MULTIMEDIA CONTENT DOWNLOADING IN VANET WITH DENSITY MEASUREMENT

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ABSTRACT

The presence of Internet-connected navigation systems is becoming a truth that will easily lead to a significant growth in bandwidth demand by in-vehicle users like mobile user. For example the applications of vehicular communication proliferate, and range from the updating of road maps to the repossession of nearby points of interest, downloading of touristic information and multimedia files. This content downloading system will induce the vehicular user to use the resource to the same extent as today's mobile customers. By this approach communication-enabled vehicles are paying attention in downloading different contents from Internet-based servers. We summarize the performance limits of such a vehicular multimedia content downloading system by modeling the content downloading process as an effective problem and developing the overall system throughput with density measurement. Results highlight the methods where the Roadside access point deployment based upon the density of vehicles, which mean that they are working at different capabilities irrespective of vehicle density, the vehicle-to-vehicle relaying.

KEYWORDS

Vehicular ad-hoc Network, Multimedia Content Downloading Process, Max-flow problem, Optimization, Vehicular Density measurement.

1. INTRODUCTION

The communication-enabled vehicles are interested in downloading different multimedia contents from Internet-based servers. This system captures many of the entertainment services with effective information, such as navigation maps, news reporting service, and software updating, or multimedia content downloading. In this approach both infrastructure-to-vehicle and vehicle-to-vehicle communication taken place. The major aim is to maximize the overall system throughput; we formulate a max-flow problem that accounts for several practical aspects, such as channel contention and the data transfer paradigm.

As a result, Multimedia content downloading in vehicular networks by the vehicles has received increasing attention from the research community. Initially, the availability of Infrastructure-to-Vehicle (I2V) communication capabilities are based on high-throughput Dedicated Short-Range Communication (DSRC) technologies, is seen as an opportunity for transfer of large data to mobile nodes that would not be possible through the existing 2G/3G infrastructure, Next the availability of Vehicle-to-Vehicle (V2V) connectivity has fostered a number of proposals to make use of the cooperation among vehicular users so as to improve their downloading performance. In particular, V2V connectivity based approaches are especially good when one considers that the infrastructure coverage will be mottled at initial stages, and barely seamless even at later ones.

Previous works on content downloading in vehicular networks have dealt with individual aspects of the process, such as roadside APs deployment, the performance evaluation of I2V communication, the network connectivity, of V2V data transfer paradigms. No one has identified the problem of an I2V/V2V-based multimedia content downloading process. In order to fill such a gap, we introduce the following questions: (i) *which is the maximum downloading performance achievable through DSRC-based I2V/I2V communication, in a given mobility scenario?* (ii) *What are the important factors that mainly determine such a downloading performance?*

To answer these questions, we combine this downloading process to a mixed integer linear programming (MILP) known as max flow problem. The solution this problem results in the optimal Access point deployment over a given road layout and any possible combination of V2V and I2V data transmission.

Our framework introduces a DTNG time-invariant graph. We do not undertake the contacts between mobile nodes to be same but allow them to access directly, and also report the presence of roadside infrastructure and channel contention. Such an approach allows us to significantly enhance the AP deployment over the given road layout, since we maximize the overall throughput and also provide the optimal solution instead of an approximation.

At the result, the access point or relay shows the vehicle capability prior and sends the corresponding low quality or high quality file. This achieves the vehicle to receive the proper file resource. Vehicle density is calculated based on previous temporal changes and the new vehicle density is calculated. The access points' capabilities are adjusted so that it works more in high vehicle density environment and works less in low vehicle density environment.

This paper is organized as follows: Section II describes the previous work, while Section III discusses contribution of work. In Section IV, we build the system model and assumption, while we generate the Dynamic Network topology graph in Section V and we formulate the max-flow problem in Section VI, Results, derived in the design guidelines described in Section VII. In section VIII, we evaluate the vehicle density based data downloading. Section IX describes Security issues; finally section X summarizes our major findings and point out direction of future work.

2. RELATED WORK

The authors U. Paul, M.M. Buddhikot, A.P. Subramanian, and S.R. Das were stated that the complete measurement analysis of network resource deployment and the subscriber activities using a large-scale data set collected within a nationwide 3G cellular network. The data set keeps close to more number of subscribers over thousands of base stations. They find out the capability of network resources which can be used by different subscribers as well as by different applications. They also and analyze the temporal and spatial variations in different kinds of the vehicular network and examines the traffic in vehicular network from the point of view of the base stations. In order to address such coverage uncertainties the authors Z. Zheng, P. Sinha, and S. Kumar were given a idea about new the alternating coverage for mobile users, called α-coverage, and examined how such coverage can be attained by systematic deployment of more APs to create an efficiently scalable infrastructure. In other way, a deployment of APs involved in α-coverage to a network topology, if the road with length α on the given network resource meets with at least one AP in that resource. The authors Z. Lu, Z. Zheng, P. Sinha, and S. Kumar were also stated that with increasing popularity of media enabled devices; the need for high data-rate services for mobile users is obvious. Large-scale Wireless LANs (WLANS) can offer such a service, but they are very expensive to deploy and maintain. The above results not make the grade to provide any throughput assurance to a vehicular user; it can only provide opportunistic services to them.

3. MY CONTRIBUTION

The density measurement in vehicular network my contributions to this problem are as follow:

- The access point or relay tracks the vehicle capability prior and sends the corresponding low quality or high quality file. This achieves the vehicle to receive the proper file resource
- Vehicle density is calculated based on previous temporal changes and the new vehicle density is calculated.
- The access points' capabilities are adjusted so that it works more in high vehicle density environment and works less in low vehicle density environment.
- Vehicle density based download scenario is applied to Access Points.

Proposed methods where the Roadside infrastructure i.e., access points are working at different capabilities irrespective of vehicle density.

4. SYSTEM MODEL AND ASSUMPTIONS

4.1. Network Model

We create a network composed of fixed roadside APs and vehicular users, where some of them are downloader's. They are interested in downloading multimedia content from the Internet through the APs. In general, every downloader may be interested in different type of multimedia content. They can either use relays or establish direct connectivity with APs. In particular, we consider the following data *transfer paradigms*:

Direct transfers, a direct communication between an AP and a downloader. This shows the typical way how the mobile users communicate with the infrastructure as in today's wireless networks;

Connected forwarding, the result highlights the communication made through one or more vehicles, which creates a multi hop path between an Access point and a downloader. This is the conventional approach to traffic delivery in ad hoc networks;

Carry-and-forward, the communication made through one or more vehicles that store and carry the data, and delivering them either to the target downloader or to another relay which meet such downloader sooner.

Our approach allows us to processing a road layout and an associated vehicular mobility trace, so as to build a time expanded graph that represents the temporal network evolution (Sec. V). By using DNTG graph, we formulate a max-flow problem; the solution of this problem provides solution for our goals.

5. DYNAMIC NETWORK TOPOLOGY GRAPH

Dynamic network topology graph (DNTG) generate a from a different vehicular mobility trace in network topology, considering that on the corresponding road layout there are:

- (a_i, i = 1, . . . ,A)a set of A candidate locations where APs could be placed

- (v_i, i = 1, . . . ,V) a set of V vehicles travel over the road layout
- a set of D vehicles that wish to download data from the APs.

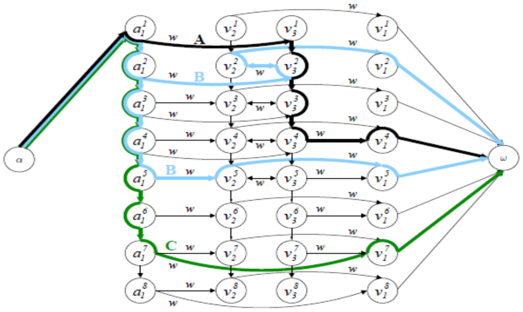

Figure1. A sample Dynamic Network Topology Graph, with one Access point A and three vehicles v1, v2 & v3, the vehicle (v1) is a downloader while the others (v2, v3) can act as relays.

In the above graph, we show up paths that are agent of the carry and-forward (A), connected forwarding (B), and direct transfer (C) paradigms. The major aim of this topology graph is to model all possible ways through which data can flow from either direct APs to the downloader's or possibly via relays. With known mobility trace, we identify the *contact events* between any pair of nodes such as V2I/V2V.

Each contact event is characterized by:

- Link quality, The quality of the link between the two nodes; specifically, the achievable data transfer rate at the network layer, which depends on the distance between the possible two nodes
- The contact starting time, The time at which the link between the two nodes is established or already established link that has quality level with new value;
- A contact ending time, the time at which, the quality level of link has changed when the link is removed or discarded

The time interval between any two contact events in the network is called *frame*. Within a frame the network is static, i.e., the link quality levels are constant which means no link is established or removed or no contact event is established. We denote the number of frames using F, and the duration of the frame is k ($1 \leq k \leq F$) using k; also, all constant contact events during each frame k are said to be *active* in that same frame. The vehicle V_i shares in the network at frame k is denoted by a vertex V_i^k ($1 \leq i \leq V$), where as each candidate AP location A_i is mapped within each frame k onto a vertex is represented by A_i^k($1 \leq i \leq A$). The subset of vertices representing the downloader's that existing in the network at frame k given by $D^k \subset V^k$. All non-downloader vehicles in the given road layout denoted by $R^k = V^k \backslash D^k$can act as relays, according to the data transfer paradigms is shown through graph.

Similarly, a directed edge (A_i^k ,V_j^k) comes from vertex $A_i^k \in A^k$ to vertex $V_j^k \in V^k$ if a contact between the candidate Access point Ai and the vehicle V_j is active during frame k. These edges are related with weights w(A_i^k , V_j^k), equivalent to the contact event rate, which is defined as L^k a. A directed edge (V_i^k, V_i^{k+1}) is also drawn from any vertex $V_i^k \in R^k$ to any vertex $V_i^{k+1} \in R_i^{k+1}$, for $1 \leq k \leq F$. While the edges in L_v^k and L_a^k represent transmission opportunity, those of the form (V_i^k, V_i^{k+1}) model the possibility that a nondownloader vehicle $V_i$physically carries some data during its association from frame k to frame k + 1. By dealing with vehicular nodes as conflicted to resource-constrained hand-held devices, we take the weight of such edges to be an infinite value. A directed edge (A_i^k, A_i^{k+1}) of infinite weight is held between two any vertices or nodes representing the same candidate AP at two successive frames, i.e., from $A_i^k \epsilon A^k$ to $A_i^{k+1} \epsilon A^{k+1}$ ($1 \leq k \leq F$). We will refer to the edges of the kind (V_i^k, V_i^{k+1}) or (A_i^k , A_i^{k+1}) as intra-nodal.

Finally, in order to generate a max-flow problem over the topology graph , we introduce two virtual nodes, denoted as $\propto$and ω, respectively representing the source and destination of the total flow of the graph. Then, the graph is finished with infinite weight edges ($\propto, a_1^i$), from $\propto$ to any vertex$a_1^i \in a_1$, and (V_i^k, ω), from any vertex $V_i^k \epsilon D_k$to ω, $1 \leq k \leq F$.

The DNTG is therefore a weighted directed graph, representing the network topology development. The sample DNTG is given in Fig. 1, representing one Access point and three vehicles v1, v2, & v3, where v1 is considered as a downloader and v2, v3 vehicles are acting as relays for the downloader v1. The graph allows us to capture all the data transfer paradigms. It is possible to identify paths in the graph that correspond to (1).In path C direct download process i.e., from the Access point to the downloader. (2).In path B connected forwarding through 3-hops (frame 2) and 2-hops (frame 5) and (3).In path A carry-and-forward through the movement in time of the relay vehicle v3.

6. MAX-FLOW PROBLEM

With the above network topology graph, our next step is to formulate the max-flow optimization problem. the main goal of this problem is to maximize the flow from $\propto$ to ω, i.e., the total amount of data downloaded by the downloader's. Denoted by x (V_i^k,ω) the dynamic traffic flow over an edge connecting two generic vertices, our intention can be expressed as:

$$Max \sum_{k=1}^{F} \sum_{V_i^k \in D^k} x(V_i^k , \omega). \qquad (1)$$

The max-flow problem needs to be solved taking into account several constraints such as, maximum number of APs that can be activated, non negative flow and flow conservation, channel access. We specify such constraints below.

A.Constraints

Non-negative flow and flow conservation: the flow on each obtainable edge in DNTG must be greater than or equal to zero this can also for any vertex in the graph, the amount of flow enter into the vertex must equal the amount of outgoing flow.

Channel access: In view of the fact that we consider an IEEE 802.11-based MAC scheme with RTS/CTS and we assume unicast transmissions, two or more of the following events cannot take place simultaneously for a tagged vehicle, and the time duration of each frame must be shared among the tagged vehicle:

1) The vehicle transmits to a neighboring vehicle;
2) A neighboring vehicle receives from any relay;
3) The vehicle receives from a neighboring relay;
4) A neighboring relay transmits to any vehicle;

5) The vehicle receives from a neighboring AP;
6) A neighboring AP transmits to any vehicle.

In the above states we have only consider the total amount of data carried by each flow. Due to the use of RTS/CTS in 2) a neighboring vehicle receiving data is accounted, considering that the sub cases are: 1) is a subcase of 2); 3) is a subcase of 4); 5) is a subcase of 6), for the generic vertex $V_i^k \epsilon V^k$ and for any frame k, we have:

$$\sum_{\substack{V_j^k \varepsilon R^k_, V_m^k \epsilon V_m^k \epsilon V^k \\ (V_j^k, V_m^k) \epsilon L_v^k}} 1\left[\left(v_m^k, v_j^k\right)\right] \frac{x(v_j^k, v_m^k)}{x\left(v_j^k, V_m^k\right)} +$$

$$\sum_{\substack{V_j^k \varepsilon R^k_, V_m^k \epsilon V_m^k \epsilon V^k \\ (V_j^k, V_m^k) \epsilon L_v^k}} 1\left[\left(v_j^k, v_i^k\right)\right] \frac{x(v_j^k, v_m^k)}{x\left(v_j^k, v_m^k\right)} + \sum_{\substack{V_j^k \varepsilon R^k_, V_m^k \epsilon V_m^k \epsilon V^k \\ (V_j^k, V_m^k) \epsilon L_v^k}} 1\left[\left(a_m^k, v_j^k\right)\right] \frac{x(a_j^k, v_m^k)}{x\left(a_j^k, v_m^k\right)} \leq \tau^k \qquad (2)$$

If the specified edge exists then the sign function is equal to 1 otherwise it is 0. In addition, for each candidate AP location, we have that the total transmission time of each candidate during each frame k cannot go over the frame duration. Thus, for any k and $A_j^k \epsilon A^k$, we have the equation as:

$$\sum_{V_i^k \in V^k (a_j^k, v_i^k) \epsilon L_a^k} \frac{x\left(a_j^k, v_m^k\right)}{x\left(a_j^k, v_m^k\right)} \leq \tau^k \qquad (3)$$

The above constraints allow a vehicle under AP coverage area to utilize either I2V or V2V communication within the same frame.

Maximum number of active APs: The final set of constraints in max-floe problem provides that no more than one candidate APs are selected, through the variables yi. Then, for any i, we can write the equation as:

$$y_i \in \{0,1\} \, ; \sum_{i=1}^{A} y_i \leq \hat{A} \, ; x(\propto . \, a_i^1) \leq M y_i$$

Where M ϵ R is a randomly large positive constant.

7. VEHICLE DENSITY BASED ACCESS POINT CONTENT DOWNLOADING PROCESS

In addition, the access point or relay tracks the vehicle capability prior and sends the corresponding low quality or high quality file. This achieves the vehicle to receive the proper file resource.

Vehicle density is calculated based on previous temporal changes and the new vehicle density is calculated. The access points' capabilities are adjusted so that it works more in high vehicle density environment and works less in low vehicle density environment.

8. SECURITY ISSUES

9.1 Digital signatures as a building block

The message authenticity is necessary to protect VANETs from outsiders. But since safety messages will not contain any sensitive information confidentiality is not required. In this system, the exchange of safety messages by vehicles in a VANET needs authentication of message but no need for encryption of such message. Symmetric authentication mechanisms usually encourage less overhead per message than their asymmetric counter parts. In the VANET setting, safety messages are typically standalone and should be sent to receivers as quick as possible so the digital signatures are a better choice. In fact, a preface handshake is not suitable and actually creates more overhead. In addition, with the huge amount of network participants and the irregular connectivity to authentication servers, a PKI (Public Key Infrastructure) mechanism is the most suitable method for implementation of message authentication.

9.2 Estimation of the signature size

Here we using a PKI for supporting security in VANETs, it is significant to choose a Public Key Cryptosystem (PKCS) with a endurable implementation overhead in the vehicular network. According to DSRC, safety messages are travel with a periodicity of 100 to 300 ms. this impose an upper bound on the processing time overhead; this overhead for the above constraint is shown below:

$$T_{oh}(M)=T_{sign}(M)+T_{tx}(M\ |Sig_{PrKv}\,[M]) + T_{verify}(M)$$

Where T_{sign} (M), T_{tx} (M), and T_{verify} (M) are the time durations for signing, to transmit, and to verify a message M, respectively; Sig_{PrKv} [M] is the signature of M and also includes the CA's certificate of the signing key by the distributing vehicle V. The above expression shows the three factors that affect the choice of a particular PKCS: (1) the execution speeds of the signature generation (2) the verification operations, and (3) the sizes of key, signature, and certificate.

Since the actual size of encrypted messages is between 100 and 200 bytes, before being signing, the message is hashed. The overhead is always constant for a given cryptosystem. Hence, it is possible to evaluate different options at least relatively to each other .In fact, there are more number of candidate PKCS for implementing the PKI in a VANET. To ensure the future security of the PKCS, and taking into account the deployment schedule of DSRC.

Table 1: Size and transmission time of PKCS

PKCS	Sig size(bytes)	T_{tx}(Sig)(Ms)
RSA	256	0.171
ECDSA	28	0.019
NTRU	197	0.131

Table 2: Comparison between signature generation and verification times on a memory-constrained Pentium II 400 MHz workstation

PKCS	Generation(ms)	Verification(ms)
ECDSA	3.256	7.618
NTRU	1.586	1.489

We record the report for public key and signature sizes:

1. RSA Sign: the key size and signature sizes are large (256 bytes).
2. ECC (Elliptic Curve Cryptography): it is smaller than RSA (28 bytes), slower in verification but faster in signing.
3. NTRU Sign: the key size is lies between the RSA and ECC (197 bytes), but in both signing and verification. It is much faster than the ECC and RSA.

In DSRC the least data rate is 6 Mbps, the transmission overhead (at 12 Mbps) is acceptable, and these two options are shown in Table 1 and Table 2 gives approximate implementation times of signature generation and verification for ECDSA and NTRU Sign. These values in the table should be taken only as suggestive for the specific platform such as Pentium II 400 MHz with memory constraints.

In conclusion, we can observe that in terms of performance, ECDSA and NTRU outperform RSA. Distinguish between each other shows the advantage of ECDSA is its small and economically designed; whereas NTRU's is much faster than ECDSA. The result should depend on case-specific evaluations.

9. CONCLUSION

We examined the main factors affecting the performance of content downloading process in vehicular networks, by formulating and solving a max-flow problem over a time extended graph representing a realistic vehicular trace.

The important results in our system are as follows:

- Our major ideas are that a density-based AP deployment yields performance close to the optimum result, and that multi-hop traffic delivery is valuable, although the gain is negligible beyond 2 hops from the AP.
- The access points' capabilities are adjusted so that it works more in high vehicle density environment and works less in low vehicle density environment.

To our best knowledge, this paper addressing the security of vehicular networks in a efficient and quantified way.

In terms of future work, we aim to further develop this proposal. In particular, we plan to explore in more detail the respective merits of key distribution by the manufacturers or by legislative bodies; we will also going to carry out additional numerical evaluations of the solutions.

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