Buffer Management for Efficient Data Dissemination in Vehicular Network

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Abstract- As there is a tremendous increase in the demand for the data dissemination in wireless networks, it is necessary to investigate an effective mechanism in order to improve the cooperative data dissemination in telematic applications. In this paper we have considered cooperative data dissemination with respect to Roadside WLANs as an infrastructure. With respect to cooperative data dissemination the contents or the data are stored at the access point (AP) and as and when required, the contents are downloaded from the content server in the internet and are disseminated to the mobile users. When multiple users request for the data, providing a satisfactory services to users cannot be achieved with the existing approach. To provide satisfactory dissemination services to the nomadic users with reduced delay, it is necessary to optimally utilize the available buffer space. Effective buffer management will thereby reduce the frequent download from the content server and thereby improve the performance with respect to content download time, latency and chunk cache hit ratio. In this paper we propose a mechanism to optimally use the available buffer space based on the user mobility and content popularity. Buffer management is carried out in this proposed work by determining the frequent set of data using least popularly used algorithm.

Index Terms— *Cooperation, Buffering, Data Dissemination, Buffer Management, Wireless Local Area Network (WLAN), Pre-download, Access Point (AP)***.**

I. NTRODUCTION

Wireless local area network(WLAN) replaced wired computer network for flexible access of data. WLANs have been widely deployed in most of the private and public places, mainly because of their low development cost and high data delivery ratio. In order for the nomadic users (users who keeps moving) to obtain the wireless access, Roadside WLANs (RS-WLANs) are implemented where large numbers of access points (APs) are deployed across the road side. It is important to have the Roadside WLAN access points to provide a satisfactory data dissemination services to nomadic users. Data dissemination is nothing but the process of delivering the data to various applications. There are various commercial applications which depend on data dissemination services. Internet is the base through which the data is disseminated across various users. Each access point can serve multiple users within the defined network area . As people move beyond the ran one access point (AP) they are automatically handed over to the next access point(AP), which is nearer to the vehicle at that point of time. Development cost and the data transmission rate are the two major issues which have to be considered. High cost and low transmission rate prompted the technology to shift from the traditional cellular network to the Roadside WLANs. There may be the cases wherein the users request for downloading large files, since the users keep moving it is difficult to deliver the satisfactory services on time within that coverage area and thus such problem of downloading large file is addressed by a mechanism called chunk scheduling [8], thus large files can be downloaded but since the storage space is not optimally utilized for proper usage, there arises the problem of not having enough memory to pre-download the packets. The data has to be stored at the buffer for the adequate dissemination of the data. The challenge is to provide the management of this available buffer space there by reducing the frequent download from the server and improve the content delivery ratio and content download time. Resource management is the main issue to be considered in most of the cases. Energy resource consumption is well studied in [1, 2]. In this work mainly we are focusing on the buffer space. Buffering is the process of determining what kind of data and how the data is placed in each of the node in its main memory. It also helps to provide necessary actions when there is a problem of loss recovery. Fair- share buffering [3] which gives uniform load distribution and reduce the buffer usage where every node has a partial view of the system. In Vehicular Ad Hoc Networks Data Pouring and Buffering is implemented as a new Data Dissemination Paradigm [4].

In this paper we propose a buffering mechanism to optimally utilize the buffer space, thereby addresses the data dissemination problem to large extends. In our proposed system considering content popularity as the base, buffer management is carried out. The data which is most popular will be available in the buffer on a periodical replacement of items based on proposed algorithm. The proposed solution ensures the efficient utilization of the limited bandwidth; maximize the content delivery ratio, reliable data dissemination, reduced delay and maximum chunk hit ratio.

The rest of the paper is organized as follows Section II discusses the related literature survey on cooperative data dissemination. Section III discusses the framework for buffer management. Section IV explores the implementation details. In section V, we conclude this work with experimental analysis and performance.

2. RELATED WORK

This section gives an overview of the existing scenarios. Many of the dissemination techniques use various methodologies to have a proper data dissemination services. Bin Bin Chen and Mun Choon Chan [5] worked on a framework, MobTorrent that has been designed for vehicles that has an access to road side Wi-Fi access points. In this work, when a mobile client wants to initiate a download, instead of waiting for contact with the AP, it informs one (or multiple) selected AP(s) to pre-fetch the content. The scheduling algorithm in MobTorrent then replicates the pre-fetched data on the mobile helpers so that the total amount of data transferred and the average transfer rate to the mobile clients are maximized. Therefore, instead of limiting high speed data transfer to the short contact periods between APs and mobile clients, high speed transfers among vehicles are opportunistically exploited.The authors claim to have a better performance over existing architecture and the performance is found to be robust when there are multiple AP's.

Another major contribution to the data dissemination from the networks to nomadic users was from the work of Hao Liang and WeihuaZhuang[6]. In this proposed method, the authors assume that there exists a a DTN/WLAN integrated network where nomadic nodes with high mobility comprise a delay tolerant network (DTN) while local nodes with low mobility reside in the coverage area of wireless local area networks (WLANs). In order to facilitate message dissemination, a delay tolerant cooperative communication scheme is proposed in the work. The messages for dissemination are first pre-downloaded to a group of storage local nodes within a WLAN before the visit of a nomadic node, and then scheduled for transmission when a nomadic node comes into the transmission range. The authors claim to have an improved message delivery performance from a WLAN to a nomadic node as compared with existing schemes without message pre-downloading or message scheduling. Cooperative download in vehicular environment [8] is another work done by Oscar Trullols-Cruces and Jose Barcelo-Ordinas where the chunk scheduling methodology is implemented to ensure continuous data delivery of large file downloads as the vehicles passes across many access points (APs).As the data is chunk scheduled the user will never feel any discontinuity while downloading the data. The cooperative download of contents from vehicle is first implemented in 2005 in [9] where cooperative parallel downloading scheme has been proposed and so it reduces the Latency in delivering the data to the destined user. In [3] stepwise fair-share buffer management technique is used and thereby balance the load and the proposed approach reduces the memory usage because for each message only a subset of the nodes are used as buffer and thereby improves the data dissemination services. There exists large acceptance to data dissemination services in wireless networks as many of the telematic applications now days require the distribution of information in the network. Hao Liang and Weihua Zhuang[7] introduce a novel approach of data dissemination from the remote servers to nomadic users. The authors have considered nomadic users as vehicle passengers and pedestrians. A two-level cooperative data dissemination approach is presented in the work. With the network-level cooperation, the resources in the RS-WLANs are used to facilitate the data dissemination services for the nomadic users and with the packet level the packet transmission rate to the nomadic user could be increased.The architecture for the existing system is shown below:

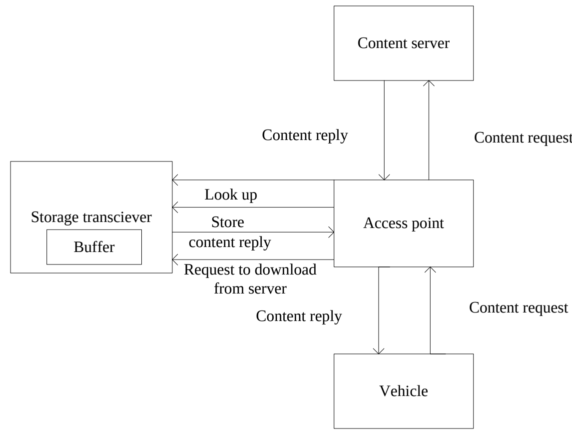

Figure 1.Data dissemination without buffer management

There are four modules connected as depicted in the above shown diagram. Buffer at the storage transceiver is not utilized optimally here. So to overcome this it is necessary to have a buffer management which is proposed in this paper.

In all these works which they have done, it is nowhere they focused on the buffer management scenario. So in this paper we are mainly concentrating on the buffer management taking it as a separate module in the access point (AP).

3. FRAMEWORK FORBUFFER MANAGEMENT

This paper proposes a framework that is very accurate and reliable in managing the buffer. We mainly consider about the buffer management techniques here. There are mainly 4 modules to be considered in the system model as shown in figure 2, say content server, access point, storage transceiver and vehicles.

3.1Content server

Content server has many contents. These contents can be requested and delivered to the vehicles using the access point.

Communication with the content server is through internet support. There is a wired connection from content server to the deployed access points. Updating the content server is not a tedious task. When a new data arrives it flows through the template and displays at the website. So through the router content server is connected to the Access Point (AP).content history will be pushed to the content server periodically and are analyzed at the server. After periodic analysis of the content history it gives out the popular items for the cache updating process.

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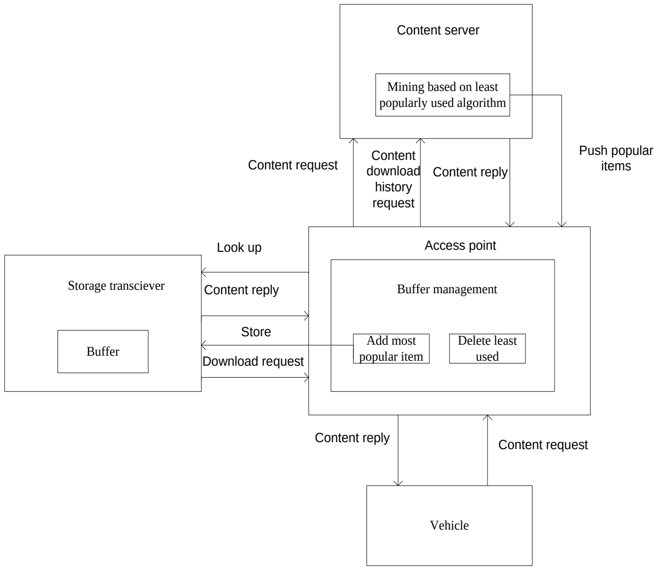

Figure2: System model

3.2 Access point (AP)

Access point module, download the content from the content server and send to storage transceiver to buffer the content. It has a sub-module within it, buffer management where it performs the main functionality of buffer management by adding and deleting the concerned data items from the buffer in the storage transceiver. APs are the static Wi-Fi access point and provide data delivery services to the nomadic user through Roadside WLANs. Distance between two APs are considered to be 200m apart and various criteria like radio propagation ,cost, hand-over-frequency , frequency reuse are considered while choosing the distance between APs. The access points are deployed across the roadside points based on the vehicle movement history. With respect to the vehicle movement history the cross over value is calculated, i.e. finding out the largest points where more number of vehicles cross over.

3.3 Storage transceiver

Storage transceiver receives vehicle content request and sends the content if available in the buffer else it will request the AP to download the content from the server and provide it to the storage. The buffer at the storage is used for pre-downloading the data and made it available to the user before it reaches to the coverage area. It is necessary to have the buffer management of the buffer space at Storage transceiver.

3.4 Vehicles

Vehicles are considered as the mobile clients in this work. Users in the vehicle send the request for content delivery. Content request and content reply is through the Access point that is deployed across the roadside network. When the mobile user receives every packets of a concerned request, it ensures the complete delivery of the content.

The main advantages with our proposed solution is the solution works for any number of nomadic users, using this solution the message delivery time is reduced and the message delivery ratio is increased.

Message delivery ratio=
$\sum$ Number of packets received / $\sum$ Number of packets sent

This illustrates the level of delivered data to the destination. Higher the value of message delivery ratio, higher the performance.

4. IMPLEMENTATION

In this section we describe a typical operation of buffer management, like how actually the data transfer takes place among different modules; Nomadic users in the vehicle send the request for the content download. The requested data is checked across the buffer in the storage transceiver. If the requested data is available in the storage, it is delivered to the vehicle through the access point. If the searched item is not there in the storage buffer the storage transceiver will request the access point to download the data from the content server. Sending the requested data to vehicle as well as storing it in the storage buffer at the storage transceiver is a parallel process. AP keeps track of the content download history along with transaction history and is being sent to the content server. During this process buffer management is also takes place in parallel. Buffer management is carried out based on the proposed algorithm, where the most popular items are pushed back to the Access point. With these new popular items the data is added to or deleted from the buffer at the cache.

Least popularly used algorithm

```
 To store the most popular content to cache

Input : the popular content
Output : cache<-Popular content

 if (content in the cache==null)
{
 cache<-content
 popular score = 1
 if (content in the cache== cachesize)
{
get the content with least count()
remove(content from cache)
}
cache <-content
}

 To get the content with least count

leastcount=90
if popular score<leastcount
{
lcount=popscore
```

least=content
}

To get the content with most count

lcount=0

while there are request from vehicle

{
if popular score>lcount
lcount=pop core
least=content
return least

}

5. EXPERIMENTAL ANALYSIS AND RESULTS

In this the experiments were performed on taking 44 vehicles move on the roadside network. Roadside network is shown by constructing a road network map. The vehicles are made move on the road randomly and accordingly based on the movement history the access points are deployed across and the request from the vehicle is noted. Based on the proposed system the content download time, latency to deliver the data packets and cache hit ratio is calculated and are shown in the graph below. We measured the content download time for different vehicle speed and we found that in our proposed solution , the time to download is lower , the reason for this being the most popular contents to download are readily available at storage transceiver and due to this time to download has been reduced.

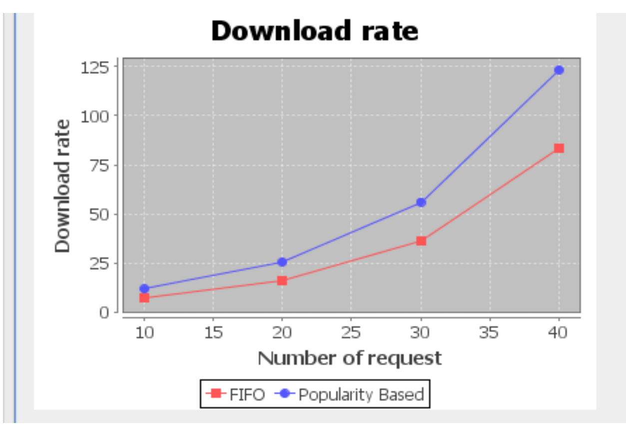

Figure 3.Comparison of content download time

The cache hit ratio for different number of request per second is measured and it is plotted in the below graph. The cache hit ratio over the period of time is measured and plotted. We observe that with respect to our approach it gives a better cache hit, and it is achieved fast. Cache hit ratio is increased compared with FIFO is due to better buffer management techniques, the data when it is not present at the place the data gets downloaded and meanwhile it also keeps a copy at the buffer space and so next time when there is a request for the same data there occurs a hit.

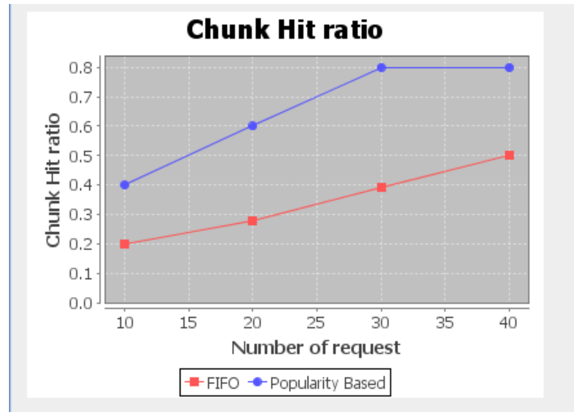

Figure 4.Comarison of chunk cache hit ratio

The latency also measured and it is compared with the existing FIFO based techniques where the latency of the proposed system is drastically reduced and are shown in graph below.

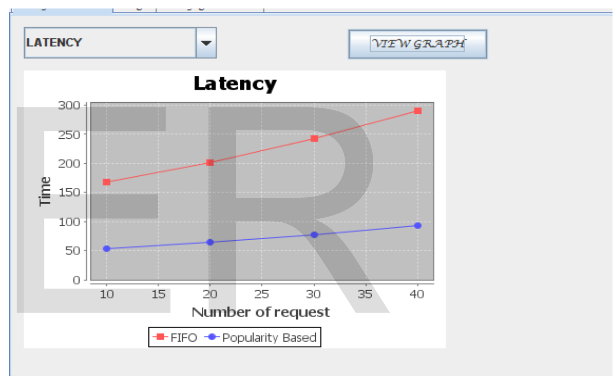

Figure 5 comparison of latency

6. CONCLUSION

Existing solution failed to provide a proper satisfactory service to the nomadic users in the vehicular network. In this paper we presented a buffer management methodology as a solution to this problem by providing satisfactory services to a large number of users. As the request increases the problem of not able to deliver the data with reduced delay is increased and so this problem is overcome to a maximum extends with our proposed solution. Buffer management is implemented so that the requested data is accessed directly from the cache than every time download it from the main server, thereby reduces the delay gap between the user request and response. Overall performance of the system is increased with respect to the latency, chunk hit ratio and content download time.

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