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Effective Hasten Content Dissemination Approach for Roadside Content Delivery Systems in VANET

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Abstract---Vehicular Ad hoc Networks (VANETs) technology uses moving vehicles as wireless routers or nodes in a network to create a mobile network. VANET uses infrastructure that supports to handle time sensitive data in exchange process. However, delivering rich content location aware information services like digital versions of restaurant menus, shopping mall maps, transportation schedules, grocery store circulars, and movie trailers is a challenging task particularly for vehicles. Technologies such as Satellite Based Broadcasting, Cellular-3G provide limited bandwidth at high costs. In contrast, providers can cheaply and easily deploy a small number of Wi-Fi Infostations that quickly deliver contents to passing by vehicles for future offline browsing. In Infostation based VANET, the challenging task is to increase the throughput of content dissemination from Infostations to Vehicles in Broadcast Communication. Most of the approaches introduced so far regarding data dissemination do not satisfy the requirements of Infostations. The Effective Hasten Content Dissemination (EHCD) Approach is proposed in this paper mainly to improve the performance of Infostation based VANET. The performance of the proposed approach for Broadcast Infostations is analyzed in terms of parameters such as Throughput, Packet Delivery Ratio, and Packet Loss Rate.

Keywords---VANET, EHCD Approach, Road Side Units (RSUs), WINMAC protocol, ENAODV protocol.

I. INTRODUCTION

Mobile Ad Hoc Network (MANET) is an infrastructure less wireless network, in which the devices or nodes are mobile [1]. Vehicular Networks are a peculiar class of mobile networks in which vehicles are equipped with nodes, radio interfaces and therefore able to communicate with inter or intra Vehicular Network in an opportunistic way [2]. The realistic mobility model plays a vital role in VANETs in order to increase the performance. It [3] consists of a realistic topological map which reflects different densities of roads and categories of streets with various speed limits. Vehicular Ad-hoc Networks (VANETs) [4] provide a way to access content based on epidemic data dissemination, costs for both the user and the content publisher, and also increasing system scalability [5]. Communication in Vehicular Ad-Hoc Network (VANETs) is a significant and challenging task [6]. The goal of research in Infostation based VANET is to develop a efficient communication system for enabling quick and cost effective data dissemination [7]. The data dissemination approaches in VANET is based on any one of the categories such as Vehicle to Infrastructural dissemination (V2I/I2V dissemination), Vehicle to Vehicle dissemination (V2V dissemination), Opportunistic dissemination, Geographical dissemination, Peer-to-Peer dissemination and Cluster based dissemination. The nature of VANET applications and inherent VANET characteristics such as different network density and fast movement of vehicles make data dissemination quite challenging [8]. However, delivering rich content like location aware information services such as digital versions of restaurant menus, shopping-mall maps, transportation schedules, grocery store circulars, and movie trailers is also challenging particularly for vehicles. Technologies such as Satellite Based Broadcasting and Cellular-3G provide limited bandwidth at high costs [9]. Thus, Wi-Fi Infostations [10] are the ideal alternative for deploying location-aware-information services to vehicles. With the ubiquity and high bandwidth of Wi-Fi devices, content providers can easily deploy a small number of Wi-Fi Infostations that quickly deliver content to the vehicle users. Individual Infostations could be placed at key locations such as freeway exits to a city, and street corners near the places of interest [9]. So far various researchers have proposed different techniques for Infostations to improve data dissemination according to applications such as network coding [11], [12] and Bit Torrent- like protocols [13], [14]. However all of these approaches are either designed on the top of the Wireless Transport Layer, or assume reliability through retransmissions at the Wireless MAC layer [9].

1.1 Overview of the Proposed Model:

An overview of the proposed system is given in Fig 1. The data dissemination process of location aware information with both the existing data scavenging approach and proposed Effective Hasten Content Dissemination (EHCD) approaches are tested to the Broadcast Infostations to analyze their performance using statistical parameters such as Throughput, Packet Delivery Ratio (PDR) and Packet Lost Rate (PLR).

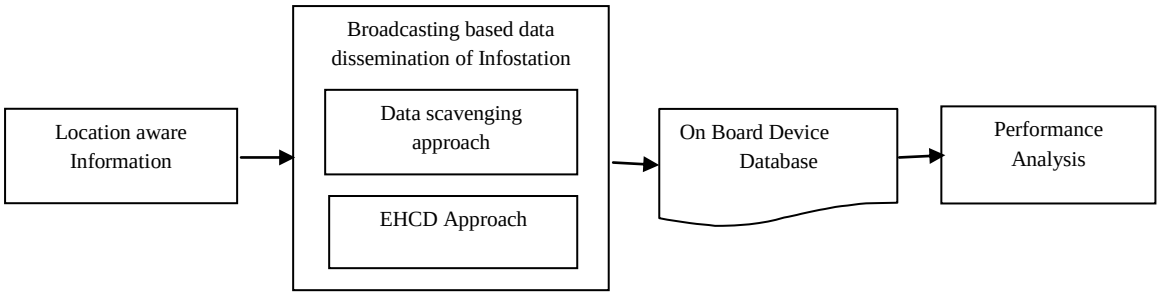

Fig 1: Block diagram of the proposed model

In the rest of the paper, Section 2 exposes a short review of related works regarding data dissemination in Infostation based VANET. Section 3 explains about problem statement. The detailed explanation of proposed model is given in section 4. The experimental results and their discussion are projected in section 5. The work is concluded in section 6 with future possible enhancements.

II. RELATED WORKS

The process of distributing some amount of data over a distributed wireless network or to transmit the message from source vehicle node to destination vehicle node is called as data dissemination. It is used to inform drivers or vehicles about location aware information and also used to increase the quality of driving in VANETs in terms of distance, time, and safety. The concept of data dissemination is wide and meaningful [8].

Data dissemination approaches for WiFi Infostations:

In 1999, An Intelligent transmission protocol called WINMAC is proposed by Gang Wu et al for Infostations in order to handle channel allocation and access, adaptive transmission rate adjustment and retransmissions of packets [15]. In 2003, Wing Ho Yuen et al proposed the data diversity technique to solve the issue of noncooperation between nodes in the context of content distribution in mobile Infostation Networks [16]. In 2004, Furuzan Atay and Christopher Rose implemented Threshold based policies to study the performance of Mobile Infostation Networks. [17]. In 2006, Helal Chowdhury and Juha-Pekka Makela proposed a mathematical framework called two throughput distance relationship models to compute the statistics such as the average throughput and information transferred while a mobile user crossing the coverage area of the Infostation [18]. An Infostation Network Based on Multi-Agent System was proposed by Ivan Ganchav et al, in May 2007 to provide Wireless mServices for mobile users at different Key points around University Campus [19]. In 2008, Laura Galluccio et al proposed Energy efficient protocols to design efficient infostation systems for rural areas to improve the data dissemination process [20]. In 2009, Mohsen Sardari et al proposed Rate Less Codes scheme for collaborative content distribution from Roadside Units to Vehicular Networks [21]. In 2010, Laura Galluccio et al proposed an analytical framework for characterization of stability conditions of Infostation systems. It depends on diffusion theory [22]. In 2011, Marcel C. Castro et al proposed a Delay-Tolerant Scenario (DTS) for file sharing applications in rural area Infostations [23]. In 2012, Zhan lin Ji et al proposed an intelligent, light-weight, and distributed Java platform based Spring-like framework for the provision of mobile services (mServices) to the Infostation-Based mLearnig environment [24]. In 2013, Abdulmalik Alhammad et al proposed a Context-Aware on-street Parking System which combines the concept of context-awareness and an Infostations (IS) for locating and reserving space in parking zone [25]. Vehicles nearby Infostation receive data faster than vehicles far away from the Infostation within its transmission coverage area. To minimize the delay and increase the efficiency of receiving data from an Infostation the approach data scavenging was introduced by Vinod Kone in 2013. The throughput of data dissemination is improved to some extent simply by adding the bandwidth of faraway vehicle with the bandwidth of nearby vehicle [9]. The faraway vehicle gets conflict when it receives content from Infostation and its nearby vehicle simultaneously. When faraway vehicles do not find any neighbor vehicles within their communication bandwidth, data scavenging approach totally fails in the case. To address these issues, the approach Effective Hasten Content Dissemination (EHCD) is proposed and its detailed description is given in section 4.

III. PROBLEM STATEMENT

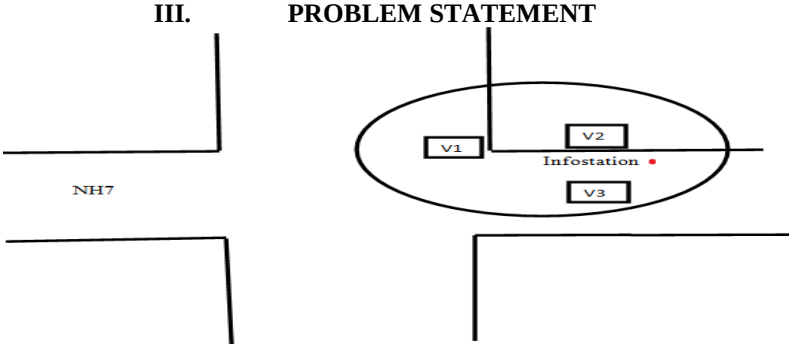

Fig 2: Process of Infostation based VANET

Vehicles located at long distance from Infostation do not get efficient data dissemination like the nearby vehicles. In Fig 2, an infostation is deployed in NH-7 and indicated as Red dot and circle denotes its transmission coverage area. V1 is the long distance vehicle whereas V2, V3 are the nearby vehicles. According to the problem statement, Infostation disseminate data effectively to v2 and v3 than v1. The technical challenges or issues in Infostation are not completely solved by simply broadcasting the data. The design of efficient data dissemination process will be a great solution for these problems by considering the various features of different layers in the VANET protocol stack.

IV. EFFECTIVE HASTEN CONTENT DISSEMINATION APPROACH

The main goal of the proposed approach is to increase the dissemination throughput of content from Infostations to Vehicles in Broadcast communication. It is developed for Infostation to take complete authority to disseminate content for vehicle by selecting forwarding nodes efficiently to improve data delivery rate. The proposed content dissemination approach is evaluated in broadcast communication. It is introduced to improve the data delivery speed and decrease latency. It is the best data dissemination approach since it provides content even though node is out of Infostation control. All the data dissemination processes are controlled only by Infostations. It does not result in more broadcasts because it is not selecting all neighbor nodes. It constructs optimum path from Infostations to respective sink for content transmission even though vehicles are farther from the Infostations. It makes the process of Infostations very simple and efficient. The step by step process of Effective Hasten Content Dissemination (EHCD) approach is shown in Fig 3.

Effective Hasten Content Dissemination Approach (EHCDA)

Input : Number of sent packets from Infostations.
Output: Number of successful delivery of packets at destination vehicles.
%IS-Infostations, NV-Nearby Vehicle, FV - Faraway Vehicle, $List_1$ [1…n] – list of all %neighbor nodes, List1 %has two types LSI and RSI. LSI [n_1] – Left Side of Infostation %neighbor list, RSI [n_2] – Right Side Infostation %neighbor list, where n_1, n_2 are the maximum %nodes limits, N_1 - Final list of necessary neighbor node values.

Step 1: IS waits for request from new vehicle or vehicles within its coverage area.
Step 2: If a single vehicle arrives, IS disseminate content via Unicasting without collision.
else if multiple vehicles arrive, IS disseminate content via Broadcasting.
Step 2 a: For NV IS simply broadcasts like one to many communications.
Step 2 b: For FV IS go to step 3.
End if
End if
Step 3: Do steps 3a to 3i.
(IS selects efficiently forwarding neighbor nodes with high data delivery rate).
Step 3a: Iteratively search LSI & RSI to choose mostly necessary forwarding neighbor nodes.
Step 3b: step 3a should be repeated until the search process reaches maximum neighbor node limit values n_1,n_2 at
both side of IS.
Step 3c: Finalize necessary forwarding of neighbor nodes list N_1 and make a shortest path towards destination.
Step3d: IS improves energy levels of nodes on shortest path for avoiding unwanted Broadcast towards destination.
Step 3e: IS has mechanisms for adding or removing of nodes dynamically without interrupting the process of making shortest path to increase the lifetime of nodes. Different nodes can be selected by different neighbor nodes to make the shortest path at any complex data dissemination.
Step 3f: A local topology system should be built and maintained for each streaming node over a communication
channel for efficient packets delivery.
Step 3g: IS provide authority and rights for nodes to reuse their existing structure dynamically wherever applicable.
Step 3h: IS use trust mechanism for instructing each node to select neighbor node efficiently which is called as
Trust Based Monitoring.
Step 3i: Disseminate the location aware content packets with Authentication to FV.
Step 3j: If FV didn't get efficient content like NV, IS dynamically redistribute packets to destination nodes
end if
Step 4: IS gives authority to its source vehicle for disseminating data for new strange vehicles with same efficiency and delivery ratio.

Fig 3: Effective Hasten Content Dissemination (EHCD) Approach

Each node knows its selected neighbor nodes which increase efficiency of infostation and the infostation iterates over all files and distribute all files in an arranging order. Packet flooding or overlapping does not occur. Experimental results and analysis are given in section 5.

V. EXPERIMENTAL RESULTS AND DISCUSSION

The performance of Data scavenging protocol and EHCD algorithm described in previous sections are analyzed using NS2simulator in the context of data dissemination of location aware information. NS2 came as extension of Tool Command Language (TCL). The execution of NS-2 is carried out by means of cluster surroundings of wireless vehicle nodes. The simulation area or open area topology of NS-2 execution is 1200 meters x 1200 meters by means of 5m/s node velocity. Each packet information has a size of 1024 bytes in NS-2 Simulation. Simulation path is used to indicate the source to destination connections. NS-2 is used to build non real time vehicular ad-hoc environment at low cost. The parameters and their values used for simulation configuration settings are tabulated in Table 1.

Table 1: NS-2 Simulation Configuration Settings

PARAMETERS	**VALUES**
Version	NS-allinone 2.28
protocols	AODV
Simulation Area	1200 m x 1200 m
Broadcast Area	400 m
Transfer Model	UDP, CBR
Data packet Size	1024 bytes
Simulation time	300 seconds
No of vehicles	4,10,50,75,113
MAC protocol	IEEE 802.11

The data dissemination process of providing location aware information from Infostation to Vehicle nodes starts from first node itself. In the existing data scavenging approach, faraway vehicles scavenge data from nearby neighbor vehicle with in Infostation coverage area by combining their communication bandwidth. EHCD algorithm uses neighbor information to select the optimized forwarding vehicle nodes for broadcasting content to all types of vehicles effectually. The mobility of all vehicle nodes (maximum 113 nodes) is traced through simulations and noted for 300 seconds in order to analyze the performance of proposed model. The parameters such as Average Throughput, Average Packet delivery ratio, and Average Packet lost rate are used to evaluate the performance of the proposed method for data dissemination in Infostation based VANET and compared to others. The parameters and their formulae are shown in Table 2.

Table 2: Parameters with its Formulae

parameters	**Formulae**
Throughput	$\frac{\text{No of received packets x packet size}}{\text{Transmission Time}}$
Packet delivery ratio	$\frac{\sum \text{No of packets received}}{\sum \text{No of packets sent}} \times 100$
Packet lost rate	(No. of packet sent – No. of packet received)

The amount of work that is successfully done by an Infostation within a particular amount of time is called as throughput. It measures the effectiveness of data dissemination approaches. The data dissemination approach EHCD achieves high throughput when compare to data scavenging approach. The average throughputs earned by these approaches for various vehicle nodes 4,10,50,75,113 in different transmission time 60s, 120s, 180s, 240s, and 300s are tabulated in Table3 and the graphical representation of the same are given in Fig 6,7,8,9 and 10 respectively.

Table 3: Average Throughput (bits per second) of data dissemination approaches

Transmission time (seconds)	Data dissemination approaches									
	Data scavenging approach					EHCD approach				
	4N	10N	50N	75N	113N	4N	10N	50N	75N	113N
60	8055	7236	5734	4915	4096	9284	8738	7645	7099	6553
120	4505	4232	3686	3345	2594	5120	4846	4437	4164	3686
180	3367	3231	2821	2548	2139	3822	3640	3322	3094	2776
240	2867	2730	2457	2218	2048	3140	2935	2696	2525	2389
300	2457	2348	2129	1911	1747	2676	2512	2348	2157	2048

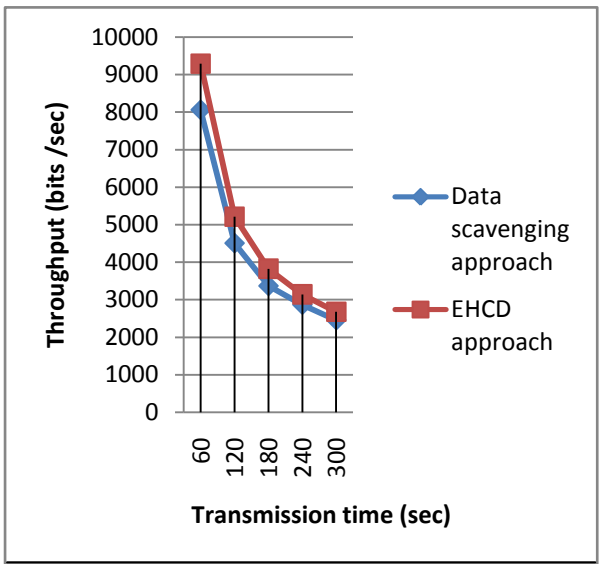

Fig 6: Average Throughput for 4 Nodes

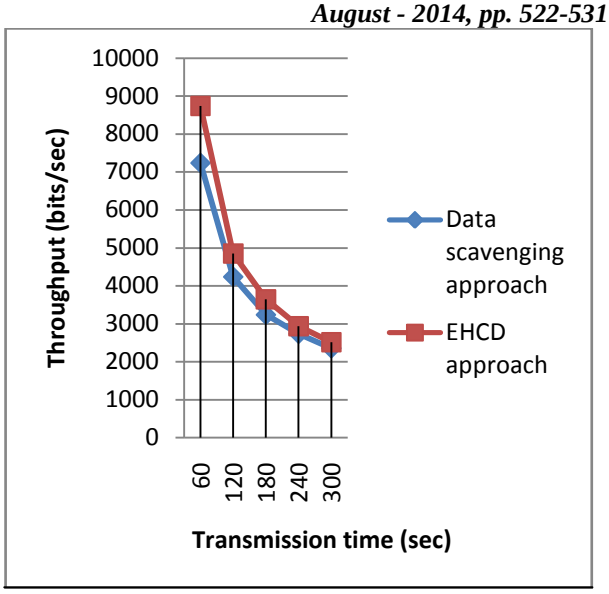

Fig 7: Average Throughput for 10 Nodes

From the simulation results, it is noted that the high throughput is achieved by data scavenging approach for 4 vehicle nodes in 60 seconds and reduces when the time increases. This result also reflects the same when number of vehicle nodes increased like 10, 50, 75 and 113. Effective Hasten Content Dissemination (EHCD) Approach also produces similar results but achieves high throughput compared to data scavenging approach. In Infostation based VANET, the approach which earns the maximum throughput values is considered as efficient data dissemination approach. Hence, proposed EHCD Algorithm shows better performance than data scavenging approach with respect to throughput.

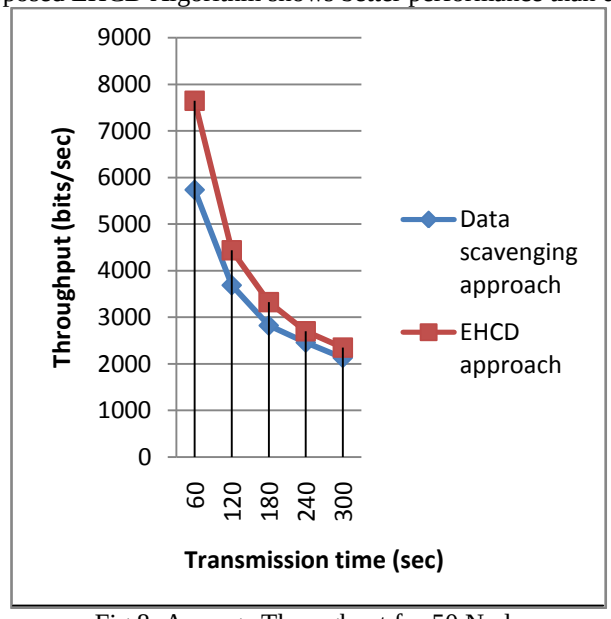

Fig 8: Average Throughput for 50 Nodes

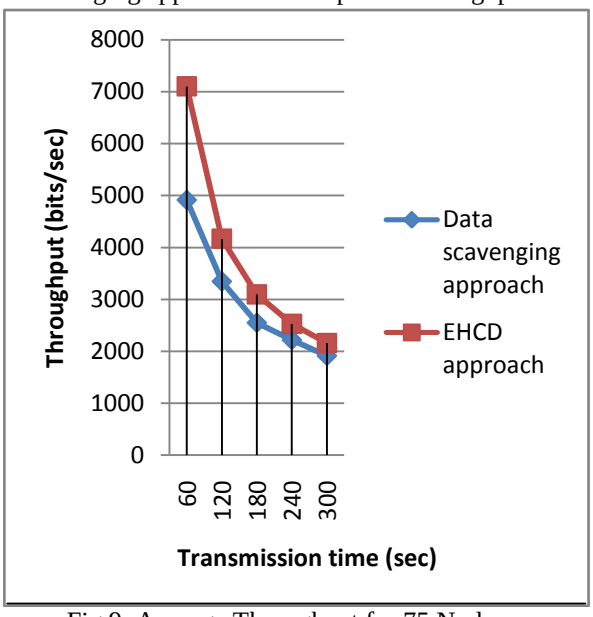

Fig 9: Average Throughput for 75 Nodes

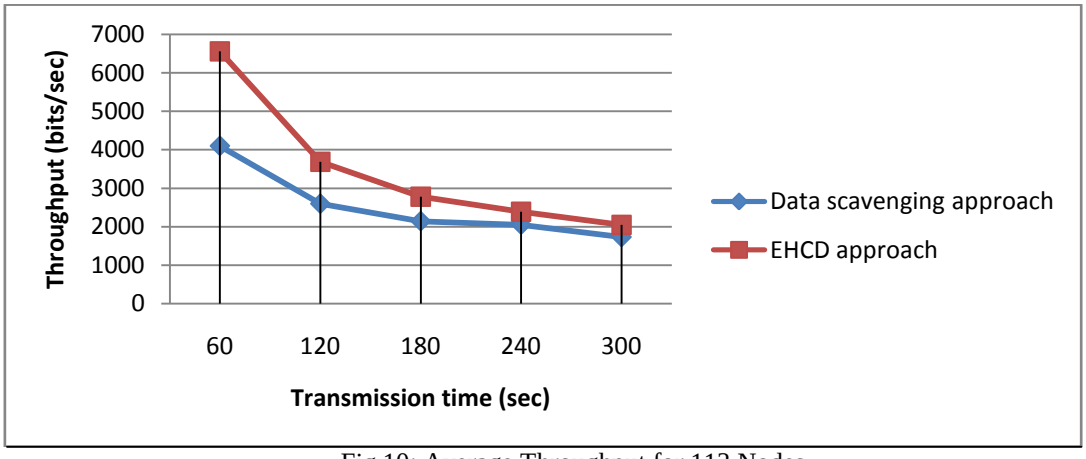

Fig 10: Average Throughput for 113 Nodes

Packet delivery ratio is the ratio between sum of total number of packets received by vehicles and sum of total number of packets sent by Infostation. It measures the data loss rate of the data dissemination approaches and also used to determine efficiency, completeness and correctness of the approaches used in Infostation. The packets delivery ratio of each data dissemination approach for various nodes in varying time are projected in table 4 and the diagrammatic representation of the same also given in Fig 11,12,13,14, and 15 respectively.

Table 4: Average packet delivery ratio (%) of data dissemination approaches

Transmission time (seconds)	Data dissemination approaches									
	Data scavenging approach					EHCD approach				
	4N	10N	50N	75N	113N	4N	10N	50N	75N	113N
60	59	53	42	36	30	68	64	56	52	48
120	66	62	54	49	38	75	71	65	61	54
180	74	71	62	56	47	84	80	73	68	61
240	84	80	72	65	60	92	86	79	74	70
300	90	86	78	70	64	98	92	86	79	75

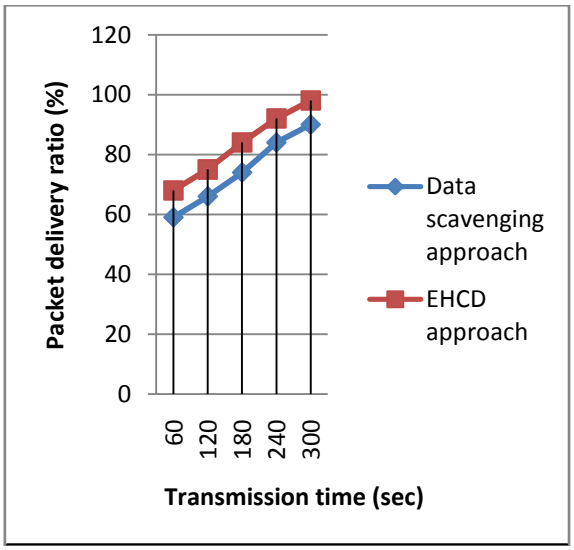

Fig 11: Average Packet Delivery Ratio for 4 nodes

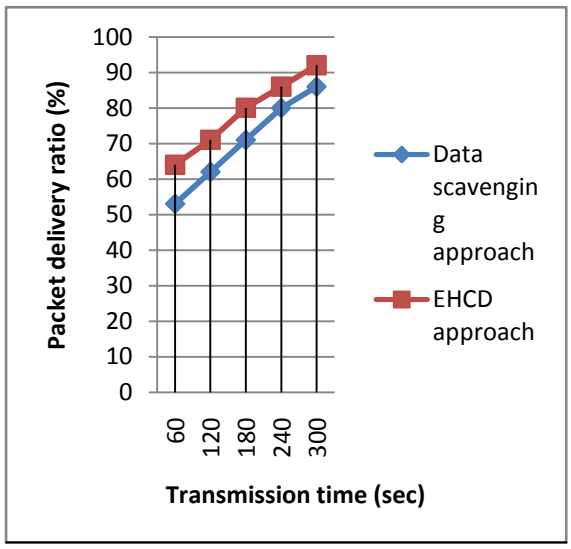

Fig 12: Average Packet delivery ratio for 10 nodes

The simulation results clearly show that Packet Delivery Ratio value will be low in transmission time by 60 seconds. Packet Delivery Ratio (PDR) values are increased while the transmission time increases from 60 seconds to 300 seconds for both data scavenging approach and EHCD approaches. But the same is decreased when the vehicle nodes are increased from 10 to 113. The approach which yields high Packet Delivery Ratio is considered as better data dissemination approach. While comparing data scavenging approach with Effective Hasten Content Dissemination (EHCD) approach, EHCD yields highest Packet Delivery Ratio. From this study, reliability of EHCD algorithm is greater than data scavenging approach for different number of node and it is noted that EHCD approach is the efficient data dissemination approach.

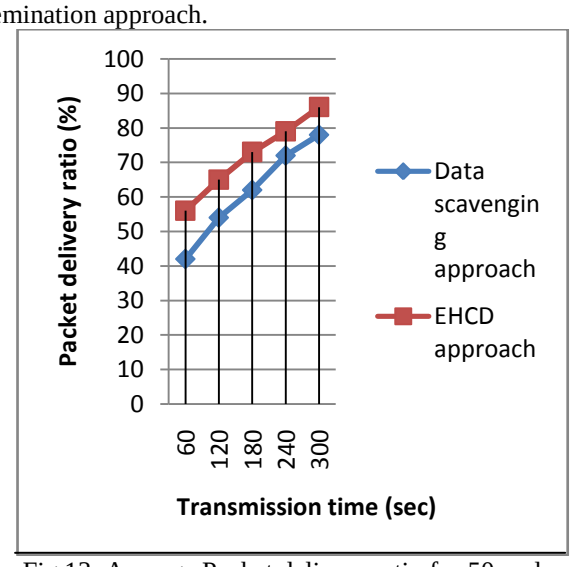

Fig 13: Average Packet delivery ratio for 50 nodes

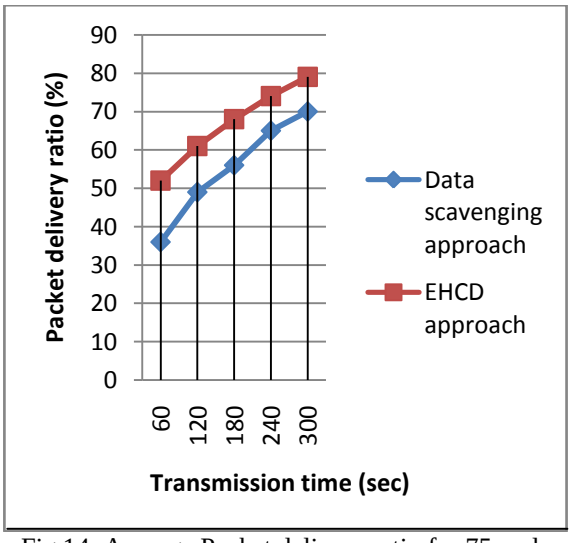

Fig 14: Average Packet delivery ratio for 75 nodes

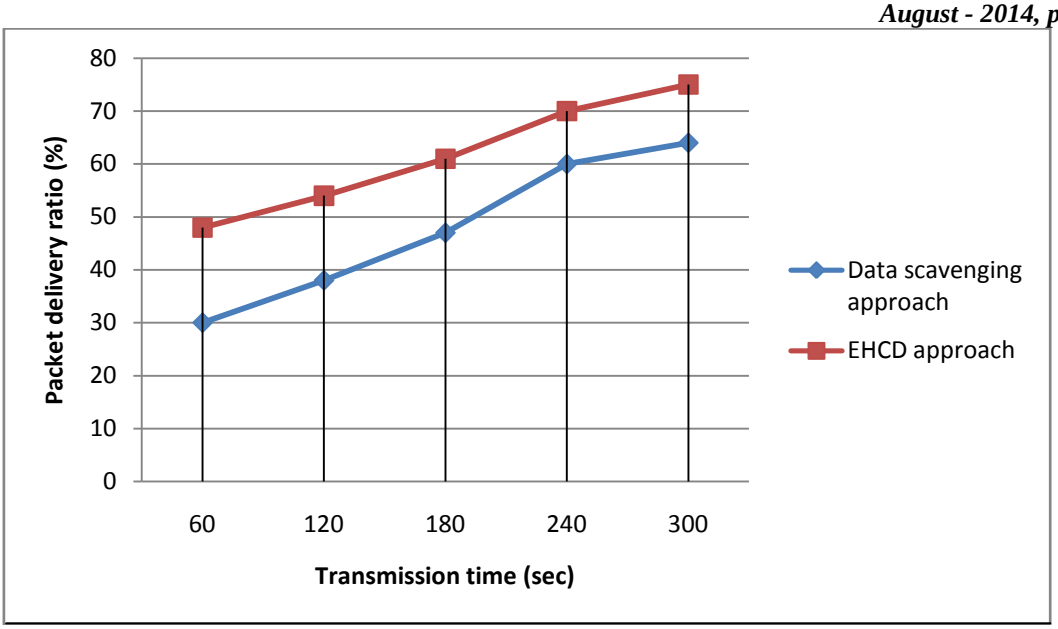

Fig 15: Average Packet delivery ratio for 113 nodes

Packet Lost Rate (PLR) is the difference between number of sent packets and received packets by the infostation and vehicles respectively. It is used to know how many packets are lost during the transmission, and it also helps to analyze the data dissemination methods. The average PLR of data scavenging and EHCD for 4, 10, 50, 75, 113 vehicle nodes in different transmission times 60s, 120s, 180s, 240s, and 300s are shown in Table 5 and the same are flashed in Fig 16, 17, 18, 19, and 20 respectively to show the effect of various data dissemination approaches.

Table 5: Average packet lost rate (%) of data dissemination approaches

Transmission time (seconds)	Data dissemination approaches									
	Data scavenging approach					EHCD approach				
	4N	10N	50N	75N	113N	4N	10N	50N	75N	113N
60	41	47	58	64	70	32	36	44	48	52
120	34	38	46	57	62	25	29	35	39	46
180	26	29	38	44	53	16	20	27	32	39
240	16	20	28	35	40	8	14	21	26	30
300	10	14	22	30	36	2	8	14	21	25

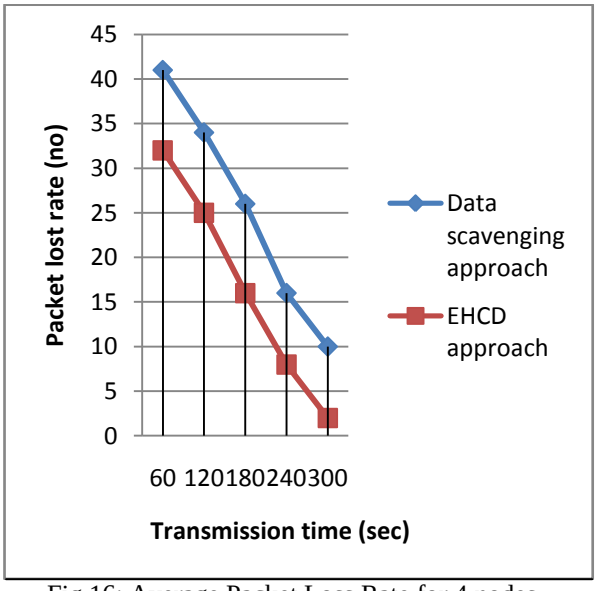

Fig 16: Average Packet Loss Rate for 4 nodes

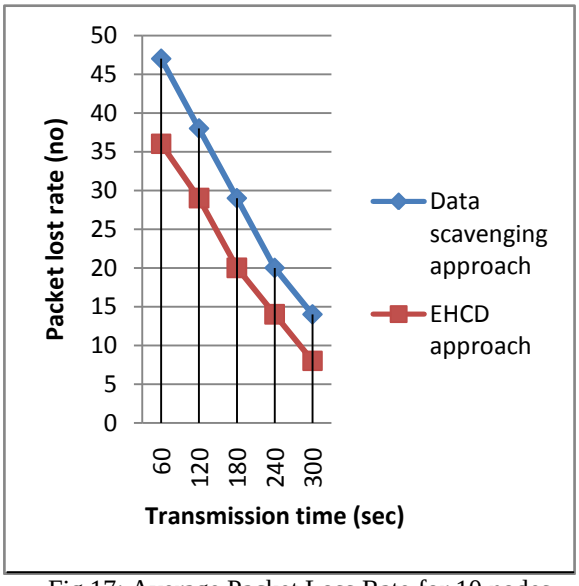

Fig 17: Average Packet Loss Rate for 10 nodes

According to the simulation results, initially the packet lost rate value of data scavenging protocol at 4 vehicle nodes is high in 60 seconds and get reduced when transmission time increases from 60 seconds to 120 seconds, 180 seconds, 240 seconds and 300 seconds respectively. The same result also reflects for different vehicle nodes 10, 50, 75, and 113. The packet lost rate of EHCD is low compared to data scavenging approach. The approach which has the low packet lost rate values in high time interval is considered as efficient data dissemination approach. Hence, EHCD Algorithm shows better performance than data scavenging approach with respect to average node packet lost rate.

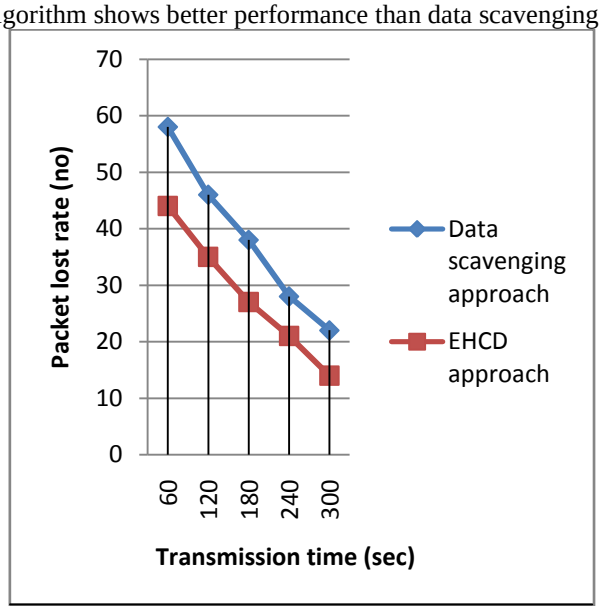

Fig 18: Average Packet Loss Rate for 50 nodes

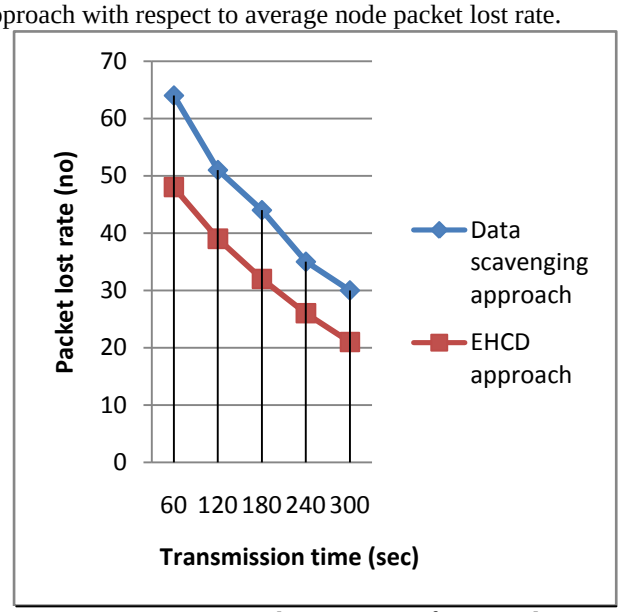

Fig 19: Average Packet Loss Rate for 75 nodes

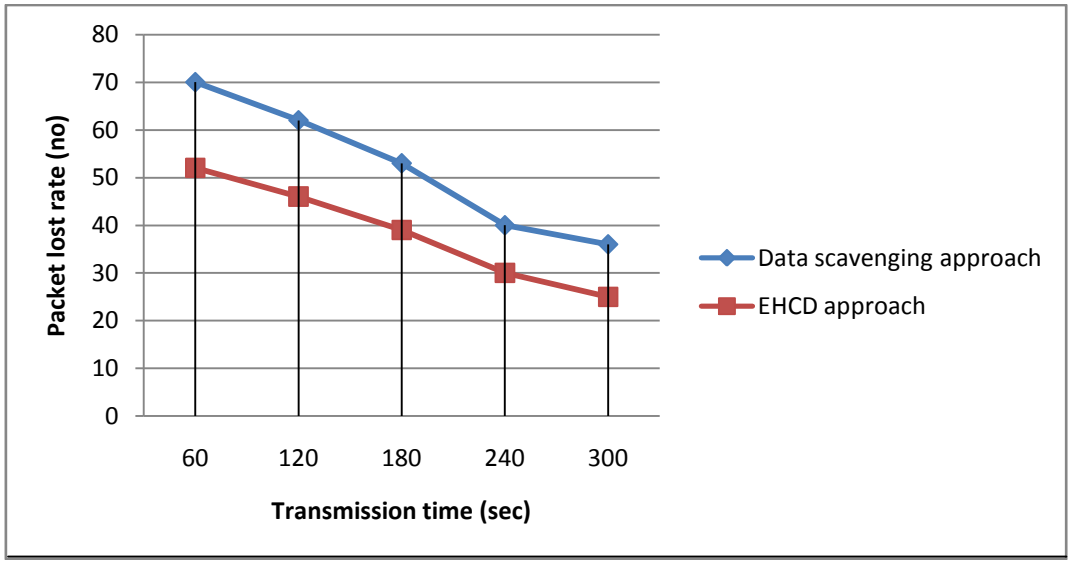

Fig 20: Average Packet Loss Rate for 113 nodes

From the experimental results and discussion, results revealed that the proposed Effective Hasten Content Dissemination (EHCD) approach is the better data dissemination approach when compared with data scavenging approach since it provides high throughput, high Packet Delivery Ratio, and low Packet Lost Rate.

VI. CONCLUSION AND FUTURE CONSIDERATIONS

The performance of data dissemination approaches such as data scavenging protocol and Effective Hasten Content Dissemination (EHCD) Algorithms are analyzed in broadcast Infostations using NS-2 simulator. Results revealed that the proposed Effective Hasten Content Dissemination Approach provides better results for efficient data dissemination from roadside content delivery systems to vehicles in Infrastructure to Vehicle (I2V) communication by improving the delivery ratio, reducing the unwanted neighboring forward nodes, providing direct authority for Infostations compared to existing approach data scavenging. The proposed approach is very useful to vehicles for accessing location aware information like shopping mall maps and petrol punks etc. In future, researchers may concentrate on data dissemination approaches to facilitate high throughput, high Packet Delivery Ratio (PDR) and low Packet Lost Rate (PLR) even though complex scenarios will occur in Infostation Networks such as increased transmission time and more vehicle density.

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