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Vehicular Delay Tolerant Network - A Survey

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Abstract

The Vehicle based Delay Tolerant Networks (VDTNs) are emerging research topics that have attracted keen research efforts from both academia and industry. Delay tolerant networks are characterized by frequent network partitioning, intermittent network connectivity, long and variable delays, and high error rates. The DTN architecture model has been applied for vehicular networks called Vehicular Delay Tolerant Networks (VDTN). Such performance challenging conditions can be found in many different environments such as vehicular networks (VANET), in-the-field military or disaster-rescue networks, terrestrial networks serving remote or rural areas.

The connectivity pattern is unpredictable due to the destruction in communication infrastructures by the natural disaster. Hence in this research it focuses on providing a connectivity infrastructure with Vehicular Delay Tolerant Network (VDTN) robust to disaster effects. The main objective of routing protocols in VDTNs is to maximize the probability of delivery at the destination while minimizing the end-to-end delay.

In this paper an attempt has been made to survey on VDTN having some basic features with new architecture which support a securable routing mechanism for an effective data packets forwarding. This paper also discussed about different types of protocols of vehicular delay tolerant network to support for the establishment of end-to-end connection effectively.

Keywords: Delay Tolerant Network, Vehicular Delay Tolerant Network, Routing Protocol

I.INTRODUCTION

Internet access is usually not available in remote and sparsely populated areas or undeveloped regions. Internet access may also be unavailable due to natural disasters (earthquakes, floods, etc.) or war territories, where network infrastructures are destroyed. The Delay Tolerant Network (DTN) [1] architecture appears as a possible solution to provide communication in such challenged environments characterized by sparse intermittent connectivity, long or variable delays, asymmetric data rates, high loss rates, and with limited expectation in end-to-end connectivity. DTN concept can be extended to vehicular networks, where vehicles are exploited to provide a low cost message relaying service where a telecommunications infrastructure is not available. Vehicular networks have also been proposed to implement transient networks to benefit developing communities and disaster recovery networks [2-4].

The DTN architecture concept was also extended to transit networks, called Vehicular DTN (VDTN). In these networks vehicles (e.g., cars, buses, and boats) are exploited to offer a message relaying service by moving around the network and collecting messages from source nodes.

Vehicle based delay tolerant networks (VDTNs) use vehicles, such as cars, trains and buses, as mobile nodes in delay tolerant networks environment. Compared with the DTNs, VDTNs work in a highly dynamic network topology and short contact [5]. It turns every participating vehicle into a wireless point to provide data dissemination service. In general, each vehicle has capability to connect with other devices in approximately 100 to 300 meters. As vehicle has a large movement range, almost unlimited power supply and capability to carry large and powerful wireless devices, they can be used as data carrier for remote areas, particular for Data Dissemination in Delay Tolerant Networks with Geographic Information those remote rural communities and regions, and provide offloading services for cellular networks.

The case of VDTNs, store-and-forward, or store-carry-and-forward techniques are used [6]. This means that the nodes which receive a message, store it for some time, possibly carry it to another location, and afterwards forward it to other nodes.

II.ARCHITECTURE OF VEHICULAR DELAY TOLERANT NETWORK

Vehicular Delay-Tolerant Networking (VDTN) [7] appears as novel network architecture based on the concept of DTN, gathering also contributions from the above mentioned vehicular networks. However, VDTN architecture proposes the bundle layer placement under the network layer in order to aggregate incoming IP packets into large IP packets, called data bundles [7]. This approach decreases the number of routing decisions, resulting in less processing and in energy savings. DTN and VDTN layered architectures are illustrated in Fig 1.

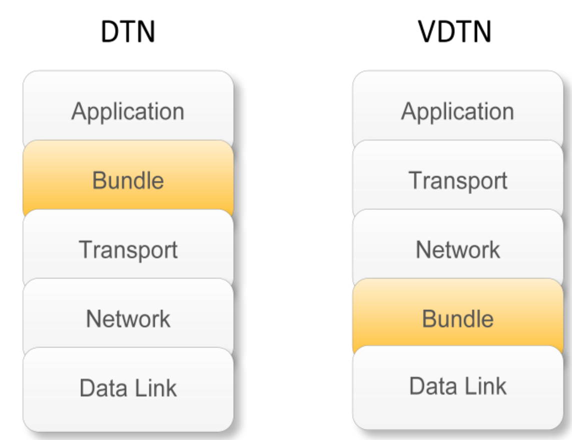

Fig 1. DTN and VDTN layered architectures

The VDTN architecture model is based on the following three node types mentioned in Fig 2. Terminal nodes, mobile nodes, and relay nodes.

Terminal nodes are access points to the VDTN and may be located in isolated regions. They provide the connection to end-users, allowing them to use non-real time applications. At least, one of the *terminal nodes* may have a direct access to the Internet. *Mobile nodes* (e.g., vehicles) are responsible for physically carrying data between *terminal nodes*. *Relay nodes* are fixed devices located at crossroads, with low-power requirements and store-and-forward capabilities. They allow *mobile nodes* that pass by to collect and leave data on them. *Mobile nodes* can also exchange information with one another.

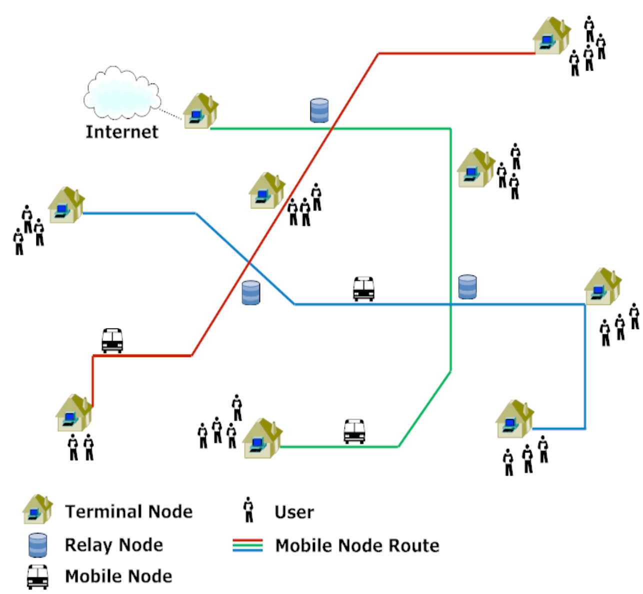

Fig 2. Vehicular Delay- Tolerant Network providing connection on rural and remote regions.

III. ROUTING PROTOCOLS

Routing is one of the important issues in delay tolerant network (DTN).The major objectives of routing in DTN is to deliver packets from the source to the destination by means of mobility of the node. The vehicle delay tolerant network make opportunistic communications by utilizing the mobility of vehicles, the node makes delay tolerant based on the paradigm of "store-carry and forward" to deliver packets to the destination, pick them in one place and deliver them in another. In order to overcome the lack of end-to-end paths, the protocols replicate messages, if necessary, in each contact

Classifications of Routing Protocols

Routing in VDTN can be classified according to several categories:

Flooding or Forwarding

Flooding strategy: In flooding strategy, messages are replicated and forward to more than one node so that destination nodes must receive it so it increases the probability of message delivery to the destination but Flooding based approach increases the contention for network resources like bandwidth and storage, and thus cannot cope with network congestions and does not scale well.

Forwarding-based: In this approaches there are much less wasteful of network resources, as only a single copy of a message is stored in the network at any given time. Knowledge about network is used to select the best path to the destination .This category is also known as knowledge-based

Single copy or multiple copies

Single-copy category maintains a single copy of a bundle in the network that is forwarded between network nodes. Multiple-copy category replicates bundles at contact opportunities.

1)Maypop (MaximumPriority). MaxProp is a routing protocol designed for vehicular DTNs. The MaxProp protocol is based on a store-carry-forward mechanism which is usually utilized in a DTN environment. However, the authors in [8] proposed an algorithm which enables the nodes to assign the priority to the packets. On the basis of the given priorities, each node can decide either to transmit or drop the packet Moreover, the buffer of node is also limited in a real environment. Therefore, to decide the priority of packets in a buffer of nodes is important when performing efficient routing.

2) PBRS (Probabilistic Bundle Relaying Scheme).

The roadside units (RSUs) support communications between vehicles and infrastructures for numerous applications. However, in real environments, RSUs cannot cover all the roadside areas because of the deployment cost. Thus, communications over relaying vehicles are considered one of the solutions to support the uncovered areas by RSUs. So store and-forward techniques for relaying data between RSUs and vehicles. The RSU transmits its data to the incoming vehicles which enter its transmission range. In this case, if an RSU transmits its data to all the vehicles which are passing by it, a lot of replicated packets are generated in the network. Therefore, PBRS [9] proposed a decision-based scheme which makes RSUs determine whether or not to release its data to a vehicle on the basis of certain criterion.

3) ASCF (Adaptive Carry-Store-Forward). ACSF also assumes that RSUs cannot cover all the roadside areas like PBRS. ACSF utilized a store-and-forward technique for relaying data. However, it focused on the outage time of a target vehicle in an uncovered area. In the ACSF scheme, a message forwarding mechanism was proposed for reducing the outage time for vehicles [10].

4) DAWN (Density Adaptive Routing with Node Awareness). The authors of DAWN in [11] assume an urban sensing applications .As shown in Figure 5, there are *N* fixed sensor in roadside, and one base station for data gathering. The sensors are regularly deployed and the base station is located at the center of the network area. The data packets are generated at the sensors, and each packet includes its origin location and generation time .The vehicles and mobile nodes are more like travelling in the random cells. When the vehicles move into new cell they collect the data packet from sensors and store it in its buffer. If two vehicles meet, they replicate their packets to each other.

5) GeoSpray (Geographical Spray in VDTN

GeoSpray adopts the replication approach of the spray-and-wait protocol to limit the number of copies. Initially, it uses a multiple copy scheme, which spreads limited copies of the bundle to exploit diverse paths. Afterwards, it switches to a single-copy forwarding scheme.[12] GeoSpray clears the delivered bundles from vehicles' storage by propagating the delivery information. As a result, it achieves better delivery ratio than GeOpps at the cost of high replication overhead.

CONCLUSION

In this article, we survey about the introduction of Vehicular Delay tolerant network architecture with their supporting features for successful packet delivery. We further define the challenges arise for efficient routing and different strategies with different types of routing protocols for making forwarding decision of message delivery.

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