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2TierCoCS: A two-tier cooperative caching scheme for Internet-based vehicular ad hoc networks

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Abstract

Vehicular Ad hoc Networks (VANETs) are emerging area of mobile ad hoc networks with high speed vehicles as their nodes. Ad hoc communication among vehicles can be used for safety purposes, entertainment and accessing Internet. Though VANETs have received enormous attention in recent years, and emerged in its capabilities, users are still not satisfied with its current performance due to poor data availability and intermittent connectivity. Studies have suggested that massive distributed systems like mobile networks can benefit appreciably by making use of appropriate caching methods. Caching is the process of transparently replicating and locating information for faster access. Cooperative caching can further improve the potential of the caching techniques, which enable coordination and sharing of cached data among multiple nodes. Rapidly changing topology and frequent disconnections makes it difficult to design an efficient caching scheme for caching critical data in VANETs. A two-tier cooperative caching scheme for Internet based vehicular networks is proposed in this paper. A theoretical complexity analysis of algorithms and procedures is also included here.

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Keywords: Ad hoc networking; Vehicular ad hoc networks; Cooperative caching; RSU.

Nomenclature

2TierCoCS	2 Tier Cooperative Caching Scheme for VANET
VANET	Vehicular Ad Hoc Network

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1. Introduction

In recent years, wireless network technologies have emerged to an extent which enable communication between anyone, anywhere at any time without any restriction. Advancement of technology have powerfully combined mobility and network communication and gave rise to more and more wide varieties of interesting applications. Vehicular ad hoc networks (VANETs) is the most recent member of this wireless network family, which has the potential in fostering a wide spectrum of existing applications, such as driving safety, intelligent transport services, mobile Internet access, and file sharing¹. VANETs are a subset of Mobile Ad hoc Networks, which are based on short range communication among vehicles and road infrastructure, deployed with transceivers. VANETs enable spontaneous exchange of information between vehicles, within their radio range, and with fixed gateways along the road. In VANETs, every node within the network coverage can move freely and they can also stay connected. As in mobile ad hoc networks (MANETs), nodes in VANETs have the self-organizing and decentralized properties. These properties enable them to detect the presence of other nodes, and perform necessary set up to facilitate, communication and sharing of data and service without any centralized administration. Basic architecture of VANET consist of mainly two components; On-Board Units (OBUs) and Road Side Units (RSUs). OBUs are sensors integrated in vehicle to enable short-range wireless communication and thus forming ad hoc networks among vehicles. OBUs are accompanied with GPS units to enable reliable navigation. RSUs acts as relays at the roadside to increase the coverage, and to make the communication robust. RSUs have the capacity to collect, store, and process data, and act as gateways to the Internet. VANETs are characterized by their unique characteristics that distinguish them from MANET. These special characteristics can be summarized as follows:

- High mobility and Rapid topology change
- Predictable and restricted mobility
- No power constraints
- Localization using GPS
- Dense network
- Hard delay constraints

Frequently changing neighbourhood, increasing channel load, irregular connectivity and high rate of packet loss are the main challenges in VANETs caused by aforesaid characteristics. Since all these issues make 'robust data transmission' hard to achieve, efficient algorithms have to be developed for routing and data communication². Research works are being done in the area of routing, than in the methods for improving data availability. Hence it is wise to concentrate on the issues in improving data availability. In mobile networks, data availability is very less due to frequent network partition when compared to that of traditional wired networks. Caching is a good solution to the problems that cause poor data availability.

The word meaning of caching is "store away for future use". Caching is just the practice of storing data in and retrieving data from that storage explicitly or implicitly. Caching of frequently accessed data on the client side is an effective technique for improving performance in a mobile environment. This is required in networks because it can reduce traffic and spread the load of overloaded origin servers to client caches. Average data access latency is reduced, since several data access requests can be satisfied from the local cache and thereby obviating the need for data transmission over the scarce wireless links³. Objective of this work is to create a cooperative caching system for VANETs. This minimizes the delay and maximizes the likely-hood of finding the consistent data, which is cached in the network, all without inducing excessively large traffic at the nodes. Cooperative caching allows the local nodes to act as surrogate data centers and permit neighbouring nodes to share their cached contents. This can reduce the access delay which is caused by accessing data from distant data centers and also reduce bandwidth utilization. These local caches can serve data requests without forwarding them to original data center. Likely-hood of finding data can be improved by caching maximum distinct data in the near neighbours. Consistency of data means cached data items should be similar to that of original data server. A number of cache consistency methods have been proposed in the area of MANETs, which can be used in the area of VANETs with sufficient modifications. All these should be achieved without inducing excessive large traffic at the nodes. Here a two-tier cooperative caching scheme for VANETs is proposed. This two-tier cooperative caching scheme for VANETs, which is referred as 2TierCoCs, which

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