# Towards Intelligent Caching and Retrieval Mechanisms for Upcoming Proposals on Vehicular Delay-Tolerant Networks

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***Abstract*: Vehicular delay-tolerant networks (VDTNs) are opportunistic networks that enable connectivity in challenged scenarios with unstable links where end-to-end communications may not exist. VDTN architecture handles non-real time applications using vehicles to relay messages between network nodes. To address the problem of intermittent connectivity, network nodes store messages on their buffers, carrying them through the network while waiting for transfer opportunities. The storage capacity of the nodes affects directly the network performance. Therefore, it is important to incorporate suitable network protocols using self-contained messages to improve communication that supports store-carry-and-forward operation procedures. Clearly, such procedures motivate content caching and retrieval. This paper surveys the state-of-the art on intelligent caching and retrieval mechanisms focusing on ad-hoc and delay tolerant networks (DTN). These approaches can offer important insights for upcoming proposals on intelligent caching and retrieval mechanisms for VDTNs.**

**Index terms: Vehicular Delay-Tolerant Networks; Delay-Tolerant Networks; Vehicular Ad-Hoc Networks; Mobile Ad-Hoc Networks; Caching, Web-caching**

## I. INTRODUCTION

Mobile ad-hoc networks (MANETs) [1] are autonomous ad-hoc networks where mobile hosts are connected by multi-hop wireless links. MANETs do not rely on common network infrastructures and services since nodes perform all the networking functions [2]. Typical applications of MANET include rescue operations [3], military scenarios [4], and in cases where is impossible to establish a wired backbone [5]. This communication technology can also be used for extending the coverage of current wireless networks. Vehicular ad-hoc networks (VANETs) [6] are considered a subset of MANETs and are presented as an important component of intelligent transportation systems (ITS) [7].

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The key differences between MANETS and VANETs are the nodes mobility that can be anticipated due to the roads and traffic signalization (traffic lights) and also the rapid changes on the network topology taking into account vehicles velocity and movement [8]. Vehicles provide all network services relaying data between them. VANET networks can also include "infostations" that are wireless access points placed on the roadside. Infostations may be used to provide connectivity to the Internet for passing by vehicles. Then, vehicles can be exploited to propagate and deliver data across the network [9, 10]. Those data may include information about accident notifications, road conditions warnings and also Internet connectivity for several applications [11, 12] such as, electronic mail, Web browsing, audio and video streaming, among others. VANETs enable several other applications such as notification of traffic condition, advertisements [9], and cooperative collision avoidance [13].

VANETs are characterized by high mobility of vehicles, which is responsible for a highly dynamic network topology and to short contact durations. Moreover, limited transmission ranges, physical obstacles, and interferences lead to disruption, intermittent connectivity, and partition. Conventional routing protocols proposed for VANETs assume end-to-end connectivity. Thus, they were not designed to handle conditions caused by network disconnection, partitions, or long delays [14-17]. To answer these challenging connectivity problems, delay tolerant network (DTN) architectural concepts can be used [18].

DTNs are presented as a solution to challenged environments characterized by any or all of the following characteristics: intermittent connectivity, long and/or variable delay, asymmetric data rates, high error rates, and even no end-to-end connectivity [19]. DTNs introduce store-carry-and-forward functions by overlaying a bundle protocol layer above the transport layer, which provides internetworking on heterogeneous networks (regions) operating on different transmission media. The bundle protocol [20] is end-to-end, strongly asynchronous, message (i.e., bundle) oriented. The store-carry-and-forward paradigm avoids the need for constant connectivity. The idea behind it is to exploit node mobility to physically carry data between disconnected parts of the network. This approach circumvents the lack of an end-to-end path, enabling non real time (i.e., delay-tolerant) applications. [21]. DTNs have been applied to various scenarios such as

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