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Reducing the Delay in Roadside Unit Caching Mechanism Via Hybrid Compression Technique

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Abstract:
Recent improvements in vehicular ad hoc networks are accelerating the realization of intelligent transportation system (ITS), which not only provides road safety and driving efficiency, but also enables infotainment services. Since data dissemination plays an important part in ITS, recent studies have found caching as a promising way to promote the efficiency of data dissemination against rapid variation of network topology. In this paper, we focus on the scenario of roadside unit (RSU) caching, where multiple content providers (CPs) aim to improve the data dissemination of their own contents by utilizing the storages of RSUs. To deal with the competition among multiple CPs for limited caching facilities, we propose a multi-object auction-based solution, which is sub-optimal and efficient to be carried out. A caching-specific handoff decision mechanism is also adopted to take advantages of the overlap of RSUs. We will improve the system using a novel compression algorithm which will take into consideration general compression with data aggregation in order to improve the overall system performance.

Keywords: Vehicular Adhoc Network, Road side unit catching using multiple content provider, Novel compression algorithm.

1. INTRODUCTION:

Recently, with the development of vehicle industry and wireless communication technology, vehicular ad hoc networks are becoming one of the most promising research fields. Due to their unique characteristics such as high dynamic topology and predictable mobility, VANETs attract so much attention of both academia and industry. Vehicular ad hoc networks (VANETs) are becoming increasingly popular in recent years, aiming to cope with the strong demands for communicating on the move. As more and more communication and computing techniques being enabled by VANETs, it is promising to deploy Intelligent Transportation Systems (ITS) widely in our real world [1]. By combining the theoretical improvements with the development of transportation infrastructure, ITS is expected to alleviate or even prevent many road traffic problems such as congestions and accidents effectively. To achieve these targets, roadside units (RSUs) are being deployed as the most significant infrastructure in ITS [2]. RSUs are typically Internet-connected devices, dedicated in exchanging information with on-board units (OBUs) placed at vehicles. Therefore, vehicle-to-roadside (V2R) communications are enabled in addition to the vehicle-to-vehicle (V2V) communications. Although initially designed to improve road safety and driving efficiency, ITS can also provide infotainment services for the passing-by drivers and passengers with the help of RSUs, such as commercial, informative, and entertainment services [3]. One of the prerequisites for infotainment services is to design the data dissemination strategy in VANET environment, where data can either be generated by the OBUs in VANETs or by the content provider on the Internet. In both cases, wireless data need to be disseminated to the given set of target vehicular users through VANET. However, due to the rapid changes in network topology and high variability of the connectivity, it is hard to guarantee that data can arrive at targets safely, accurately and punctually [4].Therefore, data dissemination in VANET still remains to be a challenging task.

The main contributions of this project work are listed below:

1) To focus on the roadside unit caching scenario which involves multiple CPs those are competing for the limited caching storages of RSUs.
2) To formulate the caching problem with the objective to maximize the total amount of downloaded data, where a caching-specific handoff mechanism are adopted due to the overlap of RSUs.
3) To provide a sub-optimal solution based on multi-object auctions, which is efficient to be carried out and also compatible with the existence of multiple MNOs.

VANETs which use vehicles as mobile nodes are a subclass of mobile ad hoc networks (MANETs) to provide communications among nearby vehicles and between vehicles and nearby roadside equipment but apparently differ from other networks by their own characteristics. Specifically, the nodes (vehicles) in VANETs are limited to road topology while moving, so if the road information is available, we are able to predict the future position of a vehicle; what is more, vehicles can afford significant computing, communication, and sensing capabilities as well as providing continuous transmission power themselves to support these functions. However, VANETs also come with several challenging characteristics, such as potentially large scale and high mobility. Nodes in the vehicular environment are much more dynamic because most cars usually are at a very high speed and change their position constantly. The high mobility also leads to a dynamic network topology, while the links between nodes connect and disconnect very often. Besides, VANETs have a potentially large scale which can include many participants and extend over the entire road network. It is precisely because of both of these unique attractive features and challenging characteristics that VANETs could draw the attention from both industry and academia.

2. MOTIVTION AND CHALLENGE:

The design and development of data dissemination mechanisms for VANETs which Aim at increasing the ratio of solved queries with the minimum network overhead, while Maintaining acceptable levels of information quality, has been the target of research Investigations in the recent literature [5,6]. Due to space limitation, in the following Paragraphs we present the most indicative ones (a survey of recent work can be found in [7]). Currently, carry-and-forward data dissemination schemes have been proposed, investigating the layout of road networks. An efficient such a protocol, called VADD, was proposed in [8]. VADD proposes the data forwarding using a stochastic model based on Vehicular traffic statistics, such as traffic density and vehicles' speed, in order to achieve The lowest delivery delay from a moving vehicle to a static destination. More recently, a trajectory-based data forwarding scheme, called TBD, for light-traffic road networks has been proposed [9]. This scheme exploits both private trajectory information and Traffic statistics. Also, an adaptive query evaluation scheme based on the underlying road network was proposed in [6]. The proposed query scheme leverages the road-network connectivity 518 n. Loulloudes, g. Pallis, and M.D. Dikaiakos Graph to create an evaluation tree for traffic information queries. However, this method imposes a significant overhead in the network by broadcasting control messages to inform the VANET on any location changes of vehicles participating in a specific query Evaluation. In large and dense VANETs this approach can lead to the saturation of the already limited network capacity, which in turn is bounded to degrade the quality of Vehicular services [10]. Recently, the authors in [5] presented hamlet, a fully-distributed caching scheme in which vehicles decide independently of each other whether to cache and for how Long a piece of information. Decisions are made based on individual node's observation of the information present within its radio range. The objective of this approach is to Increase content availability in the proximity of nodes and minimize network overhead. Although hamlet demonstrates an increase in the query success rate and a decrease in network overhead, the results are based on confined static information data-set within a simple urban mobility scenario. However, it is important to study the effects of caching in urban environments with diverse topographical layouts using a larger Information data-set, since the performance of caching in VANETs is mainly affected by the mobility scenarios. The closest works to ours is [5]. Similarly to us, this work studies the effects of Caching in VANETs. However, there are two fundamental differences. The authors do not consider a cache-based, proactive, communication protocol for the dissemination of Vehicular information in their experiments, nor do they conduct experiments in dense Mobility scenarios where information is generated by both mobile and stationary nodes And under the presence of unscheduled events like accidents. Our work is more general In the sense that hamlet [5] can be used upon our cache-based VITP protocol.

Objective:

1) Our aim is to reduce the Delay, Increase the Throughput (maximum rate of production at which something can be process), and Save the energy in road side unit caching by using hybrid compression technique.
2) For the result we have to use NS2 software which implement the network simulation on result which is having 3 files TCL file, TRACE file, AWK file. AWK file is a program to analyze the Trace file and its output is a graph or XG file.
3) After the flow of TCL>TRACE>AWK>XG we will get our final result. First we have to write the code for TRACE file and AWK file Set the NAM file ,configure the node position and then apply Delay AWK file on TRACE file to plot the graph for Delay, apply Throughput AWK file on TRACE file to plot the graph for Throughput, apply Energy AWK file on TRACE file to plot the graph for Energy.

3. VEHICULAR ADVOC NETWORK:

VANET is a technology that uses moving cars as nodes in a network to create a mobile network. VANET turns every participating car into a wireless router or node, allowing cars approximately 100 to 300 meters of each other to connect and, in turn, create a network with a wide range. As cars fall out of the signal range and drop out of the network, other cars can join in, connecting vehicles to one another so that a mobile Internet is created. Fixed equipment can belong to the government or private network operators or service providers [1]. It is estimated that the first system that will integrate this technology are police and fire vehicles to communicate with each other for safety purposes. Advancing trends in ad hoc network scenarios allow a number of deployment architectures for nearby vehicles and between vehicles and nearby fixed roadside equipment. Vehicular Ad-hoc Networks are expected to implement a variety of wireless technologies such as Dedicated Short Range Communications (DSRC) which is a type of Wi-Fi. Other Wireless Technologies are Cellular, Satellite and Wi MAX. Vehicular Ad-hoc Networks can be viewed as component of the [2]Intelligent Transportation Systems (ITS).

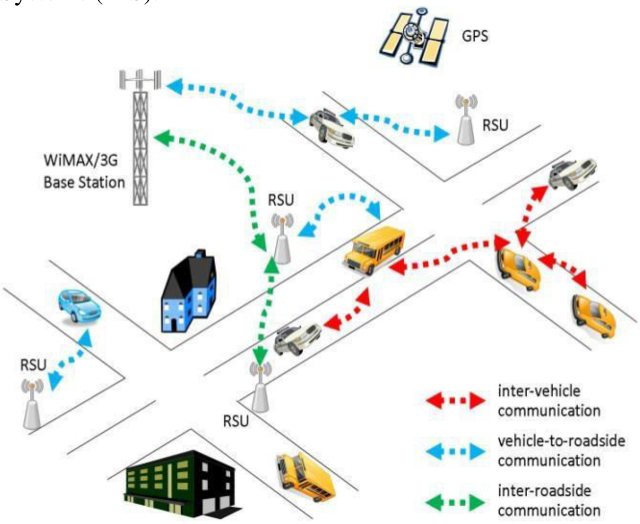

Figure.1.VANET

In Figure 1, it consists of vehicles and roadside base stations that exchange primarily safety messages to give the drivers the time to react to life-endangering events.

3.1. SPECIAL CHARACTERISTICS OF VANET:

Though VANET could be treated as a subgroup of Mobile Ad Hoc Networks (MANETs) and it is still necessary to consider VANETs as a distinct research field, especially in the light of security provisioning. The unique characteristics of VANET include features:

High Dynamic Topology:

The speed and choice of path defines the dynamic topology of VANET. If we assume two vehicles moving away from each other with a speed of 60 km/h (25 m/s) and if the transmission range is about 250 m, then the link between these two vehicles will last for only 5 seconds (250m). This defines its highly dynamic topology.

Frequent Disconnected Network:

The above feature necessitates that in about every 5 seconds or so, the nodes needed another link with nearby vehicle to maintain seamless connectivity. But in case of such failure, particularly in case of low vehicle density zone, frequent disruption of network connectivity will occur. Such problems are at times addressed by road-side deployment of relay nodes.

Mobility Modeling and Prediction [3]:
The above features for connectivity therefore needed the knowledge of node positions and their movements which is as such very difficult to predict keeping in view the nature and pattern of movement of each vehicle. Nonetheless, a mobility model and node prediction based on study of predefined roadways model and vehicle speed is of paramount importance for effective network design.

Communication Environment:
The mobility model highly varies from highways to that of city environment. The node prediction design and routing algorithm also therefore need to adapt for these changes. Highway mobility model is essentially a one-dimensional model which is rather simple and easy to predict. But for city mobility model, street structure, variable node density, presence of buildings and trees behave as obstacles to even small distance communication make the model application very complex and difficult.

Unlimited Transmission Power:
The node (vehicle) itself can provide continuous power to computing and communication devices.

Hard Delay Constraints:
The safety aspect (such as accidents, brake event) of VANET application warrants on time delivery of message to relevant nodes. It simply cannot compromise with any hard data delay in this regard. Therefore, high data rates are not as important as an issue for VANET as overcoming the issues of hard delay constraints.

Interaction with onboard Sensors:
These sensors help in providing node location and their movement nature that are used for effective communication link and routing purposes.

Higher Computational Capability:
Indeed, operating vehicles can afford significant computing, communication and sensing capabilities.

Rapidly Changing Network Topology:
Due to high node mobility, the network topology in VANET tends to change frequently.

Potentially Unbounded Network Size:
VANETs could involve the vehicles in one city, several cities or even a country. Thus, it is necessary to make any protocols for VANET is scalable in order to be practical.

Anonymous Addressee:
Most applications in VANETs require identification of the vehicles in a certain region, instead of the specific vehicles. This may help protect node privacy in VANETs.

Time-Sensitive Data Exchange:
Most safety related applications require data packet transmission in a timely manner. Thus, any security schemes cannot harm the network performance of VANETs.

Potential Support from Infrastructure:
Unlike common MANETs, VANETs can actually take advantage of infrastructure in the future. This property has to be considered to make any protocols and a scheme for VANET is better.

Abundant Resources:
VANET nodes have abundant energy and computation resources. This allows schemes involving usage of resource demanding techniques such as ECDSA, RSA etc.

Better Physical Protection:
VANET nodes are better protected than MANETs. Thus, Nodes are more difficult to compromise which is also good news for security provisioning in VANETs.

Partitioned Network:
Vehicular networks will be frequently partitioned. The dynamic nature of traffic may result in large inter vehicle gaps in sparsely populated scenarios and hence in several isolated clusters of nodes.

3.2. APPLICATIONS OF VANET:
Vehicular ad-hoc network applications range from road safety applications oriented to the vehicle or to the driver, to entertainment and commercial applications for passengers, making use of a plethora of cooperating technologies. Thus, we have divided the applications into two major categories:

Safety-Related Applications:
These applications contain safety related applications such as collision avoidance and cooperative driving (e.g., for lane merging). The common characteristic of this category is the relevance to life-critical situations where the existence of a service may prevent life-endangering accidents. Hence, the security of this category is mandatory, since the proper operation of any of these applications should be guaranteed even in the presence of attackers.

Other Applications:
It includes traffic optimization, payment services (e.g. toll collection), location-based services (e.g. finding the closest fuel station) and entertainment information (e.g. Internet access. VANET would support life-critical safety applications, safety warning applications, electronic toll collections, Internet access, group communications, roadside service finder.

4.1. ROAD SIDE UNIT:
Vehicular ad hoc network (VANET) is an emerging technology for future on-the-road applications. However, because of the vehicle mobility uncertainty, the temporal network fragmentation influences the communication connectivity. The roadside unit (RSU) has been considered to support the Vehicle-to-Infrastructure (V2I) communication and to increase the vehicle-to-vehicle (V2V) communication connectivity. Currently, it is impossible to deploy a large number of RSUs at the initial stage of VAENT due to the expensive installation cost, and the authority limitation. The Connectivity-oriented Maximum Coverage RSU deployment Scheme (CMCS), aiming at the maximum V2I communication performance in urban areas. The V2V&V2I network in a real urban area of Chengdu city in China via NS2 and VANETs Mobisim simulators. Results show that the RSU deployment scheme is able to cover the majority of vehicles on the road and guarantee the communication performance with a reduced number of RSUs.

4.2. ROAD SIDE UNIT CACHING:
Over the past decades, vehicular ad hoc networks (VANETs)

have been core networking technology to provide drivers and passengers with safety and convenience. As a new emerging technology, the vehicular cloud computing (VCC) can provide cloud services for various data-intensive applications in VANETs, such as multimedia streaming. However, the vehicle mobility and intermittent connectivity present challenges to the large-scale data dissemination with underlying computing and networking architecture. In this paper, we will explore the service scheduling of virtual RSUs for diverse request demands in the dynamic traffic flow in vehicular cloud environment. Specifically, we formulate the RSU allocation problem as maximum service capacity with multiple-source and multiple-destination, and propose a bidirectional RSU allocation strategy. In addition, we formulate the content replication in distributed RSUs as the minimum replication set coverage problem in a two-layer mapping model, and analyze the solutions in different scenarios. Numerical results further prove the superiority of our proposed solution, as well as the scalability to various traffic condition variations.

4.2.1. System Structure Overview:

We consider a vehicular cloud computing architecture in Figure 1, which includes vehicles in dynamic traffic flow, virtual RSUs distributed in urban areas, and a cloud platform to support on a large scale. Initially, the traffic flow map in urban areas can be achieved through the distributed traffic monitoring or a third party Internet map service provider. With the traffic flow map, the virtual RSU scheduling can be implemented by cloud platform for a large scale content delivery coverage. The RSUs cache the file items that can be downloaded by the vehicles nearby. There are a large set of files in total, which are all stored in the cloud platform as backups. Meanwhile, the RSU storage capacity is limited, and cache items need to be updated according to the replication strategy. Each RSU receives the requests from the traffic flow in its coverage area, and feeds back the request demand according to its local replication. From the viewpoint of a specific vehicle, its request demand can be fulfilled by the RSUs passing by; otherwise, it will resort to the support of cloud platform or vehicle-to-vehicle communications. The RSU scheduling strategy includes RSU allocation and cache replication. Specifically, the RSU allocation determines where to allocate the RSUs, and the content replication determines what to cache in these allocated RSUs.

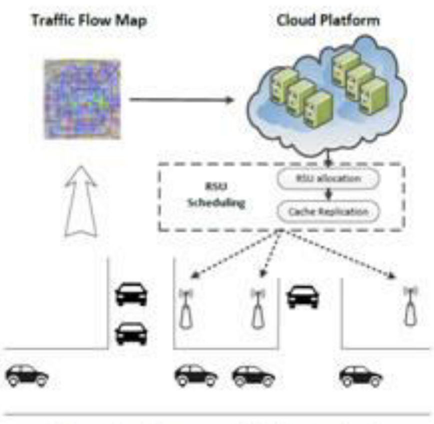

Figure 1. A road segment with a bidirectional road.

4.3. RSU ALLOCATION:

Given the traffic flow map, RSU allocation will select an RSU distribution to balance the system cost and performance. As we assume a virtual RSU based on network function virtualization (NFV) technology, the RSU can be started or terminated dynamically according to the time-varying traffic flows. Intuitively, provisioning more RSUs would bring higher service coverage, and also leads to higher system cost. Through V2V and V2I communications in VANETs, the RSUs are allocated to facilitate the content delivery under the cost constraints. In other words, given a limited number of RSUs, we need to find an appropriate RSU placement to improve the connectivity of the whole system.

4.4. CACHE REPLICATION:

After the RSUs are allocated, the cache replication strategy refers to the file item management in the local storage of RSUs. As the RSUs usually have limited storage capacity, the content replication needs to be updated according to the various request demands of vehicles passing by. Naively caching the most popular item content can hardly guarantee the efficiency of the whole system, as the RSUs are usually allocated along the road and accessed by the passing-by vehicles in sequence. Therefore, we need to consider both the request demand and RSU distribution, and explore the service scheduling strategy among the neighboring RSUs. We present the details of the RSU scheduling strategy design procedures in, including the RSU allocation and cache replication. Initially, we consider the dynamic environment with time-varying. Traffic conditions and various request demands. According to the traffic conditions, the RSU allocation strategy is designed to improve the service capacity with a limited number of RSUs. According to the RSU distribution and the popularity of the request demand, the cache replication is designed to improve the service efficiency with storage capacity constraint.

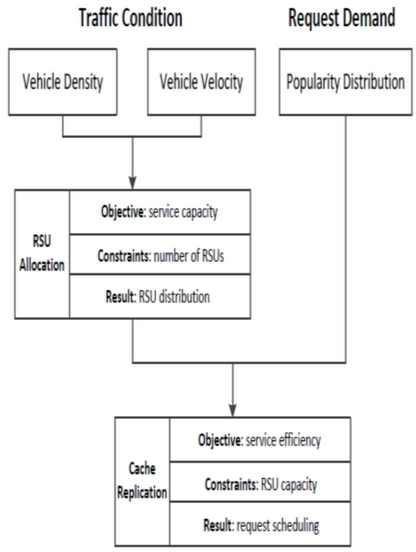

Figure 2. RSU scheduling strategy design.

5. DATA COMPRESSION:

Data compression refers (11) to the process of converting an input stream (original raw data) into another output stream (compressed stream) that has a smaller size. A stream can be either a file or a buffer in memory. Data compression can also be defined as the science of representing information in a compact form. These compact representations can be created by identifying and using structures that exist in the data. Data can be in the form of characters in the text file, numbers that are samples of speech or image waveforms, or sequences of numbers that are generated by other processes. Data compression is required because more and more of the information that we generate and use is in digital form i.e. in the form of numbers represented by bytes of data and the number of bytes required to represent multimedia data can be huge.

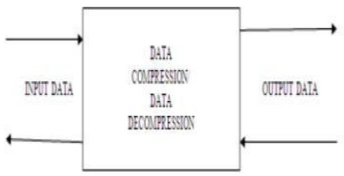

Fig.1.1 Data compression and decompression

There exists variety of techniques for data compression. All are based on different ideas and are suitable for different types of data. Different methods produce different results, but they are all based on the same basic principle i.e. they compress data by removing redundancy from the original data in the source file. There are different types of redundancies.

5.1. A. Alphabetic Redundancy: For example, the letter 'E' appears very often, while 'Z' is rare. This is called alphabetic redundancy, and suggests assigning variable size codes to the letters with 'E' getting the shortest code and 'Z' the longest one.

5.1. B. Contextual Redundancy: For example, the letter 'Q' is almost always followed by the letter 'U'.

5.1. C. Image Redundancy: For example, in a non-random image, adjacent pixels tend to have similar colors. Variable-size code has less redundancy than a fixed-size code (or no redundancy at all). Fixed size codes make it easier to work with test, so they are useful, but they are redundant. The general law of data compression is to "assign short codes to common events (symbols or phrases) and long codes to rare events.

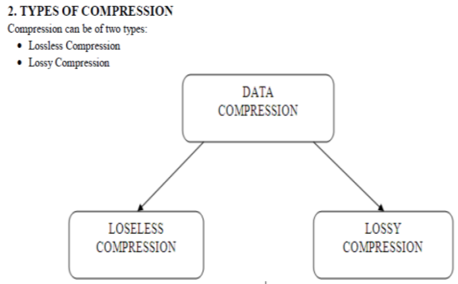

Fig.1.2 Types of Data Compression

5.2. A. Lossless Compression:
In this compression technique, no data is lost. The exact replica of the original file can be retrieved by decrypting the encrypted file. Text compression is generally of lossless type. In this type of compression generally the encrypted file is used for storing or transmitting data. For general purpose use we need to decrypt the file.

5.2 B. Lossy Compression:
Lossy Compression is generally used for image, audio, video. In this compression technique, the compression process ignores some less important data and the exact replica of the original file can't be retrieved from the compressed file. To decompress the compressed data we can get a closer approximation of the original file. Image compression JPEG encoding, Video compression : MPEG , audio compression.

5.2. C. Hybrid Compression algorithm:
In this proposed hybrid algorithm performed based on lossless image compression, using both DWT and SPHIT algorithm (14). In this hybrid algorithm performed based on lossless image compression. First initialize using 2-Level DWT, then set the LSP as an empty list and add the coordinate values (i, j) ε H to the LIP. Add the sorting pass LIP values. The refinement pass for each entry to LSP. Then transform the LSP and restored the image. From the performance are analyzed and found a hybrid technique produce good accuracy than other two compression techniques with its highest accuracy values by using PSNR (Peak Signal Noise Ratio) and structural similarity (SSIM).

6. CONCLUSION:

Thus it is conclude that, Recent improvements in vehicular ad hoc networks are accelerating the realization of intelligent transportation system (ITS), which not only provides road safety and driving efficiency, but also enables infotainment services. Since data dissemination plays an important part in ITS, recent studies have found caching as a promising way to promote the efficiency of data dissemination against rapid variation of network topology. In this paper, we focus on the scenario of roadside unit (RSU) caching, where multiple content providers (CPs) aim to improve the data dissemination of their own contents by utilizing the storages of RSUs. To deal with the competition among multiple CPs for limited caching facilities, we propose a multi-object auction-based solution, which is sub-optimal and efficient to be carried out. A caching-specific handoff decision mechanism is also adopted to take advantages of the overlap of RSUs. We will improve the system performance by Hybrid Compression Technique using a novel compression algorithm which will take into consideration general compression with data aggregation in order to improve the overall system performance.

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