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IMPROVED PROTOCOL FOR OPPORTUNISTIC FORWARDING IN URBAN TRAFFIC

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Abstract— **In opportunistic networks the existence of a simultaneous path between a sender and a receiver is not assumed. Routing in opportunistic networks is usually based on some form of controlled flooding. But often it results in very high resource consumption and network congestion. In this paper we advocate an improved protocol that exploits the city traffic to send packets by mechanical forwarding (data mulling) and by bypassing the city infrastructure for managing and using context for taking forwarding decisions. This protocol significantly reduces the message loss rate and preserves the performance in terms of message delay.**

Index Terms— **opportunistic networks, protocol, data mulling**

I. Introduction

Opportunistic dissemination protocols have potentially applications in the domain of vehicular networking, ranging from advertising to emergency/traffic/parking information spreading: one of the characteristics of vehicular networks is that they are often partitioned due to lack of continuity in connectivity among cars or limited coverage of infestations in remote areas. Most available opportunistic, or delay tolerant, networking protocols, however, fail to take into account the peculiarities of vehicular networks. This paper introduces a novel opportunistic event dissemination protocol for vehicular networks. The improved protocol takes into account the characteristics of these networks in order to dispatch the publications to the subscribers.

Vehicular networks are hybrid mobile ad-hoc networks where access points (collection and dissemination points, from where information from the backbone network can flow towards the vehicles and information from remote vehicles can reach the backbone) and vehicles are present. Vehicles inter-network with each others, disseminating messages further in remote areas where there is poor or no coverage. There are a growing number of applications for vehicular networks that require disseminating information around specific geographical areas. For example, a driver might require to receive available parking spaces around his current location (in real-time). Or, to be able to monitor traffic conditions along his/her suggested route: In case of traffic jam the navigation system may automatically calculate an alternative route to the driver's destination. In this paper we propose an approach which allows for message dissemination to specific receiver in an area. The use of an opportunistic networking approach, possibly exploiting geographical information might be preferable. This solution may provide real-time local information to the driver; it may be free of charge and would not require full coverage by access points. Furthermore, we exploit the unique characteristics of vehicular networks like mobility patterns, road topology, map availability and suggested routes to disseminate the notifications more efficiently. Finally, our evaluation shows that periodic broadcasts in a vehicular network are more efficient than epidemic spreading.

The paper is organized as follows: In Section 2 we briefly describe the existing approaches. In Section 3 we present our approach. Section 4 contains packet format and system architecture followed by conclusions and possible future works in Section 5.

II. EXISTING APPROACHES

There is a class of protocols that tend to exploit the social mobility patterns of the carriers for Opportunistic data forwarding called social context based protocols. To the best of our knowledge, there are two protocols that fall in this category:

A. HiBOp [1]

This protocol exploits social mobility patterns, the former uses is a set of information that describes the node profile, and the history of social relationships among nodes. At each node, the information used to build the context can be personal information about the user (e.g. name, residence, workplace, profession). Nodes share their own data during contacts, and thus learn the context they are interested in. HiBOp assumes that each node locally stores an Identity Table (IT) that contains personal information on the user that owns the device. Nodes exchange ITs when getting in touch. At each node, its own IT, and the set of current neighbors' ITs, represents the Current Context, which provides a snapshot of the context the node is currently in.
The second context information in HiBOp is the information of encounter history. Even if a node is not currently a good forwarder because of its current context, it still can be a good forwarder because of its habits and past experiences. Under the assumption that humans are most of the time 'predictable', it is important to collect information about the context data seen by each node in the past, and the recurrence of these data in the node's current context. To this end, each context attribute seen in the current context (i.e. each row in neighbors' ITs) is recorded in a History Table, together with a continuity probability index that represents the probability of encountering that attribute in the future. The main idea of

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HiBOp forwarding is looking for nodes that show an increasing match with the known context attributes of the destination. A high match means a high similarity between node's and destination's contexts and, therefore, a high probability for the node to bring the message in the destination's community (possibly, to the destination). Therefore, a node wishing to send a message through HiBOp specifies (any subset of) the destination's IT in the message header. Any node in the path between the sender and the destination asks encountered nodes for their match with the destination attributes, and hands over the message if an encountered node shows a greater match than its own.

B. *Propicman/SpatioTempo[2]*

SpatioTempo (Nguyen et al., 2008) is derived from Propicman, and also uses context information as node profiles to compute the delivery probability of nodes to destinations. The forwarding process is performed as in Propicman: the sender sends a message header that contains some information about the destination, the two-hop neighbors' compute their own delivery probability based on their matching context information with the

Destination and send the results back to the sender. The sender will select the highest two hop route(s) to forward the message content.

SpatioTempo is the first scheme that takes into account temporal context information. In this scheme, human activities are divided into two main categories: periodic and non-periodic behaviors. The periodic behavior includes activities that happen quite often, as people's activities are repeated periodically. Every morning at a given time, people leave home for their activities (work, school, etc.); perhaps spend some hours working in the office, stop to have lunch/coffee or other recreation activities, and so on. They probably meet a group of people repeatedly at the same places and in the same periods during the day. The nonperiodic behavior groups are all the other activities: for example, when a person goes on holiday this activity is not frequent and not repeated.

Furthermore, the authors consider in depth the social relationship between users. They observe that most people have some frequent contact persons and other occasional contact persons in their social relationships. The occasional contact persons are those that they rarely send messages to, whereas they often send messages to the frequent contact persons. For their frequent contact people, they may have some knowledge of these individuals' periodic behavior. Thus they know when and where to send out messages in order to have a higher delivery probability. Thus in SpatioTempo, they classify two classes of destinations: Frequent destinations and Occasional destinations. Thus exploiting social mobility patterns is of great use to opportunistic data forwarding. The one area where the deduction of mobility pattern is easy is the mobility of city Buses. This protocol uses auxiliary nodes in roadside points (mainly Bus stops) and Buses themselves as the carriers for opportunistic forwarding. The parameters chosen for calculating the delivery probability will be different from the aforementioned protocols.

III. PROPOSED SYSTEM

The MTC survey shows that in metropolitan city like Chennai the average Buses in each of the 820 routes is a Bus every 8 mins at the max.

A. *Actors:*

Auxiliary Node (AN): A Roadside point most commonly a Bus stop.

Carrier/Cluster Head (CH): City Bus

Mobile Node (MN): Every Person Travelling in the Bus.

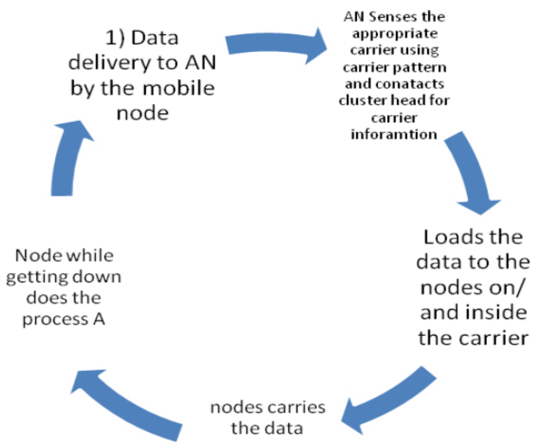
B. *Data Required:*

This protocol requires the auxiliary nodes to know the entire city bus traffic that passes through them and those that are a viable candidate for opportunistic forwarding. This protocol requires the Carriers/Cluster Head to have local information. This protocol requires the Mobile Node to have a check on the routing info of Packets they carry.

C. *Process:*

The decision on which Bus to choose from for data forwarding will be based on the value calculated from the mobile nodes' past delivery history ,deviation from the expected time, sensitivity of the data being forwarded, amount of the data to be transmitted, Type of message (unicast ,multicast etc) The Bus itself will act as a carrier of data and the cluster head and the people inside the Bus will also be used to transfer data. The carrier acting as a cluster head will gather information about the mobile nodes inside them and will maintain a kind of local information about them. The point is that we are very sure about the mobility pattern of the Bus and it seldom never changes. But the person who travels by the bus has no restriction on his movement even Though the observed history of the person shows that the he/she is likely to get down at a particular point.

D. *Process A:*



In case of a person getting down will give a reactive Beacon to the auxiliary node, get the current place and compares that with the packet he has and if any of the packets is not intended for this, the mobile node will send a offload packet to the carrier/cluster head. The cluster head based on the information it has can decide whether the packet can be forwarded in the same bus or will it have to take a stop here. In the former case the packet will be forwarded to another vacant mobile node or in the latter it would be offloaded to the auxiliary node at the Bus stop. The auxiliary node in this case would again start the process. In case if the auxiliary node finds that a direct route (Bus/Carrier) for a packet is not available for a specified period and if it is understood that the data should be transferred as quickly as possible then the auxiliary node will choose an intermediate hop for the packet and sends the packet. While doing so it will wrap the packet with another header having destination address as the intermediate hop and indicating that the original destination is within the wrapped header. The auxiliary node at the receiving end unwraps the packet and continues the forwarding to the intended destination.

A particular process cycle is depicted below. This protocol will not incorporate end to end connectivity (no ACK's from the destination to the sender directly) rather ACK's in between the intermediate hops if necessary.

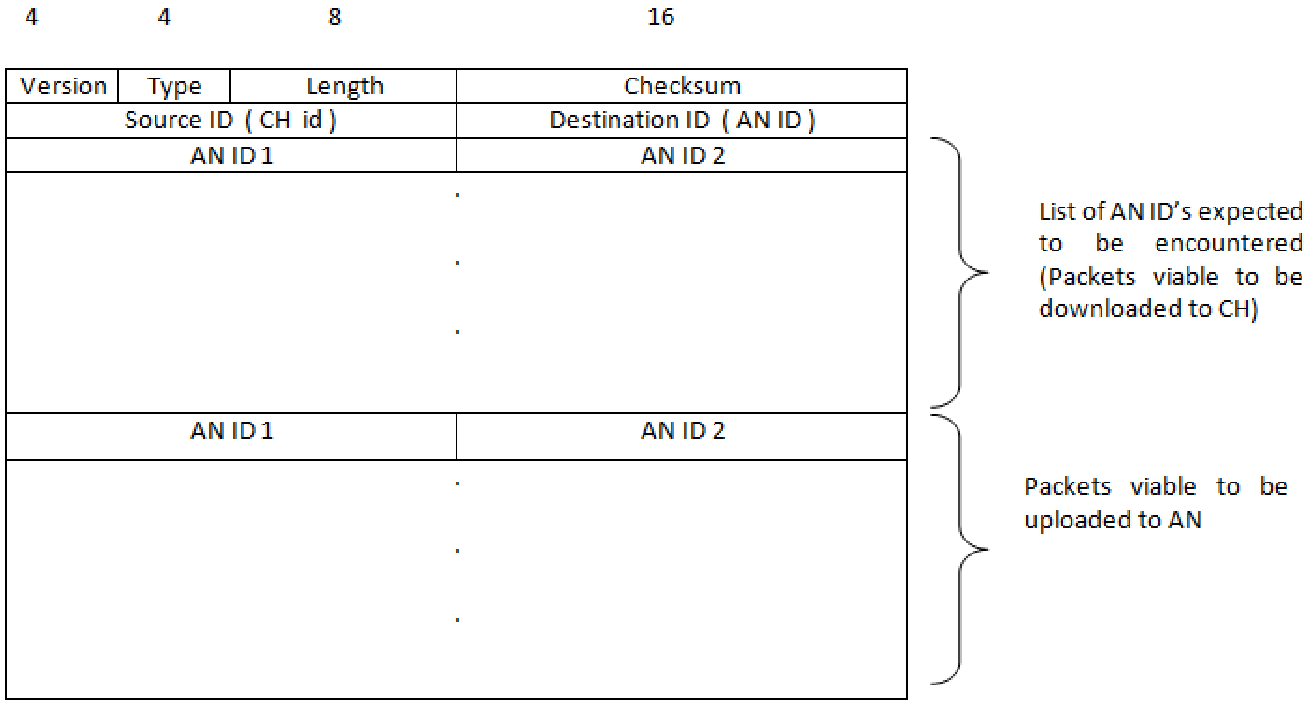
IV. PACKET FORMAT AND PROTOCOL FLOW

AN ←→ CH communication

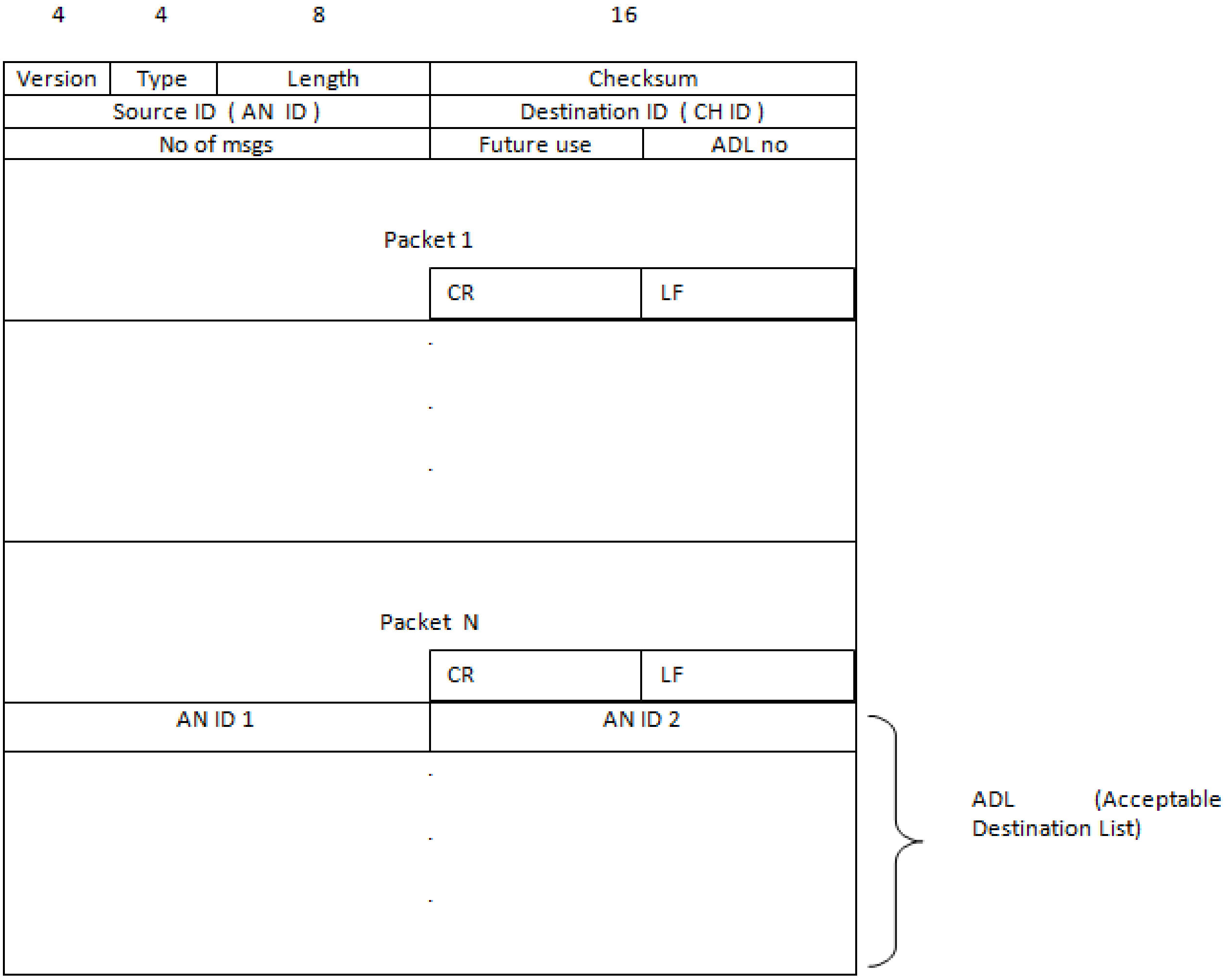
1) AN Beacon frame

4	4	8	16
Version	Type	Future use	Auxiliary node ID

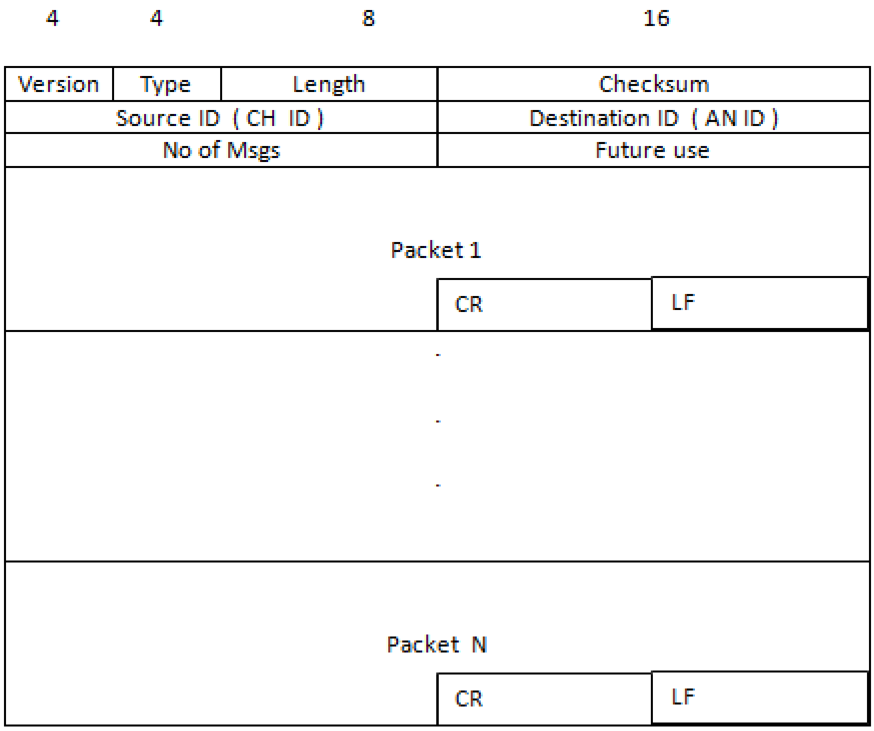
2) CH Association message



3) Data Download Packet:



4) Data Upload Packet:



CH ←→ MN communication

5) CH Beacon frame

4	4	8	16
Version	Type	Future use	CH ID

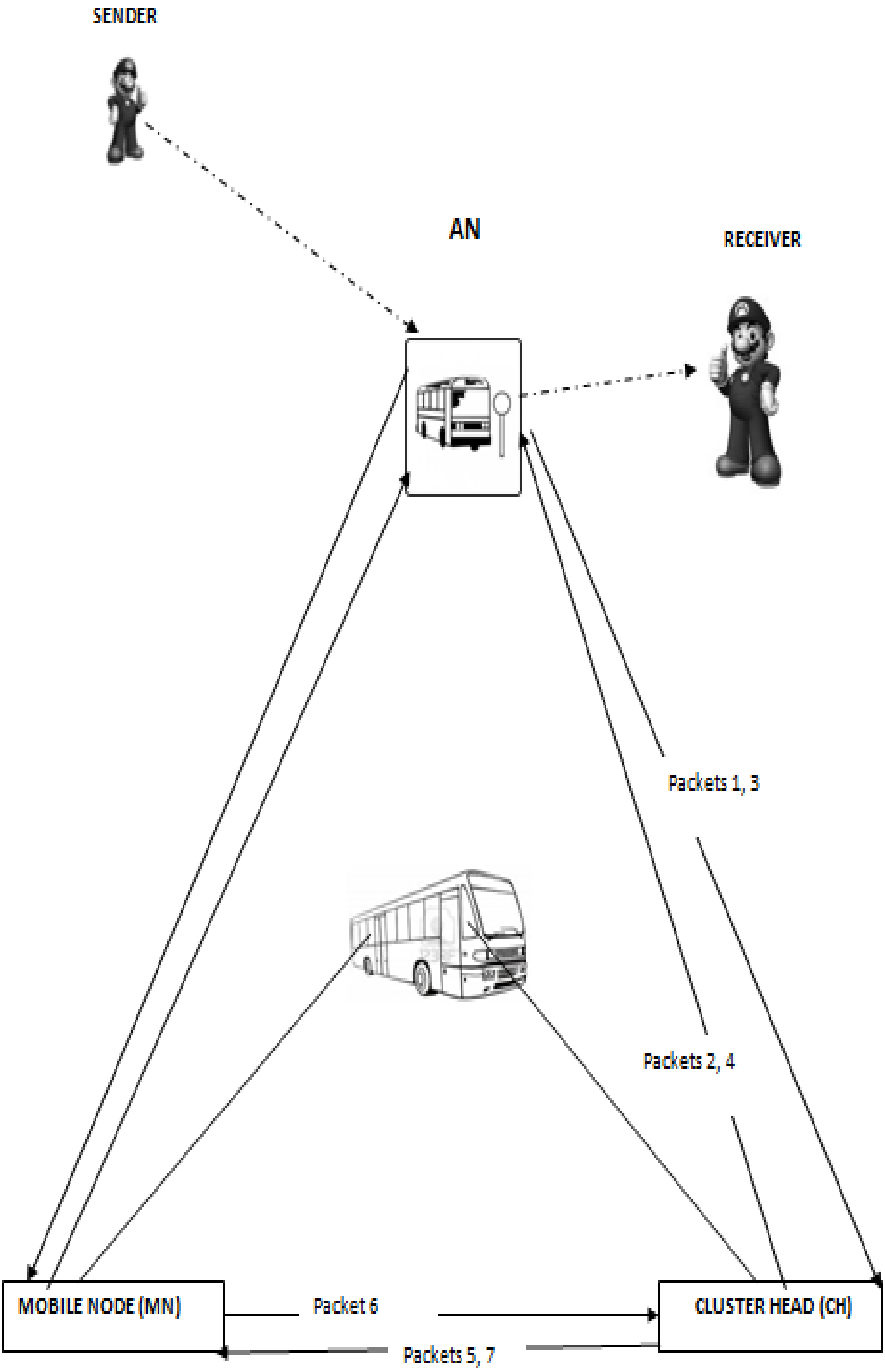
6) MN Response frame

4	4	8	16
Version	Type	Future use	CH ID (Destination ID)
MN MAC Address (Source ID)			
MN MAC Address		Future use	

7) Data Download Packet:

4	4	8	16
Version	Type	Length	Checksum
Source ID (CH ID)		Destination ID (MN MAC)	
Destination ID (MN MAC)			
No of Msgs		Future use	
Packet 1			
		CR	LF
. . .			
Packet N			
		CR	LF

PROTOCOL FLOW


SENDER
AN
RECEIVER
Packets 1, 3
Packets 2, 4
MOBILE NODE (MN)
Packet 6
CLUSTER HEAD (CH)
Packets 5, 7

5. CONCLUSION AND FUTURE WORK

In this paper we have illustrated an opportunistic dissemination system for vehicular networks:
We introduced an advanced approach of communication paradigms to opportunistically disseminate such information in vehicular networks inside a specified geographical location. We took advantage of the information that can be extracted from the vehicle's navigation systems (location, map, destination of the driver etc) to generate paths. We showed that we can take advantage of this observation to efficiently disseminate events only in areas where this is relevant (i.e., in areas where there are hosts that are interested in receiving the notification).

As future work, we would like to extend our evaluation to assess how existing topic aggregation techniques could improve performance further. Furthermore, we did not consider routing the messages to remote areas (for example sending traffic alerts from an access point to be disseminated in a specific geographical region).

6. ACKNOWLEGEMENT

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7. REFERENCES

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