ZIF-Zone Centric Interest Forwarding Strategy In NDN Based Vehicular Adhoc Networks

S.Padmadevi, Dr.K.Dhanalakshmi

Abstract: Named Data Networking (NDN) is termed as future internet where content is retrieved based on the name not with the IP address. Even though NDN has lot of merits, it suffers a lot during interest forwarding. In highly dynamic VANET environment, VANET cannot use Forwarding information Base (FIB) of NDN to forward the packet. Therefore it uses simple flooding mechanism to forward the interest which may result in broadcast storm problem. To mitigate the storm problem, we propose a zone based forwarding strategy where forwarders are selected only within the required zone. It controls the flooding outside the required zone. Our result shows that ZIF gives better results than other forwarding strategies RUFS and DADT.

Index Terms: Named data networking, Content centric networking, Flooding, Broadcast storm problem, Interest forwarding strategy, Location based forwarding, Zone based forwarding, geographic forwarding, Forwarder selection, Content retrieval.

1. INTRODUCTION

VANET is emerging area of research in wireless networks. It forms as a basic infrastructure for building intelligent transportation system (ITS) for smart cities. Vehicular Ad hoc network (VANET) is an ad hoc network where network is established between the moving automobiles in the road side which is depicted in Fig.1. It plays a key role in improving comfort, safety and efficiency of the transportation system. One of the main application of ITS is dissemination of timely and critical information to drivers. It can be either traffic related information like traffic conditions, parking areas, safety, accident , weather conditions or entertaining information like advertisements local to that area so that driver can find nearby restaurants, theatres, petrol stations or hospitals. Several content delivery techniques has been proposed using existing TCP/IP implementations [1-3] but it will not work effectively in highly dynamic environment and in the low traffic areas. This is mainly due to poor or intermittent connectivity. Also all TCP/IP based content delivery techniques focuses on IP addressing schemes. In highly dynamic VANET it is very difficult to assign a unique IP address for each vehicle. Even after using the IP addressing scheme it is very difficult to locate a vehicle until it comes under searching node's transmission range. Named Data Networking (or) Content centric networking is recently proposed approach for future internet [4]. Here instead of giving a request to a server using IP address of the server, an Interest packet is sent by the requester in the network. When it reaches the provider, it checks whether the interest packet matches with the data in it. If the request matches, it replies with data packet through the path from which interest packet has been forwarded. If any intermediate node that receives the interest packet has matching data packet in it, it can also reply.

- *S.Padma devi, Assistant Professor, Department Of Computer Science and Engineering ,Velammal College of Engineering and technology. Madurai,TamilNadu, India., Email: paddevima@gmail.com*
- *Dr.K.Dhanalakshmi Professor, Department of Computer Science and Engineering PSNA College of Engineering and Technology, Dindigul, TamilNadu, India , Email: dhanalakshmikrs@gmail.com*

1.1 NDN Architecture

In Today's network IP plays a major role. It was designed mainly for communication between endpoints but overwhelmingly used for content distribution. Internet architecture is poorly designed to match our current needs. Here for every node in the network a unique identifier is assigned which is hierarchically structured. The main aim of this design is to locate the node easily which results in faster communication. A simple change to this model by adding name to the content and searching the content based on the name make the work easier. It creates a lot of new opportunities

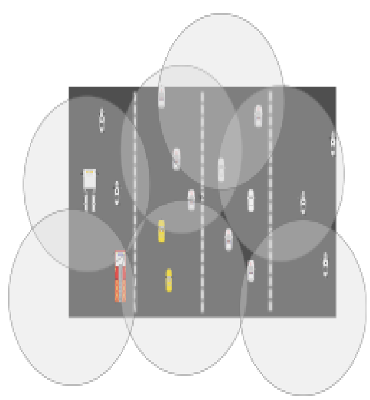

***Figure 1 :** A VANET Scenario*

Here applications are written in terms of information rather than where they are located.

- In NDN all the data is secured end to end. NDN can concentrate on providing security to the data rather than checking authentication of the entities.
- Here every chunk of data can be uniquely named, loops can be prevented using the memory already provided at the router.

To receive data, a consumer sends out interest packet which carries the name that identifies the desired data. A router remembers the interface from which the request comes in and the forwards the interest packet by looking up the name in its forwarding information base (FIB) which is populated by name-based routing protocol. Once the interest reaches a node that has requested data, a data packet is sent back which carries both the name and content of the data together with the signature by the producer's key. Data packet traces in reverse the path created by the interest packet back to the consumer.NDN routers keep both interest and data for some period of time. When multiple interest for the same data are received from downstream, only the first interest is sent upstream towards the data source. The router then stores the interest in pending interest table (PIT) where each entry contains the name of the interest and set of its interfaces from which the matching interest has been received.

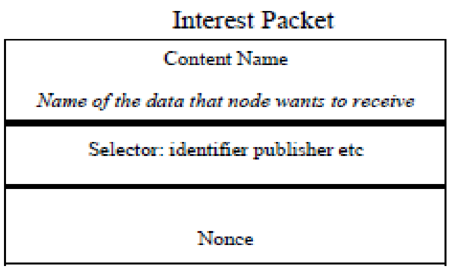

FIGURE 2 *STRUCTURE OF INTEREST PACKET*

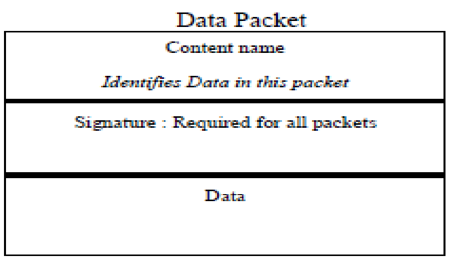

FIGURE 3*: STRUCTURE OF DATA PACKET*

1.1.1 Names:
NDN names are hierarchical in nature. It is very helpful to indicate the relationship among the data for eg., docs/userA/pics/img1.jpg [4,5] retrieve dynamically generated data, consumer must be able to generate desired name using any deterministic algorithm without knowing about the previous data or name. Consumers can retrieve data based on partial names. Still designing a naming convention is a biggest challenge.

1.1.2 Data Centric Security:
Each piece of data is signed together with its name, securely binding them. Signature along with data publisher information allow consumer to trust the data decoupled from how and where the data is obtained. Secure binding of names to data provides basis for defining various trust model.

1.1.3 Routing and forwarding:
NDN packets are routed and forwarded based on the names not on the IP addresses which remove the address exhaustion problem since the namespace is unbounded. NDN router announces the name prefix of the data that it can serve. This announcement is propagated using a routing protocol. Every router build its FIB based on this announcement. But the unbounded name space creates a problem of how to keep the routing table size scalable one.

1.2 Our Contribution
- Our Proposed work mainly concentrates on a simple and efficient interest forwarding strategy in NDN based VANETs.
- It addresses the broadcast storm problem by selecting single forwarder in the direction it needs the content.
- Our scheme is scalable and it is suitable for high density and highly dynamic environment.
- It reduces the latency of packet transfer by minimizing the data structures that NDN uses.
- It controls the flooding interest packet by restricting the flow only within the zone

1.3 Organisation of Paper
In the section 2 we discuss the existing works related to interest forwarding strategies in Named VANETs. In section 3 we propose simple and efficient zone based interest forwarding strategy. In section 4 we evaluate the performance of our proposed work by comparing it against other forwarding techniques and analyzing their results. We conclude the paper in section 5.

2 RELATED WORKS
In NDN based VANET an interest which carries the name of the content is propagated from the consumer. When the interest packet reaches the producer or the intermediate vehicle which caches the content, the data is sent back through the path from which interest packet is received. Our work mainly concentrates on interest forwarding strategy in NDN based Vehicular networks. Vehicular Ad hoc networks are highly dynamic in nature. When the interest packet is flooded in such networks, it may result in broadcast storm problem. To mitigate such problems, several forwarding strategies have been proposed. Geo based forwarding techniques use position information such as latitude and longitude for interest forwarding. Nodes within that geographical zone will greedily forward the packet towards the producer.[6-9] On-demand forwarder selection techniques are used in VANET, since it is very difficult to identify a complete forwarding path before sending the packet. At each node next forwarder is selected based on multiple criteria.[10-12] Store and carry techniques are used in highly disconnected scenarios, here it is very difficult to select the next forwarder. So packets are carried until next forwarder can be chosen.[13]

The main challenges faced in interest forwarding techniques are
- It is very difficult to identify the content producer's location. Hence it becomes critical to decide in which direction the packet has to be routed.
- When the interest packet is sent out without any information about the producer's location the simple technique that can be followed is flooding. This result in broadcast storm problem which may reduce the efficiency of the network and it will lead to packet loss.

3 PROPOSED SYSTEM
Vehicular applications are mostly related to specific areas. They need data specific to particular area. So instead of searching for particular location of the producer, vehicle can

inform about its current location and the range of the area from which it has to acquire the data. For example, a smart city application like smart parking system if a vehicle need a parking space , it may give its interest like /Consumer location/Content zone/Content name/. Vehicles need information from the forwarding direction only, so it may direct or select the forwarder based on the forwarding direction In order to mitigate the broadcast storm problem, flooding of interest packet has to be controlled. In our work, to control flooding we are restricting the area in which interest packet has to be forwarded. So we are using zone based approach, where zone is created based on the range of the area from which a vehicle needs a particular content. Zone is created in a semi-circle format in the forwarding direction using vehicle's current locationIf a vehicle is assumed to be in x-y coordinate system, where r is the range from vehicle needs the content and r covers the set of coordinates (x,y) then the zone can be created using the formula

$$y = \sqrt{r^2 - (x-a)^2} + b$$

3.1 Forwarder Selection

Forwarder node is selected based on on-demand approach using the neighborhood information. Every node will maintain two tables neighbor table and forwarder table. All the vehicles will be send hello messages at a periodic interval to collect the information about the neighbors. Neighbors (i.e) vehicles that are in the transmission range of a particular vehicle will reply with current location (longitude, latitude). These information are stored in the neighbor table. Vehicles that are at the farthest distance and in forward direction are selected as forwarding nodes for a particular interest and stored in the forwarder table. Interest is sent only to the selected forwarder not to other neighbors. When the interest has been received by the forwarder, it is added to the pending interest table. Data packets are sent back in reverse path that is created while forwarding the interest.

```
Algorithm 1: Select_Forwarder(interest)
consumer_location=extractcurrent_location (consumer)
Interest_zone=constructzone(consumer_location, range)
    Forwarder[]=select forwarder(neighbor[])
    For each forwarder in forwarder[]
            If(position of forwarder is inside Interest_zone)
                Forward(interest)
            Else
                Drop(interest)
        endif
    endfor
```

```
Algorithm2: ConstructZone(consumer_location,range)
    a,b=current coordinates of consumer location
    r= range with in which consumer need the content
    for x varies from –r to +r
        y=Sqrt(r^2+(x-a)^2)+b
        plot(x,y)
    end for
```

```
Algorithm3: selectForwarder(neighbour[])
T=transmission range of vehicle V
    for each neighbor in neighbor[] of V
        if angle(neighbor) ranges from 0 t0180 and distance =T
            Add neighbor to the forwarder table
        endif
    endfor
```

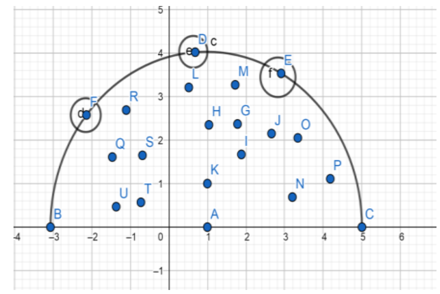

***Figure4 :** Zone Creation and forwarder selection of node A in ZIF*

4 PERFORMANCE EVALUATION

In this section we study the performance of the proposed forwarding strategy including simulation parameters and metrics that are used in evaluation and comparison of performance with other strategies.

4.1 Simulation Parameters

We implement the proposed work in an NS-3 based open source simulator ndnSIM[14]. To generate vehicle mobility trace in an urban traffic environment, we used SUMO which uses a map of manhattan like grid with a length of 600m, covering a total area of 1.5km×1.5km. For each road, there are two lanes one in each direction where the vehicles travel at a spped of 40km/h. The transmission range of vehicle is 150m.Two stand-alone RSU are established at each side of the lane which act as content provider. Interest packets will come from the random position at a series of interval of 4s. Every vehicle send HELLO messages of mean frequency 1Hz at random instances to avoid collision. The number of consumer nodes varies from 50 to 100.

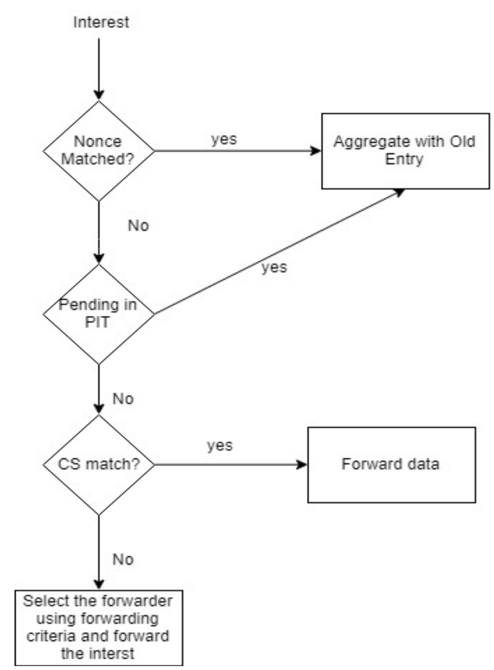

Figure 5 : *Interest forwarding in ZIF*

Table1 : *Simulation Parameters*

Parameter	Value
Simulation time	300s
Simulation area	1.5km×1.5Km
Transmission range	150m
Stand-alone RSUs	2
No.of Vehicles	100-500
MAC/PHY protocol	802.11a
Velocity of Vehicle	40Km/h
Cache Capacity	10,000KB
Cache Replacement policy	LRU
Distance of the consumer to original producer	1 to 5 Km

4.2 Performance Metrics

We have run the simulation 25 times for the number of nodes that varies from 100 to500. Here three metrics are used to evaluate the performance of proposed work

- Total No.of Interest packets used – Number of interest packets that need to be transmitted so that all consumers receive the content.
- Content delivery latency – Time duration from sending the request till the reply received by the consumer
- Hop count for content reply – Number of hops required to send the reply from original producer to consumer.

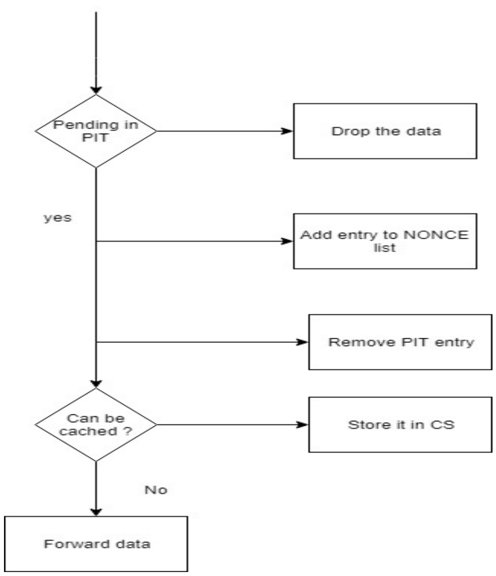

Figure 6: *Data forwarding in ZIF*

We compared ZIF against 2 different strategies

RUFS – A mechanism proposed by Ahmed et al where it uses multiple criteria to select the forwarder such as recently satisfied list (RSL), closer to the provider of the content (Min no of hops), minimum relevant velocity to ensure maximum connectivity and highest ISR. DADT – This method aims to improve the packet delivery ratio while trying to keep the transmission overhead low. It defers the rebroadcast of interest until a forwarder closer to the producer has been identified.

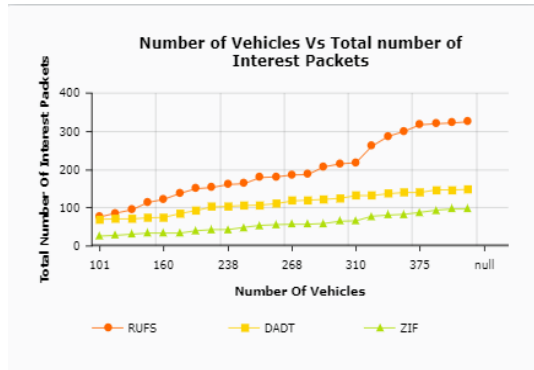

Figure 7: *Total Number of Interest packets*

Number of interest packets:

Figure 7 shows the performance comparison of ZIF with RUFS and DADT in terms of total number of interest packets that are required to forward the interest between the consumer and producer. Both RUFS and DADT does not flood the interest. RUFS select a forwarder based on multiple criteria and DADT defers the interest forwarding until a suitable node is selected. In our proposed work ZIF selects the farthest forwarder in the direction it needs the content. Our Results shows that ZIF works 70% better than RUFS and 34% better than DADT.

Latency:

Time required for the content to reach the consumer from the producer is also an important criterion for the content to be delivered correctly and also on time. Figure 8 show that ZIF works 50% better than RUFS and 29% better than DADT.

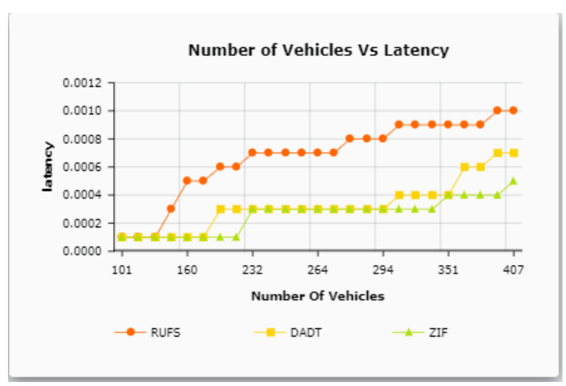

Figure 8: *Latency*

Hop Count:

Number of hops that is required for the content to reach the consumer from the producer have larger impact on the latency. Figure 9 shows that number of hops required by ZIF is 69% lesser than RUFS and 50% lesser than DADT.

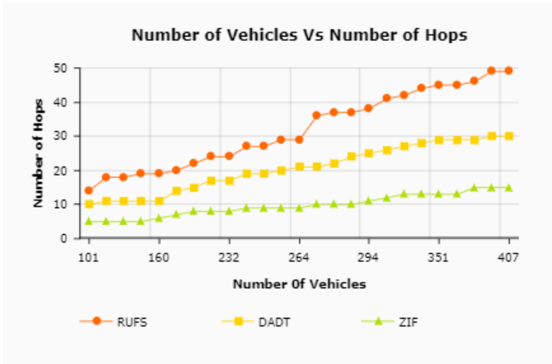

***Figure 9** : Hop Count*

5 CONCLUSION

The main aim of ZIF is to mitigate the flooding of interest packets. ZIF have simple structure compared to other strategies, because introducing new data structures may increase the latency. To reduce the latency, ZIF selects only forwarders in the direction, it requires the contents. Since the interest flow is restricted with in a zone, interest packet may not flow uncontrollably if the required content is not found. Our result shows that ZIF works better than other forwarding strategies.

REFERENCES

[1] Shen,X., Cheng,X., Yang,L., Zhang,R., and Jiao., “Data Dissemination in VANETs: A Scheduling Approach”, 2014, IEEE Transactions on Intelligent Transportation Systems Vol.15, pp .2213–2223.

[2] Tiennoy,S and Saivichit,C., ``Data dissemination protocol for VANET by utilizing distributed roadside traffic information processing node,'' in Proc. 8th Int. Conf. Elect. Eng. Electron., Comput., Telecommun. Inf. Technol.,Khon Kaen, Thailand, May 2011 pp. 413-416

[3] Wu,H., Fujimoto,R., Guensler,R., and M. Hunter. ,``MDDV: A mobility- centric data dissemination algorithm for vehicular networks'', in Proc. ACM Int.Workshop Veh. Ad Hoc Netw,Philadelphia, PA, USA, OCT 2004, pp. 47-56.

[4] Zhang,L et al., “Named data networking (NDN) project,” 2010, Xerox Palo Alto Res. Center, PARC, Palo Alto, CA, USA, Relatòrio Técnico NDN-0001, Tech. Report (Accessed Oct31, 2010)

[5] Pesavento,D., Grassi.G., Palazzi,C and Pau, G “A naming scheme to represent geographic areas in NDN,” in Proc. IFIP/IEEE Wireless Days, 2013, pp. 1–3.

[6] Amadeo, M., Campolo, C., and Molinaro, A., ``CRoWN: Content-centric networking in vehicular ad hoc networks,'' 2012, IEEE Commun. Lett., vol. 16, no. 9, pp. 1380-1383.

[7] Coutinho,R W L., Boukerche, A., and Yu, X., “A Novel Location-Based Content Distribution Protocol for Vehicular Named-Data Networks.”, In Proc. Of the IEEE Symposium on Computers and Communications (ISCC), 2018.

[8] Grassi,G., Pesavento, D., Pau, G., Zhang, L., and Fdida, S., “Navigo: Interest forwarding by geolocations in vehicular Named Data Networking”. In Proc. Of IEEE 16th International Symposium on a World of Wireless, Mobile and Multimedia Networks 2015, (WoWMoM). 1–10.

[9] Yu, X., Coutinho,R W L., Boukerche , A., and Loureirol, A A F., “A distance based interest forwarding protocol for vehicular information-centric network”, In Proc/ of the IEEE 28th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC). 2017, 1–5

[10] Bian ,C., Zhao, T., Li, X., and Yan, W.,“Boosting named data networking for data dissemination in urban VANET scenarios”, 2015, Vehicular Communications, Vol.2, No.4, pp.195–207.

[11] Ahmed,S H., Bouk, S H and Kim,D., ``RUFS: RobUst forwarder selection in vehicular content-centric networks,'' 2015, IEEE Commun. Lett., vol. 19, no. 9, pp. 1616-1619

[12] Ahmed, S., Bouk,S., Yaqub,M., Kim, D., Song, H., Lloret, J.,” CODIE: Controlled Data and Interest Evaluation in Vehicular Named Data Networks”, 2016, IEEE Transactions on Vehicular Technology, vol.65, No.6,pp.3954-3963.

[13] Kuai, M., Hong, X., Flores, R R.,“Evaluating Interest Broadcast in Vehicular Named Data Networking”, 2014, Research and Educational Experiment Workshop, Third GENI. IEEE, pp.:77-78

Afanasyev,A., Moiseenko,I and Zhang,L.,``ndnSIM: NDN simulator for NS-3,'' 2012, NSF's Future Internet Archit. Program, Tech. Rep. NDN-0005.