content to vehicles. The major contribution of the work can be summarized as follows:

The PMFs of the dissemination completion time for both LNC and SATNC based broadcast in a prototypical three-node case are mathematically derived. Believe that in-network aggregation is an important building block to enable multi-hop information dissemination in VANET. The proposed work provides analytical results for V2V data dissemination under a simple Long Term Proportional Fairness with Modified Quantum-behaved Particle Swarm Optimization (LTPFMQ) scheduling model, the complete data set being received at a new node each time. LTPFMQ analyses the multicast throughput of SATNC aided content distribution in a linear VANET.

II. BACKGROUND STUDY

Different data dissemination techniques for VANETs are pro-posed to fit different applications. Basically, two major applications are heavily researched in this area: traffic safety, and travel comfort. Traffic safety applications are low data-rate, confined to limited number of neighborhood with strict latency constraints. While travel comfort applications are known as delay-tolerant applications with more relaxed time constraints, but are expected to require data transmission spanning relatively faraway distances. Push model is generally preferred for safety messaging systems such as collision warning systems, emergency message dissemination systems and information systems specified for hazardous road conditions like ice, water or snow. Nevertheless, other approaches also exist to support other types of applications such as arrival time estimation, speed expectation and congestion detection.

In [12], the data push model is studied in the context of the “Traffic View” vehicular information dissemination system. The study differentiates between the vehicle’s own data and the stored data about other vehicles. Three propagation models were com-pared: same-direction, opposite-direction and bi-direction. In the same-direction model, a vehicle periodically broadcasts both its own data in addition to its stored data in a single packet, which is propagated “backward” by vehicles moving in the same direction. While in the opposite-direction model, vehicles in the same direction only broadcast their own generated data, which are aggregated and propagated backwards by vehicles moving in the opposite direction.

In [13] presents two candidates for dissemination protocols: a zone flooding protocol and a zone diffusion protocol. The two protocols combine ideas from sensor networks and geo casting to ensure that data is aggregated and distributed only in a bounded geographical area. The simulation study has been conducted using the Network Simulator 2 (NS-2) and compared with two protocols that can be used as a basis for selecting the most appropriate protocol.

Address Based Service Resolution Protocol (ABSRP) [14] integrates a pull-based technique to discover services in VANETs. When a vehicle needs a service, it creates a service request with the specification of the type of service and the desired service area, and then transmits it to the nearest roadside unit. The receiving roadside unit checks if it has proactively learned about the service provider. If it is aware of the service provider’s IP address, it forwards the service request to the tar-get service provider. Otherwise, it broadcasts the service request destined to the target service provider over the backbone network. After receiving the request, the target service provider creates a service response and transmits it to the originating vehicle. In the former case, broadcasting can rapidly flood a congested vehicular network with data packets, since no optimization is proposed in ABSRP.

Vehicle-Assisted Data Delivery (VADD) is another pull-based approach for data dissemination in VANETs [15]. When a vehicle issues a request to a certain fixed site, VADD proposes techniques to efficiently route the packet to that site and receive the reply within a reasonable delay. Involved nodes carry the packet when routes do not exist and forward it to the new receiver that moves into its vicinity. Nevertheless, VADD is designed specifically for applications in sparsely connected networks, and did not resolve communication issues under high-densities.

In [16] consider two algorithms to transfer warning messages in VANET. They have developed analytical models to obtain time-probabilistic characteristics of these algorithms. Dissemination algorithms to transfer warning messages from the originator node to the remaining recipient nodes within a specified geographic area are considered. The applicability of the obtained results to the vehicular ad-hoc networks is discussed in this paper. In [17] three critical information dissemination algorithms are proposed and analytical methods to obtain their time-probabilistic properties are given. Here note that the network connectivity problem is left out of scope and the authors assume that the transmission radius always exceeds the inter-node distance.

In [18], the analysis uses two priority classes of traffic, assuming that safety messages have higher priority compared to the other network traffic. A highway of length R meters is assumed, and the transmission range is set to cover a constant distance d for each node. First, the probability of interference between two nodes is de-rived. Then, a birth–death process analysis is used to derive the probability distribution of lower priority messages, which are con-currently transmitted at the steady-state, and also to derive the percentage of destination node population which is affected by the interference, and thus cannot receive the message correctly. Finally, the performance of high-priority traffic is studied in the presence of low-priority traffic. One drawback of the proposed analysis is assumed that topology does not change during each broadcast cycle, and topology modifications are considered only at the be-ginning of new cycles.

III. NETWORK MODEL AND PROPOSED METHODOLOGY

Linear Network Coding (LNC) [19] is a block code conducted over finite field$\mathbb{F}_q$, where q is the finite field size. Every packet x_i consisting of log(q)-bit symbols, can be treated as a vector in $\mathbb{F}_q$. The drawback of LNC over large finite field is that it resulted in high encoding and decoding computational complexity. To solve the problem of high encoding and decoding computational complexity Triangular Network Coding (TNC) is introduced.

A. *Scalar Algebraic Triangular Network Coding (SATNC)*

In SATNC model network is represented as a directed graph $G = (V, E)$, where Visthe set of network nodes and Eis the set of links, such that informationcan be sent noiselessly from node i to j for all $(i, j) \in E$. Nodes i and j are called the source and destination, respectively, of link (i, j) . The origin and destination of a link $\mathcal{L} \in E$ are denoted $s(\mathcal{L})$and $d(\mathcal{L})$, respectively. In the SATNC model, the source information processes, the receiver output processes, and the information processes transmitted on each link, are sequences of length-u blocks or vectors of bits, which are treated as elements of a finite field ,$\mathbb{F}_q, q = 2^u$. The information process $Y_j$transmitted on a link j is formed as a linear combination, in $\mathbb{F}_q$, of link 's inputs, i.e., source processes $X_i$for which $a(i) = s(j)$and random processes $Y_{\mathcal{L}}$for which$d(l) = s(j)$, if any. For the delay-free case, this is represented by the equation

$$Y_j = \sum_{\{i=1:a(i)=s(j)\}}^{r} \gamma_{i,j} X_i + \sum_{\{\mathcal{L}:d(\mathcal{L})=s(j)\}} \delta_{\mathcal{L},j} Y_{\mathcal{L}} \tag{1}$$

$\gamma_{i,j}$are the triangular NC coefficients selected uniformly in $\mathbb{F}_q$ at the j-th transmission. $\delta_{\mathcal{L},j}$are the triangular NC coefficients selected uniformly in $\mathbb{F}_q$ at the $\mathcal{L}$-th transmission. The ith output process $Z_{\beta,i}$at receiver node β is a triangular linear combination of the information processes on its terminal links, represented as

$$Z_{\beta,i} = \sum_{\{\mathcal{L}:d(\mathcal{L})=\beta\}} b_{\beta,\mathcal{L},i} Y_{\mathcal{L}} \tag{2}$$

$b_{\beta,\mathcal{L},j}$are the triangular NC coefficients selected uniformly in $\mathbb{F}_q$ between i and β–th transmission. For multicast on a network with link delays, memory is needed at the receiver (or source) nodes, but memory less operation suffices at all other nodes [20]. Consider unit delay links, modelling links with longer delay as links in series. The corresponding linear coding equations are

$$Y_j(t+1) = \sum_{\{i=1:a(i)=s(j)\}}^{r} \gamma_{i,j} X_i\,(t) + \sum_{\{\mathcal{L}:d(\mathcal{L})=s(j)\}} \delta_{\mathcal{L},j} Y_{\mathcal{L}}(t) \tag{3}$$

$$Z_{\beta,i}(t+1) = \sum_{u=0}^{\mu} b'_{\beta,i}(u)\, Z_{\beta,i}(t-u) + \sum_{\{\mathcal{L}:d(\mathcal{L})=\beta\}} \sum_{u=0}^{\mu} b''_{\beta,i,l}(u) Y_{\mathcal{L}}(t-u) \tag{4}$$

where$X_i(t)$,$Y_{\mathcal{L}}(t)$,$Z_{\beta,i}(t)$,$b'_{\beta,i}(u)$, and $b''_{\beta,i,l}(u)$ are the values of the corresponding variables at time t, respectively, and μ represents the memory required. These equations, as with the random processes in the network, can be represented algebraically in terms of a delay variable D.

$$Y_j(D) = \sum_{\{i=1:a(i)=s(j)\}}^{r} D\gamma_{i,j} X_i\,(t) + \sum_{\{\mathcal{L}:d(\mathcal{L})=s(j)\}} D\delta_{\mathcal{L},j} Y_{\mathcal{L}}(t) \tag{5}$$

$$Z_{\beta,i}(D) = \sum_{\{\mathcal{L}:d(\mathcal{L})=\beta\}} b_{\beta,\mathcal{L},i}(D) Y_{\mathcal{L}}(D) \tag{6}$$

$$\text{Where} b_{\beta,\mathcal{L},i}(D) = \frac{\sum_{u=0}^{\mu} D^{u+1} b''_{\beta,i,l}(u)}{1-\sum_{u=0}^{\mu} D^{u+1} b'_{\beta,i,l}(u)} \tag{7}$$

$$X_i(D) = \sum_{t=0}^{\infty} X_i(t) D^t \tag{8}$$

$$Y_j(D) = \sum_{t=0}^{\infty} Y_t(j) D^t\ , Y_j(0) = 0 \tag{9}$$

$$Z_{\beta,i}(D) = \sum_{t=0}^{\infty} Y_t(j) D^t\ , Z_{\beta,i}(0) = 0 \tag{10}$$

The coefficients $\{\gamma_{i,j}, \delta_{\mathcal{L},j}, b_{\beta,\mathcal{L},i}\}$can be collected into $r \times |E|$matrices from TNC method.

$$\gamma = \begin{cases} (\gamma_{i,j})\text{intheacyclicdelayfreecase} \\ (D\gamma_{i,j})\text{inthegeneralcasewithdelays} \end{cases} \quad (11)$$

$$\delta = \begin{cases} (\delta_{L,j})\text{intheacyclicdelayfreecase} \\ (D\delta_{\mathcal{L},j})\text{inthegeneralcasewithdelays} \end{cases} \quad (12)$$

whose structure is constrained by the TNC schema. In coding theory, Triangular Network Coding (TNC) is a network coding based packet coding scheme introduced by Qureshi et al [21]. TNC schema therefore essentially addresses the high encoding and decoding computational complexity without degrading the throughput performance, with code rate comparable to that of linear network coding.

B. Scheduling Model

For scheduling model [22] a vehicle platoon on a stretch of highway as a static multiple source lattice network of equal inter-vehicle spacing, corresponding to motion with identical velocity. Initially (at time t = 0), there is a multiple file (M packets denoted by $x_1, x_2, \ldots, x_M,$) at a multiple source node (vehicle) to be disseminated to all other vehicles in a multiple direction. In the ideal scheduler, the disseminator role is handed-off node by node in the desired propagation direction, each time the complete data set is received at a new node.

Network aggregation: However during scheduling model because the percentage of information that can be forwarded multi-hop is low, dissemination mechanisms need to implement selection criteria to decide what subset of available information to forward and what to discard. Bad selection can result in skewed information, which does not reflect the real world situation. It is, therefore, crucial for data utility that forwarding criteria are well selected. Even better though, the classical approach of routing information unmodified through the network should be reconsidered. Continuing the above traffic jam example, the core idea is as follows. Instead of forwarding notifications from every single vehicle in the traffic jam, each receiving vehicle assesses whether it is part of the same traffic jam and, if so, only forwards a merged message. Even distant vehicles that receive a notification about two segments of the same traffic jam can merge the messages and only forward the aggregated result. Such merging of different information items can provide bandwidth savings that are superior to schemes that do not modify information in the forwarding phase. For the purpose of this paper, we define the VANET in-network aggregation pattern as follows.

In-network aggregation in VANETs is any kind of multi-hop message dissemination where a number of vehicles collaborate to gain knowledge about real-world phenomena. To do so, they exchange messages containing relevant information derived from atomic sensor readings or other means of information collection.

During the dissemination of information, atomic information items are modified and processed by intermediate vehicles. An aggregation scheme can be characterized by how much local network bandwidth it spends on spreading information that stems from a source at a given distance. This characterization is independent from how aggregation is performed in detail and independent from the specific application and protocol used to generate, transport, and make use of the information. A “source” in this context is an atomic item about which information can be obtained and distributed by the vehicles for instance, a single segment of a road. Scheuermann et al [23] introduce a bandwidth profile to capture the network bandwidth usage. A non-negative function $b : \mathbb{R}_0^+ \rightarrow \mathbb{R}_0^+$ is a bandwidth profile of a given aggregation mechanism A if A ensures that information about a source at distance d is provided at least with bandwidth b(d). Under very generic assumptions, which hold regardless of the specific application and protocol, it is shown in [23] that aggregation schemes can, in general, only deal with the finite network resources if their bandwidth profiles are in $o(1/d^2)$. That is, any aggregation mechanism in VANETs must reduce the amount of network bandwidth spent on data from a source at distance d asymptotically faster than $1/d^2$. It is also shown that this bound is tight, i.e., it is possible to build aggregation mechanisms with bandwidth profiles that come arbitrarily close to that bound and can still under all circumstances deal with finite locally available bandwidth. To solve this problem scheduling is also done using Three-

Node Case model.

Three-Node Case: First demonstrate the (potential) gains from NC by comparing PMFs of the completion time with and without NC via this prototypical three-node example as in Fig. 1 [24] with communication depth N = 2. At t = 0, Node 0 (the disseminator) has the M packets to be disseminated whereas Nodes 1 and 2 start with none. The reception probabilities from Node 0 at the two nodes satisfy $1 > Q_1 > Q_2 >> 0$. Let T_1 denote the completion time for Node 1, i.e., the duration required for Node 1 to receive all M packets successfully. Now, at T_1, Node 2 has accumulated $C \in \{0, 1, . . ., M\}$ packets due to overhearing the broadcasts. At T_1, Node 1 assumes the disseminator role, and the one-hop link probability between Nodes 1 and 2 is now Q_1. Let T_2 denote the additional time for Node 1 to complete the transfer to Node 2.

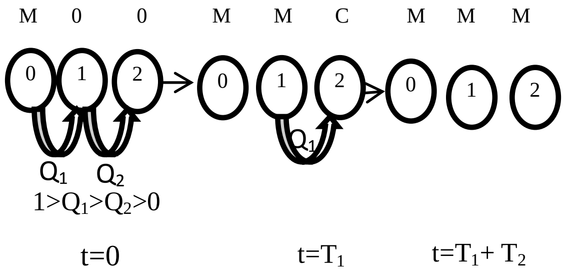

Figure 1: Data Dissemination in a Prototypical Three-Node Network in Presence of Wireless Link Unreliability

Packet data transmission is to utilize the radio resource effectively and support the high transmission rate max Carrier to- Interference Ratio (CIR) scheme, which focus on one side of the fair is show ness and channel condition, respectively, a Proportional Fair (PF) algorithm is suggested by considering the channel condition. In the meantime, users in bad channels are also considered since their low average rate $R_i(t-1)$ will increase their chance of being selected for the next scheduling event. The performance of this algorithm is a function of $T_c$is the observation window. One of the proposed solutions to the unfairness problem in PF is the PF with Data Rate Control (DRC) exponent rule in [25]. The selection criteria are modified to:

$$j = \underset{1 \le i \le N}{argmax} \frac{D_i^n}{R_i} \tag{13}$$

where i is the user index, j is the selected user, N is the total number of users, $D_i(t)$ is the current supportable data rate by the channel of the ith user and

$$R_i(t) = \begin{cases} 0 \; i \neq j \\ \left(1 - \frac{1}{T_c}\right) R_j(t-1) + \frac{1}{T_c} D_j(t) i = j \end{cases} \tag{14}$$

Where T_c is the observation window, $R_i(t)$ is the data rate per unit time for the ith user observed at time "t" and averaged over $T_{c.}$, 'n' is a weighted parameter introduced to manage the relationship between the data rates of the users with different channel conditions. However, the control parameter n is a constant for all users, and two problems exist in this approach: 1) the control parameter is fixed in time and does not adapt to the current radio conditions of each user; 2) n is set to the same value for all users, thus impossible to choose a value for n that ensures fairness among all users at the same time. The PF scheduling rules do not apply sufficiently to different QoS requirements. To solve this problem consider a multiuser scheme where multiple access is provided by assigning a subset of subchannels to each receiver at each time frame. Let 'W' and 'P' denote the total bandwidth and power, respectively. Total bandwidth 'W' is divided into K subchannels of bandwidth W_{sub} Hz, each consisting of a group of carriers.

To solve the problem of QOS constraint selection, Long term proportional fairness in multi-access interference systems was formulated in [25].

Modified Quantum behaved Particle Swarm Optimization (MQPSO)

They use the following Modified Quantum behaved Particle Swarm Optimization (MQPSO) algorithm for weight calculation. The average rates are computed using a moving average formula (15)and consider the maximization of the following objective function.

$$C(D(t)) = \sum_{i=1}^{N} log \Big(\alpha_i R_i(t-1) + (1-\alpha_i) D_i^n\big(w_i(t), p_i(t)\big)\Big) \tag{15}$$

where $0 < \alpha_i < 1$ is typically close to one. After some rearrangements the objective for data users becomes:

$$\max_{p(t),w(t)} \sum_{i=1}^{N} \log\left(\alpha_i + \frac{(1-\alpha_i)D_i^n\big(w_i(t),p(t)\big)}{R_i(t-1)}\right) \tag{16}$$

$$= \max_{p(t),w(t)} \prod_{i=1}^{N} \left(\alpha_i + \frac{(1-\alpha_i)D_i^n\big(w_i(t),p(t)\big)}{R_i(t-1)}\right) \tag{17}$$

The noise and interference power density is N_0, and the channel gain averaged over the entire band from the BS to user i at time t is $h_i(t)$, where $h_i(t)$ includes path loss. In the function (17) 'n' weight value$w_i(t)$is computed based on the bandwidth and power. Modified Quantum-behaved Particle Swarm Optimization (MQPSO) is proposed for the selection of the weight values to each user. In the original MQPSO with M particles, each particle (weight value) is represented as a potential solution to a problem in a D-dimensional space and its position at the tth iteration is denoted as $we_i^t = \left[we_{i,1}^t, \dots we_{i,j}^t, \dots, we_{iD}^t\right]$ .Each particle remembers its own previous data rate control best position and its velocity along each dimension as $v_i^t = \left[v_{i,1}^t, \dots v_{i,j}^t, \dots, v_{iD}^t\right]$. The velocity and position of weight values in particle i at (t + 1)th iteration are updated by the following equations:

$$v_{i,j}^{t+1} = iwV_{i,j}^{t+1} + c_1\mathcal{K}_{i,j}^{t+1}\left(P_{ij}^t - \mathcal{W}_{ij}^t\right) + c_2\mathcal{L}_{i,j}^t\left(\mathcal{G}_j^t - \mathcal{X}_{i,j}^t\right) \tag{18}$$

$$\mathcal{X}_{i,j}^t = \mathcal{X}_{i,j}^t + \beta.V_{i,j}^{t+1} \tag{19}$$

where c_1 and c_2 are two positive constants, known as the acceleration coefficients; $\mathcal{W}_{ij}^t$ and $\mathcal{X}_{i,j}^t$are two uniformly distributed random numbers on the range (0,1) for the jth dimension of weight values of channels in particle i. In QPSO is better than PSO for the problems which have several minima and escape from the local minimum but note that the performance of QPSO is decreases for the problem which have minimum not zero .To solve this problem new modified the beta step value is introduced to equation (21). βparameter is called the Contraction-Expansion (CE) coefficient, which can be tuned to control the convergence speed of the algorithms [26]. Introducing a damping oscillating equation forβ

$$\beta = \left(\frac{1}{n_{iter} + \beta_{wavelength} \div 2}\right)^{0.25} \times \left(cos(\frac{n_{iter}}{\beta_{wavelength} \times \pi}\right) + 1) + \frac{1}{3} \tag{20}$$

Increase diversity after certain number of iteration without finding better new solution. Improved quantum-behaved particle swarm optimization is introduced with new beta value according to fitness values of the particles. It is shown that the improved QPSO has faster local convergence speed, resulting in better balance between the global and local searching of the algorithm, and thus generating good performance. The proposed improved QPSO, called Modified QPSO (MQPSO) algorithm, is tested on VANET and compared with QPSO and standard PSO. Vector $P_i^t = \left[P_{i,1}^t, \dots P_{i,j}^t, \dots, P_{iD}^t\right]$ is the position with the best fitness found so far for the ith particle, which is called personal best (pbest) position and vector $G_i^t = \left[G_{i,1}^t, \dots G_{i,j}^t, \dots, G_{iD}^t\right]$ records the best weight position discovered by the swarm so far, known as the global best (gbest) position. Usually iwdecreases linearly with the iteration generations as:

$$iw = iw_{max} - \frac{t(iw_{max} - iw_{min})}{T} \tag{21}$$

whereiw_{max} and iw_{min} are the maximum and minimum weights and usually set to 0.9 and 0.4, respectively [27]. T is a predefined maximum number of iterations, and t represents the number of current iteration. Let f be the fitness function to be minimized. In this work the fitness value to each weight values of channels is determined based on the three parameters such as bandwidth$w_i(t)$, power $p_i(t)$and path loss. All of these parameter values become less then fitness value of the channel to the selection of the 'n' number of weight parameters becomes to pbest and gbest is high.

$$f = \frac{w_i(t) * p_i(t) * numberofvehicles}{pathloss} \tag{22}$$

Traditional PSO in [27], assume that, at iteration t, particle i moves in D-dimensional space with a d potential well centered at $p_{i,j}^t$ on the jth dimension.

$$\psi(we_{i,j}^{t+1}) = \frac{1}{\sqrt{L_{i,j}^{t}}} exp\left(-\frac{\left|we_{i,j}^{t} - p_{i,j}^{t}\right|}{L_{i,j}^{t}}\right) \tag{23}$$

$$p_{i,j}^{t} = \varphi P_{i,j}^{t} + (1 - \varphi)G_{j}^{t} \tag{24}$$

$$\varphi = \frac{c_1 \mathcal{W}_{ij}^{t}}{c_1 \mathcal{W}_{ij}^{t} + c_2 \mathcal{X}_{i,j}^{t}} \tag{25}$$

where$L_{i,j}^{t}$ is the standard deviation of the double exponential distribution, varying with iteration number t. Hence, the probability density function Q is a double exponential distribution as follows

$$Q\left(we_{i,j}^{t+1}\right) = \left|\psi\left(we_{i,j}^{t+1}\right)\right|^{2} = \frac{1}{L_{i,j}^{t}} exp\left(-\frac{2\left|we_{i,j}^{t+1} - p_{i,j}^{t}\right|}{L_{i,j}^{t}}\right) \tag{26}$$

The value of L_{ij}^{t} is calculated as:

$$L_{i,j}^{t} = 2\alpha\left|Cost_{j}^{t} - we_{i,j}^{t+1}\right| \tag{27}$$

In [28], it is shown that setting $\alpha$to be a number in the (0.5, 0.8) interval can generate satisfactory results. $Cost_{j}^{t}$is known as the mean best (mbest) weight position defined as the mean of the pbest positions of all particles. That is

$$Cost^{t} = (Cost_{1}^{t},..Cost_{D}^{t}) = \left(\frac{1}{M}\sum_{i=1}^{M} P_{i,1}^{t}, \sum_{i=1}^{M} P_{i,2}^{t}, .. \sum_{i=1}^{M} P_{i,D}^{t}\right) \tag{28}$$

where M is the population size (Number of weight values to users) and $P_{i,1}^{t}$is the personal best position of weight values to particle i.Proposed Long term proportional fairness with MQPSO (LTPFMQ) scheduling algorithm updates the $C\big(D(t)\big)$ (15) at every sub channel allocation event and considers all possible user penality. The proposed LTPFQ algorithm is divided into two steps. In the first step, the scheduler calculates all users' penality of each sub channel at the given scheduling epoch. In the second step, the scheduler compares the all possible data rate capacity which was calculated in the first step and make a decision which sub channel contributes which user. After that, update the average rate of the user according to the decision above$C\big(D(t)\big)$. This process continues until there is no remaining sub channel anymore. Next perform simulation work to measure the results of four Network Coding (NC) schemes such as SATNC, Random Network Dissemination (RND), Network Coding (NC) and Perfect Feedback (PF).

IV. SIMULATION RESULTS

In this section, an evaluation of the performance efficiency of SATNC is carried out taking into account the extensive simulations in a vehicular environment. The simulation platform is constructed based upon ns-2 [29] simulator. In this section, simulation is used to validate analytical results for SATNC based dissemination, and a round out investigation is also conducted by demonstrating gains from NC relative to 1) random broadcast, and 2) a perfect feedback scheme. A straight three-lane highway of6 km length is considered for all simulations. The bit rate is set at the rate of 6 Mbit/s in the MAC layer. Assuming a SATNC model, the transmission power is adjusted to achieve roughly700 meters of transmission range. Vehicle movement introduces non-zero Doppler spread. However, the 156 kHz carrier spacing in current 10MHz 802.11p channel meets the requirements imposed by the observed 1.6 kHz maximum Doppler spread in several measurement studies of V2V wireless channel [30]. Based on empirical measurements on Received Signal Strength (RSS) in vehicular environment [31], simulation adopts Rayleigh fading [32] links and the path loss exponent is α. All nodes use the same transmission power p and modulation scheme for the purpose of broadcasting packets. The first five vehicles are configured for the application scenario to generate a new message at a size of 500 bytes per second. In order to evaluate the SATNC scalability, the density of vehicles is set at various levels ranging from 8 vehicles/km to 99 vehicles/km at the maximum speed of 20 m/s. Each plotted results is an average of 20 runs over 100 s with confidence interval of 95%. The simulation platform is based on NS-2. However, instead of applying the legacy implementation of the IEEE 802.11 physical (PHY) and MAC layer, the overhauled implementation of [22] is adopted. This leads to more representative simulations since this implementation introduces an accumulative interference model. This is a significant improvement compared to the legacy implementation and is of high importance when taking the hidden node problem into account. A stretch of highway is simulated with a total length of 6 km. Three lanes are defined in each direction, on each lane, the same average inter-vehicle distance is configured for a single simulation. Considered inter-vehicle distances are 160, 80, 40, and 10 m. This corresponds with traffic conditions during the night, normal daytime traffic, intense but still flowing traffic, and jammed traffic. The total amount of active nodes in a single simulation is then 188, 375, 750, and 3,000 vehicles. To exclude border effects, no performance statistics are gathered regarding the nodes located in the first and last kilometer of the simulated highway. Parameter values used in simulations are summarized in Table 1.

Table1: Parameters used in Data Dissemination Simulation

Parameters	*Specifications*
Network simulator	NS2
Simulation duration	300 s
Highway length (Unidirectional)	6000 m
Vehicle Density	8 to 99 vehicles/ km
Data packet frequency	1 Hz
Data packet Size	500 bytes
Number of source vehicles	0-500
Phy/MAC protocol	IEEE 802.11 p
Propagation model	QPSK and BPSK
Bit rate	6 Mbit/s
Transmission range	~700 m
Maximum speed	20 m/s
Number of runs	20
Power(p)	1e-5 Watt
Total Bandwidth (W)	10 MHz
Number of packets (M)	100 pks
Finite field size(q)	128
R_{BPSK}	3 Mbps
R_{QPSK}	6 Mbps
z_{BPSK}	8 dB
z_{QPSK}	5 dB

Let $\gamma_k$be the received power for a transmission from a source that is k hops (inter-vehicle spacing is d meters) away from the receiver; then γ_k is an exponentially distributed random variable with mean $p(kd)^{\alpha}$ with the following Probability Distribution Function (PDF):

$$f_k(\gamma_k) = \frac{1}{p(kd)^{-\alpha}} \exp\left(-\frac{\gamma_k}{p(kd)^{-\alpha}}\right), \forall \gamma_k \geq 0 \qquad (29)$$

There is no multi-access interference according to the proposed LTPFQ ideal scheduling model, and the receiver can decode the packet successfully if and only if it's received Signal-To-Noise-Ratio (SNR) exceeds a decoding threshold, i

$$P_{succ} = \Pr\left(\frac{\gamma_k}{n_0} \geq z\right), z > 1 \qquad (30)$$

where n_0 is the noise power, and z is the capture threshold whose value depends on the channel coding and modulation. In Random Network Dissemination (RND) broadcast scheme, the disseminator transmits one packet per slot, randomly chosen from those in buffer, till its immediate neighbor has all packets. The lack of any feedback implies that multiple copies of a packet may be transmitted, and then they may get discarded by the receiver. Perfect feedback scheme simply provides an upper bound for non-network-coding solutions; with feedback, the disseminator only transmits packets that are not yet received by the first recipient. In NC, a current disseminator broadcasts network coded packets and embeds the NC coefficient in the packet. Before a receiver can decode the data set, it stores all packets and NC coefficients. When a new packet is successfully received, the random coefficient is extracted and appended to the coefficient matrix A. The following metrics are considered for the performance evaluation:

1) Forwarding Ratio (FR): the proportion of vehicles in the network that are involved in the rebroadcast of a source packet.
2) End-to-End Delay (E2E Delay): the total latency experienced by a packet routed from a source vehicle to a destination node inside the network.
3) Link Load (bit/s): the average of broadcast traffic (in terms of bits) received by each vehicle over a unit of time.
4) Throughput refers to the total amount of data transmitted from the source to destinations in a unit period of time. In terms of NetSim's metrics, it can be described as:

Throughput= (No. of packets transmitted- No.of packets error)/(simulation time)

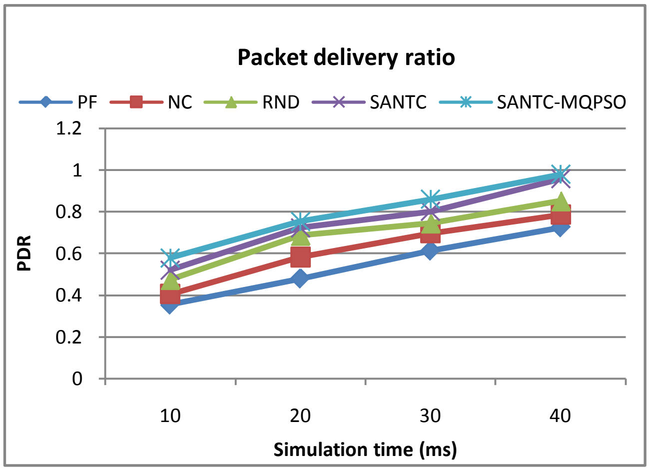

Figure 2: Packet Delivery Ratio (PDR) vs. Various Simulation time

Figure 2 shows the performance comparison results of proposed SANTC-MQPSO, Random Network Dissemination (RND), Network Coding (NC) and Perfect Feedback (PF) in terms of Packet Delivery Ratio (PDR). From the results it is concludes that the proposed SANTC-MQPSO provides high packet delivery ratio for V2V communication.

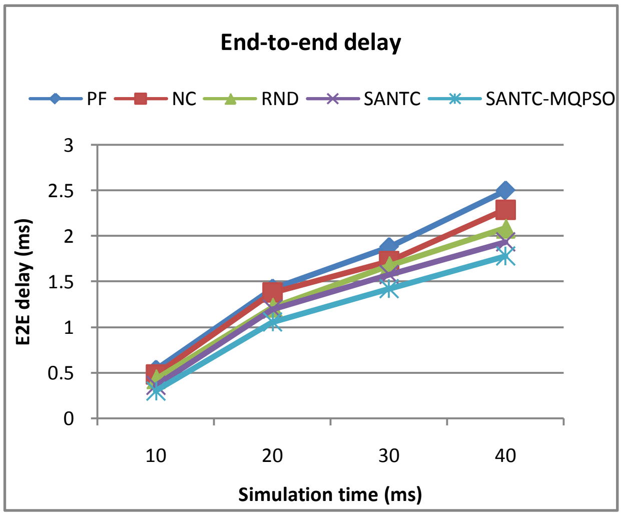

Figure 3: E2E Delay vs. Simulation Time

Figure 3 shows the comparison of the proposed SANTC-MQPSO with existing schemes in terms of end-to-end delay. From the figure it is clear that the proposed SANTC-MQPSO scheme provides better performance with less E2E delay.

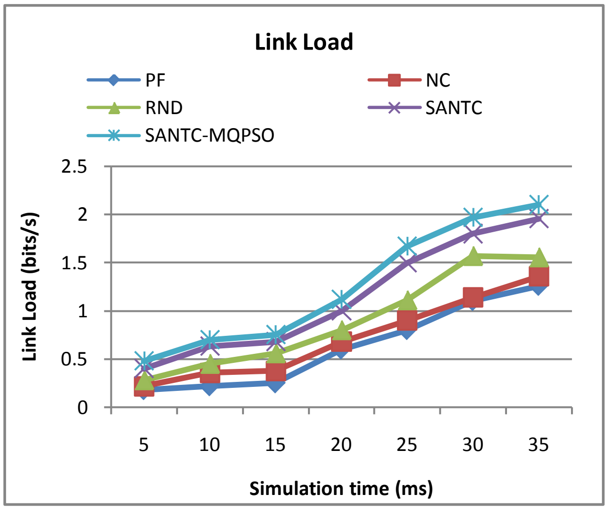

Figure 4: Link Load vs. Simulation Time

Figure 4 shows the comparison of the proposed SANTC-MQPSO with existing schemes in terms of link load. Link load ensures the capacity of the proposed SANTC-MQPSO scheme for better handling of the data packets. The proposed SANTC-MQPSO scheme provides better link load and assures the reliable communication.

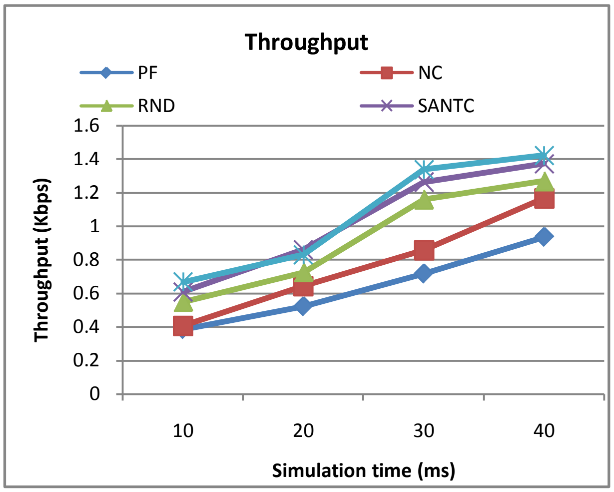

Figure 5: Throughput vs. Simulation Time

Figure 5 shows the comparison of the proposed SANTC-MQPSO with existing schemes in terms of throughput. As throughput determines the efficiency of packet delivery, the proposed SANTC-MQPSO system can be evaluated using this parameter. The proposed SANTC-MQPSO scheme provides better throughput than other existing schemes and ensures its efficiency.

V. CONCLUSION AND FUTURE WORK

This paper focused on the VANET issues regarding inter vehicle data dissemination. A multi-source dissemination scenario is studied in this paper with an ideal scheduler to understand the limits (upper bound) of the benefits from Triangular Network Coding (TNC). In this work, a simple Scalar Algebraic Triangular Network Coding (SATNC) data dissemination schema has been proposed which aims to meet the challenging problems of broadcast storm in scalable vehicular network. The pmf's of dissemination completion time in the three-node case for TNC based broadcast have been explicitly derived. Data dissemination under a simple Long Term Proportional Fairness with Modified Quantum-behaved Particle Swarm Optimization (LTPFMQ) scheduling model, the complete data set being received at a new node each time. LTPFMQ analyses the multicast throughput of SATNC aided content distribution in a linear VANET. Compared to conventional NC methods, SATNC with Modified Quantum-behaved Particle Swarm Optimization (MQPSO) has achieved an outstanding improvement in providing a high PDR within a low end-to-end delay while optimizing the limited bandwidth consumption. In addition valuable validation of SATNC in real-life circumstances should therefore be pursued in future work. SATNC can handle the most challenging scenario in terms of scalability, and it is expected to be evenly successful in less challenging urban environments. In future work, a validation of this assumption would be valuable.

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